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The Role of Mitral Isthmus Ablation in Persistent AF and Related Techniques for the Bidirectional Block

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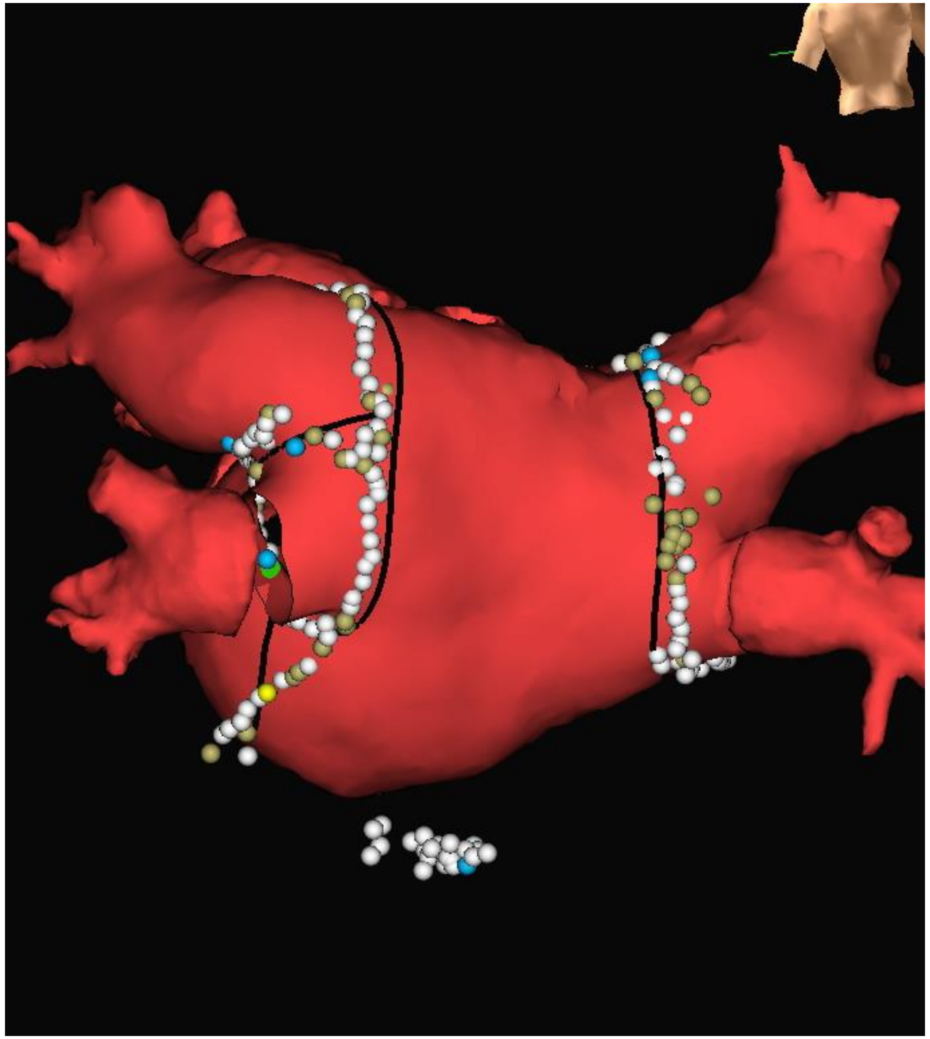
COI Disclosure

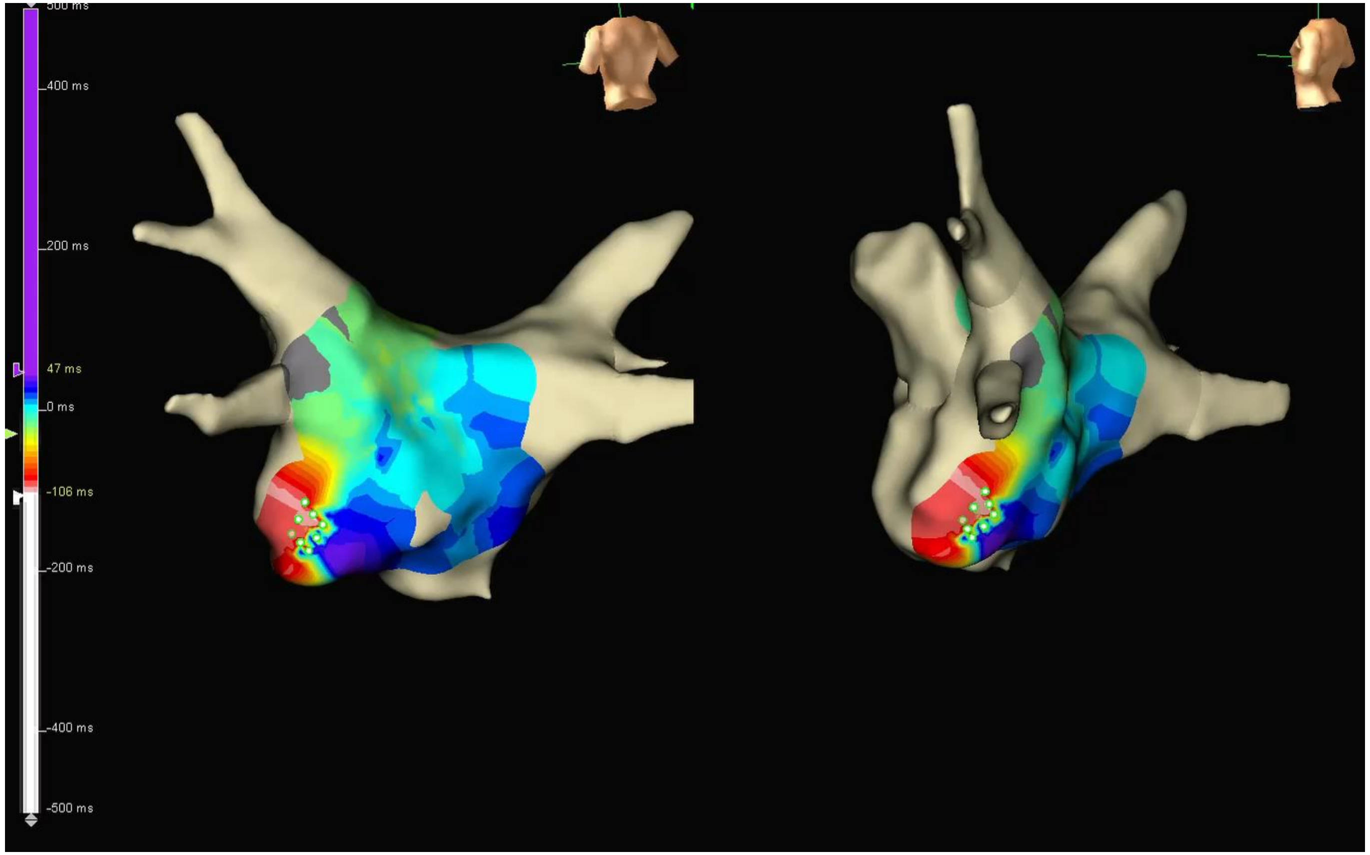
Jumsuk Ko

The authors have no financial conflicts of interest to disclose concerning the presentation

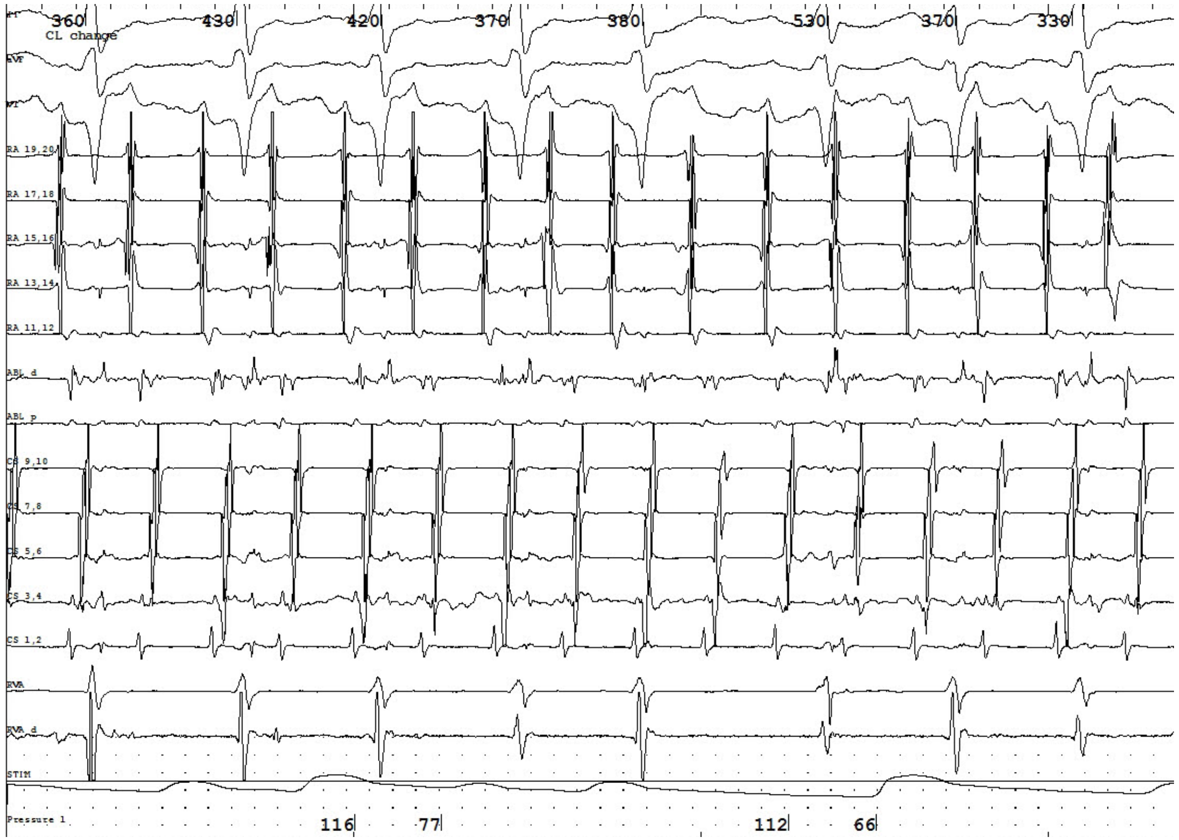
Introduction

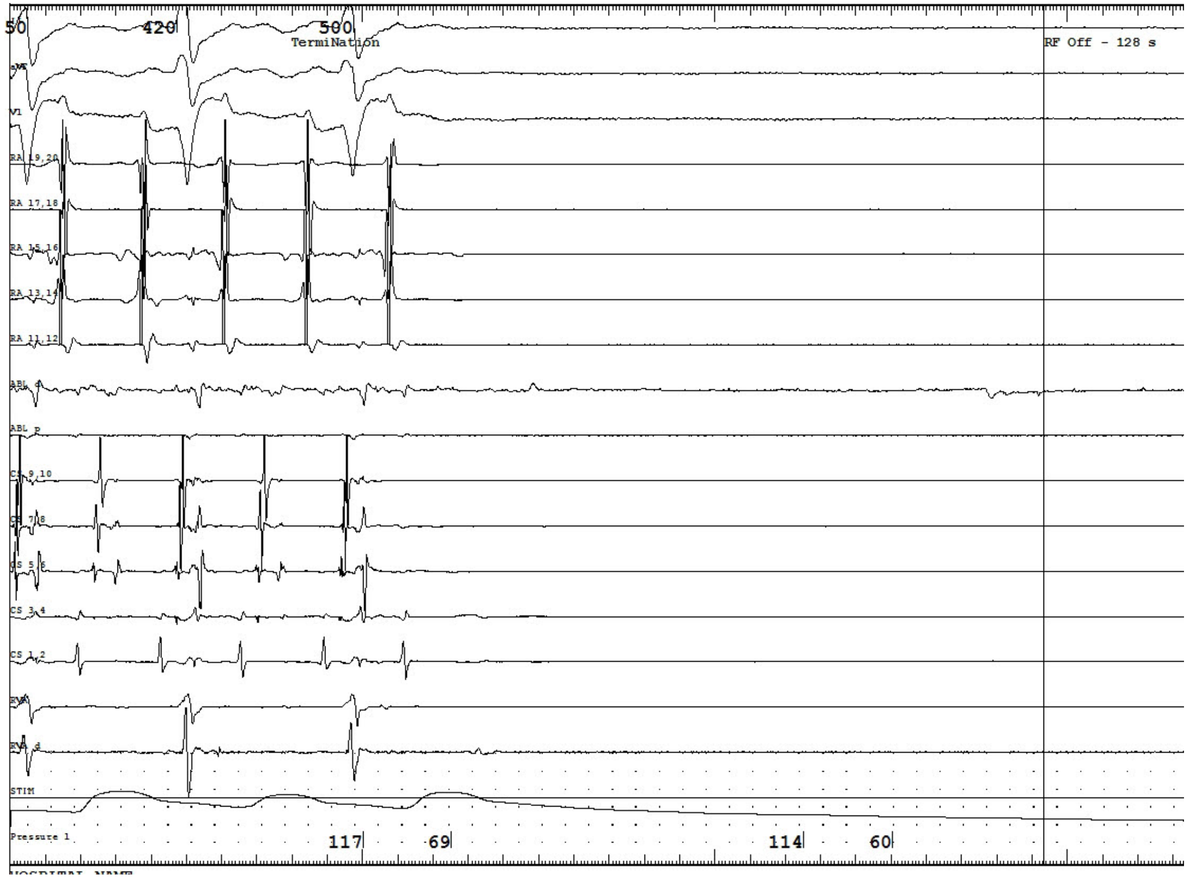
Case of mitral isthmus flutter





Case of mitral isthmus flutter





Cox-maze procedure for compartmentalize the atria

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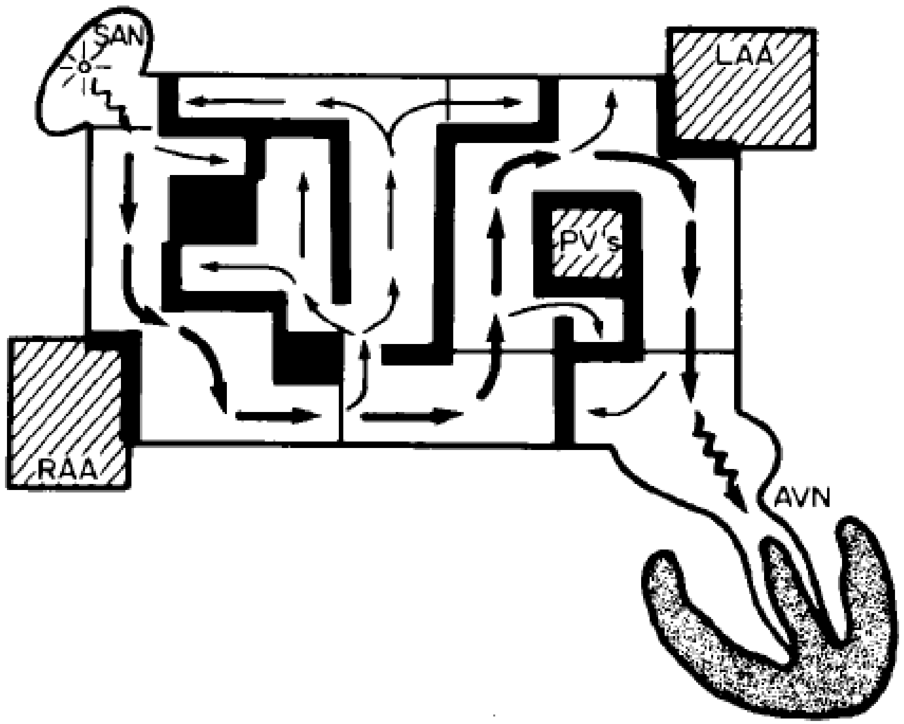
J THORAC CARDIOVASC SURG 1991;101:569-83

