ELECTRA

5-6 DÉCEMBRE 2024

HOTEL VILLA MASSALIA,
MARSEILLE I FRANCE

18èmes journées françaises
pratiques de rythmologie
& de stimulation cardiaque

2004 - 2024
20 ans
ELECTRA

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Stratégies d'ablation de la FA persistante: Plan-MARSHALL

N Derval

Bordeaux

L'INSTITUT DE RYTHMOLOGIE
ET MODÉLISATION CARDIAQUE
BORDEAUX

CHU BDX
CENTRE HOSPITALIER UNIVERSITAIRE BORDEAUX

DISCLOSURES

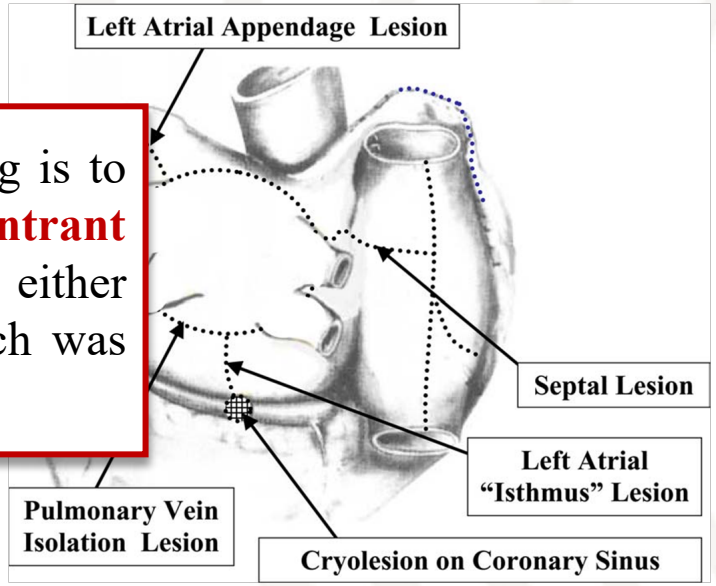
- Consulting and lecture fees from Biosense Webster
- Study Grant (IIS) from Biosense Webster

ANATOMICAL APPROACH

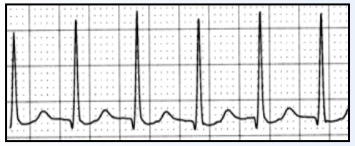
hope that a map-guided surgical procedure could be developed for the treatment of the entire spectrum of these arrhythmias. The electrophysiologic data suggested that atrial fibrillation might have the same relationship to atri
ular fibrillation has to ventricular tachyca
types of atrial fibrillation might be prece
during which the entire atrium is drive
wave" that degenerates into the multiple
tic of atrial fibrillation. Much as ventricu
prevented by surgical procedures directe
lar tachycardia, we thought it possible
might be prevented by surgical procedur
atrial flutter. We still are not certain wh
tionship exists between atrial flutter and atrial fibrillation. However, if this hypothesis proves to be true in the future, intraoperative mapping of atrial flutter might eventually be used

to guide surgical intervention. However, our present studies indicate that once complex atrial fibrillation caused by multiple reentrant flutter waves has developed, the changing patterns of
for atrial macroreentrant circuits that have been identified by intraoperative mapping either experimentally or clinically, and our eventual surgical approach was based on this principle. The

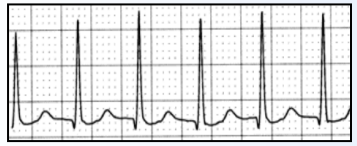
… perhaps the only way to prevent the atrium from fibrillating is to **interrupt *all* of the potential pathways for atrial macroreentrant circuits** that have been identified by intraoperative mapping either experimentally or clinically, and our eventual surgical approach was based on this principle…



Cox J of Thoracic and Cardiovascular surgery 1991

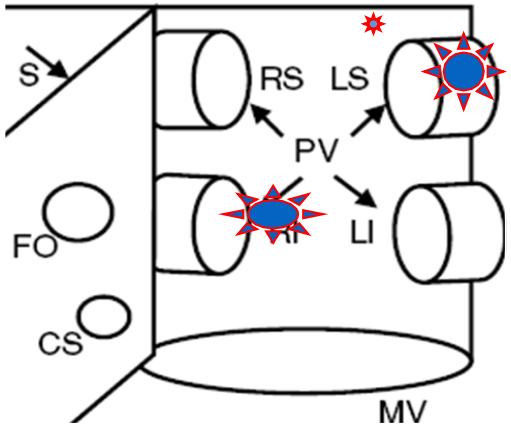


SVT



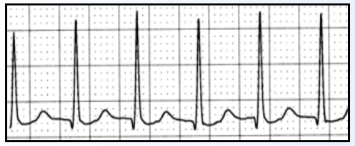
SVT

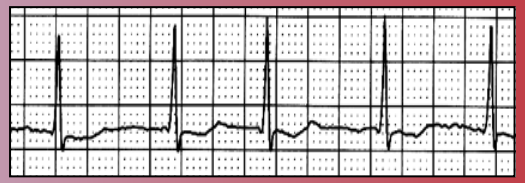
Parox AF



Trigger to "**start-up**"

