

Fire Vs. Freeze

is it really a choice?

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Disclosures:
Consultant and proctor for St Jude Medical
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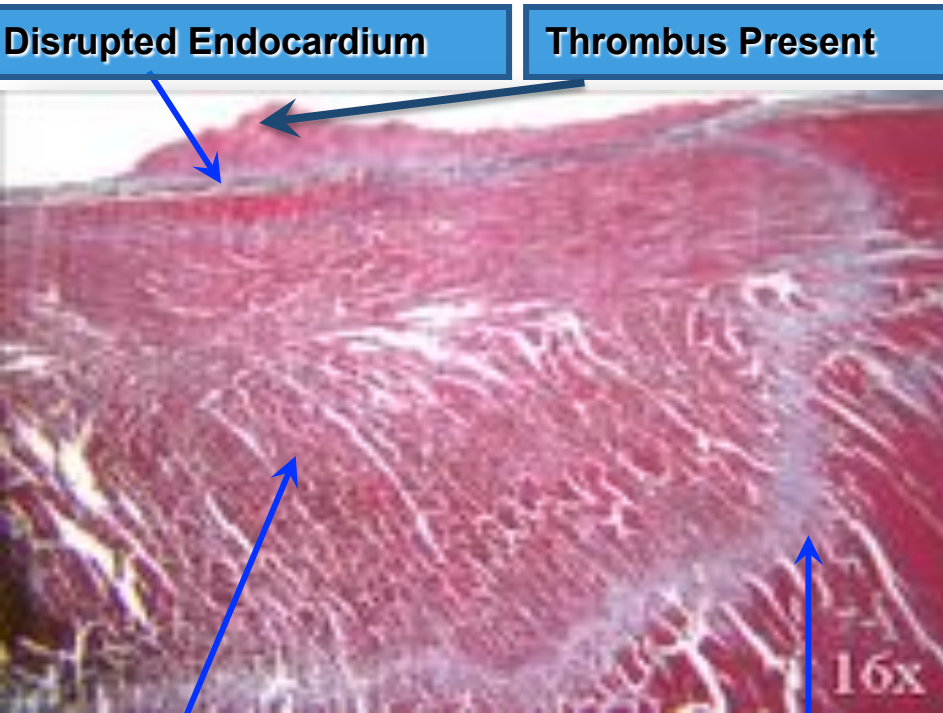


Biophysics !

KHAIRY ET AL CIRCULATION 2003

22 Mongrel Dogs
Up to 200 RF/Cryo lesions studied

Focal Cryo Vs. RF standard (not irrigated)

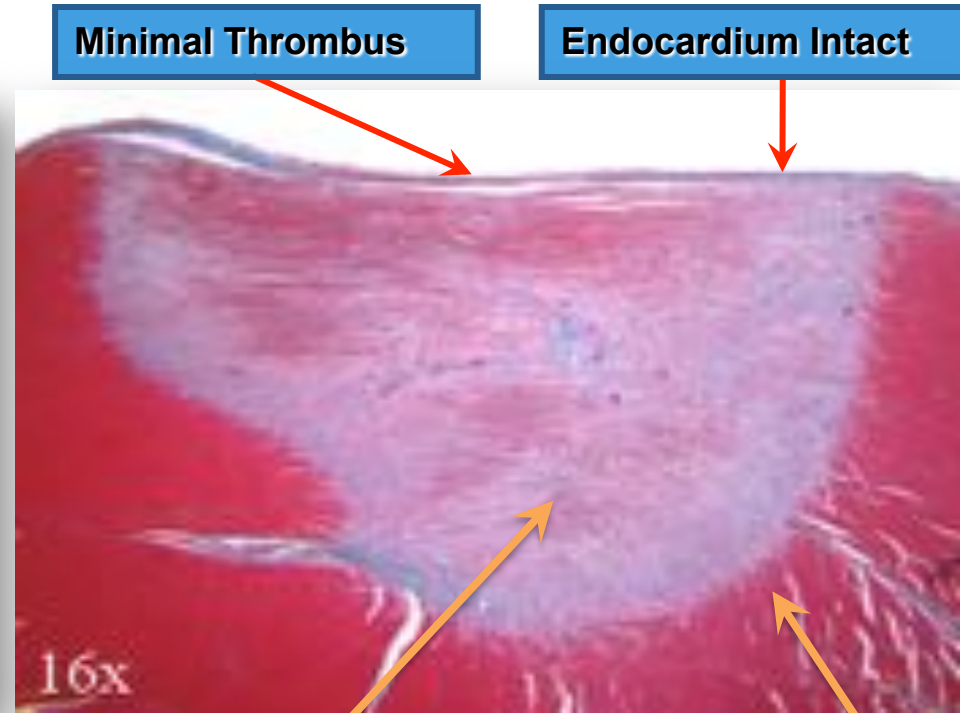


Hemorrhage Still Present

Fibrosis Started

RF Lesion at 1 Week (canine model)

+70°C • 50 W • 60 seconds



Fibrosis Complete

Well Demarcated

Cryolesion at 1 Week (canine model)

-75°C • 1 x 4 minutes

Fire vs Freeze: cellular damage and inflammatory response

Cellular damage, platelet activation, and inflammatory response after pulmonary vein isolation: A randomized study comparing radiofrequency ablation with cryoablation

Table 1 Patient characteristics

	Cryoballoon (n = 30)	Radiofrequency ablation (n = 30)	P value
Mean age (y)	57 ± 8	56 ± 10	.517
Males	25 (83.3%)	23 (76.7%)	.519
Paroxysmal AF	21 (70.0%)	17 (56.7%)	.284
History of AF (y)	4.2 ± 2.7	5.6 ± 4.2	.124
Failed AAD	2.9 ± 1.8	2.7 ± 2.2	.658
Organic heart disease (%)	8 (26.7%)	11 (36.7%)	.405
	CHD 3	CHD 4	
	HOCM 1	HCMP 1	
	Tachymyopathy 1	Tachymyopathy 2	
	Valvular 2	Valvular 4	
	DCMP 1		
Hypertension (%)	12 (40.0%)	11 (36.7%)	.305
Left atrium (mm)	41.2 ± 5.1	41.5 ± 5.2	.905

Table 3 Summary of global effect of ablation (area under curve) on all different laboratory parameters

	Cryoballoon (n = 30)	Radiofrequency ablation (n = 30)	P value
High-sensitive troponin T (ng/mL·h ⁻¹)	32.7 ± 11.5	37.8 ± 15.3	.153
Total MP captured onto annexin V (nM PhtdSer·h ⁻¹)	362 ± 107	341 ± 91	.410
Platelet-derived MPs (nM PhtdSer·h ⁻¹)	146 ± 51	144 ± 68	.891
Leukocyte-derived MPs (nM PhtdSer·h ⁻¹)	207 ± 44	217 ± 87	.585
Endothelial-derived MPs (nM PhtdSer·h ⁻¹)	40.8 ± 12.5	37.7 ± 17.2	.430
			.559
			.644
			.558
			.782

CONCLUSION Cryoablation and RF energy result in a comparable rise of markers of cell damage, platelet activation and inflammatory response. The data do not support the concept of an improved safety profile for cryoablation in PVI.

Trial STOP AF

Cryoballoon Ablation of Pulmonary Veins for Paroxysmal Atrial Fibrillation

First Results of the North American Atrial Fibrillation (STOP AF) Diverted Trial

All serious adverse events: cryoablation 12.3%; drug Rx 14.6% P=0.69

Type of Adverse Event	Drug Treatment (N = 82)		Cryoablation (N = 163)		All Cryoballoon-Treated (N = 228)	
	No. of Events	%	No. of Cryoablation Events	%	All Events	%
Stroke	0	0.0	4	2.5	5	2.2
TIA	0	0.0	3	1.8	4	1.8
Tamponade	0	0.0	1	0.6	2	0.9
Myocardial infarction	0	0.0	2	1.2	2	0.9
Hemorrhage requiring transfusion	1	1.2	3	1.8	3	1.3
New atrial flutter	12	14.6	6	3.7	8	3.5
Atrial esophageal fistula	0	0.0	0	0.0	0	0.0
Death	0	0.0	1	0.6	1	0.4
New or worsened arteriovenous fistula	0	0.0	2	1.2	2	0.9
Pseudoaneurysm	0	0.0	1	1.6	2	0.9
Phrenic nerve palsy	0	0.0	22	13.5	28	12.3
Persistent phrenic nerve palsy	0	0.0	4	2.5	4	1.8
PV stenosis	0	0.0	6	3.1	7	3.1

1STOP project

Arctic Front Advance SAFETY PROFILE

Table 3 Acute Adverse Events

Adverse Event	Total	Arctic Front Advance (n=122)		p-value
		23-mm Balloon	28-mm Balloon	
PNP	12 (2%)	10	2	0.263
PNP in last 420 patients	3 (0.7%)	2	1	----
Transient PNP during cryoablation procedure	15 (2.5%)	8	7	0.036
Asymptomatic PV stenosis	2 (0.3%)*			----
Stroke	2 (0.3%)†			----
Hemoptysis with hematoma/edema around PVs	10 (1.7%)			0.8% (1/ 122)
Pericardial tamponade	1 (0.2%)			0.0% (0/ 122)
Pericardial effusion (transseptal puncture)	1 (0.2%)			0.0% (0/ 122)
				0.0% (0/ 122)
				0.0% (0/ 122)
				1.6% (2/ 122)

*One distal, 1 after additional radiofrequency ablation. †Air embolisms; full recoveries.
PNP = phrenic nerve palsy; PV = pulmonary vein.

Incidence and Significance of Early Recurrences of Atrial Fibrillation After Cryoballoon Ablation

Insights From the Multicenter Sustained Treatment of Paroxysmal Atrial Fibrillation (STOP AF) Trial

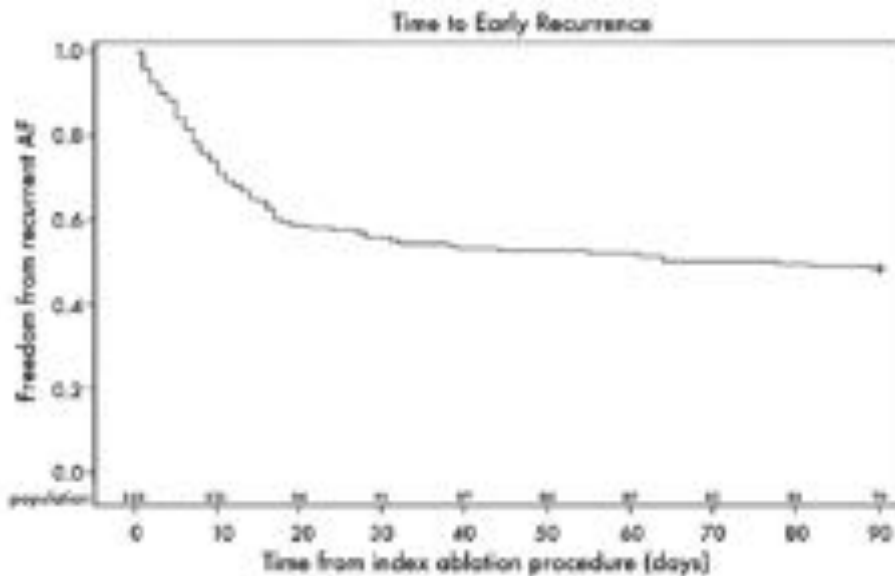


Figure 1. Time to first atrial fibrillation recurrence within the first 3 months of index cryoballoon ablation.

Table 2. Univariate and Multivariable Factors Associated with Recurrence After AF Ablation as Stratified by Timing of Recurrence

	Univariable Analysis			Multivariable Analysis		
	HR	95% CI	P Value	HR	95% CI	P Value
Early recurrence (<3 mo of index AF ablation)						
Male sex	2.18	1.03–4.61	0.041	2.18	1.03–4.61	0.0409
Late recurrence (from 3 to 12 mo post-index AF ablation)						
Current tobacco use	3.18	1.65–6.13	<0.001	3.17	1.64–6.10	0.0006
LA size, mm	1.20*	1.05–1.38	0.007			
Early recurrence (<90 d)			<0.001†			
Late recurrence after early recurrence						
Current tobacco use	4.10	1.99–8.44	<0.001	3.84	1.82–8.11	0.0004
Coronary artery disease	3.57	1.24–10.26	0.018			
Previous myocardial infarction	4.05	1.40–11.74	0.010			
LA size in mm	1.21*	1.05–1.41	0.009			
Early reablation	0.04	<0.01 to 0.31	0.002	0.04	0.01–0.32	0.002

$P < 0.001$; Table 2). Conversely, early reablation (adjusted HR, 0.04; 95% CI, 0.01–0.32; $P = 0.002$) was independently associated with a lower risk of LR on multivariable analysis. Although a history of coronary artery disease (HR, 3.57;

- 52% had recurrent AF within the first 3 months of follow-up
- In the majority of patients, the first episode of ERAF occurred within the first month (72, 86% of those with ERAF) and particularly within the first 10 days (42, 50% of those with ERAF).

The COR trial: A randomized study with continuous rhythm monitoring to compare the efficacy of cryoenergy and radiofrequency for pulmonary vein isolation

Table 1 Baseline characteristics of the study population

Characteristic	Cryoenergy (n = 25)	Radiofrequency (n = 25)	P
Age (y)	55 (45-60)	55 (45-60)	.99
Sex: male	17 (68)	17 (68)	.99
Hypertension	10 (40)	10 (40)	.99
Diabetes	0 (0)	0 (0)	.99
Structural heart disease	0 (0)	0 (0)	.99
Left atrial diameter (mm)	41 (38-44)	41 (38-44)	.99
Prior antiarrhythmic drugs	0 (0)	0 (0)	.99

Table 2 Arrhythmia burden in patients with atrial fibrillation (AF) in the baseline monitoring period

Characteristic	Cryoenergy	Radiofrequency
AF episodes (n/n)	13/13	8/8
Time in AF (h/month)	44.6 (1.4-197.5)	1.4 (0.2-5.4)
Time in AF (%)	0.06 (0.002-0.27)	0.002 (0.001-0.01)
Maximum duration of AF episodes (h)	12 (4.8-23.6)	4.4 (1.4-23.2)

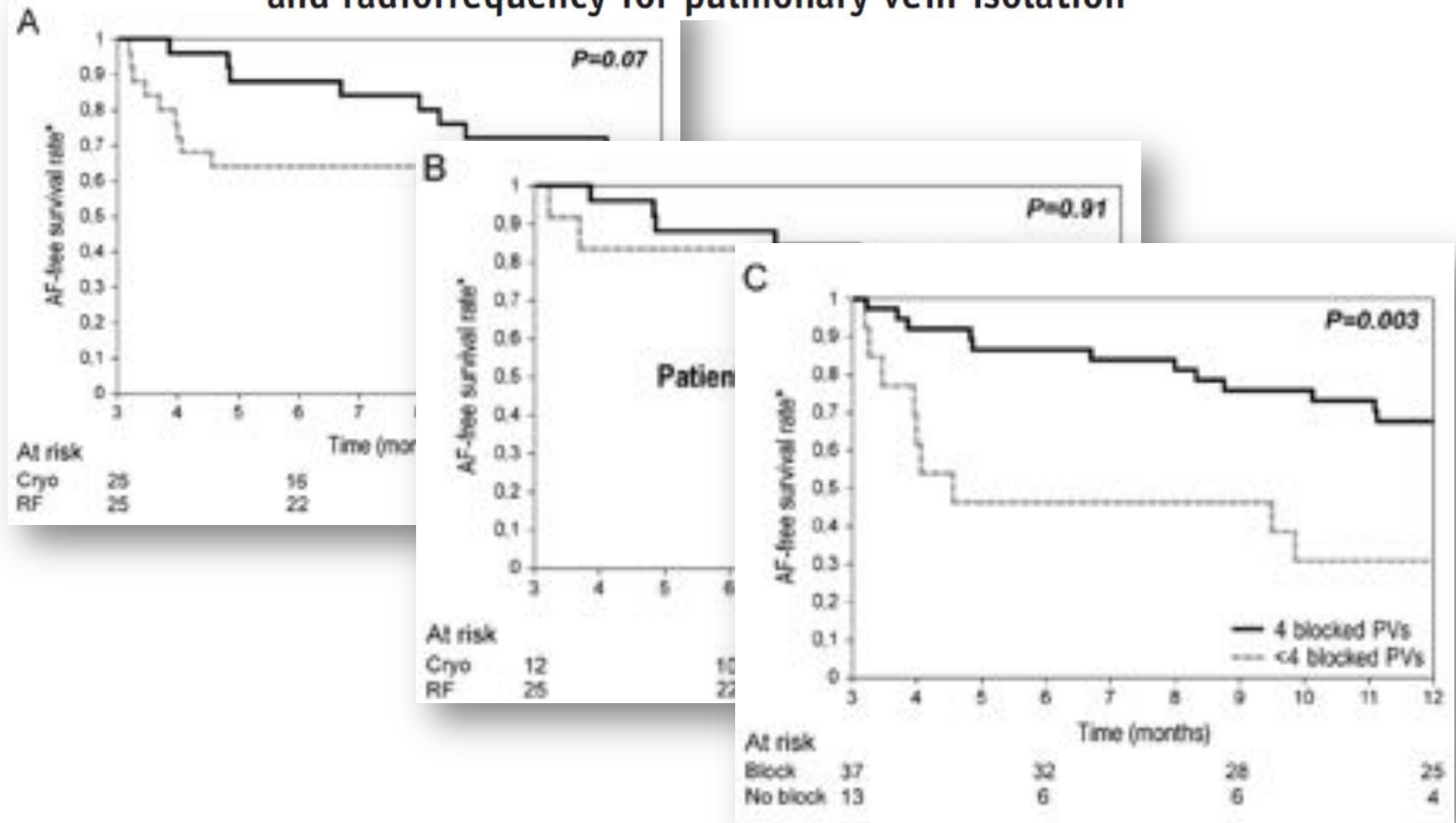
Table 3 Arrhythmia burden after 12 months of follow-up in patients with atrial fibrillation (AF) recurrences after ablation

Characteristic	Cryoenergy (n = 13)	Radiofrequency (n = 8)	P
AF episodes (n/month)	7.3 (0.2-381)	0.7 (0.1-2.2)	.07
Time in AF (h/month)	44.6 (1.4-197.5)	1.4 (0.2-5.4)	.02
Time in AF (%)	0.06 (0.002-0.27)	0.002 (0.001-0.01)	.02
Maximum duration of AF episodes (h)	12 (4.8-23.6)	4.4 (1.4-23.2)	.38

Data are presented as median (25th-75th percentile).

