ATRIAL FIBRILLATION 2015
Catheter Ablation with New Technologies

David J Wilber MD
Loyola University of Chicago
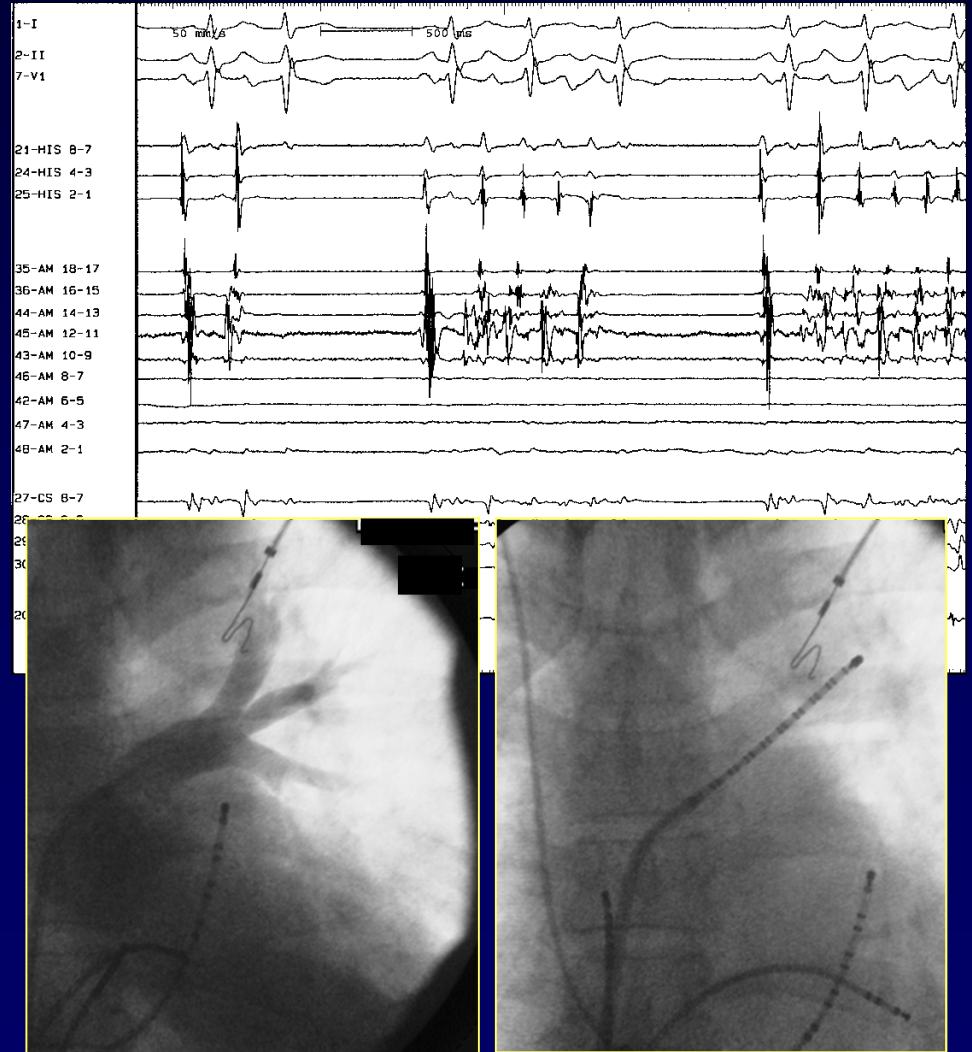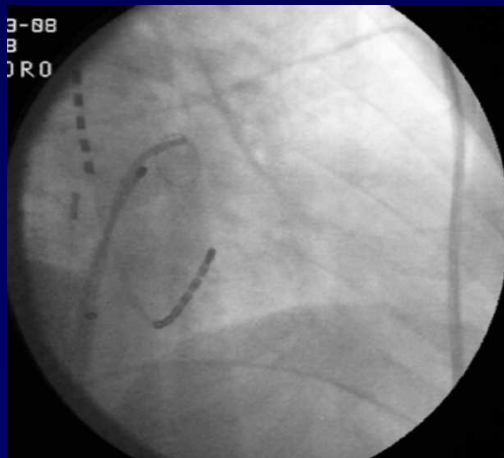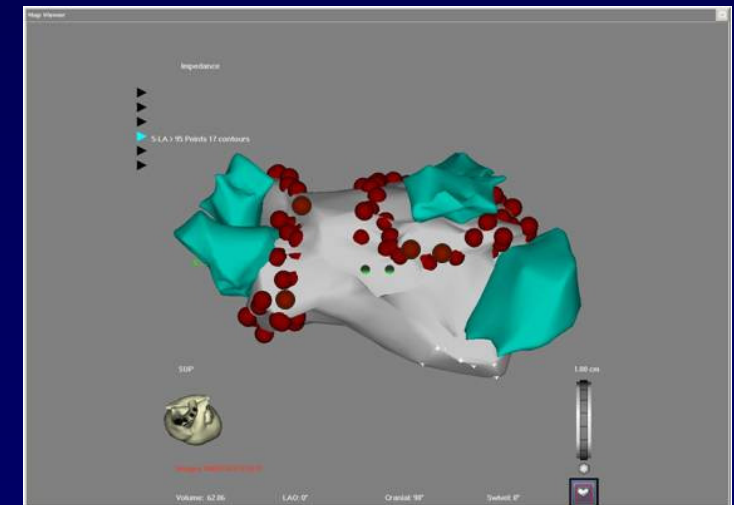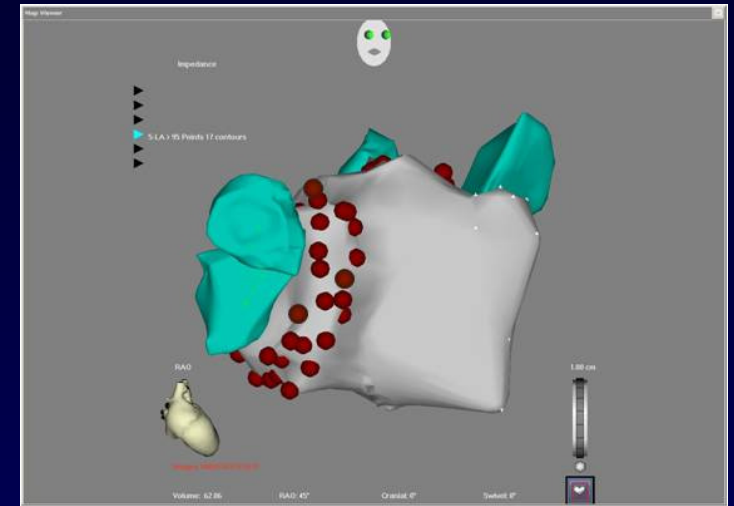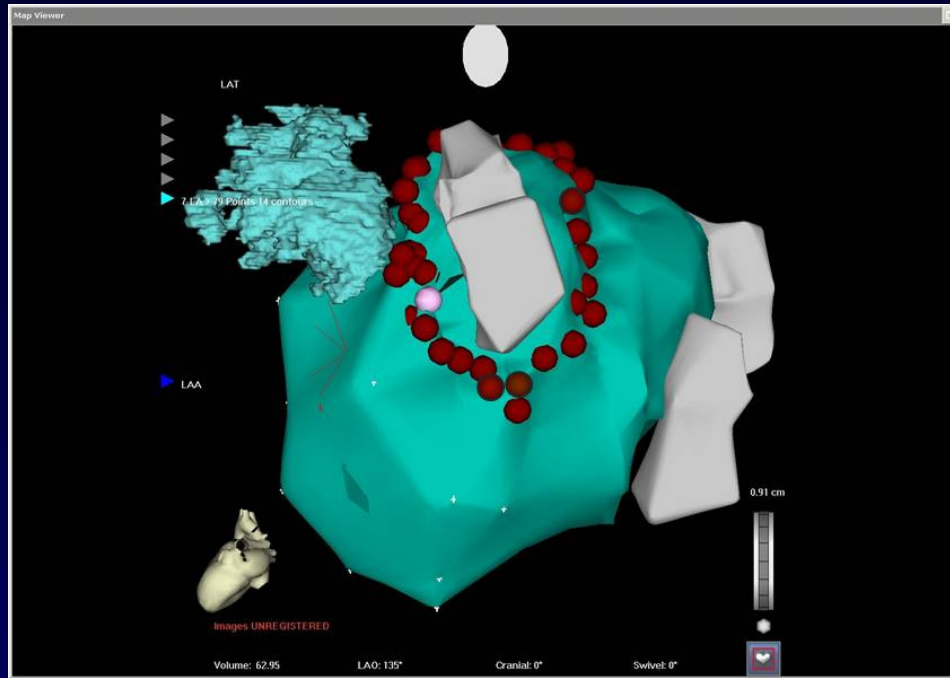
INITIAL SUBSTRATE FOR AF
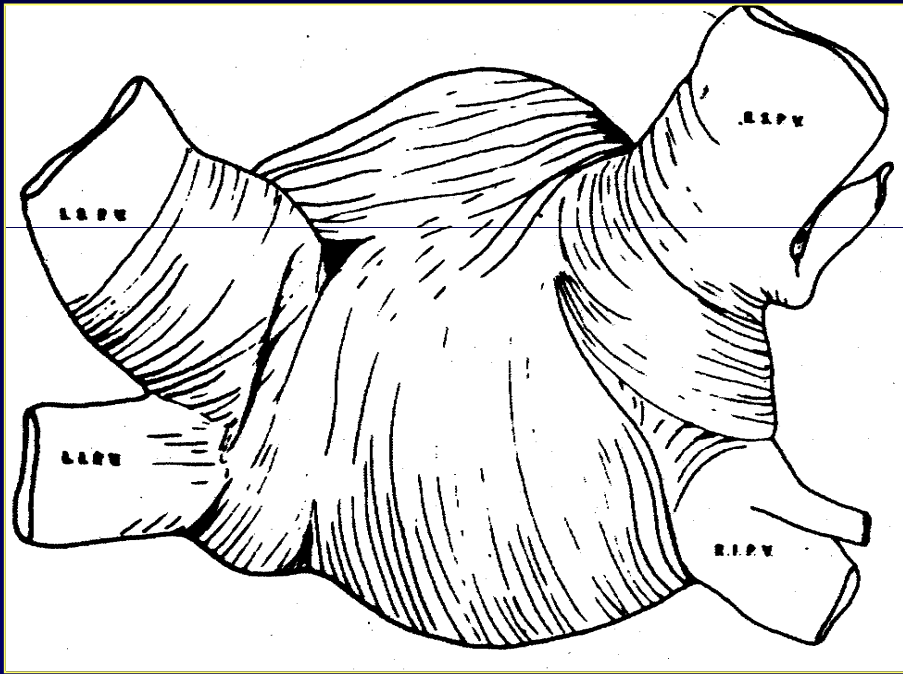
Nathan and Eliakim; Circulation 1966; 34:412

ABLATION OF PAROXYSMAL AF

NON PV TRIGGERS FOR AF

- Supraventricular tachycardia (up to 4%)
- Superior vena cava (3-12%)
- Crista terminalis and eustachian ridge
- Posterior left atrium
- Coronary sinus
- Ligament of Marshall
- AV valve annuli
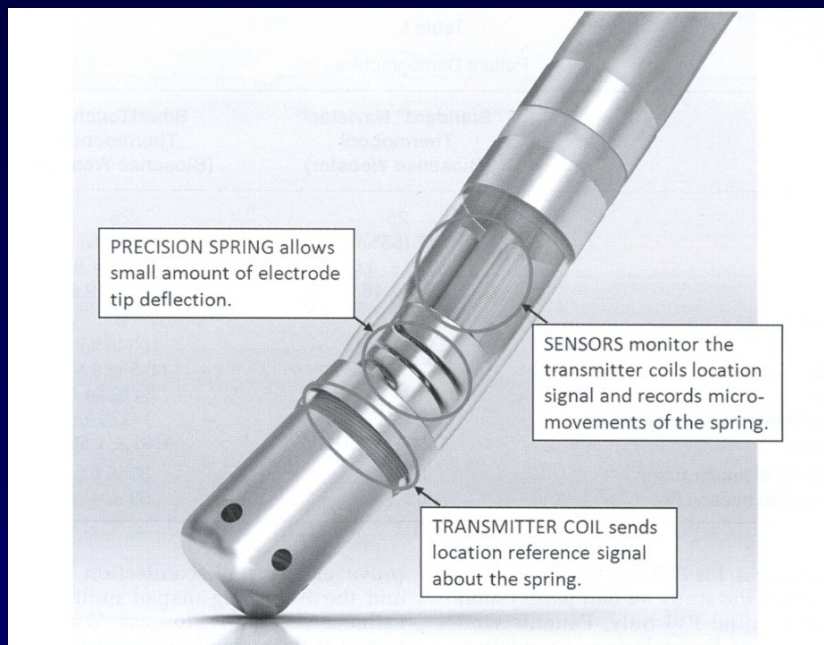
LONG – TERM OUTCOME (PAF)
Circumferential / Antral PV Isolation