Original Communications

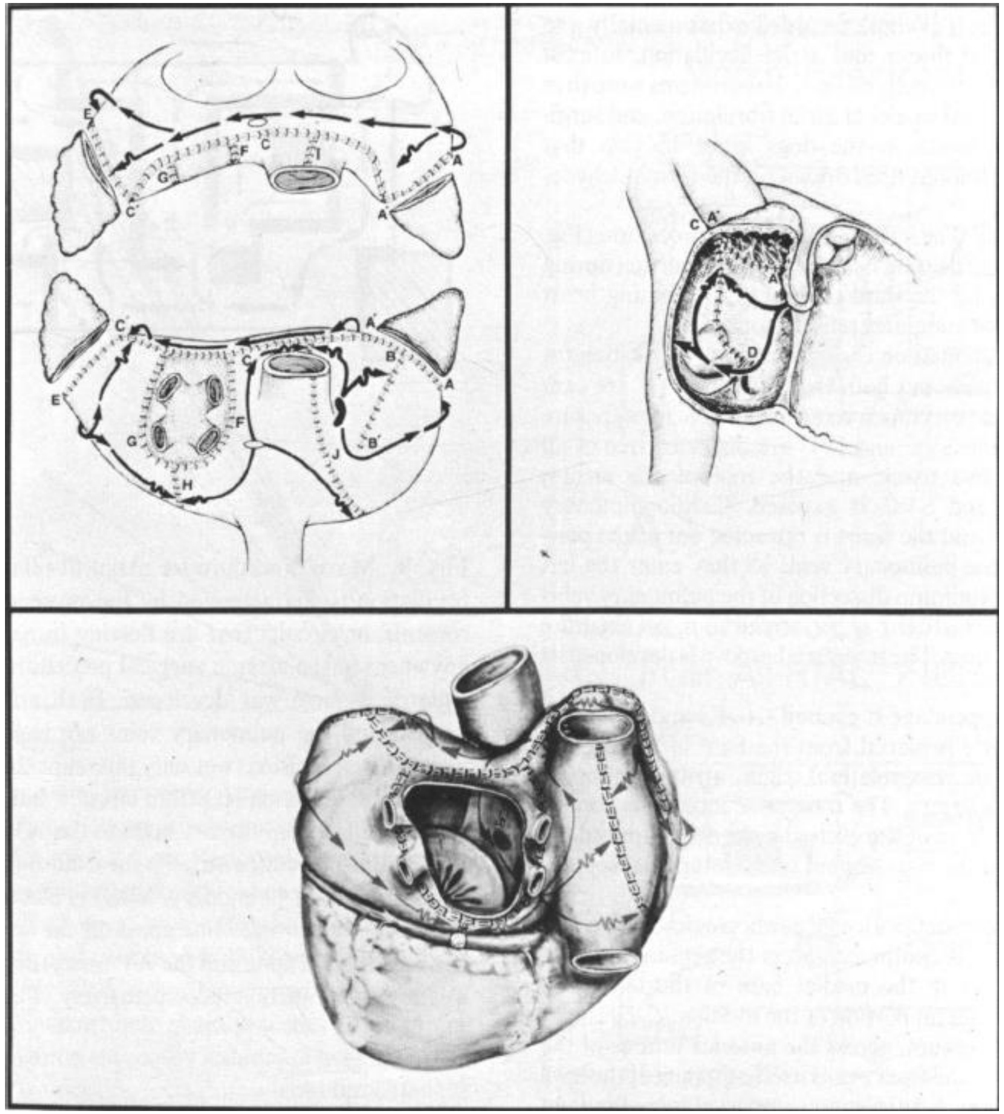
The surgical treatment of atrial fibrillation

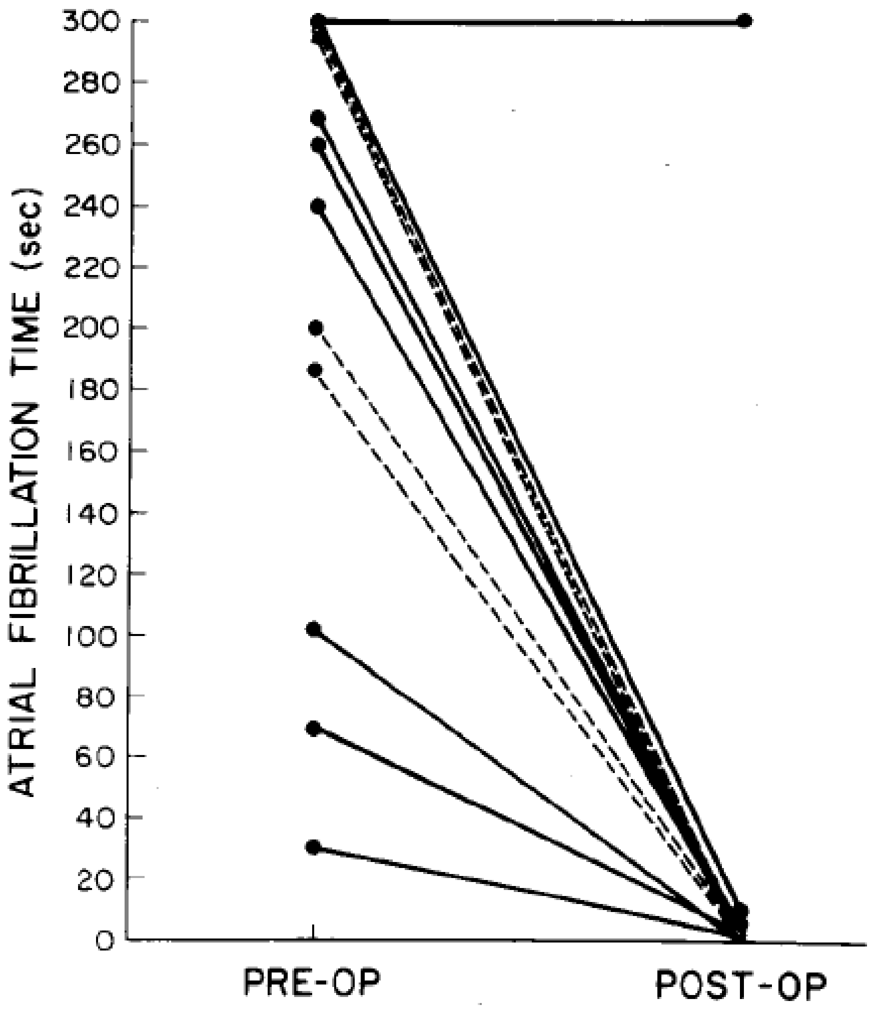
III. Development of a definitive surgical procedure

- **Concept of atrial transection " MAZE"**



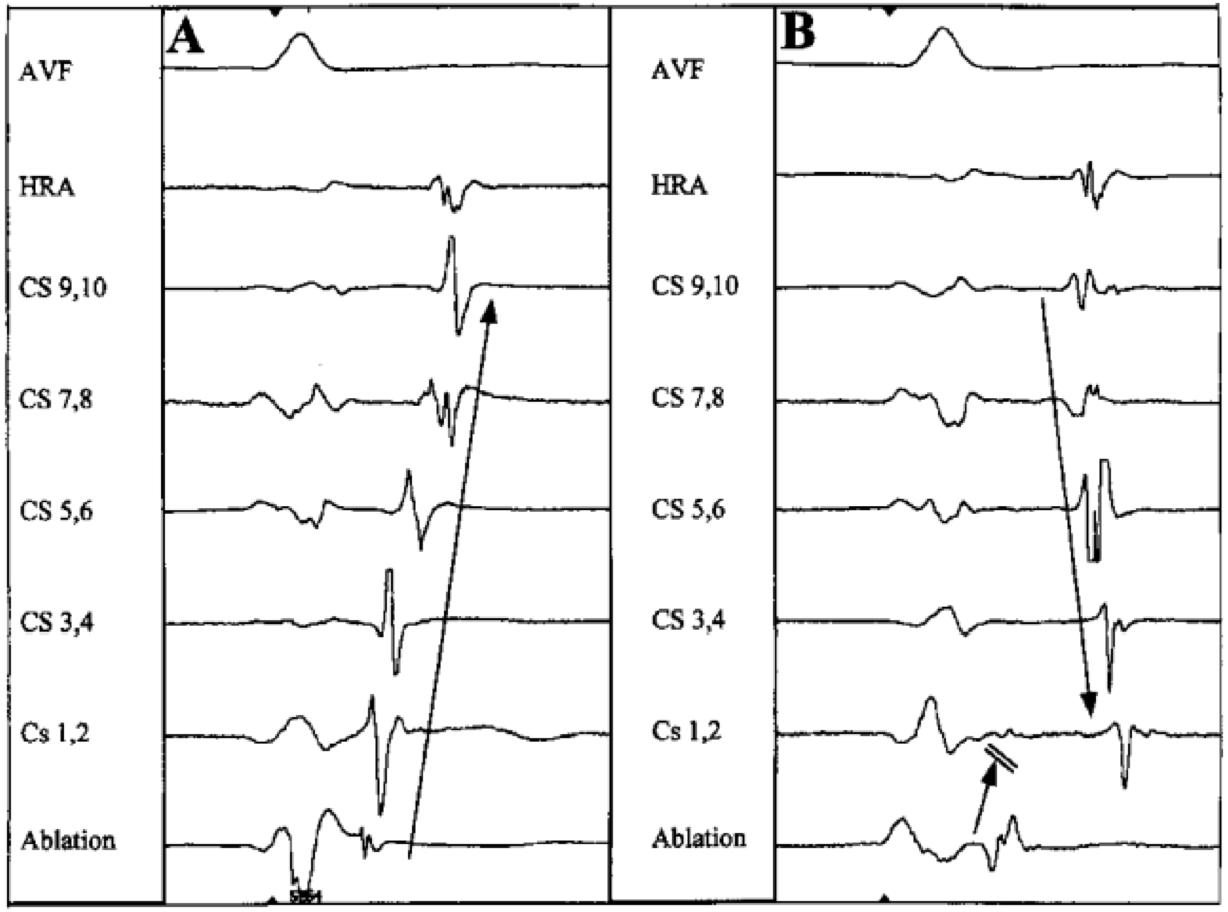
Cox-maze procedure for compartmentalize the atria

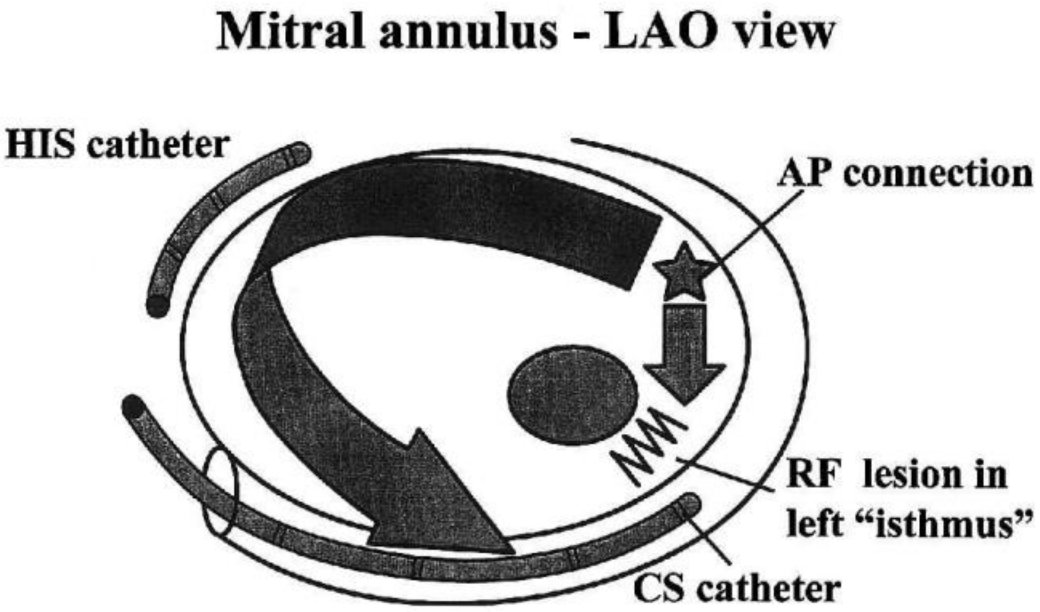




Evidence for a Left Atrial "Isthmus"

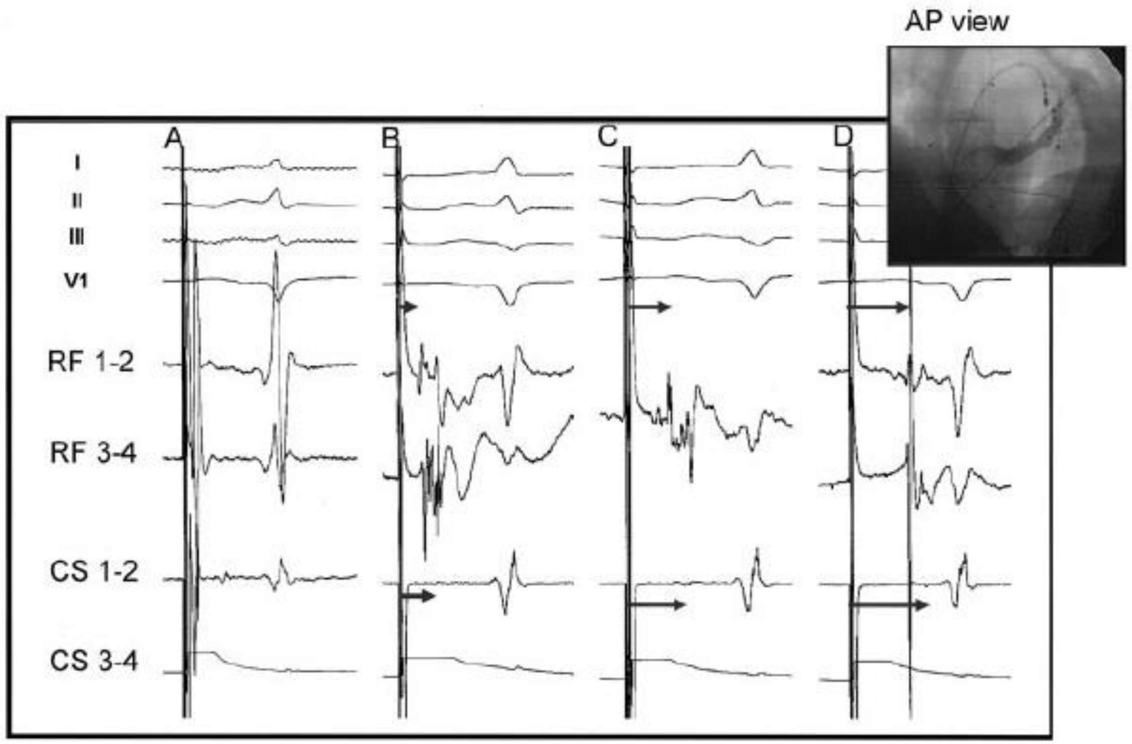
- Observation of change in the atrial activation sequence during RFCA of left accessory pathway (AP) ablation

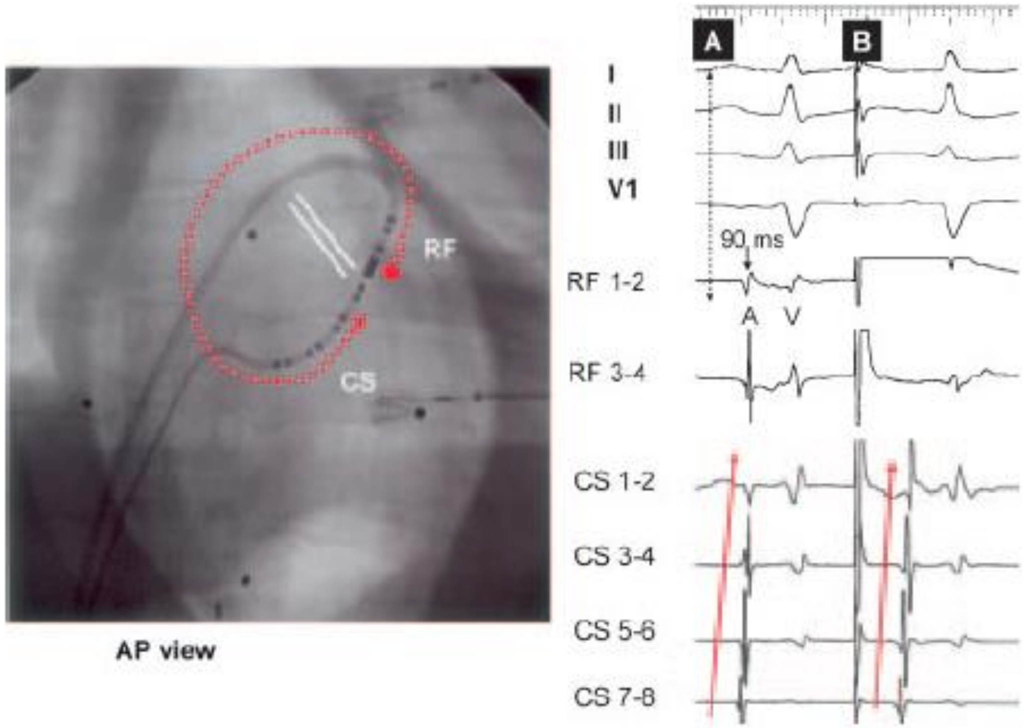




Feasibility of Catheter ablation of the mitral isthmus

- **Catheter ablation of the mitral isthmus is associated with a high cure rate for paroxysmal AF.**





Role of mitral isthmus in atrial fibrillation pathomechanism

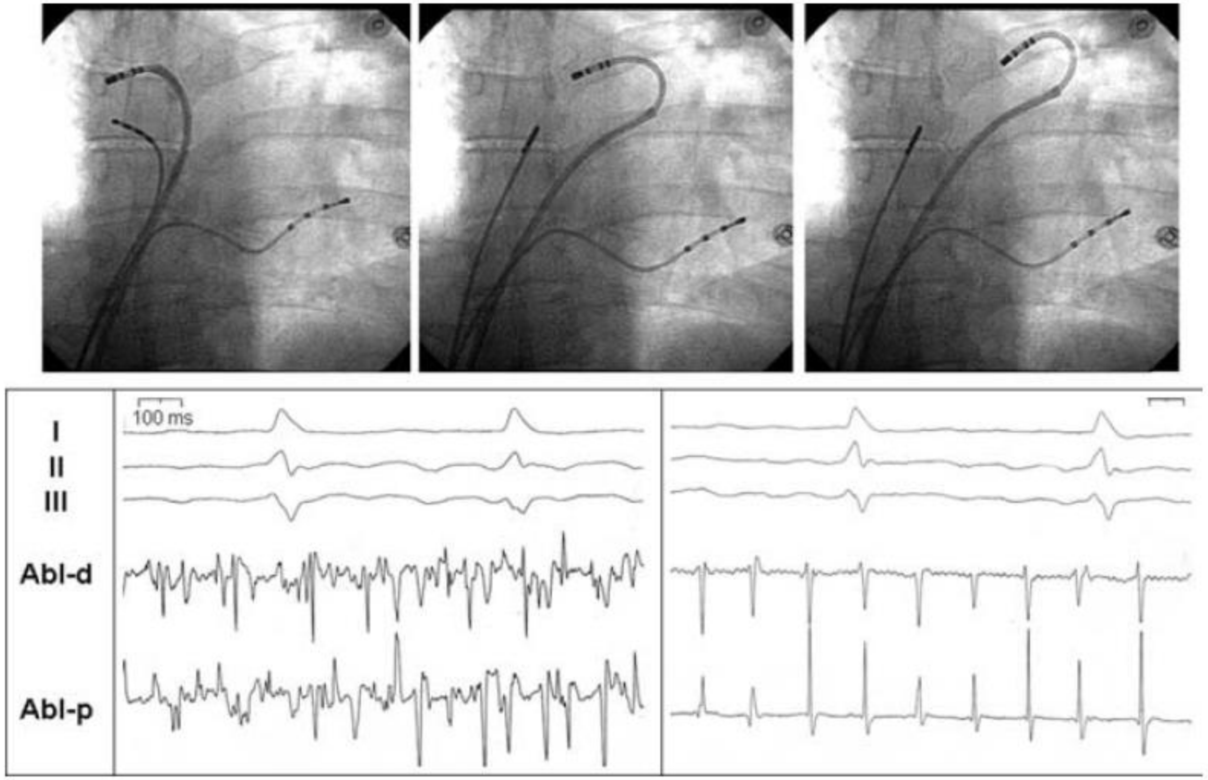
Wonkwang university school of medicine and hospital