Fire vs Freeze: role of complete PV block

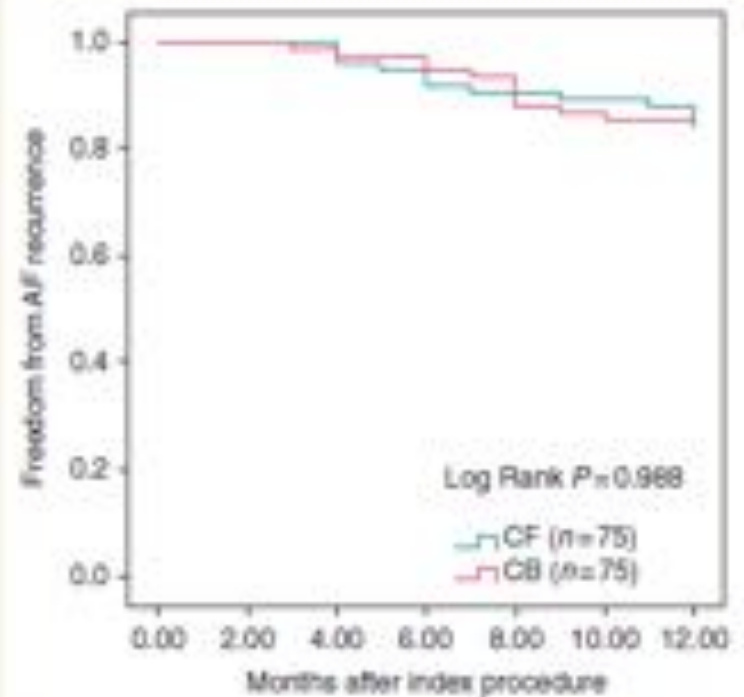
The COR trial: A randomized study with continuous rhythm monitoring to compare the efficacy of cryoenergy and radiofrequency for pulmonary vein isolation



Contact-force guided radiofrequency vs. second-generation balloon cryotherapy for pulmonary vein isolation in patients with paroxysmal atrial fibrillation—a prospective evaluation

Table 3 Procedural outcome

	Overall (n = 150)	CF group (n = 75)	CB group (n = 75)	P
Major bleeding	2.0% (3)	2.7% (2)	1.3% (1)	0.560
Thromboembolic events	0% (0)	0% (0)	0% (0)	NA
Peri-procedural deaths	0% (0)	0% (0)	0% (0)	NA
Relapse post-blanking	13.3% (20)	12.0% (9)	14.7% (11)	0.608



	3 months	6 months	9 months	12 months
CF	75	69	67	66
CB	74	71	63	62



Comparison between radiofrequency with contact force-sensing and second-generation cryoballoon for paroxysmal atrial fibrillation catheter ablation: a multicentre European evaluation

Fabien Squara^{1,2*}, Alexandre Zhao², Eloi Marijon^{3,4}, Decebal Gabriel Latcu⁵, Rui Providencia³, Giacomo Di Giovanni⁶, Gaël Jauvert², Francois Jourda³, Gian-Battista Chierchia⁶, Carlo De Asmundis⁶, Giuseppe Ciconte⁶, Christine Alonso², Caroline Grimard², Serge Boveda³, Bruno Cauchemez², Nadir Saoudi⁵, Pedro Brugada⁶, Jean-Paul Albenque³, and Olivier Thomas²

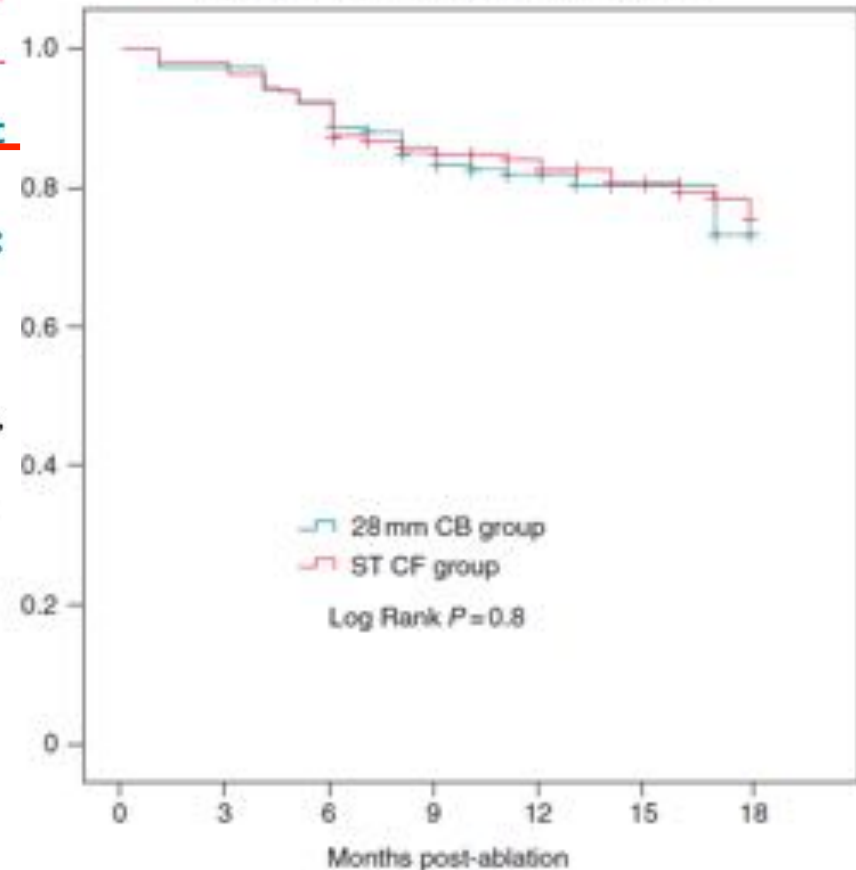
376 patients enrolled in 4 centers: 198 in CFS group and 178 in the Cryoballoon group

Procedure time was 122.5±40.7 min for CFS compared to 109.6±40 min for Cryoballoon (p=0.003)

Overall complication rates were similar in the CFS and Cryoballoon group 7.1% vs. 7.3%, respectively

Freedom from arrhythmia recurrence was 73.3% in the Cryoballoon group compared to 76% in the CFS group (p=0.63)

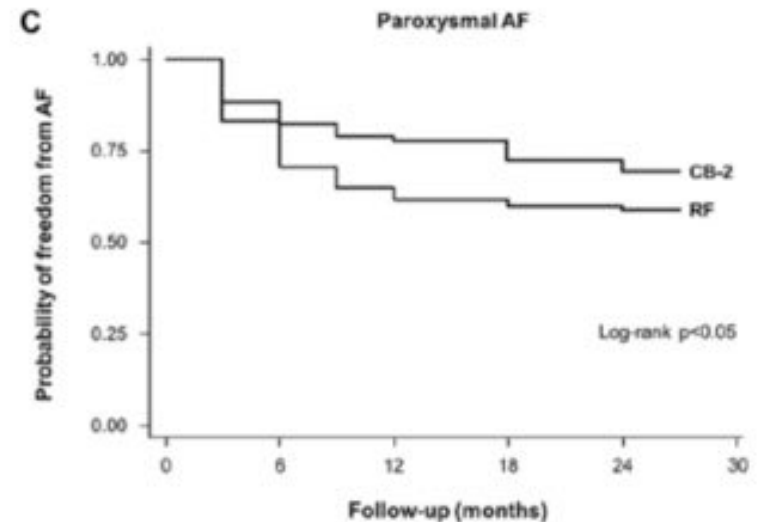
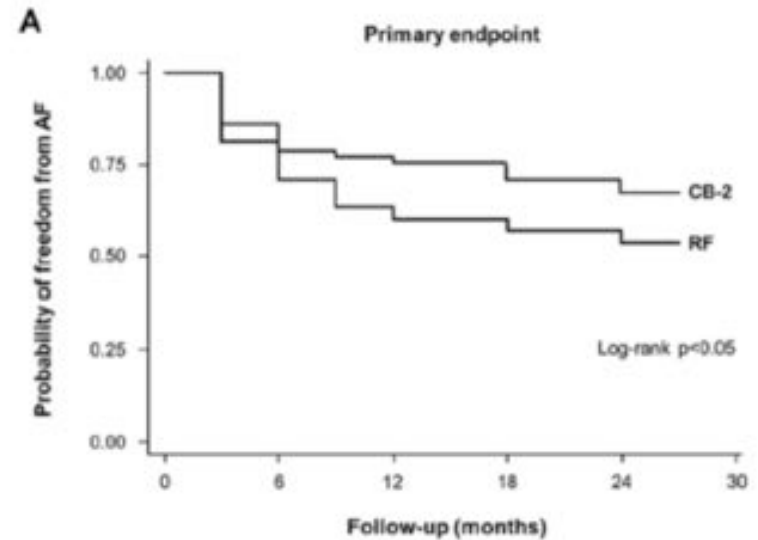
Freedom from atrial arrhythmia recurrence



	Proportion of patients free from arrhythmia recurrence					
	3 months	6 months	9 months	12 months	15 months	18 months
ST CF group	96.2%	87.4%	84.8%	82.5%	80.4%	75.5%
28 mm CB group	97.3%	88.7%	83.4%	81.9%	80.3%	73%
Number of patients at risk						
ST CF group	153	139	127	105	72	57
28 mm CB group	146	133	111	108	42	27

Acute and Long-Term Outcomes of Catheter Ablation of Atrial Fibrillation Using the Second-Generation Cryoballoon versus Open-Irrigated Radiofrequency: A Multicenter Experience

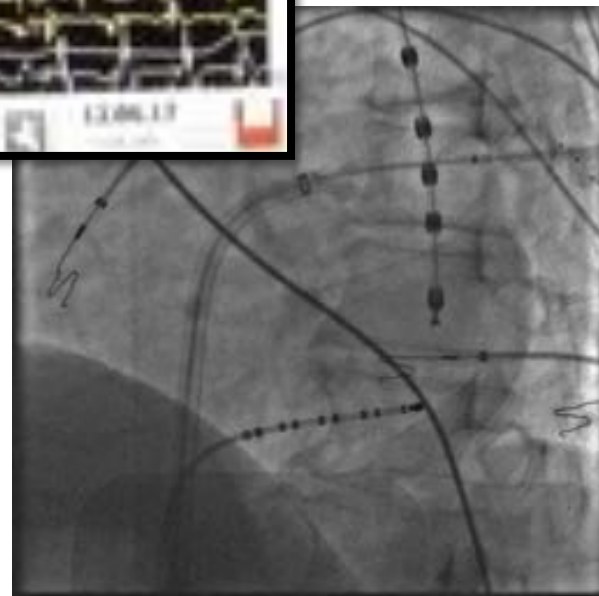
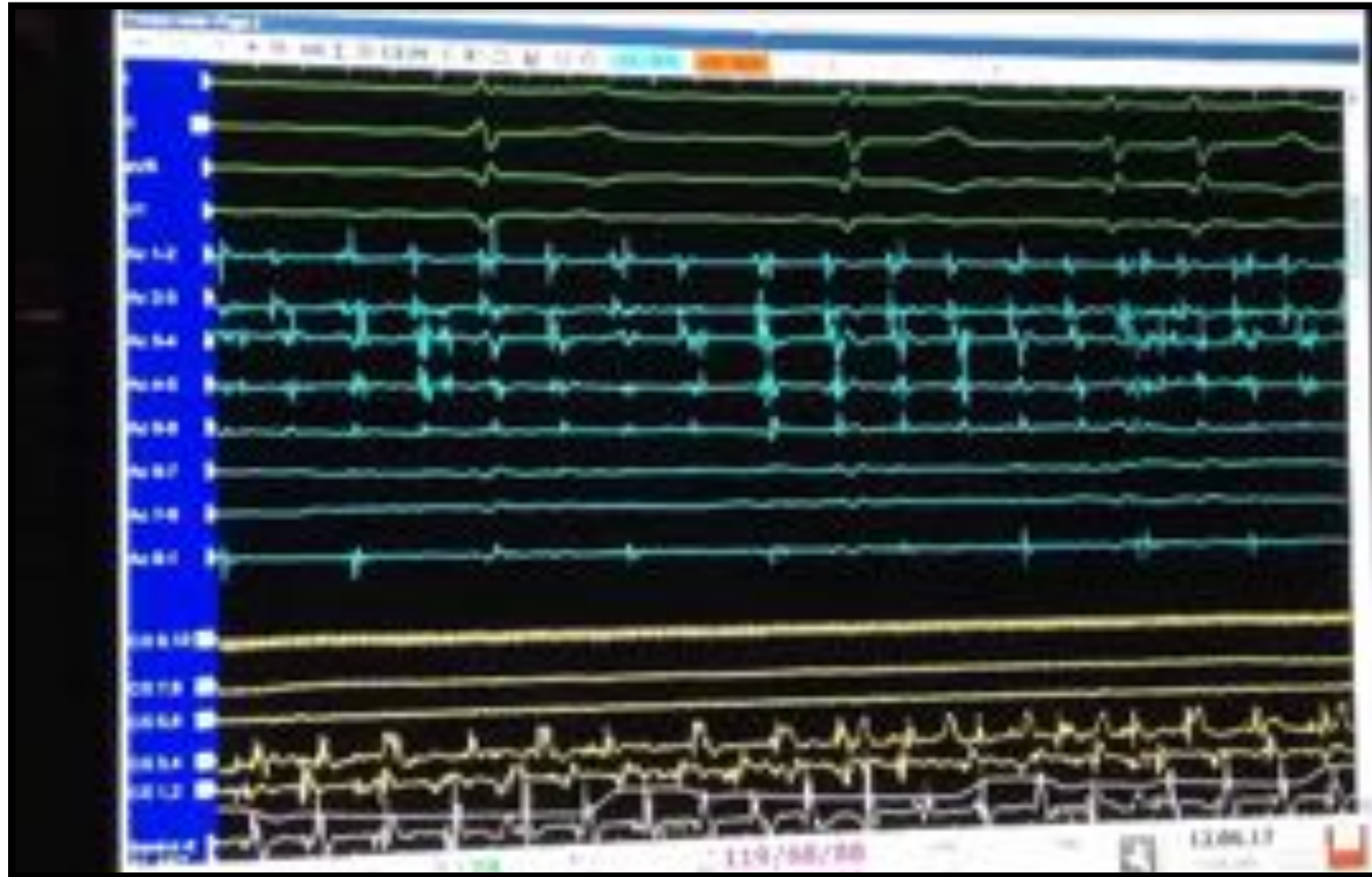
- In this retrospective clinical outcome study, 1,196 procedures were analyzed: 773 in the CB2 group and 423 in the non-force sensing RF group.
- Freedom from AF/AT/AFL recurrence was 76.6% in the CB2 group compared to 60.4% in the RF group ($p < 0.001$) after a 12 month follow up.
- Procedure time was 188 ± 42 min for RF compared to 145 ± 49 min for Cryoballoon ($p < 0.001$). Fluoro time was 23 ± 14 min for RF compared to 29 ± 13 min for Cryoballoon ($p < 0.001$).
- Overall adverse event rates were similar in the RF and Cryoballoon group 2.6% vs. 1.6%, respectively. Transient (7.6%; $p < 0.001$) and persistent (1.2%; $p = 0.026$) PNI was exclusive to CB2.
- CB2 was associated with reduced long term need for antiarrhythmic therapy (16.7% vs. 22%; $p = 0.024$) and repeat ablations (14.6% vs. 24.1%; $p < 0.001$).



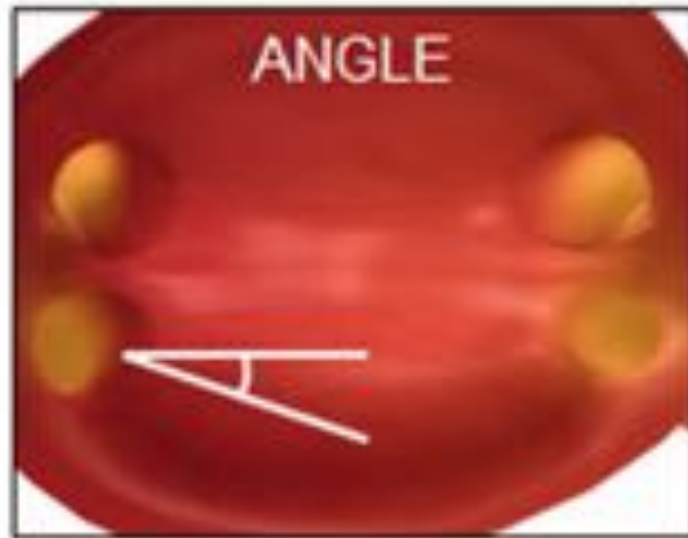
Paroxysmal , drug-refractory AF
What's the choice?

