CFAE Ablation: Absolute or Obsolete Procedure?

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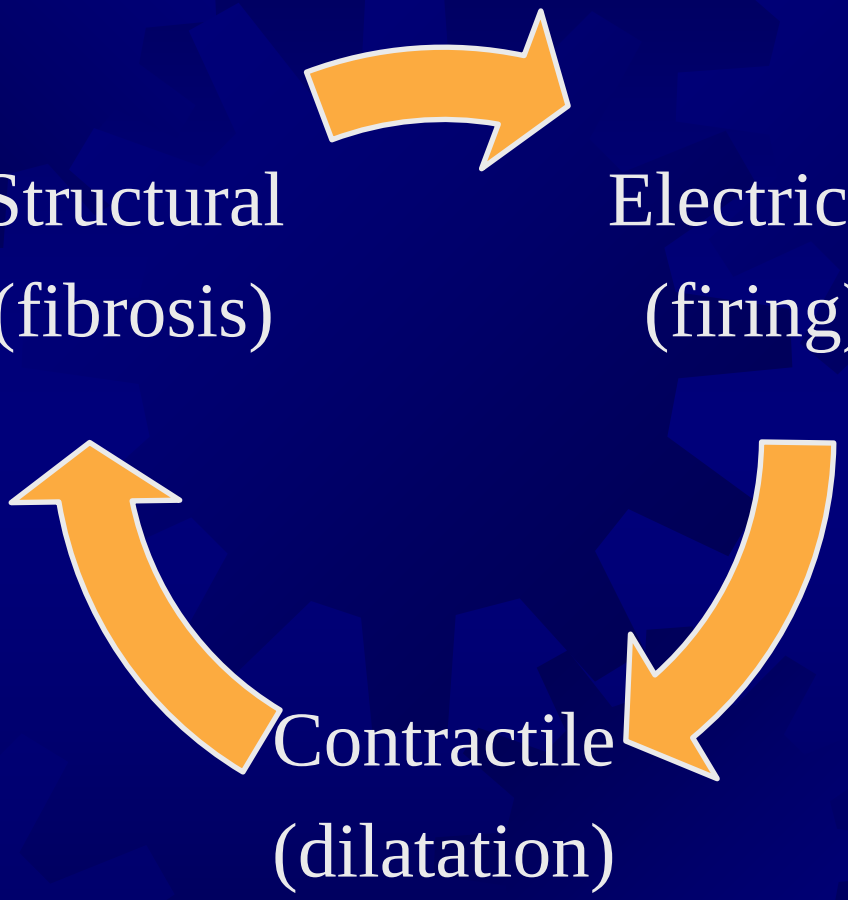
Disclosures

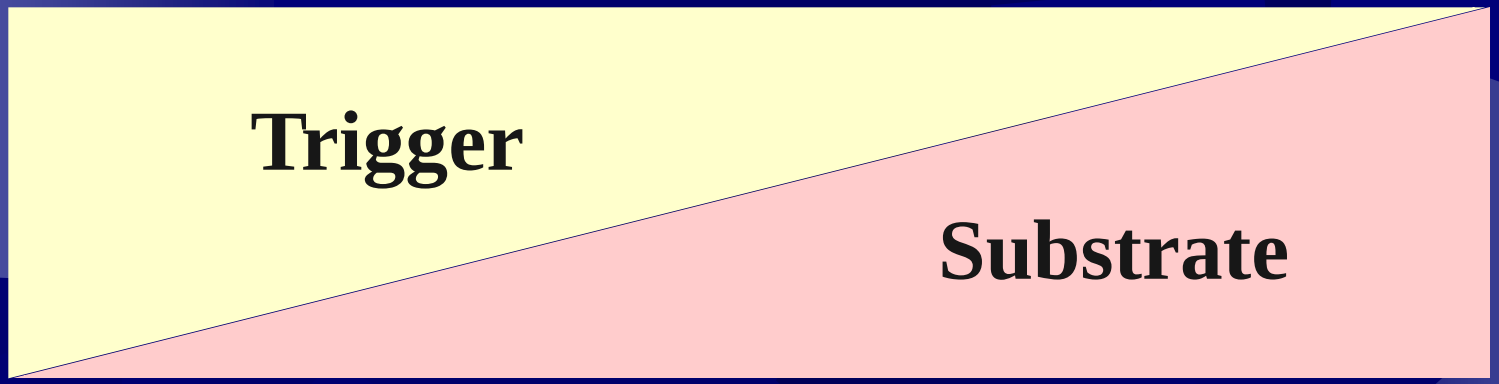
- Non

‘AF begets AF’ by atrial remodeling

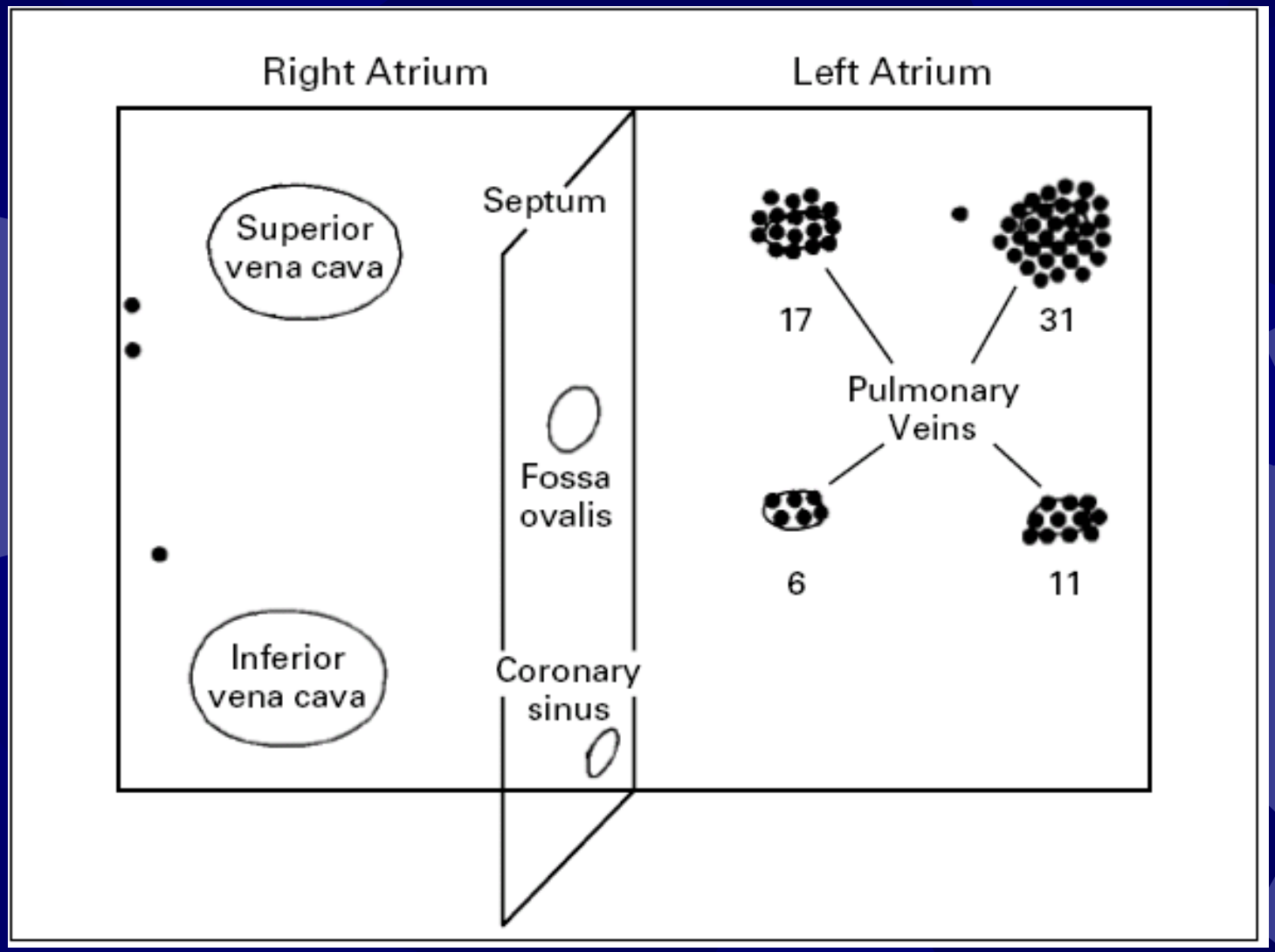


Mechanism of AF progression

Paroxysmal AF ----------> Persistent or Permanent AF

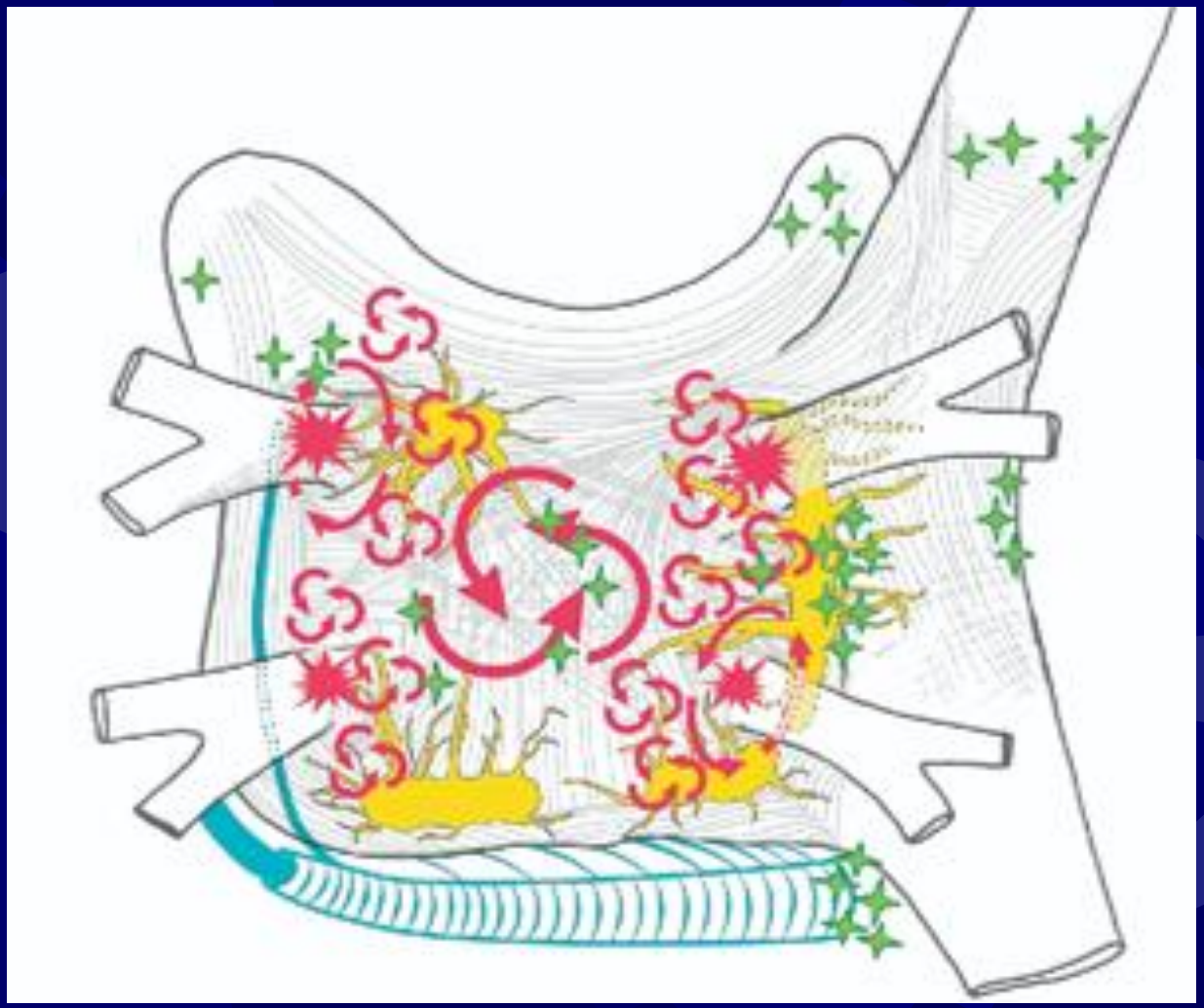


Trigger ablation ? – Mostly Pulmonary Veins



Haissaguerre et al, *NEJM*

Where to ablate the substrates?



HRS/EHRA/ECAS Consensus Statement, HR 2007

Substrate ablation

1. Linear ablation
2. CFAE (complex fractionated atrial electrograms)
3. Rotor and dominant frequency.

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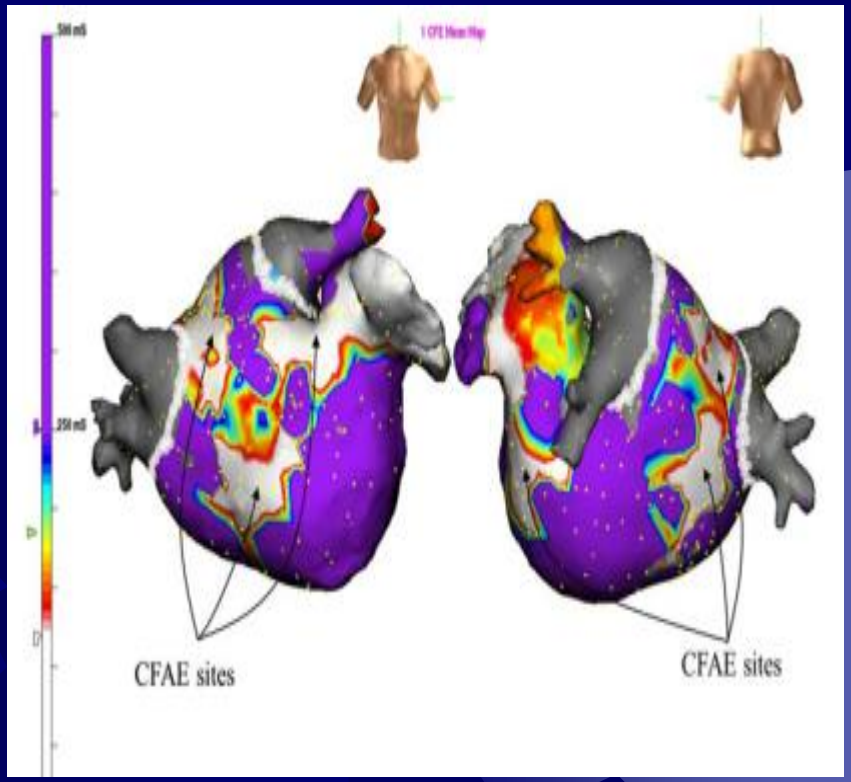
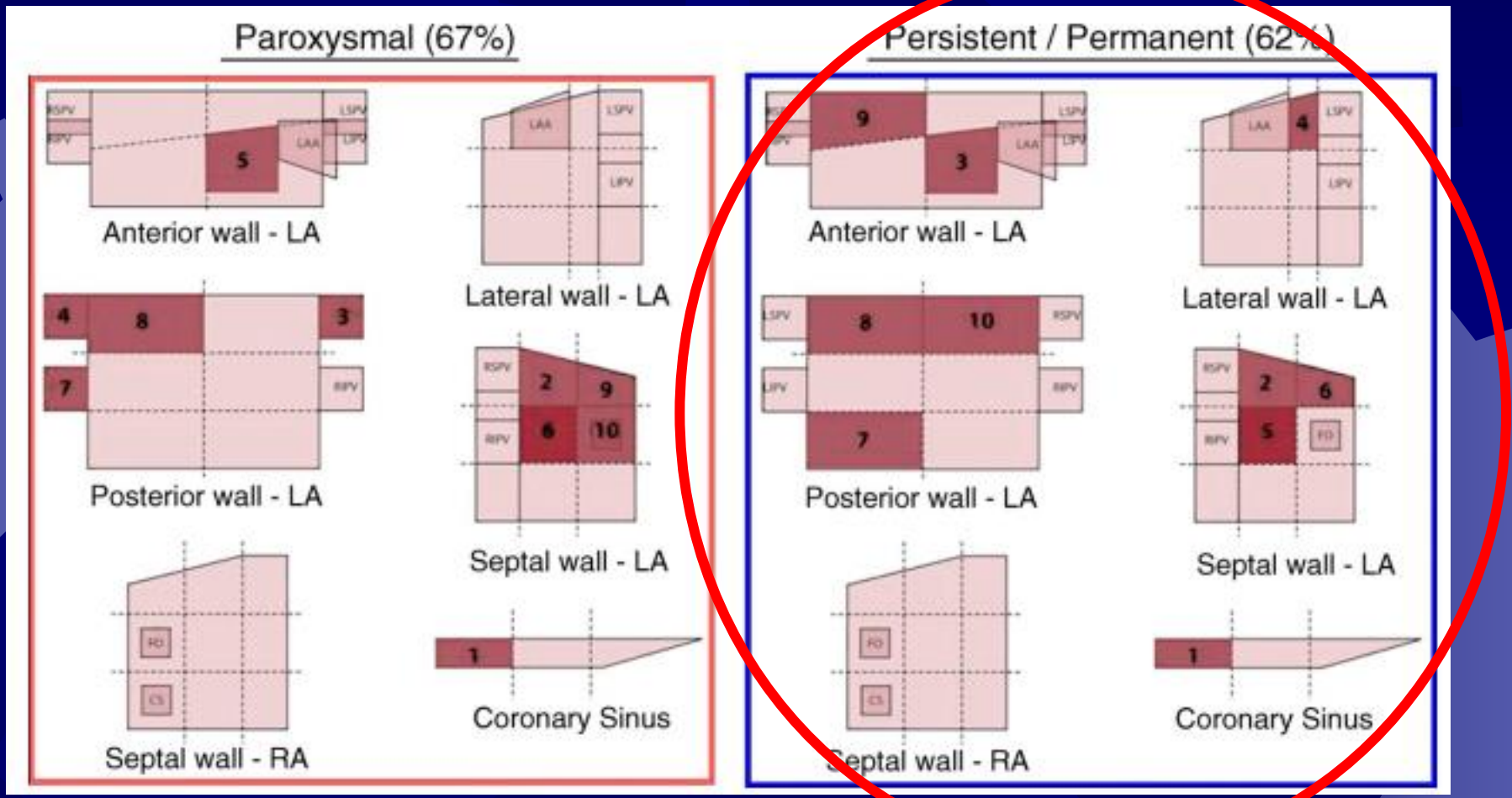
What is CFAE?