Induction phase

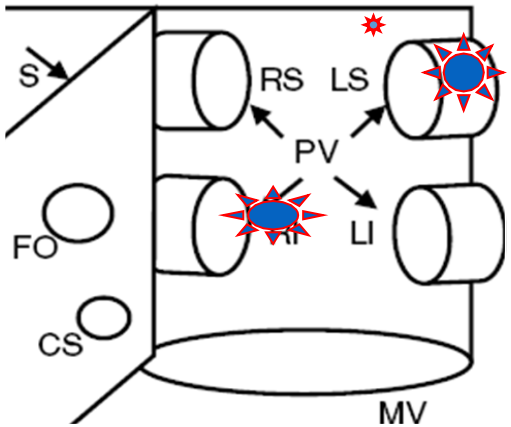


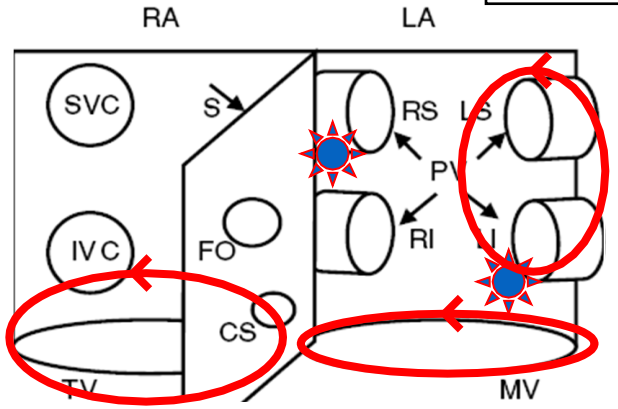


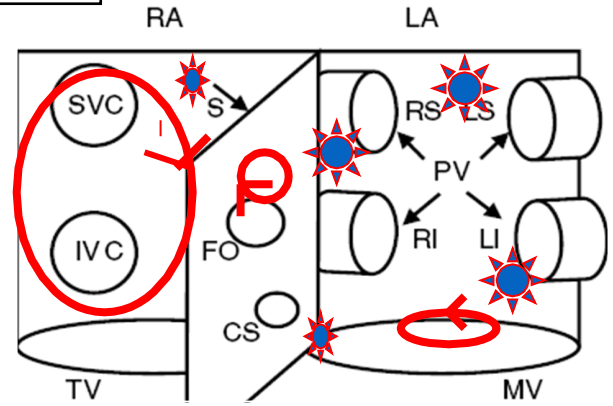
SVT

Parox AF

Persistent AF



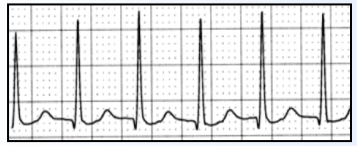


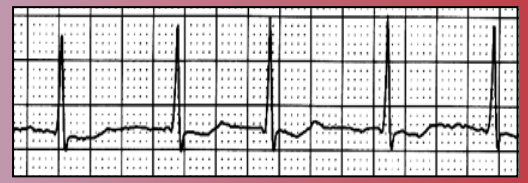


Trigger to "**start-up**"
Induction phase

Primer to "**warm-up**"
Escalation phase

Driver to "**keep-up**"
Perpetuation phase

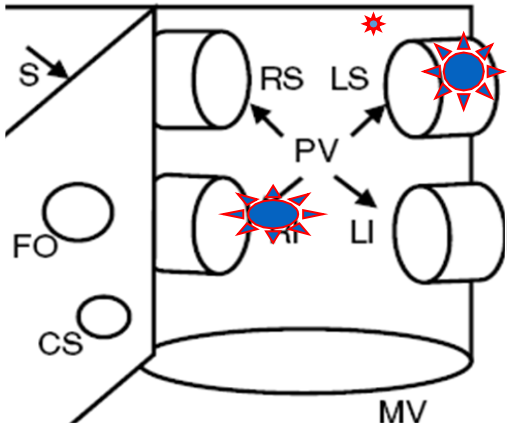