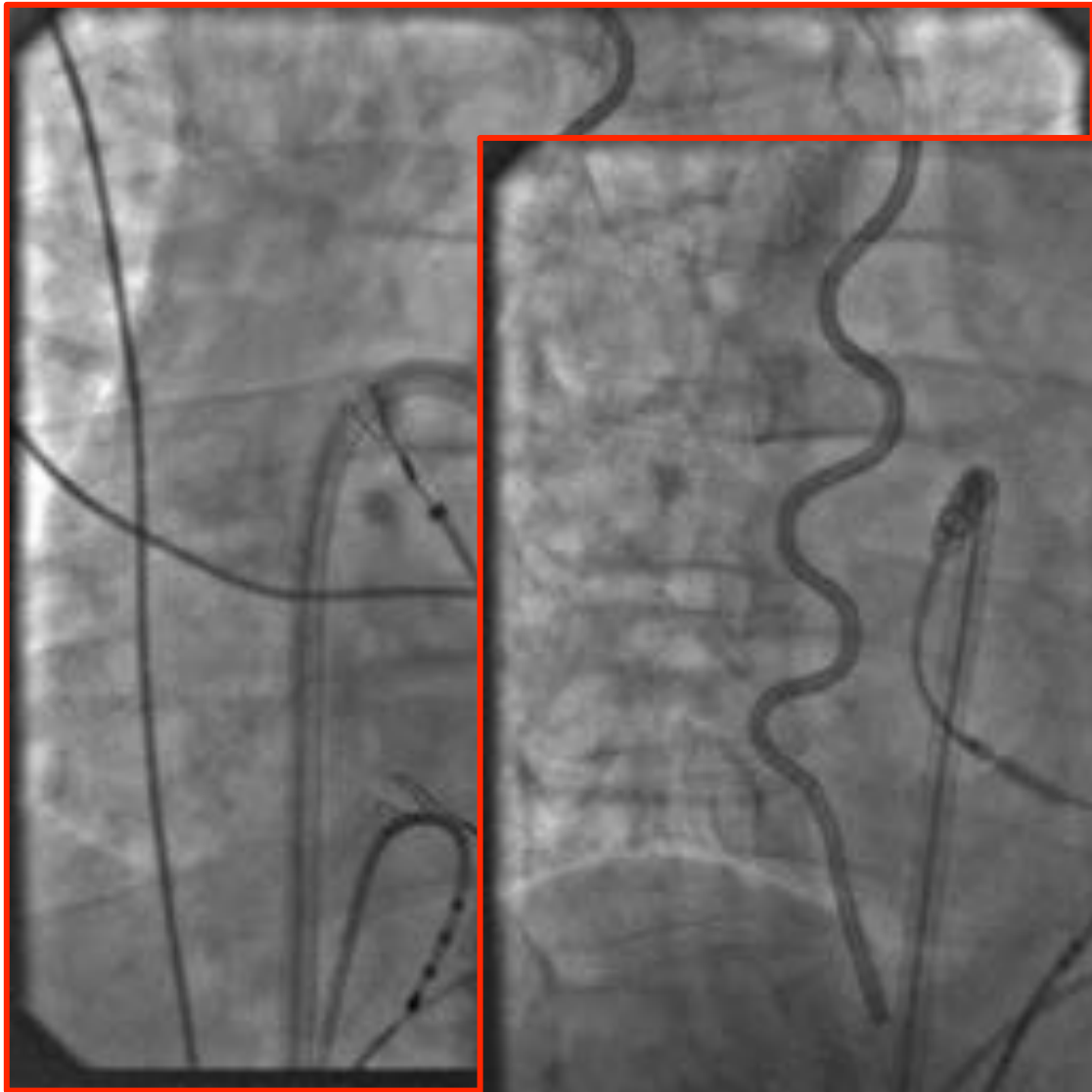


Cryoballoon

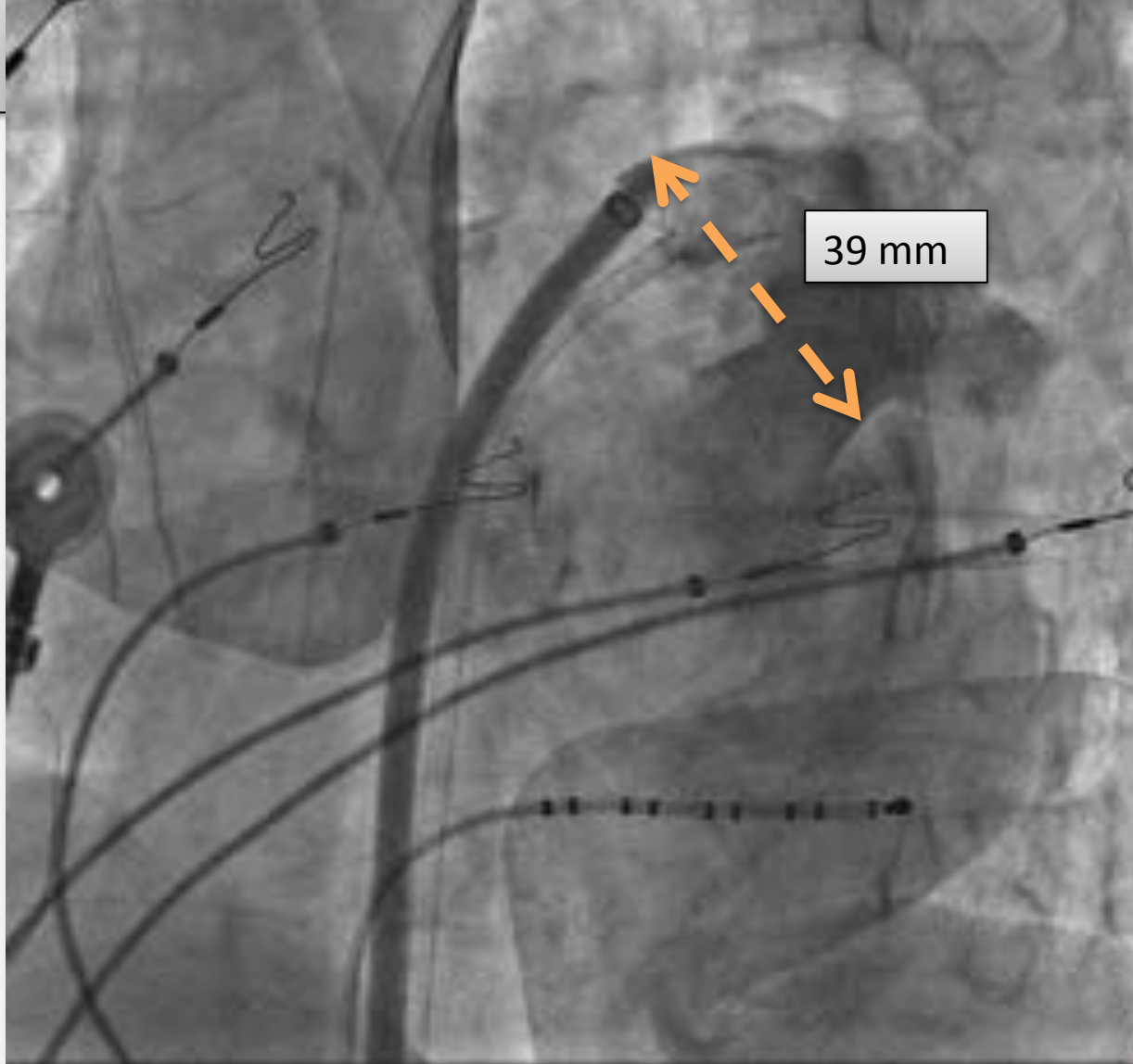


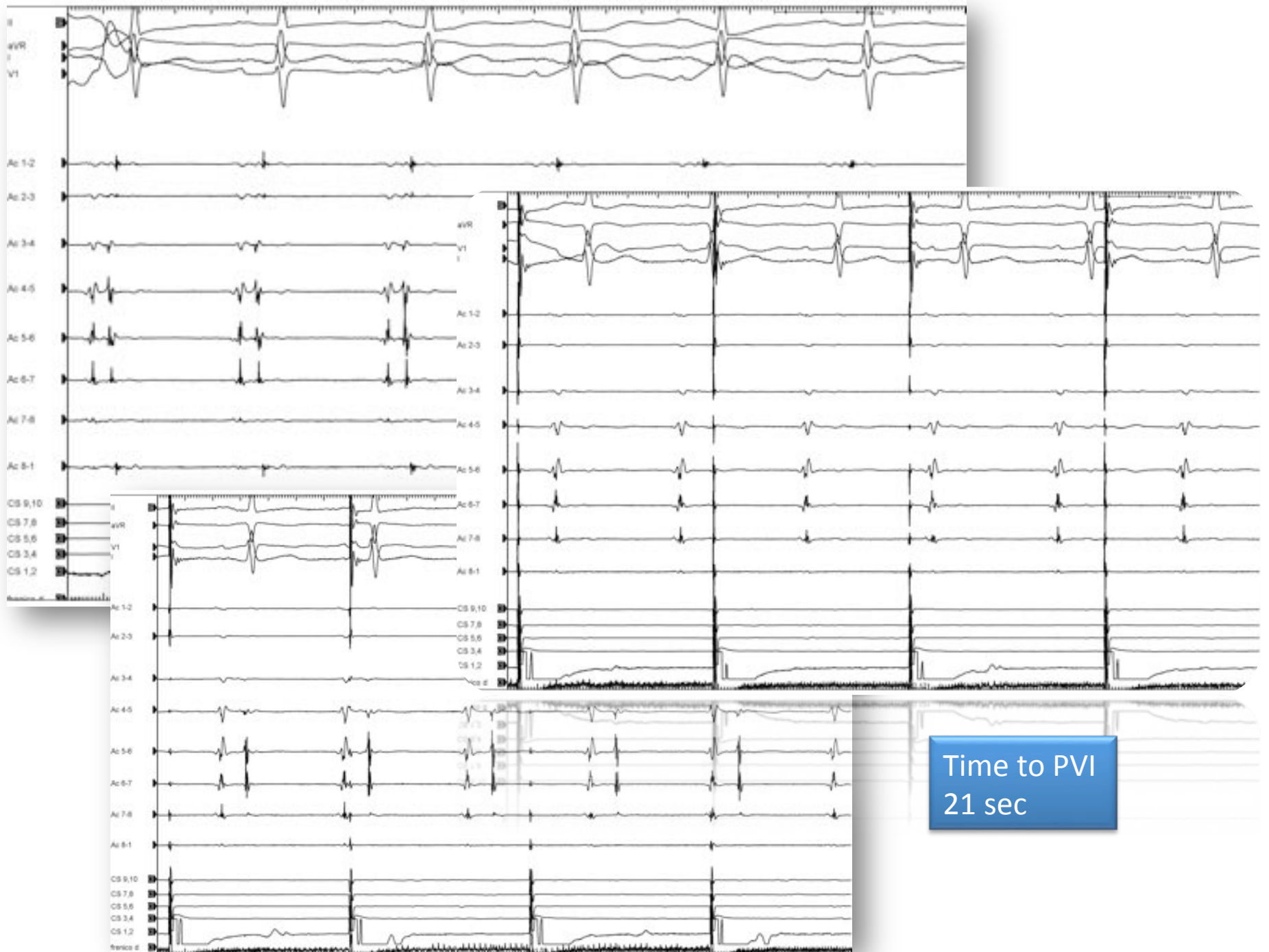
PV anatomy – facing the real life

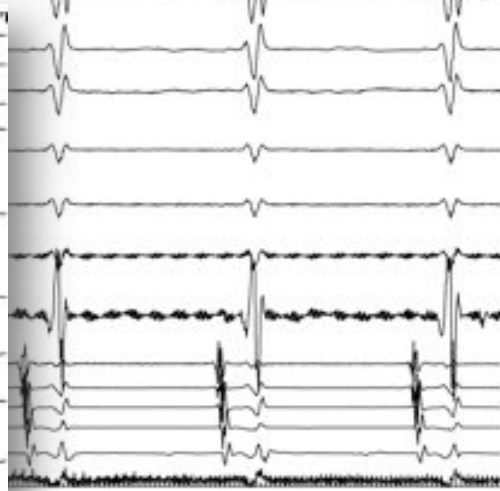
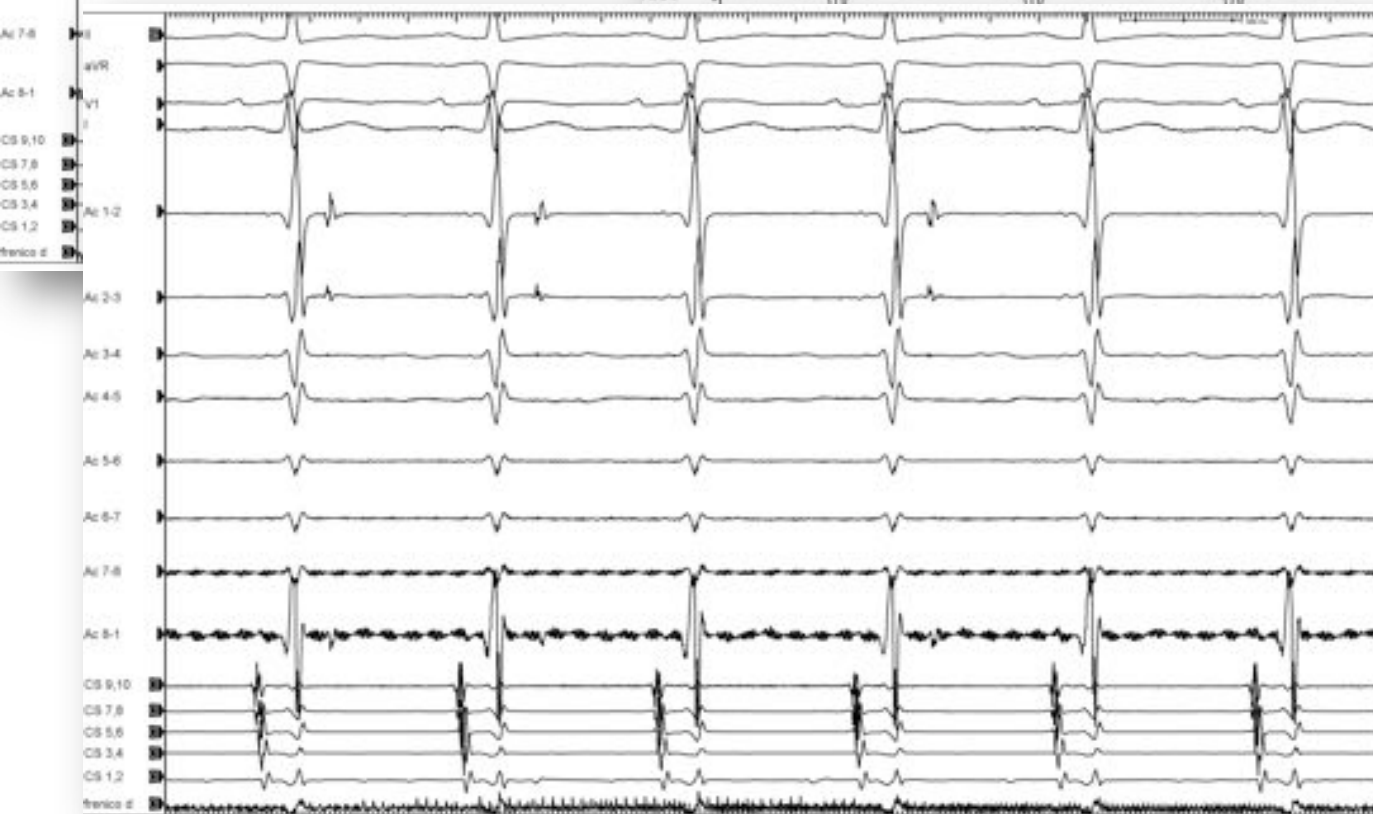
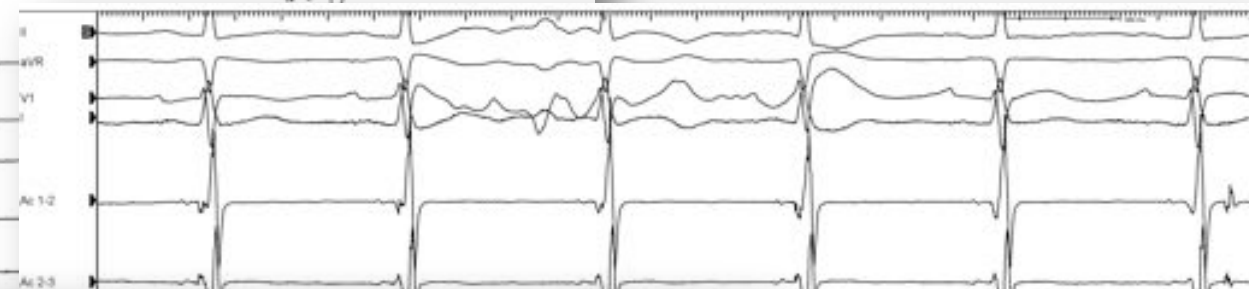
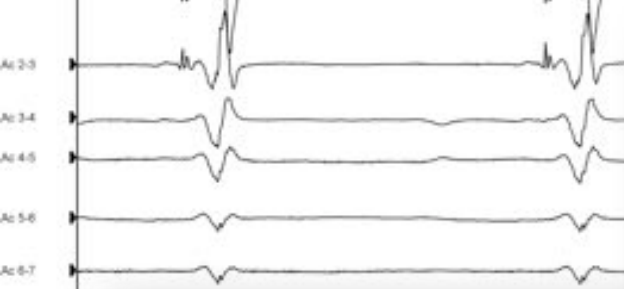




