



End point of AF ablation

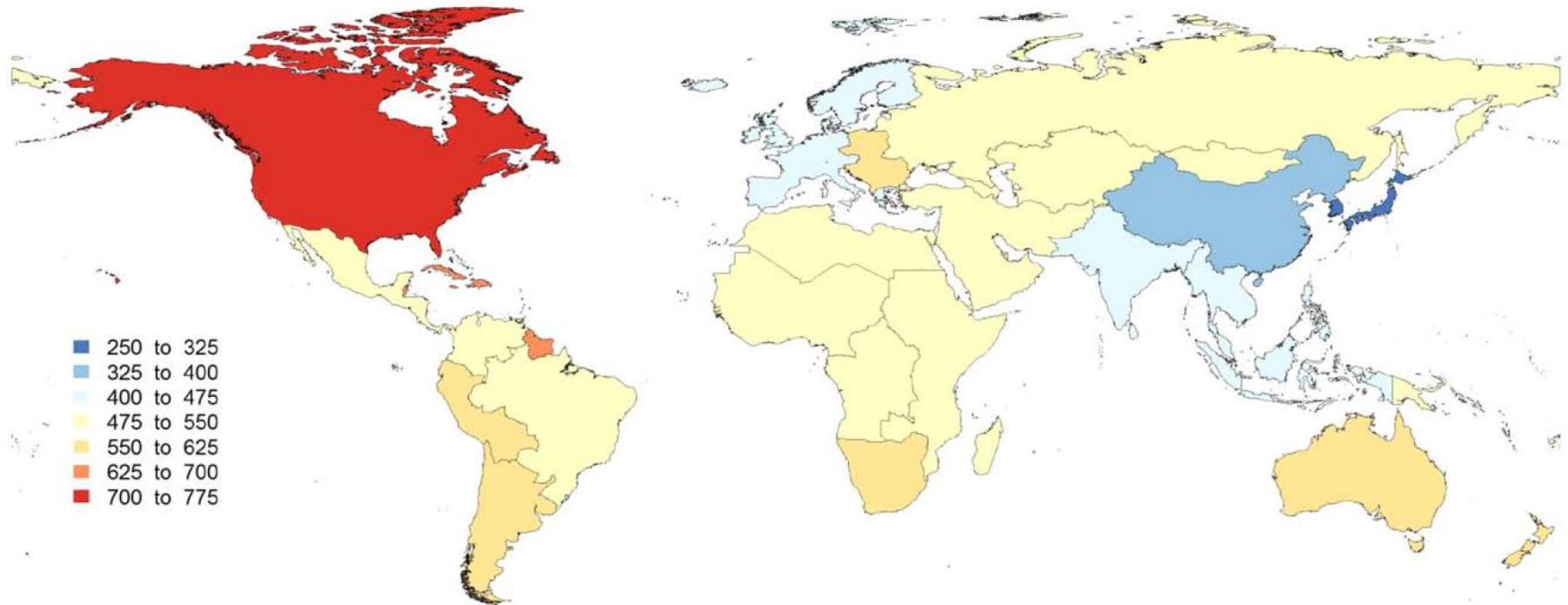


Seongwook Han, MD.PhD.

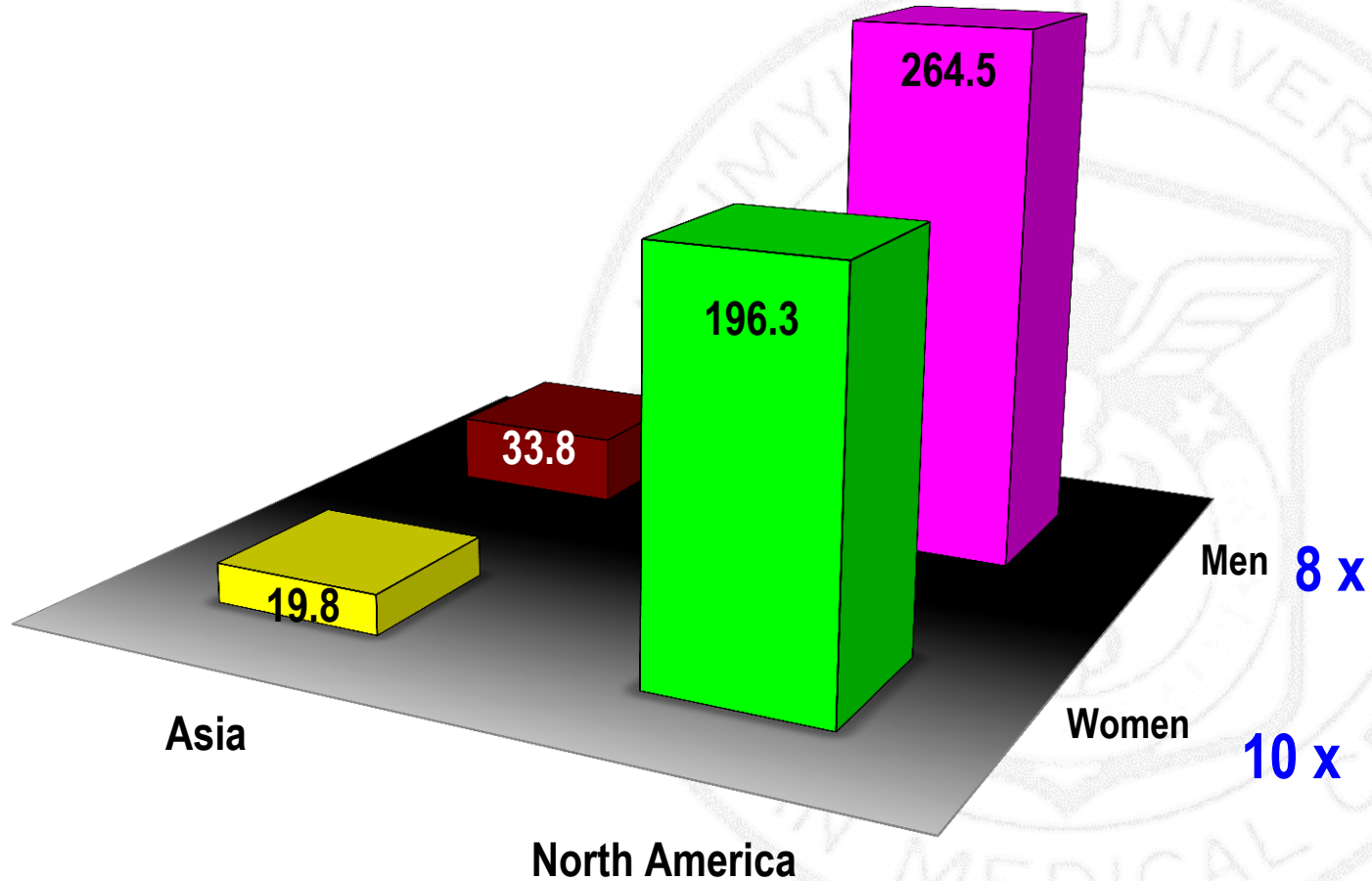
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Arrhythmia Service, Cardiology, Dongsan Medical Center

Global Atrial Fibrillation/Flutter Burden

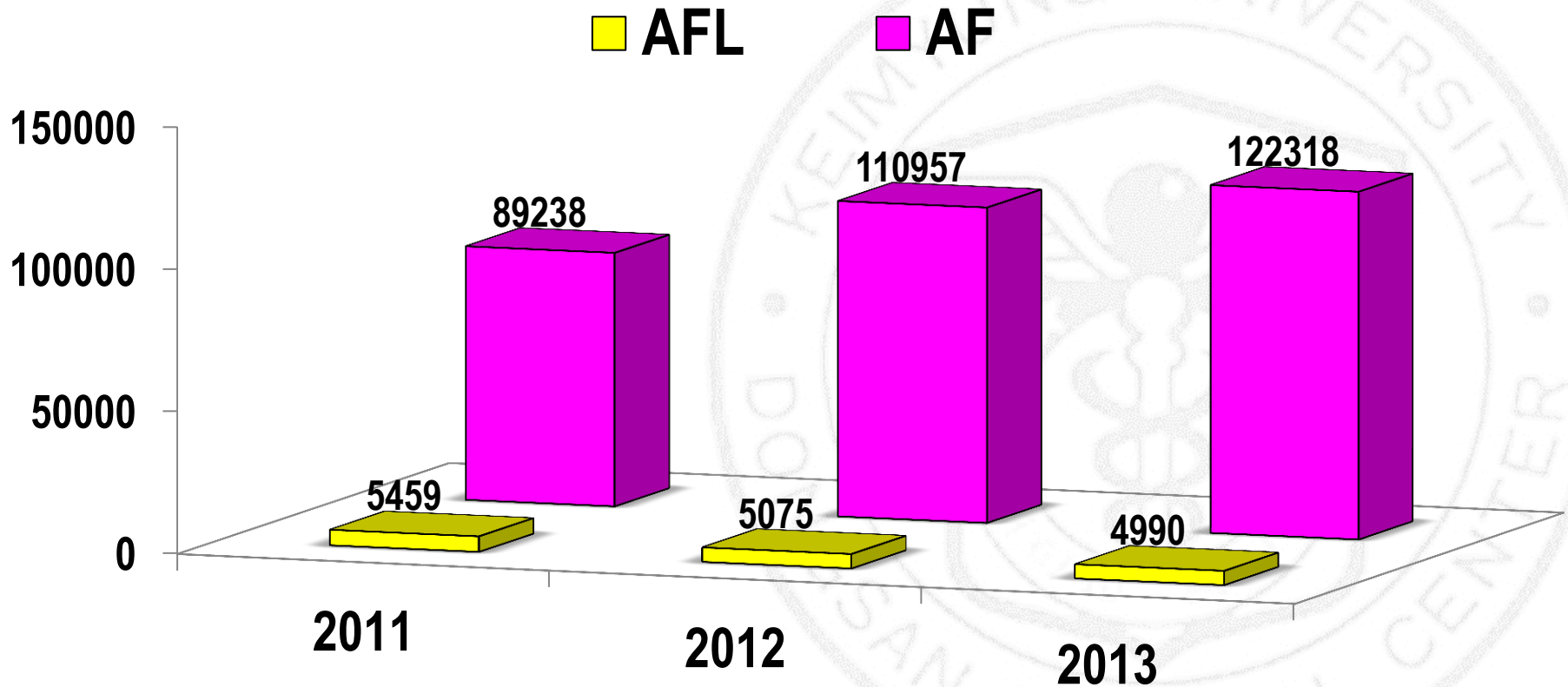
Prevalence of atrial fibrillation and flutter (per 100,000) by region, 2010



Asia vs. North America Incidence of AF per 100,000 Person-years

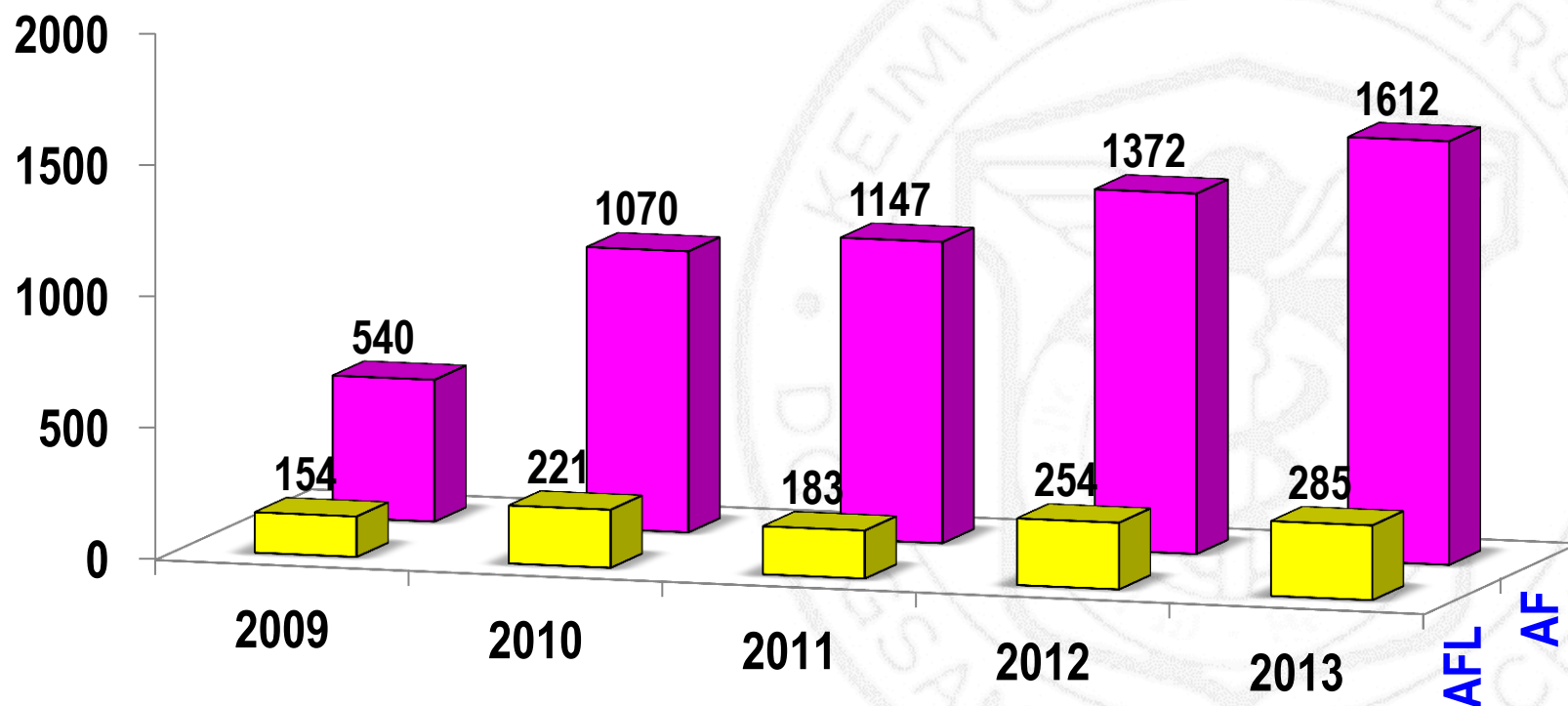


Statistics from Korean Health Insurance



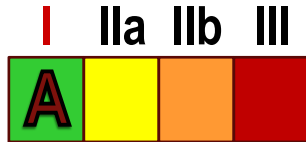
AFL: atrial flutter, AF: atrial fibrillation

Current Status of Radiofrequency Catheter Ablation for AF in Korea

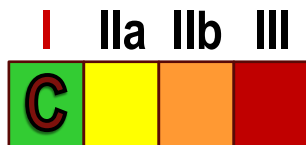


AFL: atrial flutter, AF: atrial fibrillation

2014 AHA/ACC/HRS Guideline for the Management of Patients With Atrial Fibrillation



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

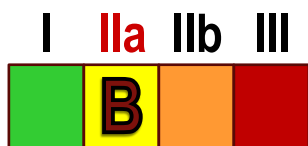


Before consideration of AF catheter ablation, assessment of the procedural risks and outcomes relevant to the individual patient is recommended

2014 AHA/ACC/HRS Guideline for the Management of Patients With Atrial Fibrillation

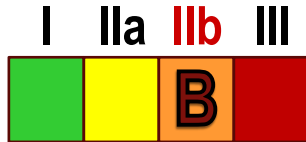


AF catheter ablation is reasonable for some patients with **symptomatic persistent AF** refractory or intolerant to at least 1 class I or III antiarrhythmic medication



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

2014 AHA/ACC/HRS Guideline for the Management of Patients With Atrial Fibrillation



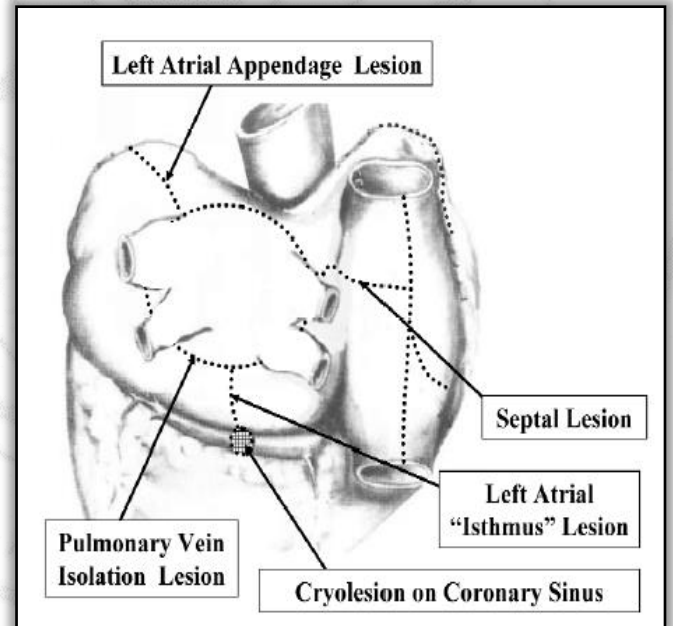
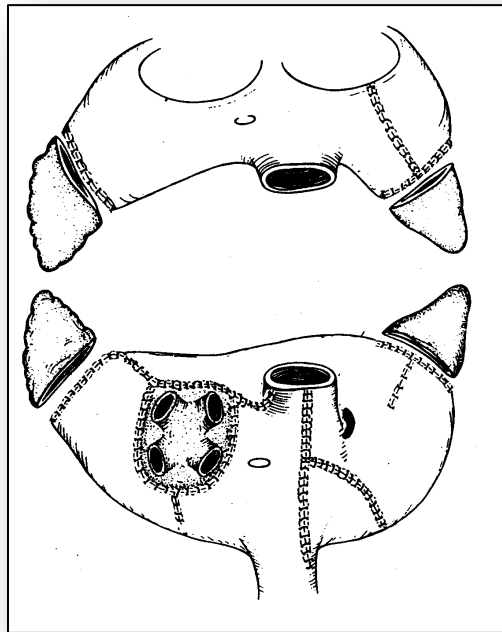
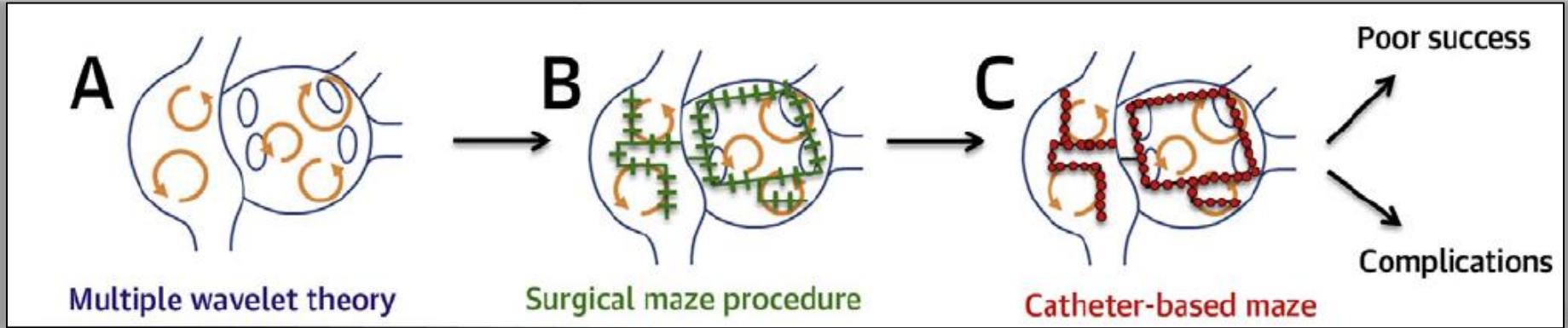
AF catheter ablation **may be considered for symptomatic longstanding (>12 months) persistent AF** refractory or intolerant to at least 1 class I or III antiarrhythmic medication when a rhythm control strategy is desired