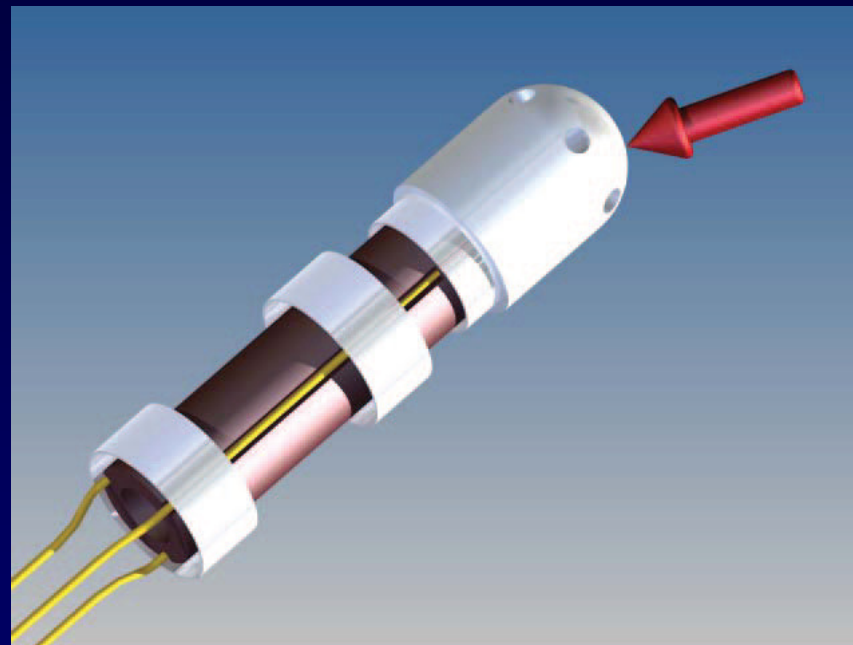|	N	Enrollment	Single Procedure SUCCESS No R, no AAD	% redo (% of all Recur)	Redo SUCCESS	FINAL SUCCESS (AAD + redo)
Wokhlu 2010	428	1999-2006	62%	15% (70%)	50%	85%
Miyazaki 2010	452	2003-2008	67% (at 5 yrs)	26% (85%)	84%	93%
Ouyang 2010	161	2003-2004	45% (at 5 yrs)	41% (77%)	80%	80%
Medi 2011	100	2003-2008	49% (at 5 yrs)	22% (59%)	86%	82%
Hussein 2011	575	2005	73%	23% (69%)	80%	80%
Pappone 2011	99	2005	73%	27% (100%)	70%	91%

POTENTIAL UTILITY OF CATHETER-BASED CFS

- Production of durable transmural lesions remains a major limitation in providing optimal long-term clinical outcomes with AF ablation.

- The quality of electrode tip – tissue contact, in addition to applied power and duration, is an important determinant of final RF lesion size

- In absence of direct force measurement, assessment of tissue contact requires reliance on indirect indices including visual assessment, electrode temperature, electrogram amplitude, and impedance.

- Prediction of complications, many potentially related to excessive contact force (thrombus formation, steam pops, perforation), remains problematic
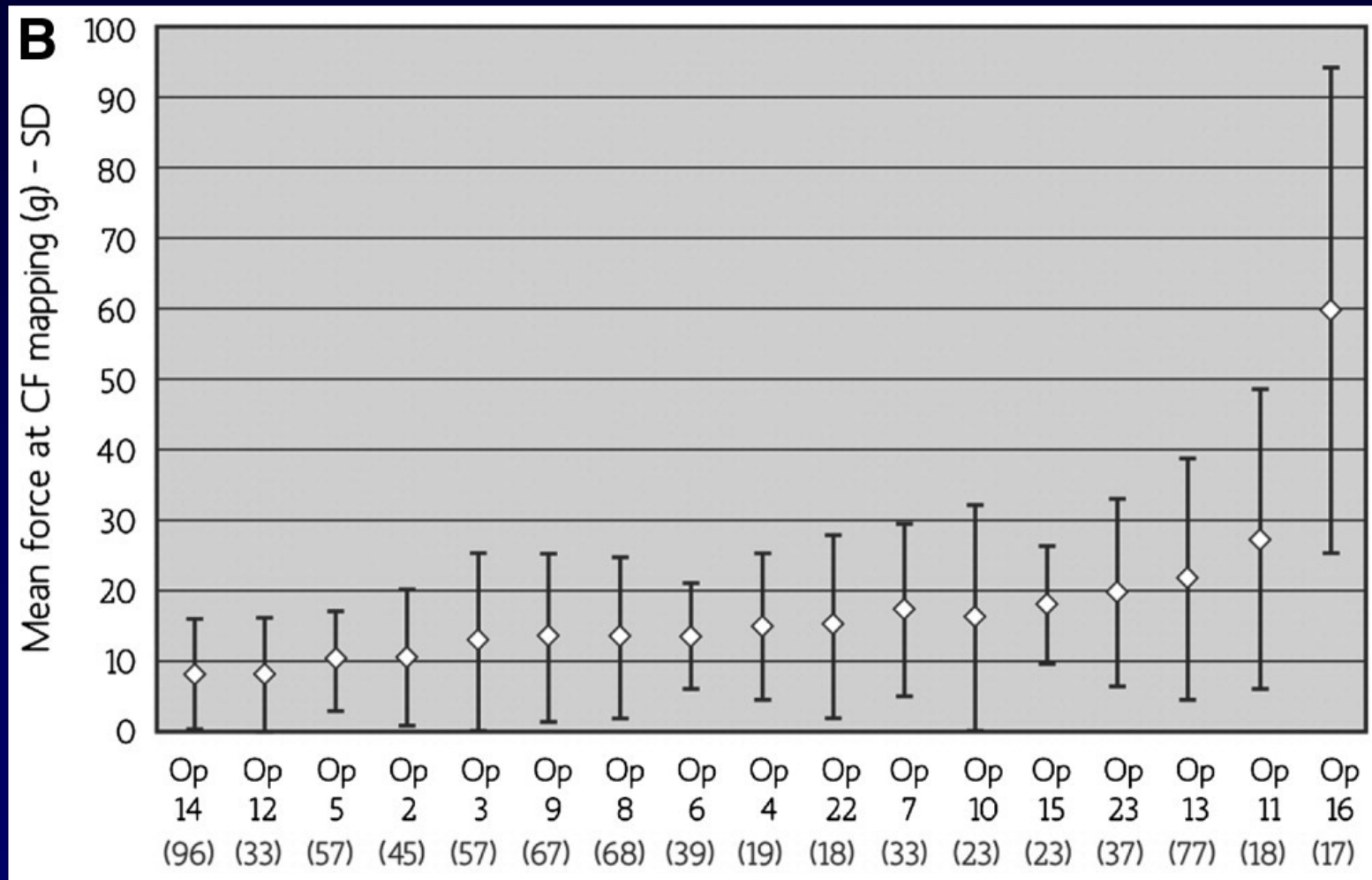
CONTACT FORCE SENSING: CURRENT TECHNOLOGY

PRECISION SPRING allows small amount of electrode tip deflection.

SENSORS monitor the transmitter coils location signal and records micro-movements of the spring.

TRANSMITTER COIL sends location reference signal about the spring.

EM Location Sensor
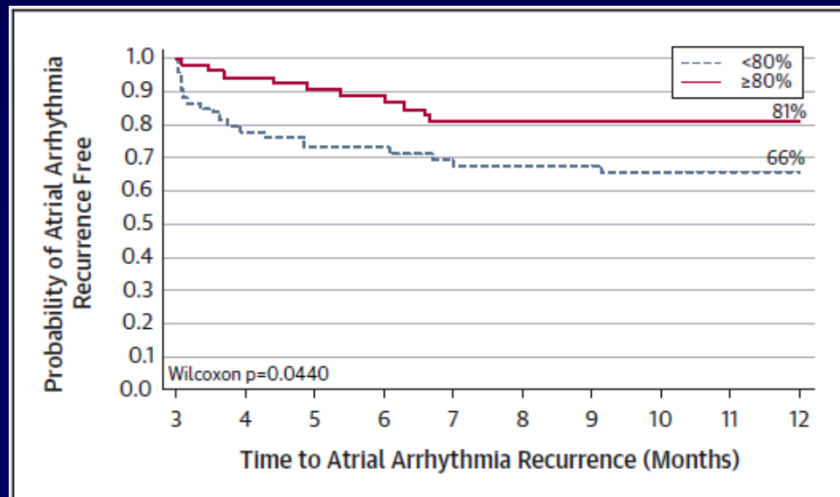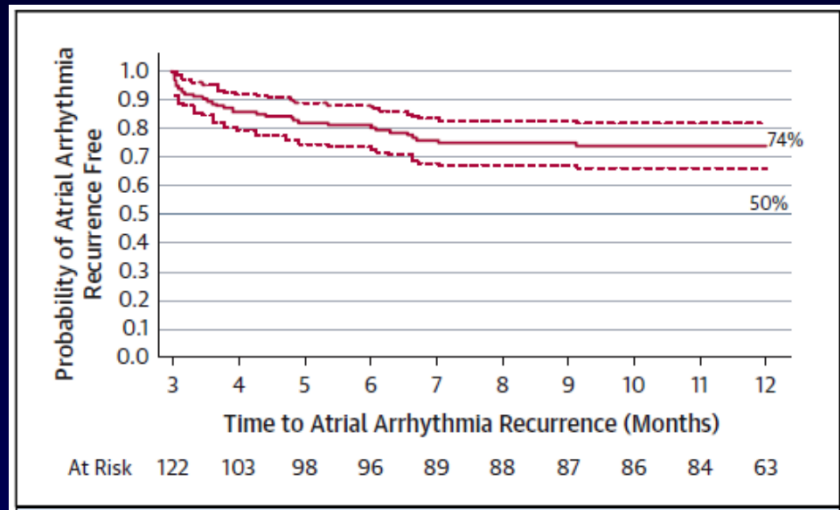SmartTouch

Optical Sensor
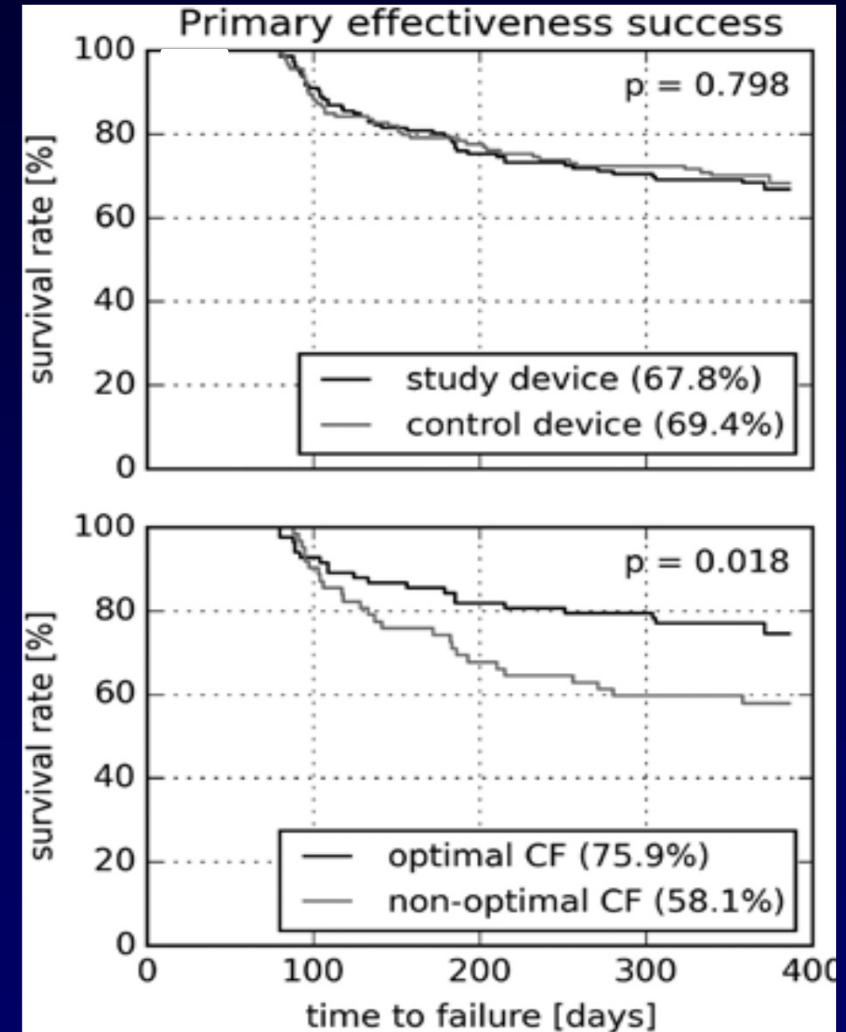TactiCath

CFS: INITIAL CLINICAL EXPERIENCE

Kuck et al, Heart Rhythm 2012; 9:18-23

CLINICAL TRIALS OF CFS

SMARTTOUCH JACC 2014; 64-:647-56

TACTICATH Circulation 2015;132:907-15

Has CFS been optimized?