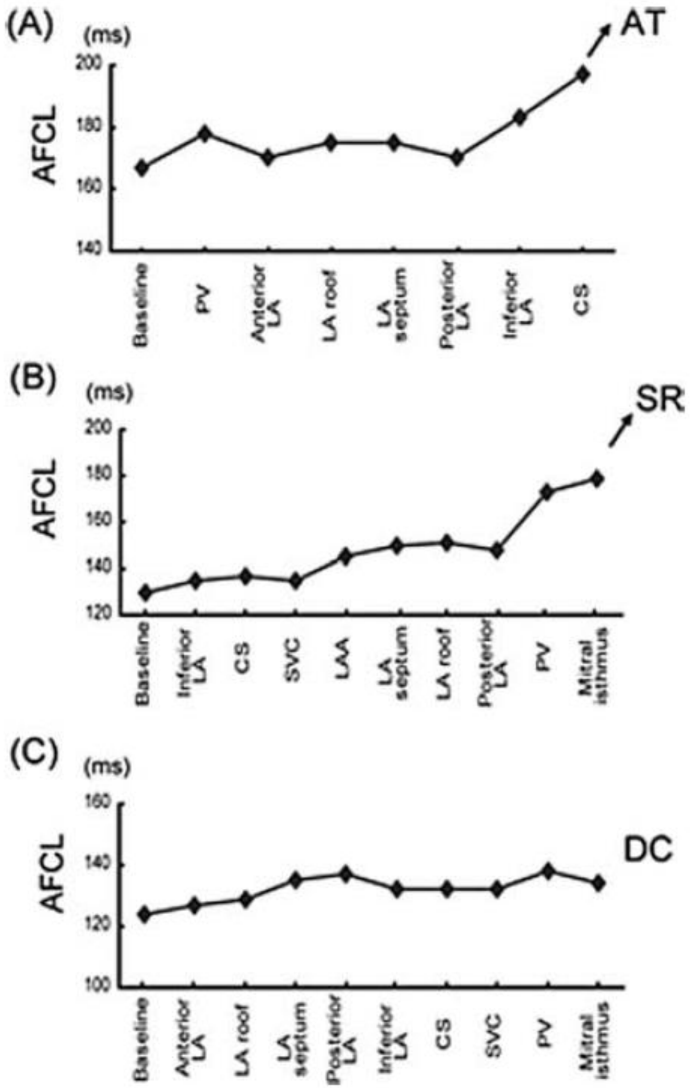
Mechanisms associated with mitral isthmus block

- Blocking of macroreentry circuit and focal triggers
- Modification of mother rotor
- Modulation of autonomic nervous innervation
- Elimination of arrhythmogenic trigger form VOM

Catheter Ablation of Long-Lasting Persistent Atrial Fibrillation: Critical Structures for Termination

- Termination of persistent AF can be achieved in 87% of patients by catheter ablation

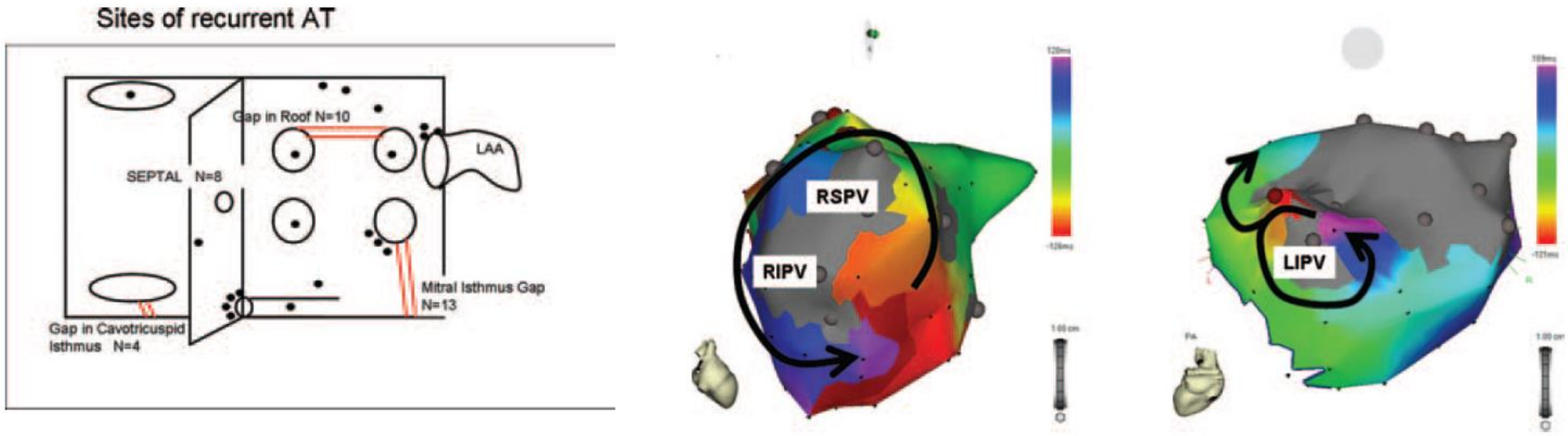




Haissaguerre M et al/Cardiovasc Electrophysiol. 2005 Nov;16(11):1125-37

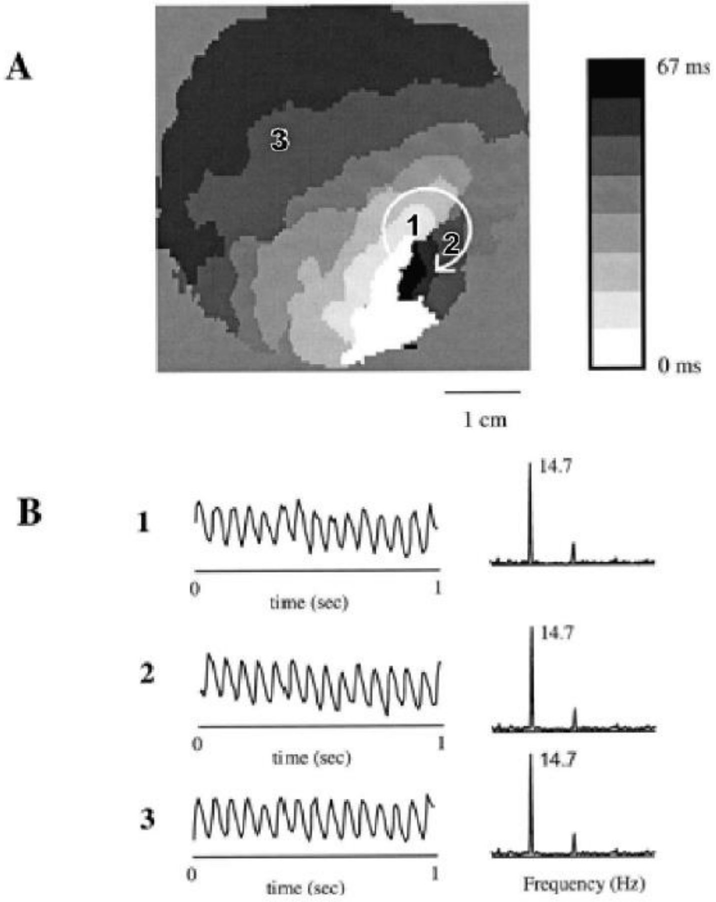
Catheter Ablation of Long-Lasting Persistent Atrial Fibrillation: Clinical Outcome and Mechanisms of Subsequent Arrhythmias

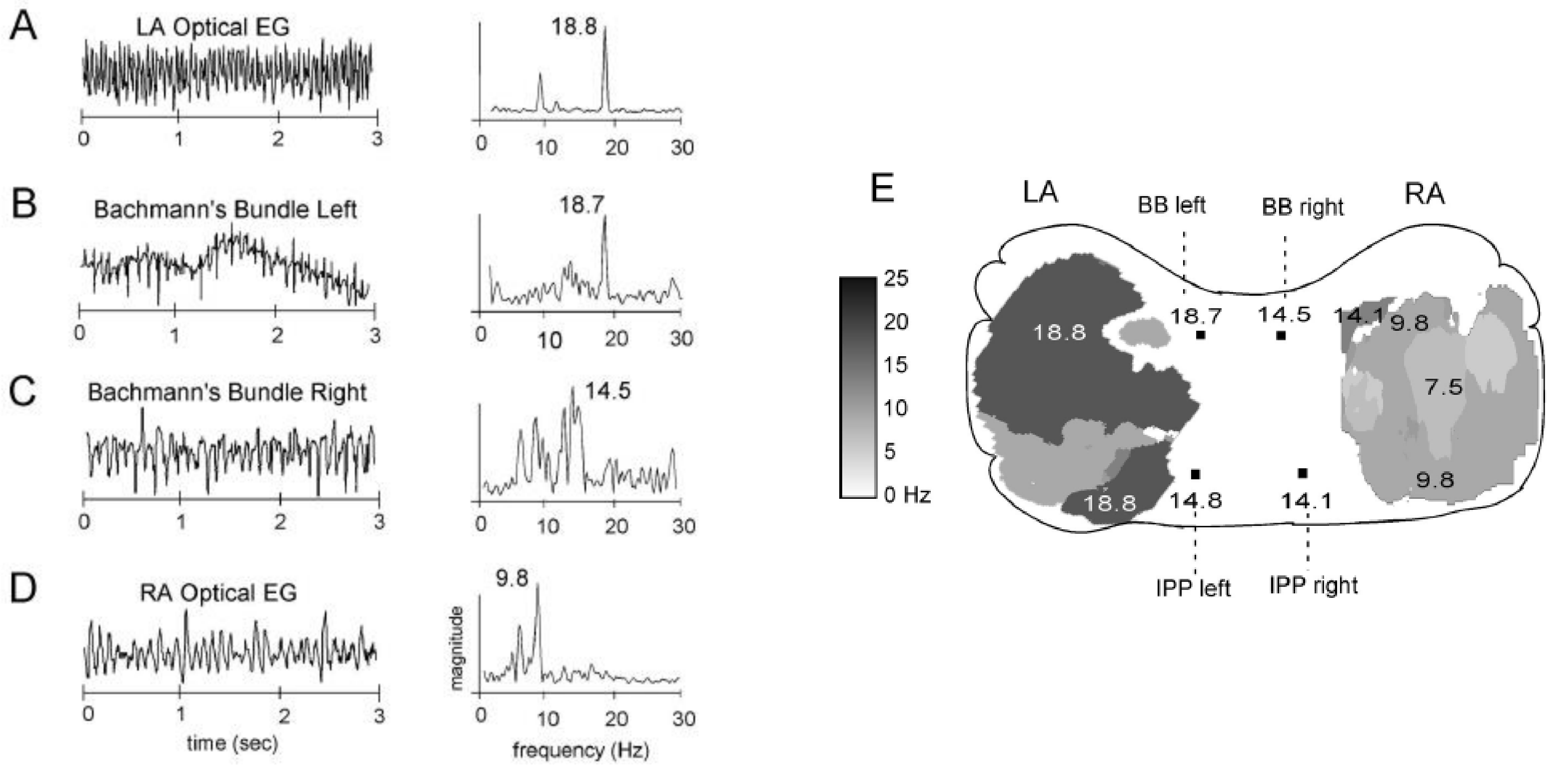
- long-lasting persistent AF associated with acute AF termination achieves medium to long-term restoration and maintenance of sinus rhythm in 95% of patients



Mother rotors and fibrillatory conduction: a mechanism of atrial fibrillation

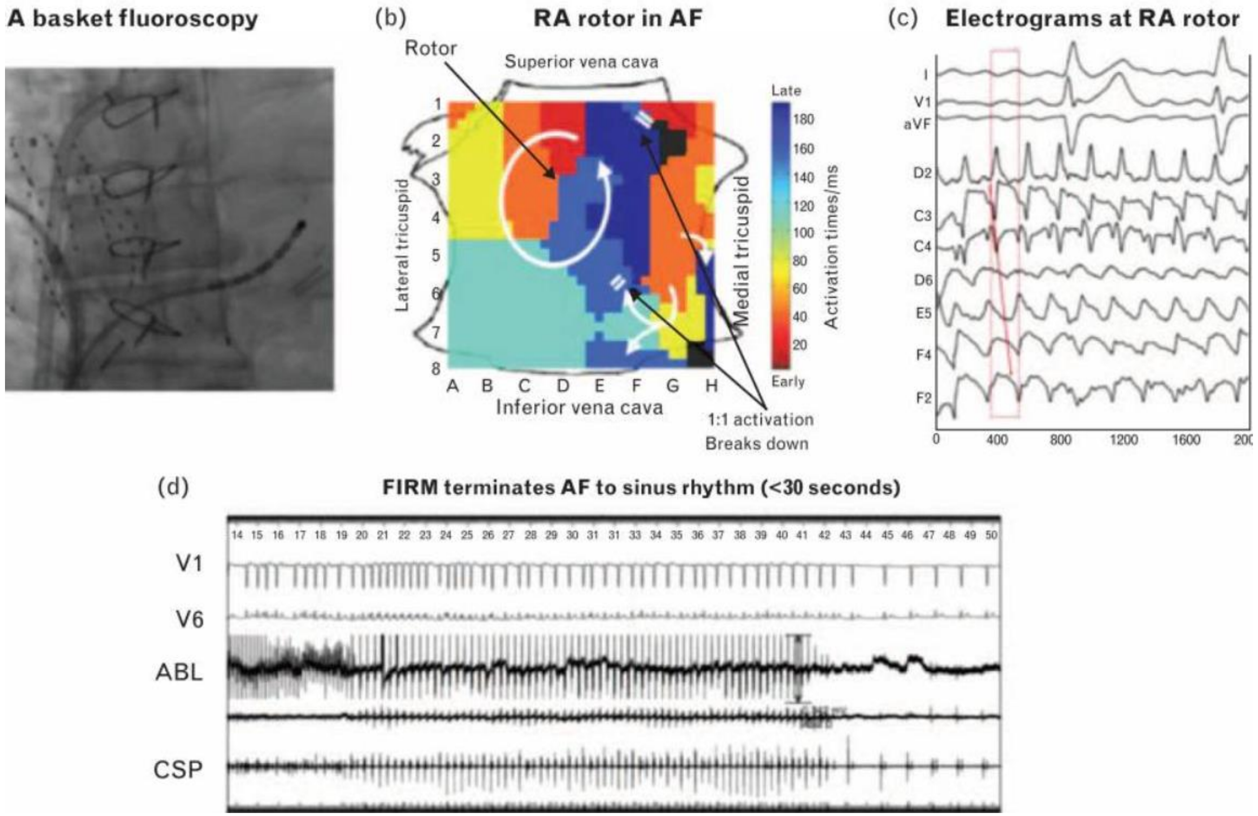
- stable, self-sustained rotors with high frequency activation in AF model