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

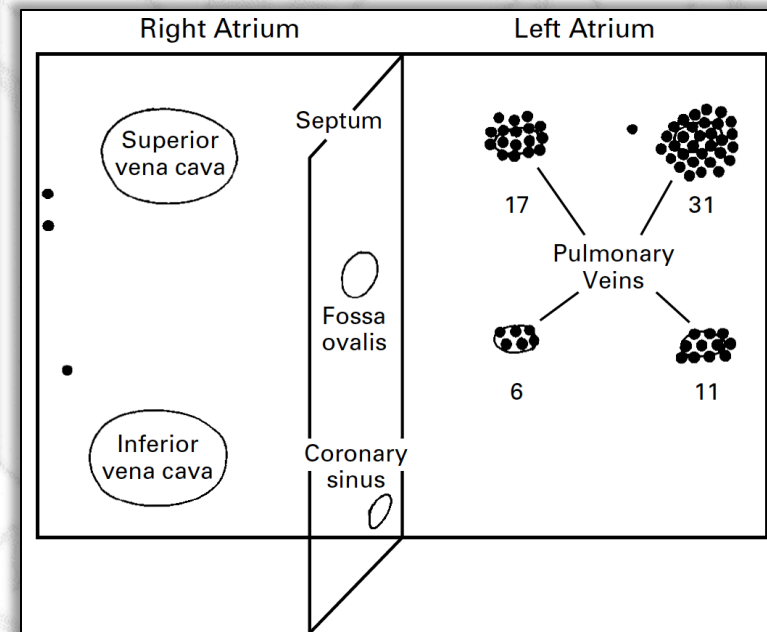
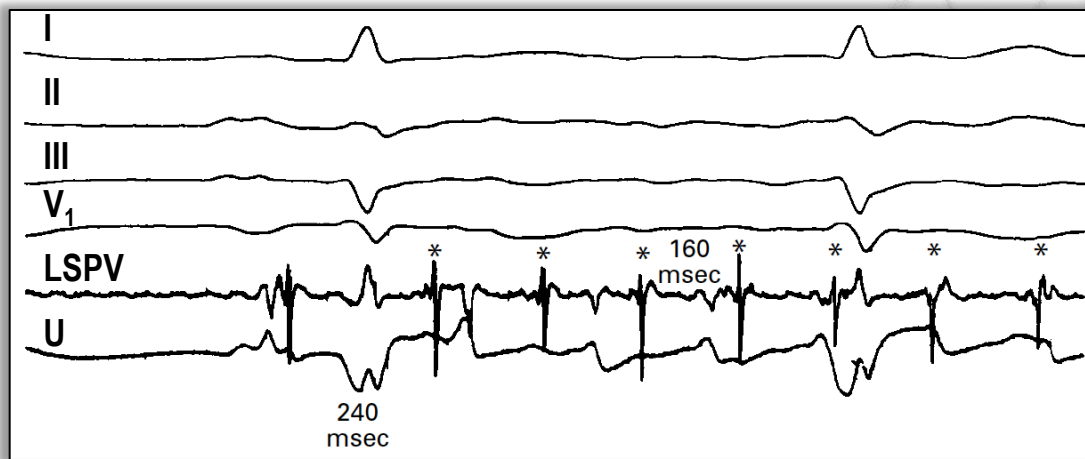
Radiofrequency Catheter Ablation

First phase of AF ablation



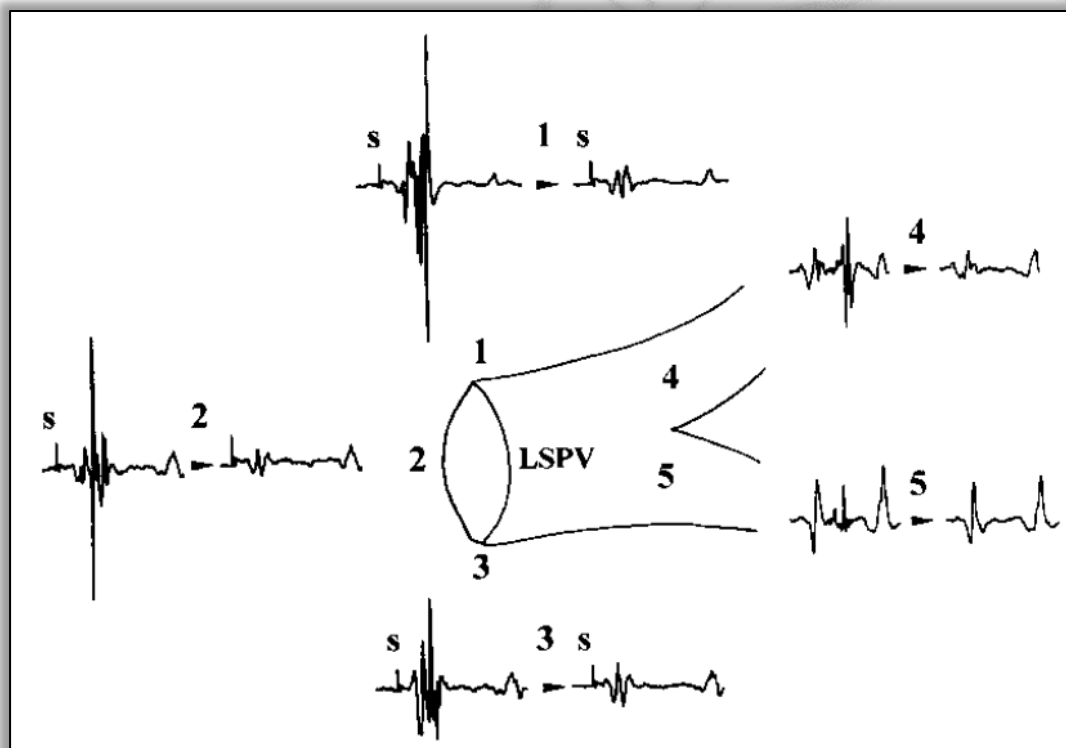
SPONTANEOUS INITIATION OF ATRIAL FIBRILLATION BY ECTOPIC BEATS ORIGINATING IN THE PULMONARY VEINS

- 45 patients with paroxysmal AF refractory to AAA
- 69 ectopic foci were found: **94% in PVs**, 6% in RA & LA posterior wall
- Focal ablation: no recurrence in 62% @ 8 ± 6 months FU



Electrophysiological End Point for Catheter Ablation of Atrial Fibrillation Initiated From Multiple Pulmonary Venous Foci

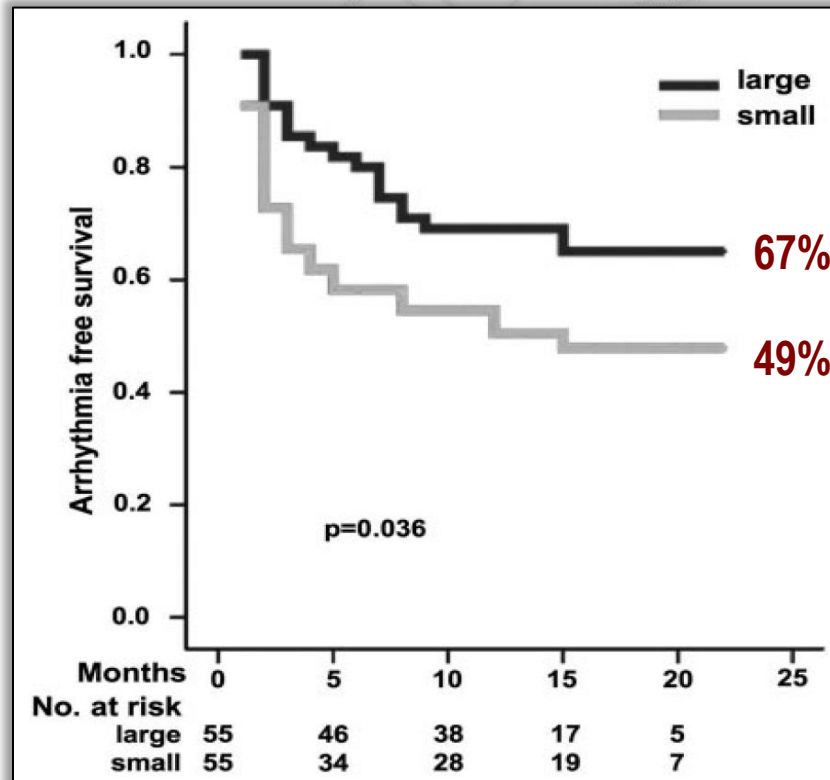
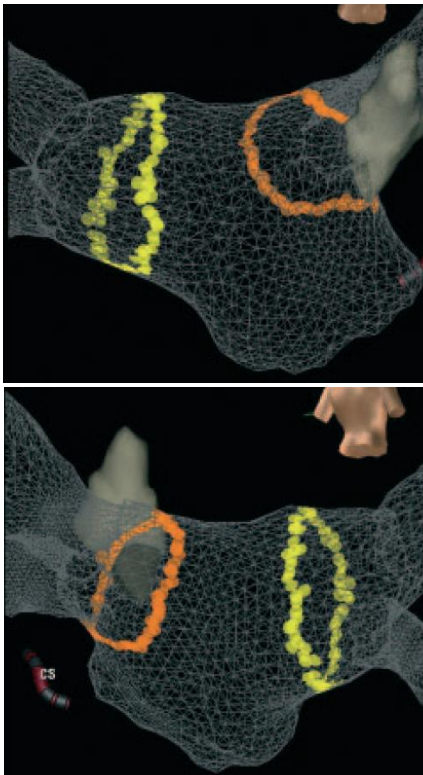
- 90 patients with 197 arrhythmogenic PV foci (97%) & 6 atrial foci
- **Segmental ostial PV ablation**, electrophysiologically guided
- **Elimination of PV muscle conduction** is associated with clinical success



Small or Large Isolation Areas Around the Pulmonary Veins for the Treatment of Atrial Fibrillation?

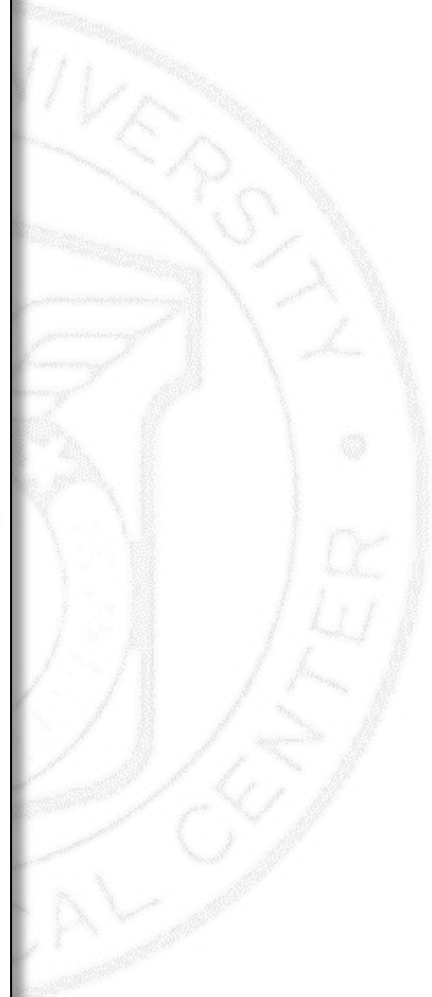
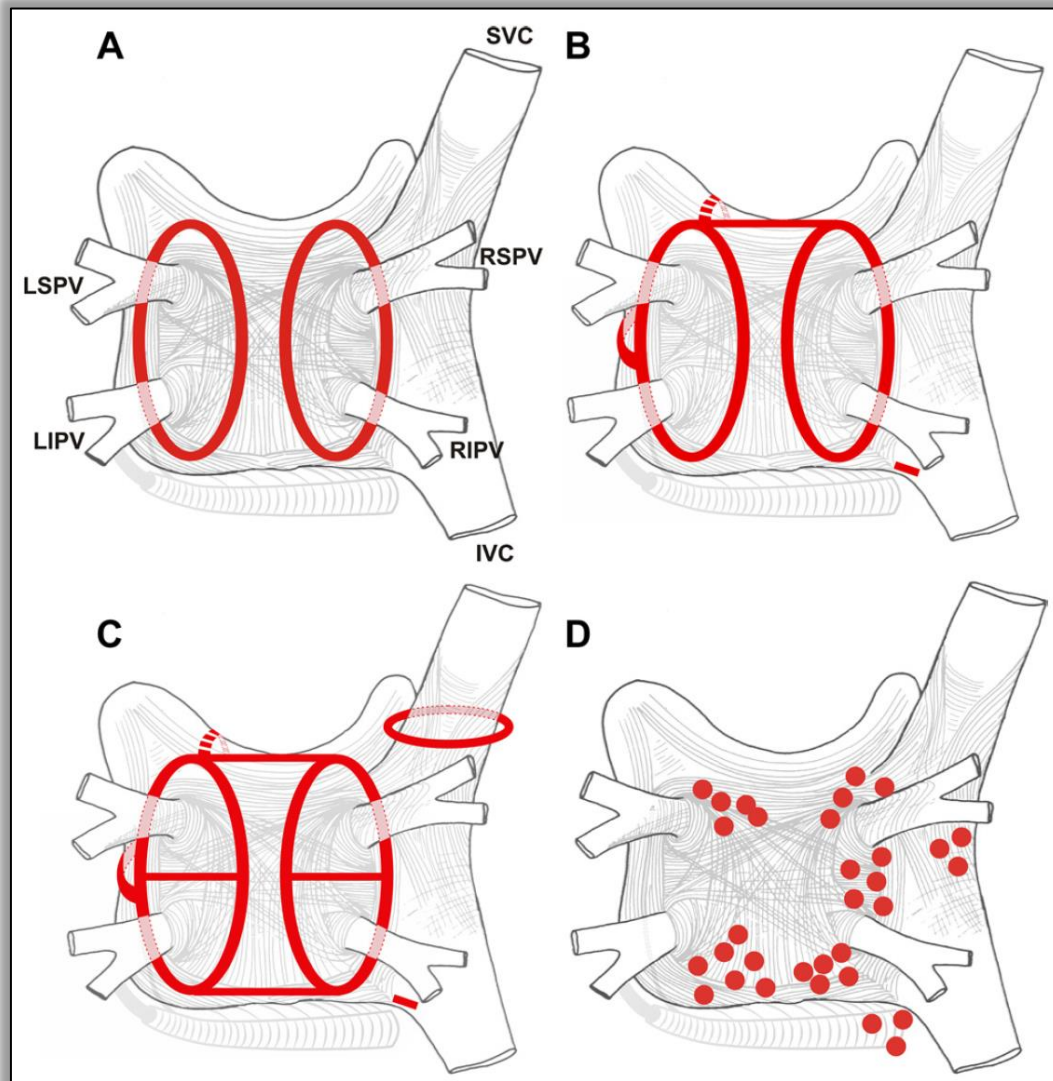
Results From a Prospective Randomized Study

- 110 patients: 67 PAF & 43 PeAF
- Group I: ostial segmental ablation of each PV - entrance block
- Group II: Isolation of large area around 2 veins with 3D – entrance block



FU@15±4 Mo

2012 HRS/EHRA/ECAS Expert Consensus Statement on Catheter Ablation



Catheter ablation of AF

- ❖ Targeting the PVs and/or PV antrum is the cornerstone of ablation
- ❖ Benefits of ancillary strategies including linear ablation, CAFÉ ablation, GP ablation, & FIRM have not been established

❖ Goal

ablate least amount of tissue necessary to make the patient free of AF

❖ Requirements

Optimal end point: ***non-inducibility & termination of AF***

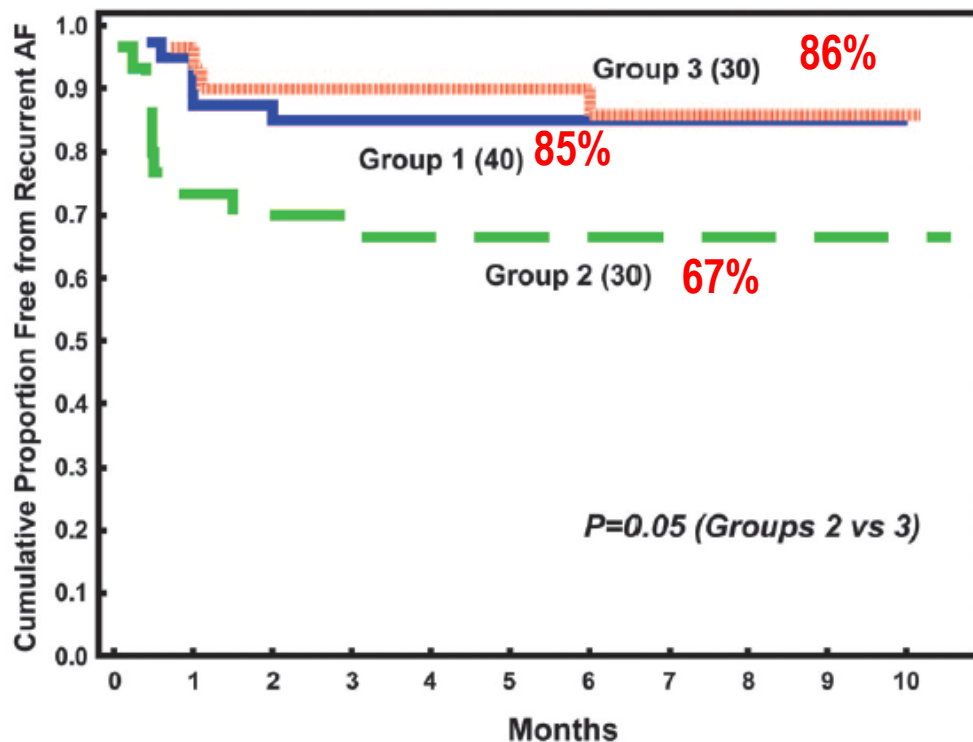
Rationale for non-inducibility

- **Non-inducibility by rapid atrial pacing (RAP)**
Normal heart will not fibrillate longer than a certain period of time
 - ✓ Will not be vulnerable to fibrillation with a given pacing protocol
 - ✓ AF will be unstable, will not sustain longer than several minutes
- **Non-inducibility with isoproterenol (ISO)**
Potential triggers of AF have been eliminated
- ✓ **Longer AF has more remodeling**