- Learning curve
- Optimal contact force still poorly defined
  - Threshold value for effective durable lesion
  - Excess force and edema
- Other factors
  - Position stability, duration, and applied force
  - Tissue factors (variable thickness, prior edema)
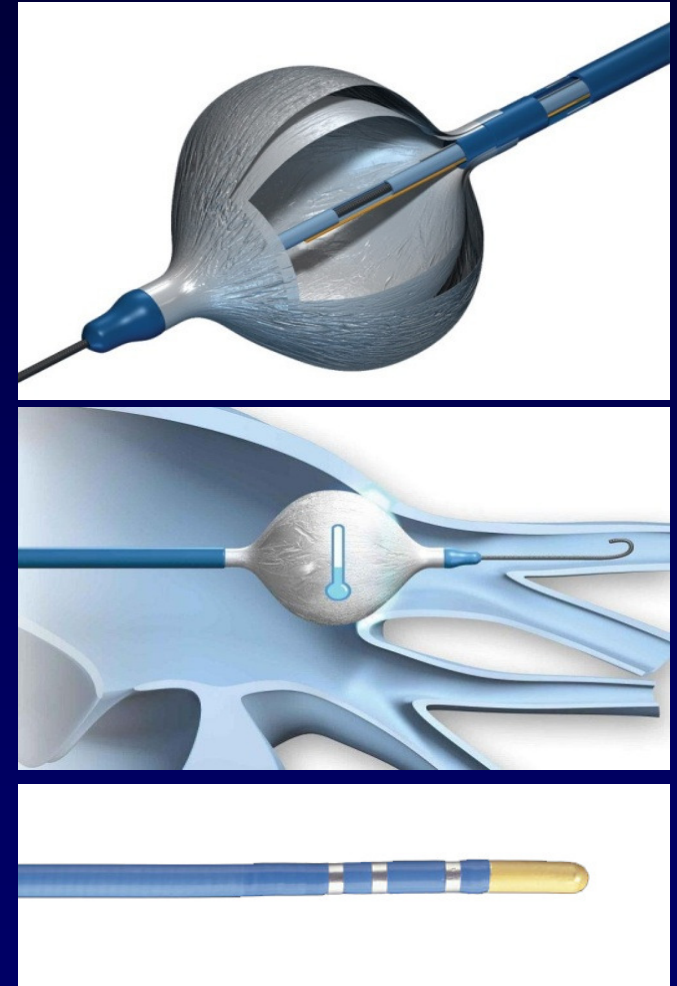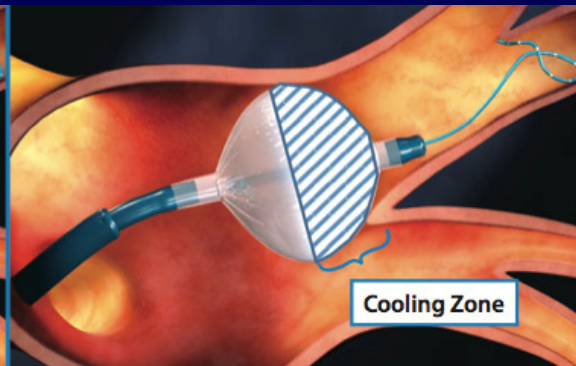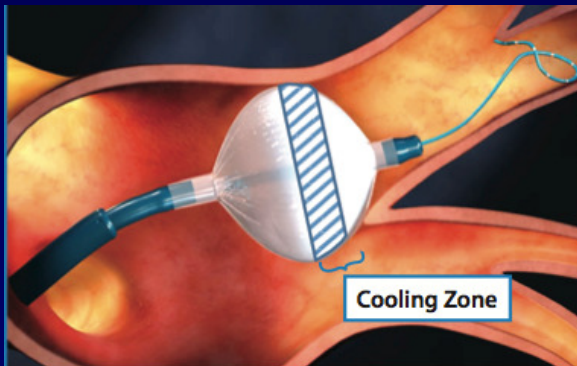
CRYOABLATION FOR PAF
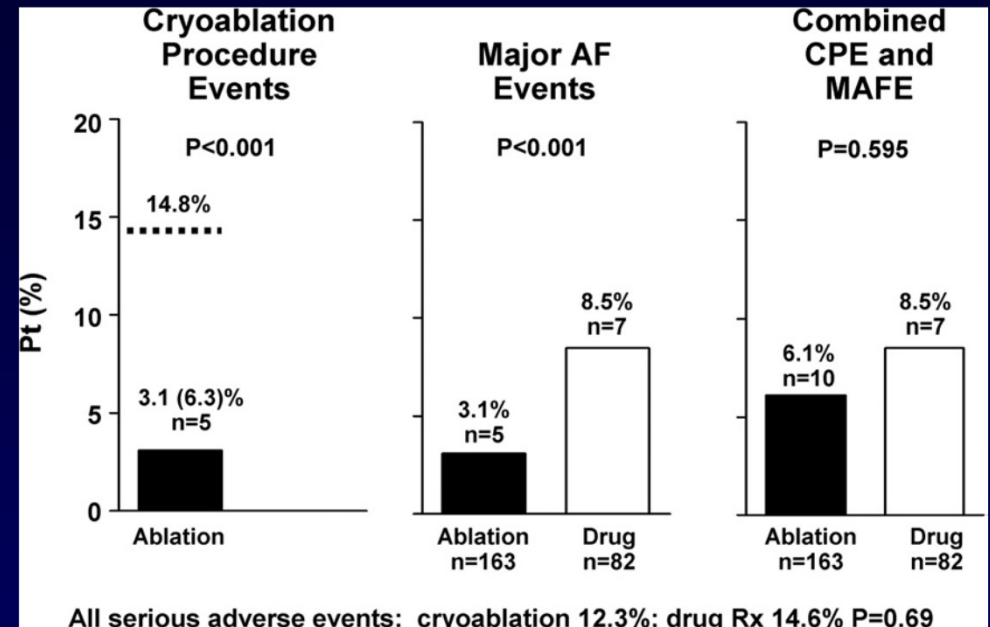
Cryoballoon sizes   23 and 28 mm

Structure   Double balloon

Cooling (in balloon)   Liquid → gas transition

STOP-AF Trial
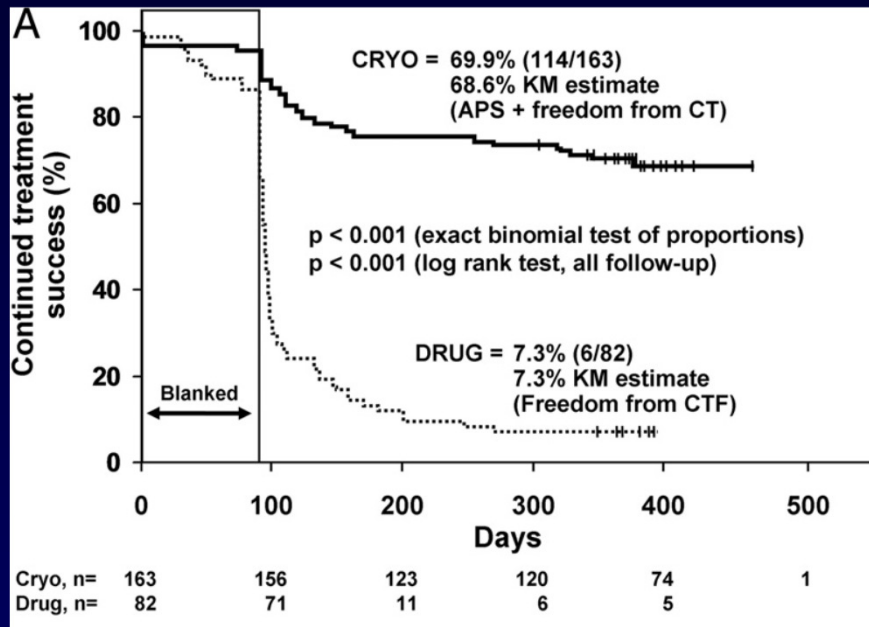
- In ablation group
  - 19% redo in blanking period
  - 8% on AAD therapy
- In control group
  - 65 pts (79%) had ablation at median 6 mo

- 22 pts (13.5%) with PNP, persistent at 12 mo in 4 (2.5%)
- 5 pts (3.1%) PV stenosis (> 75% area)
- 7 pts stroke / TIA (4.3%)

Packer et al JACC 2013; 61:1713-1723

METAANALYSIS: CRYOBALLOON vs RF

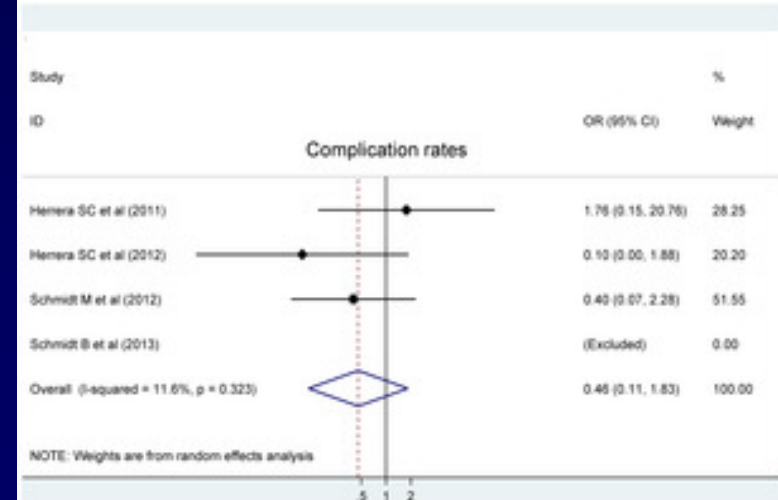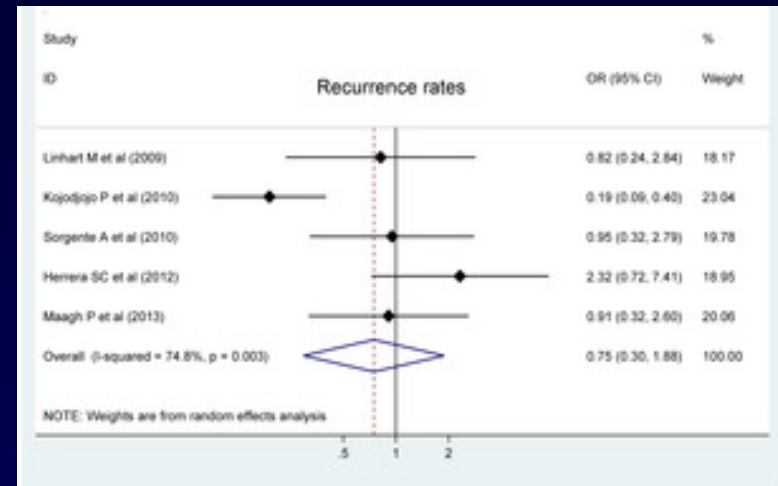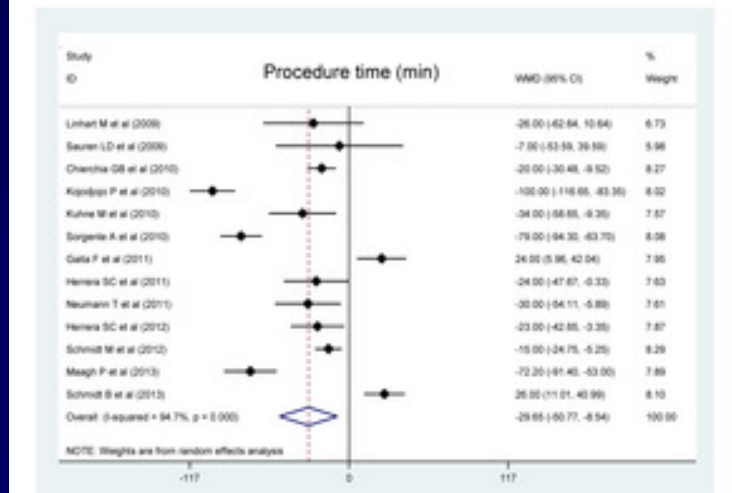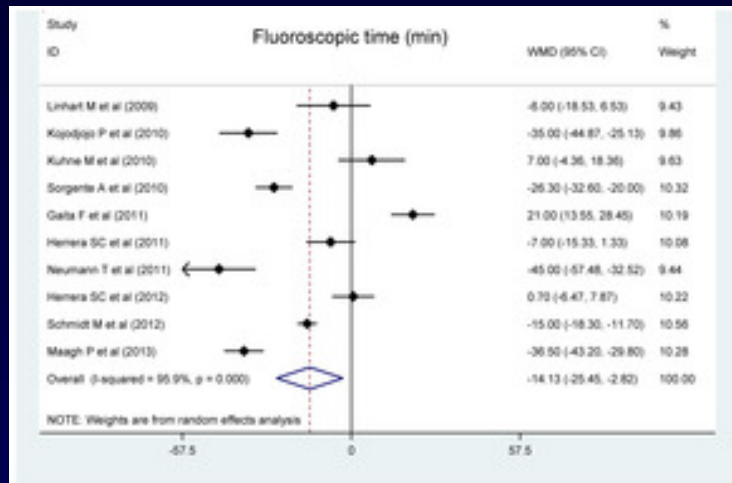# VISUALLY GUIDED LASER BALLOON
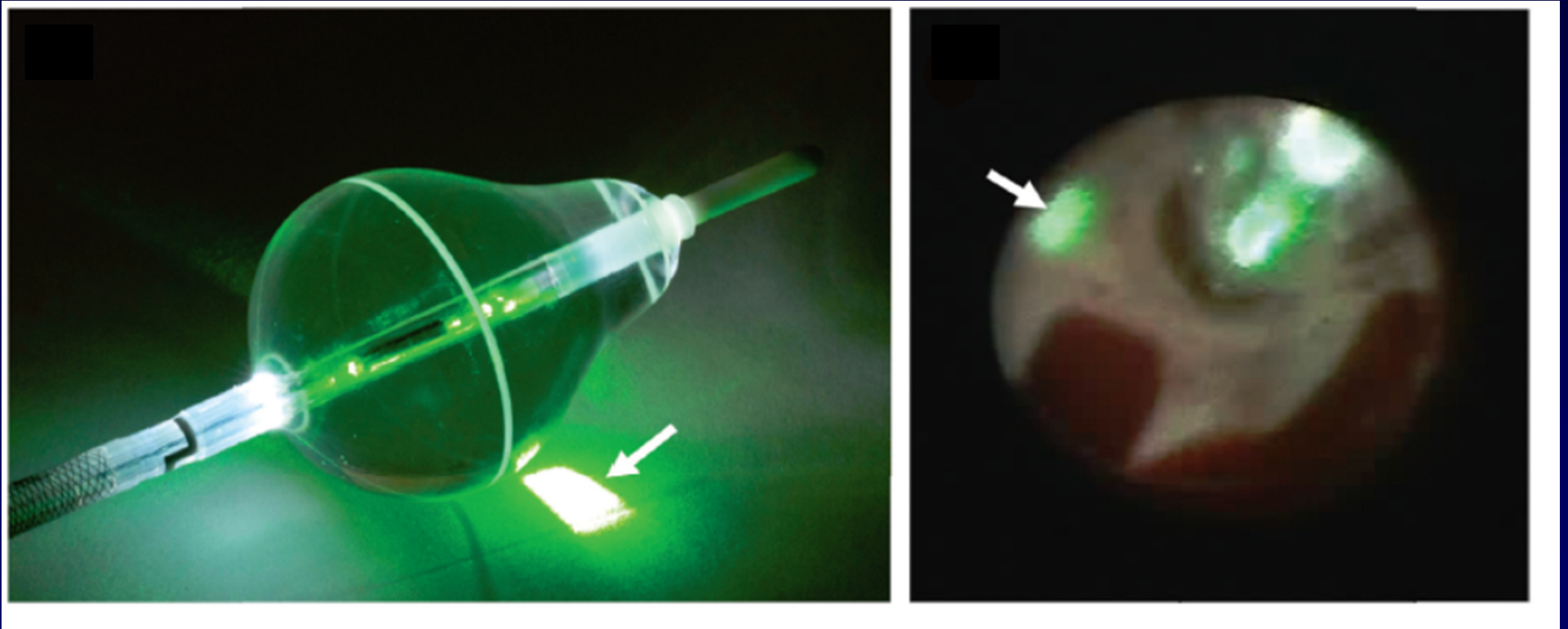
RANDOMIZED TRIAL OF VGLB vs RF