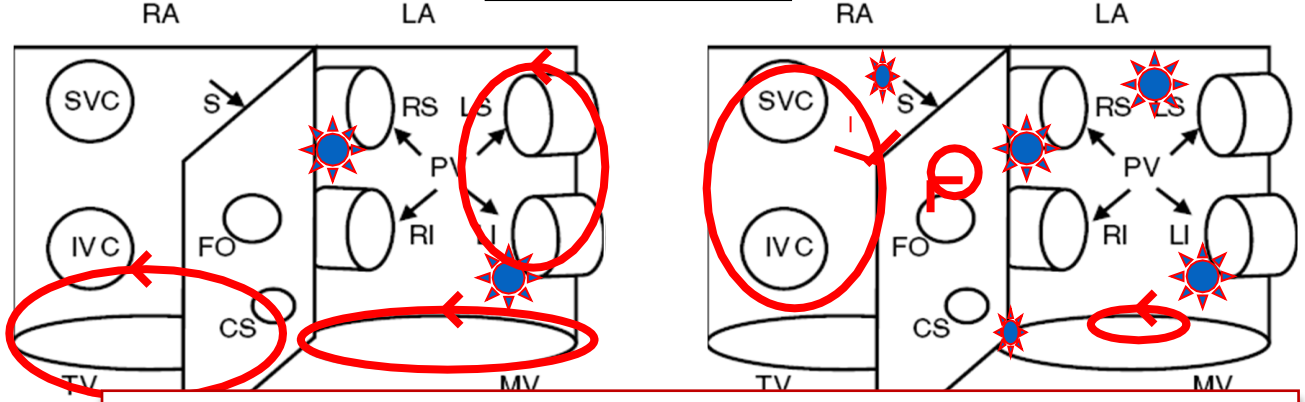


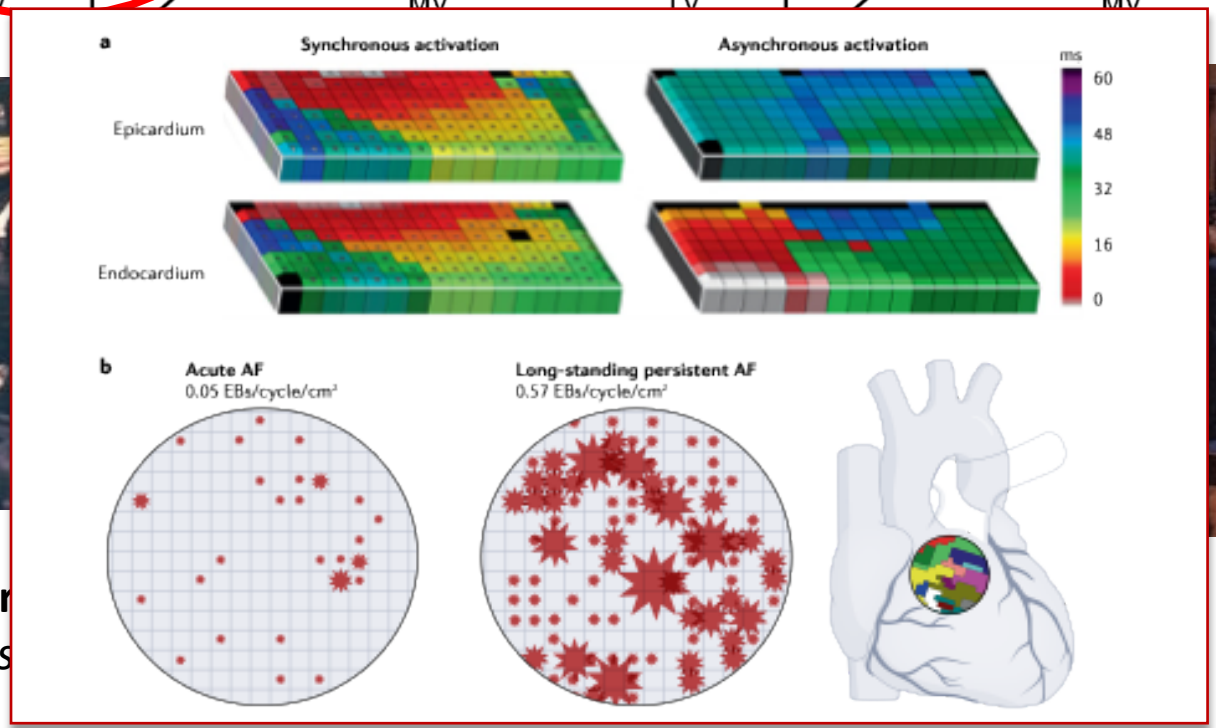
SVT

Parox AF

Persistent AF

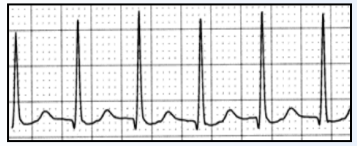


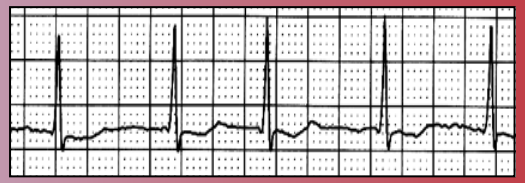




Trigger to "**start-up**"
Induction phase

Pr
Es

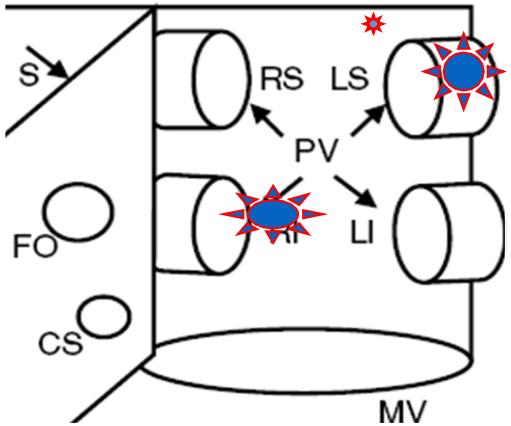


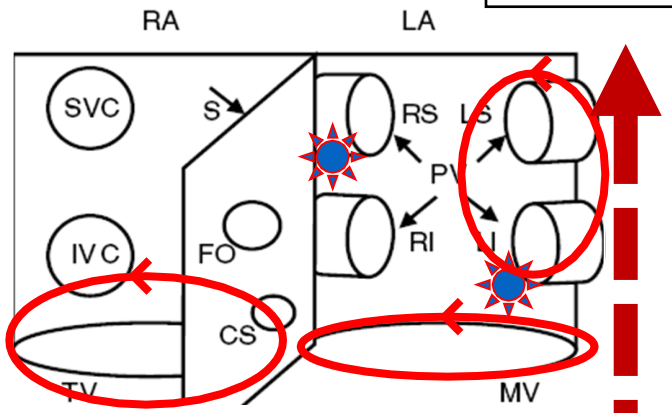


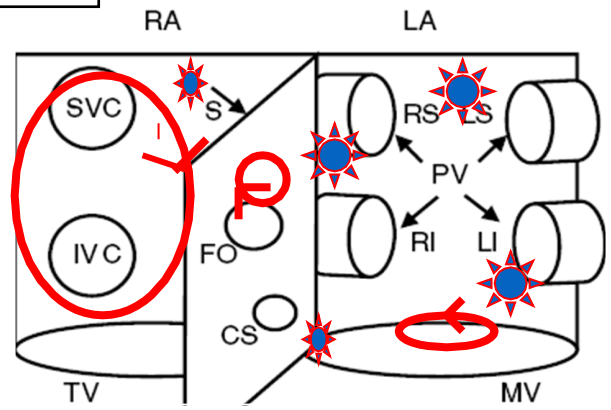
SVT

Parox AF

Persistent AF







Anatomical approach target the main persistent AF "primers"