K. Nademanee et al, *Int J Cardiol, 2010*

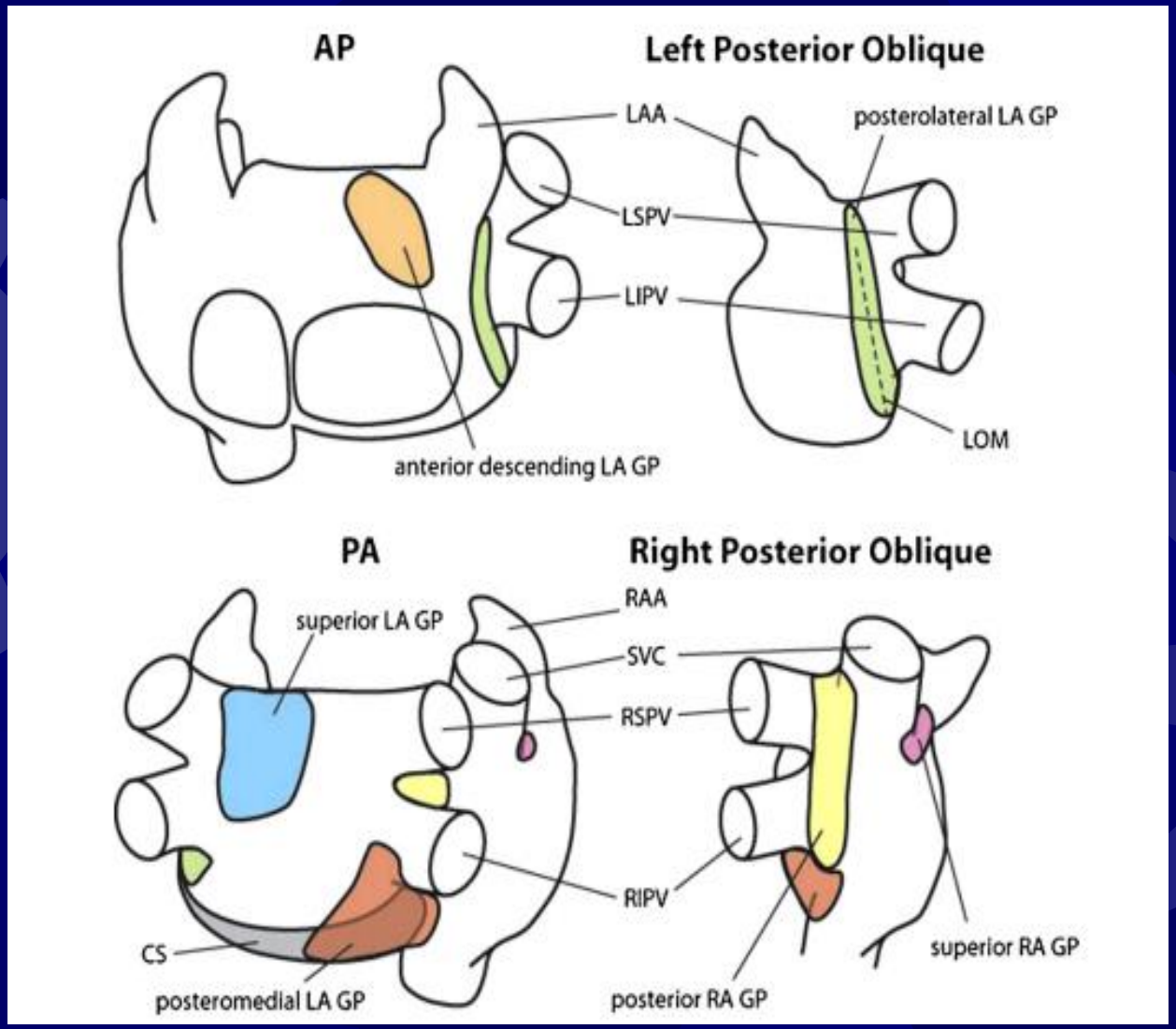
SW Han et al, *Int J Cardiol, 2014*

The most common locations of CFAE



K. Nademanee et al, *Int J Cardiol, 2010*

The location of ganglionic plexi

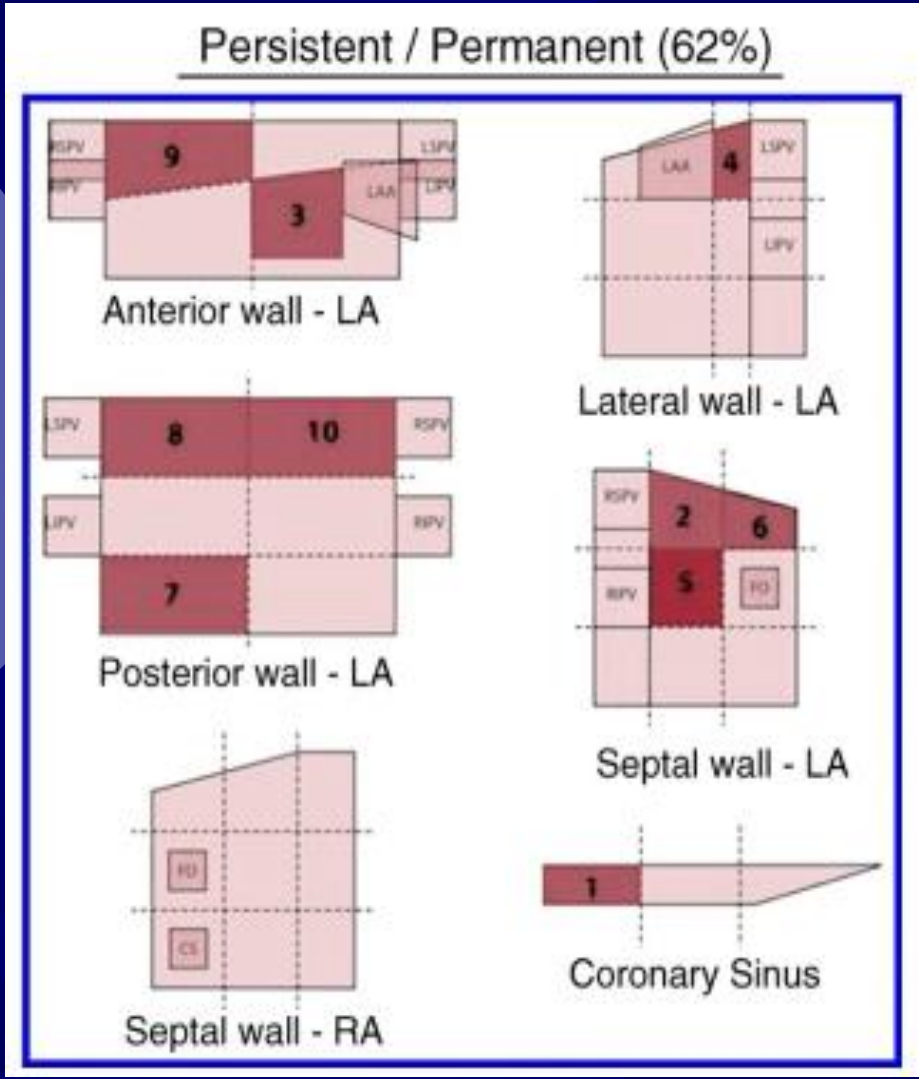


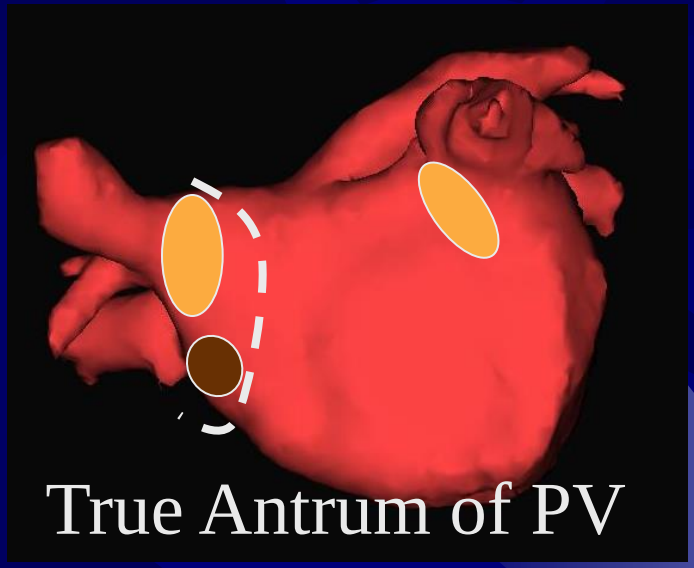
K. Nademanee et al, *Int J Cardiol, 2010*

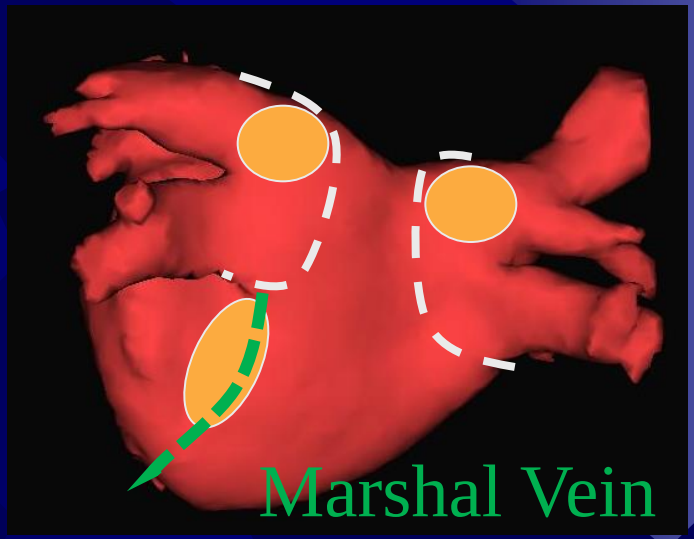
Possible mechanisms of CFAE ablation

- CFAE areas : high frequency sources driving AF or pivoting points
- The PV ostia or antrum are the most common areas of CFAE. (modify the AF substrate and eliminate AF triggers)
- Autonomic modulation by ablation of the cardiac ganglionated plexi.

The most common locations of CFAE in PEAF

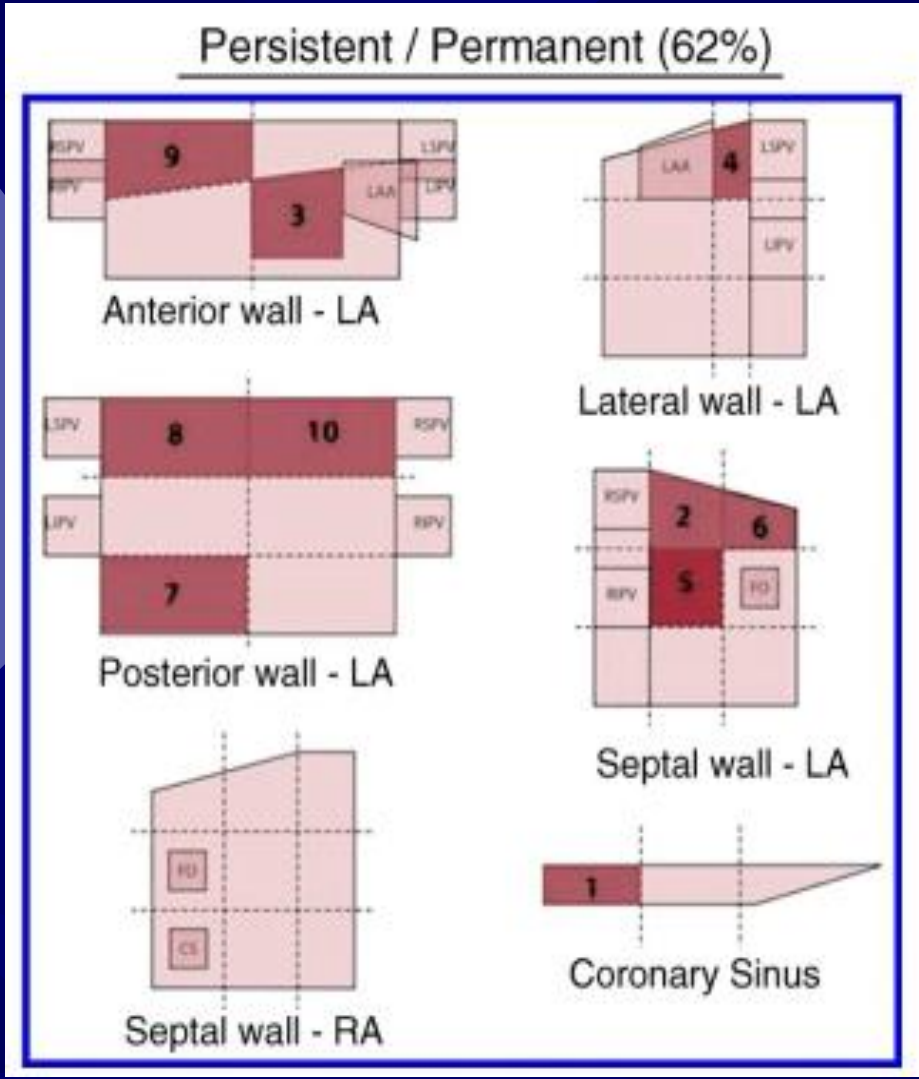


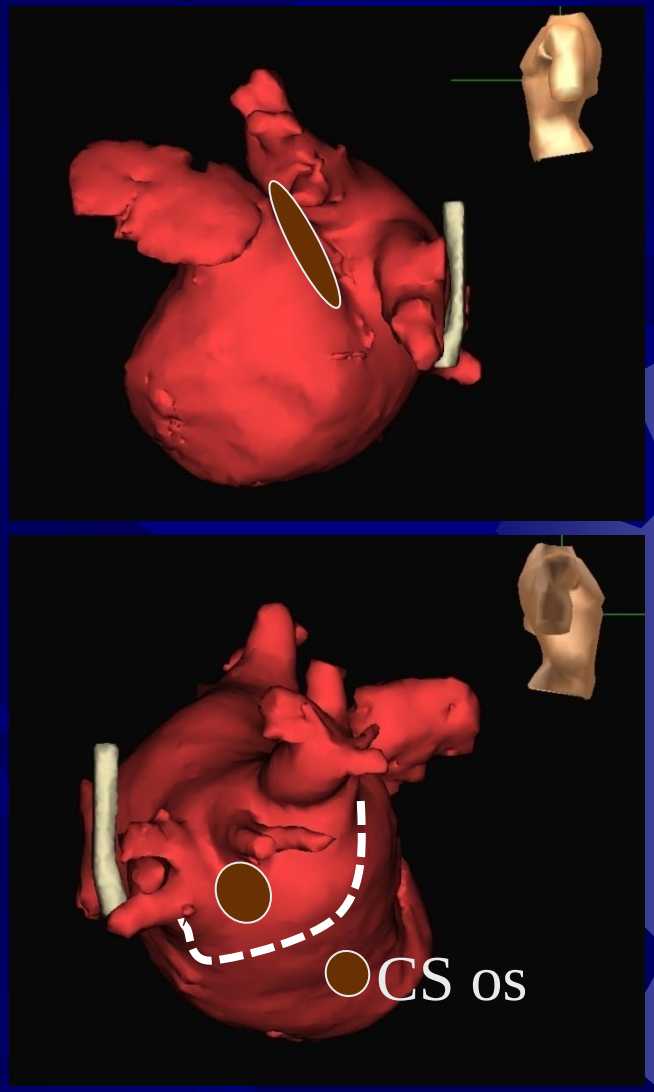




K. Nademanee et al, *Int J Cardiol, 2010*

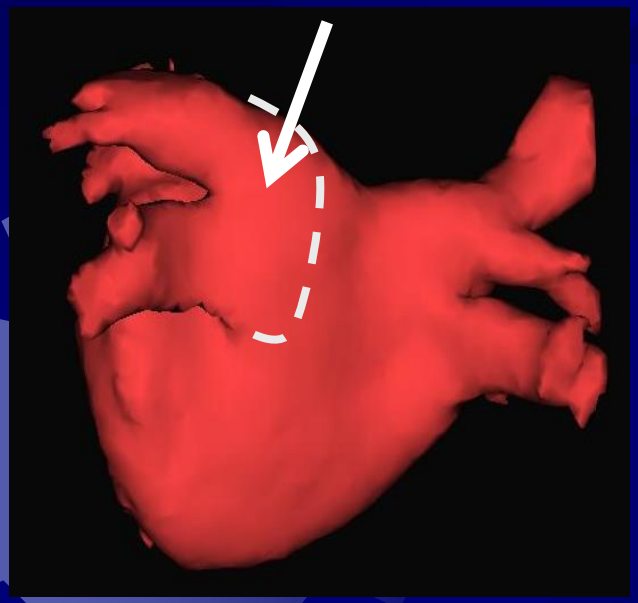
The most common locations of CFAE

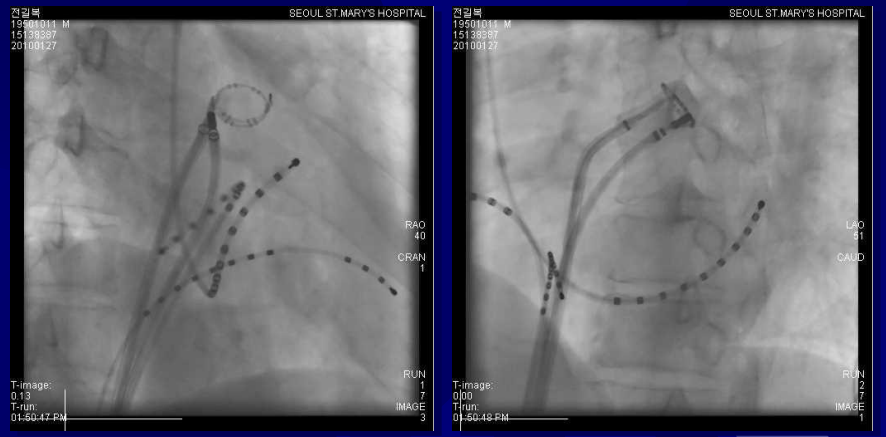


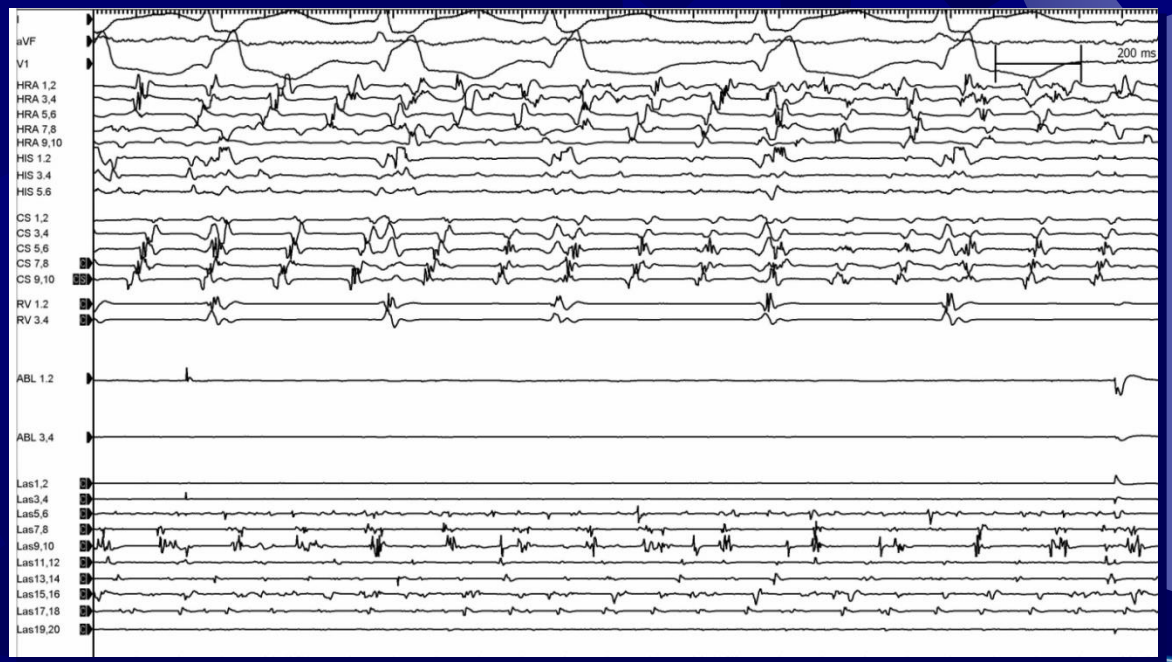


K. Nademanee et al, *Int J Cardiol, 2010*

1. Where is the true PV antrum ?

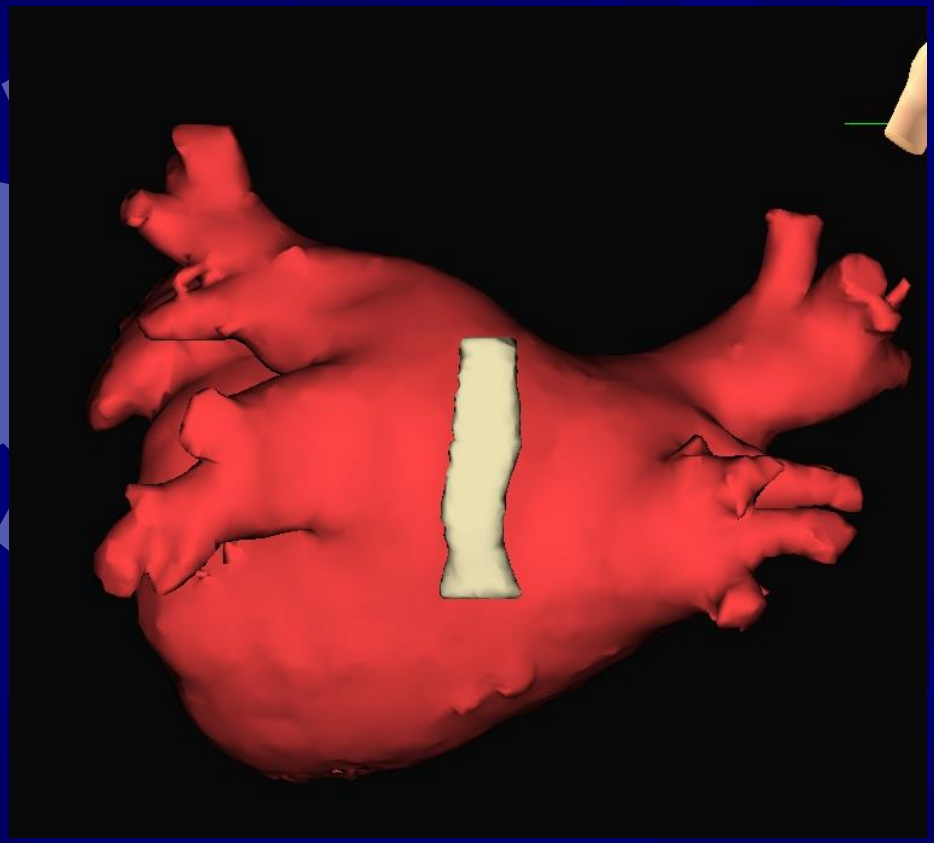


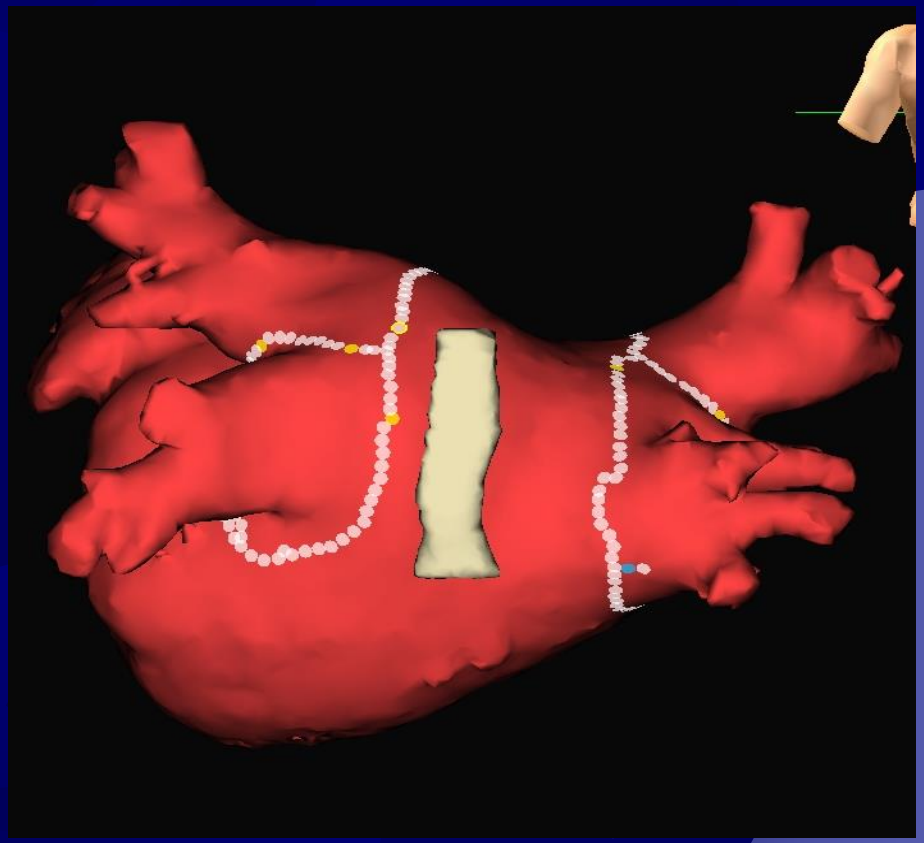




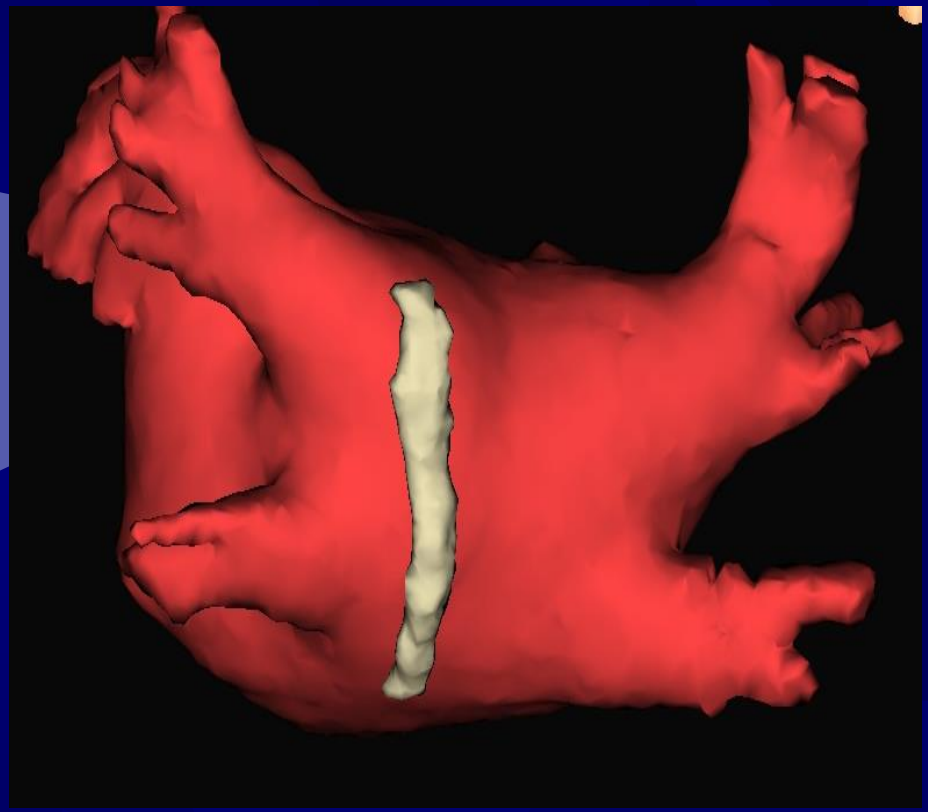
Emphasizing on map potential during Geometry