- 178 pts VGLB vs 175 pts irrigated RF
- longer fluoro, procedure times for VGLB
- Learning curve for VGLB
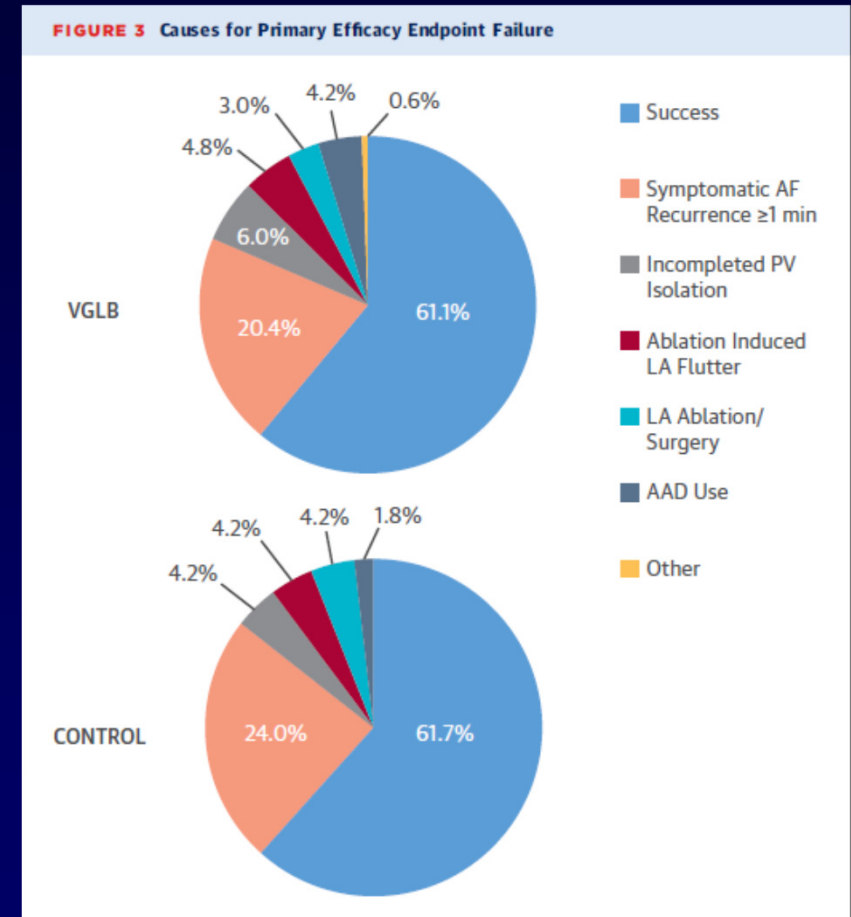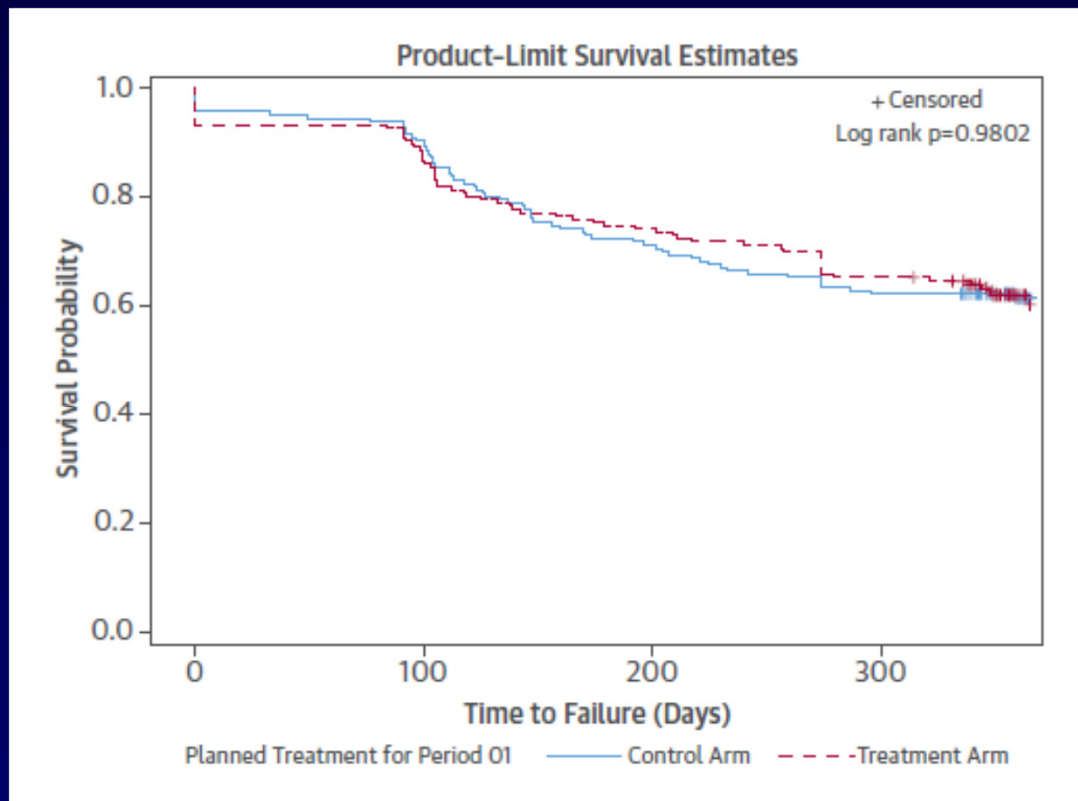
Dukkipati et al, JACC 2015; 66:1350-60

CIRCUMFERENTIAL RF ABLATION

PVAC PHASED ARRAY
CIRCUMFERENTIAL RF
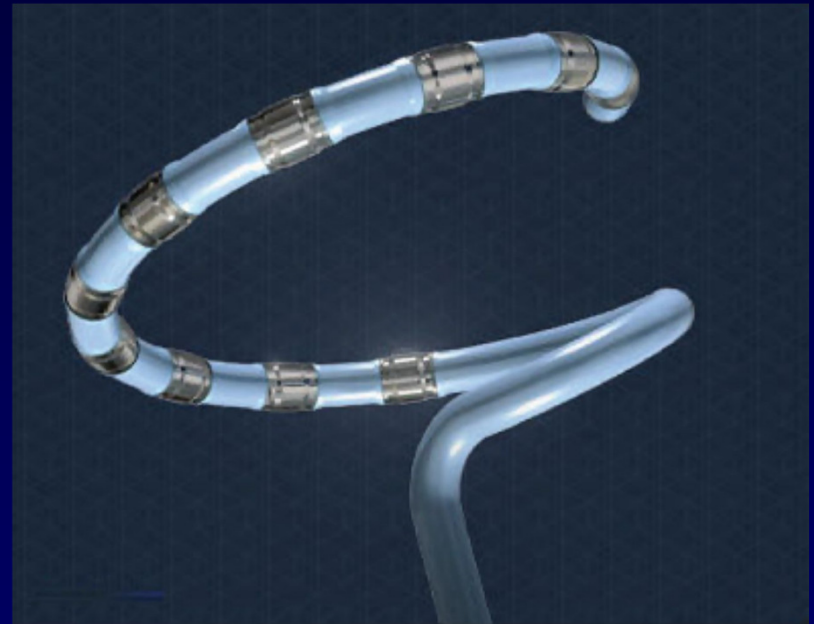
nMARQ MULTIPOLAR CATHETER

OUTCOMES OF VARIOUS ABLATION STRATEGIES FOR PERSISTENT/LONG-STANDING PERSISTENT AF
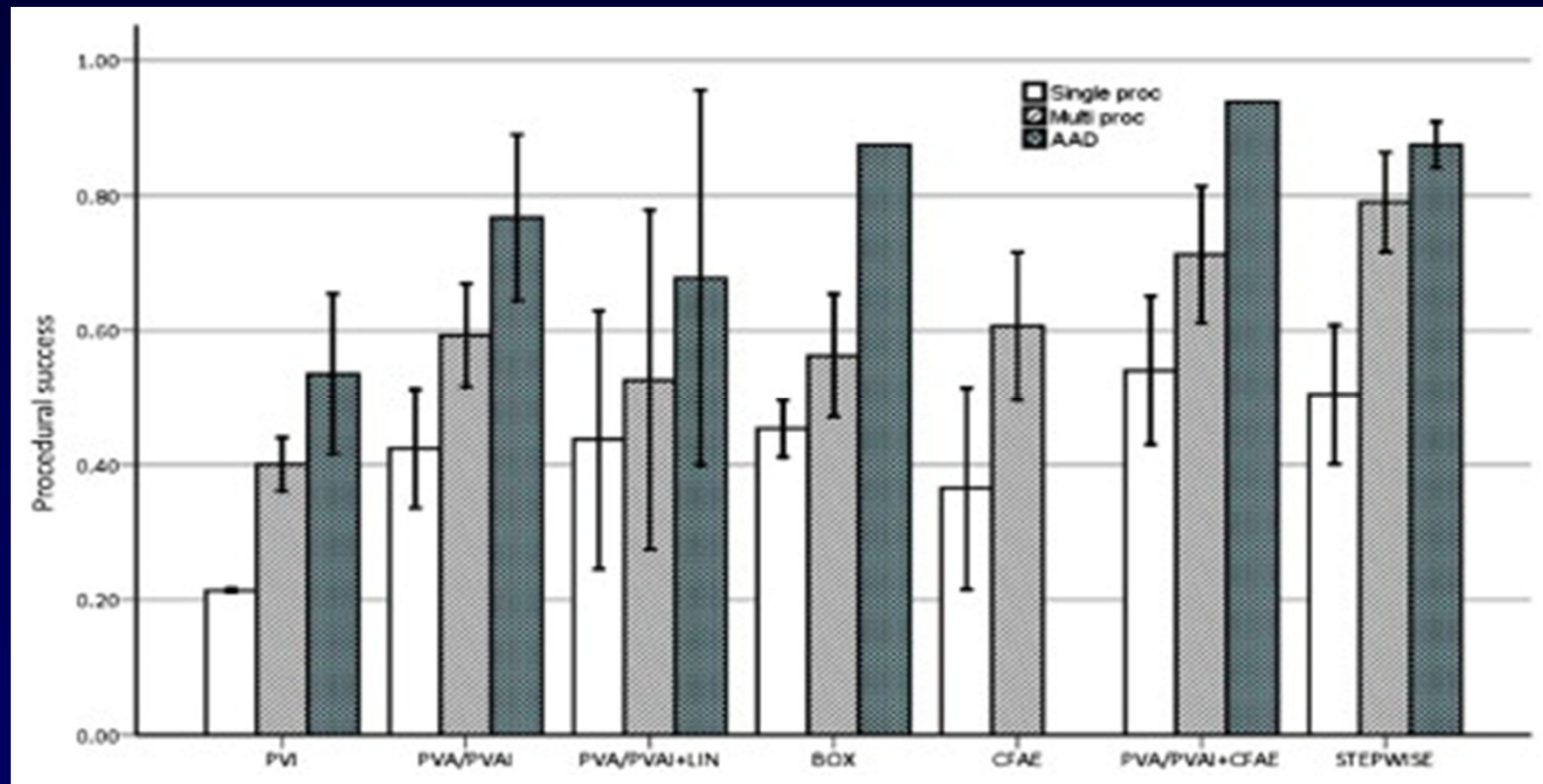
- 32 studies of LSP or mixed P/LSP AF published to 6/2009
- 30-60% redo rate, mean follow-up 1-2 yrs