PLAN-MARSHALL STRATEGY

Journal of Cardiovascular Electrophysiology

ORIGINAL ARTICLE | Full Access

MARSHALL bundles elimination, Pulmonary veins isolation and Lines completion for ANatomical ablation of persistent atrial fibrillation: MARSHALL-PLAN case series

Thomas Pambrun MD, Arnaud Denis MD, Josselin Duchateau MD, Frédéric Sacher MD, PhD, Mélèze Hocini MD, Pierre Jaïs MD, PhD, Michel Haïssaguerre MD, Nicolas Derval MD

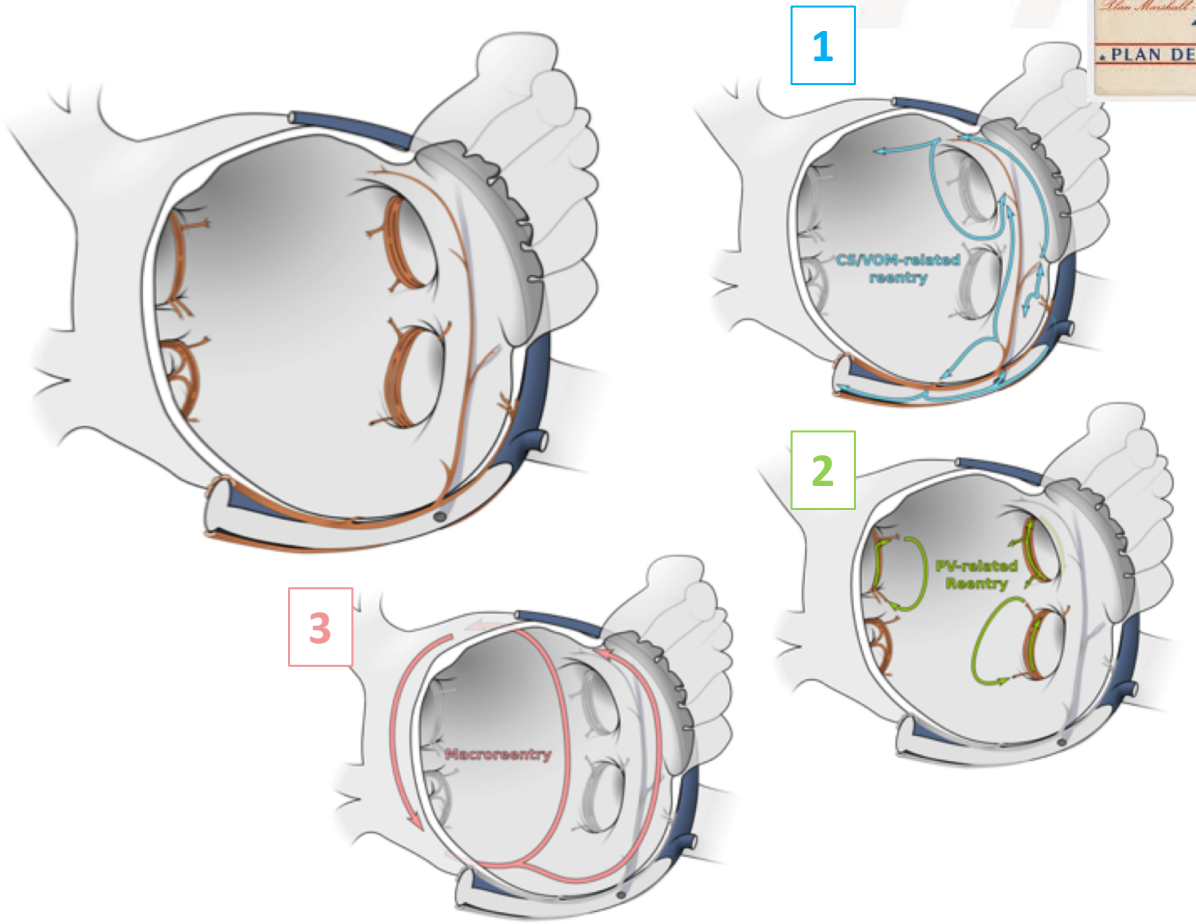
First published: 21 November 2018 | https://doi.org/10.1111/jce.13797

HeartRhythm

Marshall bundle elimination, Pulmonary vein isolation, and Line completion for ANatomical ablation of persistent atrial fibrillation (Marshall-PLAN): Prospective, single-center study

Nicolas Derval, MD,*† Josselin Duchateau, MD, PhD,*†‡ Arnaud Denis, MD,*† F. Daniel Ramirez, MD,*† Saagar Mahida, MD,§ Clémentine André, MD,*† Philipp Krisai, MD,*† Yosuke Nakatani, MD,*† Takeshi Kitamura, MD,*† Masateru Takigawa, MD,*† Remi Chauvel, MD,*† Romain Tixier, MD,*† Xavier Pillois, PhD,*†‡ Frédéric Sacher, MD, PhD,*†‡ Mélèze Hocini, MD,*†‡ Michel Haïssaguerre, MD,*†‡ Pierre Jaïs, MD, PhD,*†‡ Thomas Pambrun, MD*†