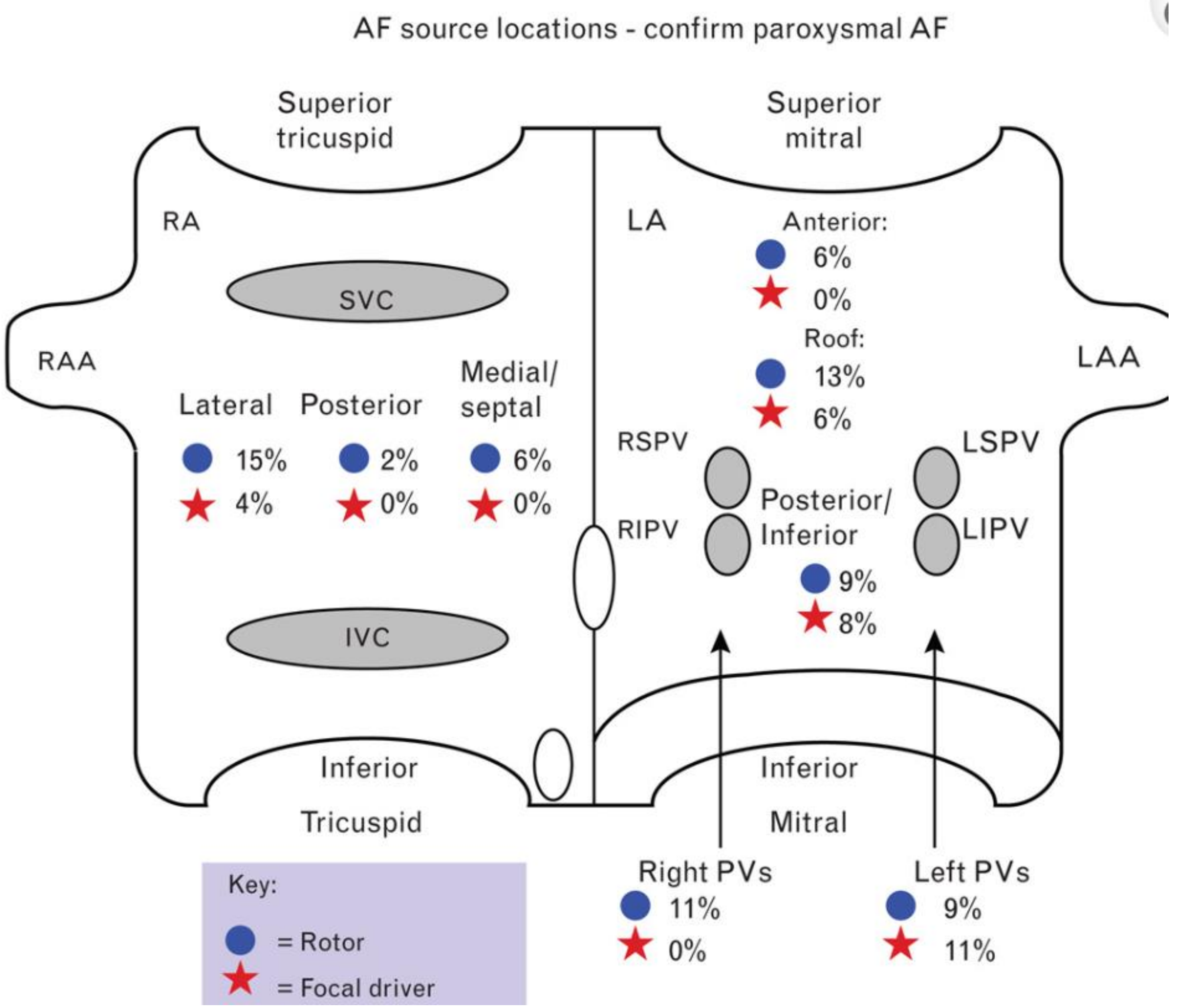




Rotor mapping and ablation to treat atrial fibrillation

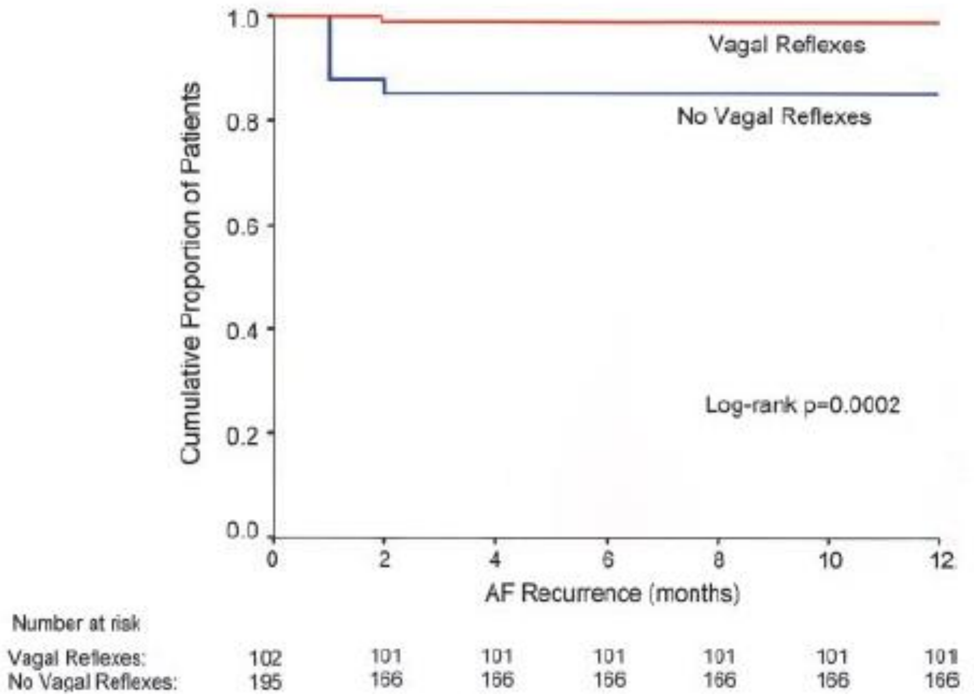
■ Distribution of rotors

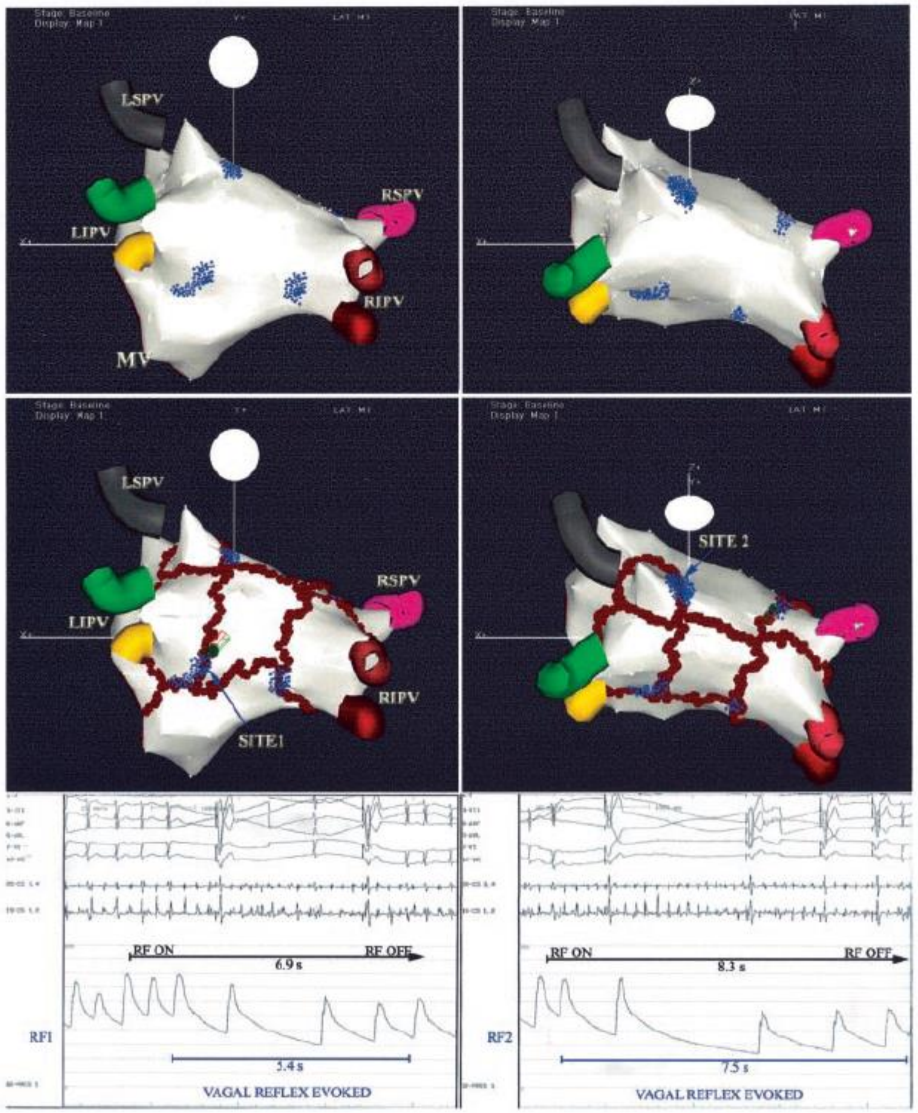




PV Denervation Enhances Long-Term Benefit After Circumferential Ablation for PAF

- adjunctive CVD during CPVA significantly reduces recurrence of AF at 12 months





Gross and Microscopic Anatomy of the Human Intrinsic Cardiac Nervous System

- most of ganglia being located on the posterior surfaces of the atria and superior aspect of the ventricles.

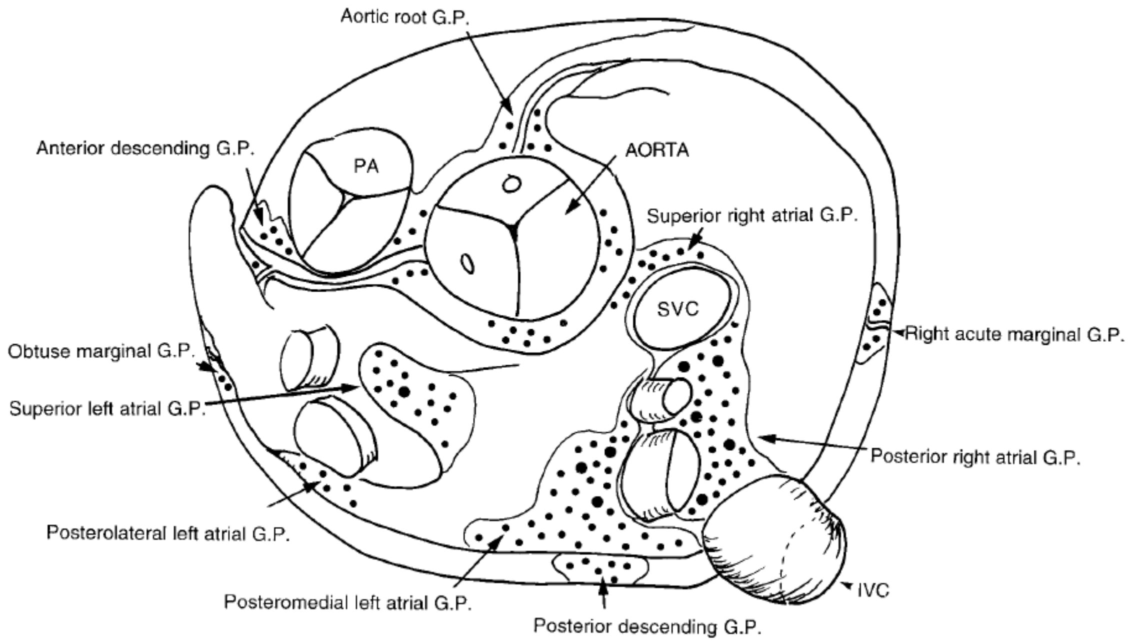
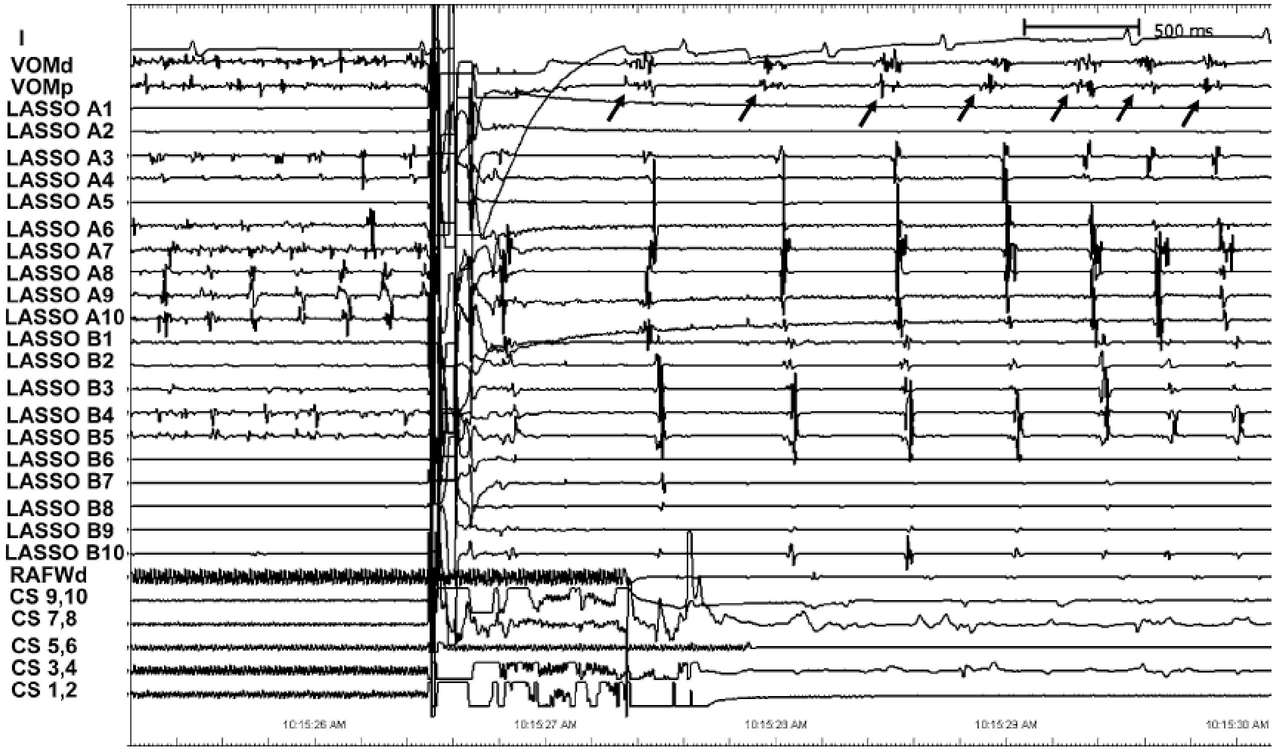


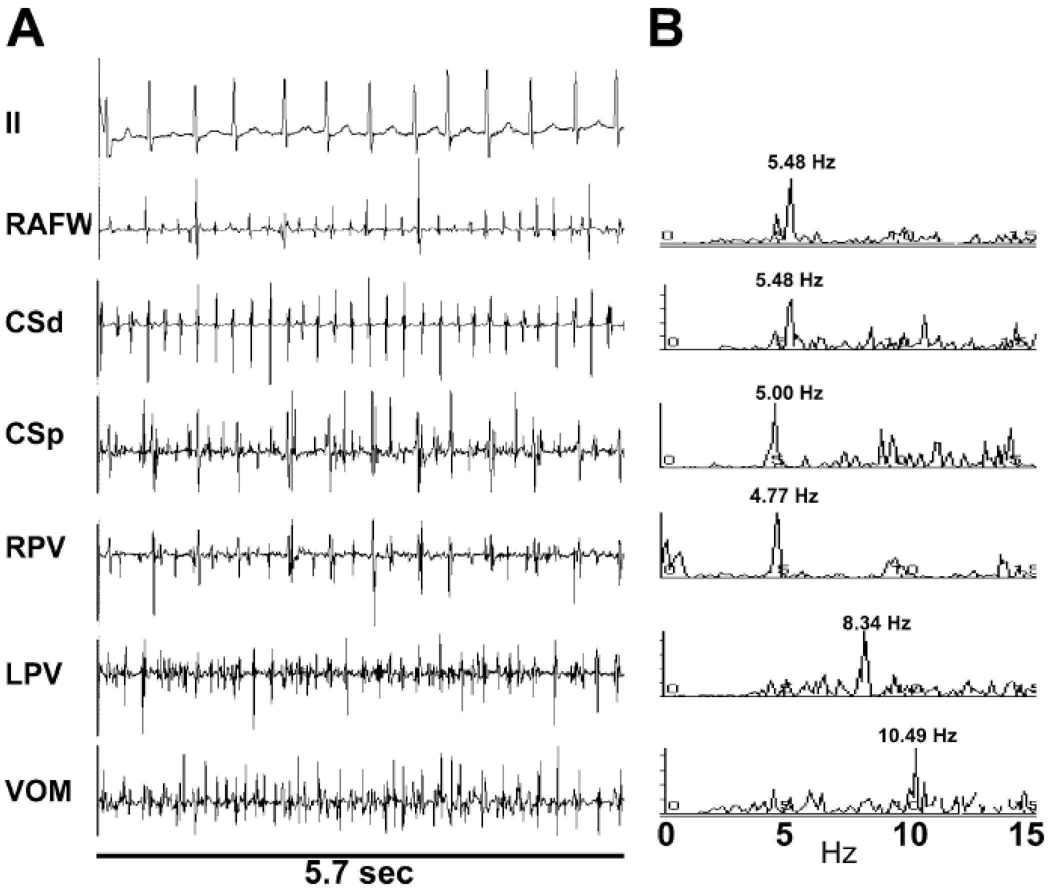
TABLE 1. Numbers of ganglia in different cardiac regions grouped according to their estimated neuronal complement (n = 6 human hearts)