Facing the impossible

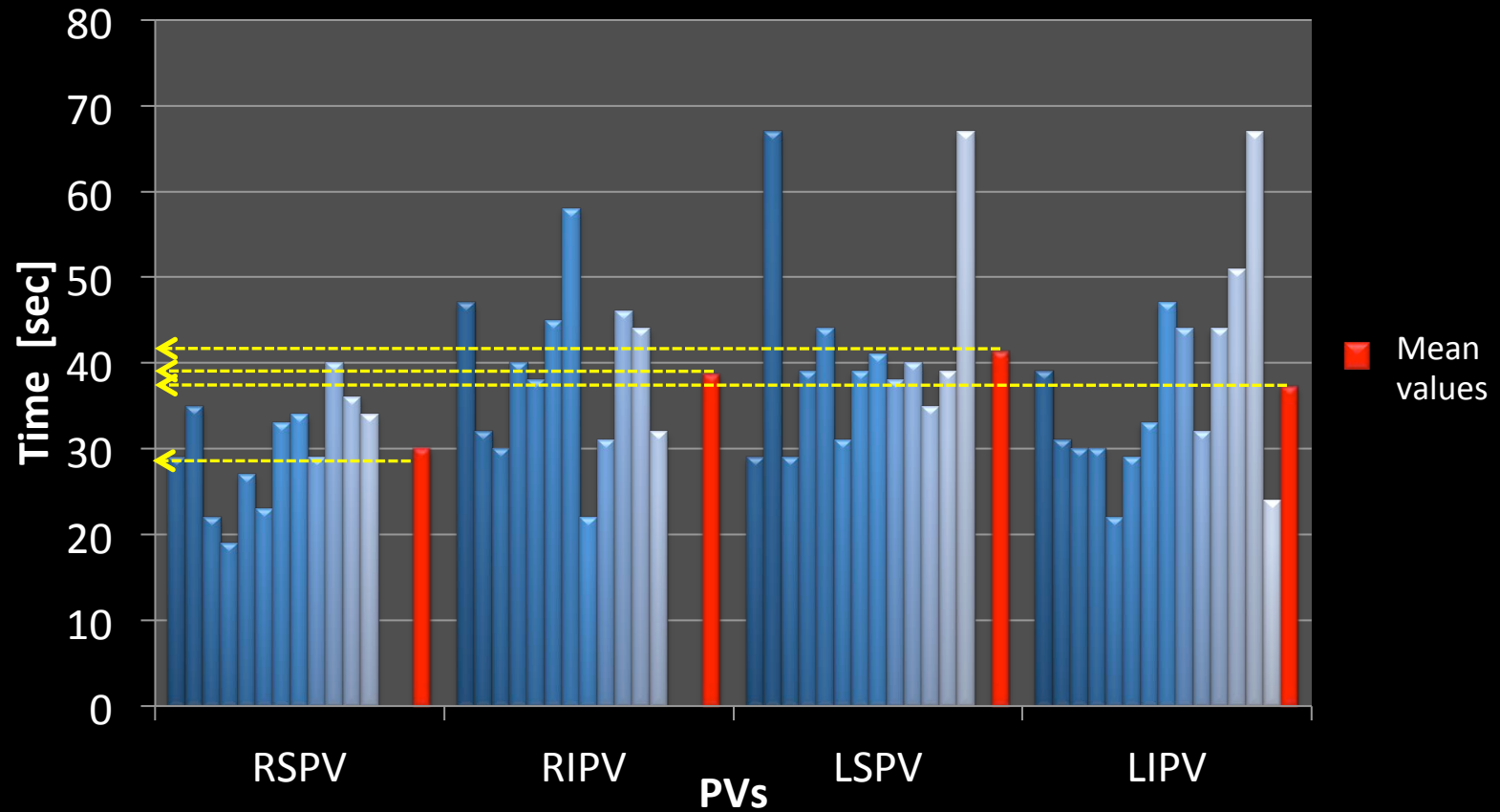


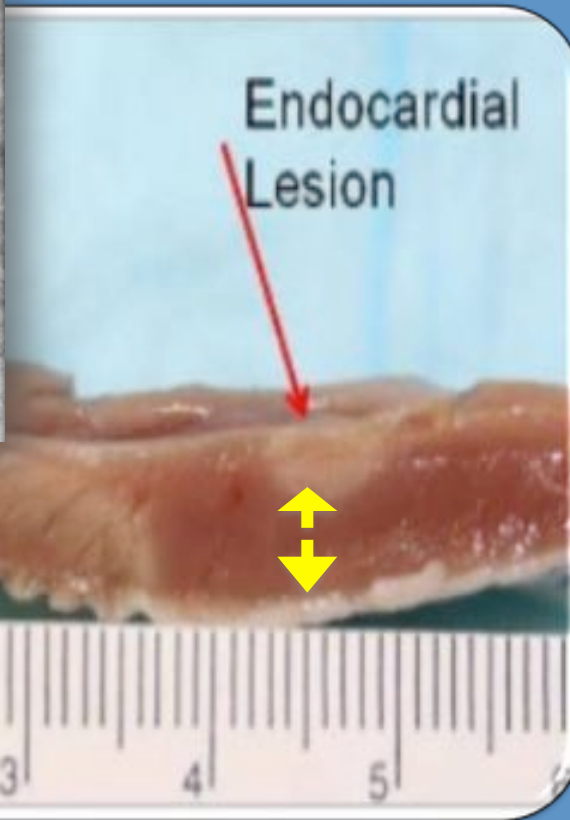
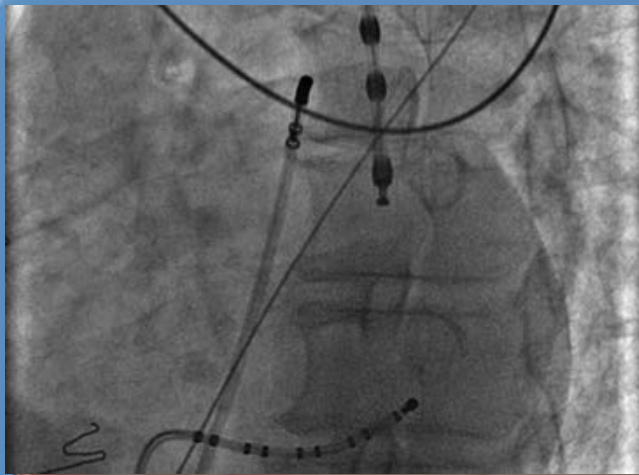




Arctic Front advance + short tip

Time to PVI - Arctic Front Advance





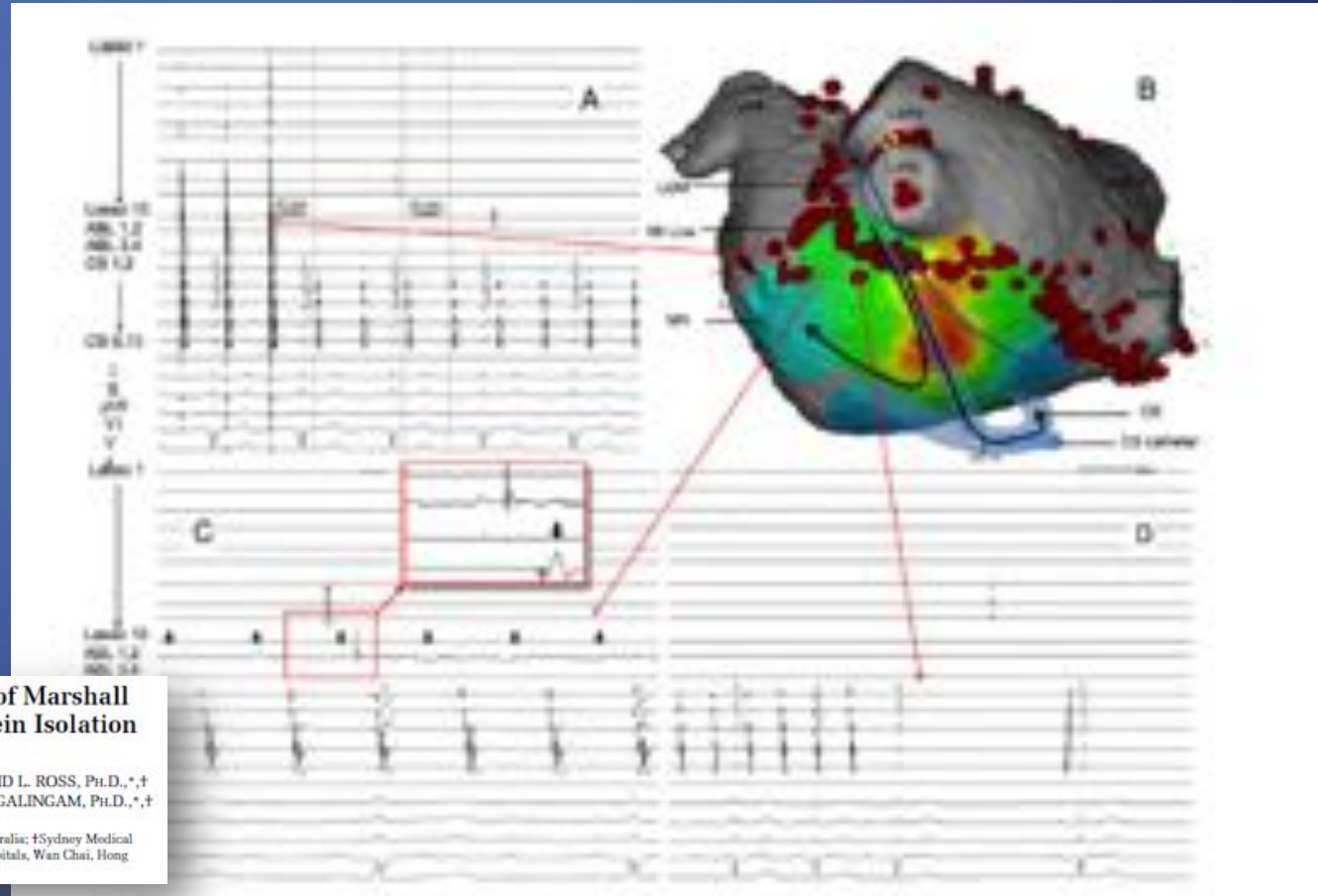
Issue 1 Lesion extension

Lesion size strictly dependent on :

- Power /time ratio
- Contact force
- Stability

Ablation lesions:

- HOW MANY ?
- OVERLAP ?
- WHEN TO STOP (once achieved the block) ?



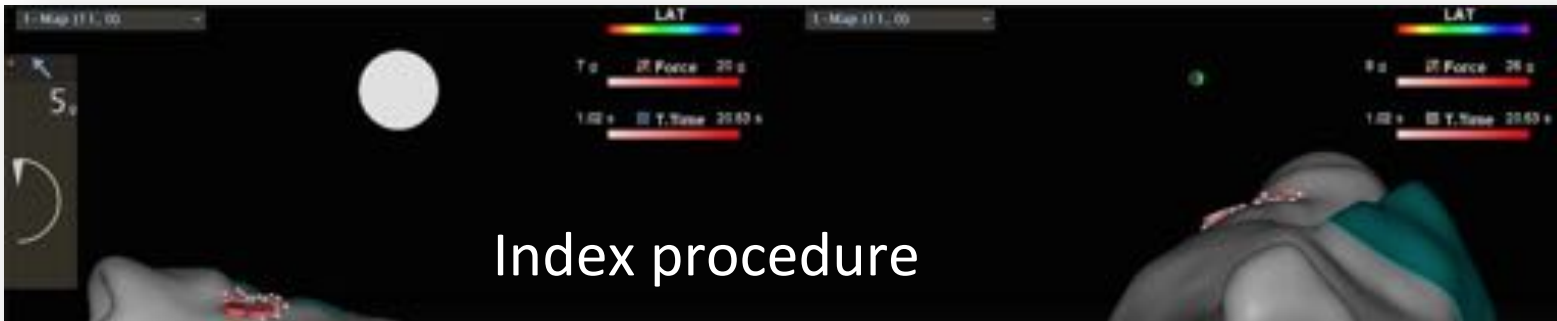
Atrial Tachycardias Utilizing the Ligament of Marshall Region Following Single Ring Pulmonary Vein Isolation for Atrial Fibrillation

WILLIAM W.B. CHIK, M.B.B.S.,* †; JACKY KIT CHAN, M.B.B.S.,* †; DAVID L. ROSS, Ph.D.,* †; JACKIE WAGSTAFF, R.N.,* †; EDDY KIZANA, Ph.D.,* †; ARAVINDA THIAGALINGAM, Ph.D.,* †; PRAMESH KOVOOR, Ph.D.,* † and STUART P. THOMAS, Ph.D.,* †

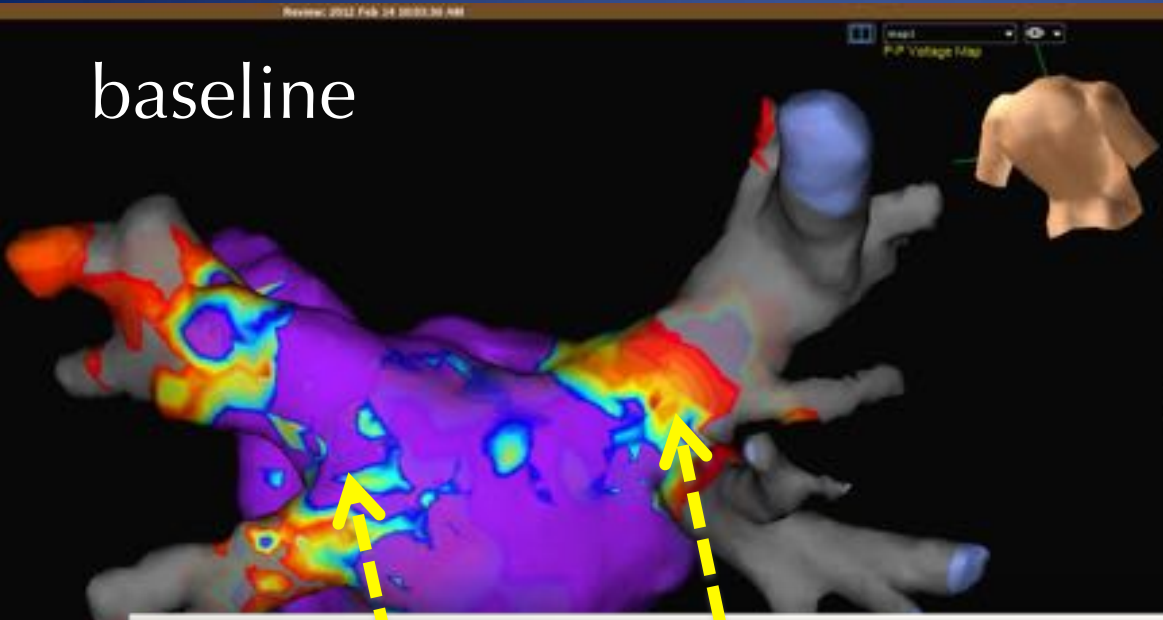
From the *Cardiology Department, Westmead Public and Private Hospitals, Sydney, Australia; †Sydney Medical School, University of Sydney, Sydney, Australia; and ‡Ruttonjee and Tang Shiu Kin Hospitals, Wan Chai, Hong Kong, SAR