ATRIAL BODY MYOCARDIUM + ADJACENT VENOUS MUSCULATURE



- **Target**: Muscular network highly propitious for reentry

- **Endpoint**: complete lesion set

PLAN-MARSHALL STRATEGY

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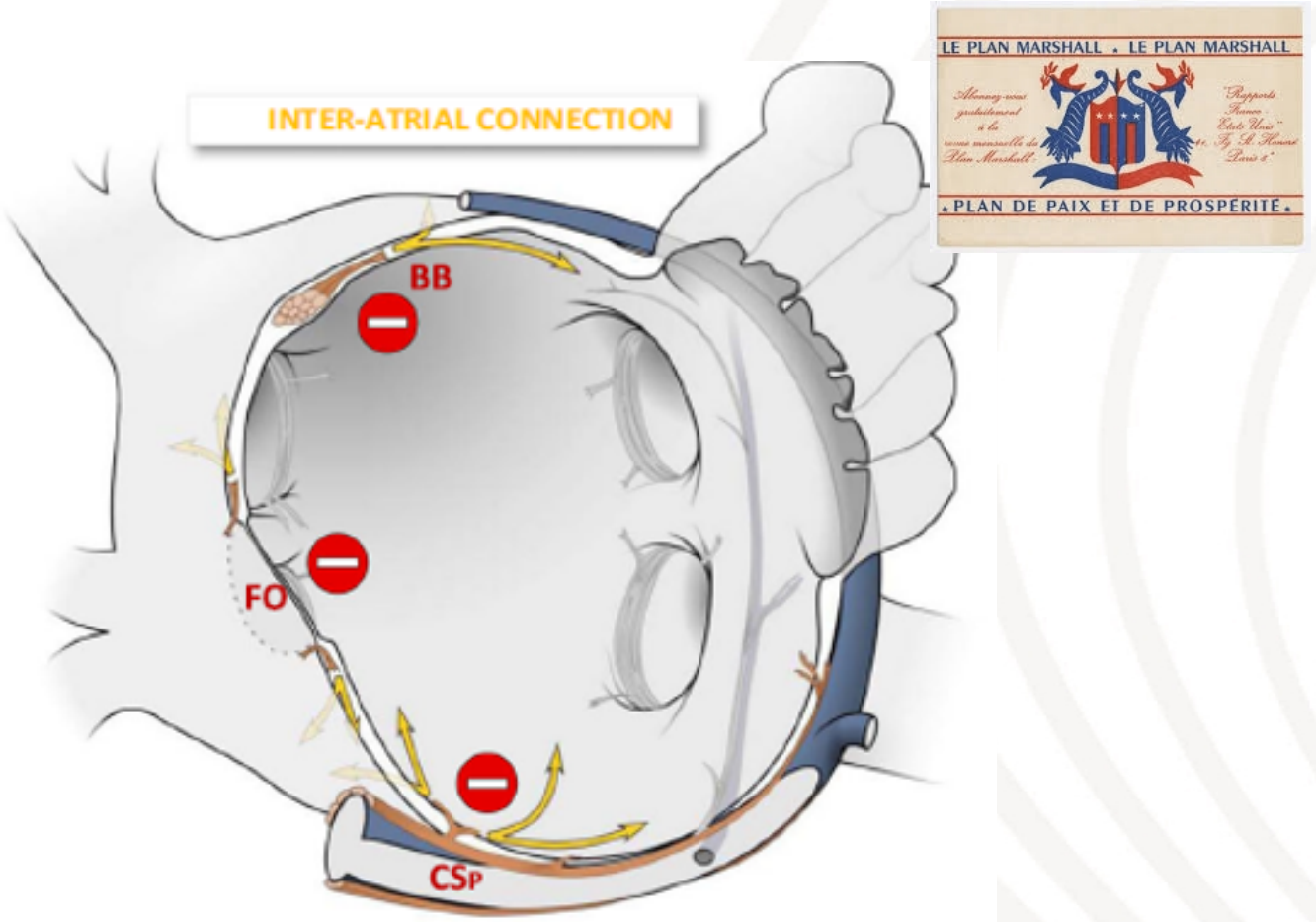

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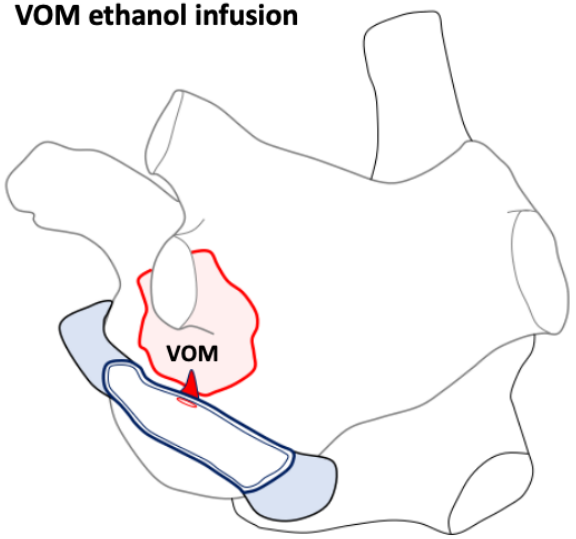
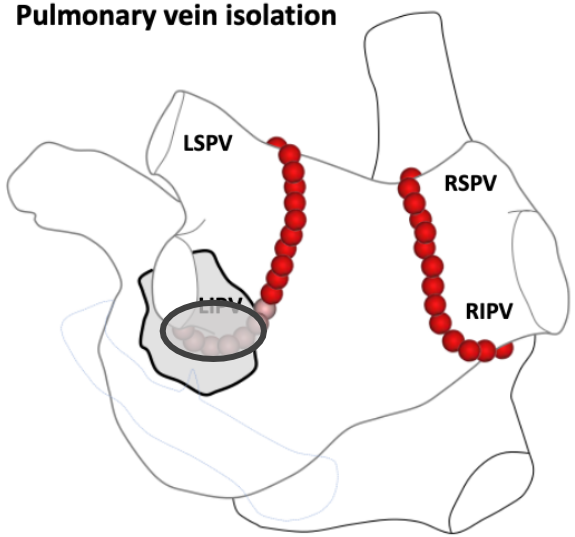
SPARING Inter-Atrial Connections