Ganglionic plexus	5–10 Neurons	11–50 Neurons	50–100 Neurons	100–200 Neurons	>200 Neurons	Total no. ganglia per heart
Atrial ganglionated plexuses						
Superior right atrial	19.2 ± 2.9	9.5 ± 2.8	2.2 ± 0.4	0.3 ± 0.1	0	31 ± 5
Superior left atrial	29.4 ± 5.9	19.7 ± 5.1	5.3 ± 1.9	2.2 ± 0.7	0.5 ± 0.2	56 ± 12
Posterior right atrial	90.1 ± 13.7	66.4 ± 7.6	22.8 ± 1.9	9.7 ± 0.7	4.7 ± 0.7	194 ± 22
Posteromedial left atrial	82.8 ± 13.5	56.4 ± 9.8	18.2 ± 4.1	4.5 ± 0.9	1.8 ± 0.6	161 ± 27
Posterolateral left atrial	8.2 ± 2.2	5.7 ± 1.1	1.7 ± 0.4	0.3 ± 0.1	0	16 ± 2
Total per heart						458 ± 43
Ventricular ganglionated plexuses						
Aortic root						
Right	12.2 ± 1.5	3.5 ± 0.7	0.3 ± 0.1	0	0	16 ± 2
Anterior	4.2 ± 1.2	1.2 ± 0.6	0	0	0	5.2 ± 1.8
Left	15.1 ± 2.3	5.5 ± 1.6	1.2 ± 0.5	0.4 ± 0.1	0	21.7 ± 4.0
Posterior	12.0 ± 1.0	5.5 ± 0.8	0.3 ± 0.1	0.2 ± 0.1	0	17.8 ± 2.0
Anterior descending	7.5 ± 1.2	3.7 ± 0.5	0.2 ± 0.1	0	0	11.2 ± 1.1
Posterior descending	4.1 ± 2.2	1.6 ± 0.6	0	0	0	5.2 ± 1.9
Right acute marginal	4.5 ± 0.8	1.5 ± 0.6	0	0	0	6.2 ± 2.8
Obtuse marginal	4.3 ± 1.6	1.0 ± 0.4	0	0	0	5.2 ± 2.0
Total per heart						88 ± 7

Vein of Marshall Activity During Sustained Atrial Fibrillation

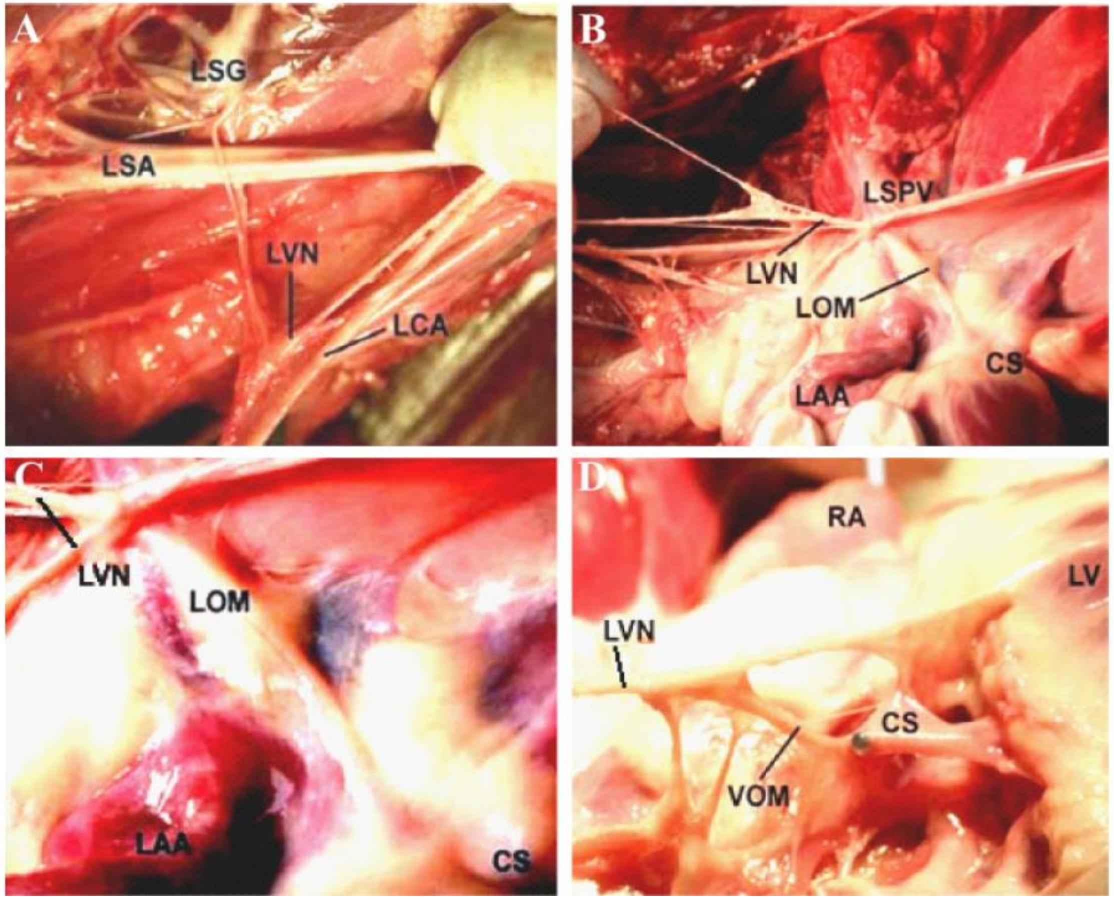
- Ectopic activity with complex local electrogram originating from VOM is commonly seen in patients with sustained AF.(NICM).

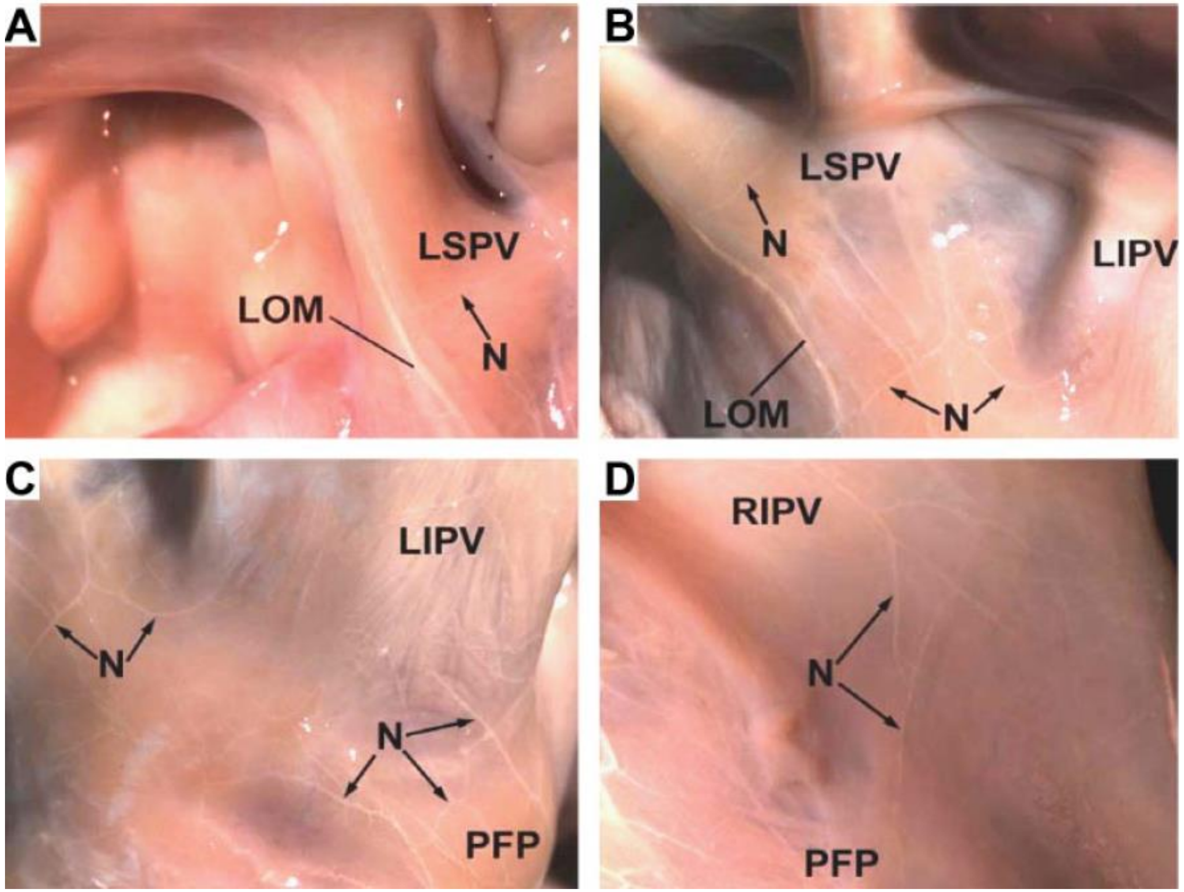




The ligament of Marshall as a parasympathetic conduit

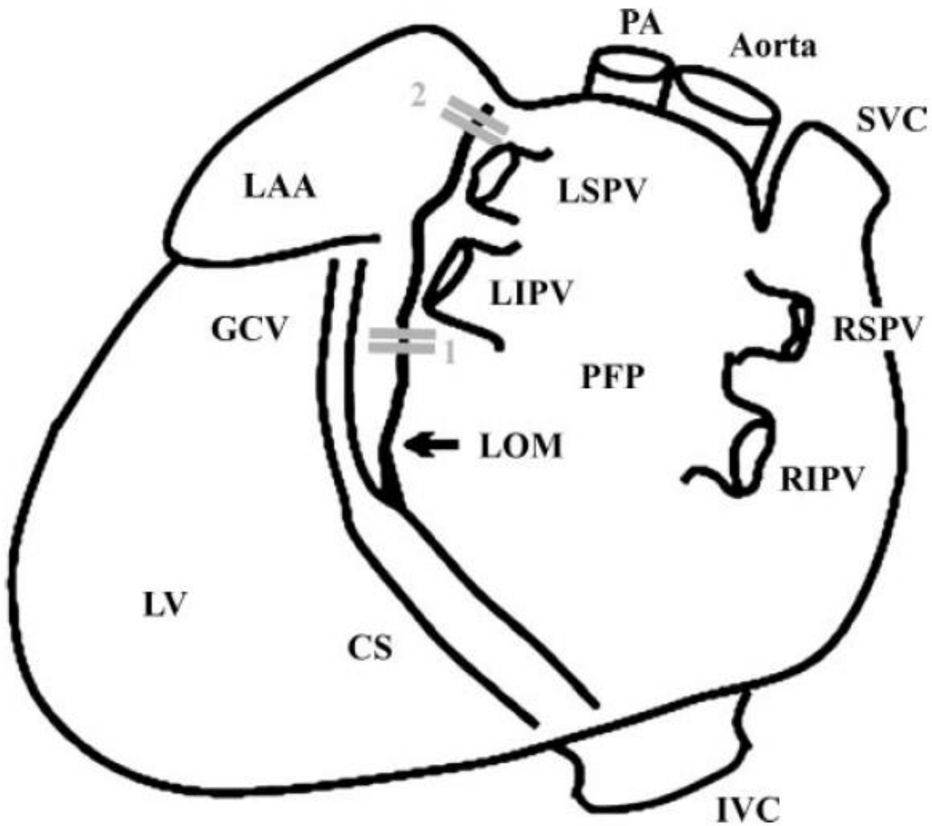
- LOM contains a predominance of cholinergic nerve fibers. fibers arising from the LOM innervate surrounding structures

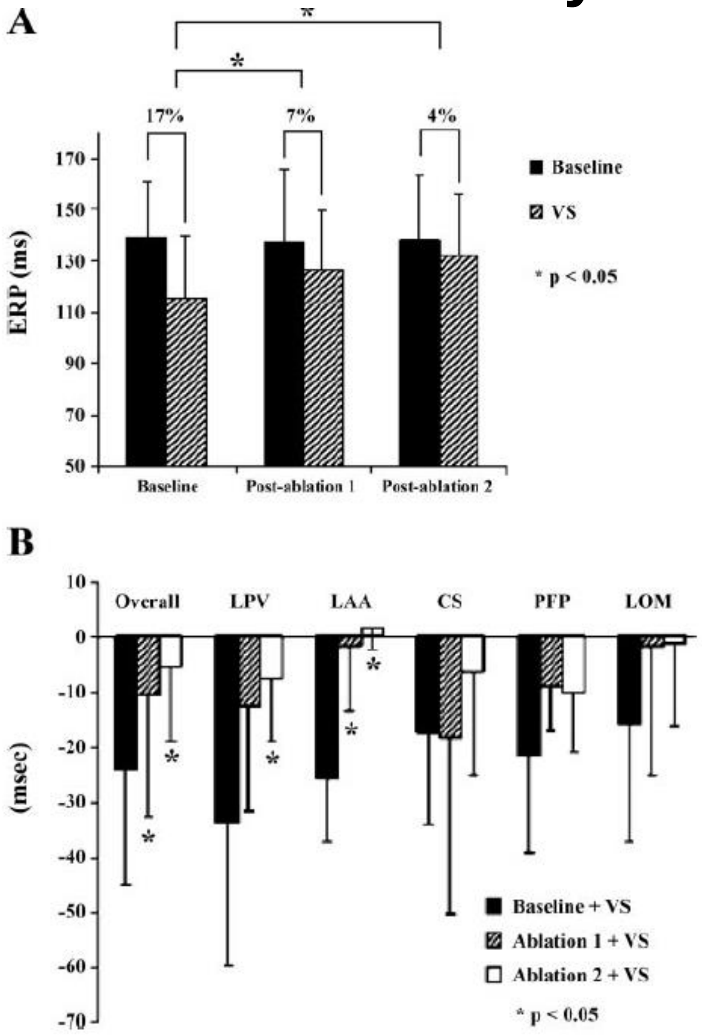




The ligament of Marshall as a parasympathetic conduit

- Ablation of the LOM significantly attenuated effective refractory period shortening at distant sites

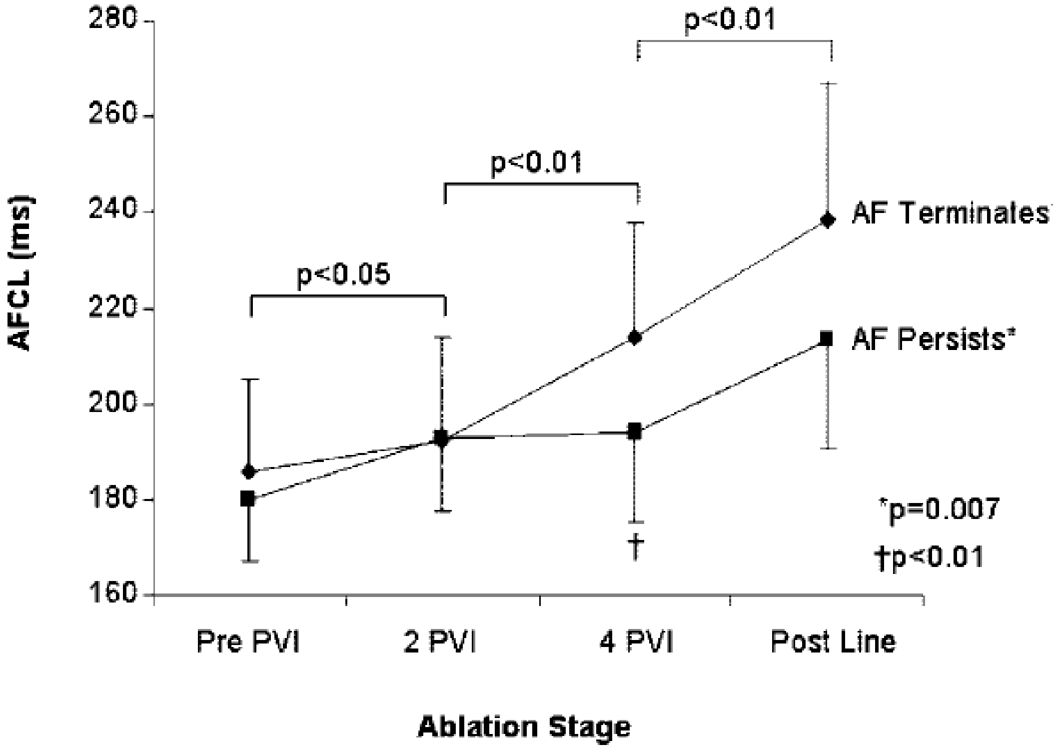


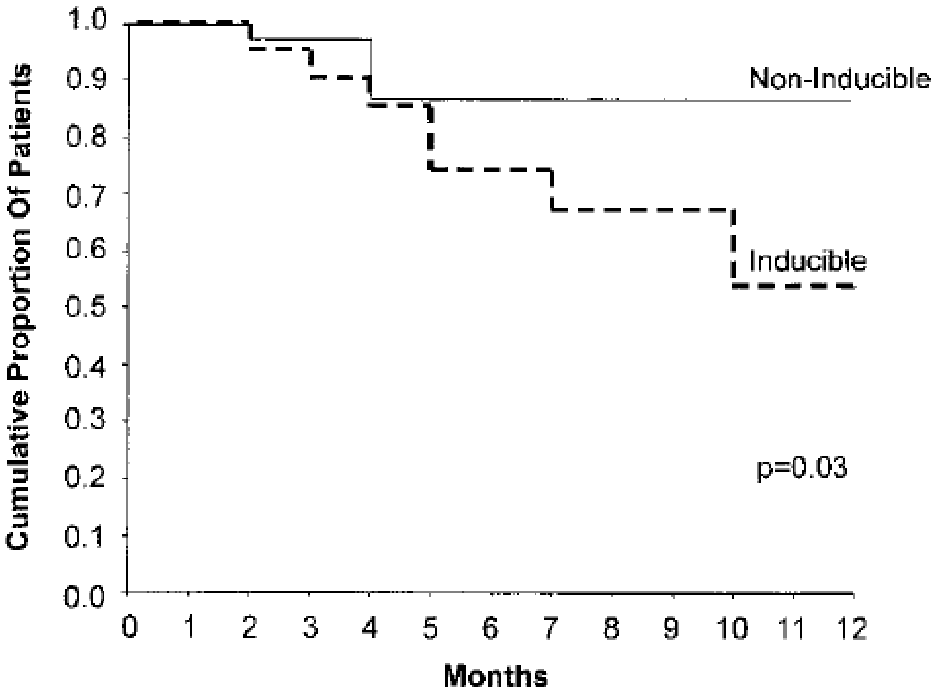


Clinical efficacy

Changes in AFCL and Inducibility During Catheter Ablation and Their Relation to Outcome