Noninducibility of Atrial Fibrillation as an End Point of Left Atrial Circumferential Ablation for Paroxysmal Atrial Fibrillation

A Randomized Study

- 100 patients with PAF: 55 ± 10 years old; 6 months FU
- Index procedure: LA circumferential ablation + LA posterior line + MI
- Inducibility: AF > 60 sec by burst pacing with 20mA until shortest 1:1 capture >15 sec

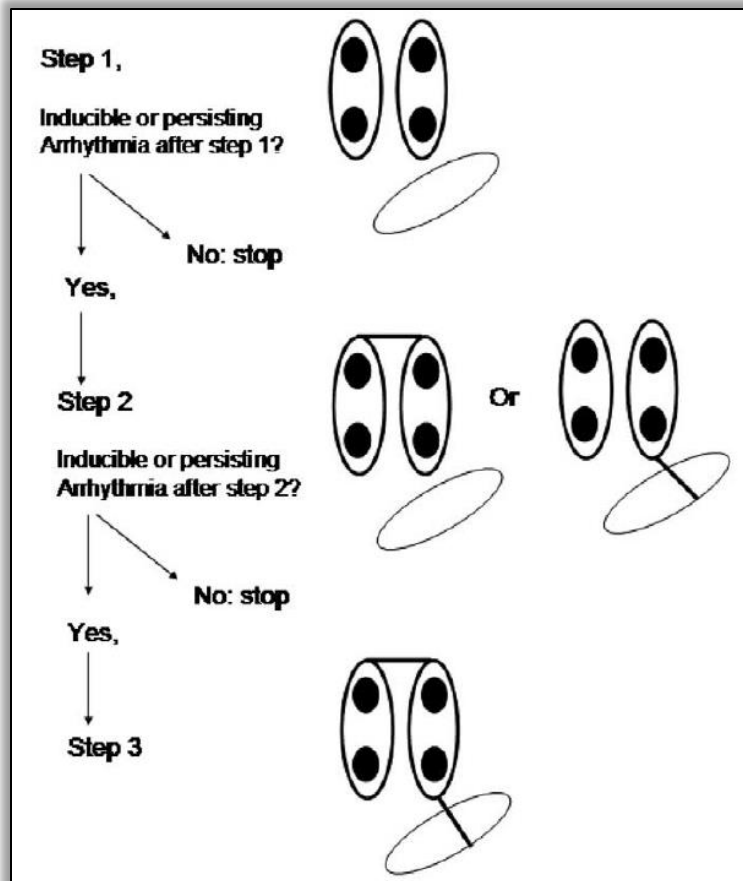


Group 1 (40) : non-inducible
 Group 2 (30) : AF or still inducible
 Group 3 (30) : additional line for group 2

Non-inducibility of AF achieved by additional ablation may be a clinically useful endpoint

Long-term evaluation of atrial fibrillation ablation guided by noninducibility

- 74 patients with PAF: 53 ± 8 years old; 18 ± 4 months FU
- Inducibility: AF/AFL ≥ 10 min by 20mA until refractory from CSos, LAA, RAA



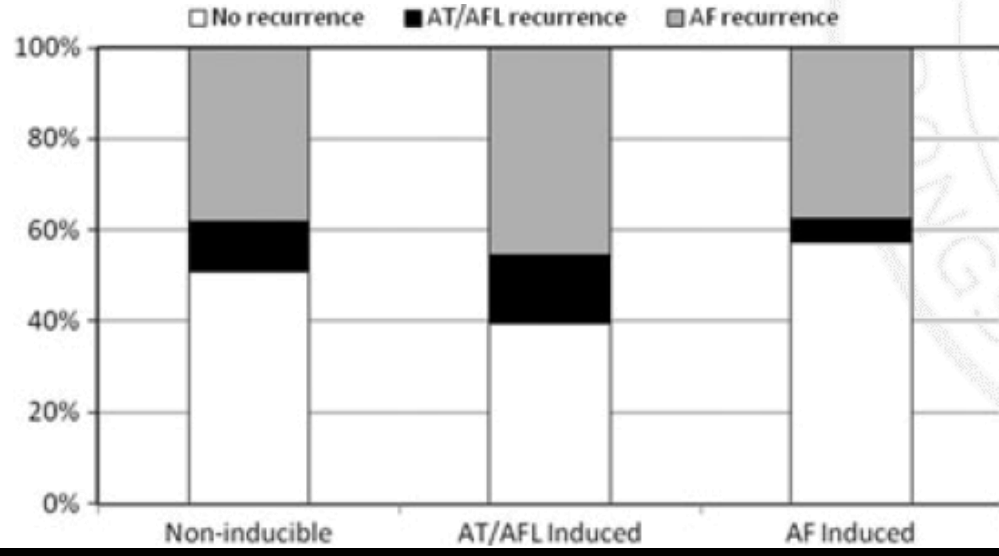
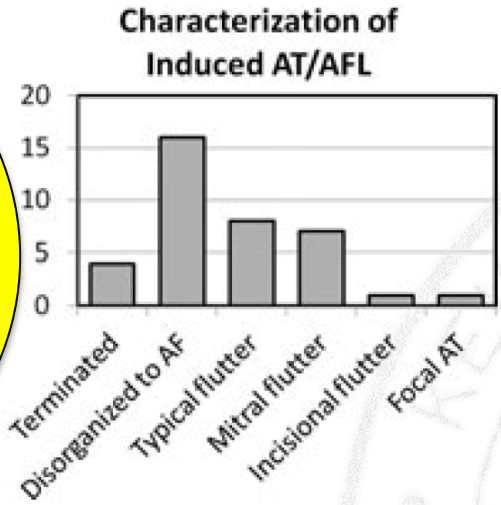
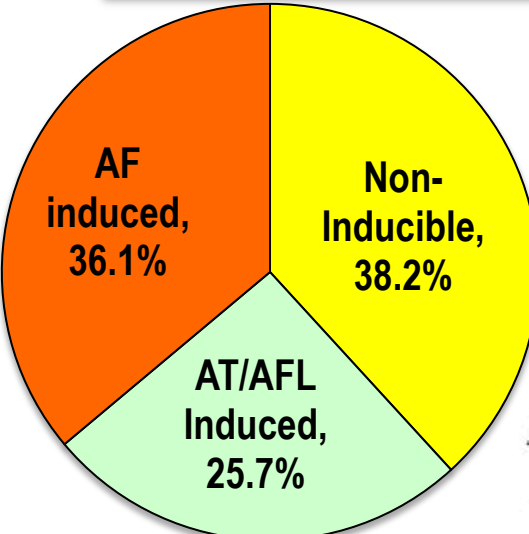
- ✓ 69 patients were non-inducible (93%)
- ✓ 67 patients were free from arrhythmia (91%)

Noninducibility can be used as an endpoint for determining the subset of patients with paroxysmal AF who require additional linear lesions after PV isolation

Inducibility of Atrial Fibrillation and Flutter Following Pulmonary Vein Ablation

- 144 patients with AF (PAF:PeAF= 54:46%)
- Index procedure: antral PVI + focal ablation of non-PV trigger on ISO
- Burst pacing from CS, RA with 20 mA @ 250 ms for 15 beats
 - ✓ 10 ms decremental 15 beats burst pacing until atrial 2:1 capture or minimum cycle length of 180 ms
- Sustained arrhythmia ≥ 2 min
 - ✓ Organized AT/AFL: beat to beat variability in cycle length < 30 ms

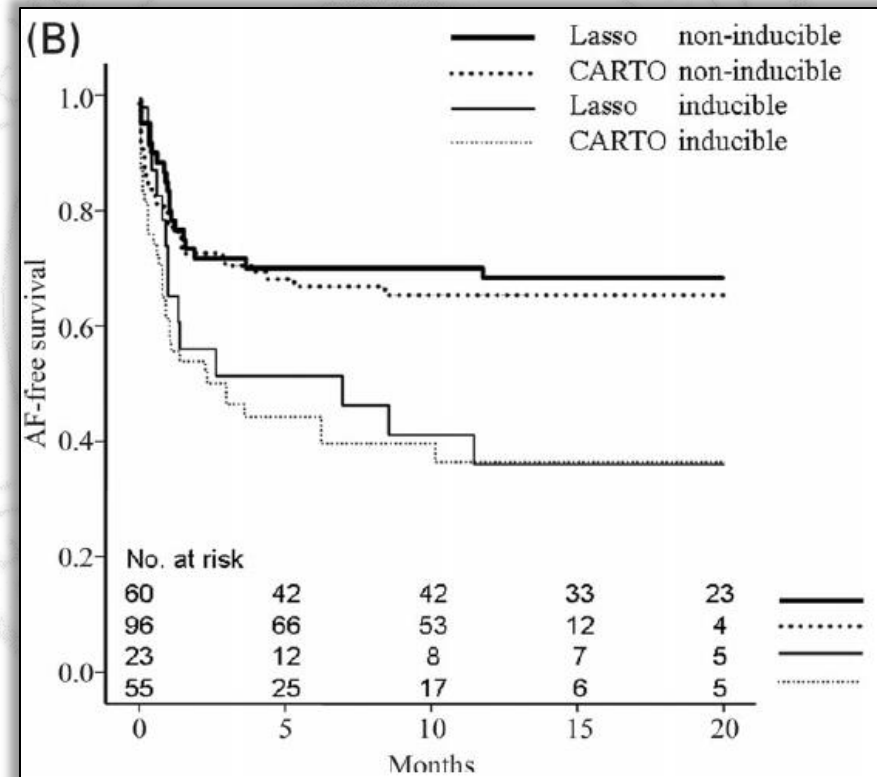
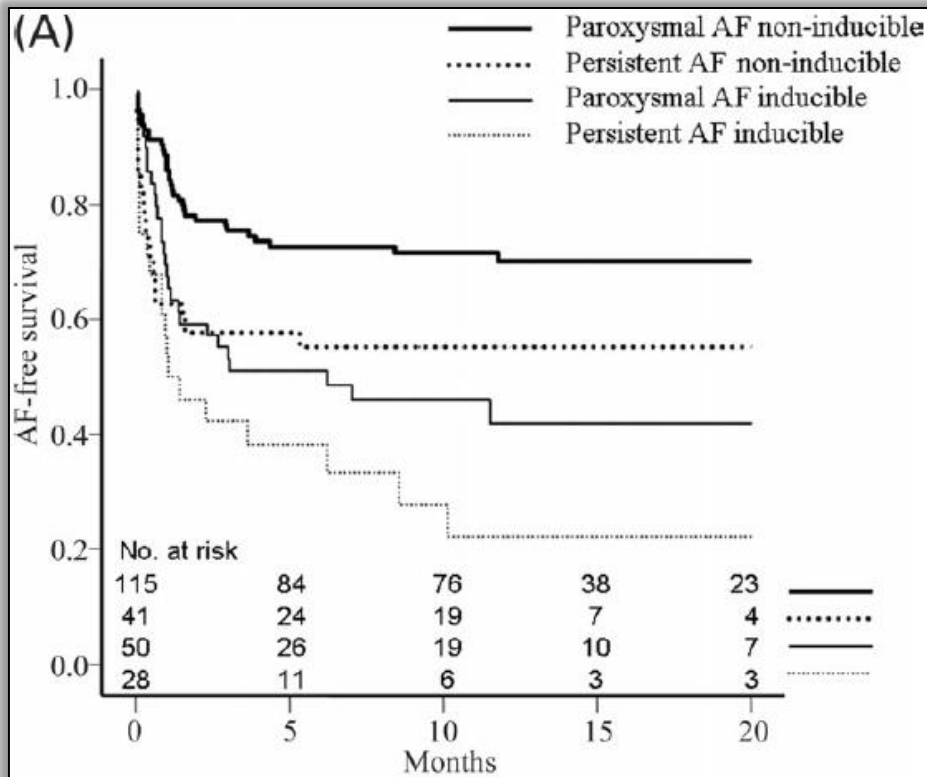
Inducibility of Atrial Fibrillation and Flutter Following Pulmonary Vein Ablation



- ✓ **inducibility did not predict clinical recurrence in 1 year follow-up**
- ✓ **Hypertension and age predict inducibility of arrhythmias**
- ✓ **LA size & PeAF predicted atrial arrhythmia recurrence**

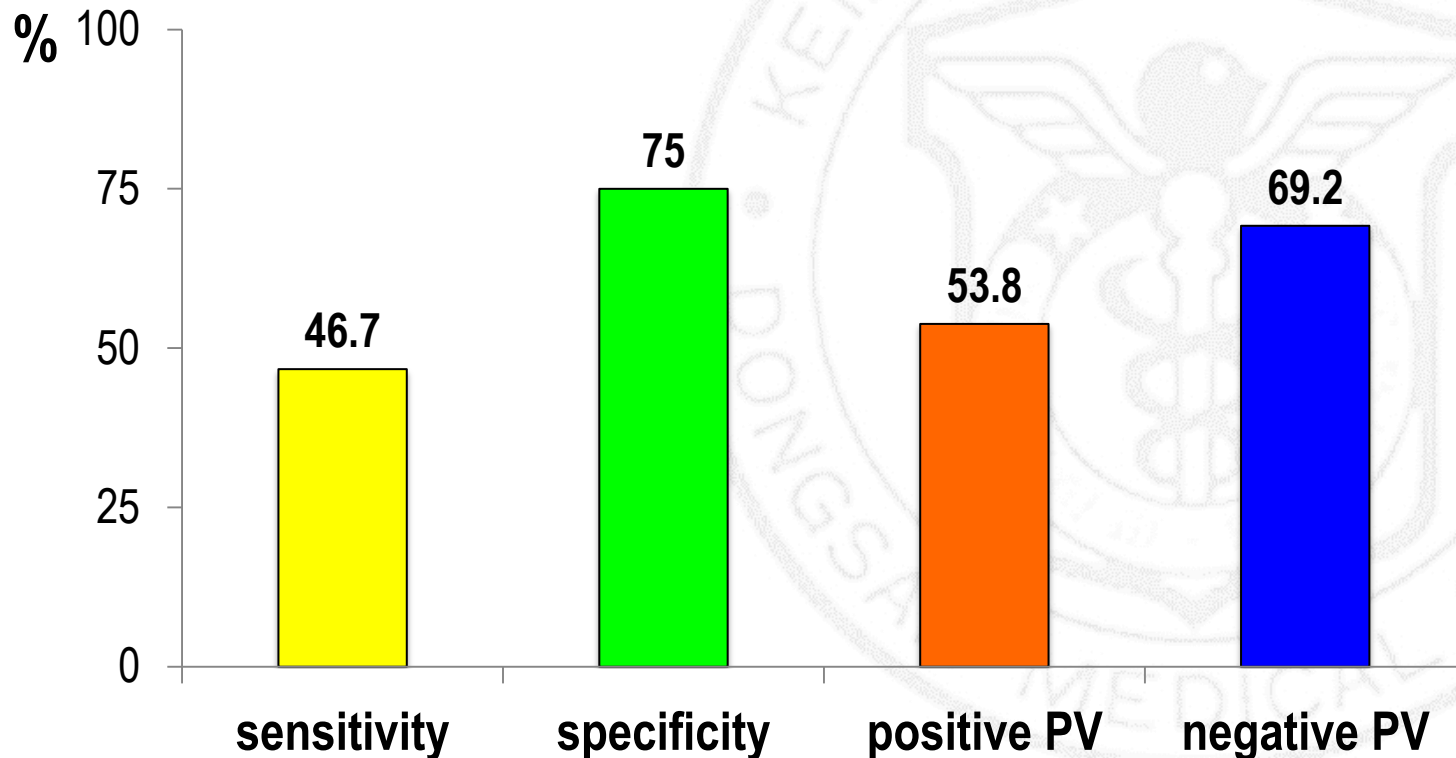
Is inducibility of atrial fibrillation after radio frequency ablation really a relevant prognostic factor?

- 234 patients with PAF (165) & PeAF (69) @ 6 months FU
- Segmental PVI (83) & Carto guided WACA (151)
- Inducibility: AF > 1 min, 2 attempts from CS



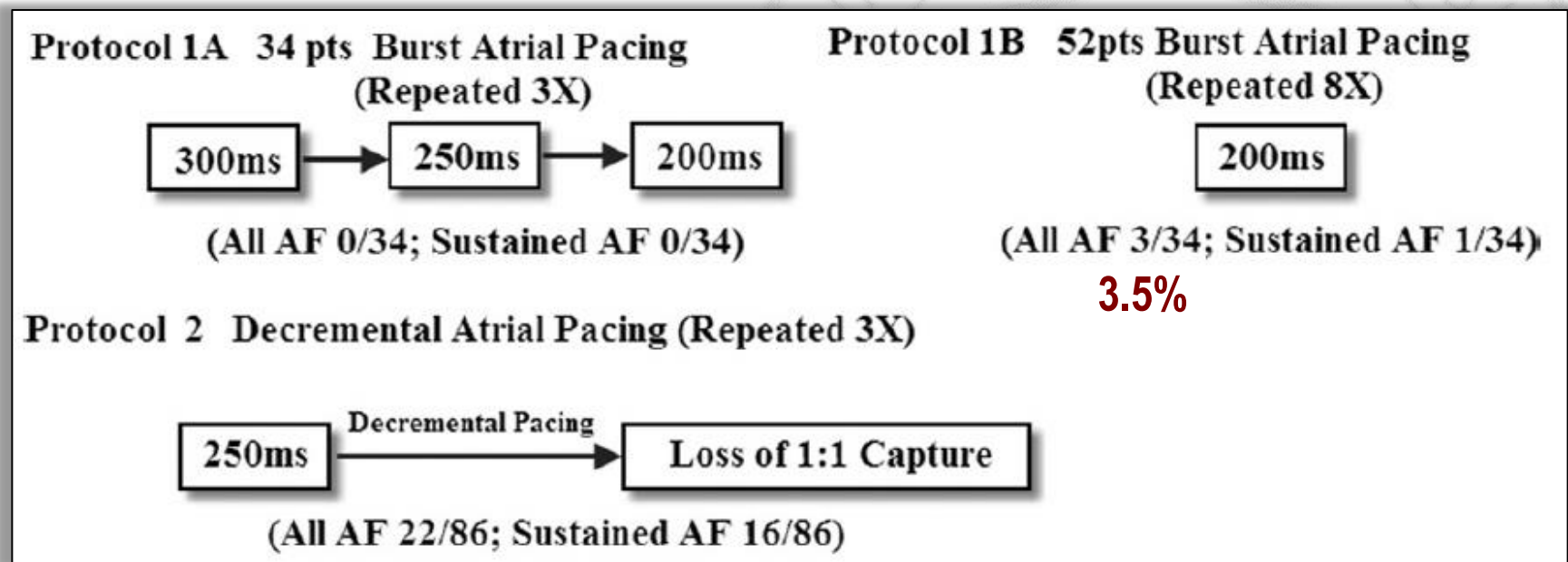
Is inducibility of atrial fibrillation after radio frequency ablation really a relevant prognostic factor?