Brooks et al Heart Rhythm 2010; 7:835-846

STAR AF 2

- 589 pts randomized between 2010-2012 in 1:4:4 ratio to
  - Antral PVI alone (n=67)
  - PVI + EGM (n=263)
  - PVI + LA lines (n=259)
- Entry criteria
  - Symptomatic persistent AF
    - > 7 day episodes up to 3 yrs continuous AF (75% > 6 mo)
    - Failed > 1 AAD trial
  - Age $\geq$ 18
  - LA diameter $\leq$ 60 mm
- Primary endpoint: recurrent AF > 30 sec after single procedure and 3 mo blanking during 18 mo follow-up
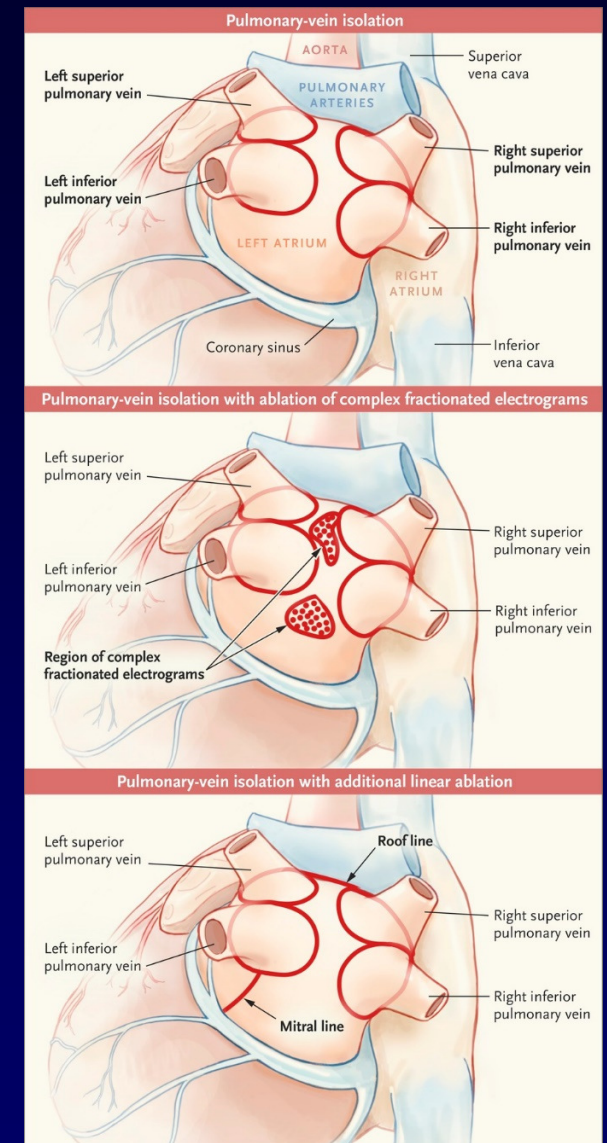
Verma et al. N Engl J Med 2015;372:1812-1822

STAR AF 2: Primary Endpoint

* 12% of pts without recurrent AF on AAD at end of follow-up

SECONDARY ENDPOINTS

AF Burden

- Pulmonary vein isolation
- Isolation + Electrograms
- Isolation + Lines

(AF burden % chart: BASELINE, 3 MONTH, 6 MONTH, 9 MONTH, 12 MONTH, 18 MONTH)

Table 2. Major Efficacy Outcomes.

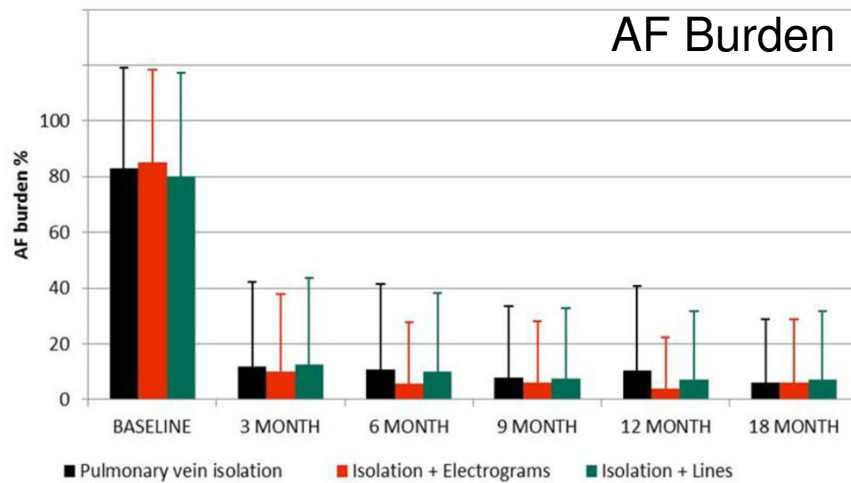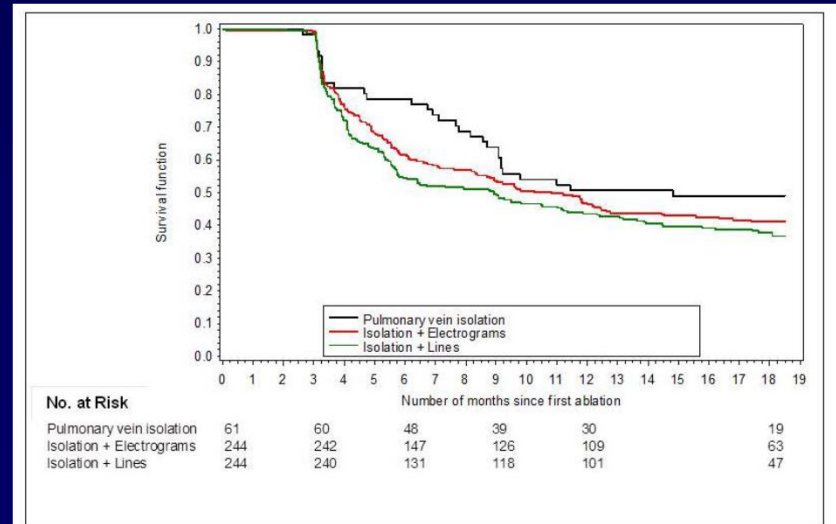| Variable	Isolation Alone (N = 61)	Isolation plus Electrograms (N = 244)	Isolation plus Lines (N = 244)	P Value
	number (percent)			
Freedom from documented atrial fibrillation after one procedure, with or without antiarrhythmic drugs	36 (59)	119 (49)	112 (46)	0.15
Freedom from documented atrial fibrillation after one procedure, without antiarrhythmic drugs*	29 (48)	90 (37)	81 (33)	0.11
Freedom from documented atrial arrhythmia after one procedure, with or without antiarrhythmic drugs	30 (49)	100 (41)	90 (37)	0.15
Freedom from documented atrial arrhythmia after one procedure, without antiarrhythmic drugs*	25 (41)	81 (33)	71 (29)	0.08
Freedom from documented atrial fibrillation after two procedures, with or without antiarrhythmic drugs	44 (72)	146 (60)	142 (58)	0.18
Freedom from documented atrial arrhythmia after two procedures, with or without antiarrhythmic drugs	37 (61)	122 (50)	117 (48)	0.24
Documented atrial flutter or tachycardia after one procedure, with or without antiarrhythmic drugs	7 (11)	27 (11)	34 (14)	0.57
Documented atrial flutter or tachycardia after two procedures, with or without antiarrhythmic drugs	7 (11)	32 (13)	29 (12)	0.98
Patients undergoing a second ablation procedure	13 (21)	63 (26)	81 (33)	0.10

Multiple Procedure Outcome

(Survival function plot vs Number of months since first ablation)

- Pulmonary vein isolation
- Isolation + Electrograms
- Isolation + Lines

No. at Risk

|						
Pulmonary vein isolation	61	60	48	39	30	19
Isolation + Electrograms	244	242	147	126	109	63
Isolation + Lines	244	240	131	118	101	47

MECHANISM BASED ABLATION?

- ## Multiwavelet hypothesis
  - AF is maintained by reentrant self perpetuating wavelets that propagate randomly through heterogeneous atrial tissue. AF is sustained as long as an adequate number of wavelets propagate simultaneously.

- ## Focal Source hypothesis:
  - AF is maintained by a relatively small number of repetitive focal sources (rotors or focal impulses) that produce disorganized global activation when rapid impulses cannot be uniformly propagated

Focal Impulse and Rotor Modulation (FIRM)

- 64 electrode basket catheter in both RA and LA

- 30 pts with persistent AF, 19 PAF

- Contact unipolar EGMs obtained during AF preprocessed to remove QRS and improve signal-to-noise ratio. Signals at each site analyzed by novel software to define physiologically plausible propagation pathways based on previously defined APD and conduction restitution characteristics

- Movies of isopotential maps analyzed to define activation around (rotor) or from (focal impluse) AF sources that are sustained over 50-100 cycles

- Focal sources in 96% of pts, more frequent in persistent AF (2.1$\pm$1) than PAF (1.5$\pm$0.8, p=0.017), 27% in RA, rotors more common (84%)

- Spatial and temporal stability in multiple samples over many minutes
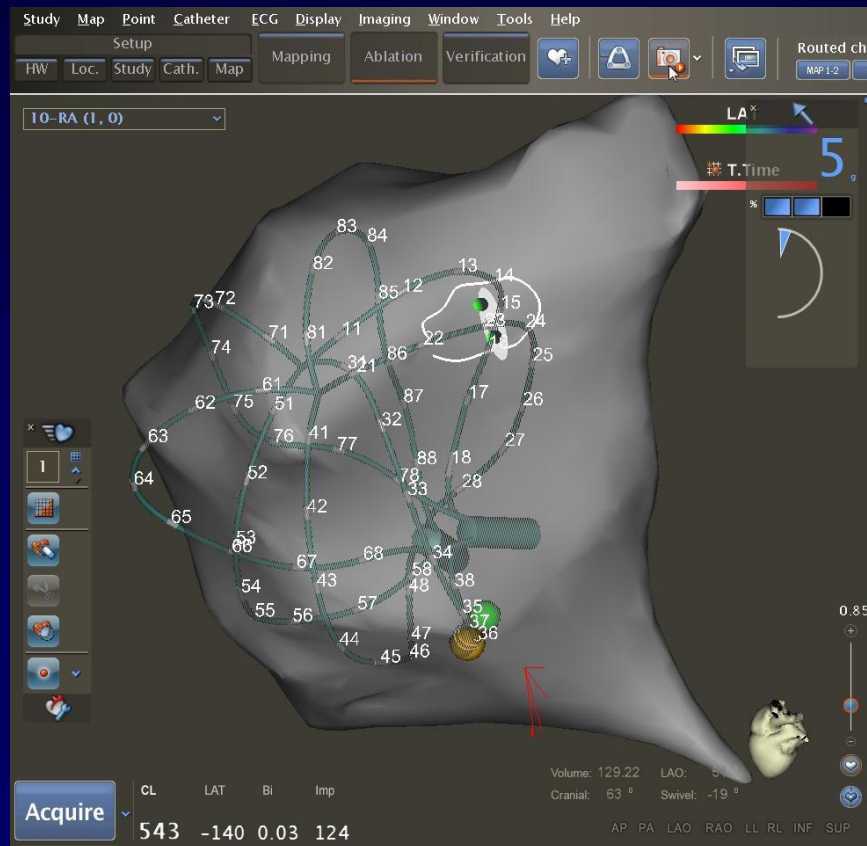
Narayan et al, JCVE 2012 23:447-454
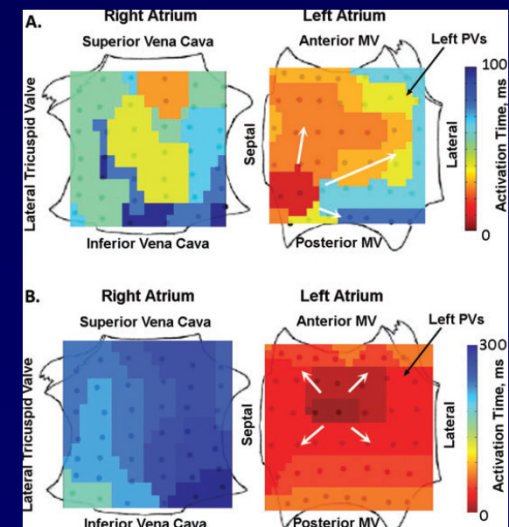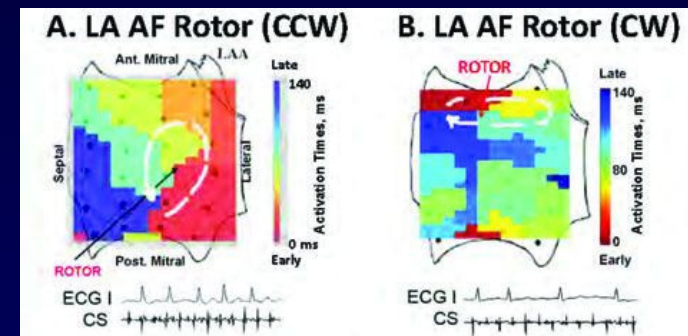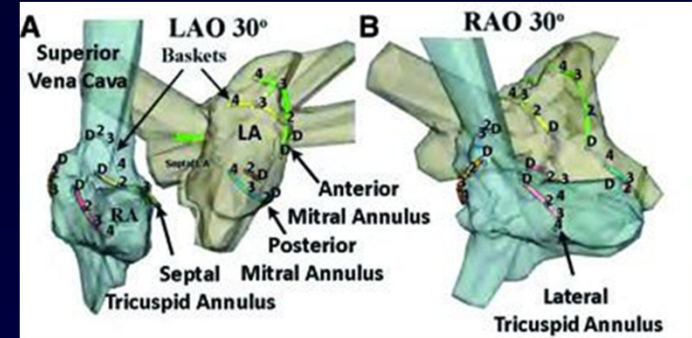
ROTOR RECOGNITION
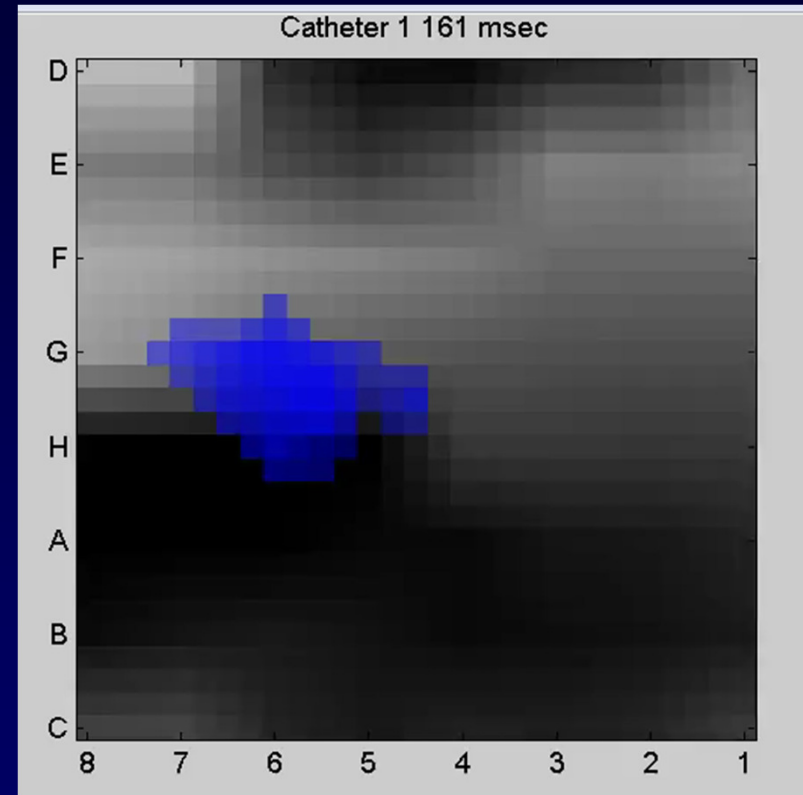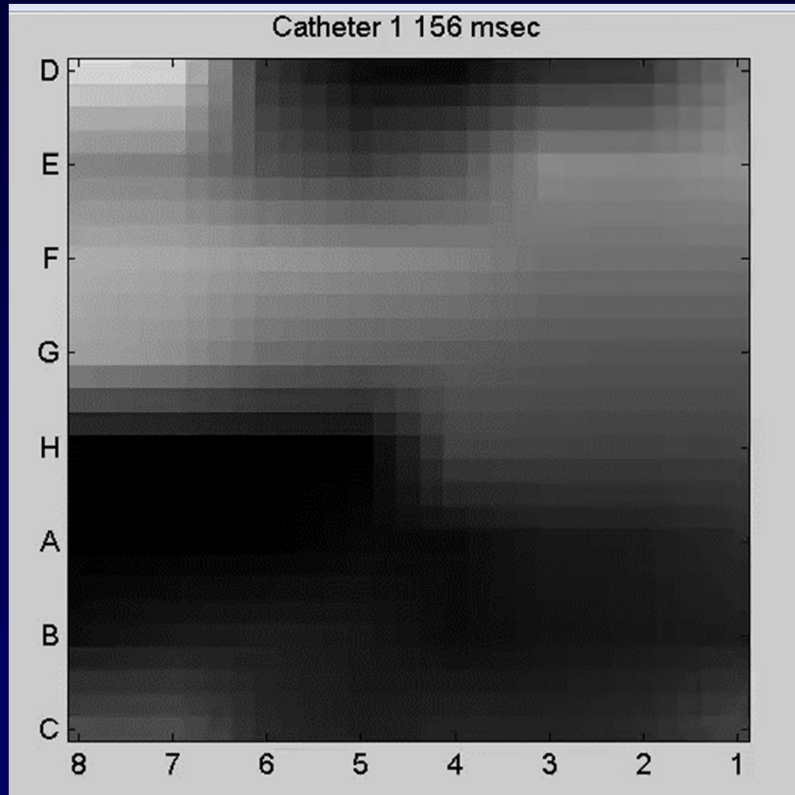
CORE PROJECTION ON ATRIAL SURFACE GEOMETRY