Index procedure

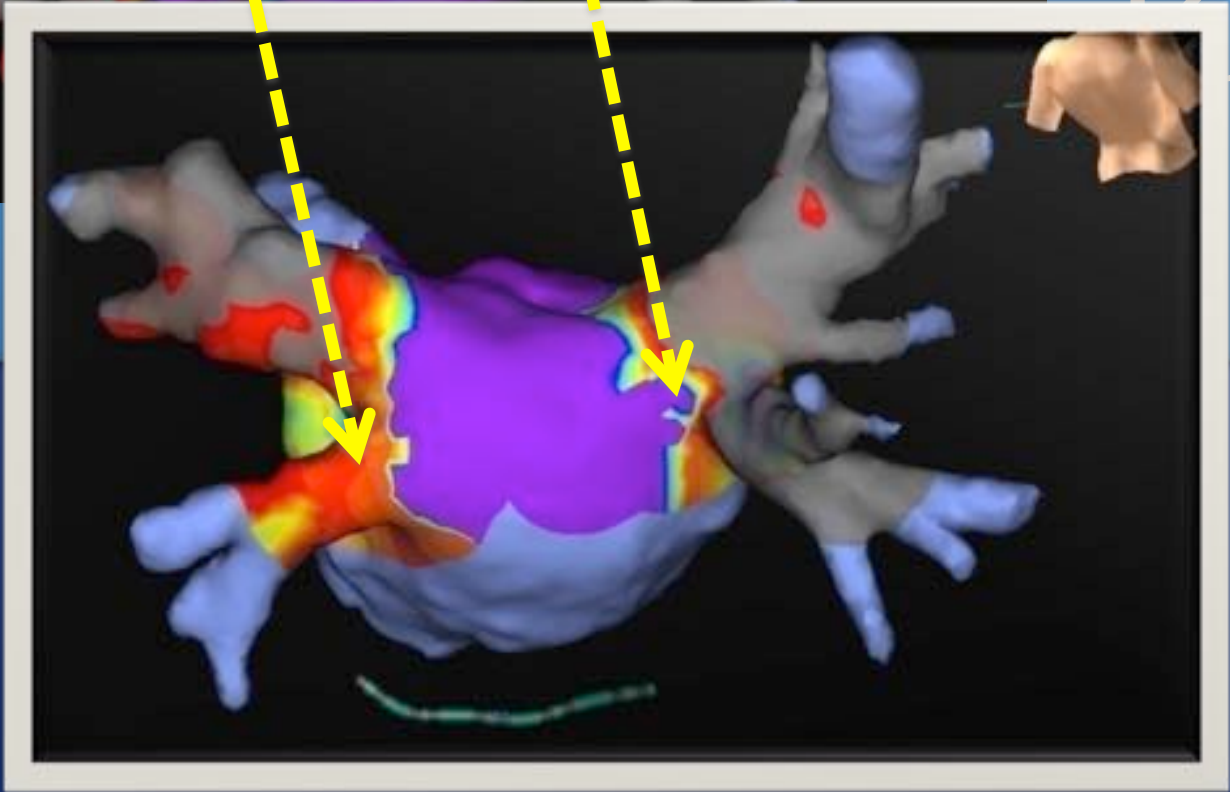
3 months check and redo with robotic



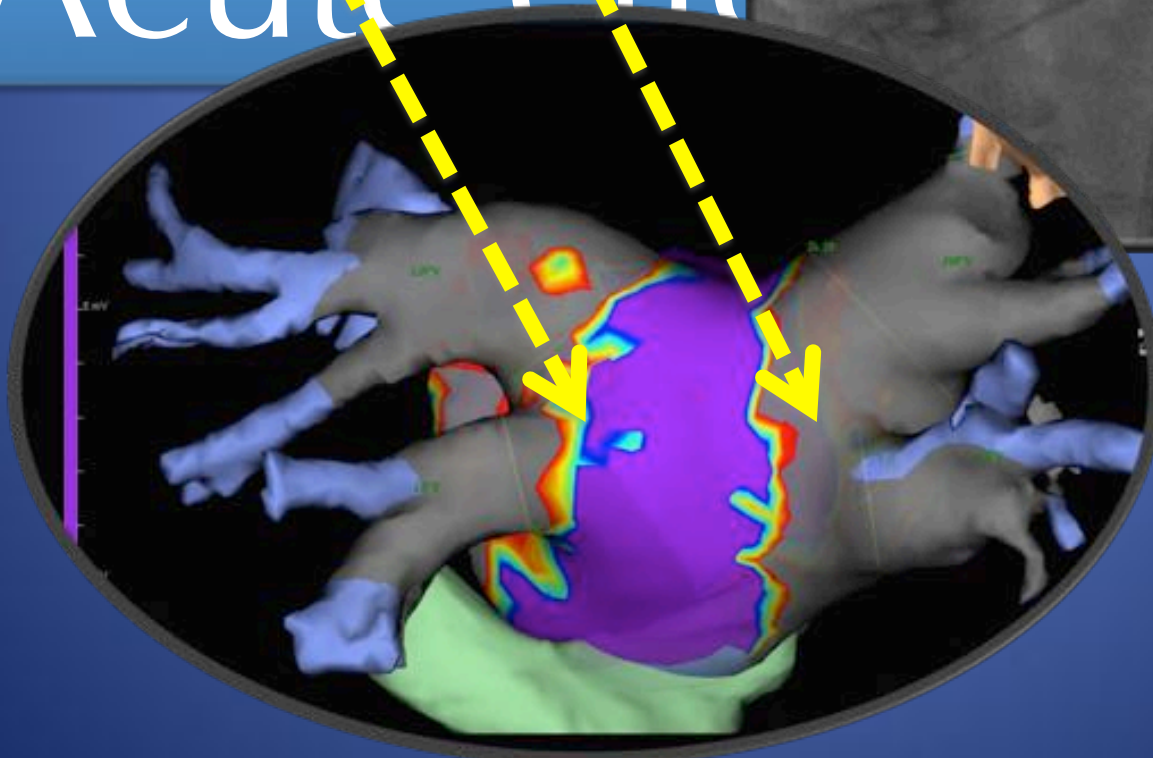
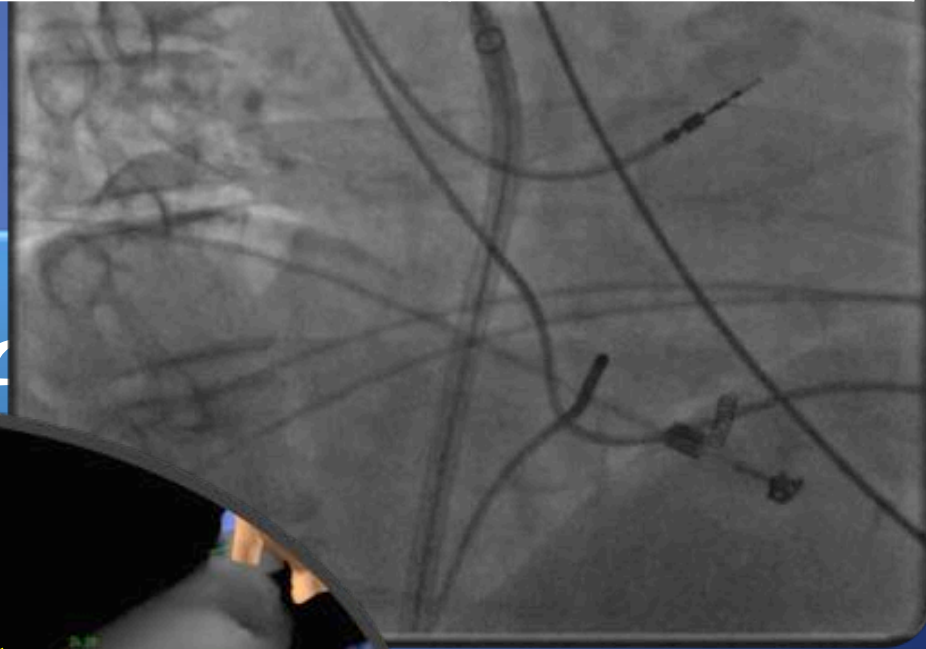
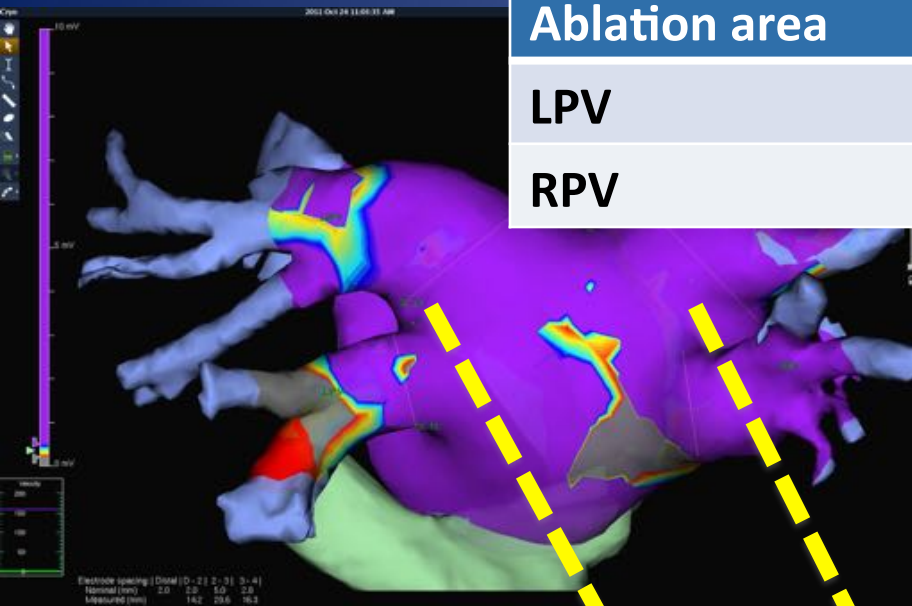
baseline



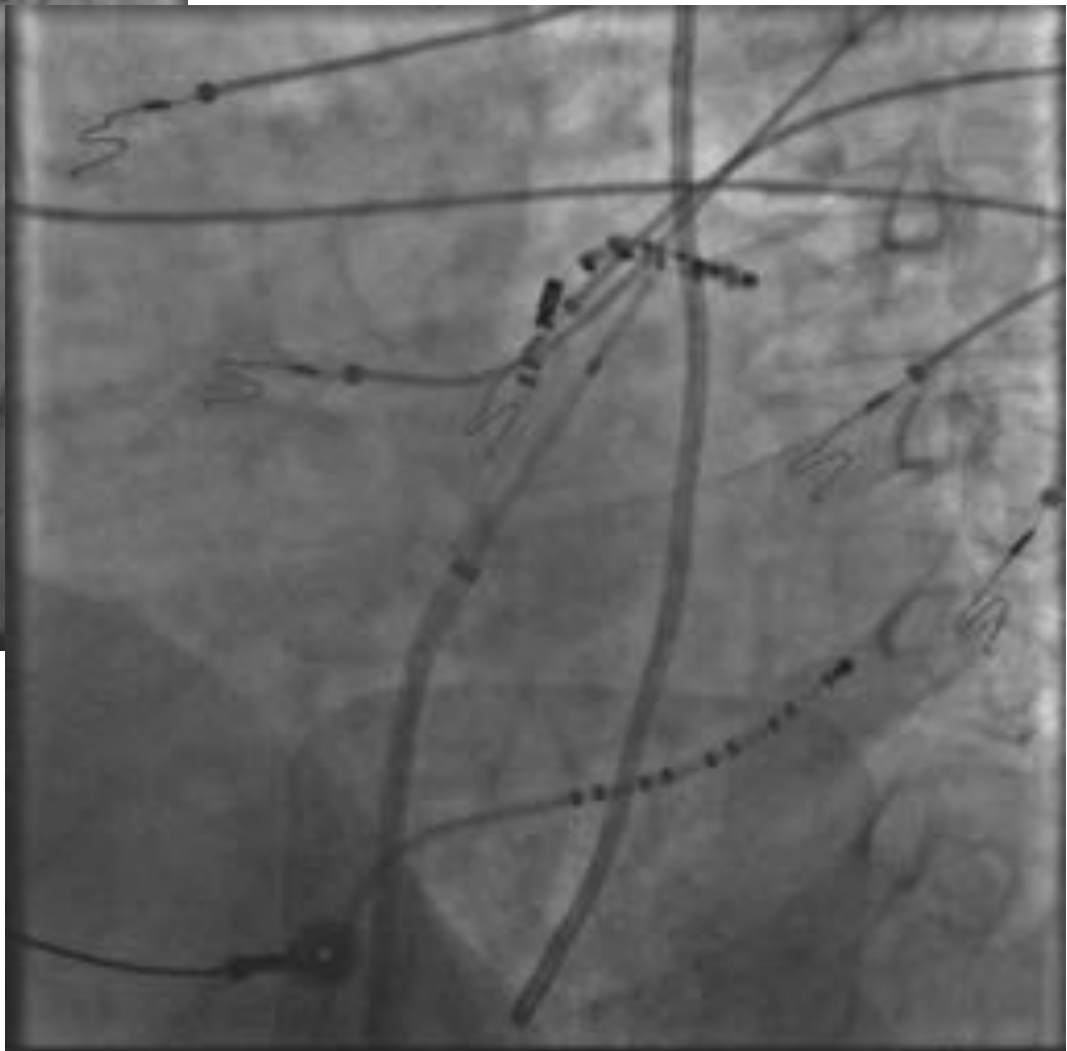
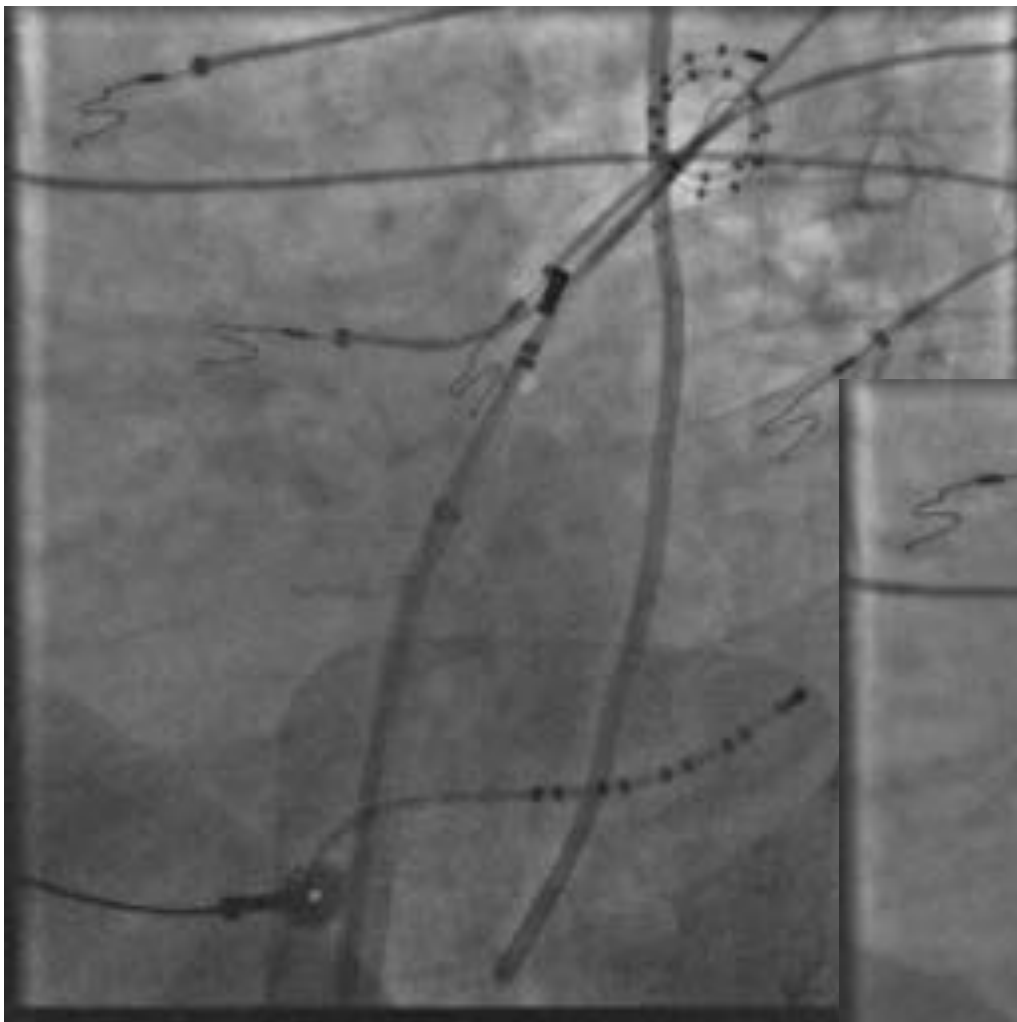
focal



Ablation area	Cryo	Focal RF
LPV	62.4	39.7
RPV	65.5	31.3

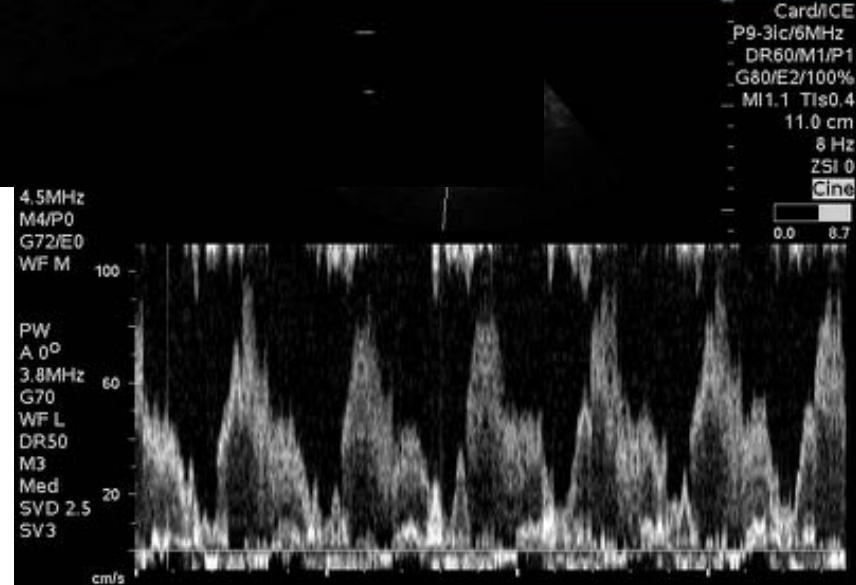
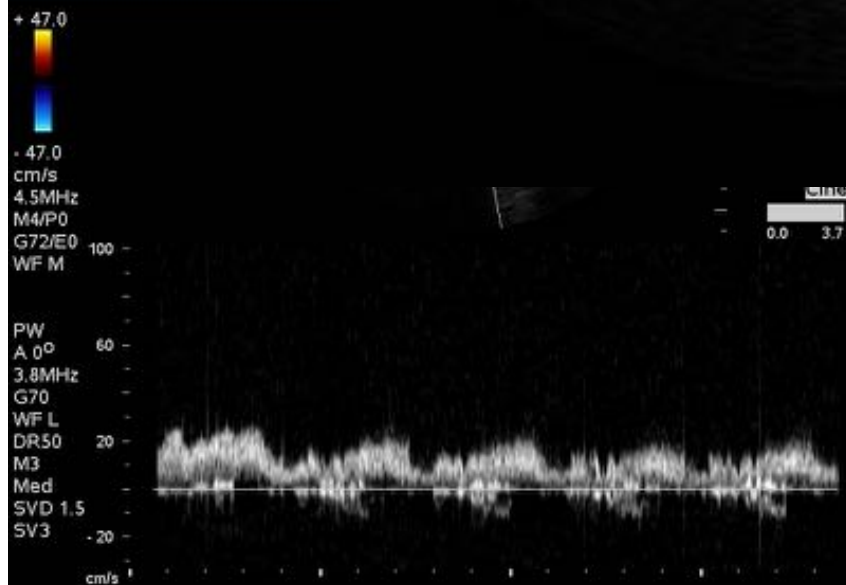
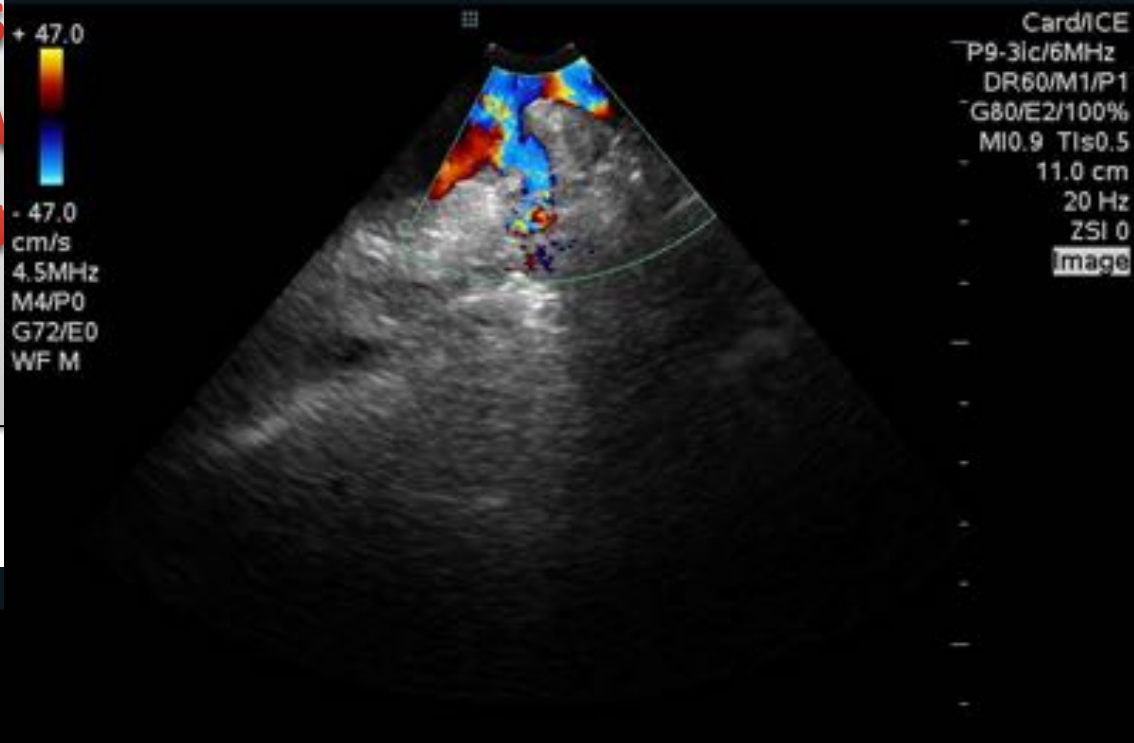