PLAN-MARSHALL STRATEGY

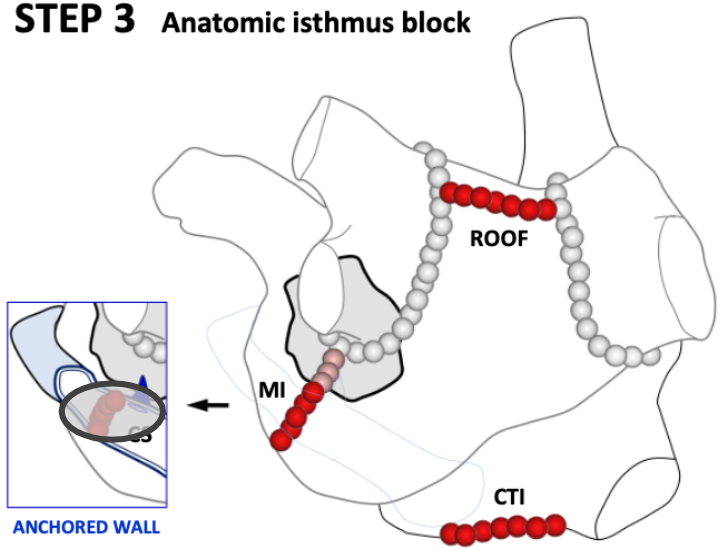
STEP 1 VOM ethanol infusion



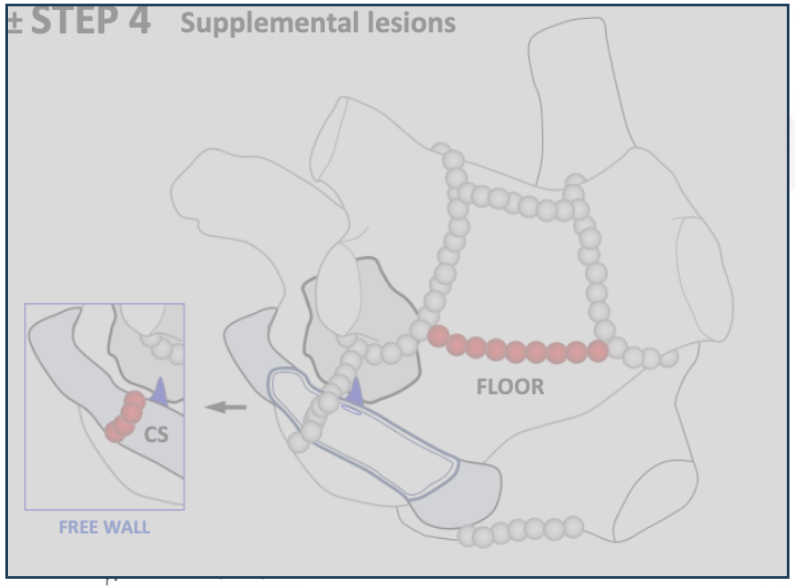
STEP 2 Pulmonary vein isolation



STEP 3 Anatomic isthmus block



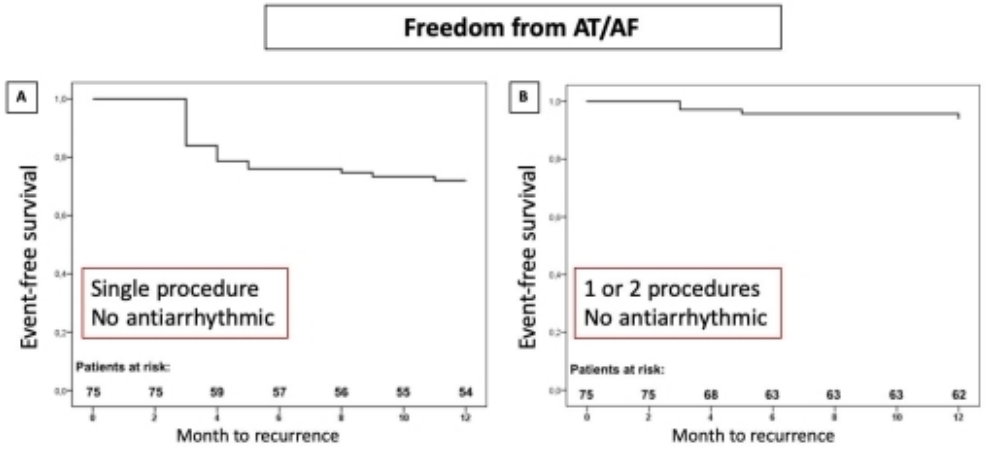
± STEP 4 Supplemental lesions



RESULTS OF "PLAN-MARSHALL" ABLATION

Prospective monocentric
75 patients with pers AF
VOM OH success rate: 92%

2020



Single procedure, off AAD, 12 m: **72%**

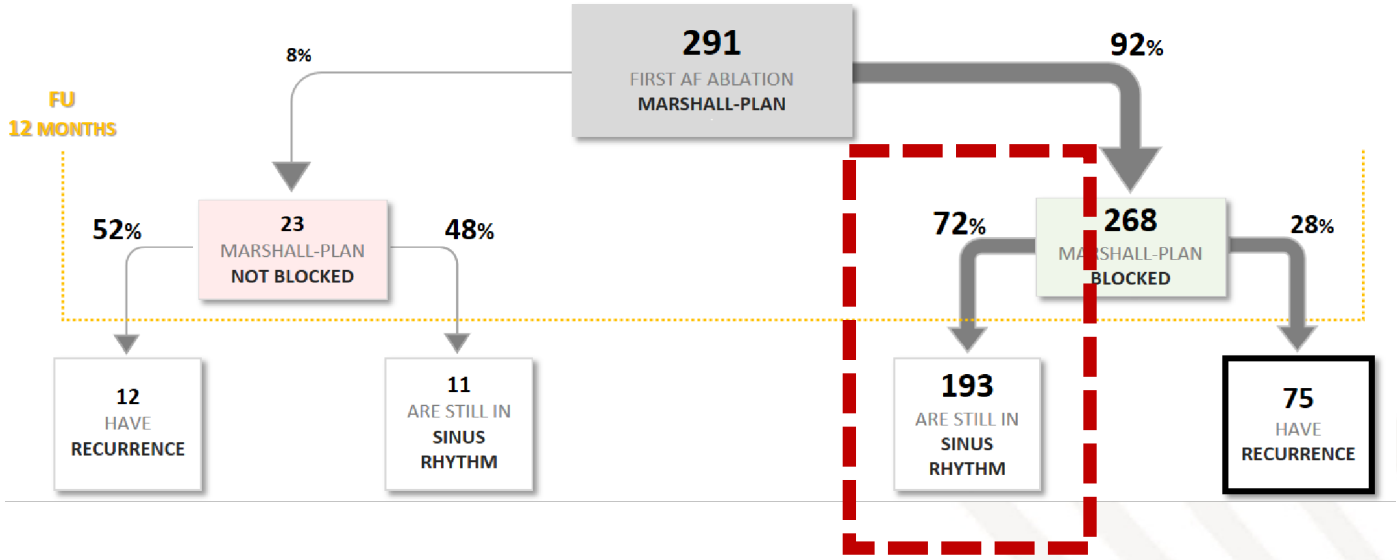
Single procedure, off AAD, 12m, VOM+: **79%**