- Inducibility is a significant predictor of AF recurrence
- Non-inducibility **does not qualify as reliable procedural endpoint**, due to low diagnostic accuracy



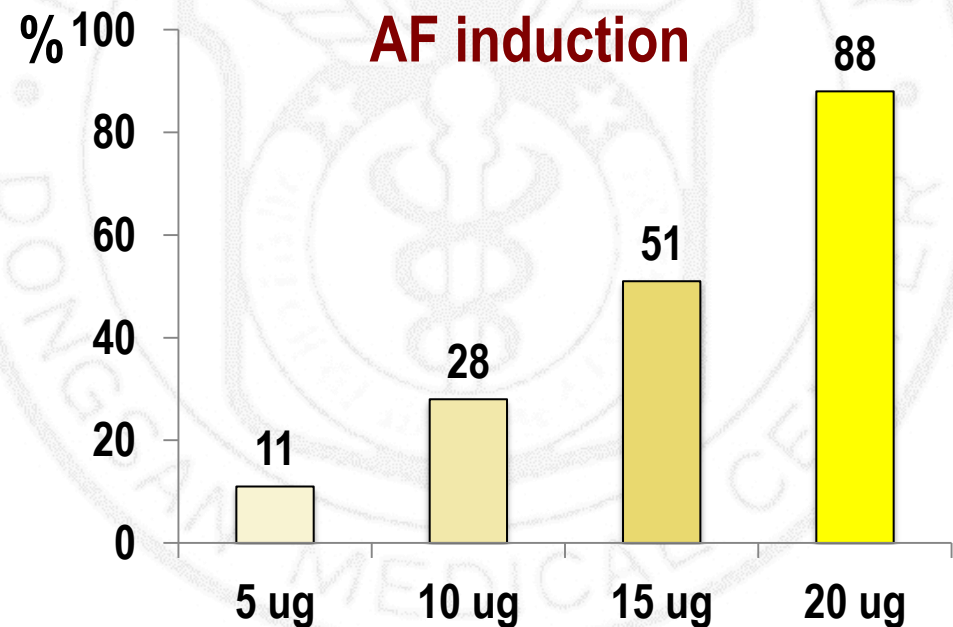
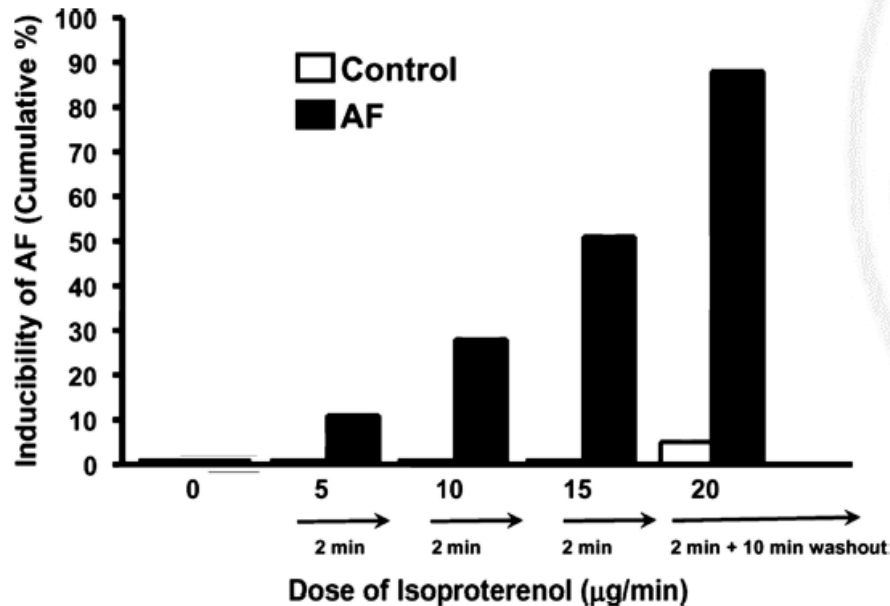
Inducibility of atrial fibrillation in the absence of atrial fibrillation: what does it mean to be normal?

- 86 patients with SVT: burst pacing vs decremental pacing
- Inducible AF ≥ 1 min, sustained AF ≥ 5 min



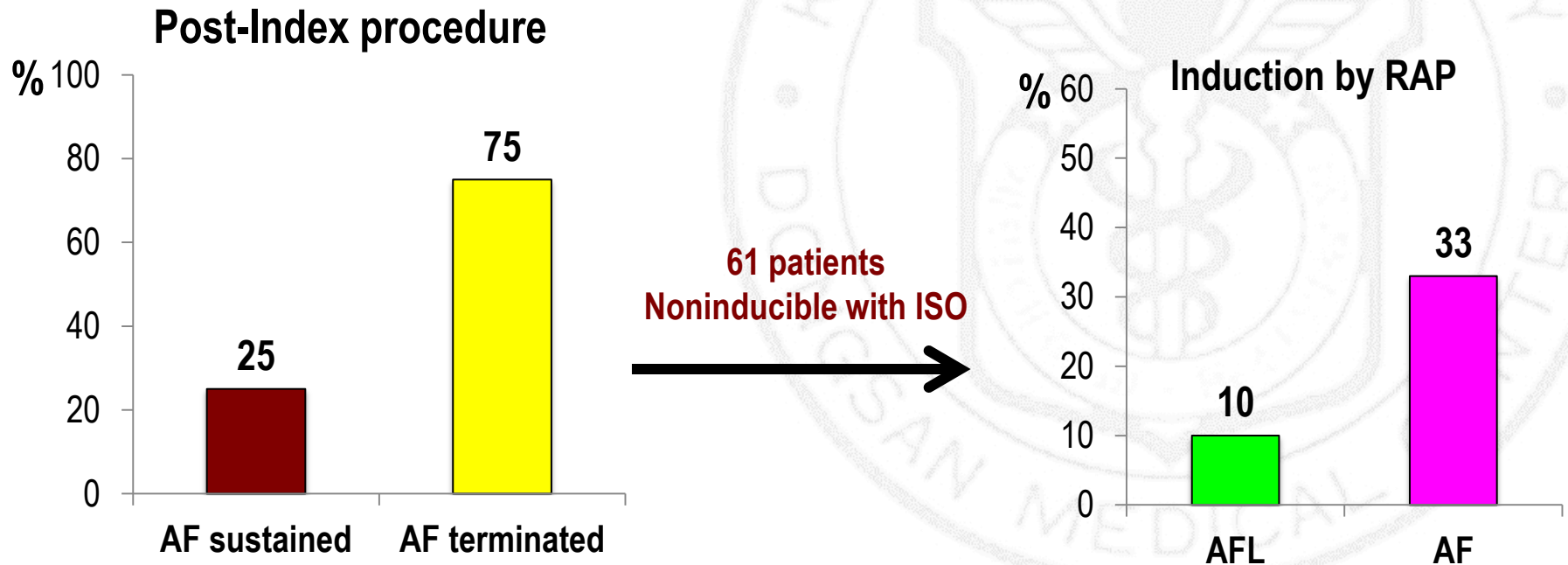
Inducibility of Paroxysmal Atrial Fibrillation by Isoproterenol and its Relation to the Mode of Onset of Atrial Fibrillation

- PAF vs control = 80:20
- AF inducibility = PAF vs control = 84% (67/80) vs 5% (1/20)
- Sensitivity 88%, Specificity 95%
- Must be assessed before & after ablation

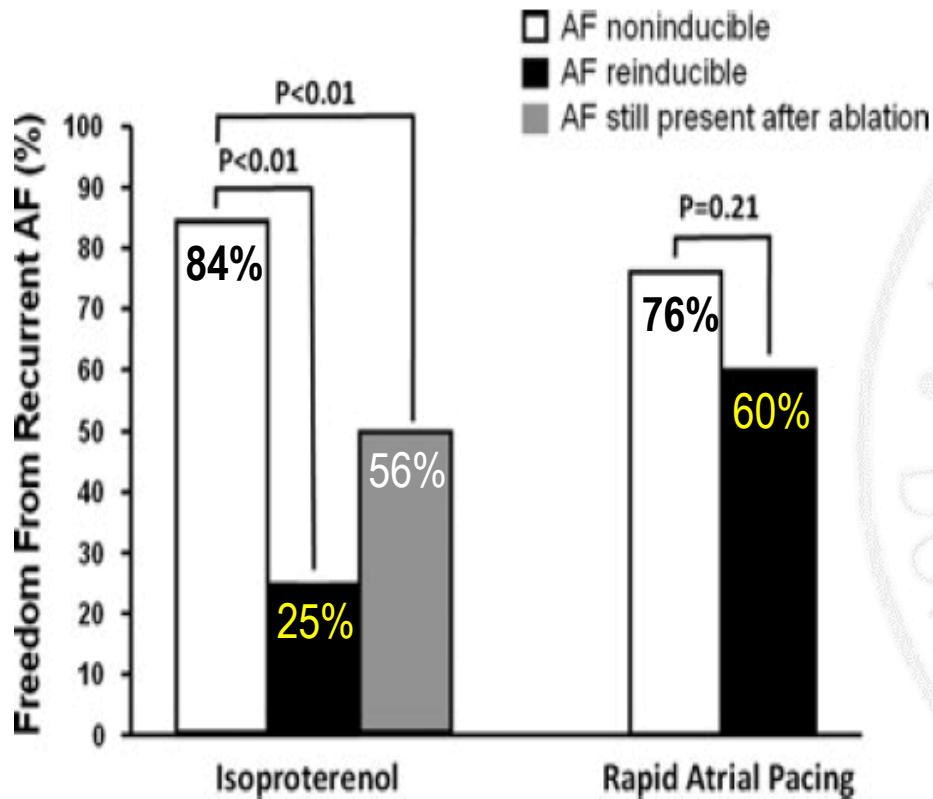


Clinical Value of Noninducibility by High-Dose Isoproterenol Versus Rapid Atrial Pacing After Catheter Ablation of Paroxysmal Atrial Fibrillation

- 112 patients with PAF: 12 ± 5 months FU
- AF was inducible in 87% (97/112) with up to 20 ug/min of ISO before ablation
- Index procedure during AF: antral PVI + CAFÉ ablation



Clinical Value of Noninducibility by High-Dose Isoproterenol Versus Rapid Atrial Pacing After Catheter Ablation of Paroxysmal Atrial Fibrillation



	Isoproterenol Induced AF After Catheter Ablation	Pacing Induced AF After Catheter Ablation	P
Sensitivity	33%	44%	0.73
Specificity	97%	72%	0.0002
Positive Predictive Value	75%	40%	0.21
Negative Predictive Value	84%	76%	0.27
Diagnostic Accuracy	83%	64%	0.03

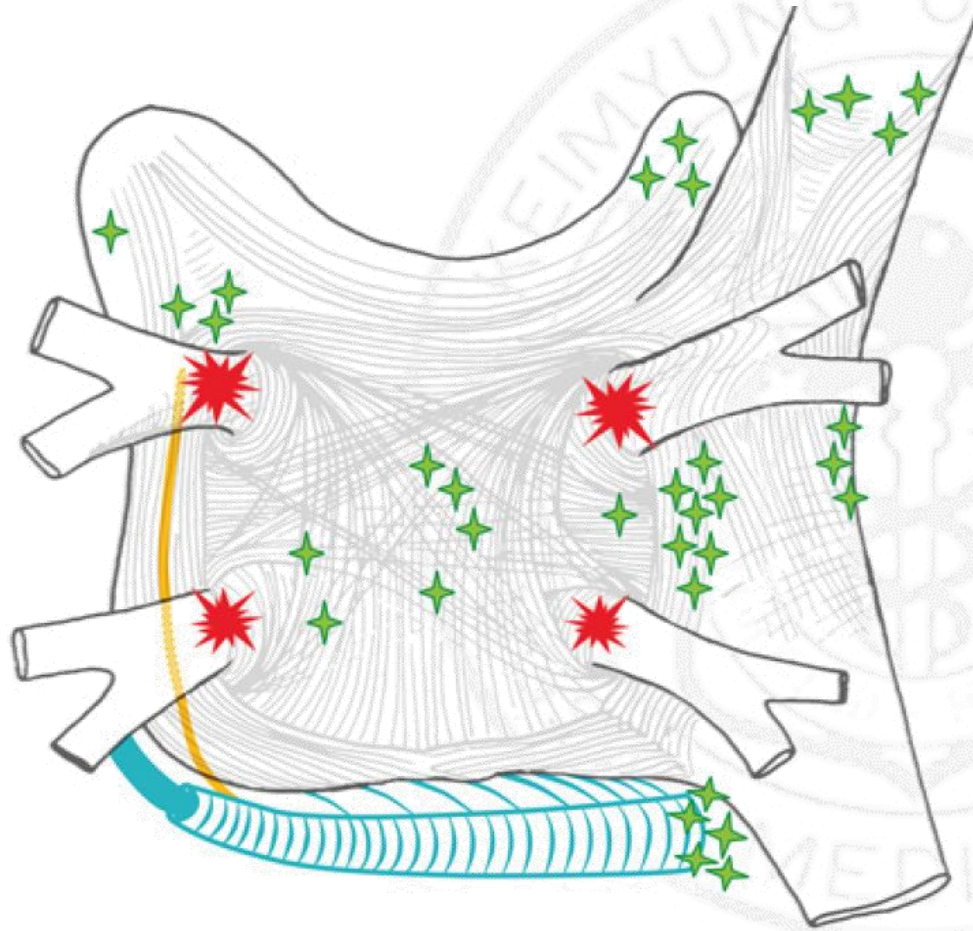
The response to isoproterenol after catheter ablation of PAF more accurately predicts clinical outcome than the response to RAP

Recommendations regarding ablation technique

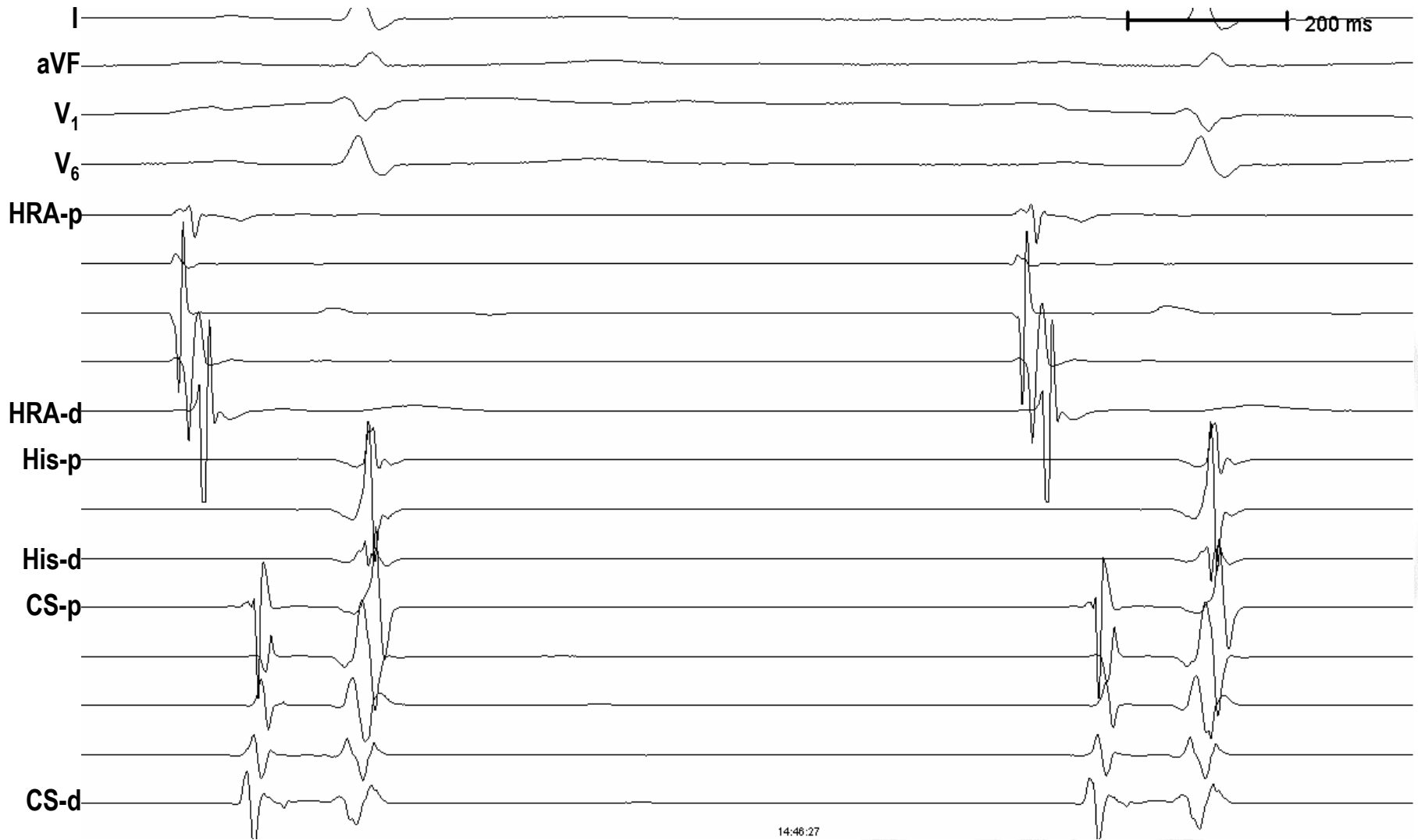
- ✧ Targeting the PVs and/or PV antrum is the cornerstone
- ✧ If the PVs are targeted, **electrical isolation** should be the goal (entrance block at a minimum)
- ✧ Monitoring for PV reconnection **for 20 minutes** following initial PV isolation should be considered
- ✧ If a **focal trigger is identified outside a PV** at the time of an AF ablation procedure, ablation of that focal trigger should be considered