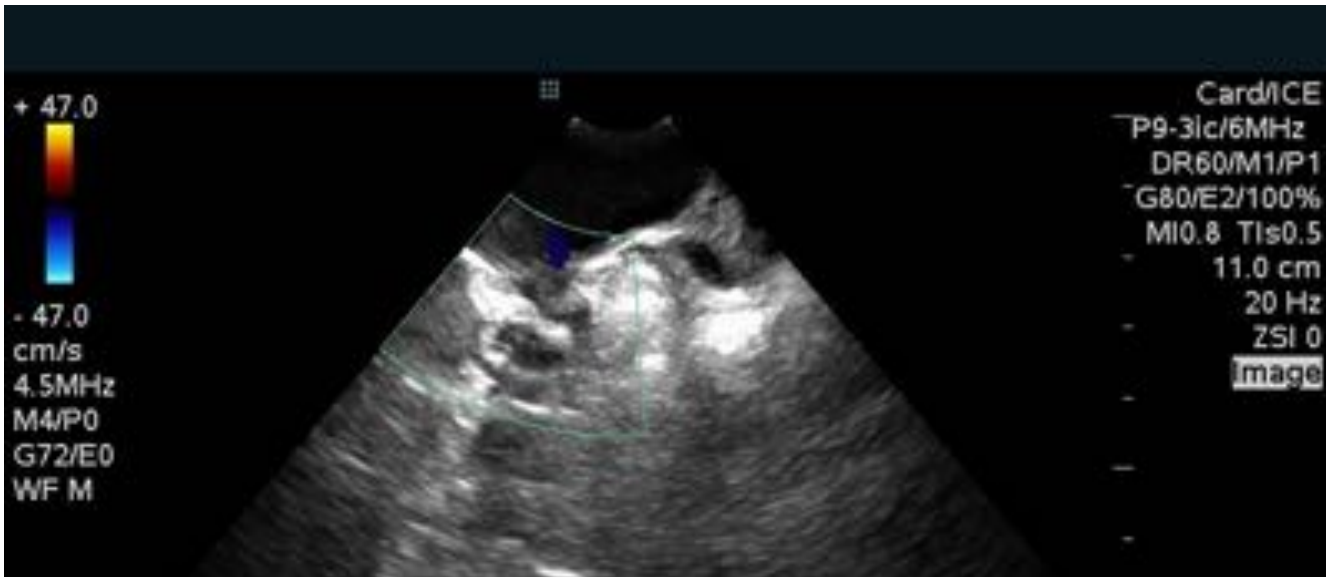
Acute inf



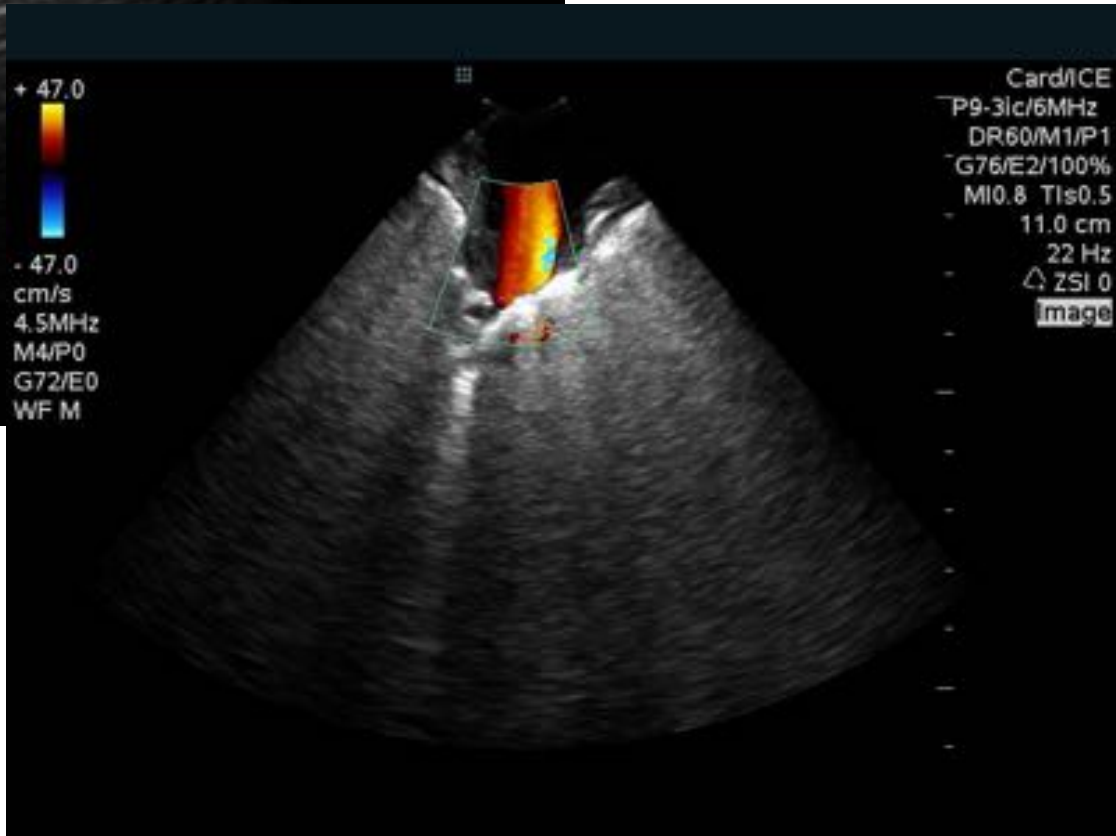
Acute assessment of pulsed wave Insights in

and PVI



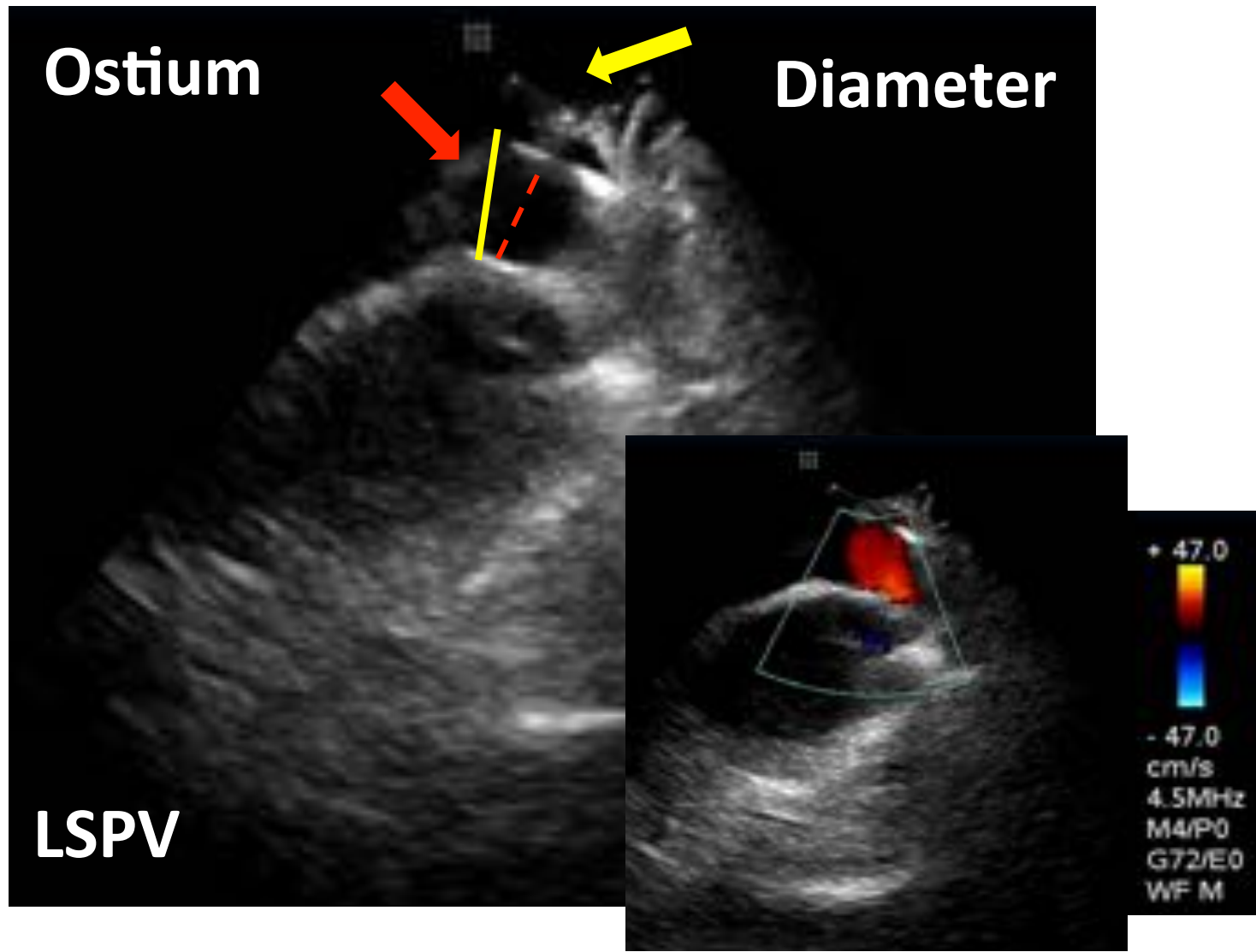


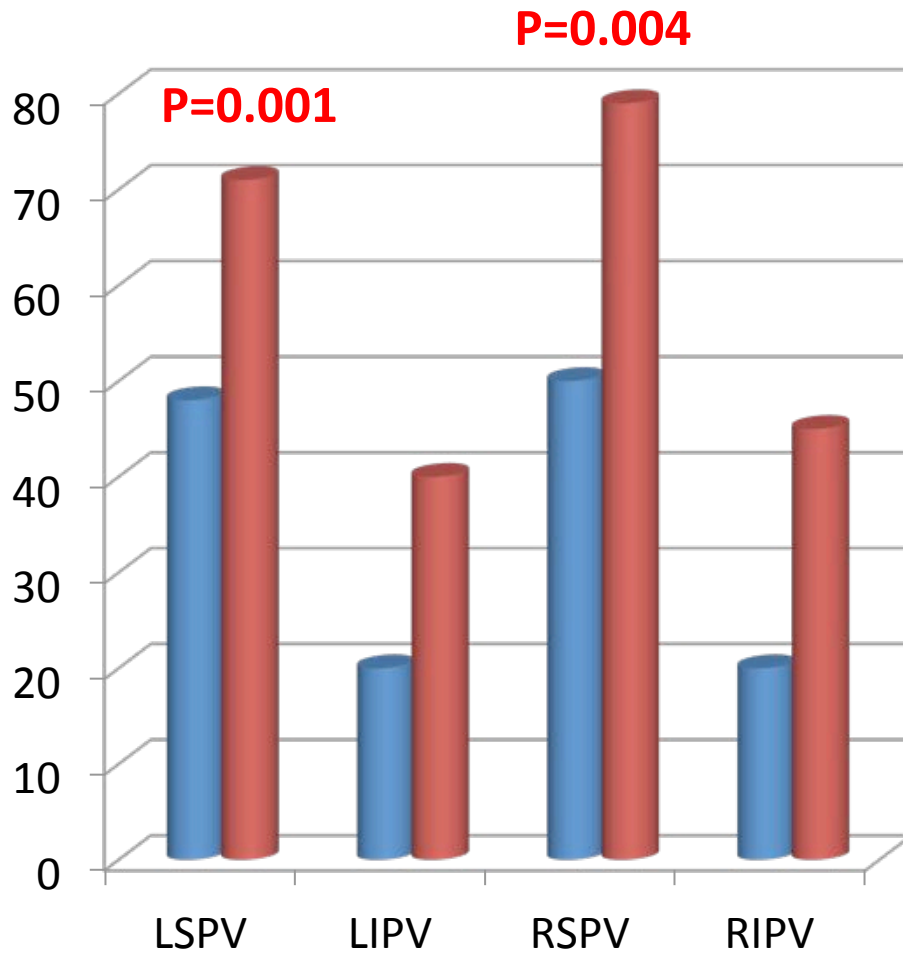
ICE probe within the left atrium



- Before PVI:
the diameters of PV have been measured at 5 mm from the ostium, pulse wave flow has been evaluated using Pulsed Doppler.

All these measures have been repeated after ablation.

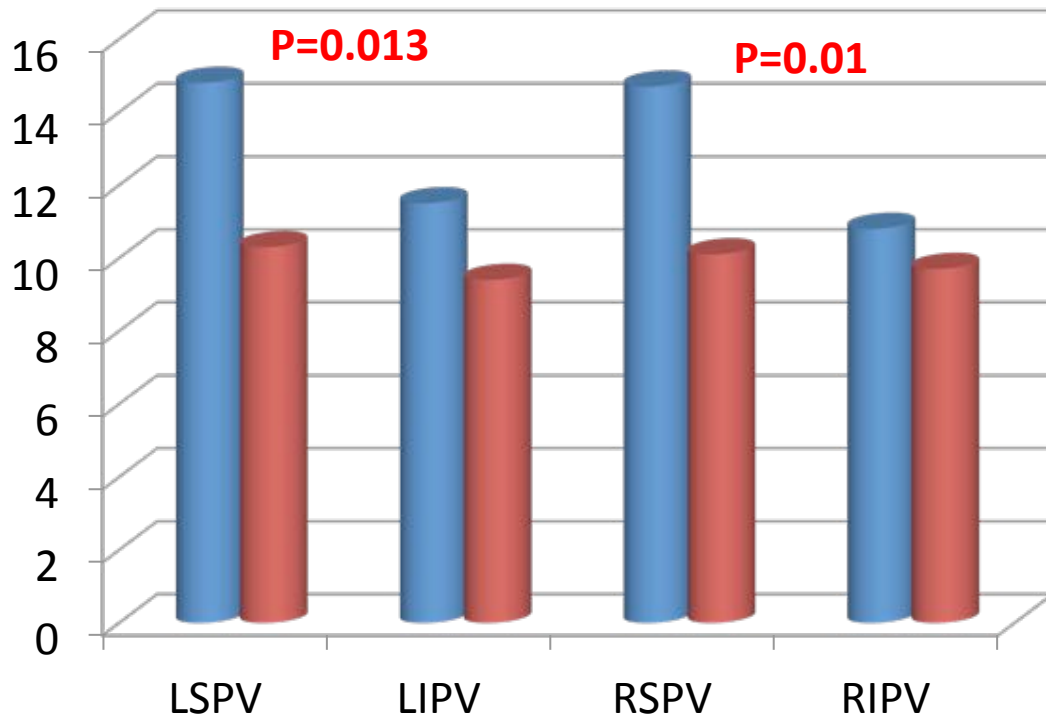




RF sub-group

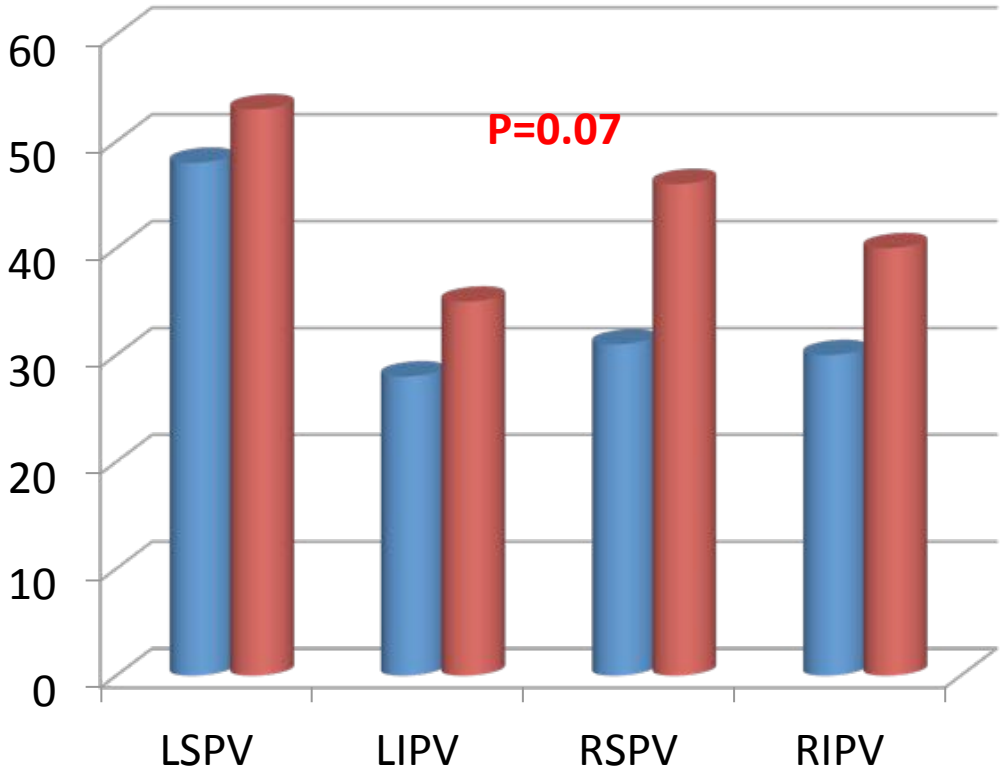
- PW flow before ablation
- PW flow after ablation