- Rotate image to place electrodes of interest perpendicular to image plane

- End expiration or respiratory gated mode

CONFIRM TRIAL

- FIRM mapping in 107 pts
- Nonrandomized comparison
  - FIRM guided, then conventional (N=36)
  - FIRM blinded, conventional only (N=71)
- Localized rotors or focal impulses found in 97% of pts
  - 2.1±1.0/pt
  - 70% rotors
- Acute endpoint (guided vs blinded)
  - Termination: 56% vs 9% (median 2.5 min)
  - CL prolongation > 10%: 31% vs 11%
  - Usually to AF rather than AT
- Total RF similar (mean 58 vs 52 min)
- Some imbalances between groups, FIRM guided ablation had
  - More persistent AF (81% vs 66%)
  - More prior ablation (42% vs 25%)
  - More post ablation AAD (79% vs 36%)
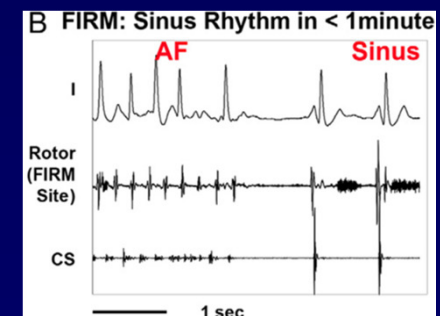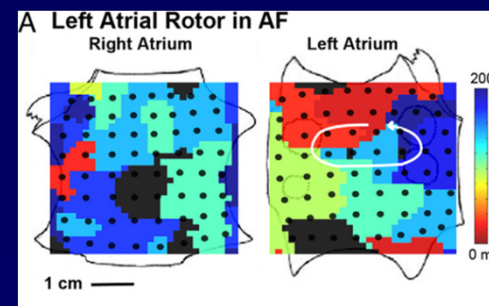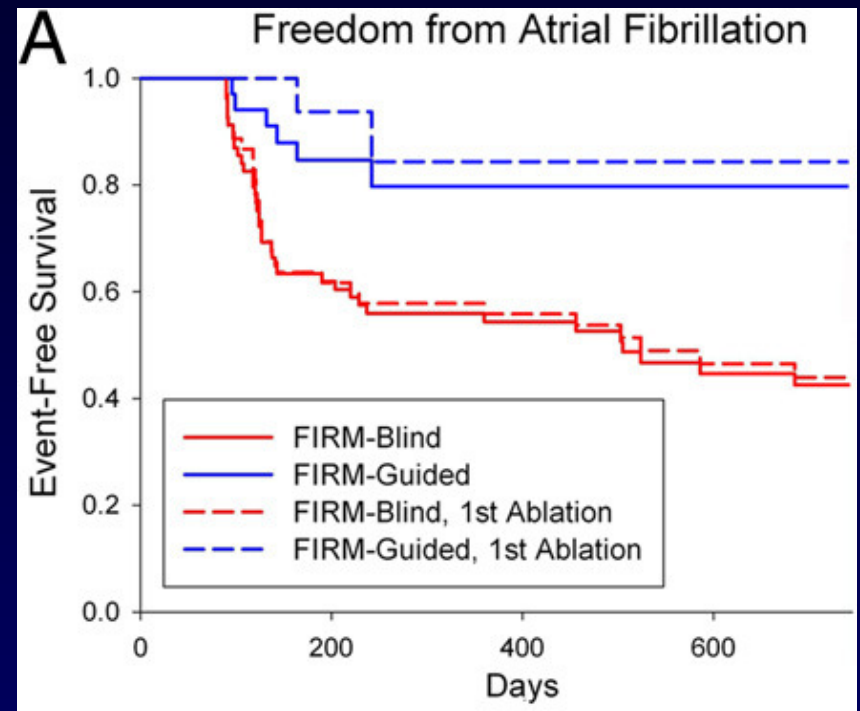
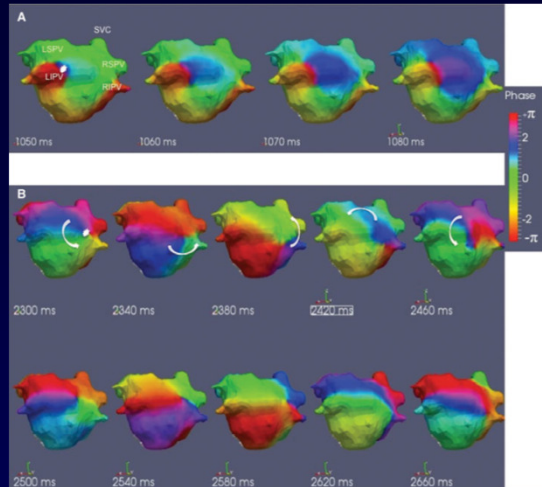*Narayan et al, JACC 2012; 60: 628-636*

ELECTROCARDIOGRAPHIC IMAGING
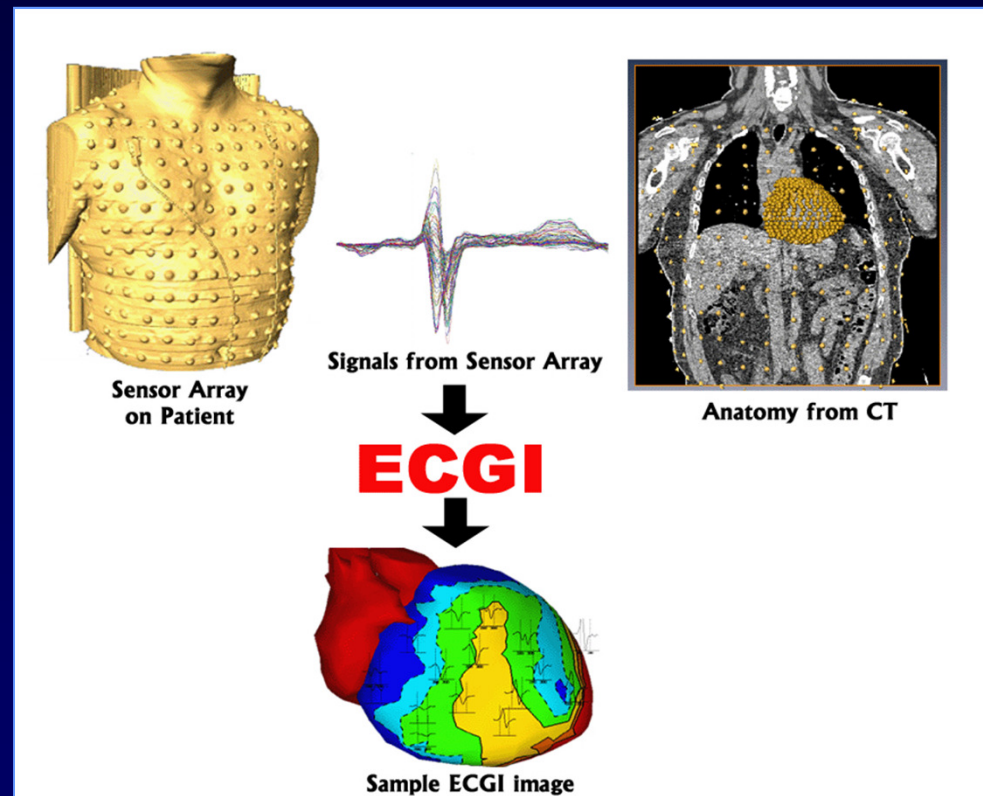
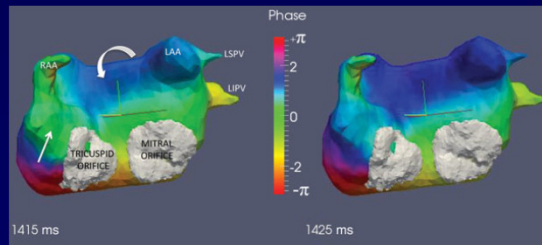252 surface electrodes, ~ 1500 reconstructed epicardial EGMs