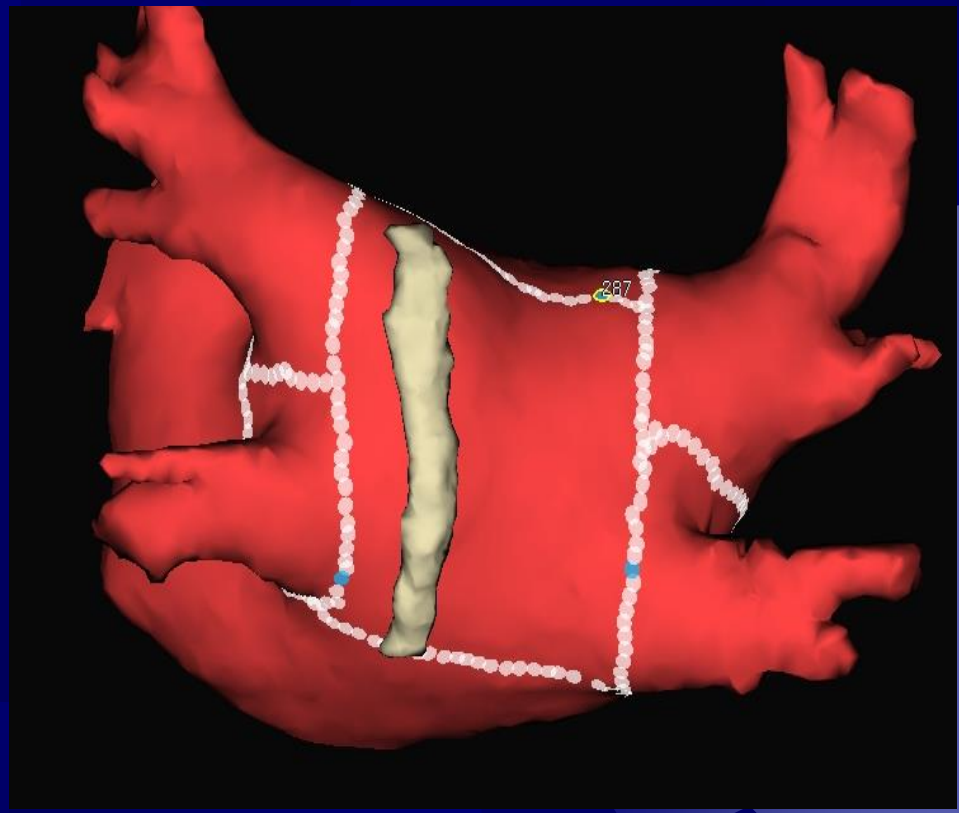
Location of Esophagus



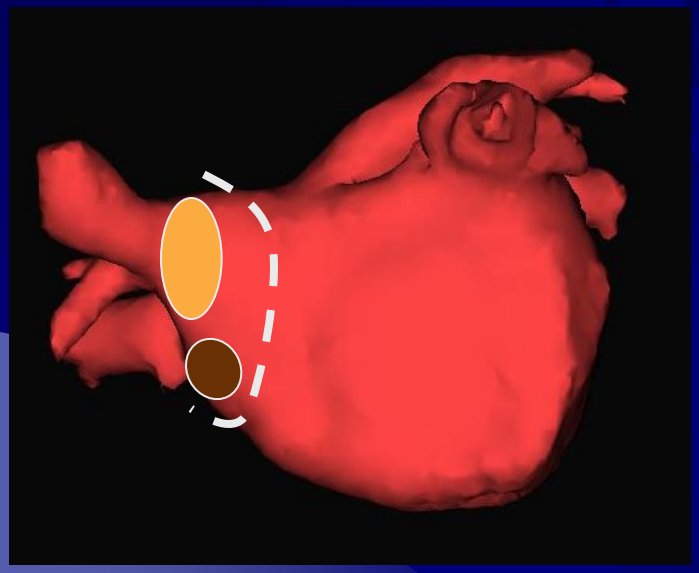


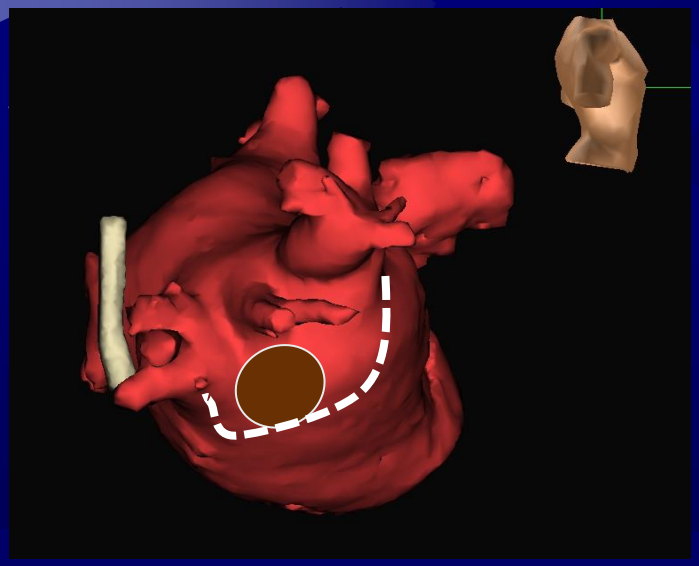
Location of Esophagus

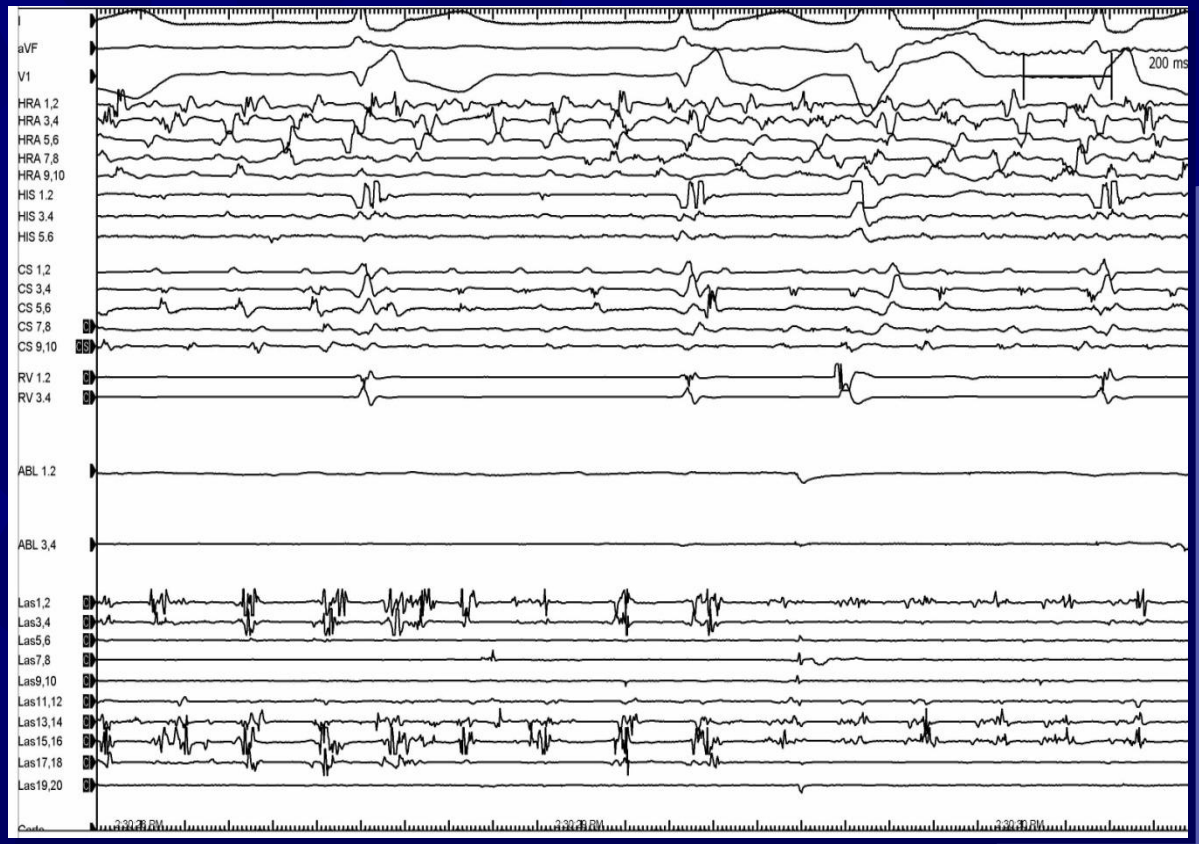




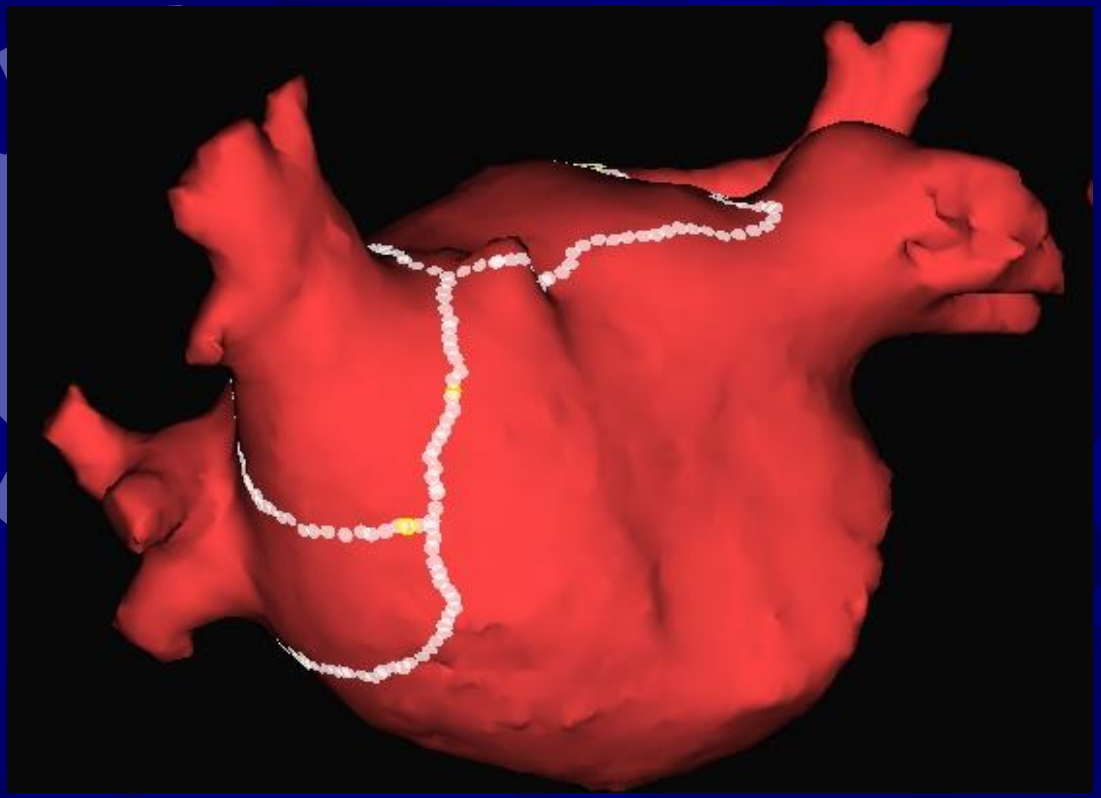
The amtrum of Right PV

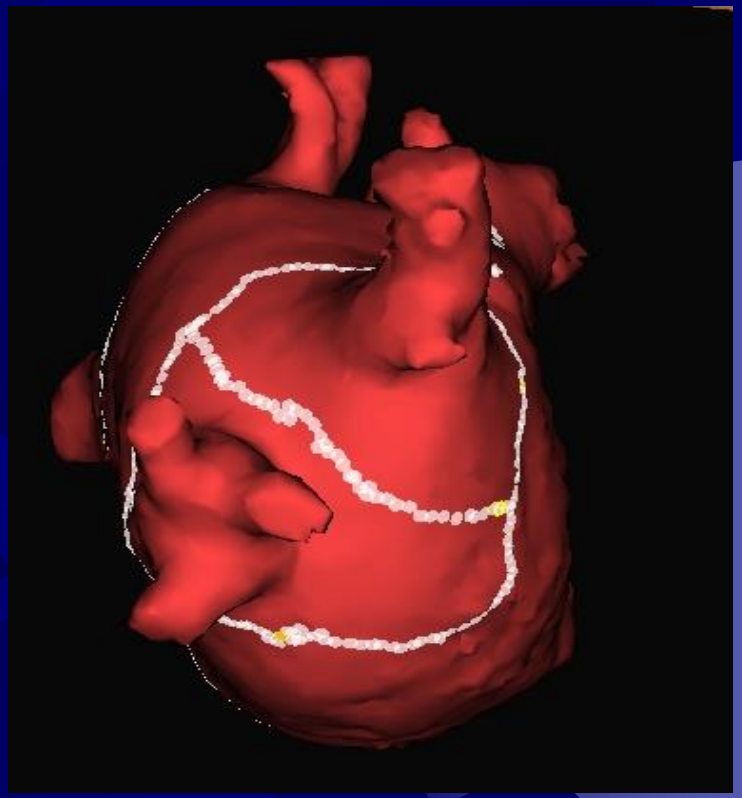




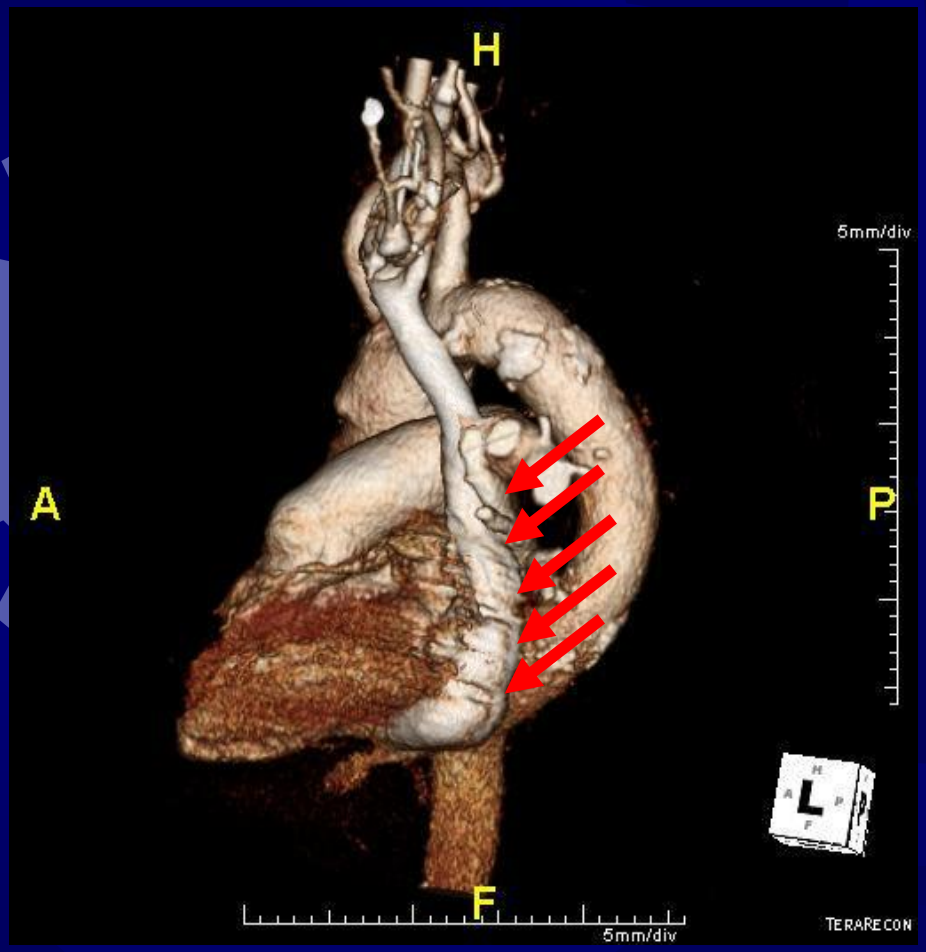


Right Antral ablation

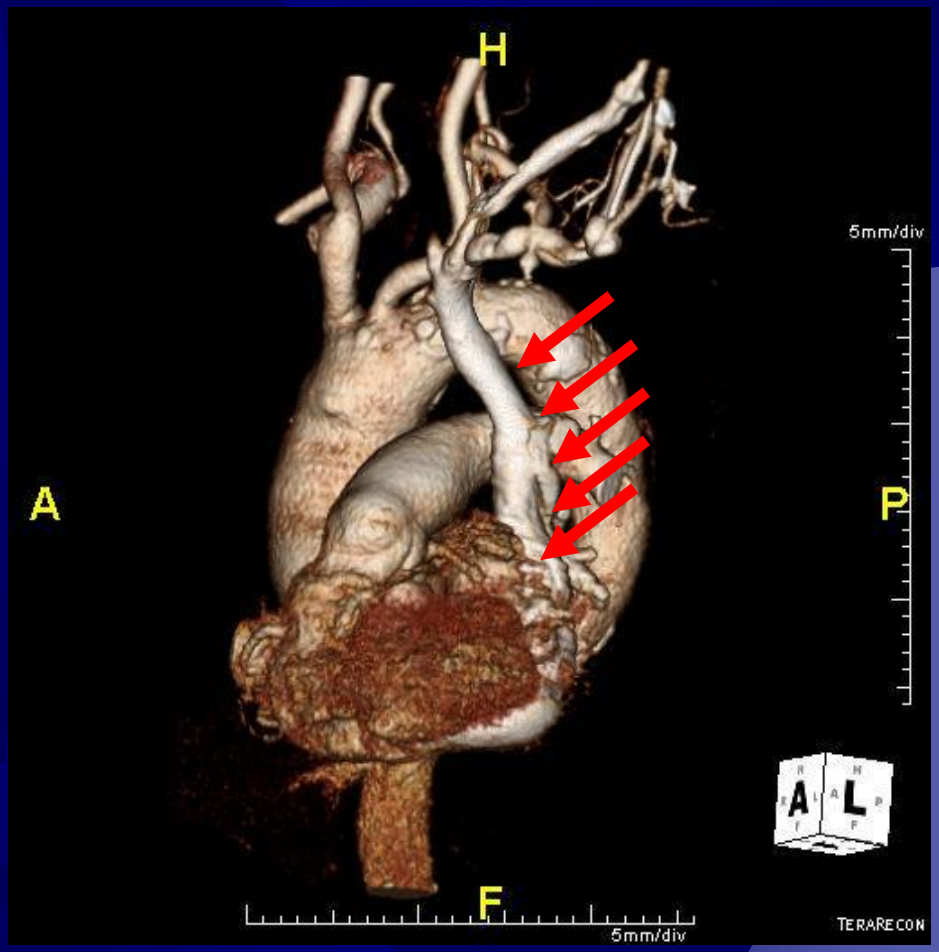




2. Ligament of Marshall : Persistent Left side SCV

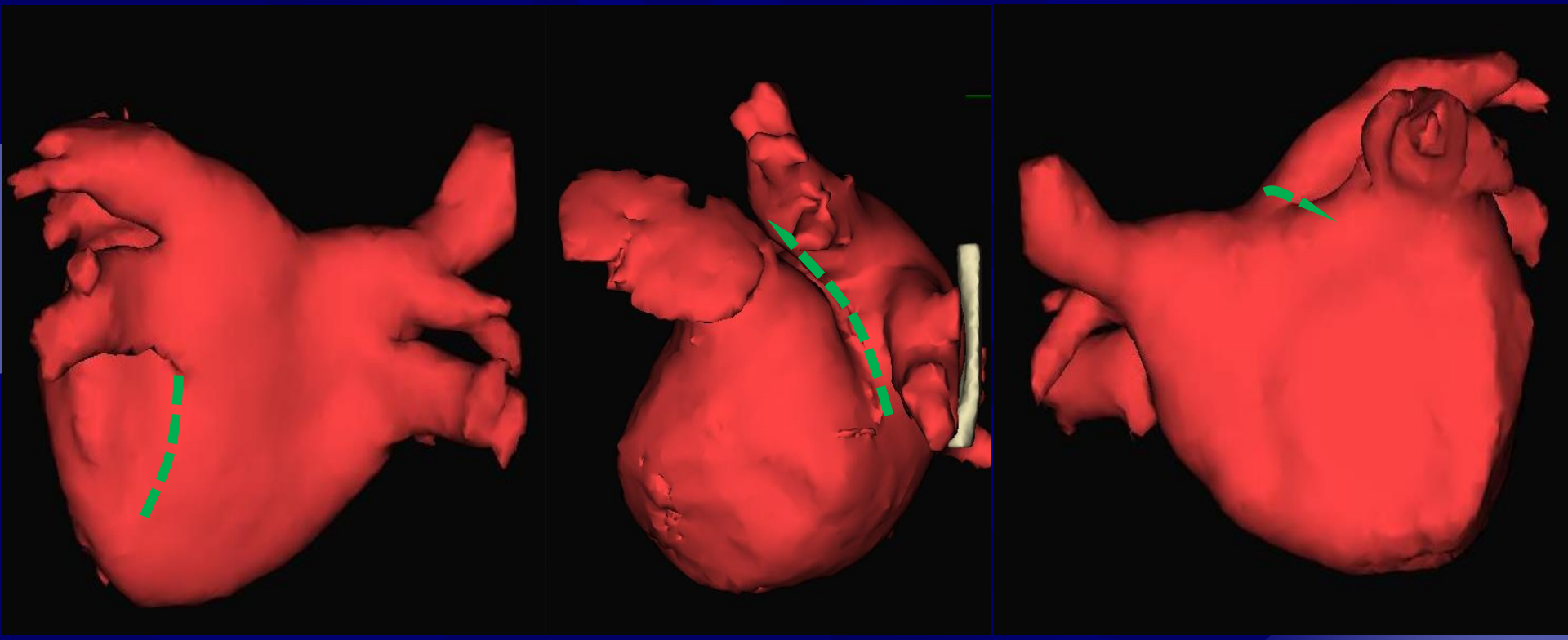


LAT