RF sub-group



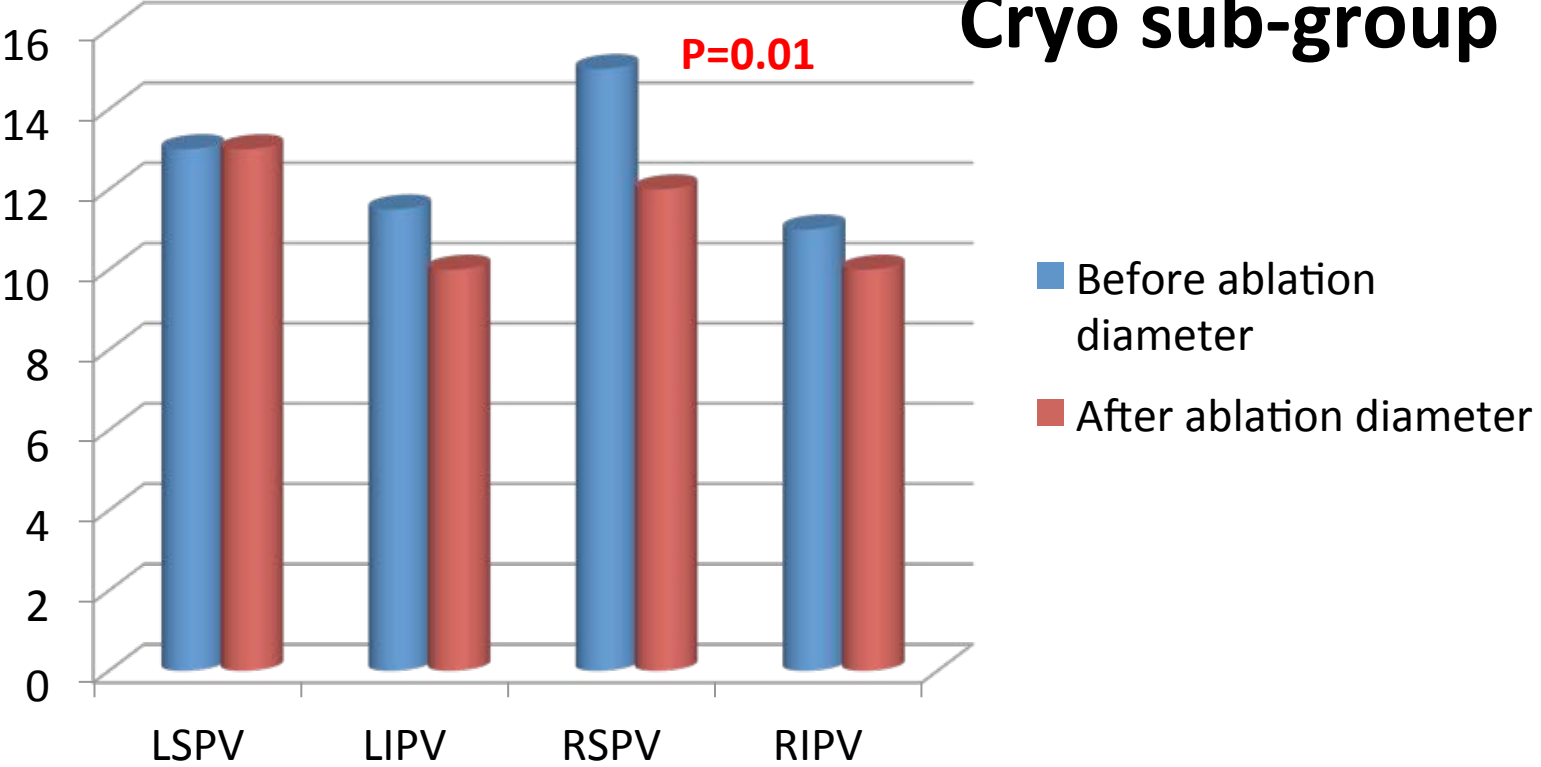
■ Before ablation diameter
■ After ablation diameter

Cryo sub-group

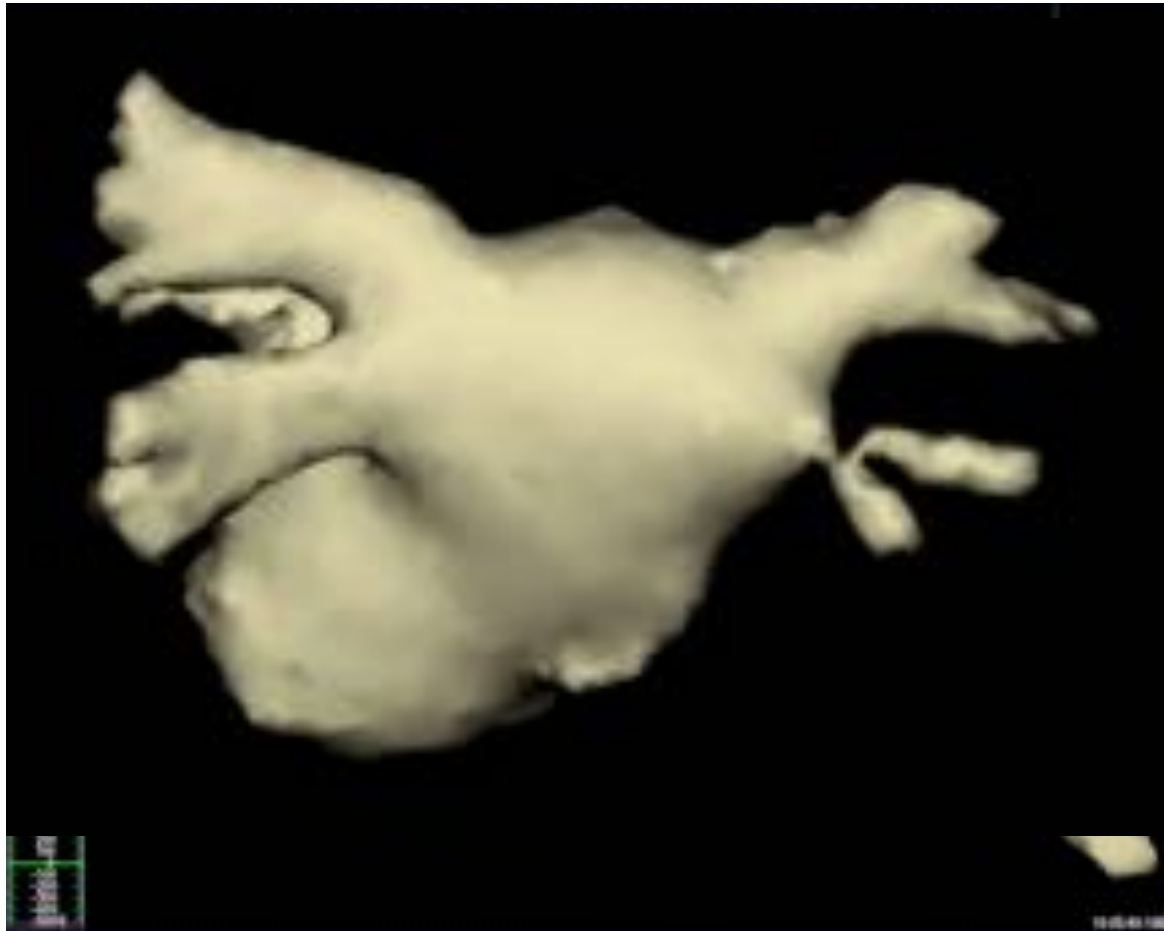


- PW flow before ablation
- PW flow after ablation

Cryo sub-group



Over 2 years' experience in our center, a rate of PV stenosis requiring intervention of 0.45% has been reported



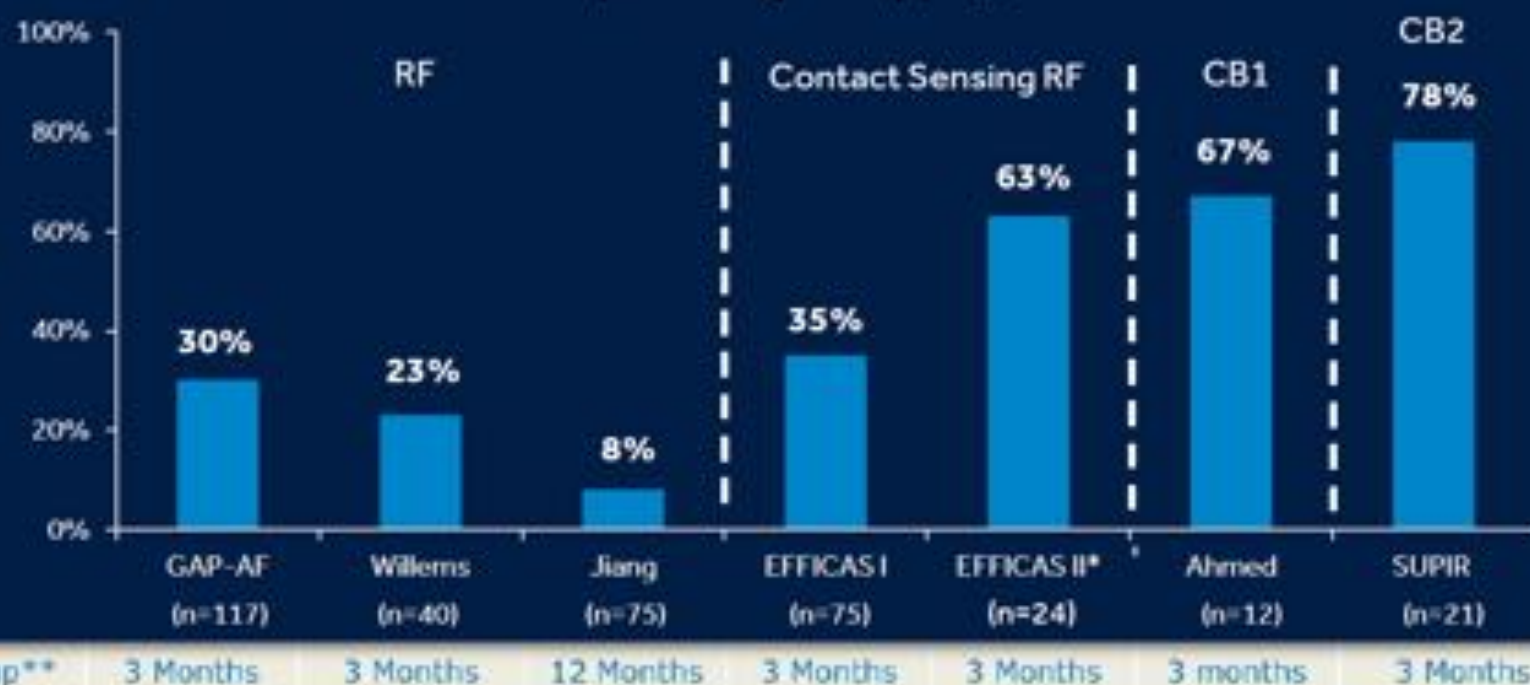


PV LESION DURABILITY WITH RF AND CRYOBALLOON

STUDIES EVALUATING PV RECONDUCTION USING REPEAT ELECTROPHYSIOLOGY AND MAPPING AFTER THE INDEX PROCEDURE

CB1 - Arctic Front Cryoballoon
CB2 - Arctic Front Advance Cryoballoon

% of Patients without Gaps During Remapping Procedure



* Calculated rate from manuscript data reporting 9/24 patients with gaps.

** Time between index procedure and re-mapping procedure. All patients were evaluated regardless of clinical symptoms.

1 Late Breaking Clinical Trials session I at the EHRA/EUROPACE 2013 meeting in Athens, Greece; 2 Willemns, et al. *J Cardiovasc Electrophysiol*. 2010; 21(10):1079-84; 3 Jiang, et al. *Heart Rhythm*. 2014; 11(6):969-76; 4 Neuzil et al. *Circ Arrhythm Electrophysiol*. [25:327-33; 5 Kautzner, J, et al. *Eurpace*. 2013; In Press; 6 Ahmed, et al. *J Cardiovasc Electrophysiol*. 2010; 21(7):731-7; 7 Reddy VY, et al. *J Cardiovasc Electrophysiol*. 2015 May; 26(5):493-500.

Electrical Reconnection After Pulmonary Vein Isolation Is Contingent on Contact Force During Initial Treatment

Results From the EFFICAS I Study

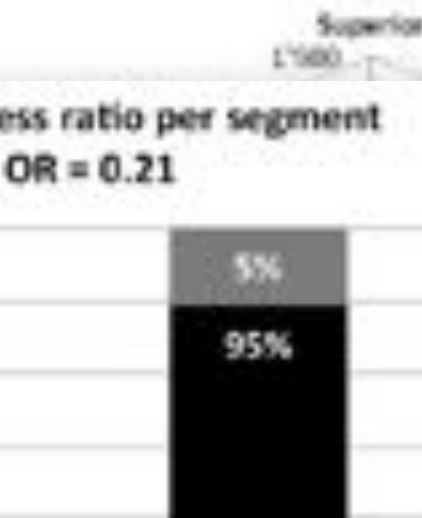
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2013

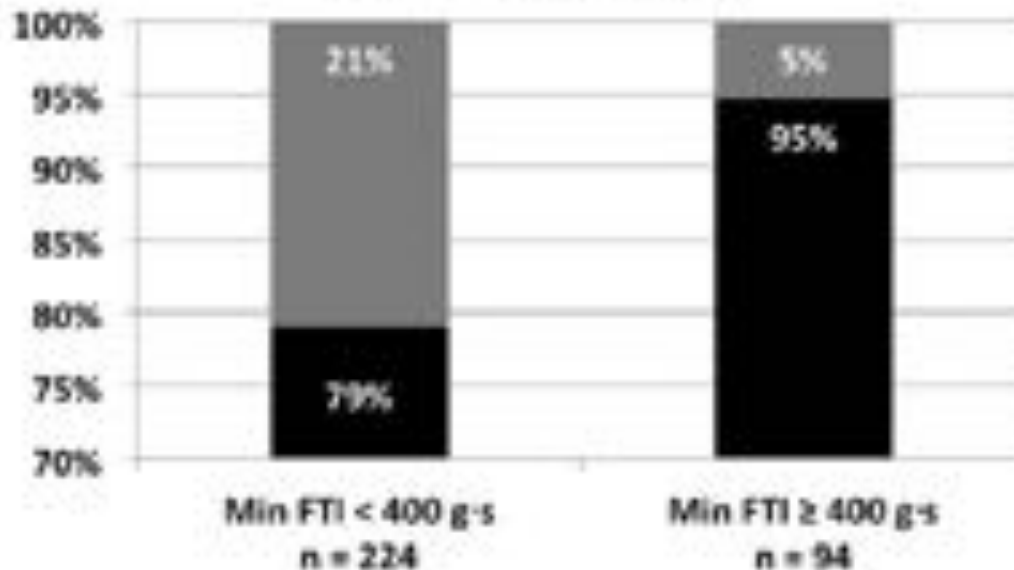
C Average Contact Force [g] per position
46 patients



D Average FTI [g·s] per position
46 patients



Minimum FTI (g·s) success ratio per segment
 $p = 0.0004$ - OR = 0.21



Durability of Pulmonary Vein Isolation with Cryoballoon Ablation: Results from the Sustained PV Isolation with Arctic Front Advance (SUPIR) Study

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2015

TABLE 5
PV Reconnections and Clinical AF Recurrence

Subject ID	Remapped	No. of PVs with Gaps	Location of Gap(s)	Clinical AF Recurrence
1	Yes	0		No
2	Yes	0		No
3	No	ND		ND
4	Yes	0		No
5	Yes	0		No
6	Yes	0		No
7	Yes	3	LSPV ridge area, LIPV anterior LAA area, RSPV posterior superior area	Yes
8	Yes	0		No
9	Yes	0		No
10	Yes	0		No
12	Yes	0		No
13	Yes	1	RIPV inferior aspect	ND
14	Yes	2	RSPV anterior/middle aspect, RIPV inferior aspect	Yes
15	Yes	0		No
15	Yes	0		No
17	No	ND		ND
18	Yes	0		No
19	Yes	0		No
20	Yes	0		No
21	Yes	0		No
22	Yes	1	RIPV inferior aspect	No

ND = not determined.