Paroxysmal AF

Main target: focal triggers



Sinus rhythm



14:48:27

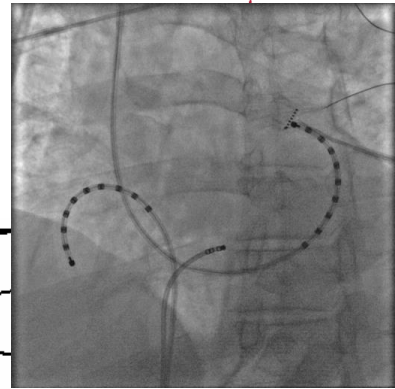
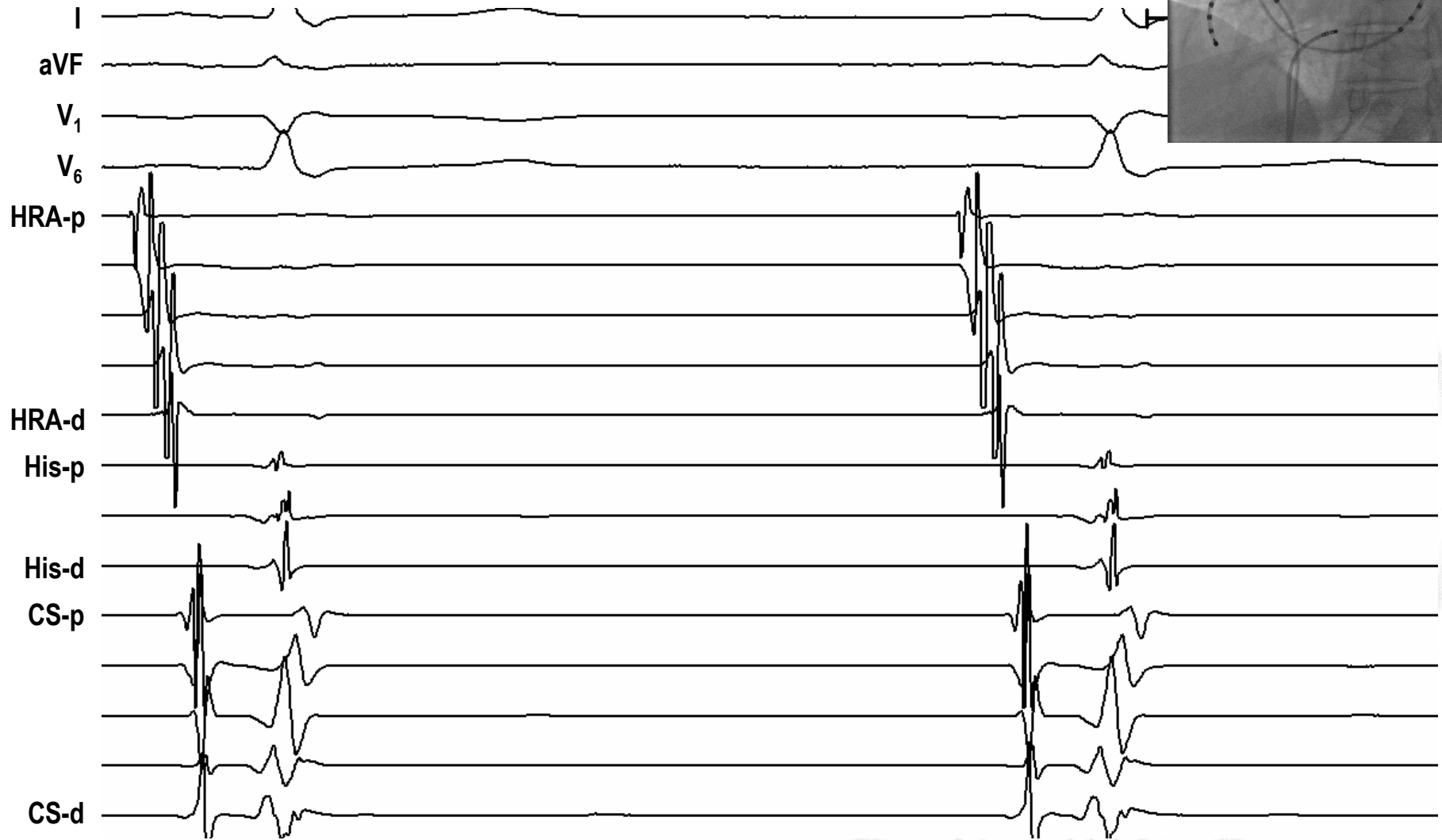
Spontaneous AT/AF



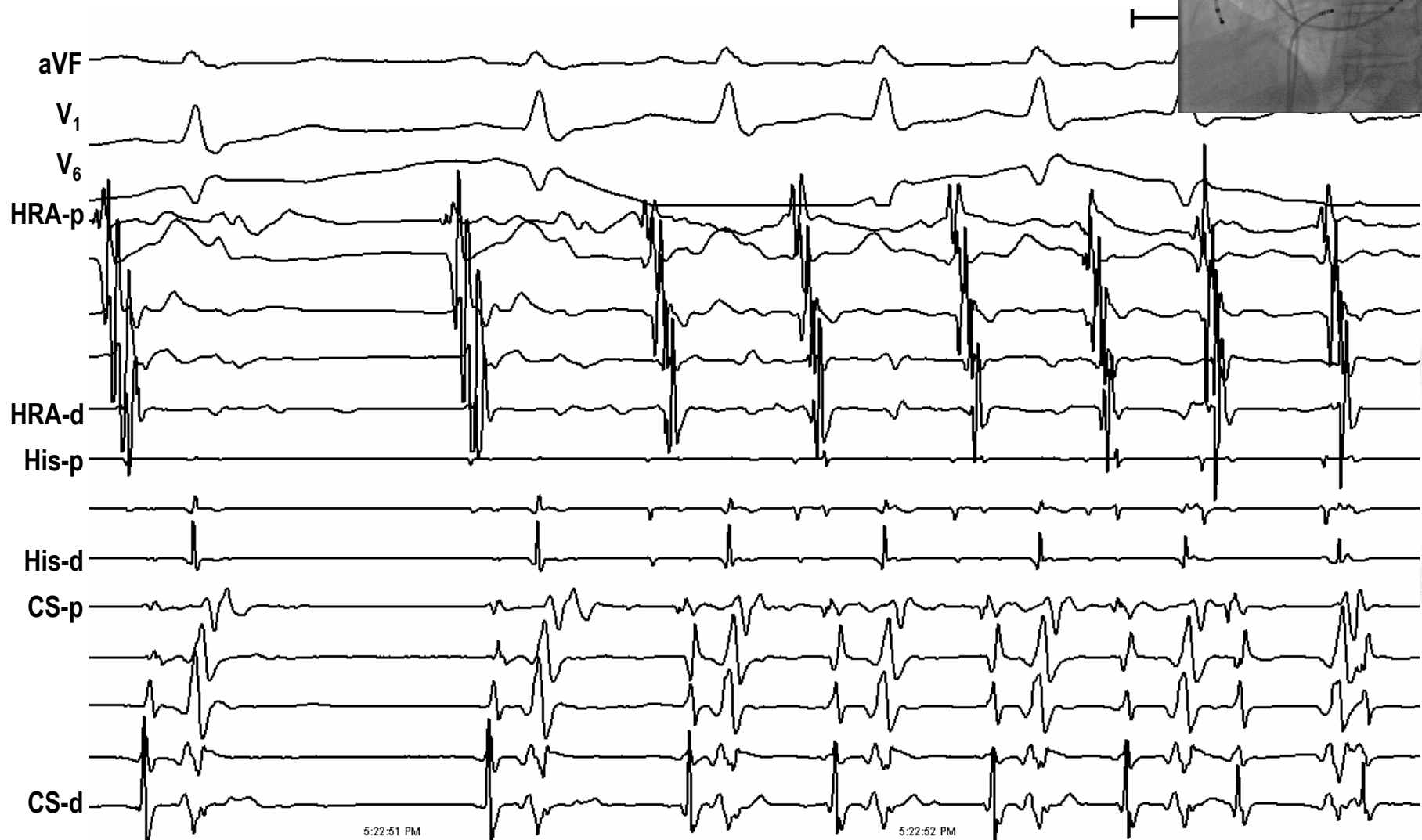
Spontaneous AT/AF from LS (71 msec early)



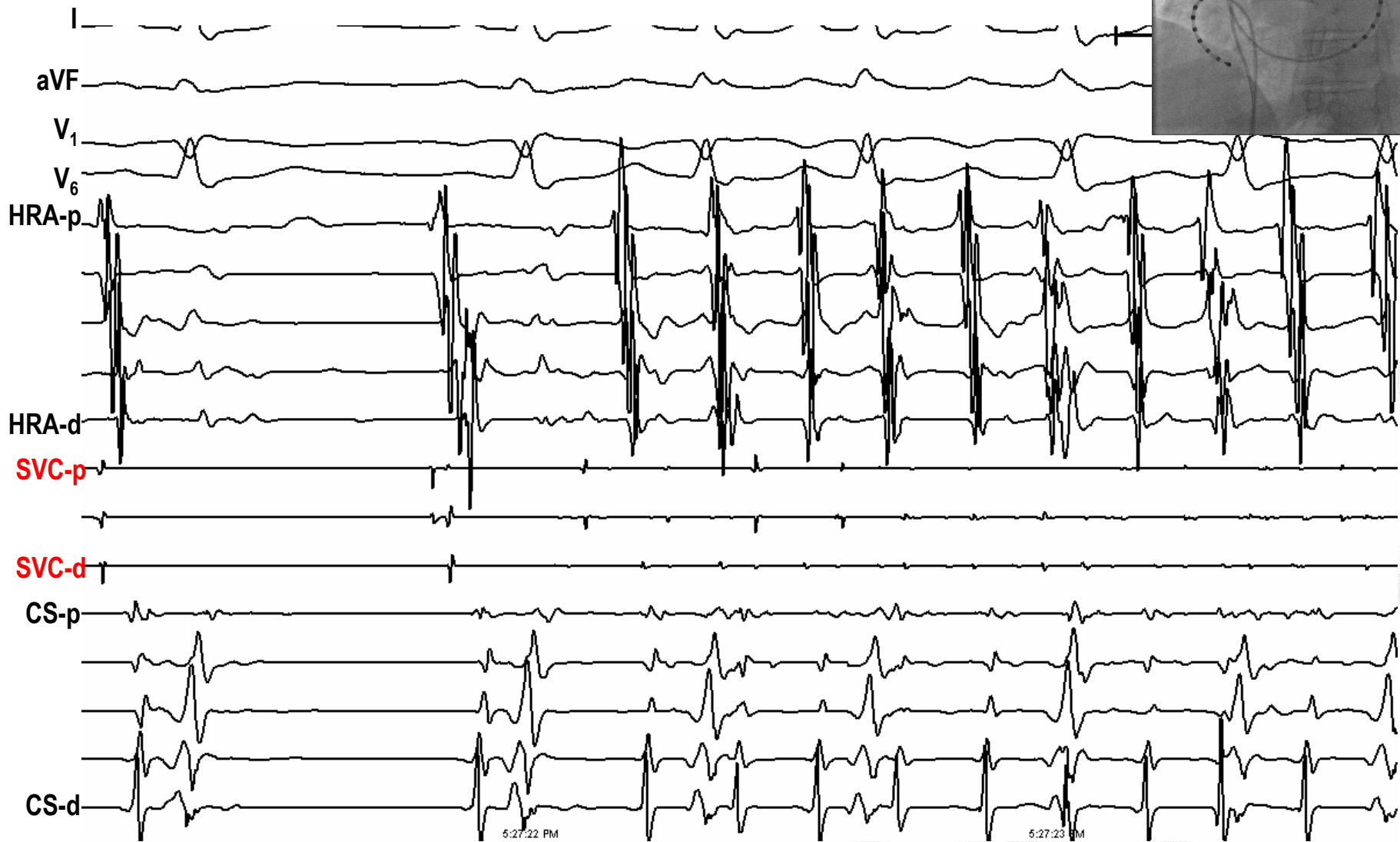
Sinus rhythm



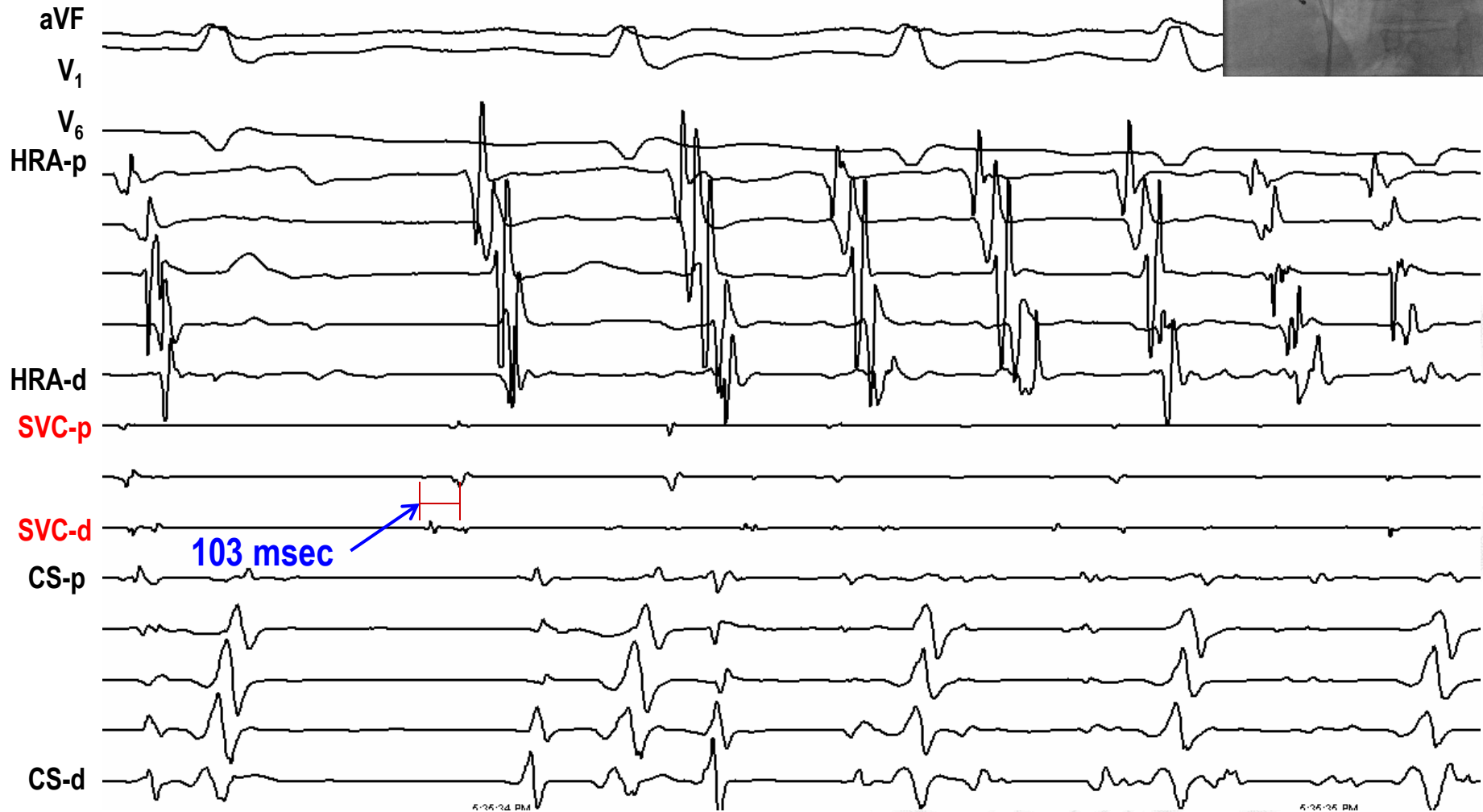
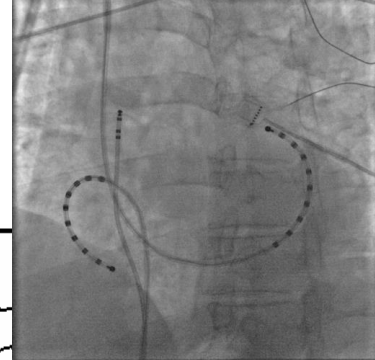
Spontaneous AT/AF