Multiple procedure (1,28/pt), off AAD: **89%**

Derval et al. Heart Rhythm 2021

Retrospective monocentric
291 patients with pers AF
VOM success rate 97%

2022



Mean f/u 12±8months

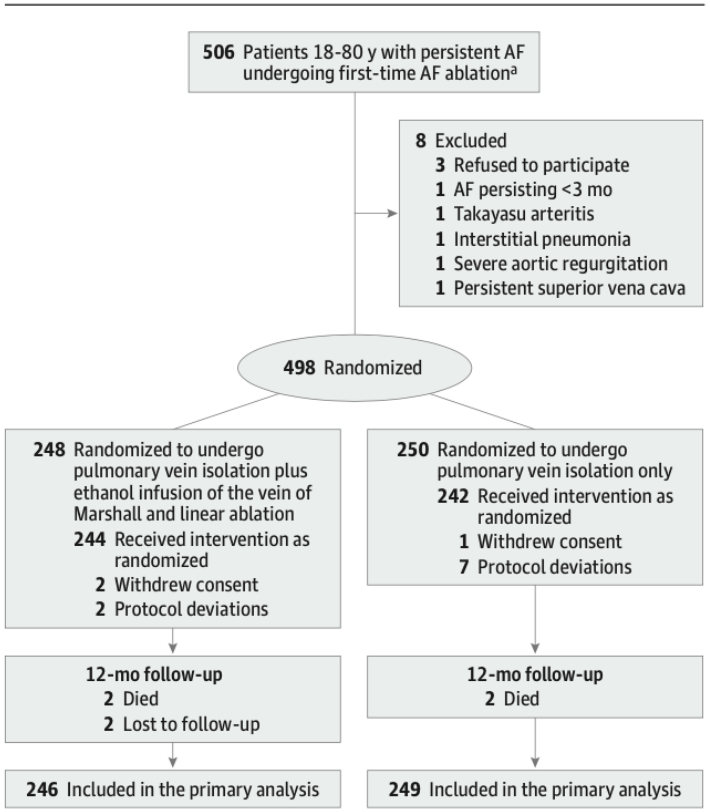
Takagi et al. Heart Rhythm 2022

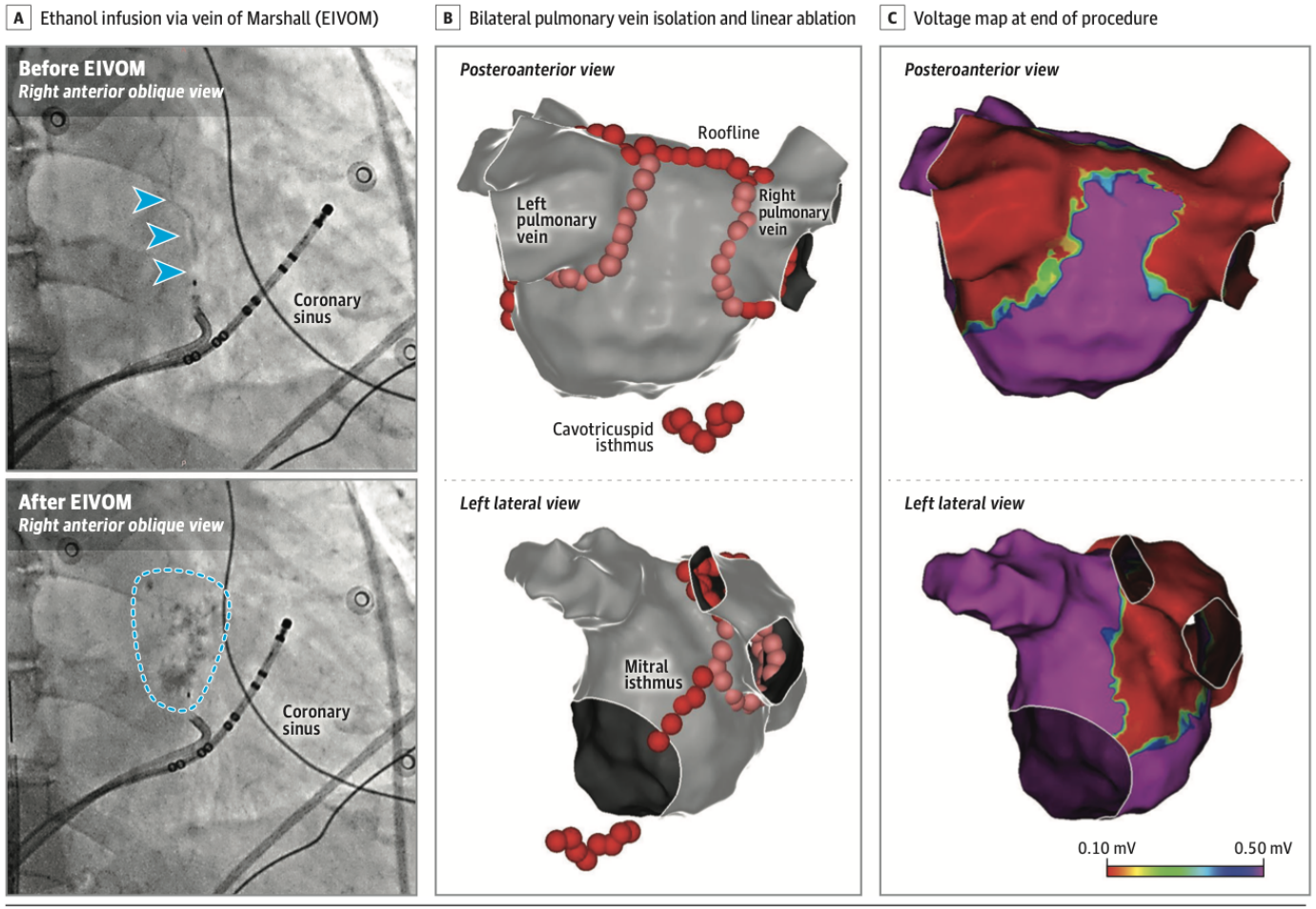
JAMA | Original Investigation

Pulmonary Vein Isolation With Optimized Linear Ablation vs Pulmonary Vein Isolation Alone for Persistent AF

The PROMPT-AF Randomized Clinical Trial

Caihua Sang, MD; Qiang Liu, MD; Yiwei Lai, MD; Shijun Xia, MD; Ruhong Jiang, MD; Songnan Li, MD; Qi Guo, MD; Qifan Li, MD; Mingyang Gao, MD; Xueyuan