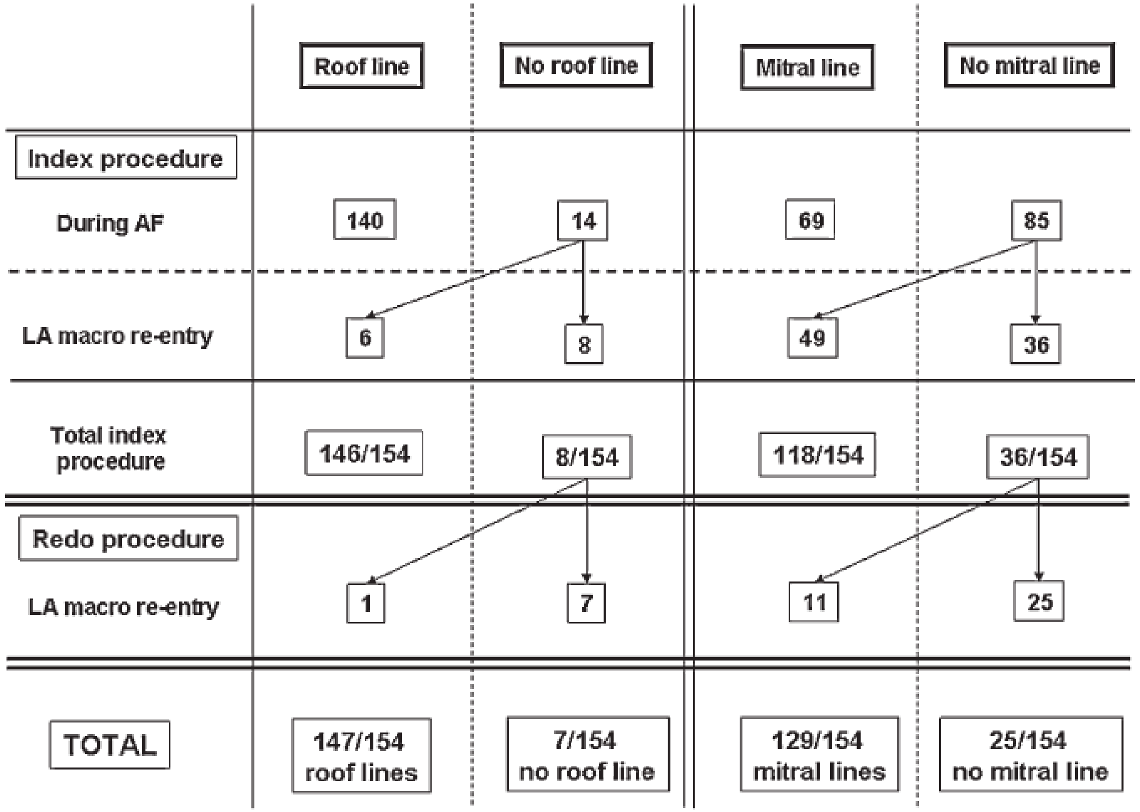
- Linear ablation results in a decline in AF frequency, with a magnitude correlating with termination of AF and prevention of inducibility

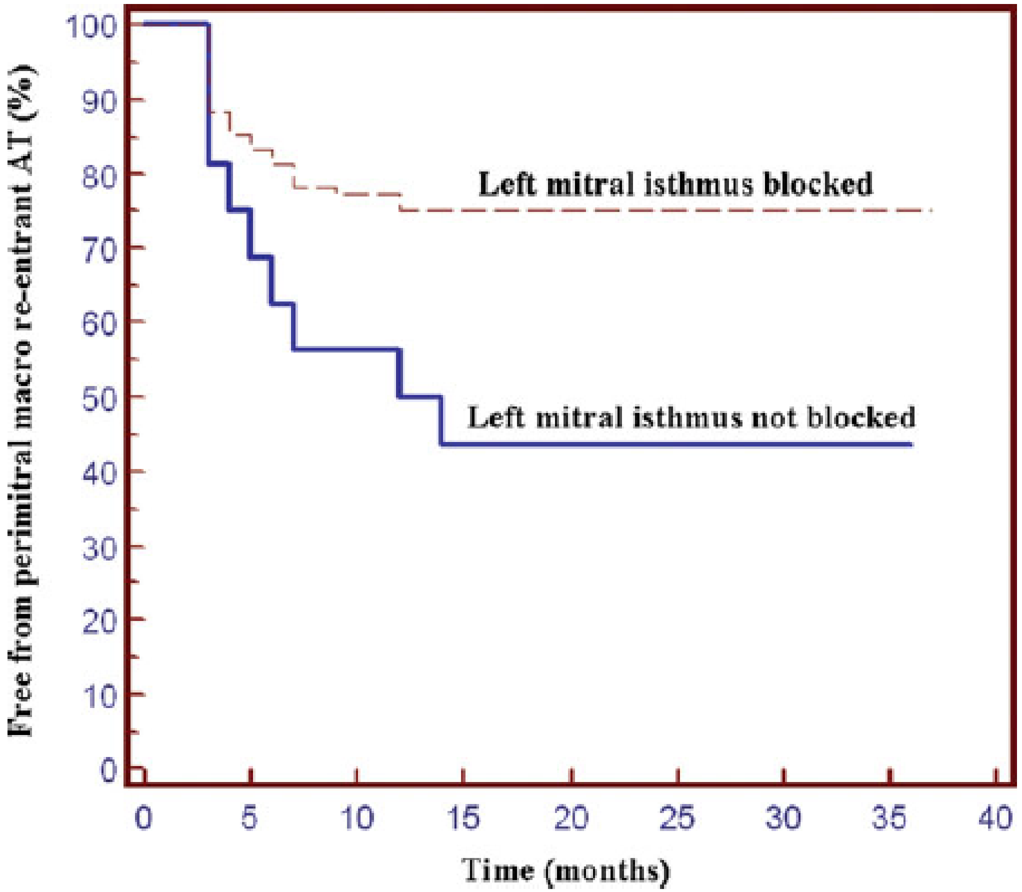




Left atrial linear lesions are required for successful treatment of persistent atrial fibrillation

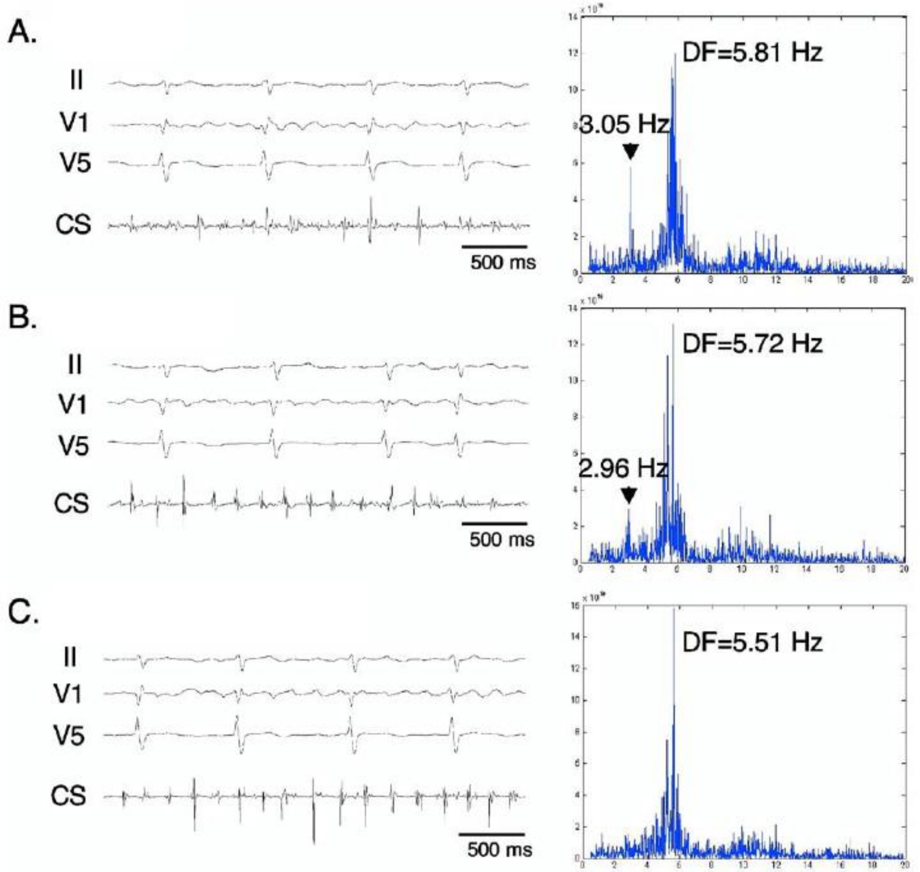
- Although persistent AF can be terminated by catheter ablation without linear lesions majority will require linear lesions for macro re-entrant AT.

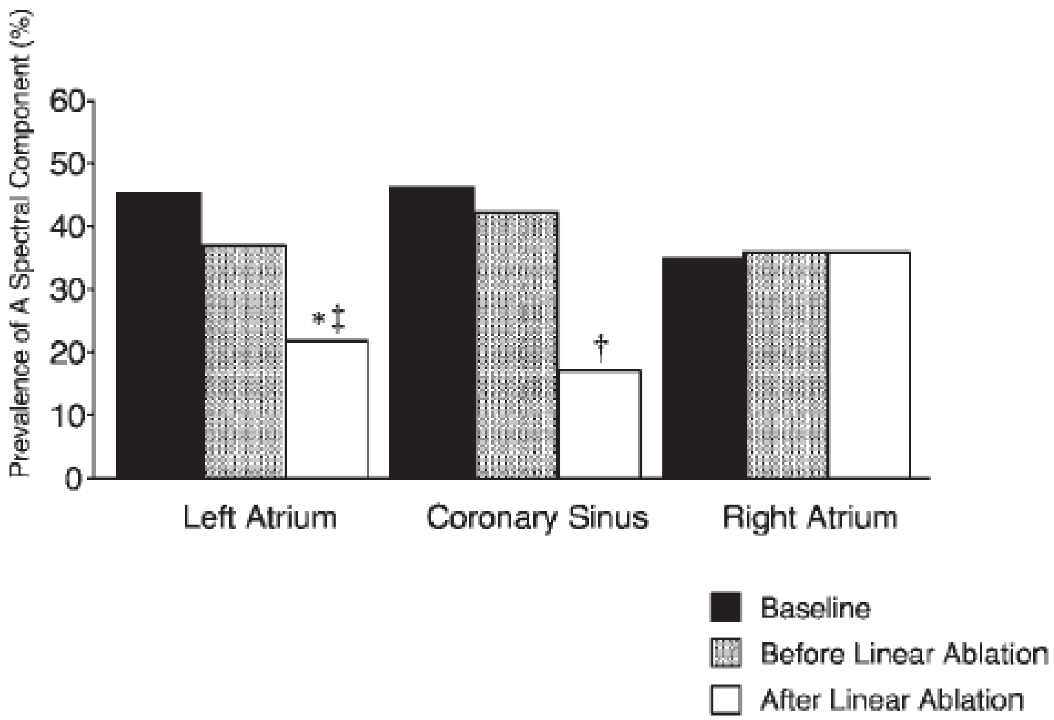




Effect of linear ablation on spectral components of atrial fibrillation

- Elimination of spectral components of AF by targeted linear ablation suggests that spectral components may indicate site-specific ATs that coexist with AF despite a lower frequency than the DF of AF.

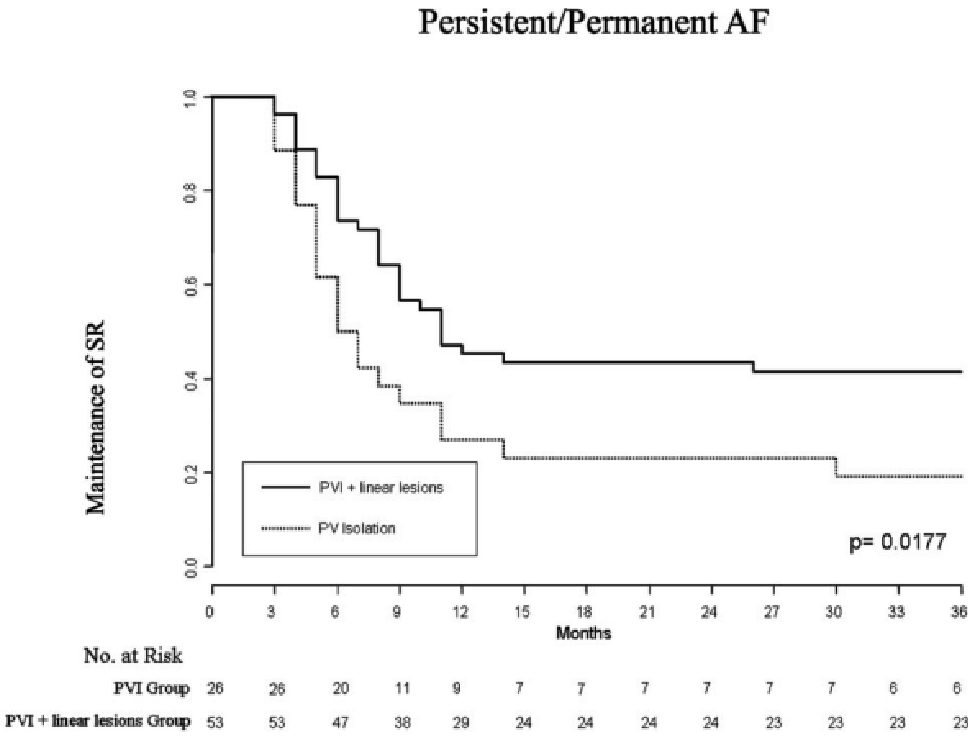




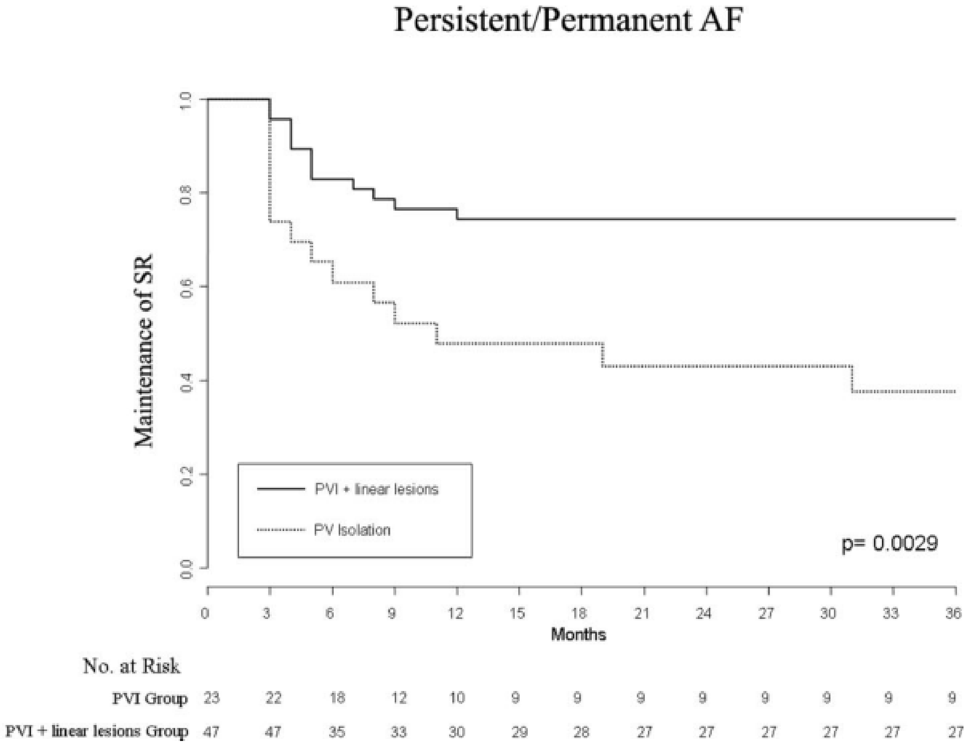
Long-Term Clinical Results of 2 Different Ablation Strategies in Patients With Paroxysmal and Persistent Atrial Fibrillation

- PVI isolation plus LL is superior to the PVI strategy in maintaining SR without antiarrhythmic drugs after procedures 1 and 2 both in paroxysmal and persistent AF.