NONINVASIVE PANORAMIC MAPPING

PAF: focal LIPV, unstable rotor near RPVs

Same PAF: passive anterior activation

- Multiple windows acquired during long pauses
- Following initial ECGI, additional proprietary signal analysis algorithms combining filtering, wavelet transform, and phase mapping
- Focal sources and rotors (typically unstable) identified
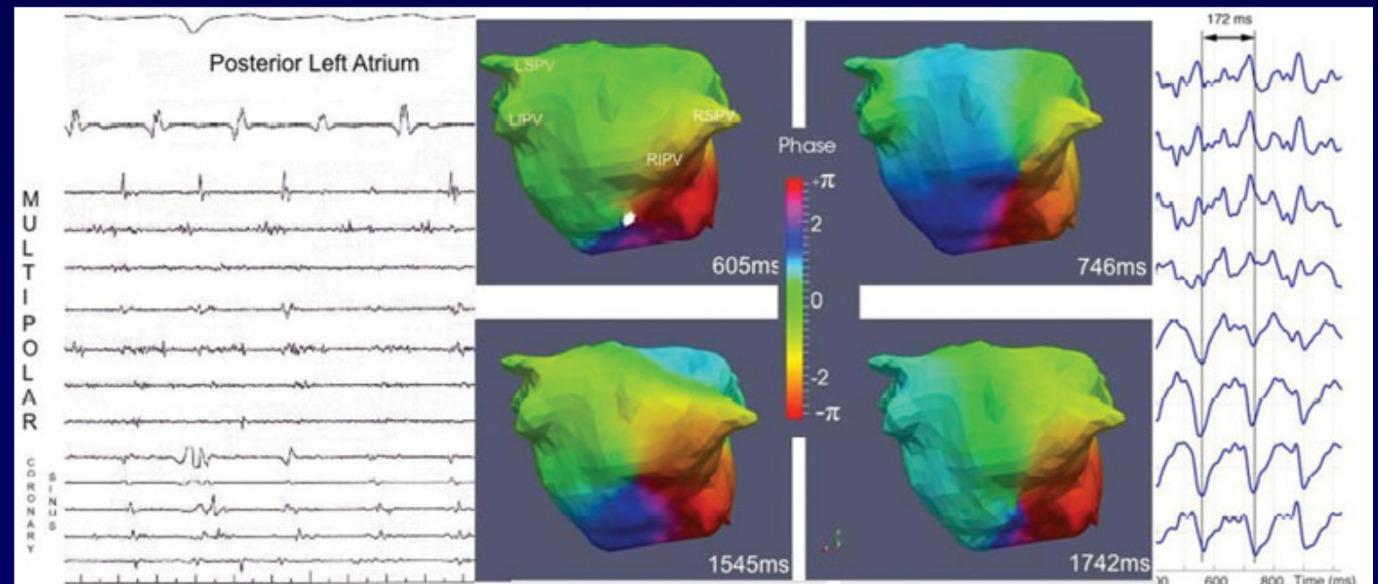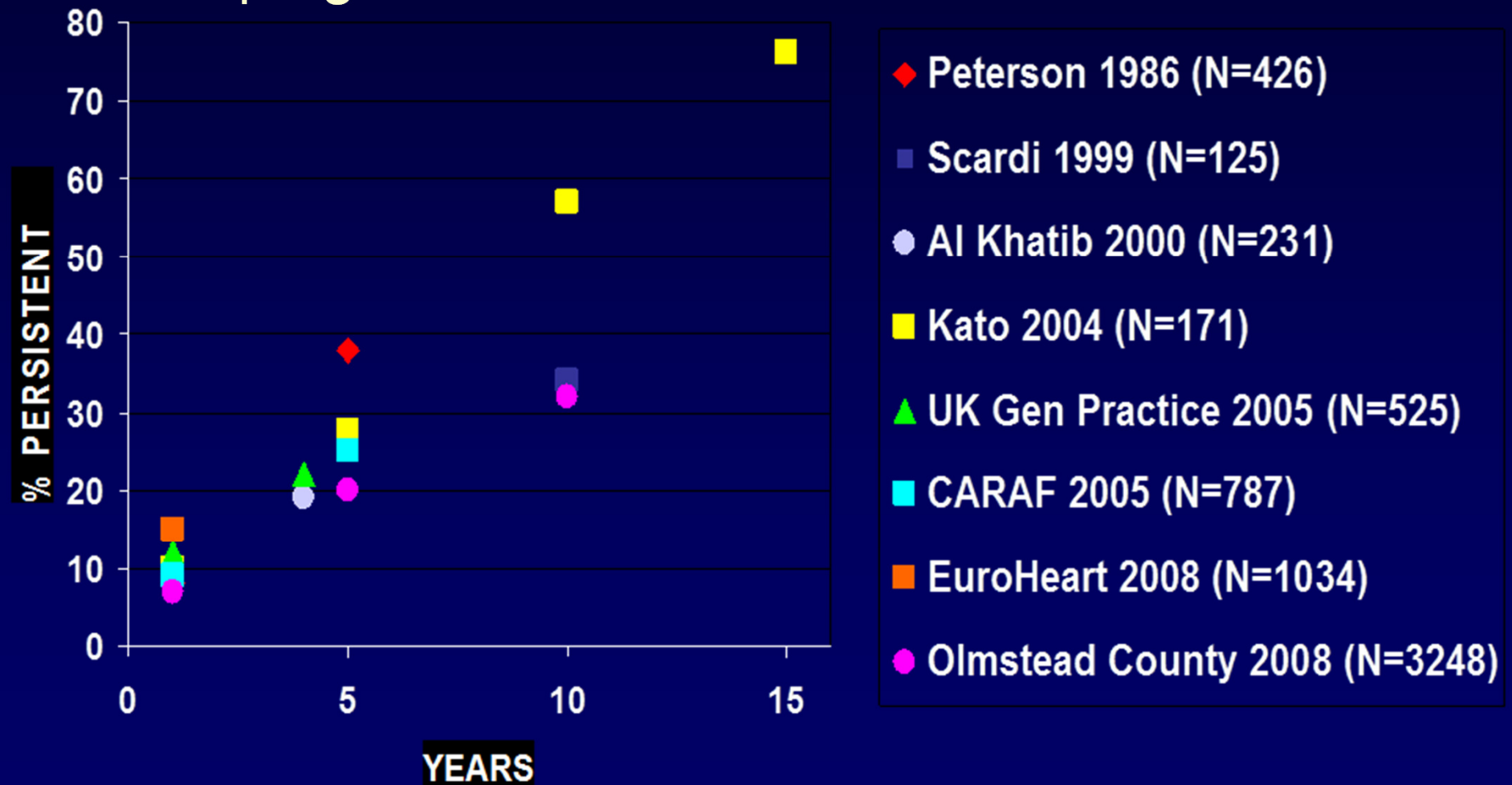- Regional ablation of identified sources

Persistent AF: unstable rotor inferior to RPVs
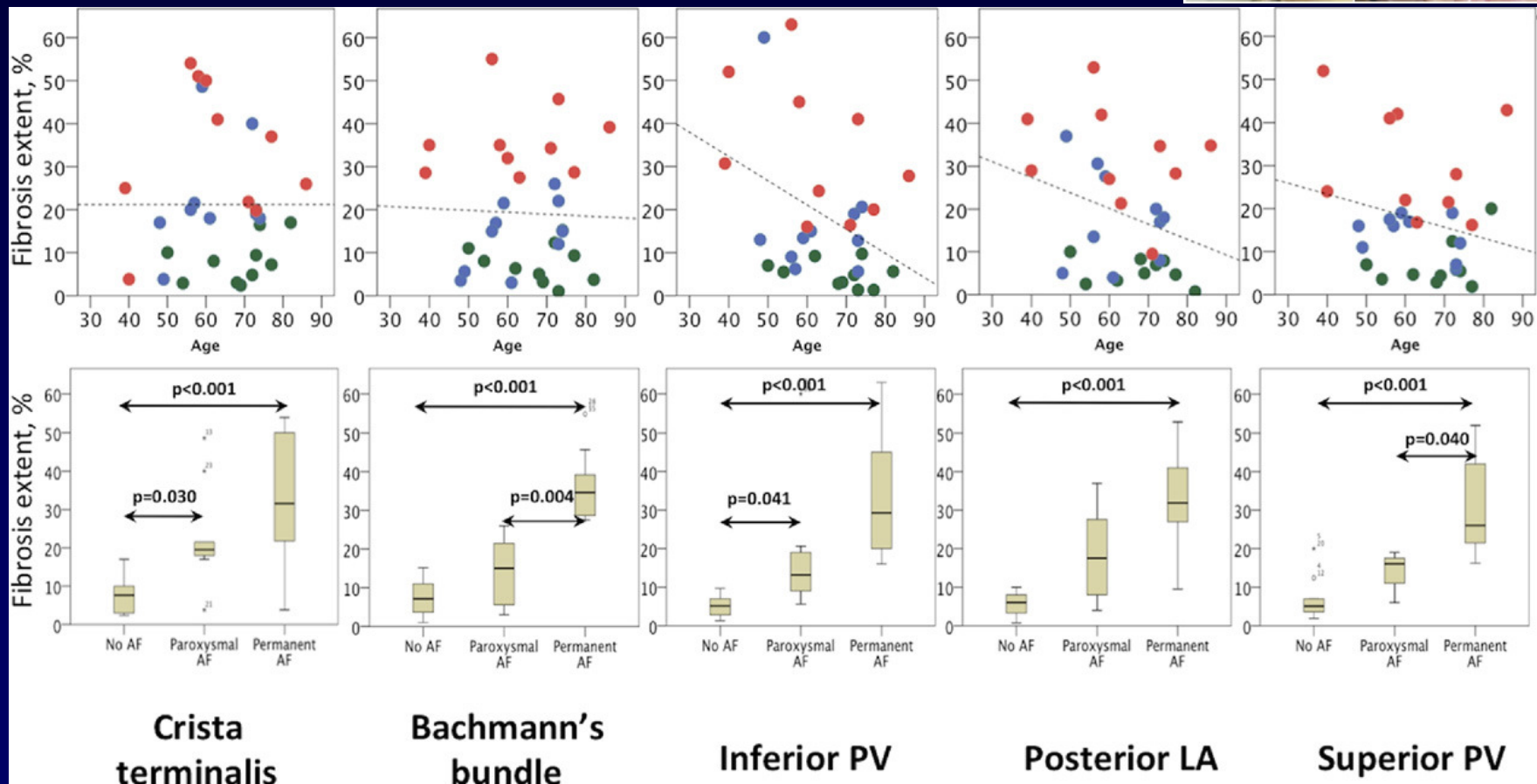

Haissaguerre et al JCVE 2013, 24:711-717

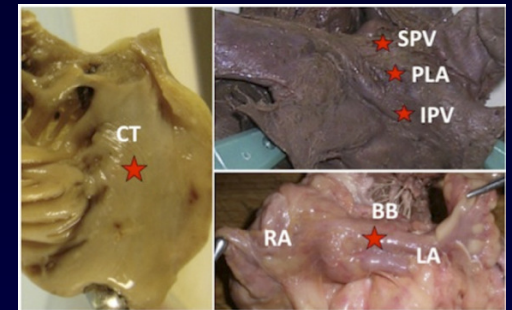# We need better models and insights into the disease process and substrate

AF as a progressive disease

FIBROSIS AND AF

- 30 pts: 10 PAF, 10 persistent AF, 10 no AF
- Postmortem morphometric analysis
- Fibrosis correlated with AF presence and severity, but not age

Platnovov et al, JACC 2011; 58:2225-32

MRI IN PREDICTING ABLATION OUTCOME

Baseline Scan
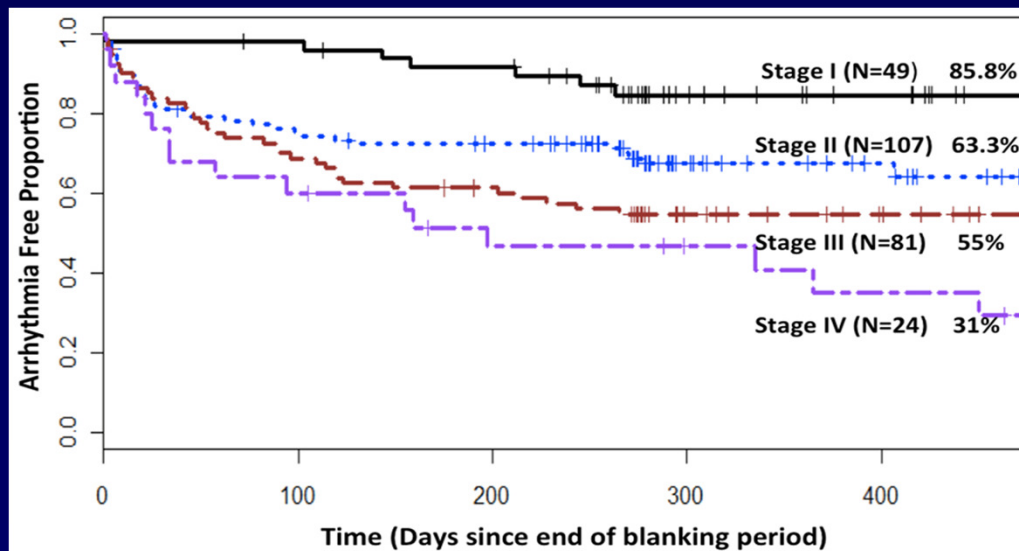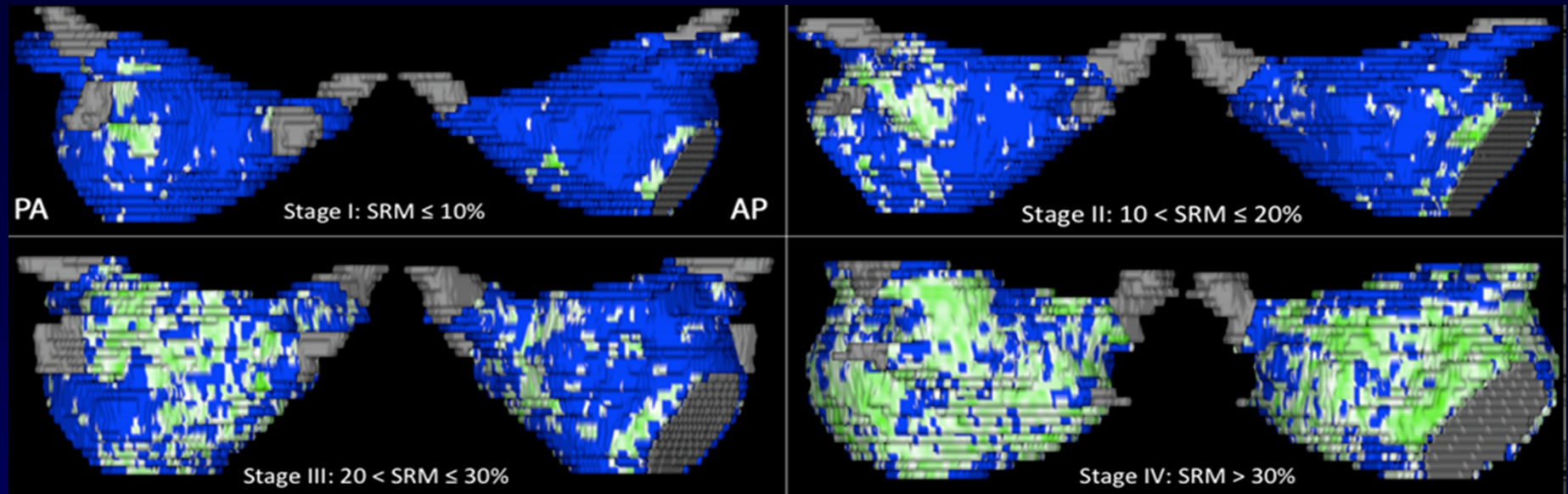
DECAAF Trial (JAMA 2013)