Spontaneous AT/AF with SVC signals

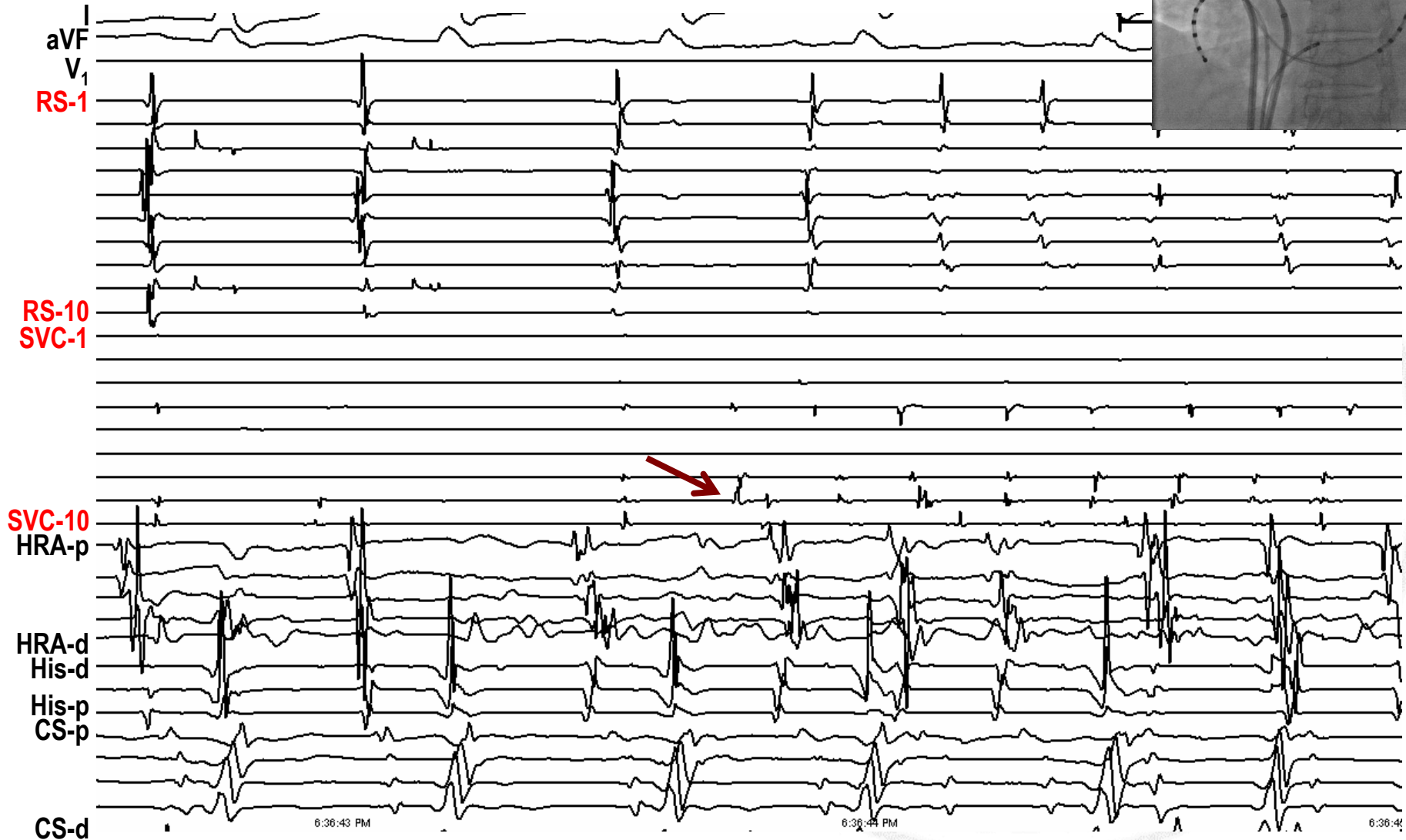
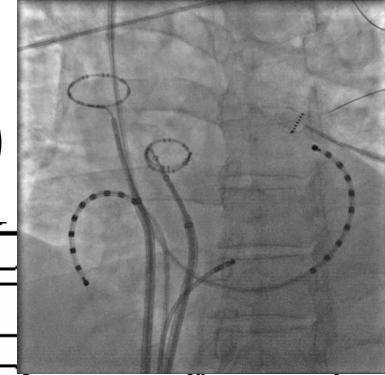


Spontaneous AT/AF with SVC signals

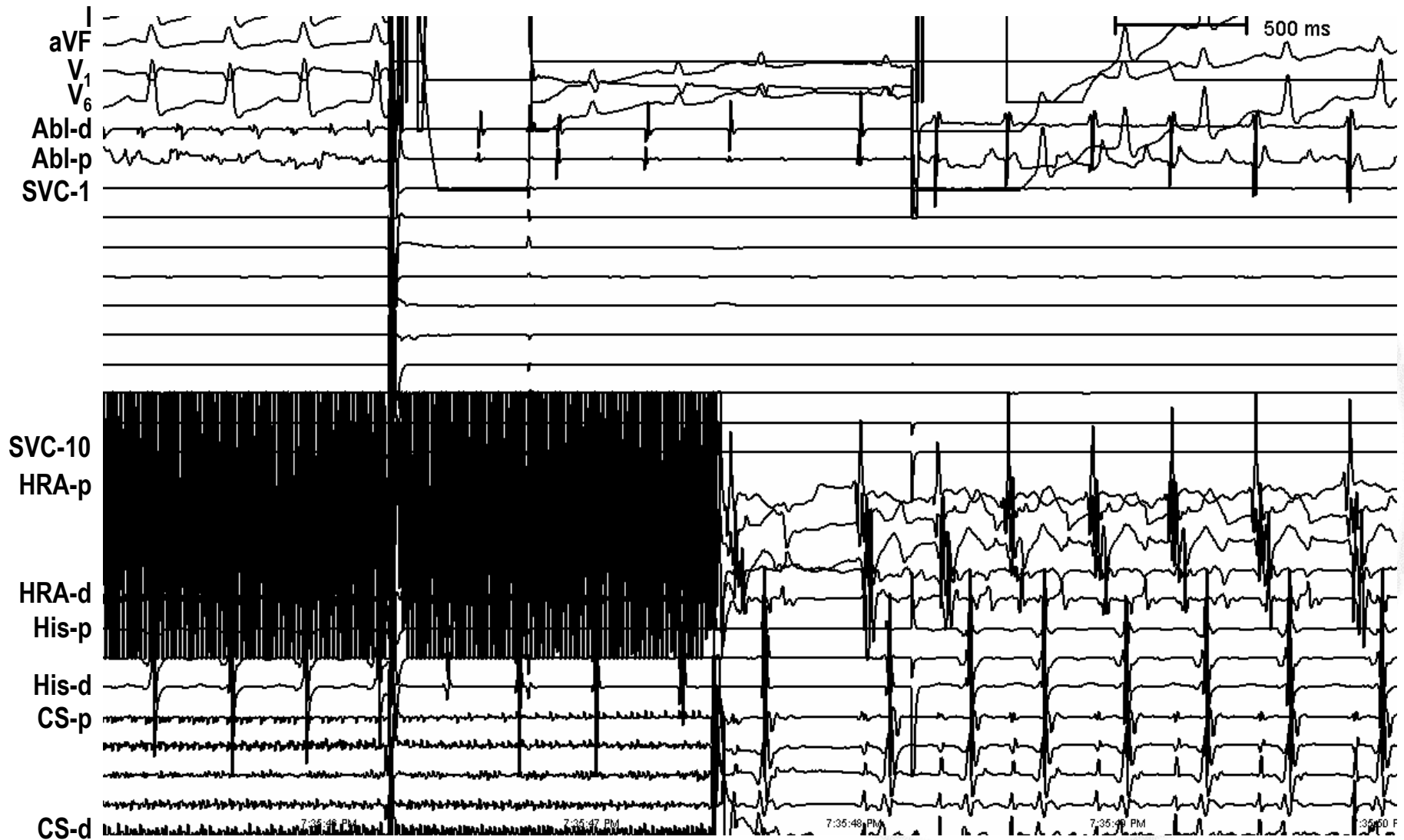


103 msec

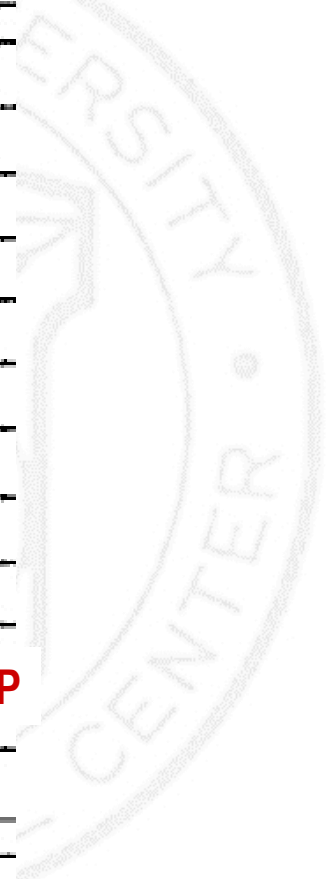
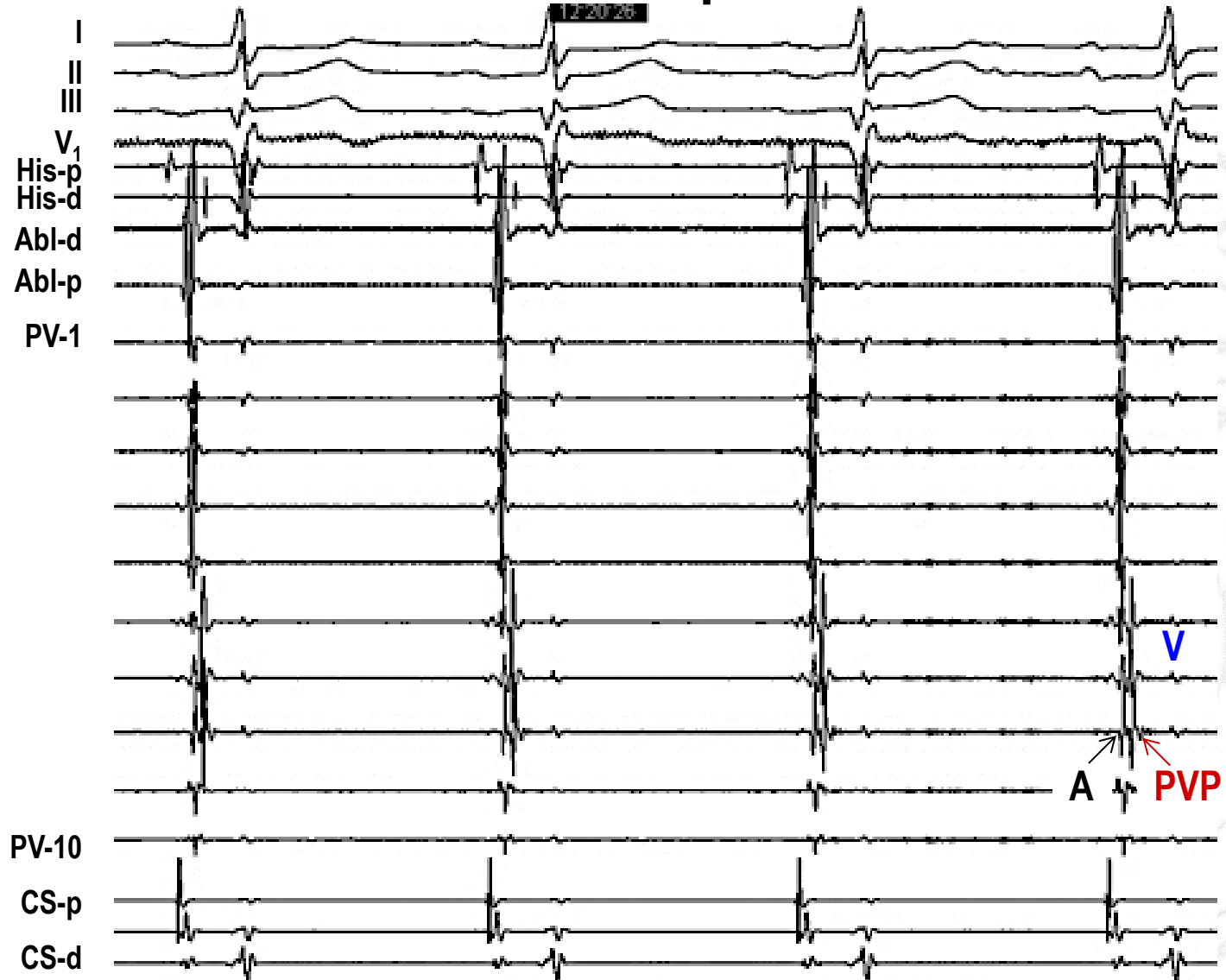
SVC trigger: Double Lasso (SVC, RSPV)



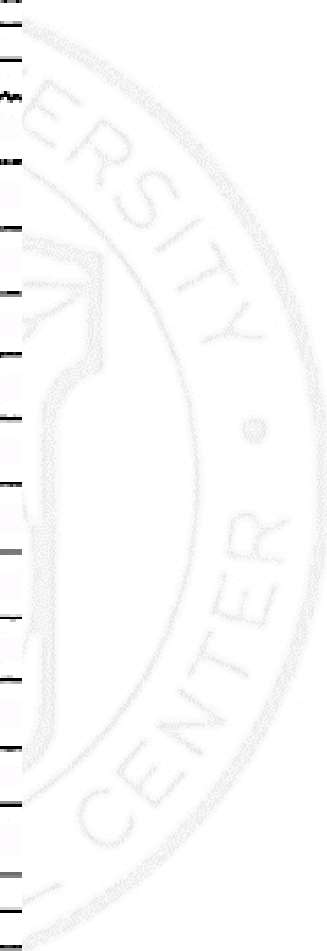
After isolation, No ERAF with isoproterenol



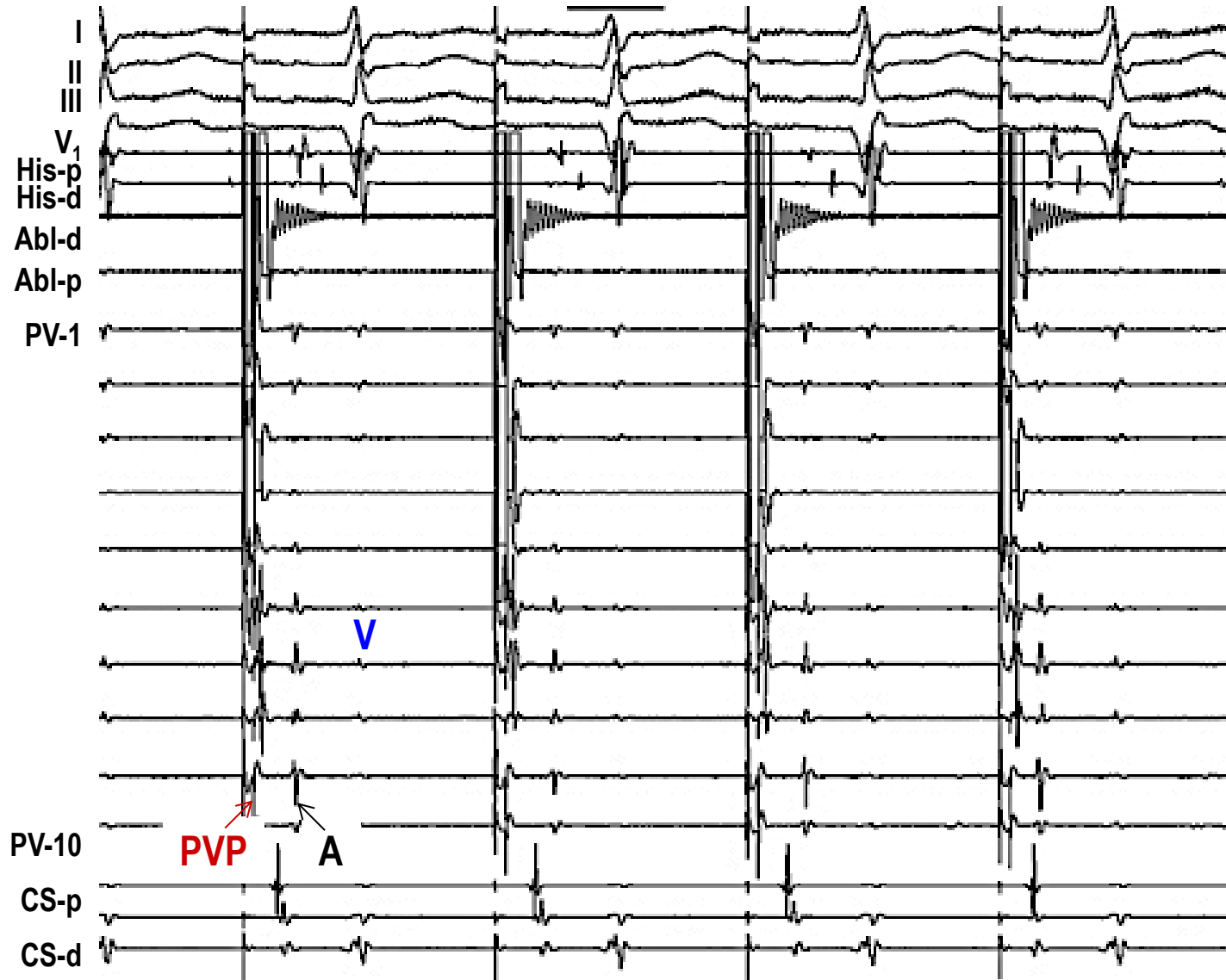
Baseline PV potentials



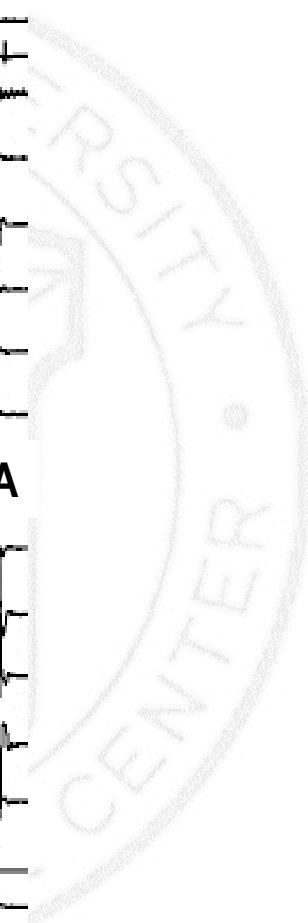
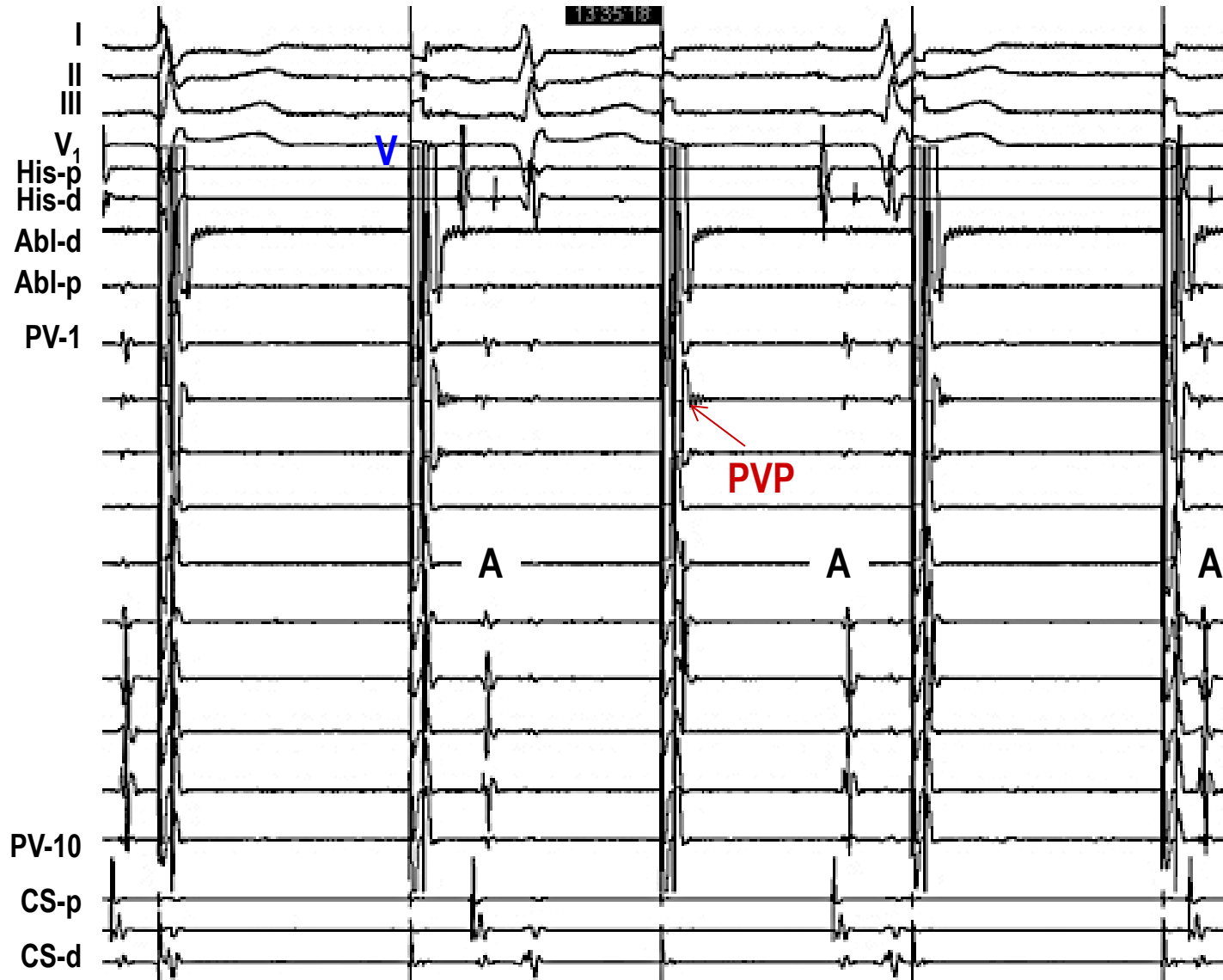
Entrance block by ablation