1st procedure

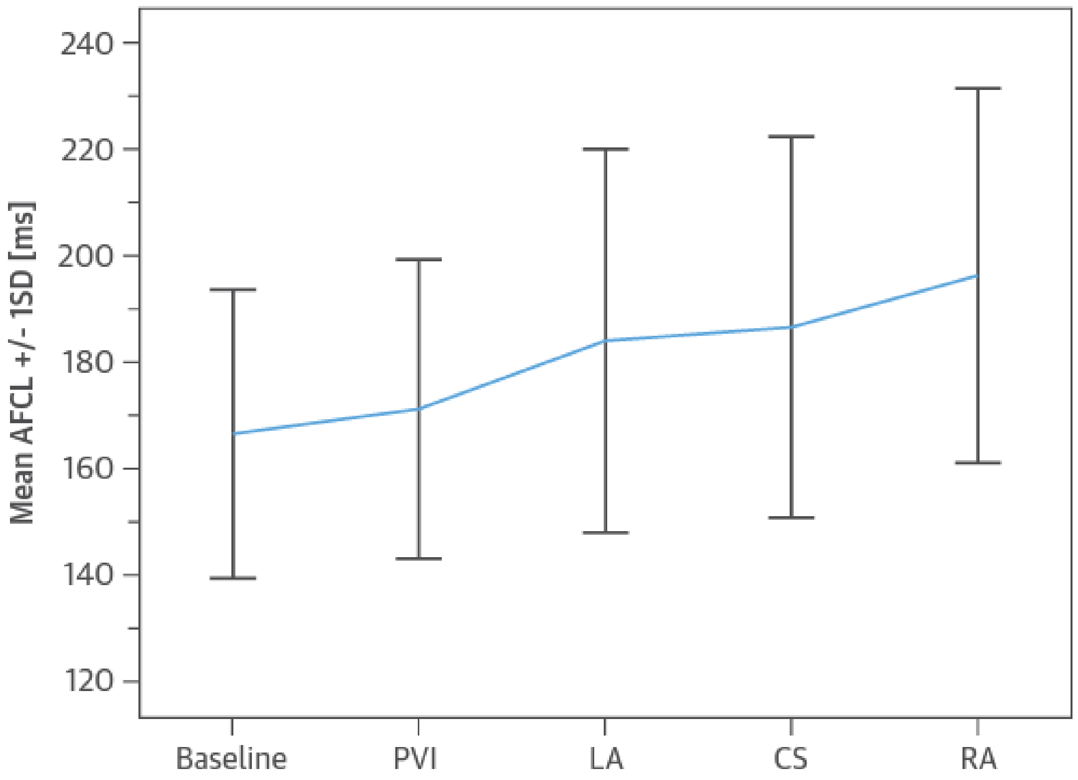


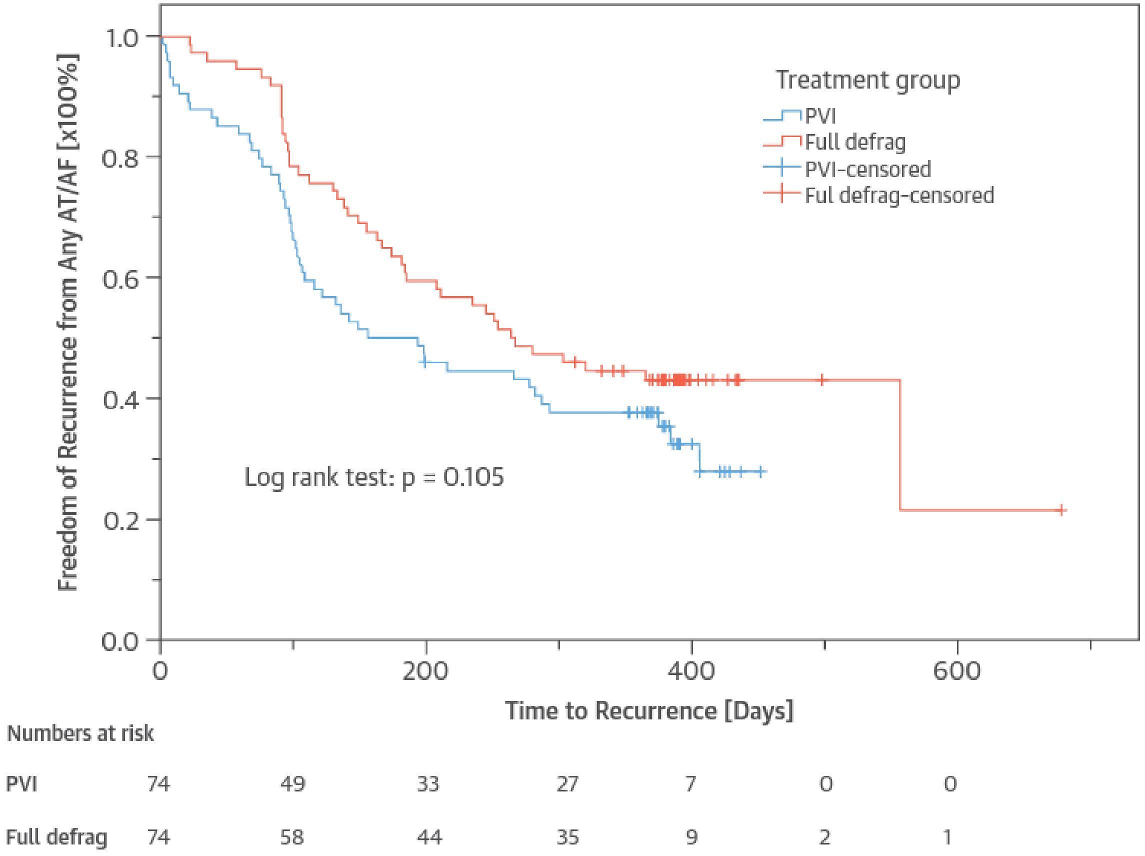
2nd procedure



Pulmonary Vein Isolation Versus Defragmentation: The CHASE-AF Clinical Trial

- A stepwise approach aimed at AF termination does not seem to provide additional benefit over PVI alone in patients with persistent AF

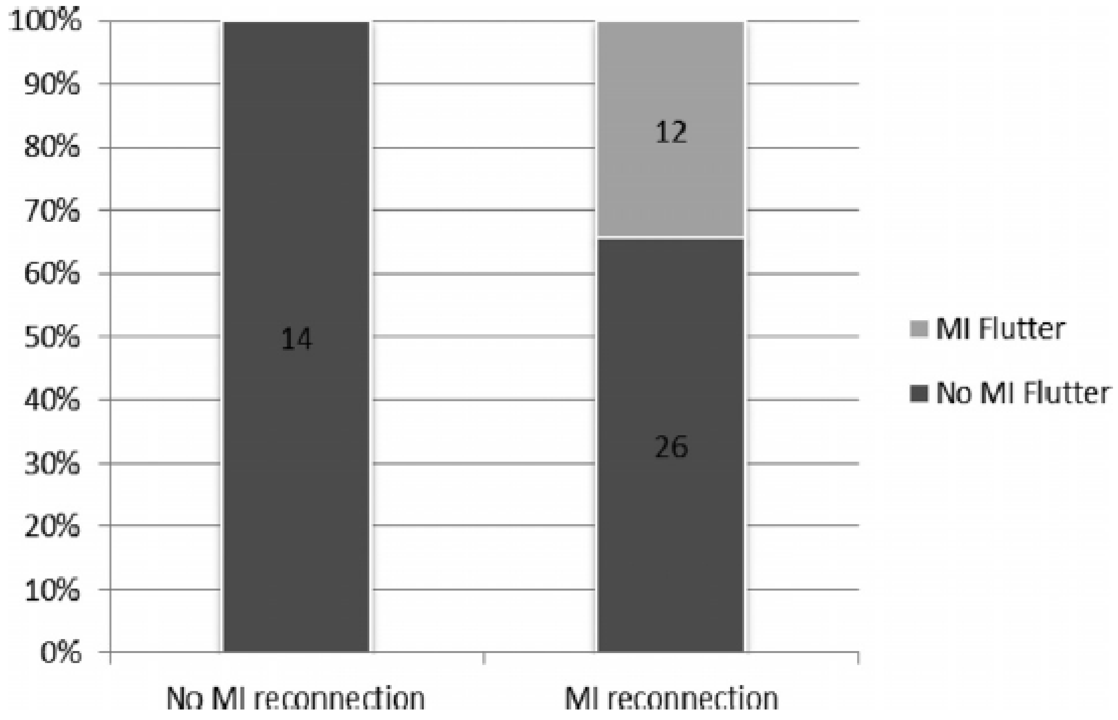




Related Techniques for the Bidirectional Block

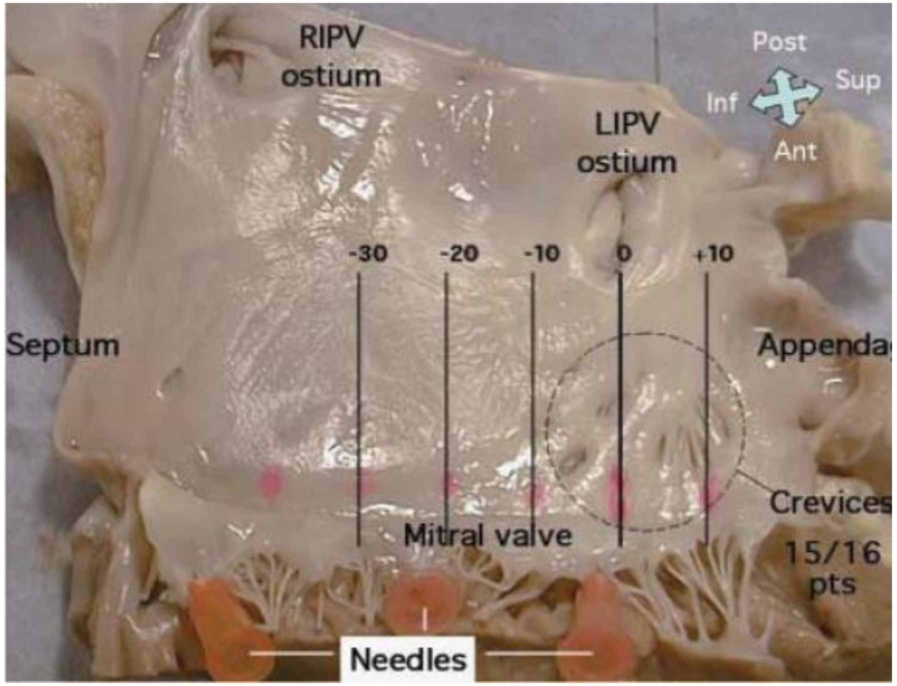
Recovery of MI Conduction Leads to the Development of Macro-Reentrant Tachycardia After Left Atrial Linear Ablation for AF

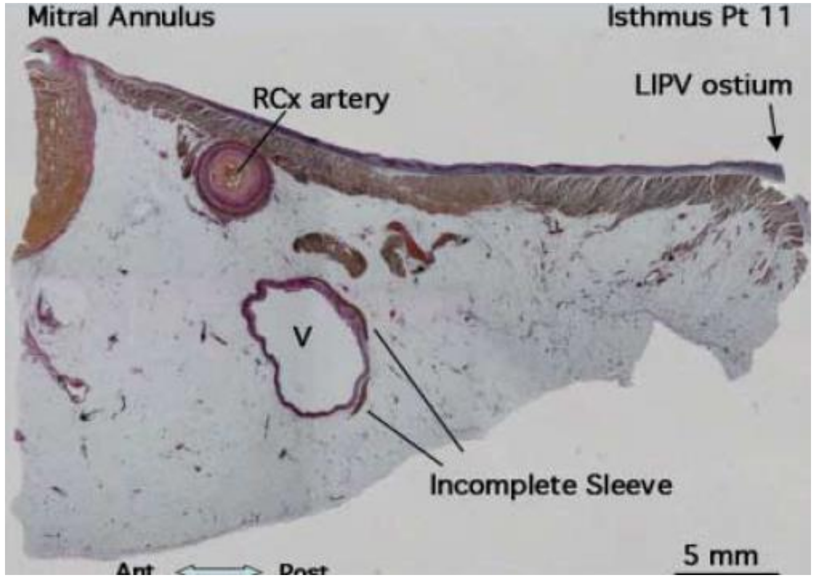
- MI conduction had recovered in 38 of 52 patients.
- recovery of MI conduction is common and may lead to LAT after left atrial linear ablation for AF.

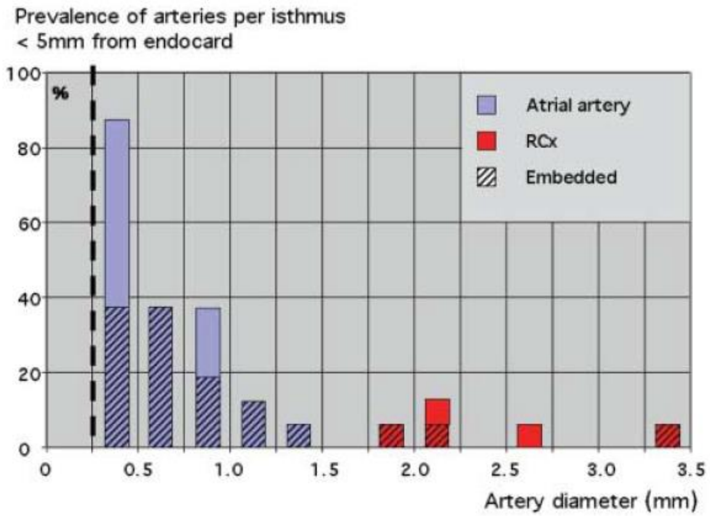


Where to draw the mitral isthmus line in catheter ablation of atrial fibrillation: histological analysis

- local cooling by atrial arteries and veins may complicate the creation of conduction block in the mitral isthmus.

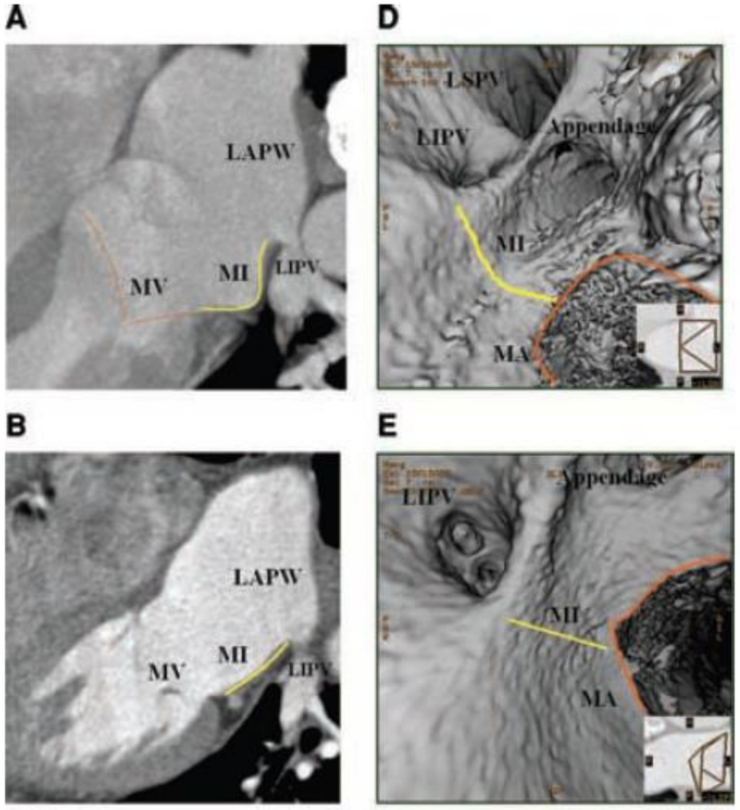






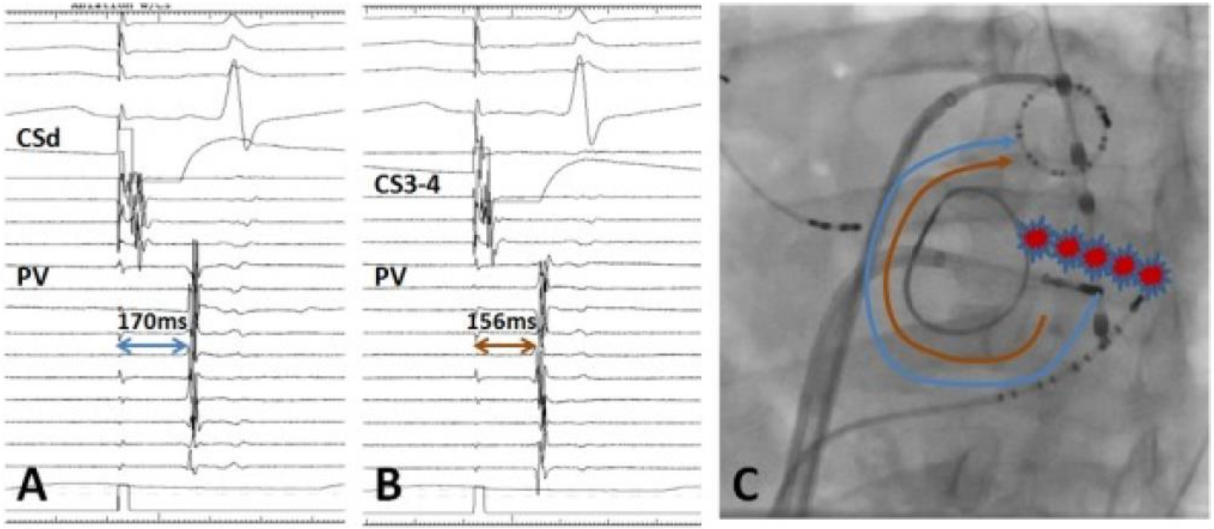
Anatomic Characteristics of the Left Atrial Isthmus in Patients with Atrial Fibrillation: Lessons from CT

- The LA isthmus was longer in the AF patients. The morphology of the isthmus was variable. Compared with the lateral isthmus, the medial isthmus was longer and had more ridges.