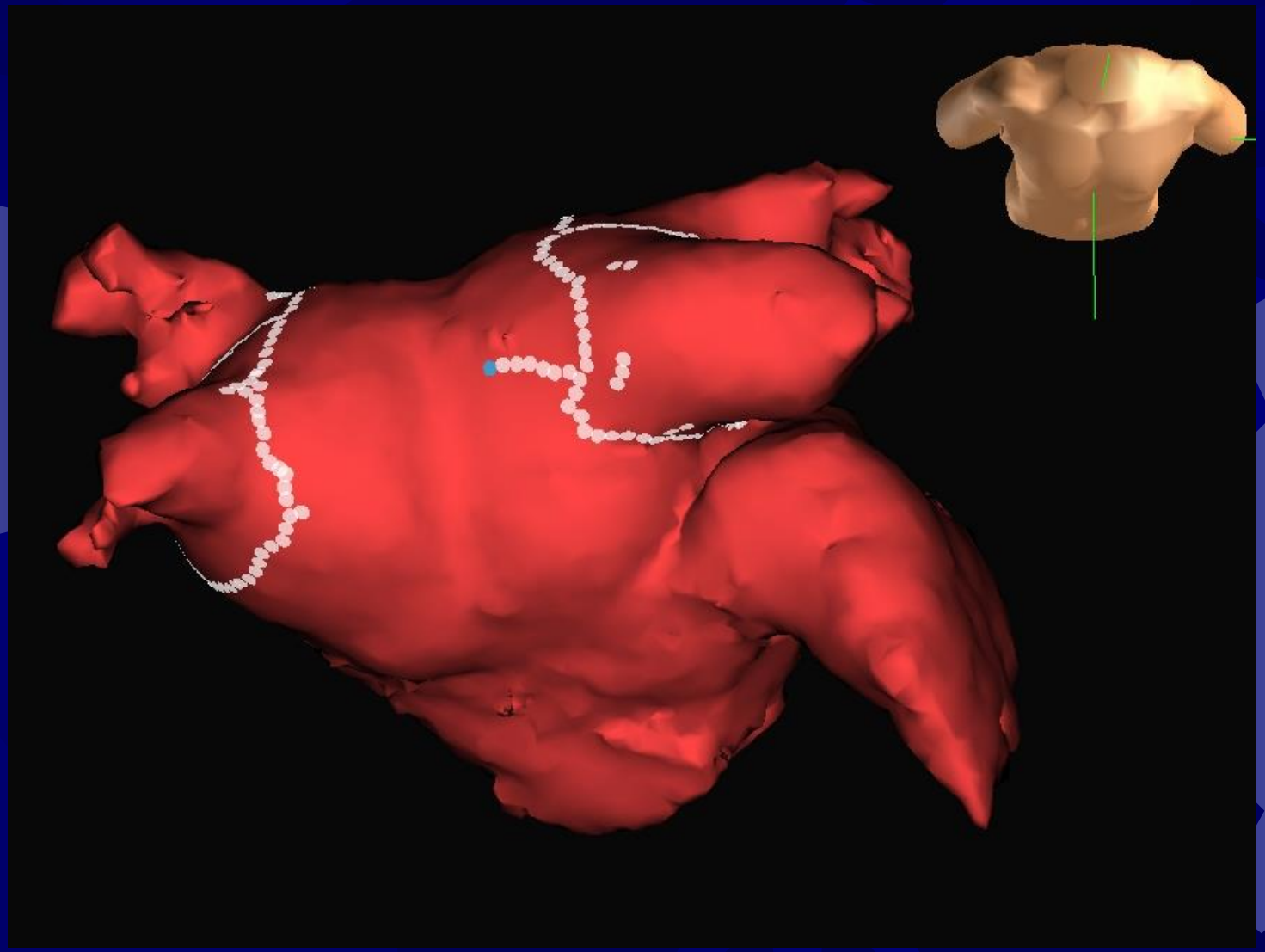


AP

The course of ligament of Marshall



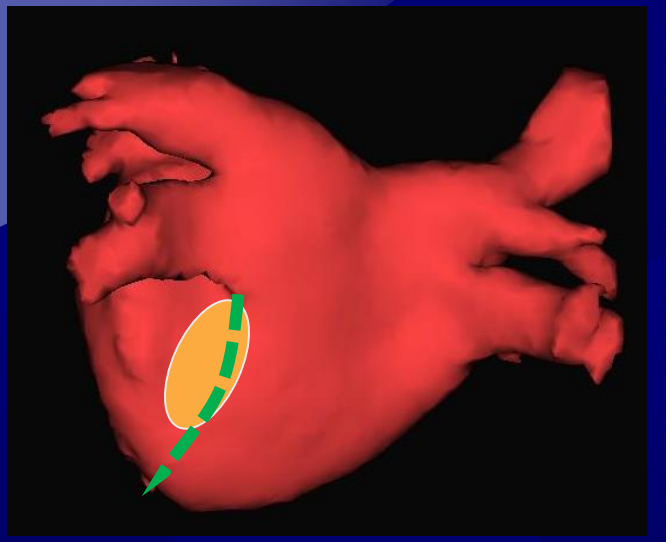
1) Sup remnants of Persistent Left side SCV

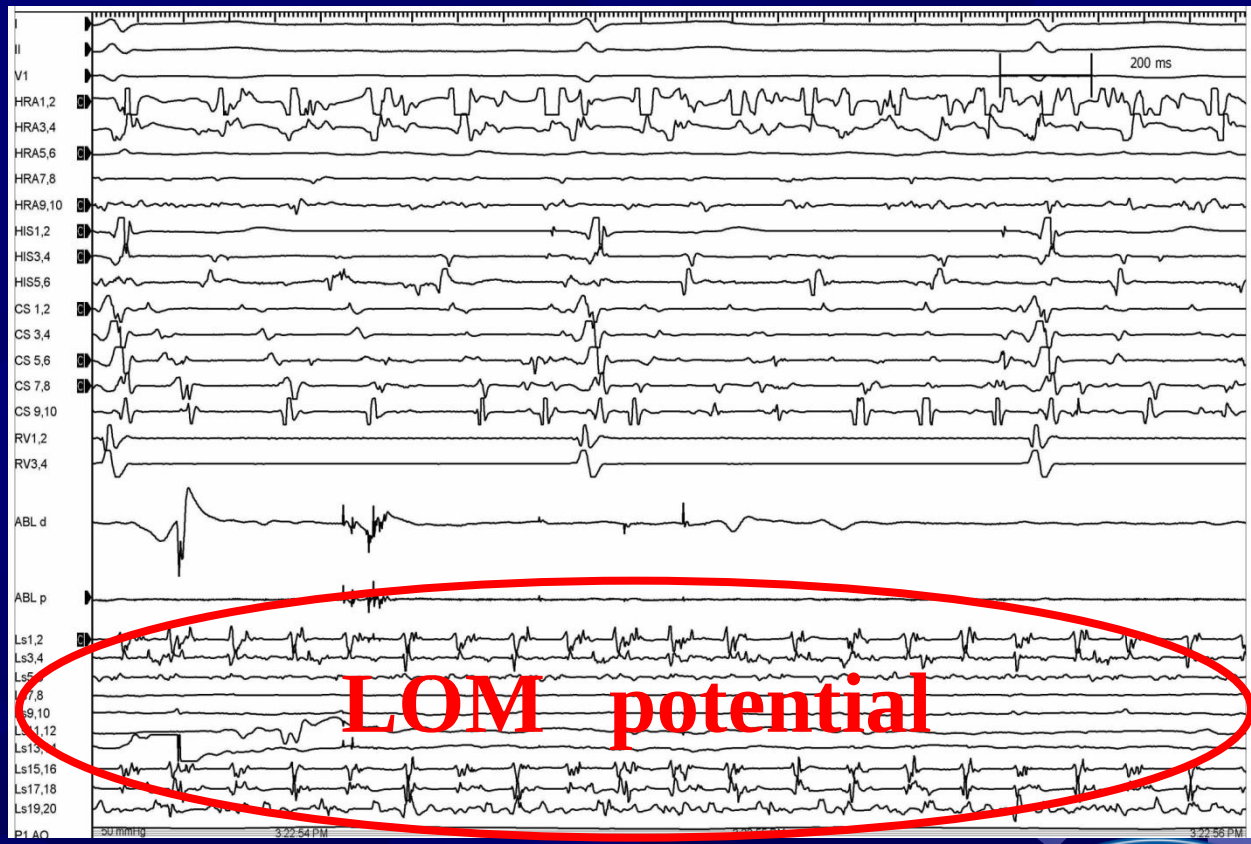


AF termination

2) How to make perimitral block?

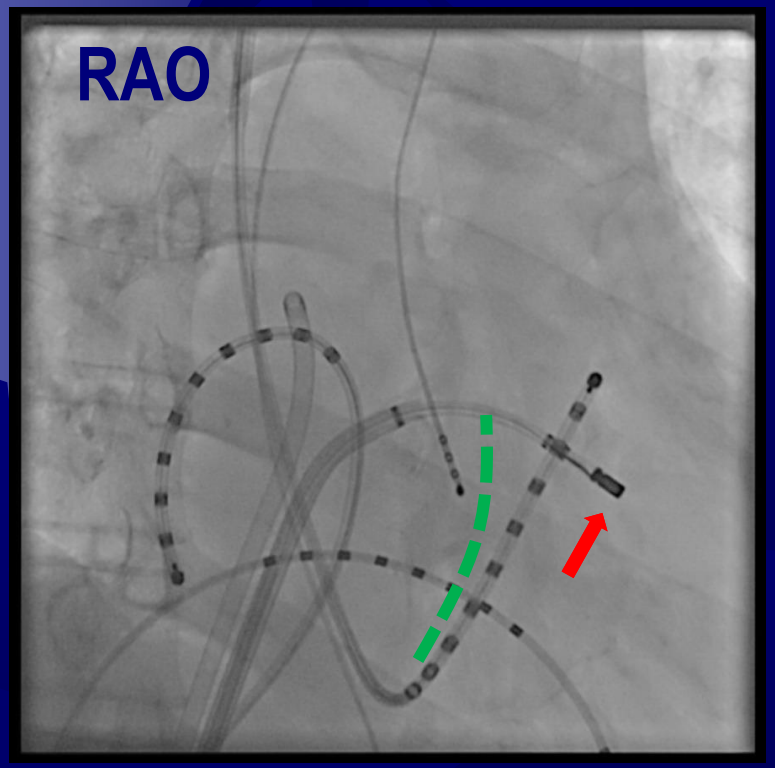
1) Mitral valve isthmus line ablation
2) Ant line ablation

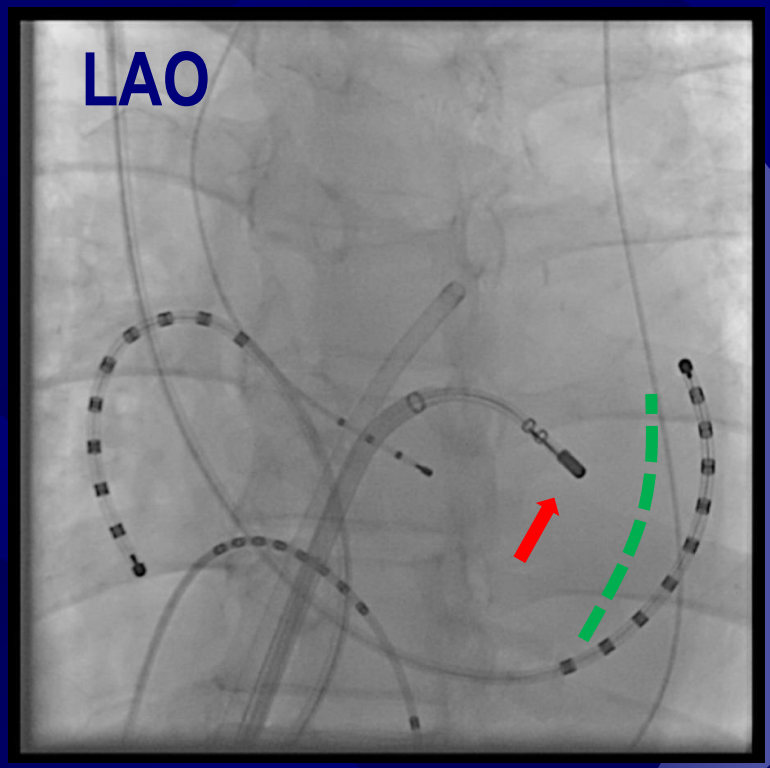




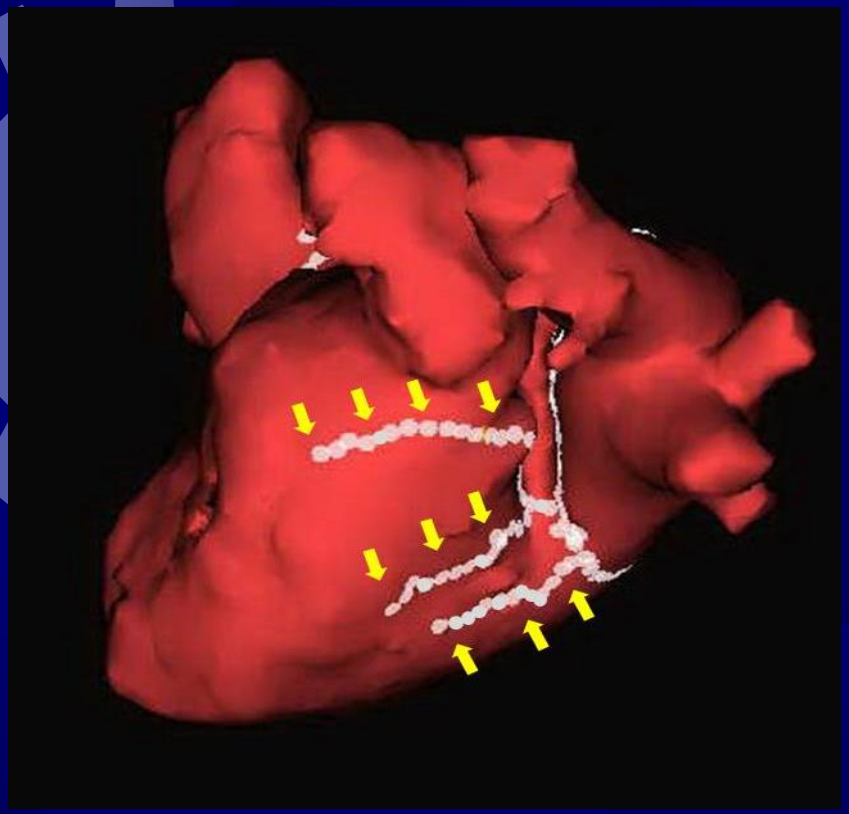
Fluoroscopic-guided ablation

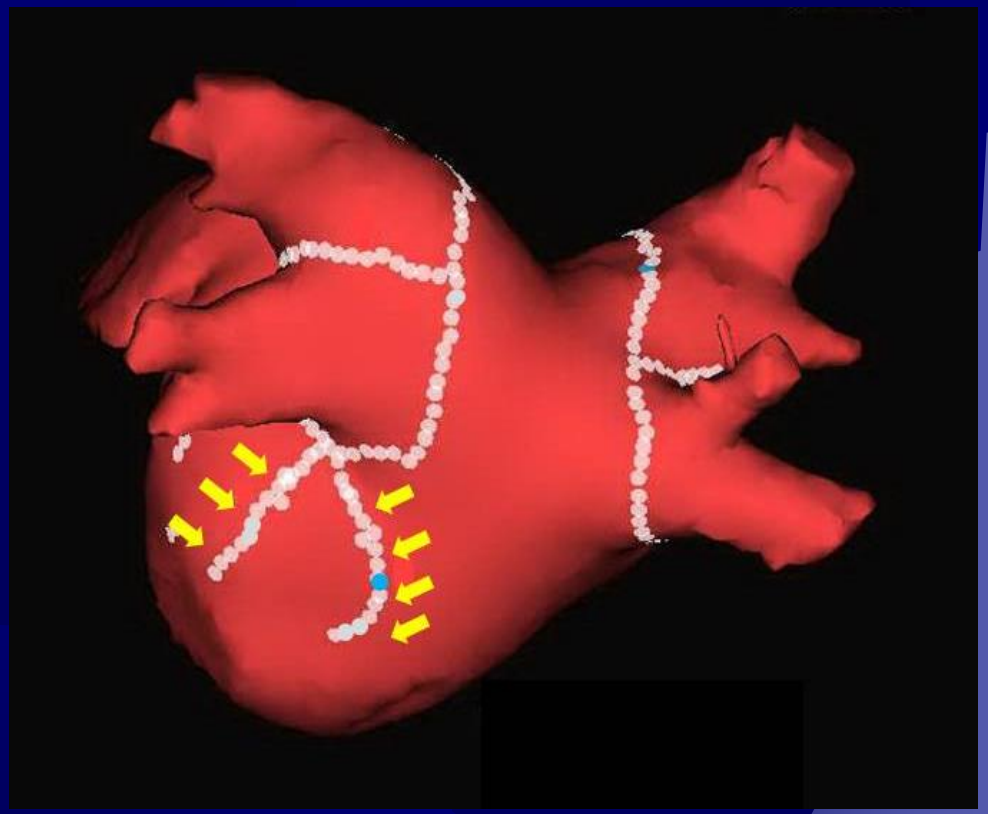
- Patients who had still AF after PV isolation