Conduction from PV to LA



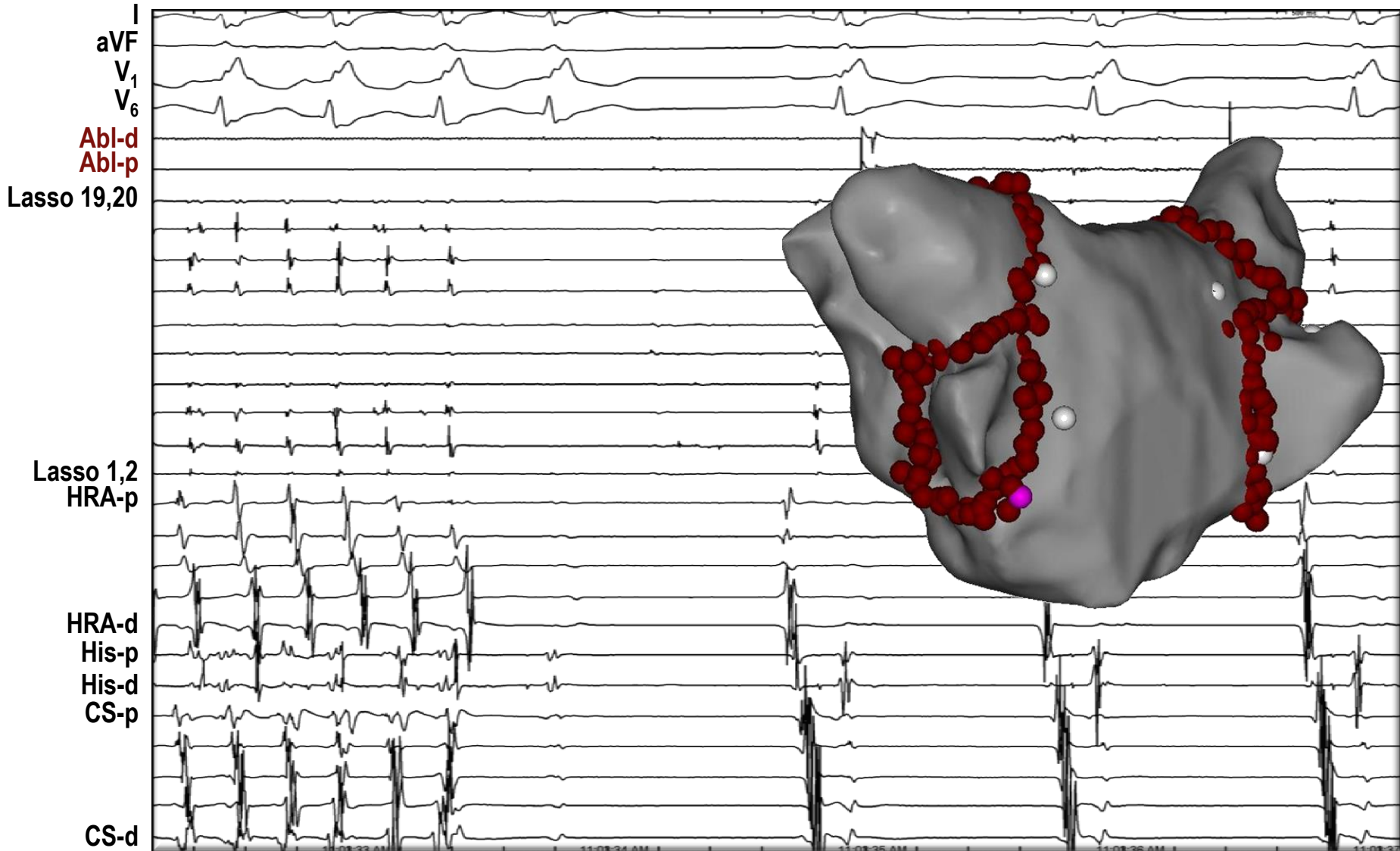
Exit block from PV



Inducibility as an end point

- AF induction by pacing or isoproterenol may be a predictor of AF recurrence
- Diagnostic accuracy is low
 - ✓ Rapid atrial pacing (RAP): lower specificity
 - ✓ Isoproterenol (ISO): lower sensitivity
- ISO: trigger, RAP: sustainability
- Non-inducibility may be a marker of less structural remodeling rather than an endpoint for ablation
- Limited data for persistent AF
- Cause of recurrence: PV reconnection

Termination of AF during ablation

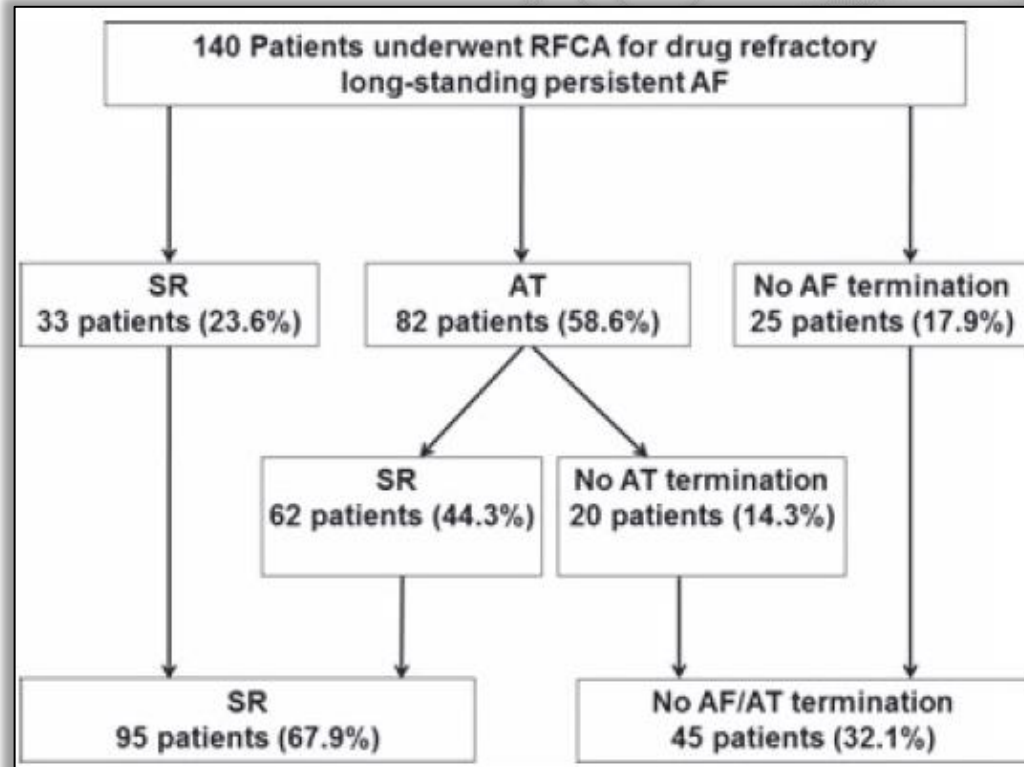


Rationale for termination of AF

- Termination of AF during ablation may result from elimination of a **focal driver** or adequate modification of the atrial **substrate** required to sustain AF
- Indicator of adequate modification of driver
- Could be used as an end point of ablation in Persistent AF
- Can be used as predictor of outcome of ablation

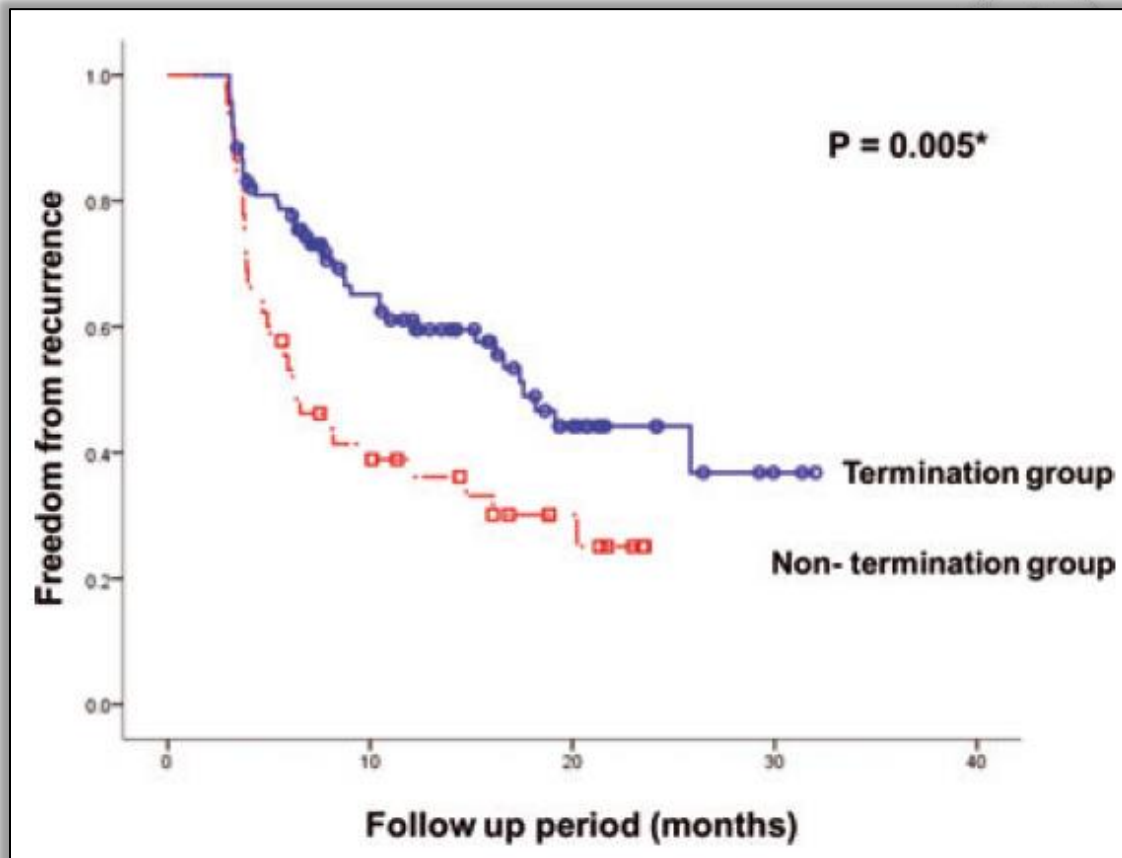
Is Pursuit of Termination of Atrial Fibrillation During Catheter Ablation of Great Value in Patients with Longstanding Persistent Atrial Fibrillation?

- 140 patients with longstanding persistent AF (LSPeAF)
- Index procedure:
Biantral ablation → CAFÉ ablation in LA & CS → CTI



Is Pursuit of Termination of Atrial Fibrillation During Catheter Ablation of Great Value in Patients with Longstanding Persistent Atrial Fibrillation?

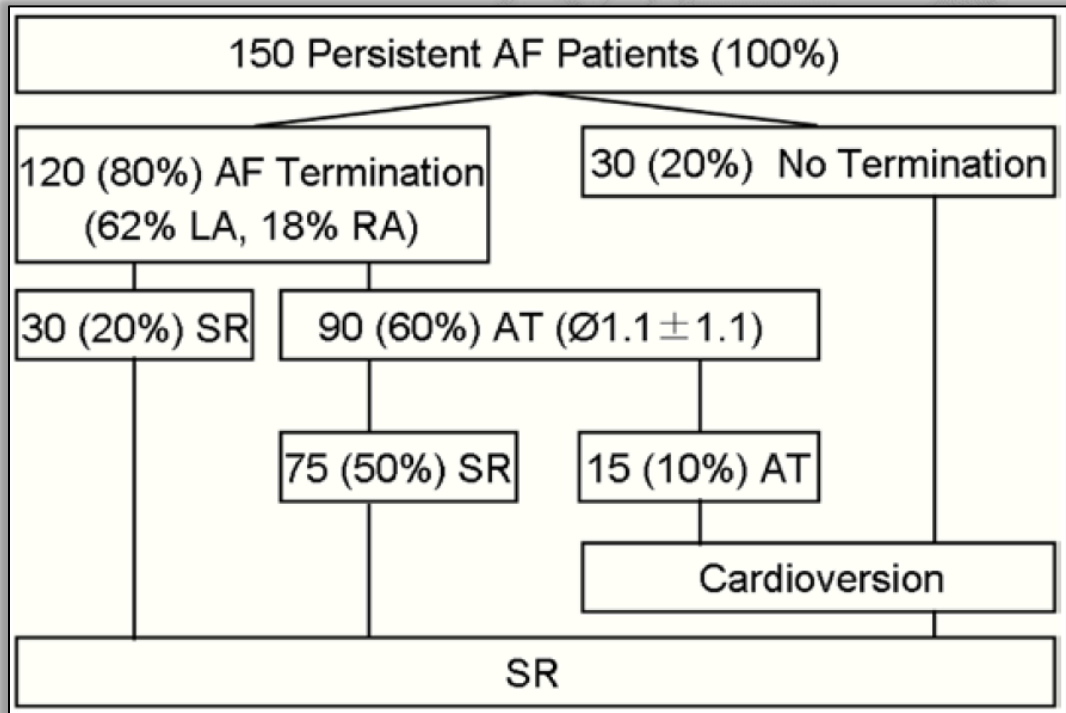
- Recurrence of termination vs non-termination group
45.3% vs 68.9% @ 18.7 ± 7.6 Months FU



Termination of AF has a better clinical outcome in patients with LSPeAF

Five-Year Outcome of Catheter Ablation of Persistent Atrial Fibrillation Using Termination of Atrial Fibrillation as a Procedural Endpoint

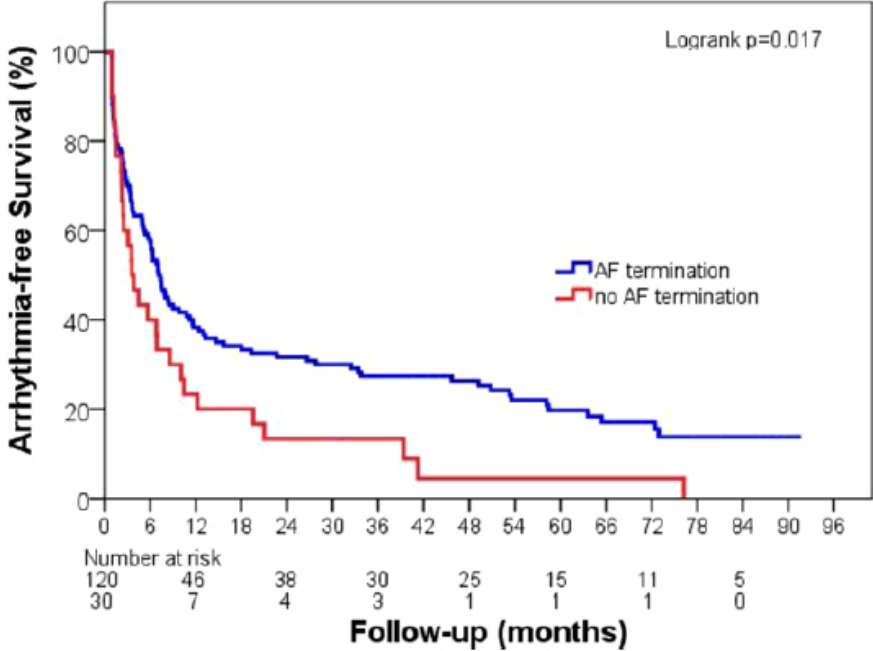
- 150 patients with PeAF; mean 2.1 ± 1.0 procedures
- Index procedure
 Biantral ablation → CAFÉ ablation in LA → inside CS → roof → MI → CAFÉ ablation in RA → CTI



Five-Year Outcome of Catheter Ablation of Persistent Atrial Fibrillation Using Termination of Atrial Fibrillation as a Procedural Endpoint