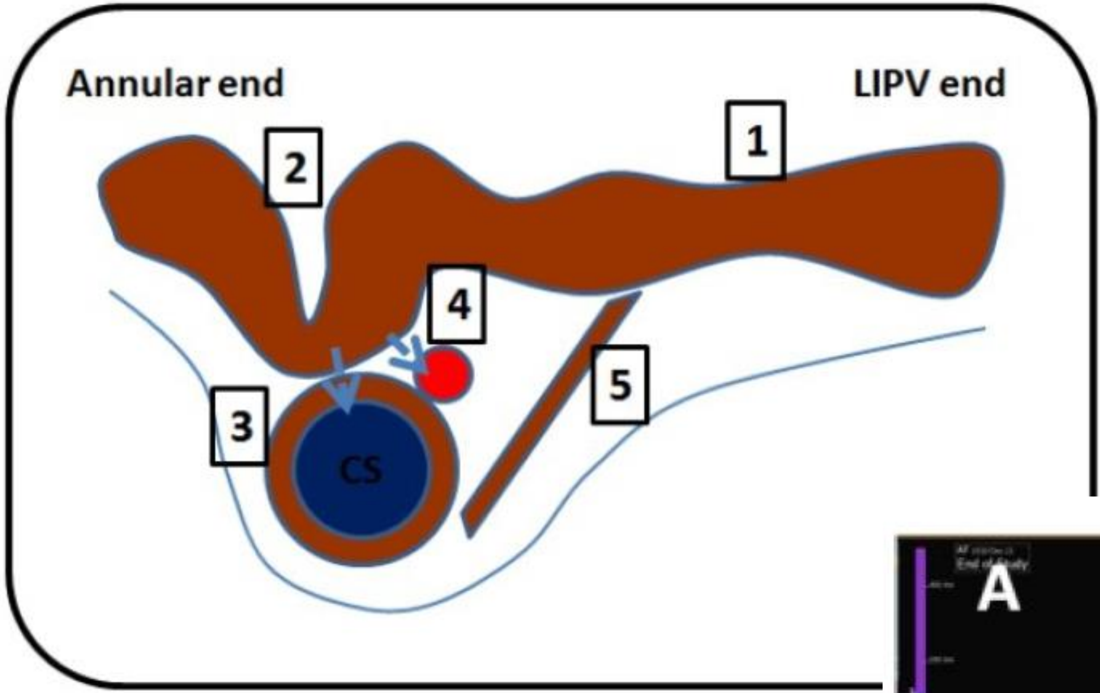


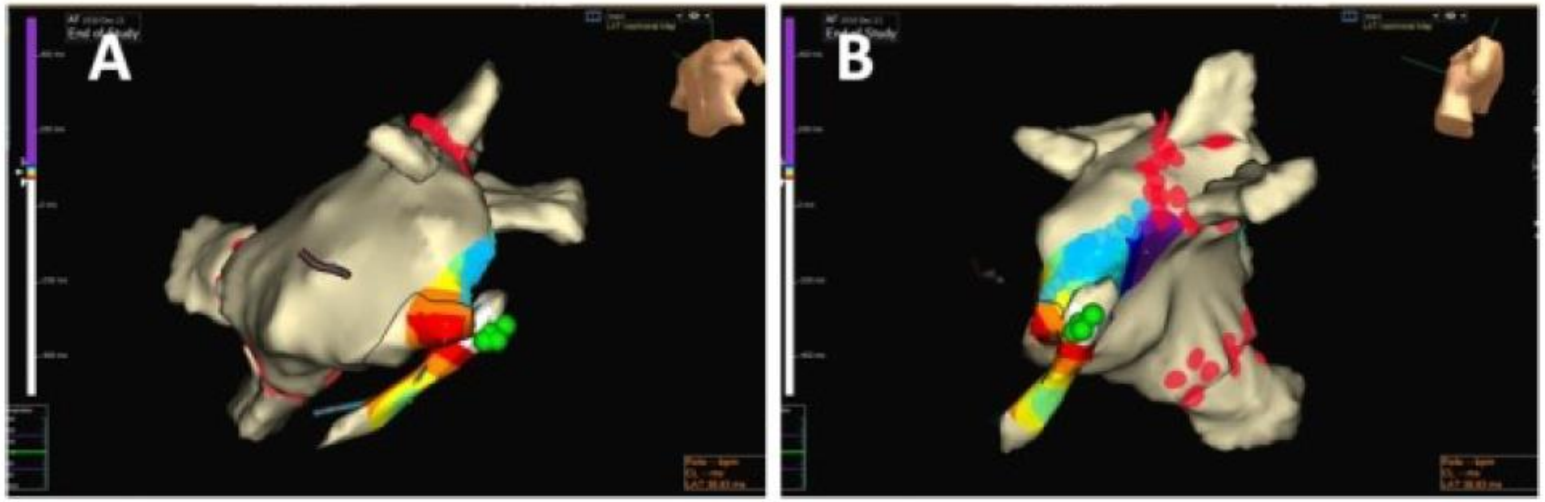
	AF (n = 45)	Control (n = 45)	P Value
Age (years)	50 ± 13	54 ± 10	0.12
Sex (male, %)	89	82	0.55
Hypertension (number)	8	8	>0.99
Diabetes	2	3	>0.99
COPD	1	2	>0.99
CHF	2	3	>0.99
CAD	3	2	>0.99
Lateral isthmus			
Length (cm)	3.30 ± 0.68	2.71 ± 0.60	<0.001
Distance (cm)	2.74 ± 0.50	2.32 ± 0.43	<0.001
Morphology			
Concave	37	35	
Straight	6	8	
Pouch	2	2	0.91
Depth (cm)	0.62 ± 0.32	0.55 ± 0.33	0.41
Medial isthmus			
Length (cm)	5.12 ± 0.94	4.45 ± 0.63	<0.001
Distance (cm)	4.72 ± 0.79	4.15 ± 0.55	<0.001
Morphology			
Concave	33	31	
Straight	4	9	
Pouch	2	2	
Ridge	6	3	0.40
Depth (cm)	0.60 ± 0.32	0.44 ± 0.25	0.01
LA dimension (cm)			
LA_1	6.10 ± 0.62	5.37 ± 0.59	<0.001
LA_2	3.64 ± 0.58	3.38 ± 0.54	0.03
LA_3	6.19 ± 0.72	5.68 ± 0.61	<0.001

Confirming bidirectional block



Need for blocking epicardial connection





Completion of Mitral Isthmus Ablation Using a Steerable Sheath:

- The MI block could be achieved in the majority of patients by using a steerable sheath.

TABLE 2

Ablation Results of MI Between Group S and Group NS

	Group S n = 40	Group NS n = 40	P
MI ablation at the beginning of AF	37	34	0.48
MI conduction block	39 (97.5%)	31 (77.5%)	0.02
Duration of RF application for MI (min)	11.8 ± 6.4	16.1 ± 6.5	0.004
Amount of RF energy (joules)	2,256 ± 2,029	30,108 ± 11,585	0.005
Epicardial ablation from the CS	5 (12.5%)	29 (72.5%)	<0.0001
Perimitral conduction time (ms)	151 ± 26	144 ± 27	0.32
Acute reconnection in success case	4/39 (10.3%)	5/31 (16.1%)	0.71

MI = mitral isthmus; AF = atrial fibrillation; RF = radiofrequency; CS = coronary sinus.

TABLE 3

Comparison of Clinical Variables Between Patients with Successful and Failed MI Ablation

	Success n = 70	Failure n = 10	P
Age (years)	54.8 ± 11.0	53.7 ± 9.5	0.76
Sex (male/female)	65/5	10/0	0.86
History of AF (years)	6.5 ± 5.3	4.7 ± 3.4	0.28
Duration of AF (months)	18.2 ± 20.3	10.9 ± 17.5	0.29
LAD (mm)	45.4 ± 3.4	46.0 ± 5.6	0.61
LVEF (%)	63.7 ± 7.3	63.9 ± 6.6	0.94
Number of AAD	1.9 ± 1.2	2.2 ± 1.1	0.50
Hypertension	32 (45.7%)	3 (30.0%)	0.55
Structural heart disease	2 (2.9%)	1 (10.0%)	0.82
MI length (mm)	30.3 ± 1.9	33.9 ± 1.6	<0.0001
MI depth (mm)	5.6 ± 1.2	6.8 ± 1.0	0.003
MI thickness (mm)	3.5 ± 0.6	3.6 ± 0.6	0.66
High take-off LIPV	7 (10.0%)	5 (50.0%)	0.005

MI = mitral isthmus; AF = atrial fibrillation; LAD = left atrial dimension; LVEF = left-ventricular ejection fraction; AAD = antiarrhythmic drug; LIPV = left inferior pulmonary vein.

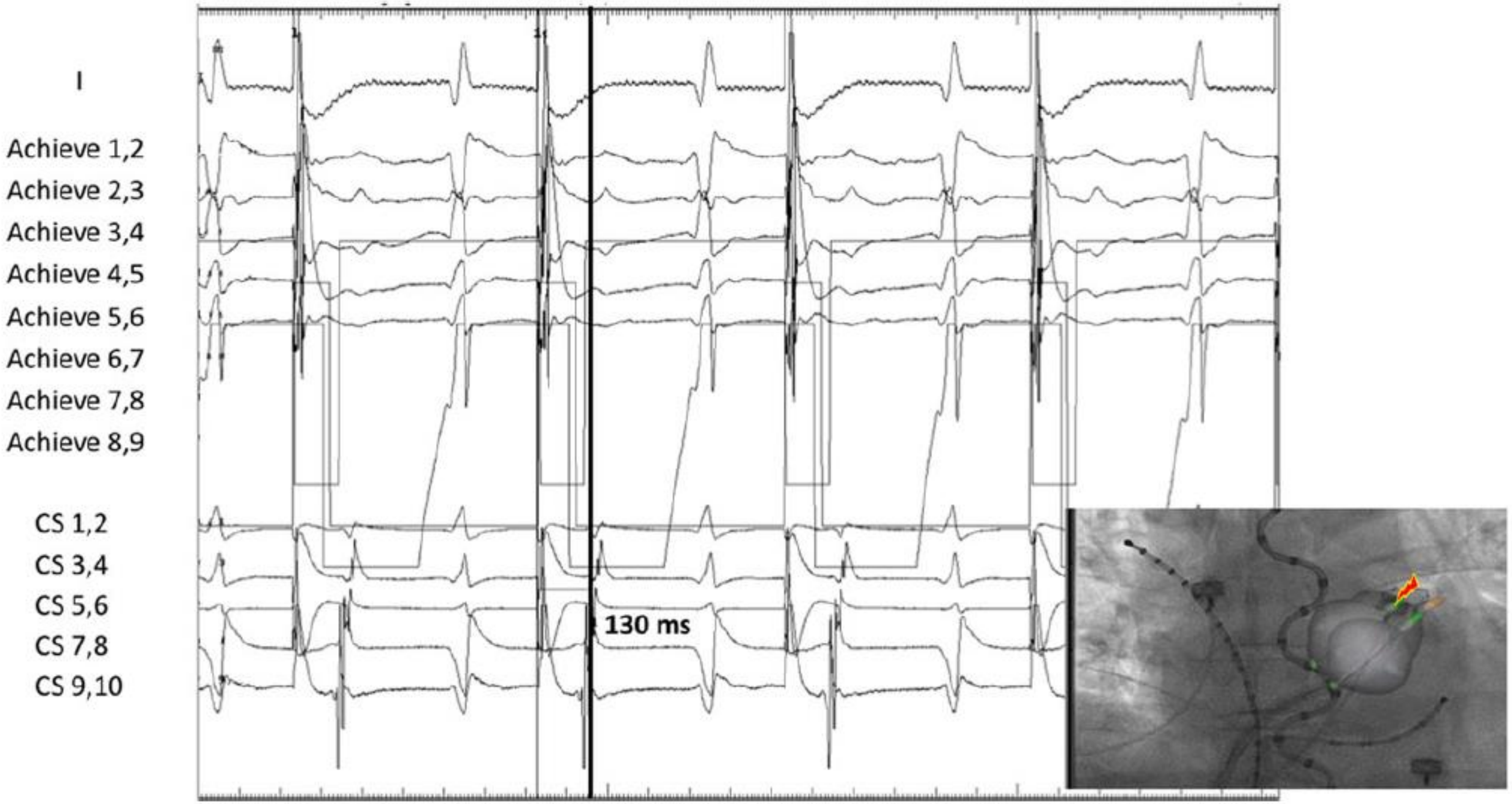
Balloon occlusion of the distal coronary sinus facilitates mitral isthmus ablation

- **Balloon occlusion of the CS during mitral isthmus ablation is feasible and safe. It significantly reduces ablation time and the need for CS ablation to achieve mitral isthmus block.**

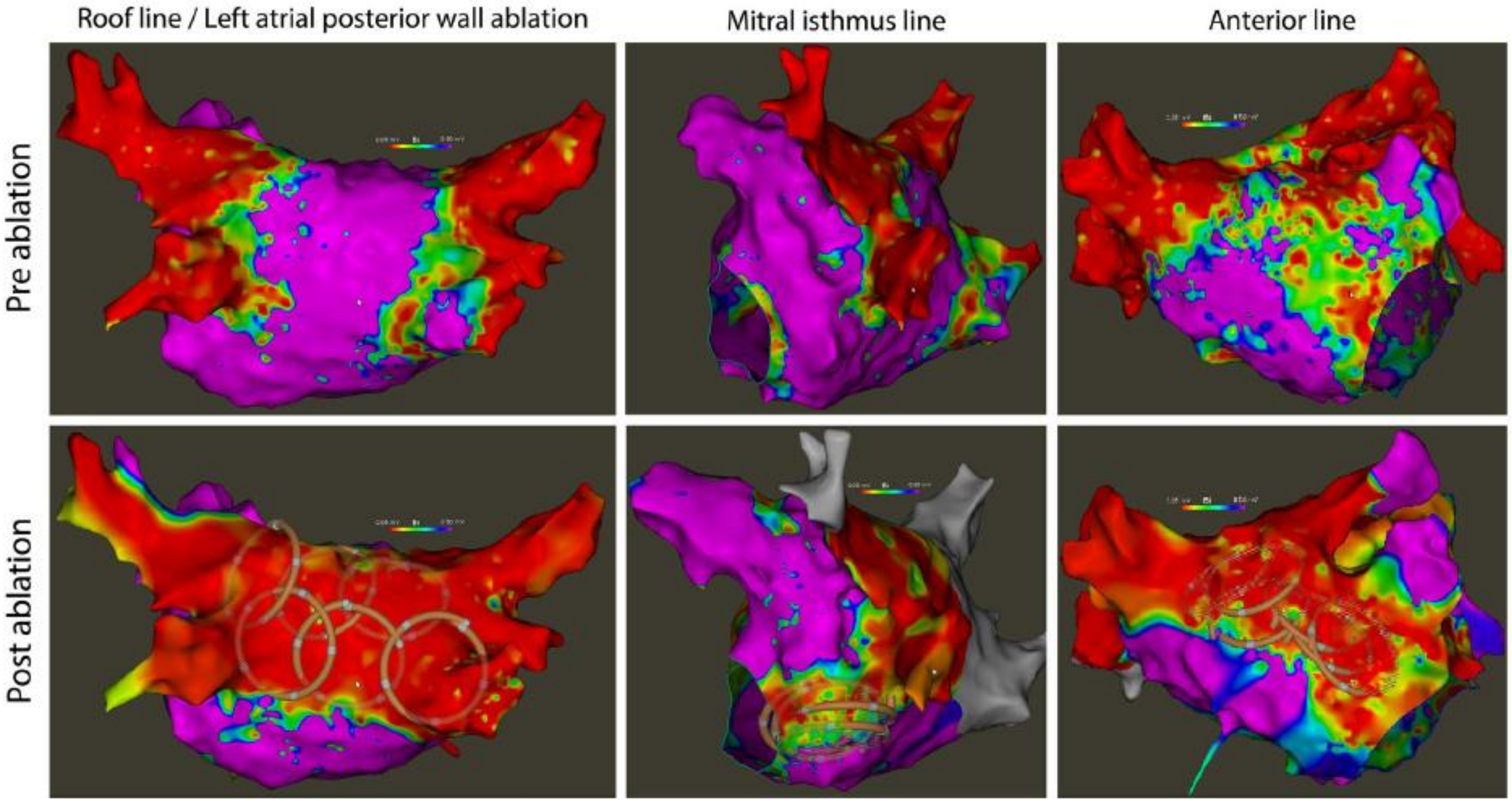
Table 2 Secondary analysis according to the treatment received

	CS occlusion (n = 20)	Control (n = 26)	*P* value
Patients with MI block	17 (85%)	24 (92%)	.43
End points			
Percentage of patients requiring ablation in CS for MI block	33% (6/17)	79% (19/24)	<.005
Mean MI procedure time (min)	21 ± 14	24 ± 15	.48
Mean total ablation time (min)	9.4 ± 5.5	13.3 ± 4.6	<.02
Mean CS ablation time (min)	1.5 ± 2.8	3.4 ± 2.7	.04
Mean time to position balloon successfully (min)	4 ± 1		
Ablation characteristics			
Mean impedance (endo)	114 ± 36	120 ± 33	.71
Mean impedance (CS)	141 ± 44	131 ± 49	.72
MI ablation @ 3 o'clock	10	13	1.0
MI block with first pass	3	2	.64
Patients needing higher ablation powers	2 (12%)	6 (25%)	.29
Electrophysiological characteristics			
Baseline: LAA to CSd (ms)	82 ± 22	81 ± 23	.86
Baseline: LAA to CSp (ms)	103 ± 21	98 ± 19	.54
Post MI block: LAA to CSd (ms)	135 ± 25	134 ± 31	.92
Post MI block: LAA to CSp (ms)	103 ± 22	98 ± 22	.55
Patients with no MI block	3 (15%)	2 (8%)	.64
Mean total ablation time (min)	21.6 ± 3.0	22.5 ± 3.3	.79
Mean CS ablation time (min)	8.6 ± 2.4	5.5 ± 0.7	.19
Mean MI procedure time (min)	49 ± 17	51 ± 1	.93

Case report: Cryoballoon ablation of the mitral isthmus using a novel mapping system



Pulsed-field ablation for the treatment of left atrial reentry tachycardia



Thank you for your attention