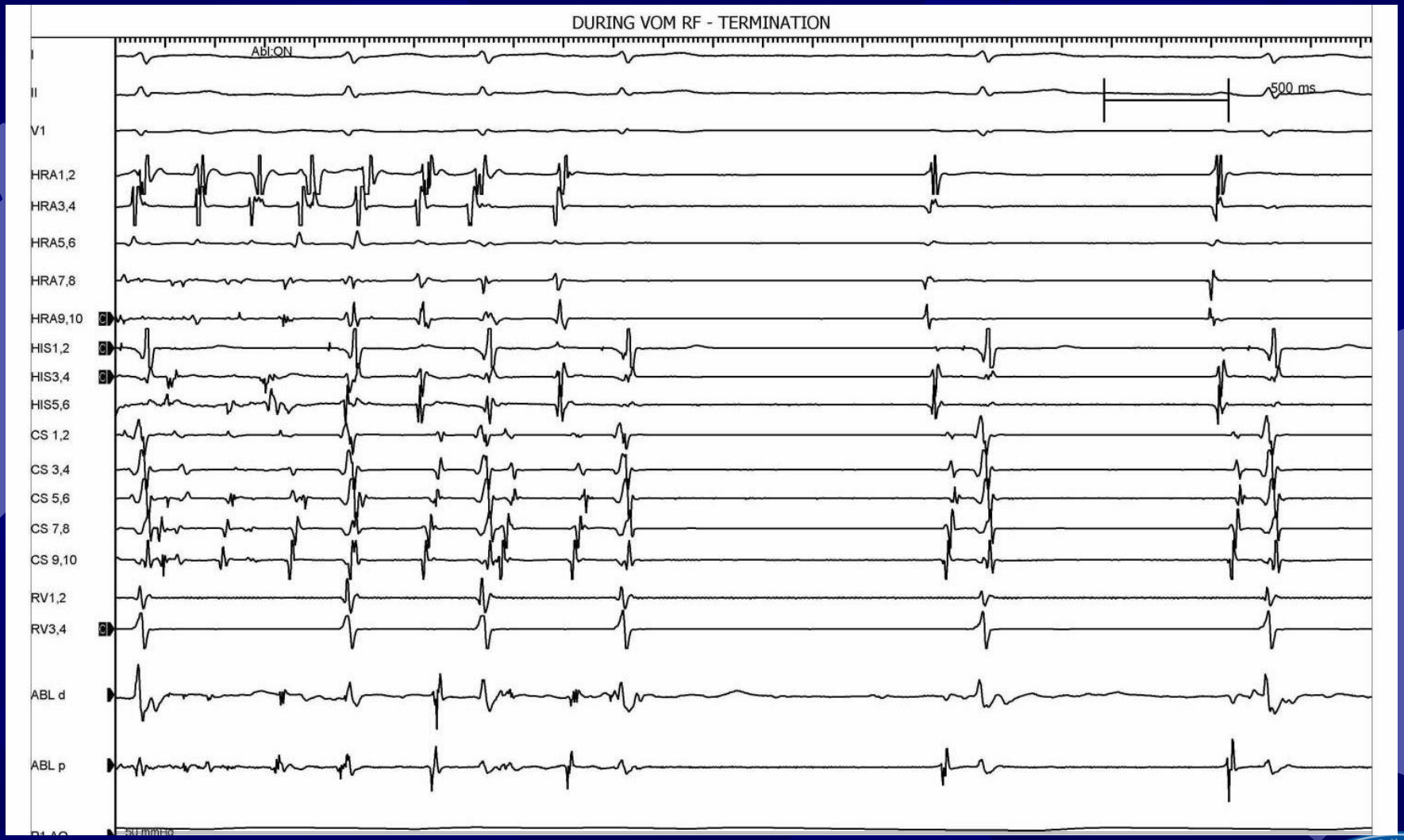


(1) Mitral valve isthmus & LOM ablation

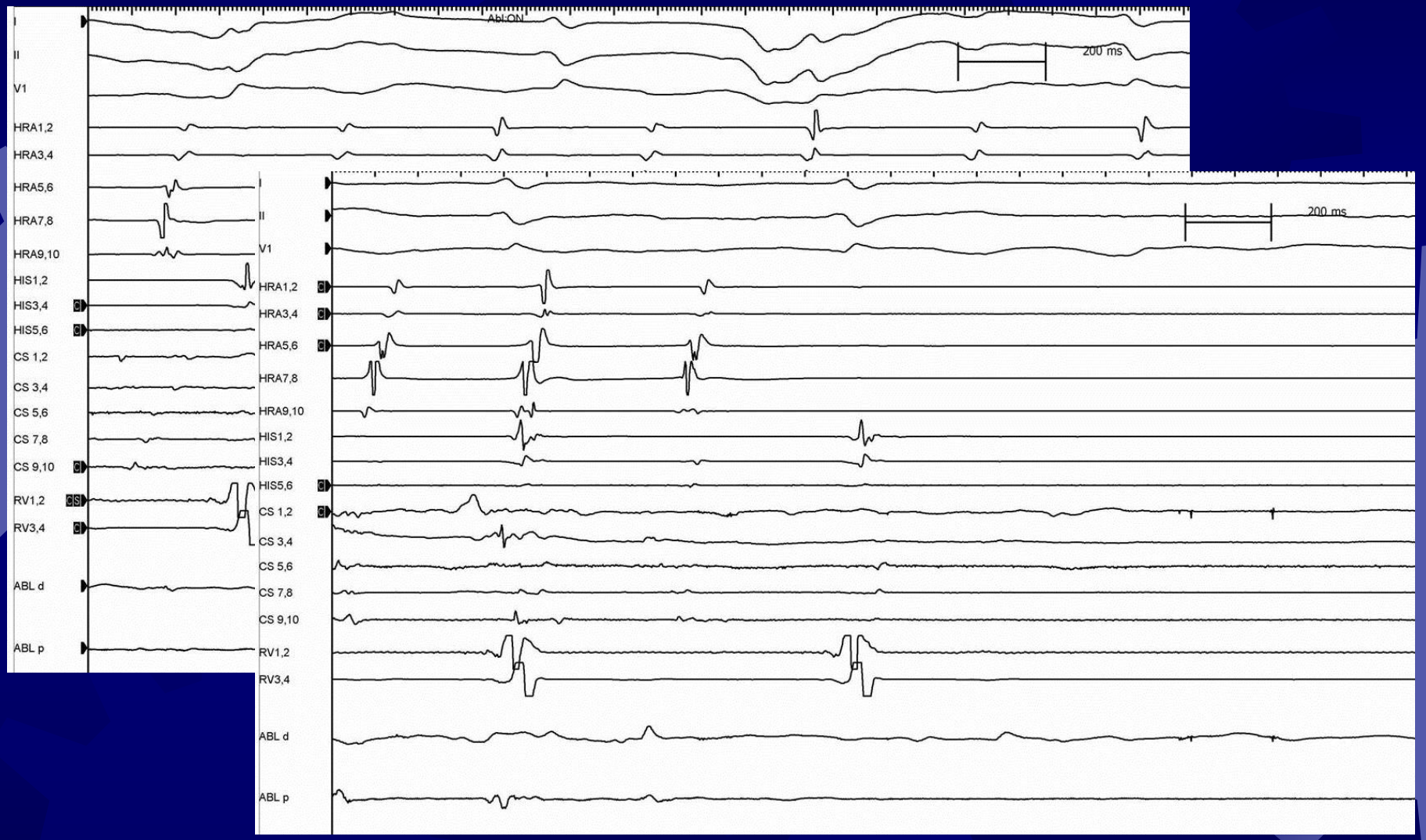




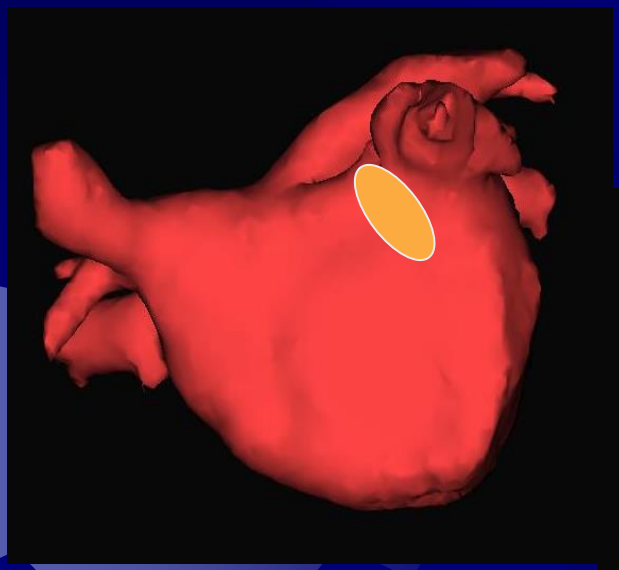
Abrupt AF termination

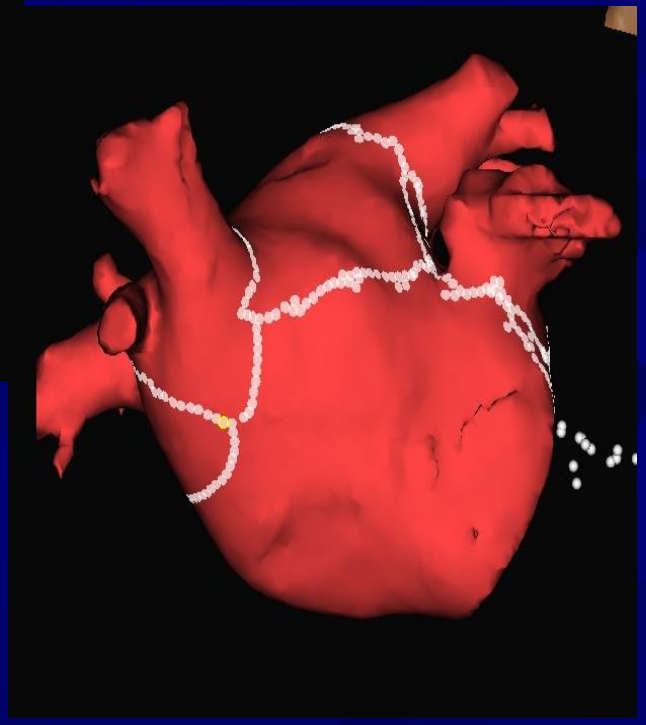


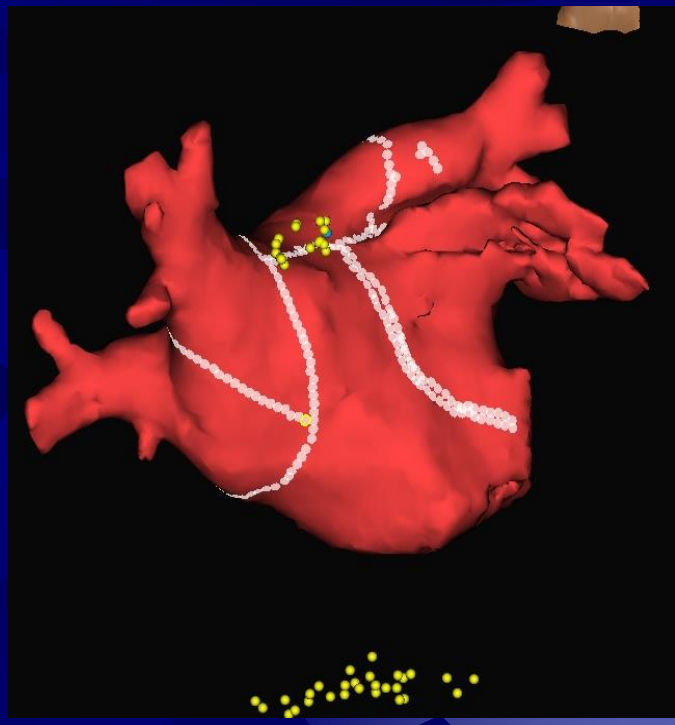
Mitral valve isthmus flutter - termination