AF termination is associated with freedom from arrhythmia recurrence in PeAF

Single procedure outcome

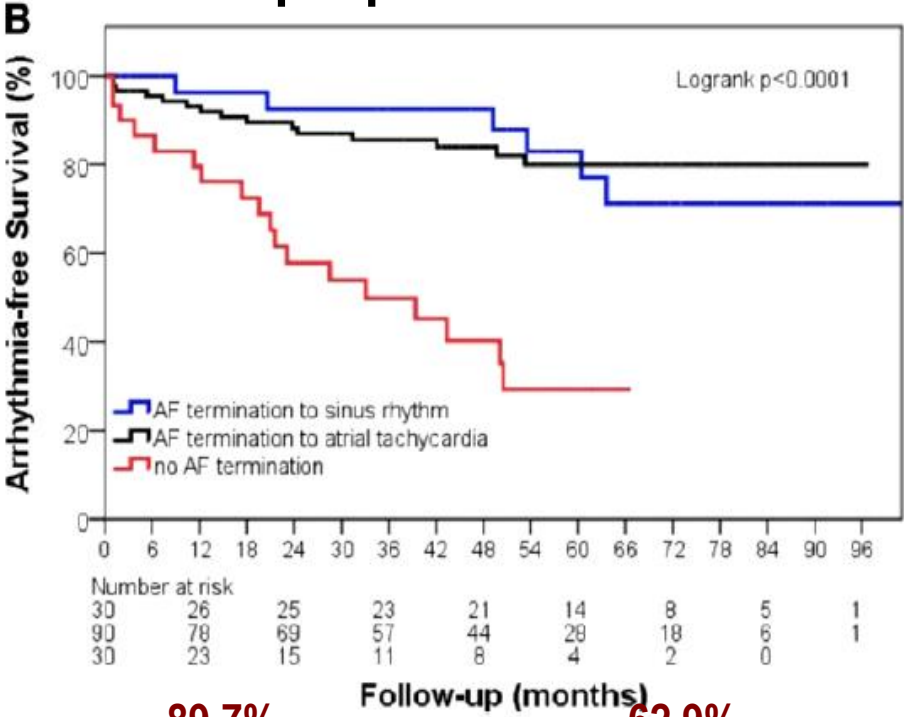


35.3%

16.8%

28.0%

multiple procedure outcome



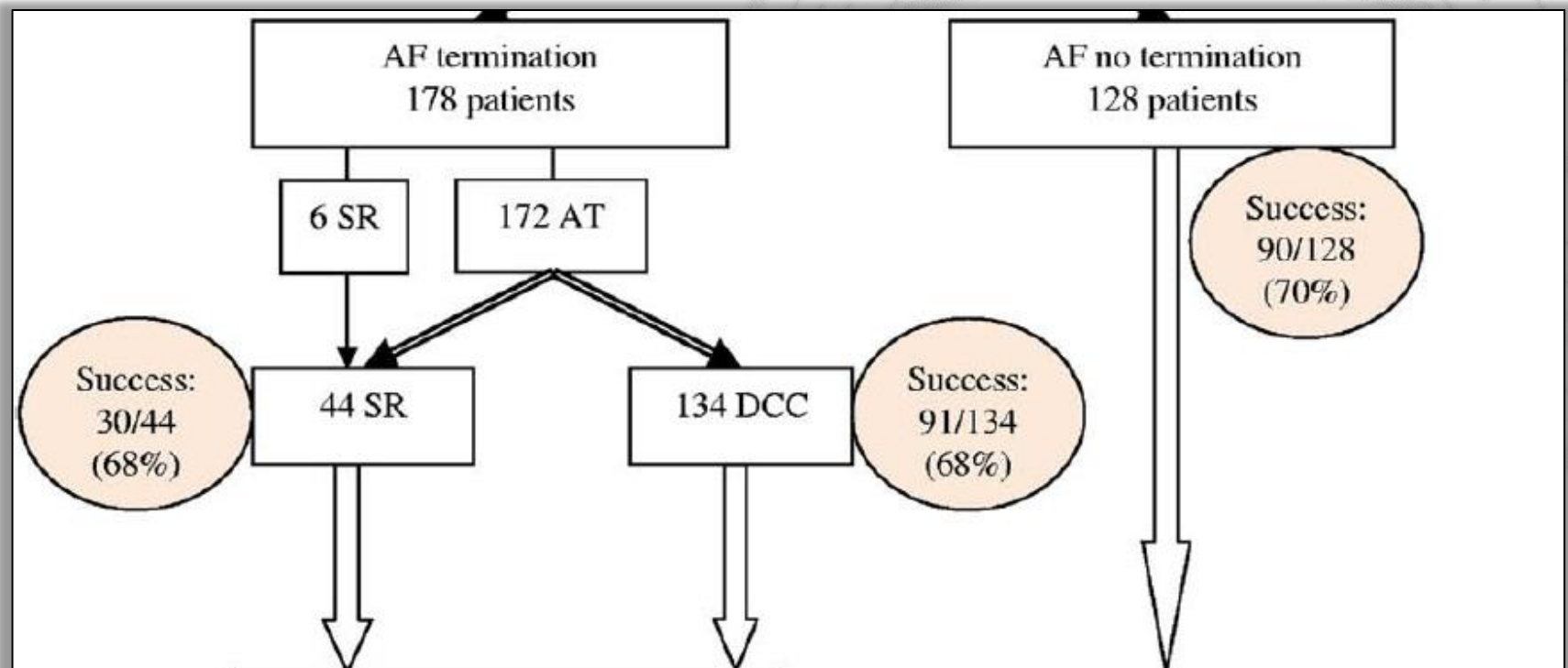
89.7%

62.9%

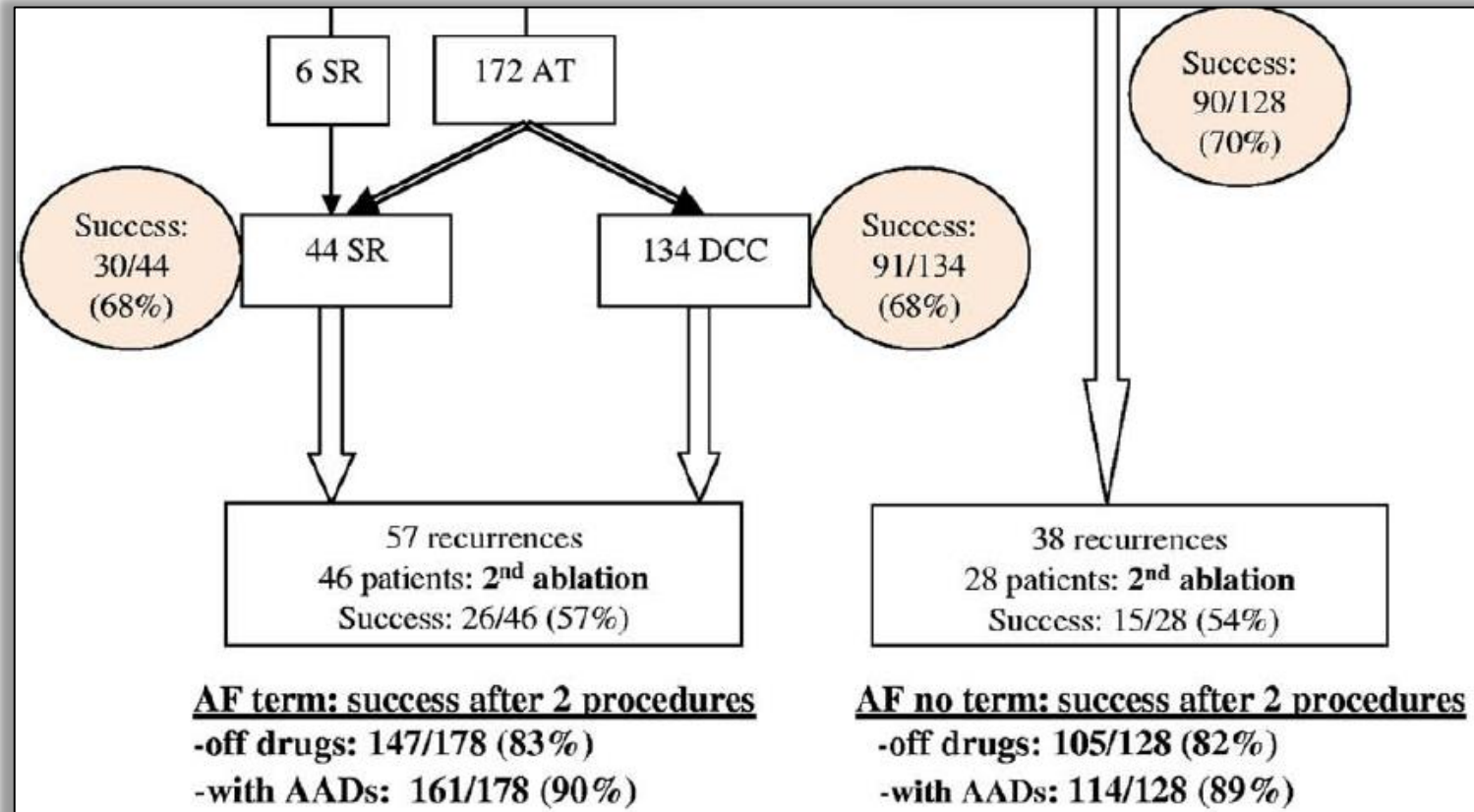
79.8%

Atrial fibrillation termination as a procedural endpoint during ablation in long-standing persistent atrial fibrillation

- 306 patients with PeAF; 25 ± 6.9 Months FU
- Index procedure
PV antral isolation with posterior wall & SVC isolation → CAFÉ ablation in LA & CS



Atrial fibrillation termination as a procedural endpoint during ablation in long-standing persistent atrial fibrillation

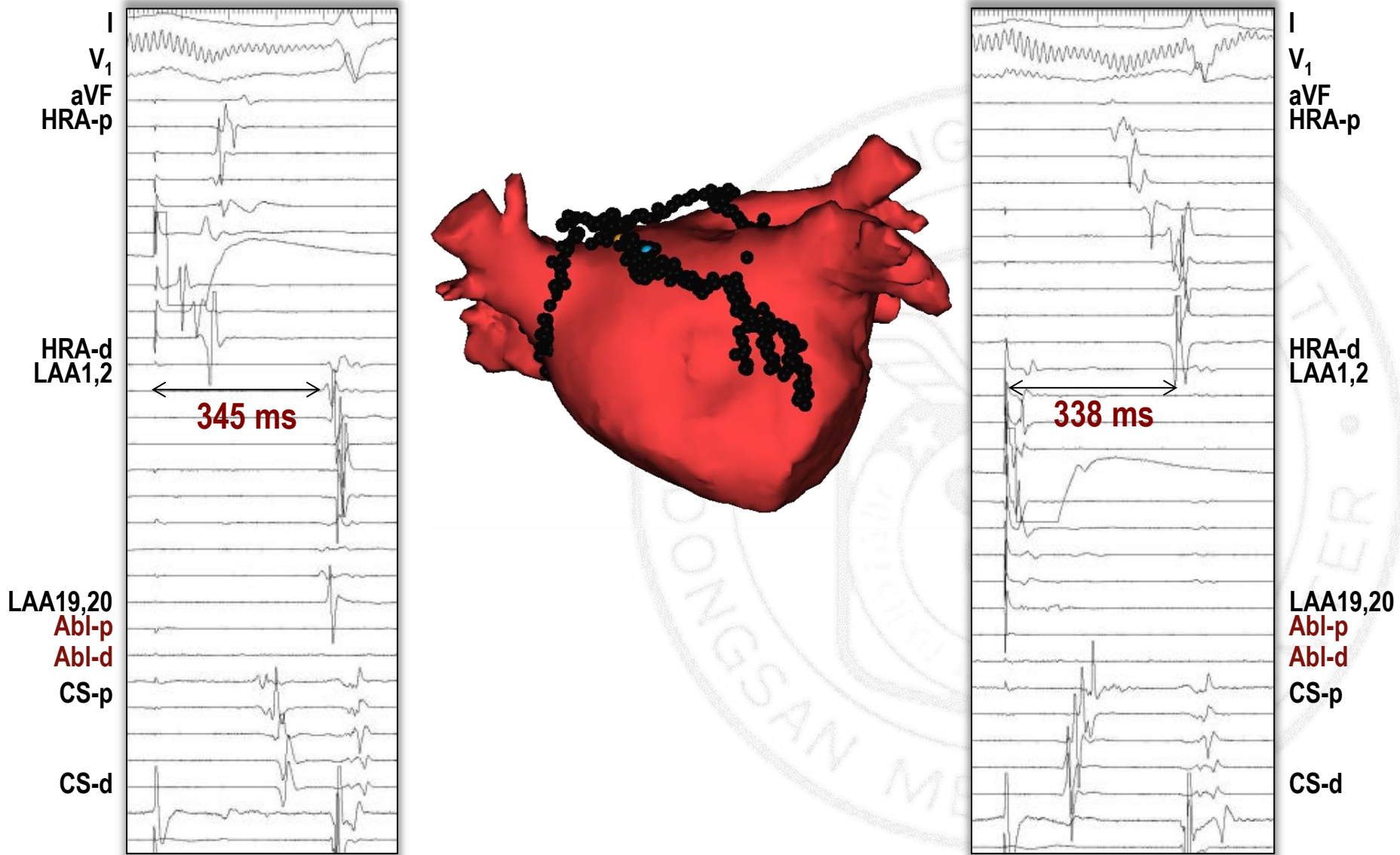


- AF termination during ablation (conversion to AT or SR) could predict the mode of arrhythmia recurrence (AT vs. AF)
- Did not impact the long-term SR maintenance after one or two procedure

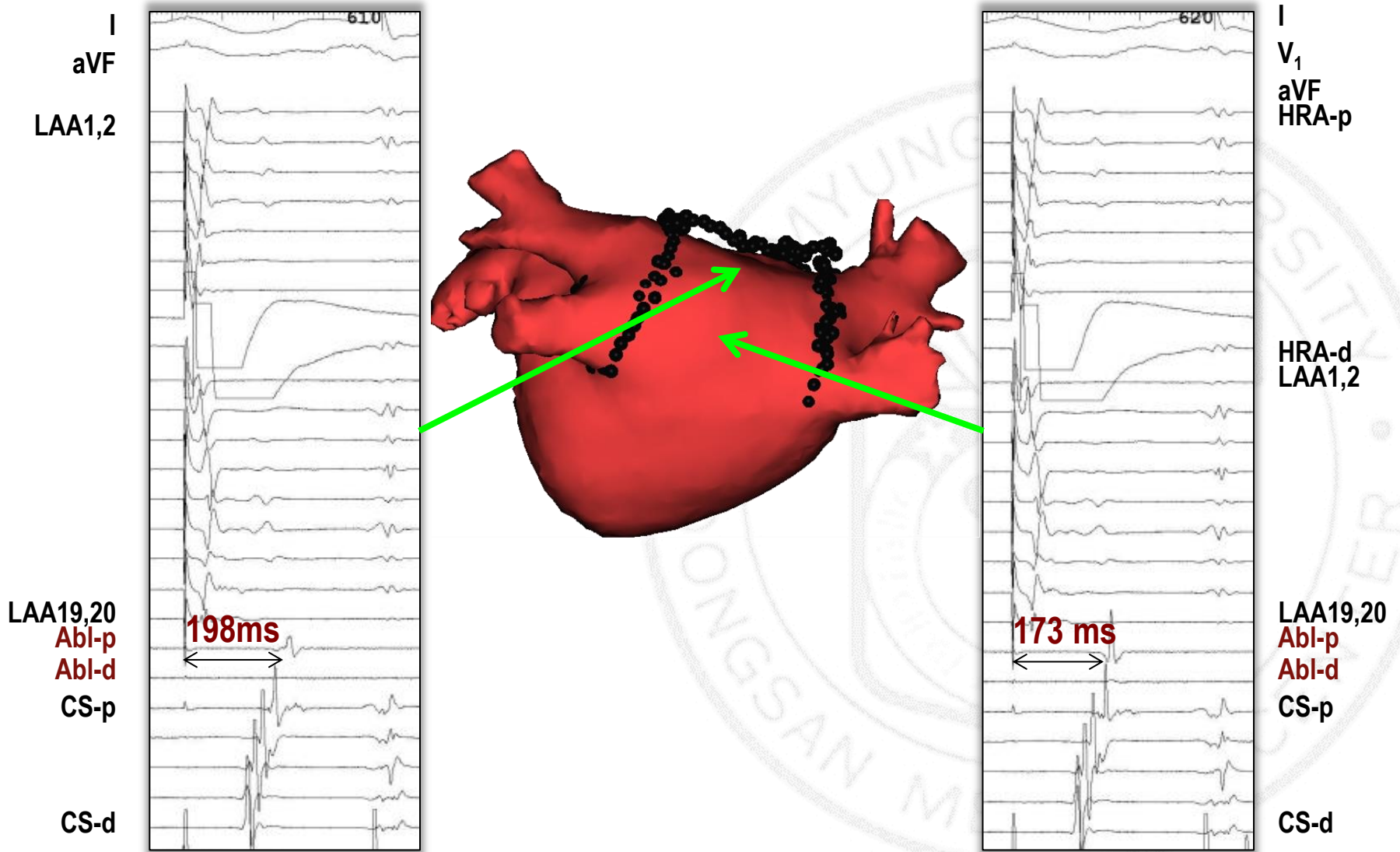
Recommendations regarding ablation technique

- ✧ If additional linear lesions are applied, operators should consider using mapping and **pacing maneuvers to assess for line completeness**
- ✧ **CTI ablation** is recommended in patients with a history of typical AFL or inducible typical AFL
- ✧ If patients with longstanding persistent AF are approached, operators should consider **more extensive ablation** based on linear lesions or complex fractionated electrograms

Bidirectional block @ anterior line



Block @ roof line



Termination of AF as an end point

- Indicator of adequate modification of driver
- Could be used as an end point of ablation in Persistent AF
- Can be used as predictor of outcome of ablation
- Issues are
 - ✓ Hard to discriminate from the degree of structural remodeling & electrical remodeling
 - ✓ Remodeling process is dynamic
 - ✓ Reverse electrical remodeling needs certain time of sinus rhythm
- Recurrent AT/FL: Lesion incompleteness, reconnections

Summary

- Inducibility by Isoproterenol for triggers seems to be working for paroxysmal AF
- Evidence for non-inducibility by rapid atrial pacing or termination is mixed
- Those may be markers of less structural remodeling rather than true end-point
- Ablation strategy may be helped if we have good tool to evaluate the degree of structural remodeling

A detailed architectural rendering of the Dongsan Medical Center. The image shows a large, modern multi-story building with a glass facade, surrounded by other medical buildings, trees, and a parking area. The sky is overcast.

THANK YOU for YOUR ATTENTION

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