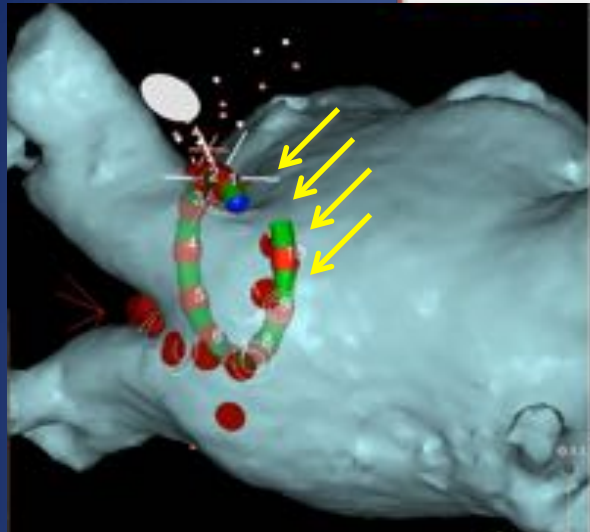
91% of PVs still isolated at 3 months check



Good correlation between AF recurrences and gaps

Simplifying atrial fibrillation ablation: How far can we go?

**German GAP-AF (AFNET 1)
effective randomized multicenter trial (233 Pts)**



Complete the isolation
encirclement or not?

At 3 months, a repeat investigation did show:

- complete PVI : GAPS IN 70 % !
- incomplete PVI : GAPS IN 89% !!

The durability of pulmonary vein isolation using the visually guided **laser balloon catheter**: multicenter results of pulmonary vein remapping studies.

Dukkipati SR. Tondo C et al. Heart Rhythm 2012

52 Pts restudied after 3 months

86% PVs still isolated

➤ **62% Pts with all PVs still isolated**



89% - 66% for experienced Operators

Liberation Study

3-months restudy for PVs check (30 Pts)

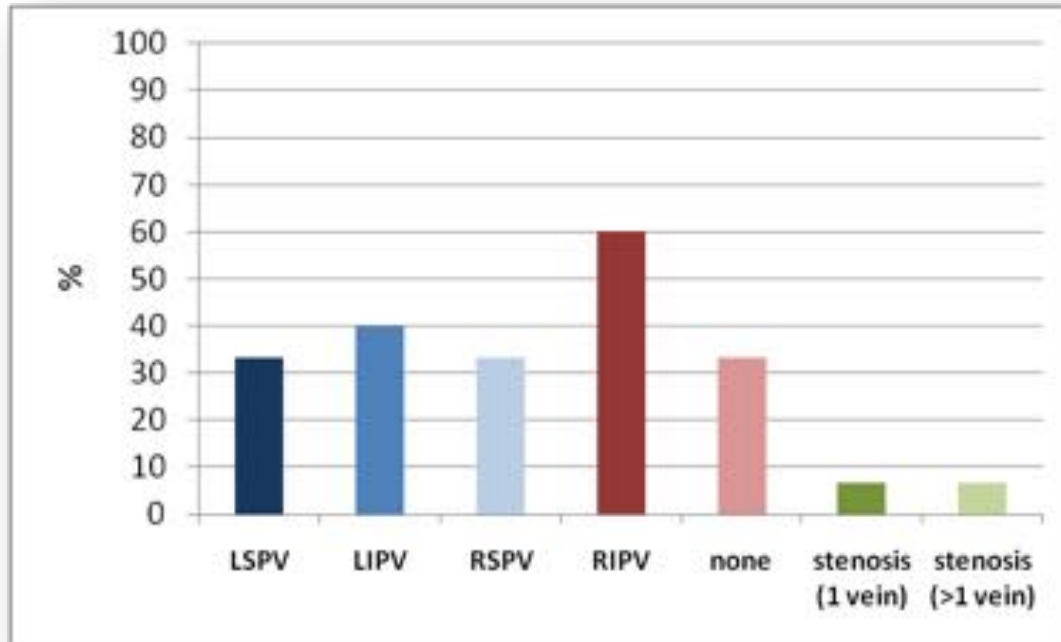
Age	56 ± 13 years
Male	93%
Female	7%

Paroxysmal AF	73%
Early Persistent AF	20%
Long Persistent AF	7%

ECHO - EF	64 ± 7 %
LA Area (ECHO)	24 ± 5 cm ²
LA Diameter (ECHO)	46 ± 8 mm

Hypertension	47%
Dyslipidemia	33%
Transient Ischemic Attack	13%
Diabetes Mellitus	13%
Smoke	7%
Ischemic Dilated Cardiomyopathy	7%
Thalassemia Minor	7%
Valvular Heart Disease	7%
Minor stroke	7%

Liberation Study

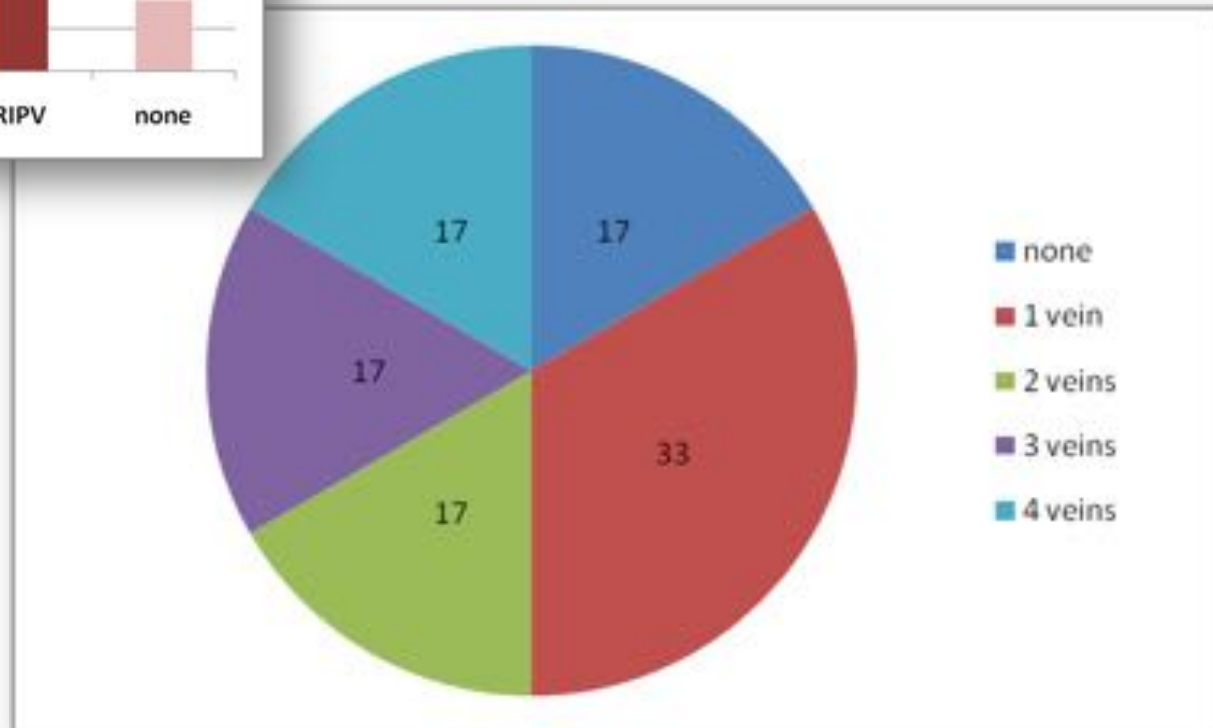
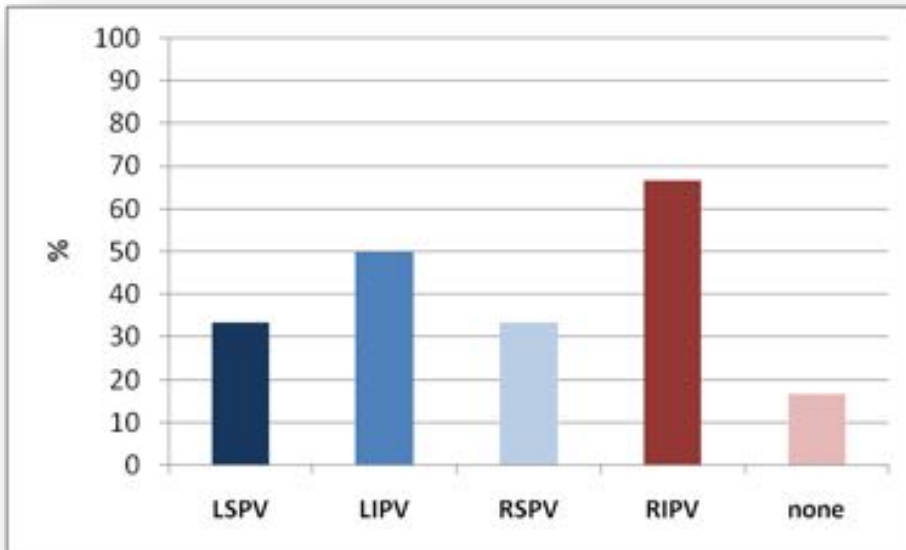


Pulmonary Vein Reconnection	
LSPV	33%
LIPV	40%
RSPV	33%
RIPV	60%
None	33%

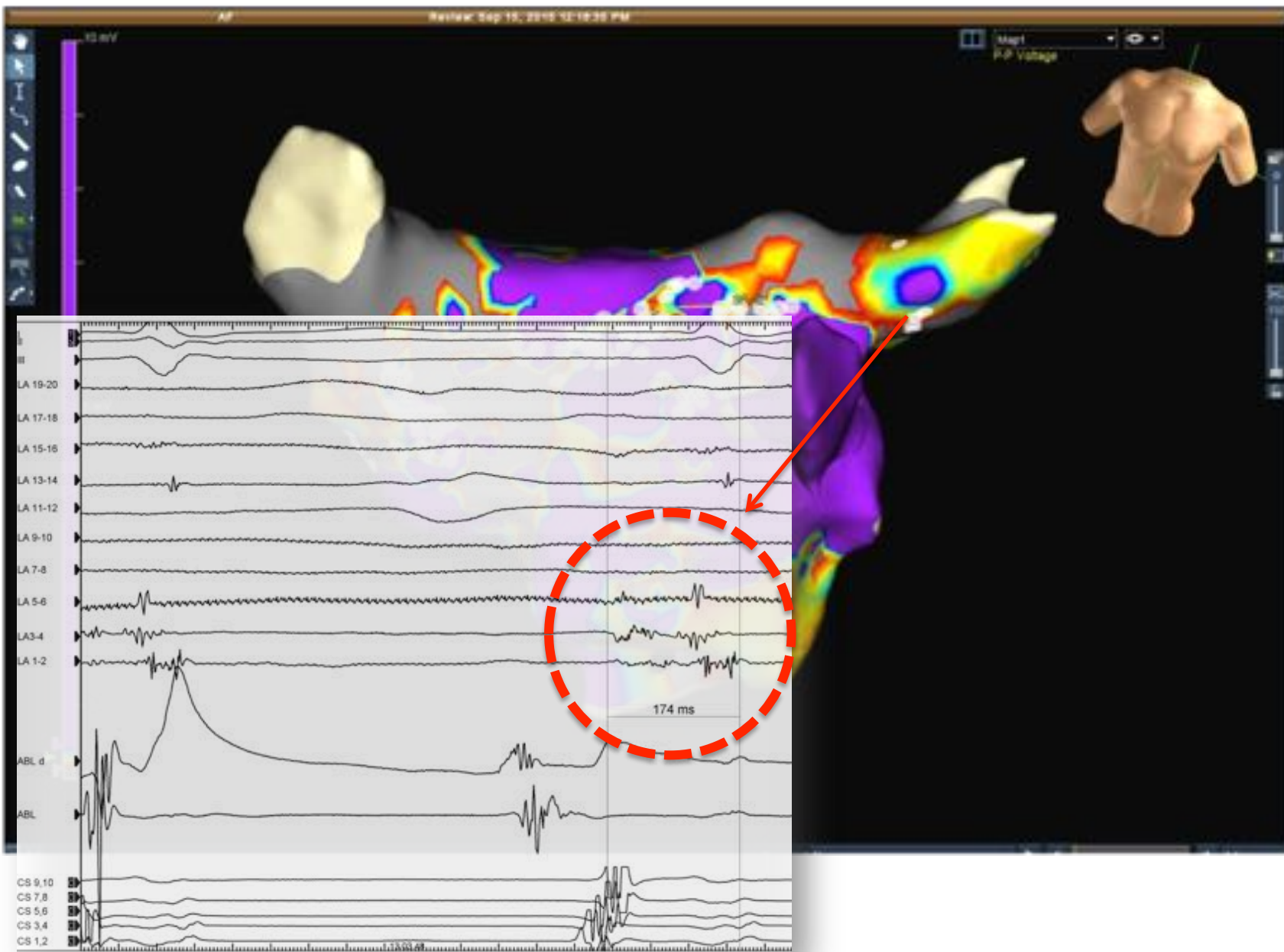
Stenosis	
1 Pulmonary Vein	7%
> 1 Pulmonary Vein	7%

Liberation Study

40% (any) AF recurrences

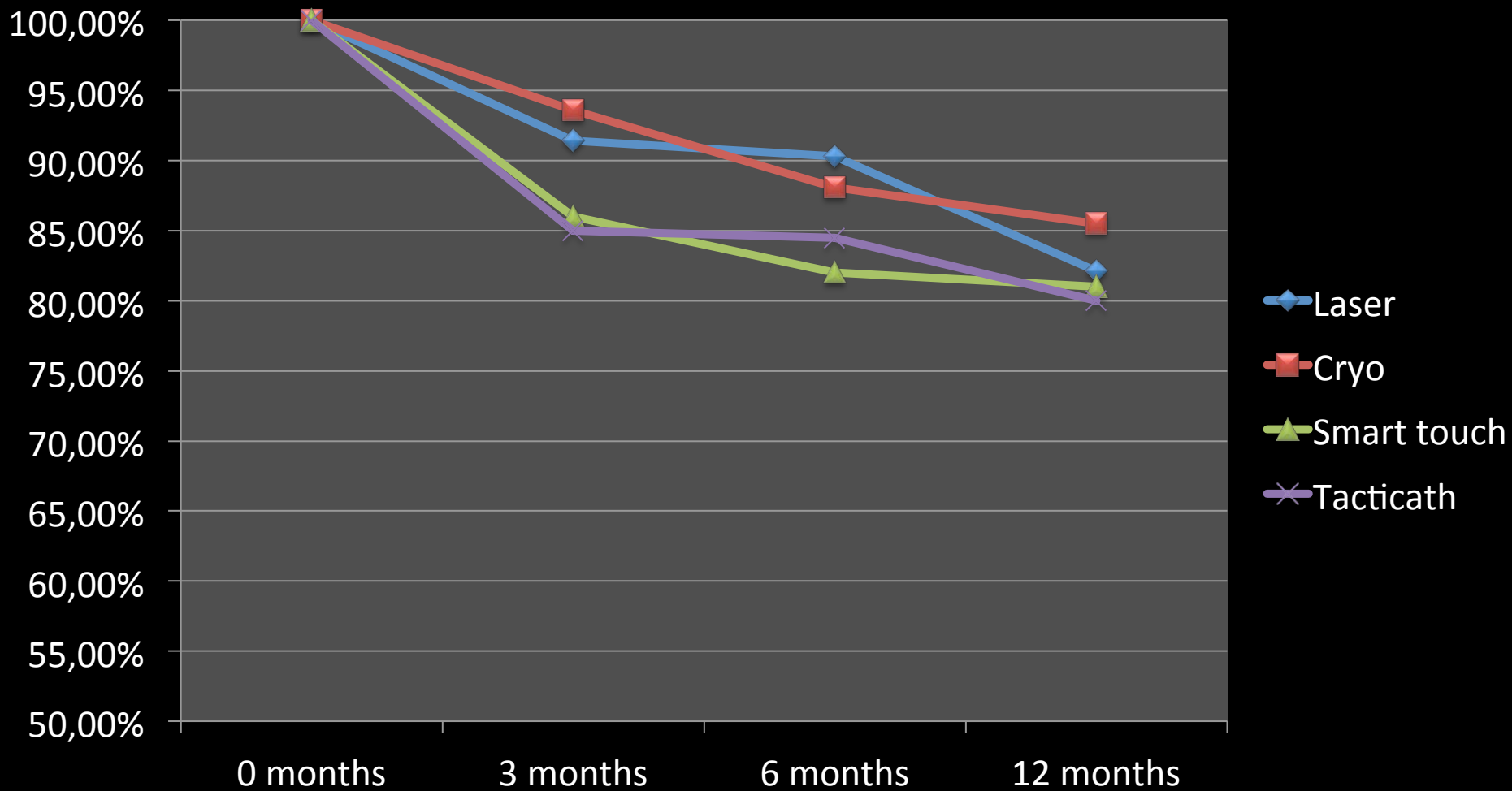


Recurrence Post Cryoballoon: which findings?





Paroxysmal AF ablation; mid term outcome Balloon Vs. focal RF





Volkswagen. Gas Auto.





Fire vs freeze....

The challenge goes

on...

ES2