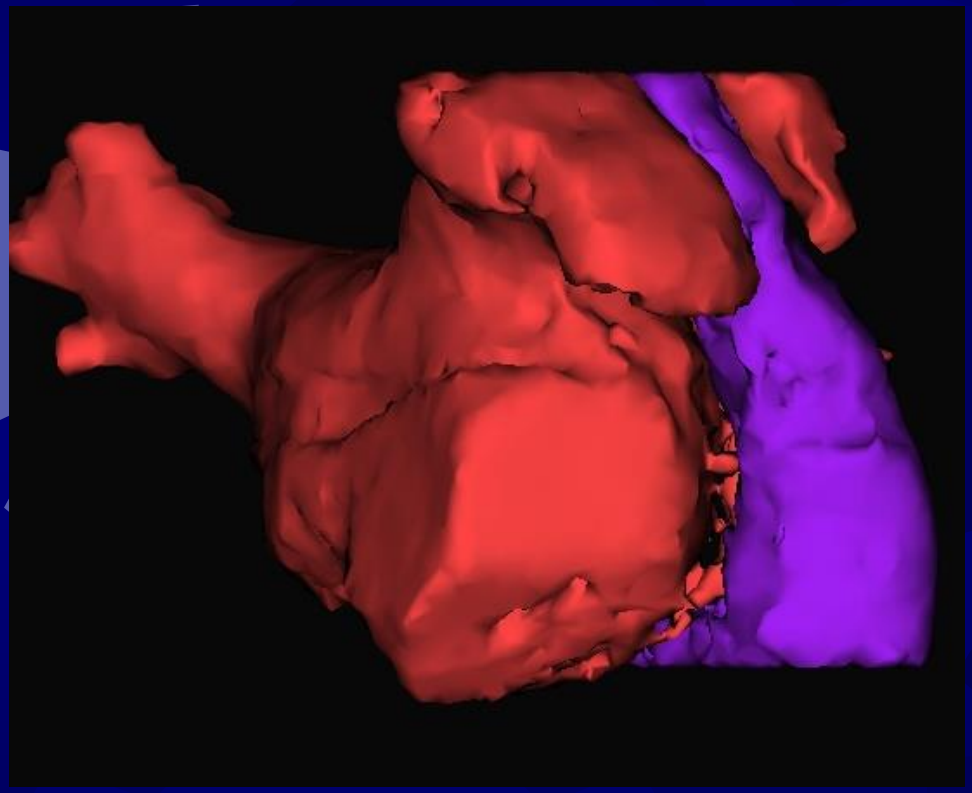
(2) Ant line ablation

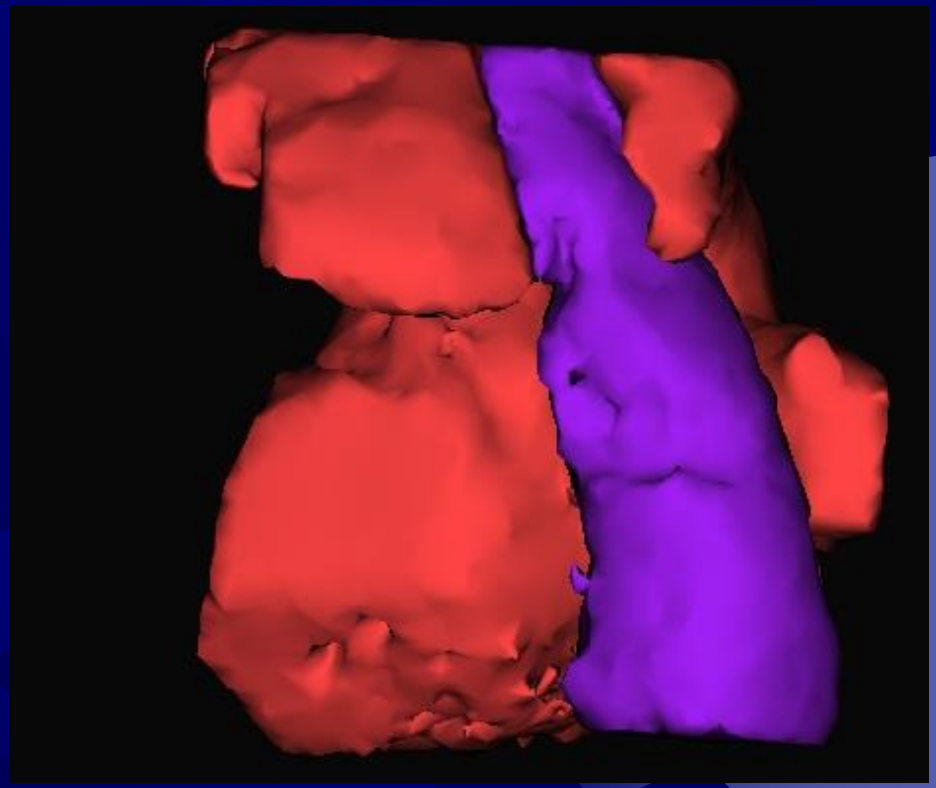


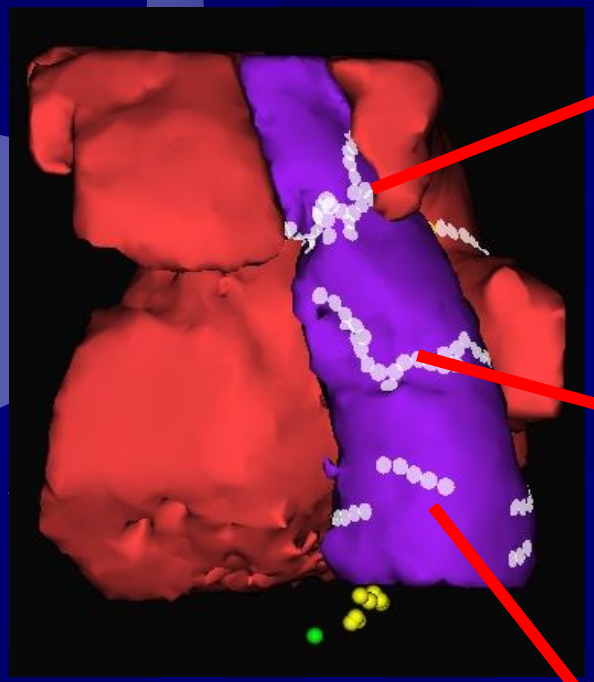


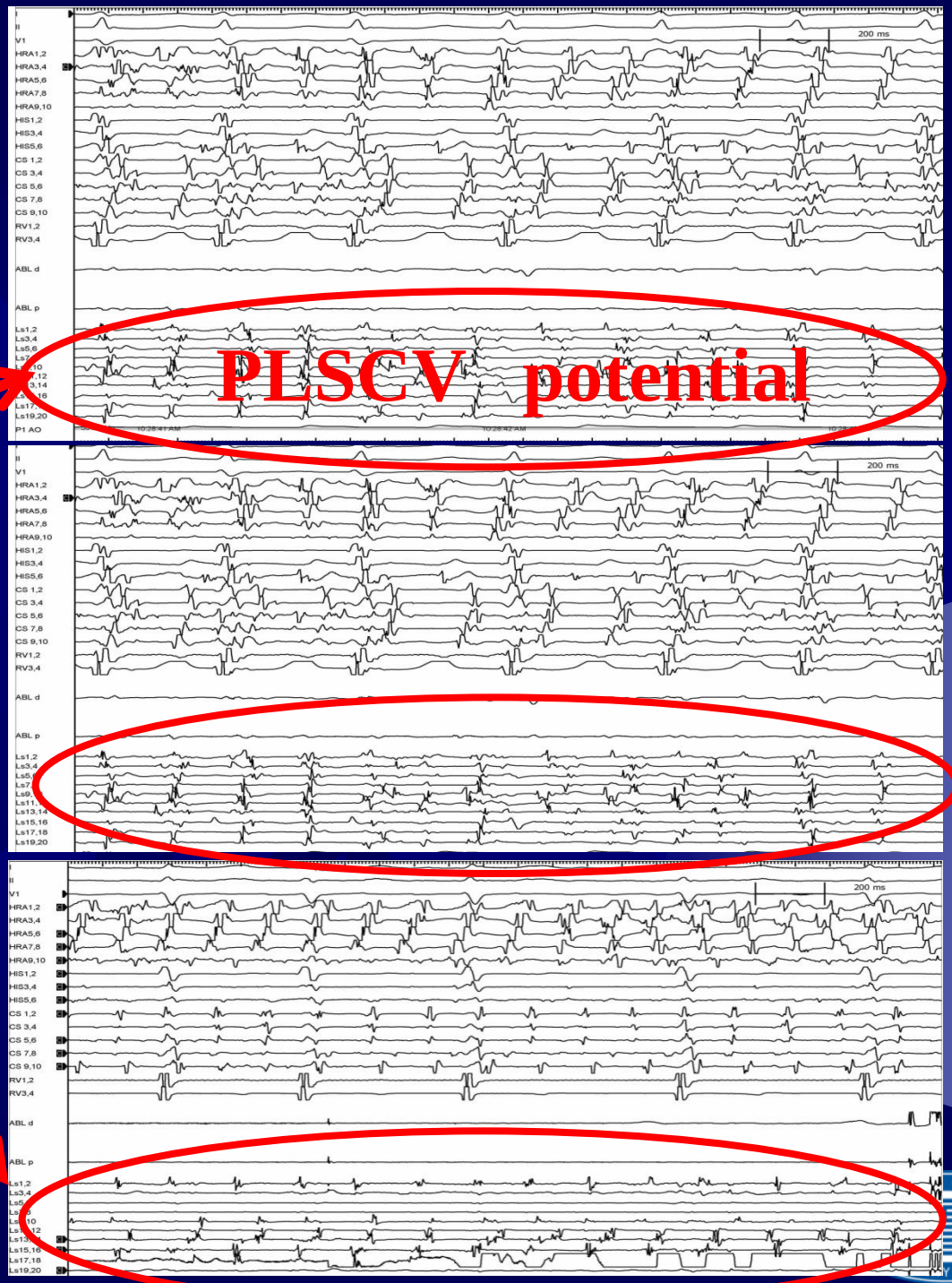


3) Persistent Left side SVC & AF ablation



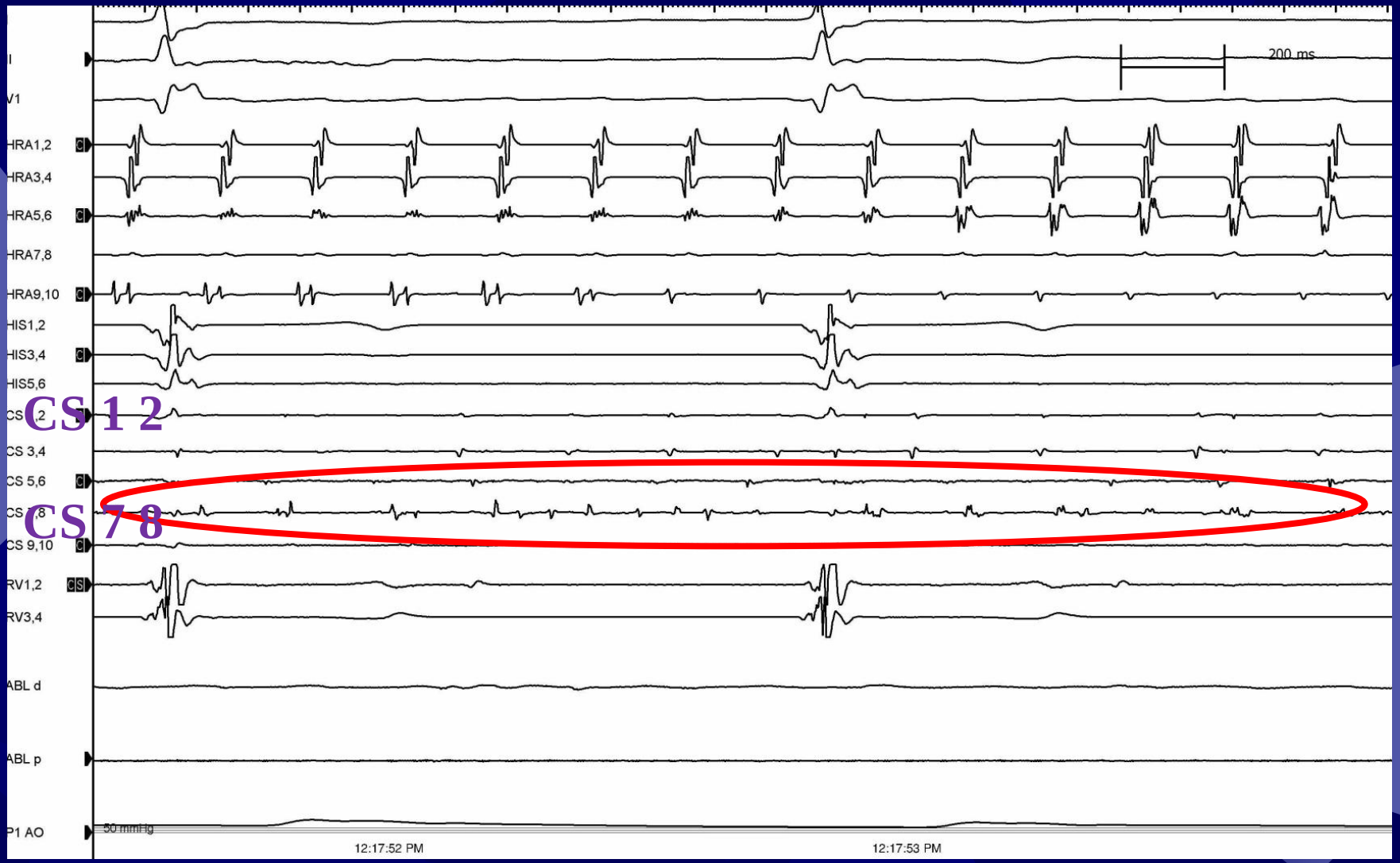




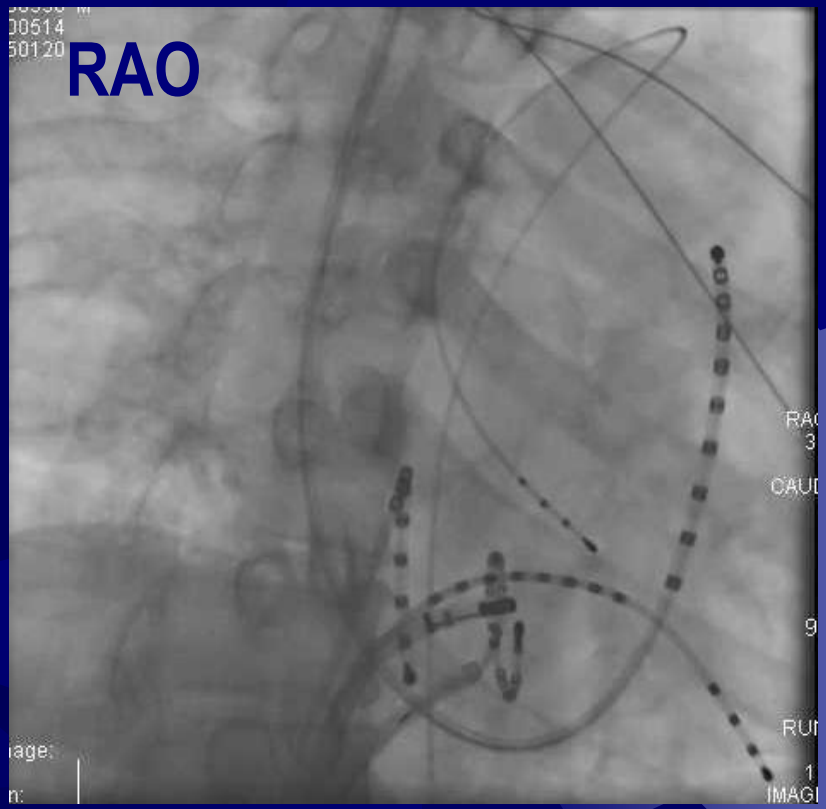

PLSCV potential
200 ms
I
II
V1
HRA1,2
HRA3,4
HRA5,6
HRA7,8
HRA9,10
HIS1,2
HIS3,4
HIS5,6
CS 1,2
CS 3,4
CS 5,6
CS 7,8
CS 9,10
RV1,2
RV3,4
ABL d
ABL p
Ls1,2
Ls3,4
Ls17,18
Ls19,20
P1 AO

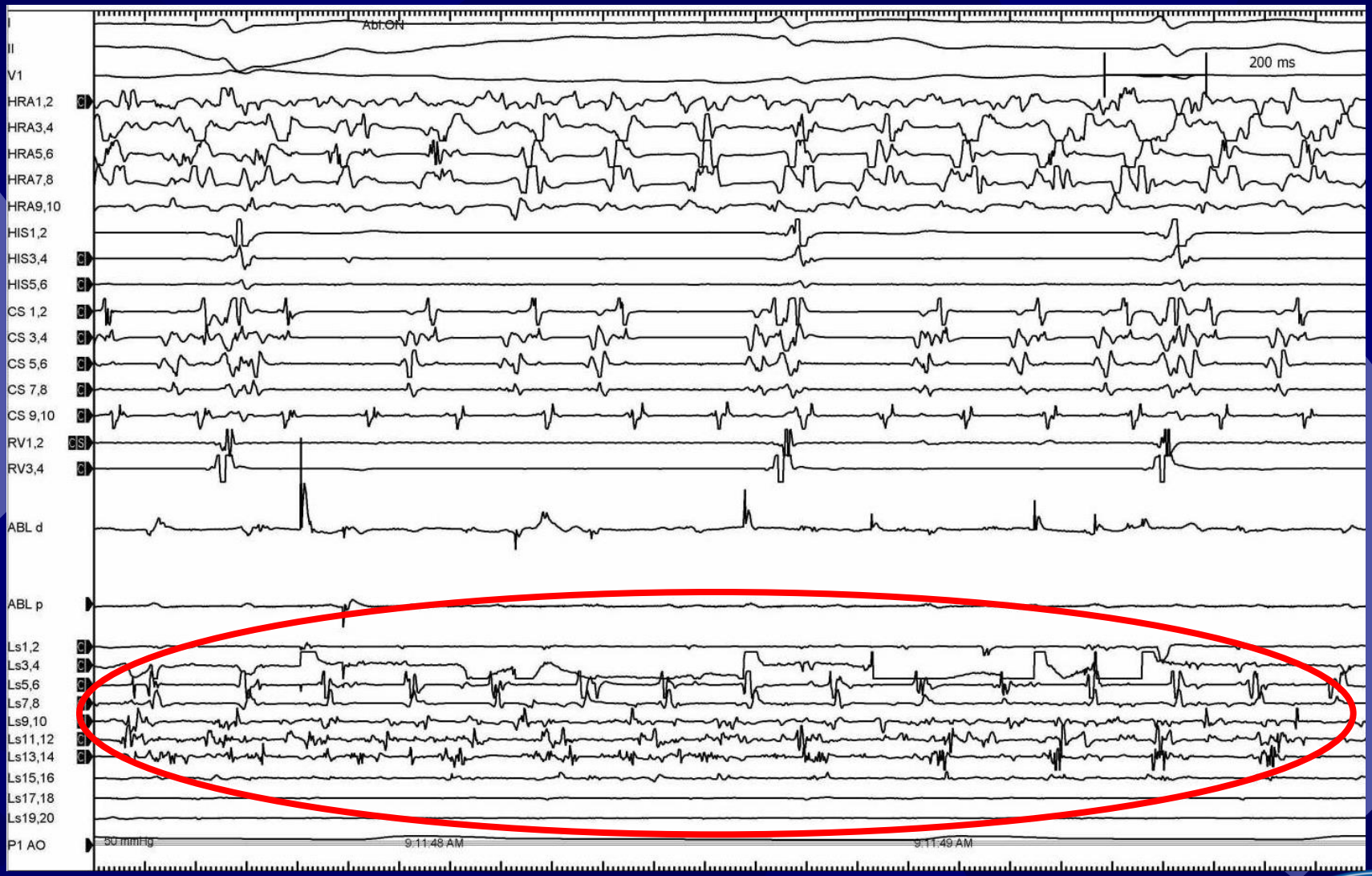
AF - termination

3, CS ostium focal ablation

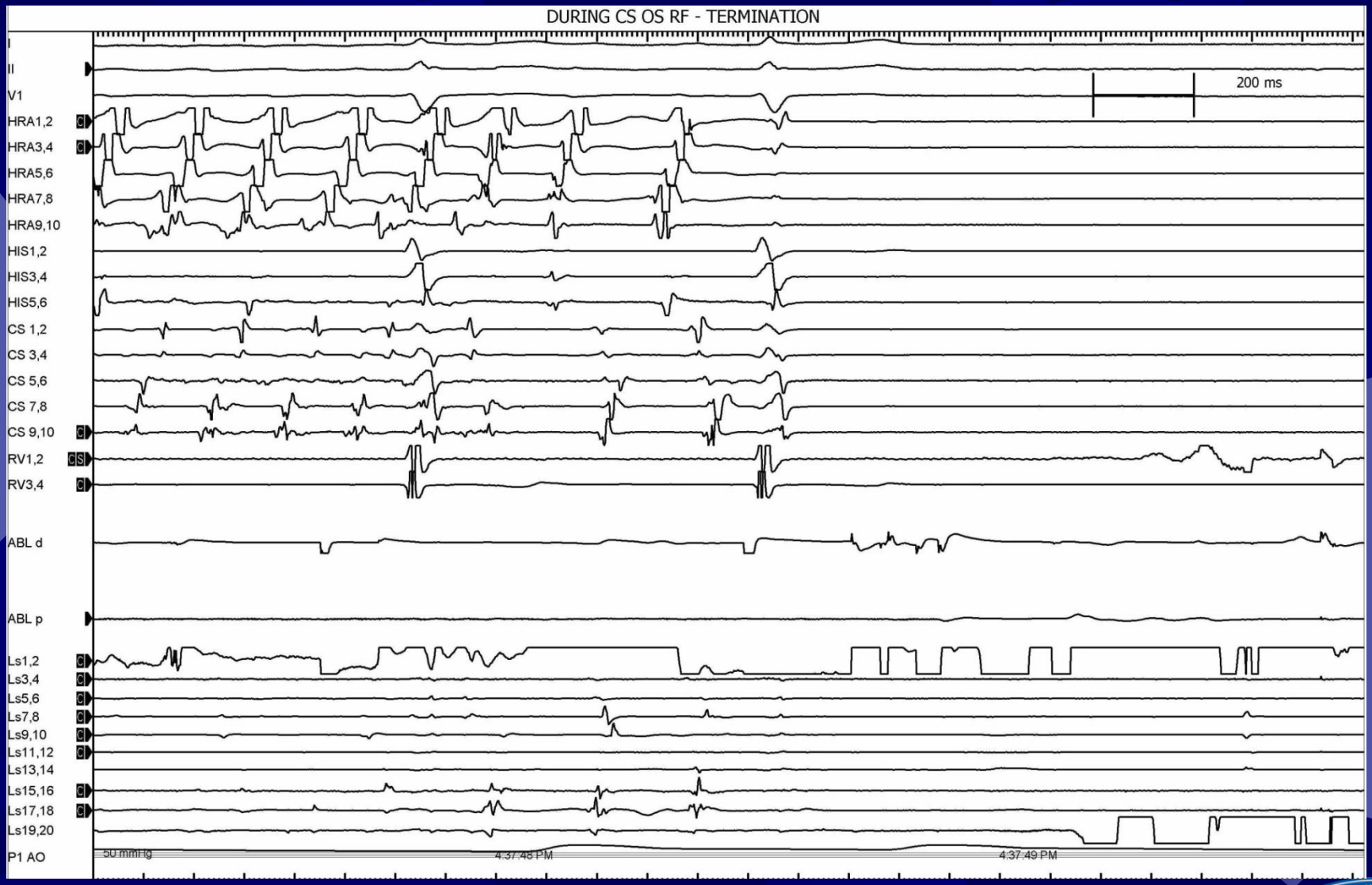



LAO

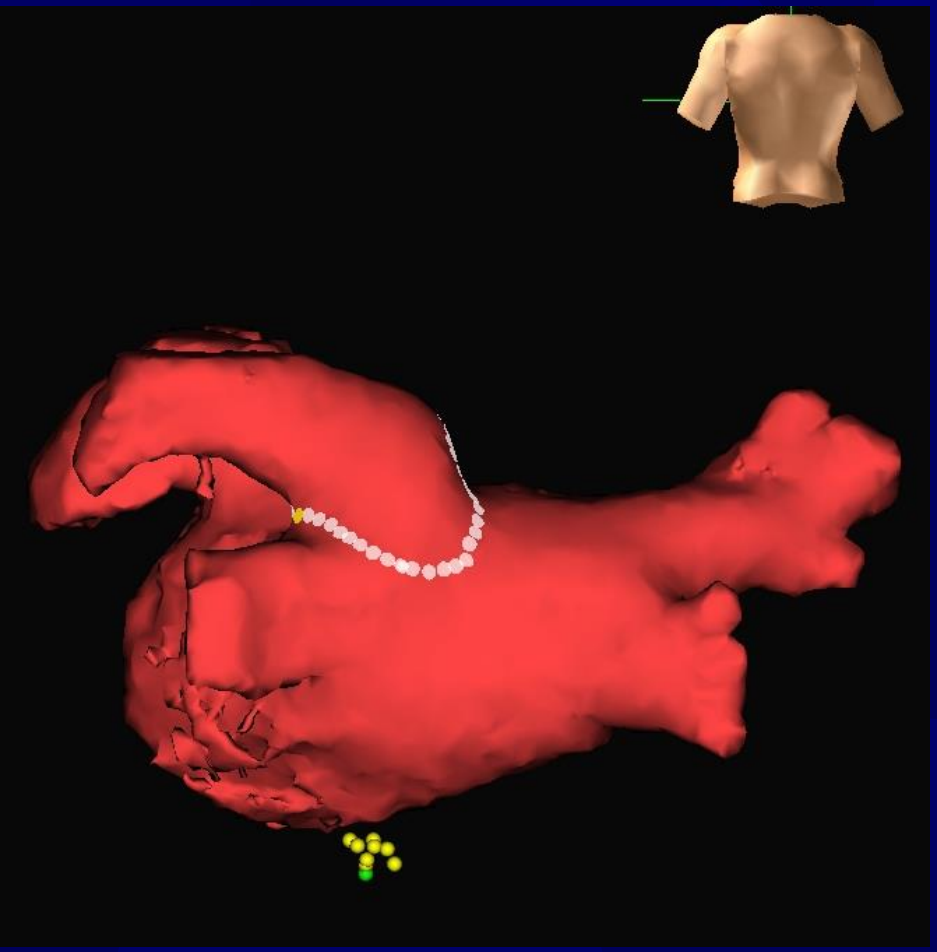

RAO

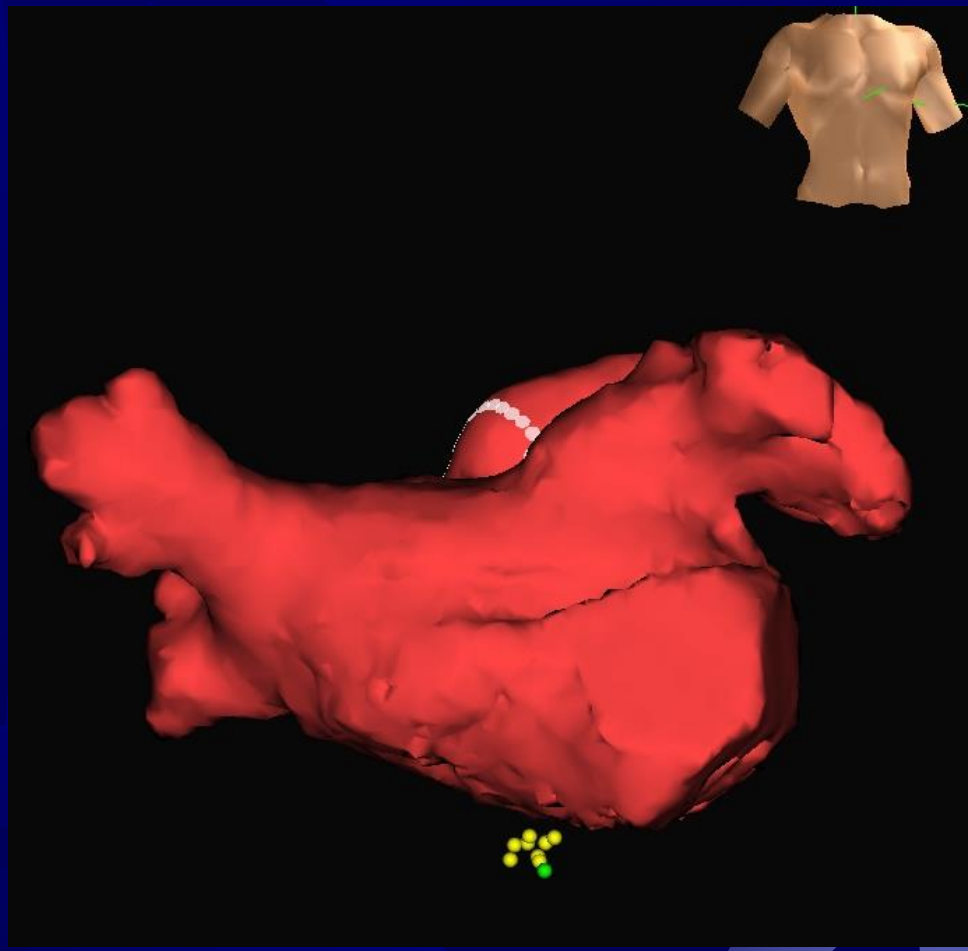

I
II
V1
Abl:ON
200 ms
HRA1,2
HRA3,4
HRA5,6
HRA7,8
HRA9,10
HIS1,2
HIS3,4
HIS5,6
CS 1,2
CS 3,4
CS 5,6
CS 7,8
CS 9,10
RV1,2
RV3,4
ABL d
ABL p
Ls1,2
Ls3,4
Ls5,6
Ls7,8
Ls9,10
Ls11,12
Ls13,14
Ls15,16
Ls17,18
Ls19,20
P1 AO
50 mmHg
9:11:48 AM
9:11:49 AM