RISK FACTORS FOR AF

- Advancing age
- Male Gender
- Genetics
- Hypertension *
- Obesity *
- Diabetes
- Hyperlipidemia
- Obstructive sleep apnea *
- Alcohol (> 2 drinks daily)
- Intensive physical exercise (> 40 minutes daily)

RISK FACTOR MODIFICATION AND AF ABLATION OUTCOMES

Pathak et al, J Am Coll Cardiol 2014; 64:2222-31

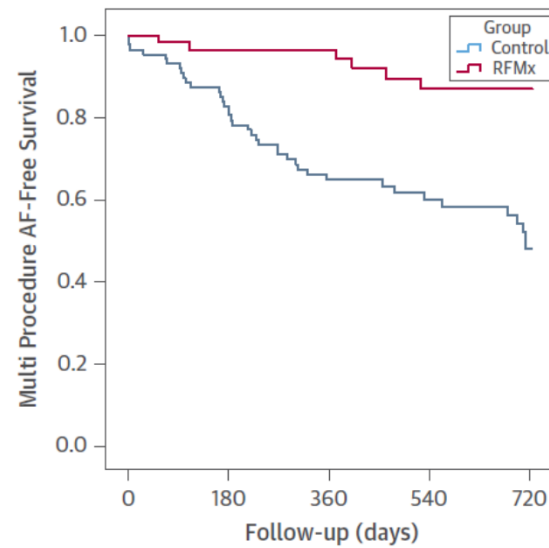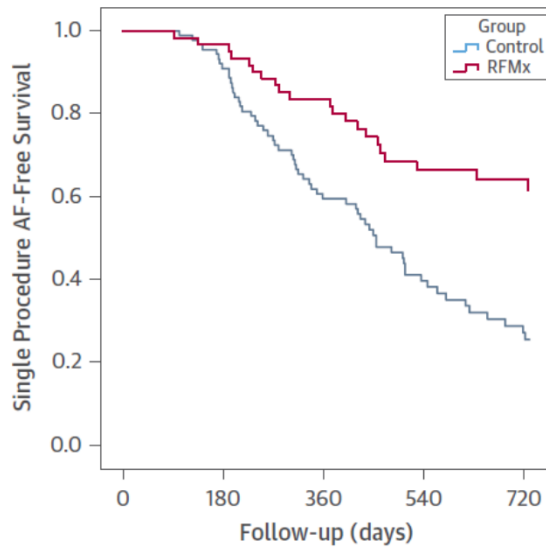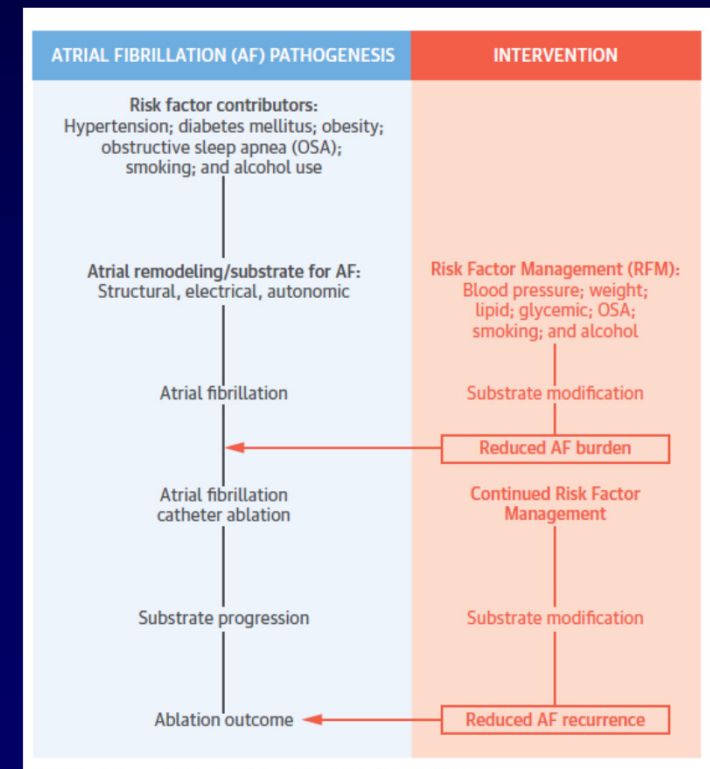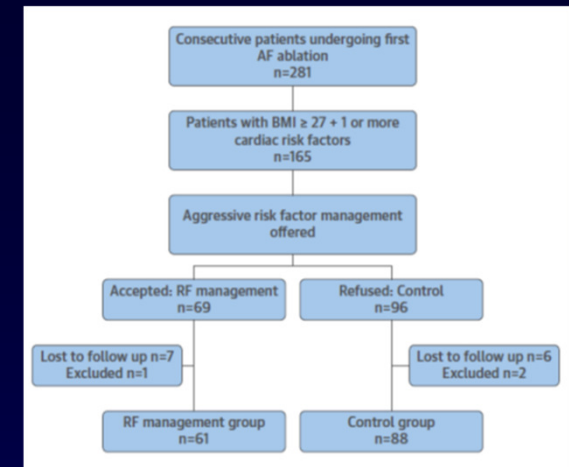*THANK YOU*

2014 AHA/ACC/HRS Guidelines for AF Ablation

CLASS I

1. AF catheter ablation is useful for symptomatic paroxysmal AF refractory or intolerant to at least 1 class I or III antiarrhythmic medication when a rhythm-control strategy is desired (363,392–397). *(Level of Evidence: A)*

2. Before consideration of AF catheter ablation, assessment of the procedural risks and outcomes relevant to the individual patient is recommended. *(Level of Evidence: C)*

CLASS IIa

1. AF catheter ablation is reasonable for some patients with symptomatic persistent AF refractory or intolerant to at least 1 class I or III antiarrhythmic medication (394,398–400). *(Level of Evidence: A)*

2. In patients with recurrent symptomatic paroxysmal AF, catheter ablation is a reasonable initial rhythm-control strategy before therapeutic trials of antiarrhythmic drug therapy, after weighing the risks and outcomes of drug and ablation therapy (401–403). *(Level of Evidence: B)*

CLASS IIb

1. AF catheter ablation may be considered for symptomatic long-standing (>12 months) persistent AF refractory or intolerant to at least 1 class I or III antiarrhythmic medication when a rhythm-control strategy is desired (363,404). *(Level of Evidence: B)*

2. AF catheter ablation may be considered before initiation of antiarrhythmic drug therapy with a class I or III antiarrhythmic medication for symptomatic persistent AF when a rhythm-control strategy is desired. *(Level of Evidence: C)*

CLASS III: HARM

1. AF catheter ablation should not be performed in patients who cannot be treated with anticoagulant therapy during and after the procedure. *(Level of Evidence: C)*

2. AF catheter ablation to restore sinus rhythm should not be performed with the sole intent of obviating the need for anticoagulation. *(Level of Evidence: C)*

January et al. J Am Coll Cardiol 2014. 64; e1-76

# Early Therapy of Atrial Fibrillation for Stroke Prevention Trial (EAST)

- Inclusion
  - recent onset AF ($\leq$ 1 year duration)
  - Age > 75, prior stroke/TIA or $\geq$ 2 other risk factors (female, age > 65, diabetes, hypertension, CHF, LVH, CAD, PAD, CKD)
- Randomization (antithrombotic therapy and rate control all pts)
  - Early Therapy of AF: AAD (amio, dronedarone, rhythmol, flecainide) or PV isolation as primary rhythm control strategy (investigator discretion, nonrandomized), background antithrombotic and rate control in all pts
  - Usual Care: optimal rate control (2010 ESC guidelines)
- Primary endpoint: Composite of CV deaths, stroke/TIA, hosp for HF or ACS
- Secondary: recurrent AF, CV hospitalizations, LV function, QOL, cognitive function, health care costs
- Planned 2745 pts, 3 yr follow-up, 103 European centers
- First enrollment 7/2011; as of 8/2015, 2243 pts enrolled

Catheter ABlation Versus ANtiarhythmic Drug Therapy for Atrial Fibrillation (CABANA)

- Randomized trial comparing ablation to best drug therapy (rate or rhythm control)
- Primary endpoint: mortality (powered for 30% mortality reduction assuming 12% 3 yr mortality in drug group)
- Secondary endpoints: QOL, AF recurrence, composite MAE
- Enrollment criteria:
  - $\geq$ age 65, or < 65 with $\geq$ 1 risk factor for stroke,
  - Minimal prior therapy for AF (AVN blockers or single AAD)
  - Includes patients with persistent AF
- Ablation technique to include PVI $\pm$ additional procedures (lines, CFAE, focal triggers)
- Planned 2200 pts, 113 enrolling centers
- Full study started fall 2009, currently 2170 pts enrolled

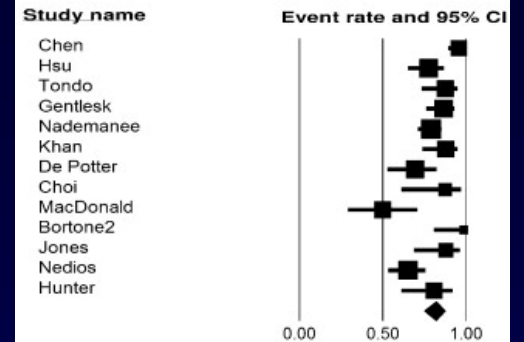# IMPACT OF ABLATION IN PTS WITH REDUCED LVEF

Primary Success of AF ablation
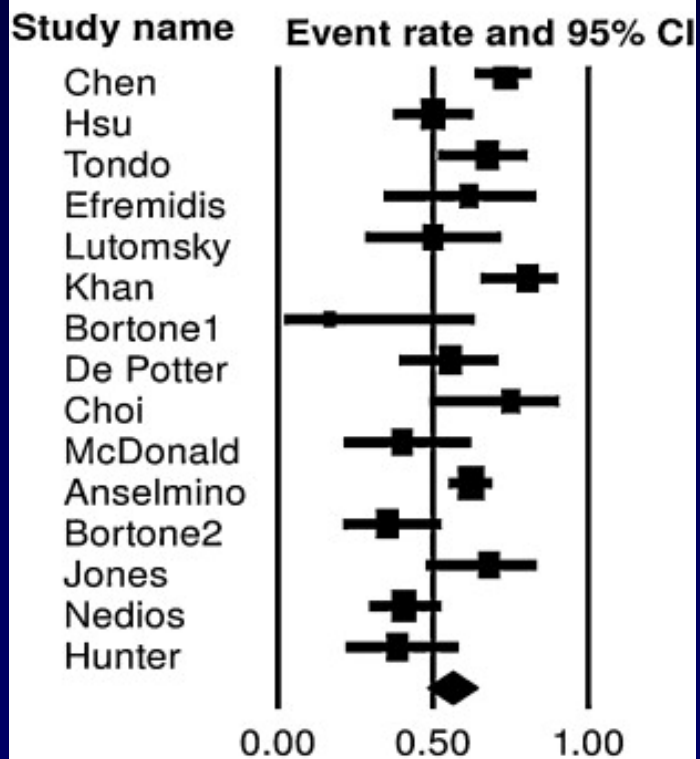
LVEF Change with AF ablation
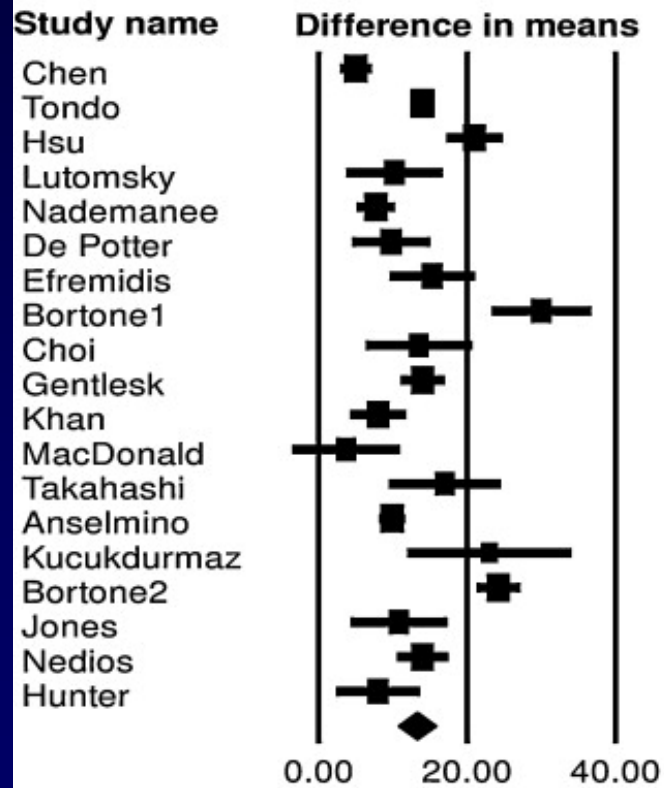
Overall Success of AF ablation

Complications of AF ablation