AF - termination

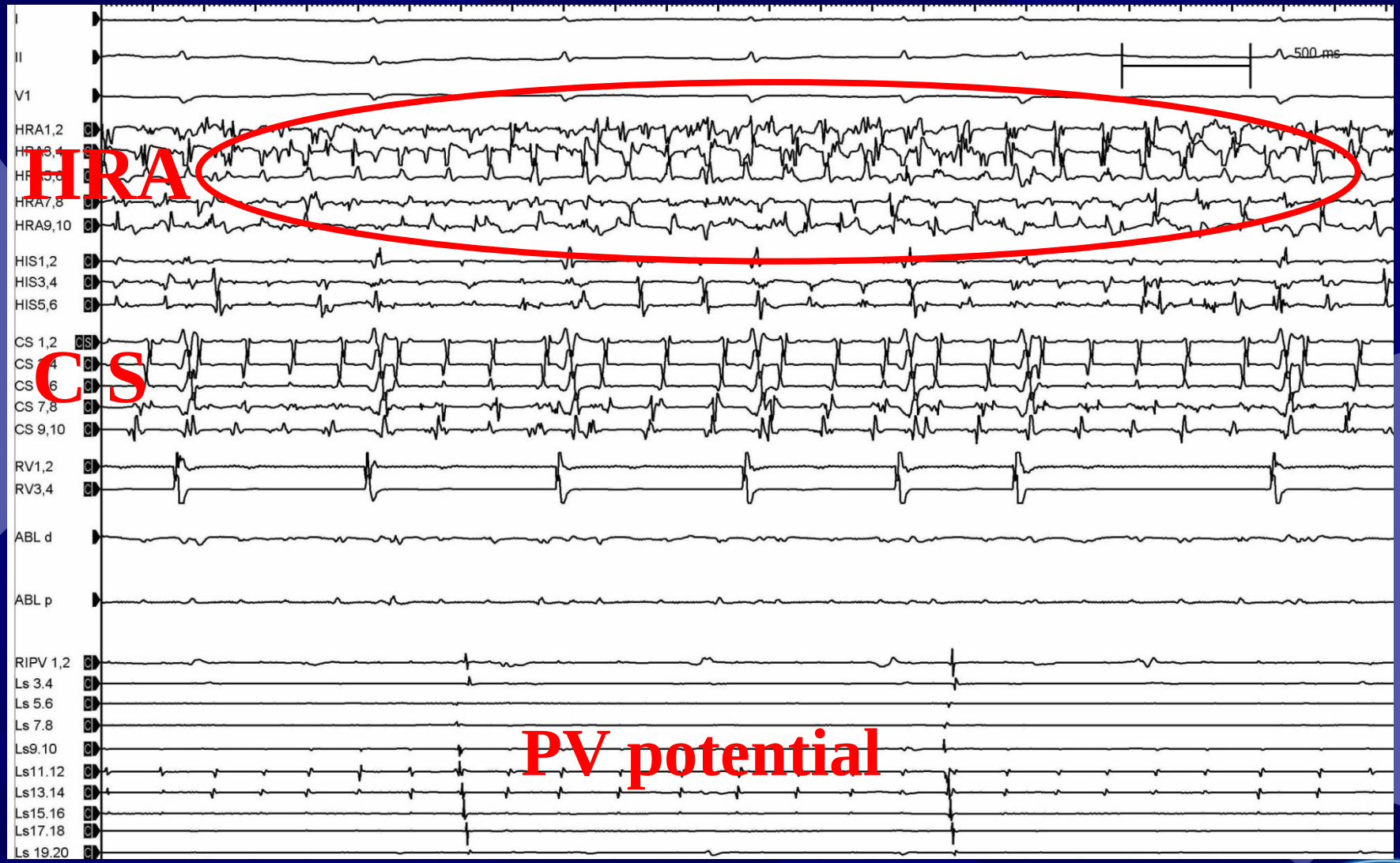


3. CS ostium focal ablation

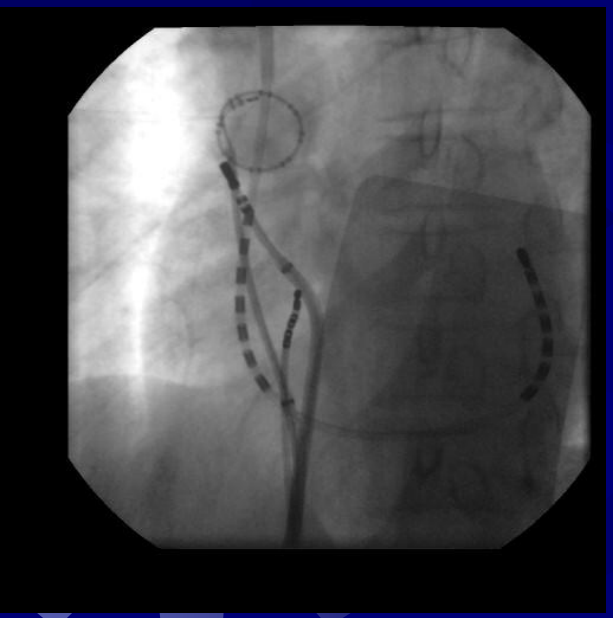


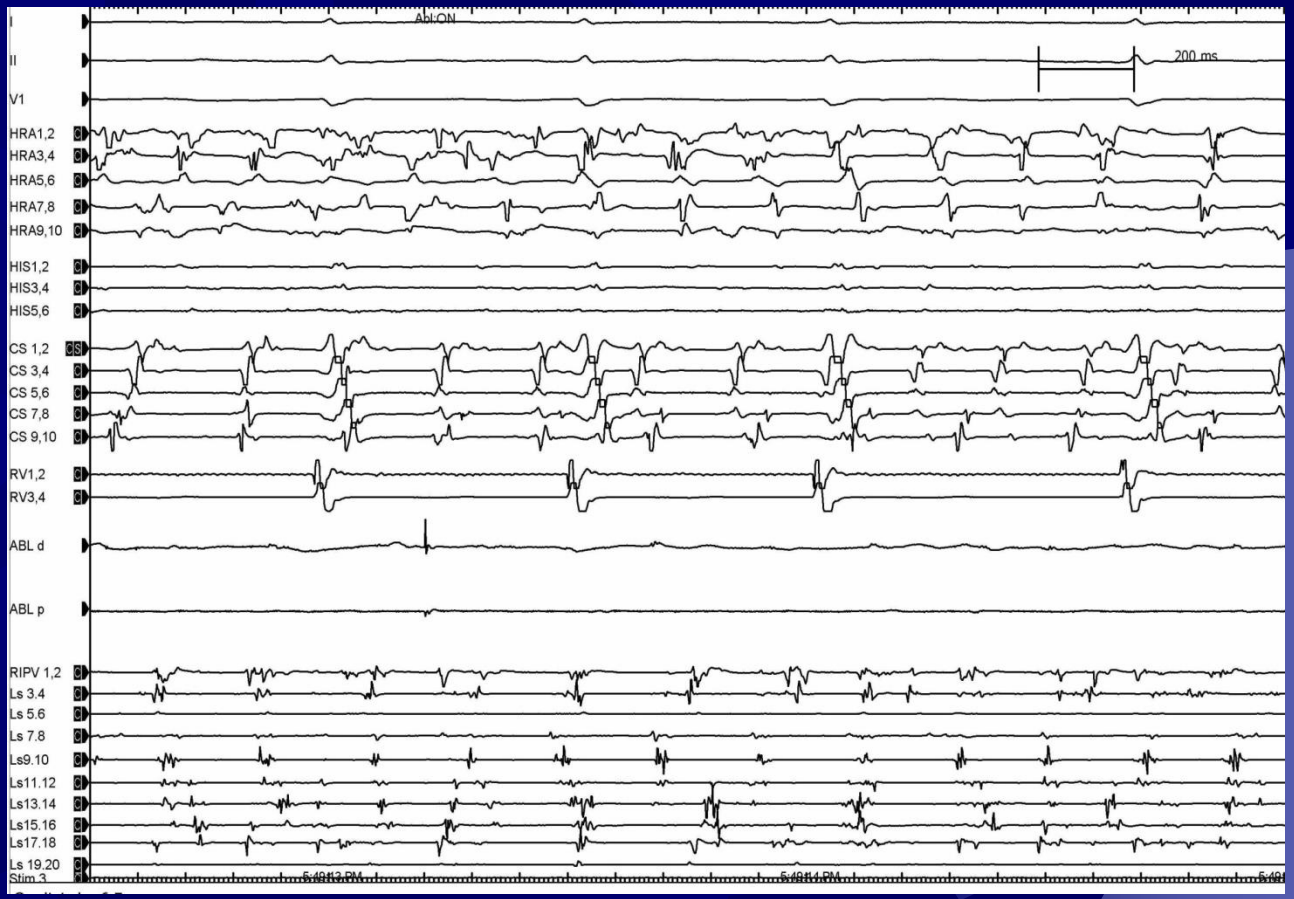


4, SVC focal AF ablation

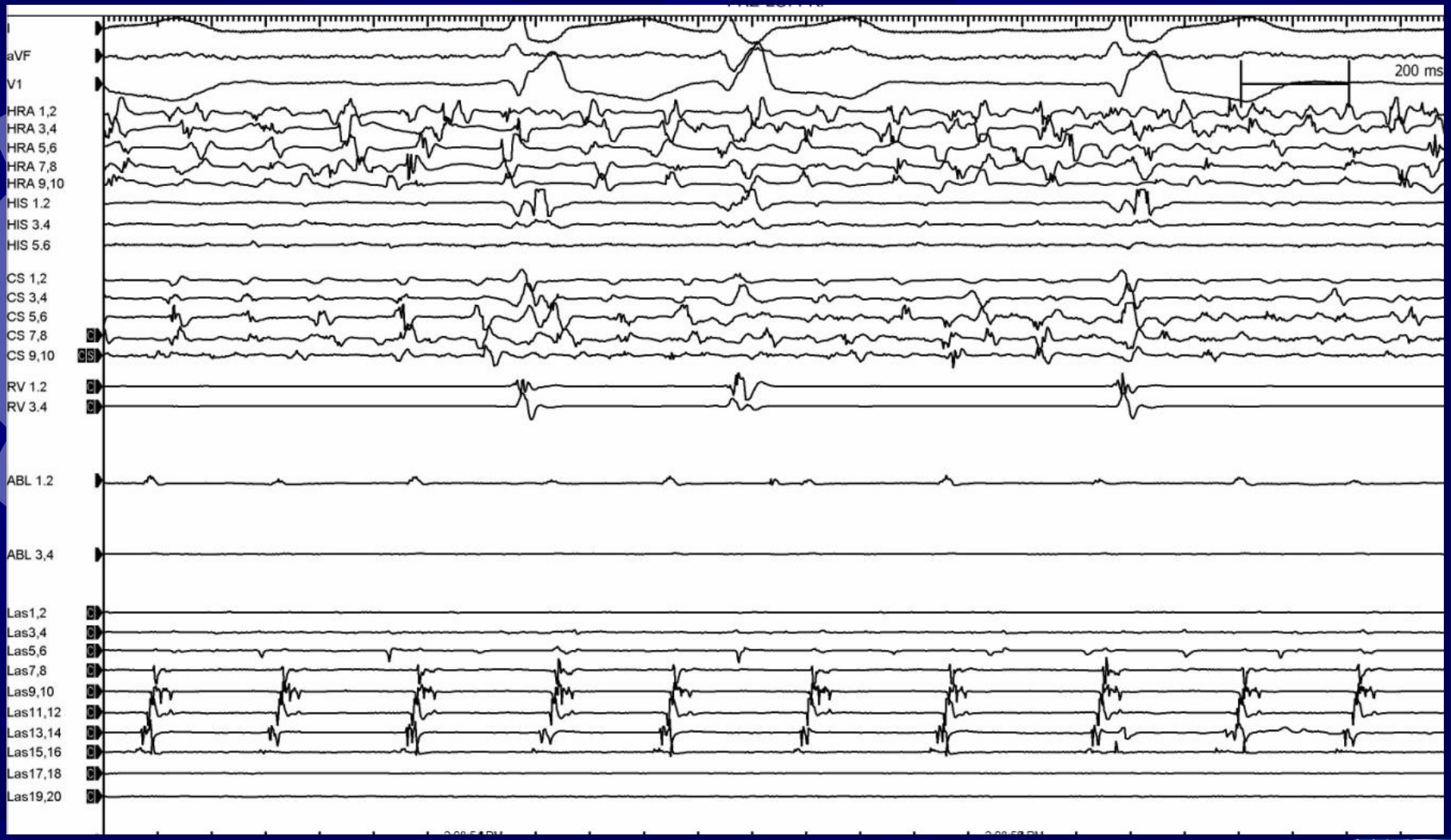


SVC focal AF ablation

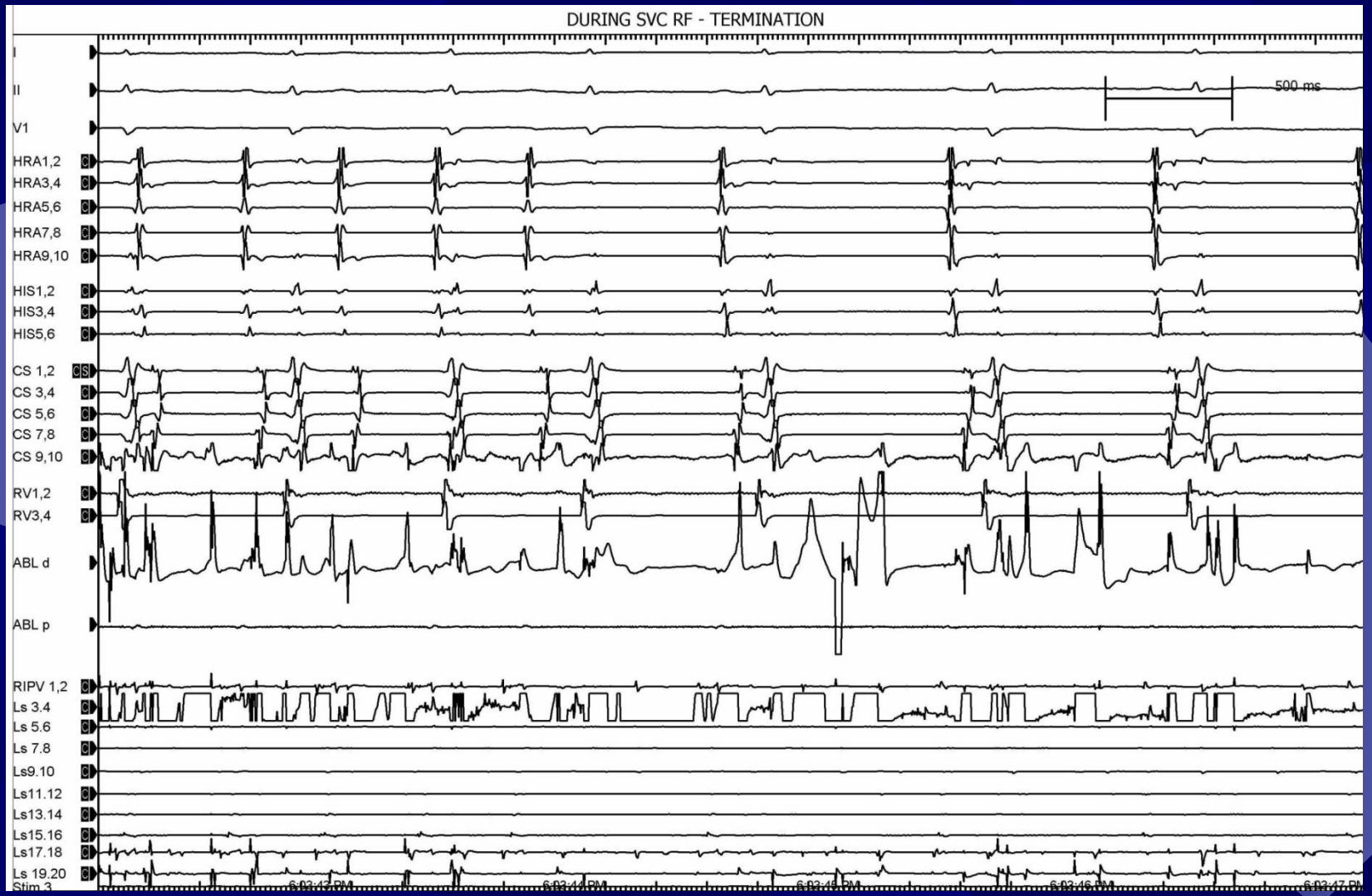




DDx from ‘Passive conduction’



AF - termination



Outcomes

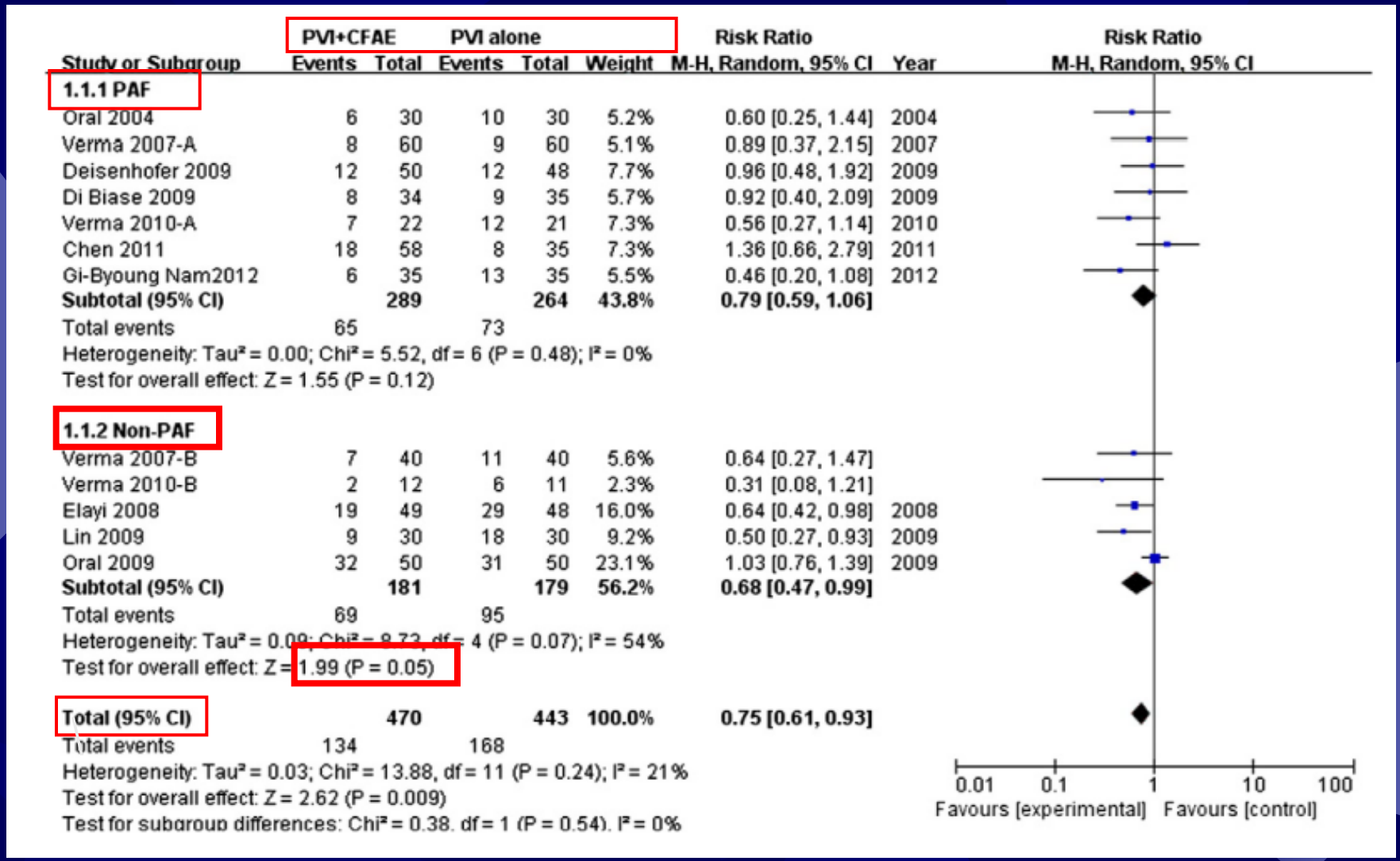
Table 3
Details of catheter ablation.

Study	Intervention/ comparator	Definition of CFAEs	CFAE Ablation Areas	Ablation endpoint
Gi-Byoung Nam 2012	PVI with or without CFAE ablation	CFAE were defined visually as highly fractionated or continuous electrograms with little isoelectric baseline	LA + CS + RA	PVI: elimination or dissociation of PV potentials CFAE: AF was noninducibility
Oral 2009	PVI with or without CFAE ablation	CFAE were defined as electrograms with a cycle length of ≤120 ms or shorter than the AF cycle length in the coronary sinus, or electrograms that were fractionated or displayed continuous electrical activity	LA, including CS	PVI: complete electrical isolation of all PVs CFAE: AF termination with non-inducibility
Elayi 2008	PVI with or without CFAE ablation	CFAE were defined as: (1) atrial electrograms with fractionation and composed of 2 defections or more and/or with continuous activity of the baseline, or (2) atrial electrograms with a cycle length of ≤120 ms	LA (including CS) and RA	PVI: elimination of all PV potentials along antra or inside veins (entry block) CFAE: complete elimination of CFAE
Chen MI. 2011	PVI with or without CFAE ablation	The CFE-mean map settings were as follows: refractory 40 ms, P–P sensitivity of 0.1 mV, duration of 10 ms, and recording duration of 6 s	LA, including CS	PVI: electrical isolation of all PVs CFAE: elimination of the areas with CFE independent of the termination and/or noninducibility of AF
Lin 2009	PVI + linear ablation with or without CFAE ablation	Targeted CFAE were defined as atrial electrograms with an averaged fractionated interval (FI) of less than 50 ms over 5 s	LA, including CS	PVI: PV-LA conduction block CFAE: obtain a prolongation of the FI with a local FI value of ≥120 ms, or to abolish the local fractionated potentials
Verma 2010	PVI with or without CFAE ablation	Complex fractionated electrogram sites defined by the algorithm (CL ≤ 120 ms) were targeted for ablation	LA + CS + RA	PVI: abolishment of all PV potentials within each antrum CFAE: elimination of all CFE sites and noninducibility of AF
Deisenhofer 2009	PVI with or without CFAE ablation	CFAE were defined as: (1) atrial electrograms with fractionation and composed of 2 defections or more and/or with continuous activity of the baseline, or (2) atrial electrograms with a cycle length of ≤120 ms	LA + CS + RA	PVI: electrical isolation of all PVs CFAE: termination to sinus rhythm with subsequent non-inducibility using high-frequency burst pacing × 5
Verma 2007	PVI with or without CFAE ablation	CFAE were defined as: (1) rapid atrial electrograms with a very short cycle length (<120 ms) averaged over a 10-second period, or (2) fractionated 1atrial electrograms composed of two deflections or more and/or perturbation of the baseline with continuous deflection of a prolonged activation complex over a 10-second recording period	LA (anterior LA)	PVI: all PV potentials surrounding the vein were abolished CFAE: elimination of all CFAE sites found on the septum and anterior LA wall
Verma 2008	PVI with or without CFAE ablation	CFAE were defined as: rapid atrial electrograms with a short cycle length (<120 ms)	LA, including CS	PVI: electrical isolation of all PV antra CFAE: AF termination and AF noninducibility
Di Biase 2009	PVI with or without CFAE ablation	CFAE were defined as (1) atrial electrograms with 2 deflections or more or with fractionated baseline complexes with continuous activity over a 10-second recording time or (2) atrial electrograms with a cycle length of ≤120 ms over a 10-second recording time	LA + CS + RA	PVI: local elimination of all PV potentials along antra or inside veins (entry and exit block) CFAE: complete elimination of CFAE areas
Oral 2004	PVI + linear ablation with or without CFAE ablation	CFAE were defined visually as fractionated or rapid atrial activity	LA	PVI: complete electrical isolation of all PVs CFAE: additional CFAE ablation in the LA and CS for up to 2 additional hours or until AF terminated, whichever came first

CS = coronary sinus, LA = left atrium, RA = right atria, PVI = pulmonary vein isolation, CL = cycle length, AF = atrial fibrillation, CFAE = complex fractionated atrial electrograms.

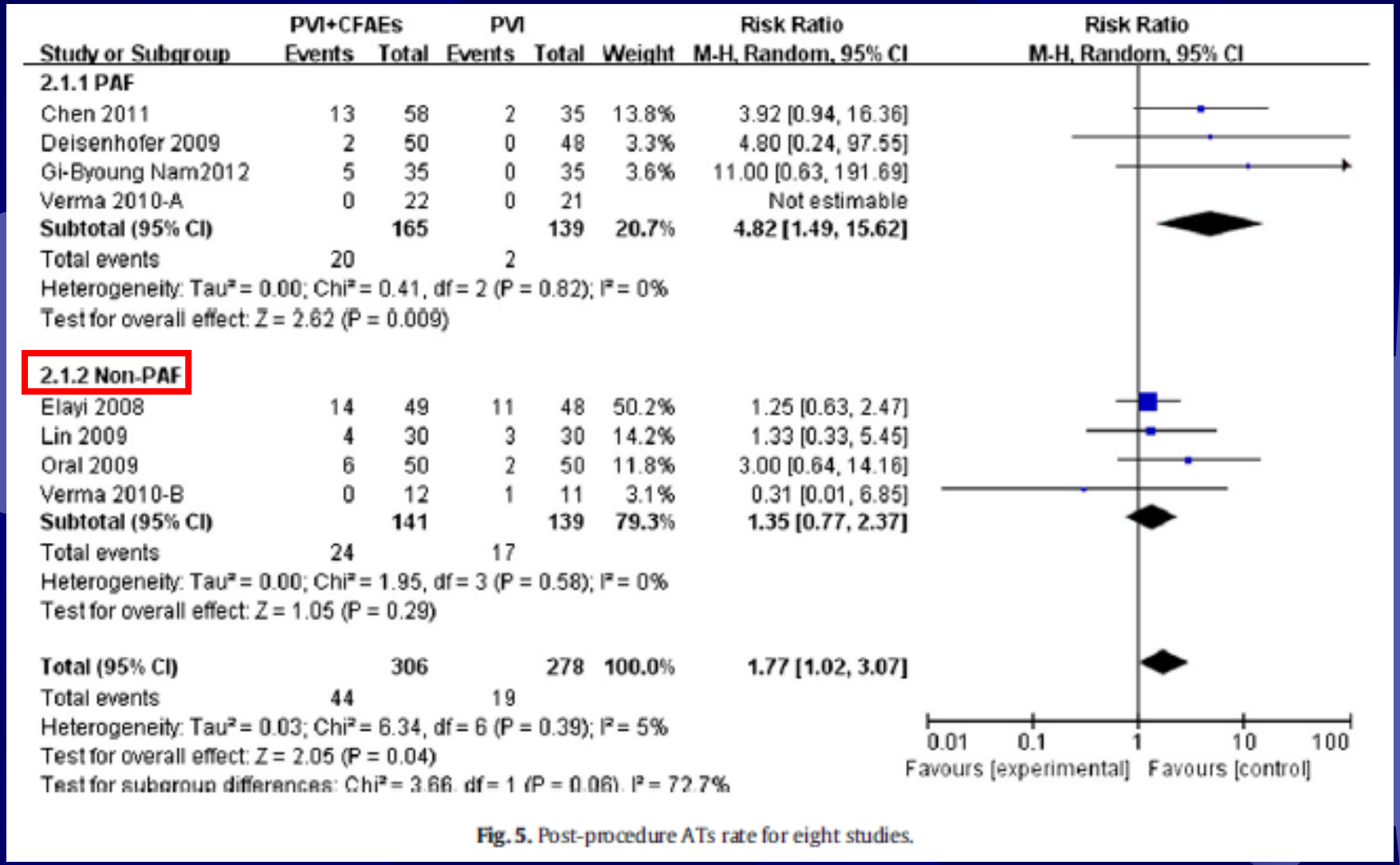
S.Wu et al, *Int J Cardiol, 2013*

Atrial tachyarrhythmia (AF/AT) recurrence



S.Wu et al, *Int J Cardiol, 2013*

Atrial tachycardia recurrence

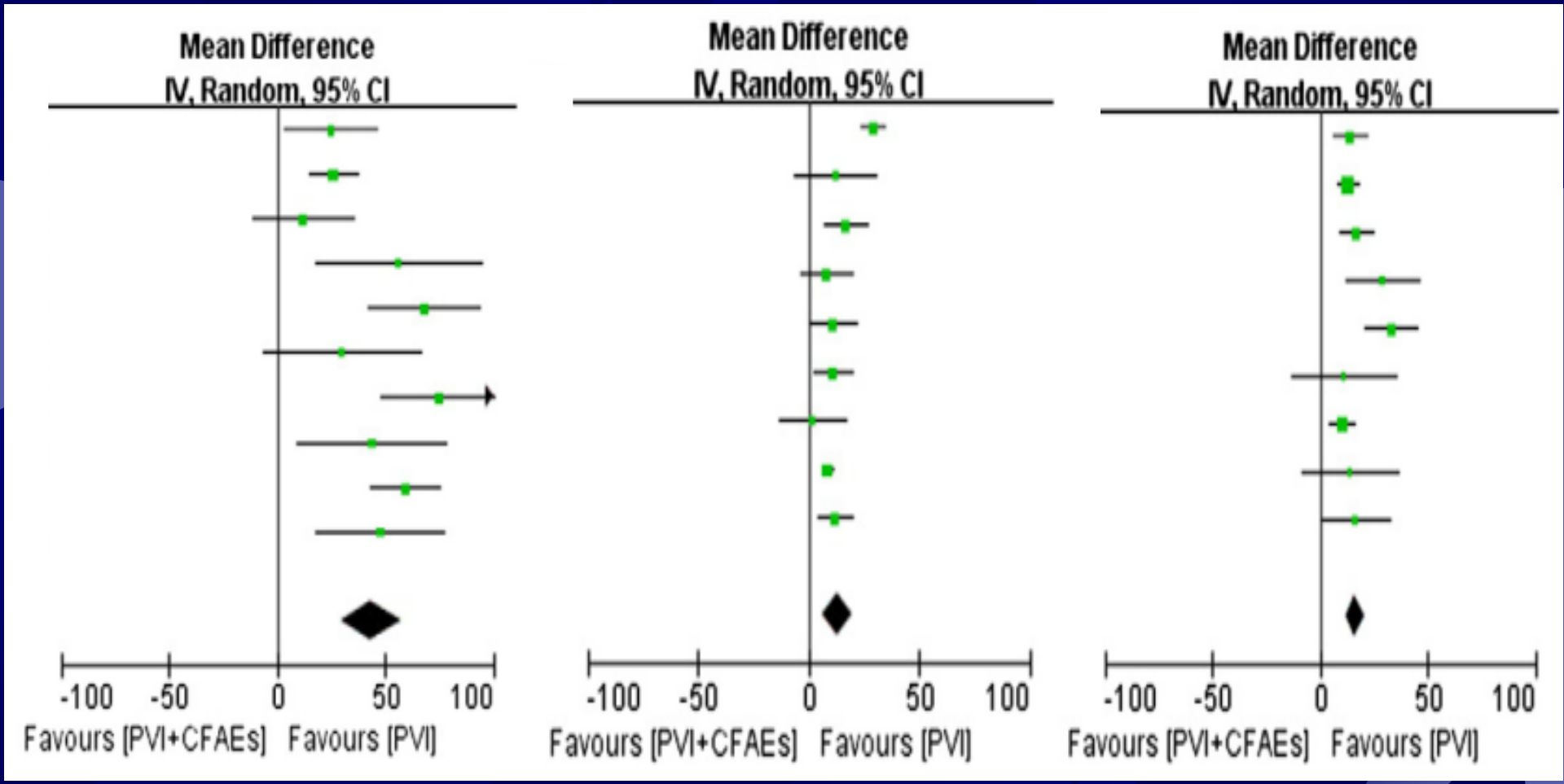


Study or Subgroup	PVI+CFAEs Events	Total	PVI Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
2.1.1 PAF						
Chen 2011	13	58	2	35	13.8%	3.92 [0.94, 16.36]
Deisenhofer 2009	2	50	0	48	3.3%	4.80 [0.24, 97.55]
Gi-Byoung Nam2012	5	35	0	35	3.6%	11.00 [0.63, 191.69]
Verma 2010-A	0	22	0	21		Not estimable
Subtotal (95% CI)		**165**		**139**	**20.7%**	**4.82 [1.49, 15.62]**
Total events	20		2			
Heterogeneity: Tau² = 0.00; Chi² = 0.41, df = 2 (P = 0.82); I² = 0%						
Test for overall effect: Z = 2.62 (P = 0.009)						
2.1.2 Non-PAF						
Elayi 2008	14	49	11	48	50.2%	1.25 [0.63, 2.47]
Lin 2009	4	30	3	30	14.2%	1.33 [0.33, 5.45]
Oral 2009	6	50	2	50	11.8%	3.00 [0.64, 14.16]
Verma 2010-B	0	12	1	11	3.1%	0.31 [0.01, 6.85]
Subtotal (95% CI)		**141**		**139**	**79.3%**	**1.35 [0.77, 2.37]**
Total events	24		17			
Heterogeneity: Tau² = 0.00; Chi² = 1.95, df = 3 (P = 0.58); I² = 0%						
Test for overall effect: Z = 1.05 (P = 0.29)						
Total (95% CI)		**306**		**278**	**100.0%**	**1.77 [1.02, 3.07]**
Total events	44		19			
Heterogeneity: Tau² = 0.03; Chi² = 6.34, df = 6 (P = 0.39); I² = 5%						
Test for overall effect: Z = 2.05 (P = 0.04)						
Test for subgroup differences: Chi² = 3.66, df = 1 (P = 0.06), I² = 72.7%						

Fig. 5. Post-procedure ATs rate for eight studies.

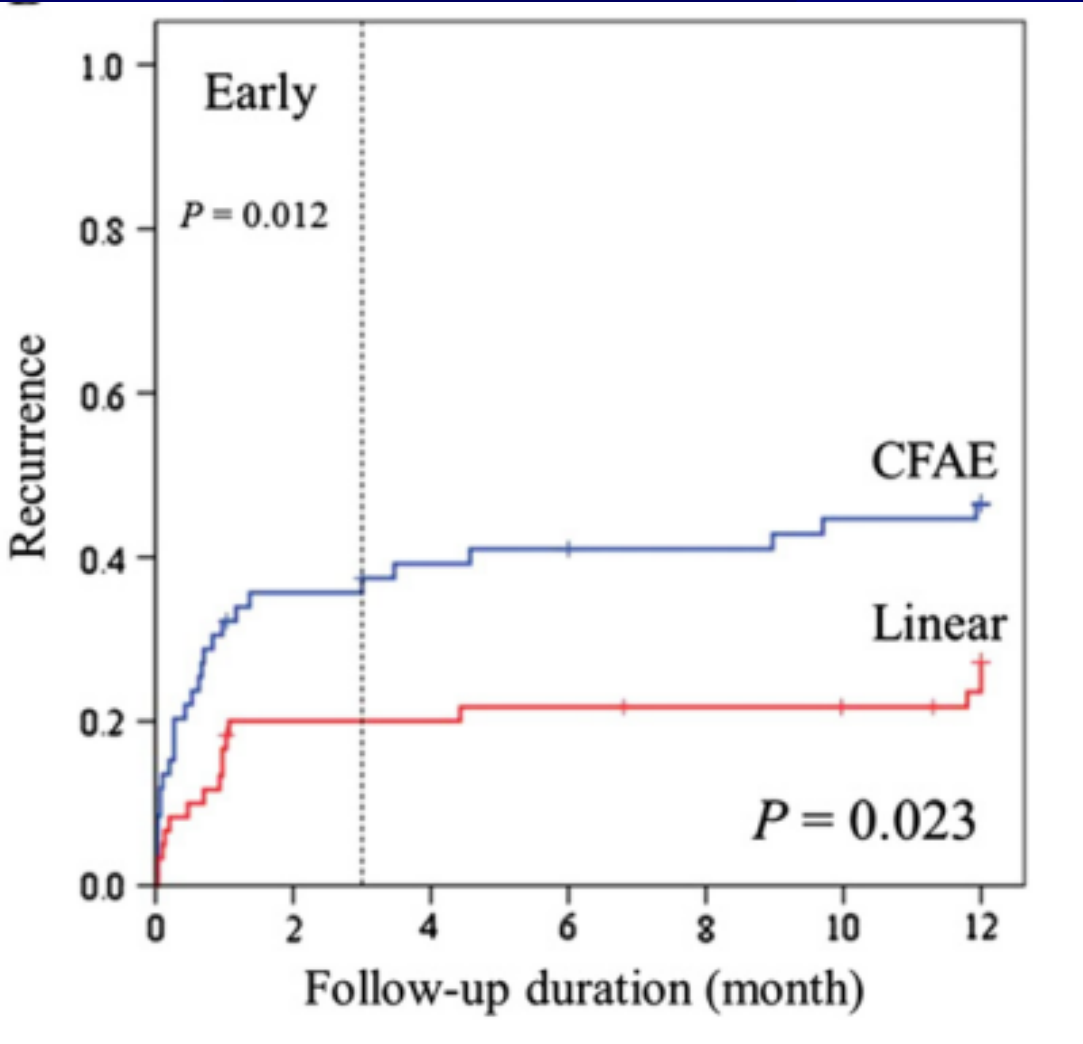
S.Wu et al, *Int J Cardiol, 2013*

Procedure/fluoroscopy / RF energy time



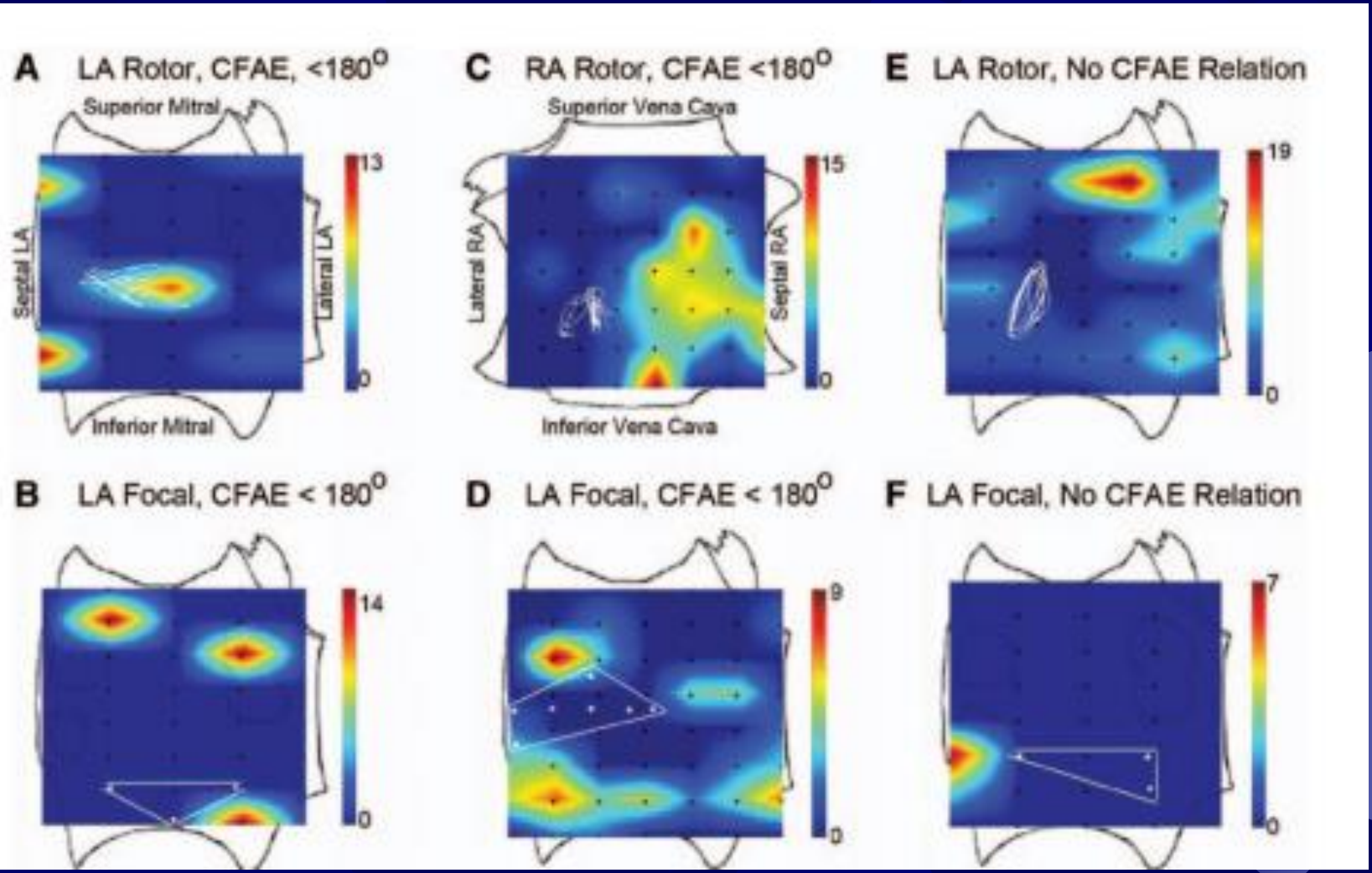
S.Wu et al, *Int J Cardiol, 2013*

Linear vs CFAE-guided ablation



SW Han et al, *Int J Cardiol, 2014*

The correlation of CFAE and active drivers of atrial fibrillation



Narayan et al, *Circ Arrhythm Electrophysiol, 2013*

서울 성모병원 지속성 심방 세동 도자절제술

기간 : 2009. 3. 27 ~ 2015. 4. 15

Procedure number = 275 cases

FU 기간 : Mean 437 ± 488 day

Redo Ablation : 36/275 (13.4%)

동정맥 유지율 : 209/275 (76.1 %)

항부정맥제 중단율 : 63/275 (22.9 %)

항응고제 중단율 : 118/275 (42.9 %)

-평균 CHADS-VASc score : 1.8 ± 1.6

-CHADS-VASc score ≥ 2.0 : 137/275 (49.8 %)

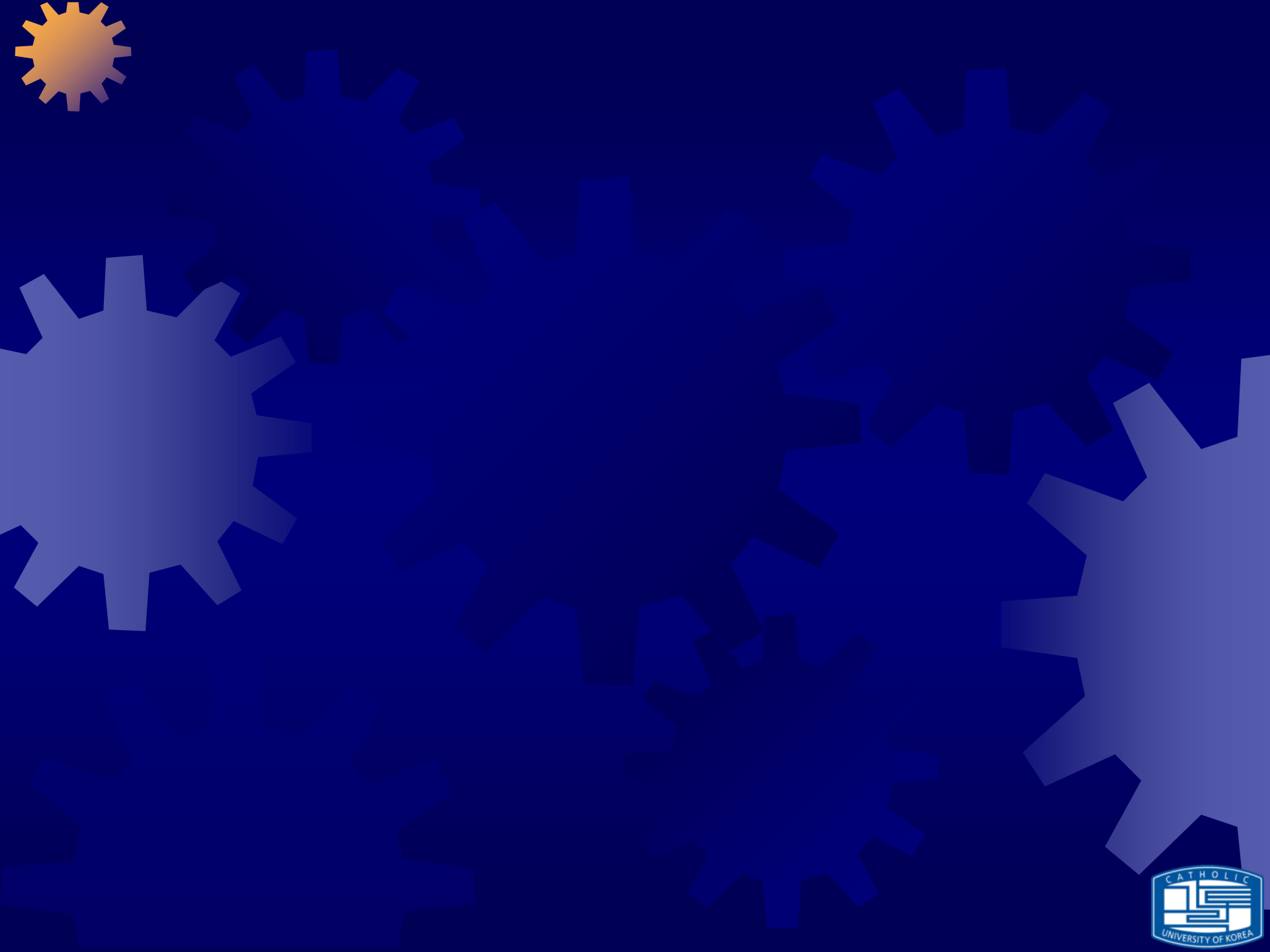
Limitations

- CFAE identification is dependent on the operator's experience and technology ,
- Difficult for all operators to identify and eliminate CFAE
- Optimal procedural end points are yet to reach consensus
- Not all CFAEs are involved in the activation and maintenance of atrial fibrillation.

Conclusions

1. CFAE ablation : Not absolute, also not obsolete.
2. Careful geometry based on electogram should be the frame of AF ablation.
3. Understanding of Marshal vein anatomy and physiology can be very helpful for deciding the taget ablation sites.
4. Reanalysis of electrogram and repeating map after ablation of each target sites can give us very important clues for the next ablation.

Thanks for your attention


CATHOLIC
UNIVERSITY OF KOREA

Pro and Cons of CFAE ablation

Pro	Cons
Atrial mass reduction	Majority of CFAE is passive
Substrate modification	Difficult to accurate mapping
Lower AF recurrence in non-PAF	Time consuming
	Create another substrate