Guo, MD; Lihong Huang, MD; Nian Liu, MD; Chenxi Jiang, MD; Song Zuo, MD; Xiaoxia Liu, MD; Mengmeng Li, MD; Weili Ge, MD; Shangming Song, MD; Lianghua Chen, MD; Shuanglun Xie, MD; Jiangang Zou, MD; Ke Chen, MD; Xiangfei Liu, MD; Hesheng Hu, MD; Xinhua Wang, MD; Jinlin Zhang, MD; Zhaojun Wang, MD; Chi Wang, MPH; Liu He, PhD; Chao Jiang, MD; Ribo Tang, MD; Ning Zhou, MD; Yunlong Wang, MD; Deyong Long, MD; Xin Du, MD; Chenyang Jiang, MD; Laurent Macle, MD; Jianzeng Dong, MD; Changsheng Ma, MD; for the PROMPT-AF investigators





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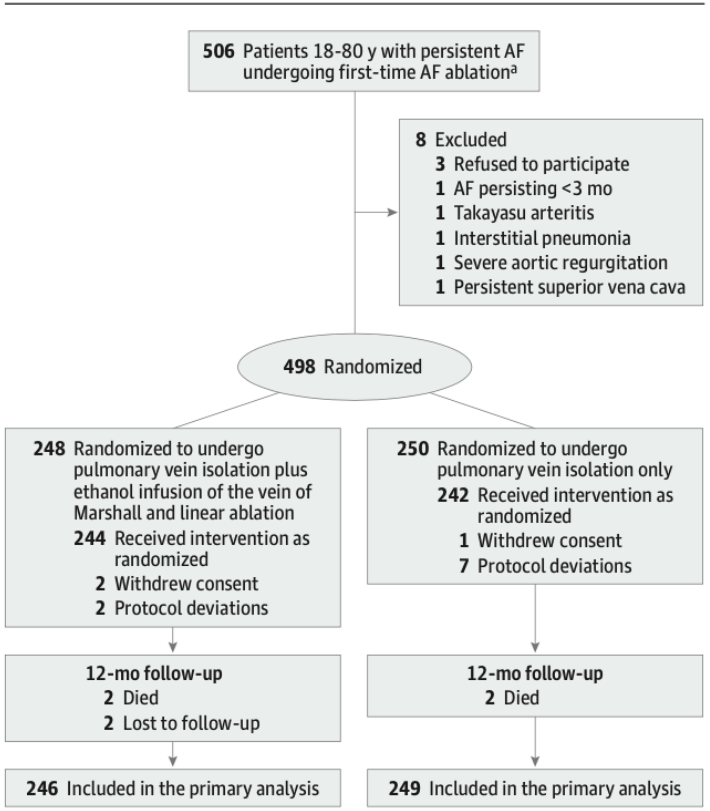
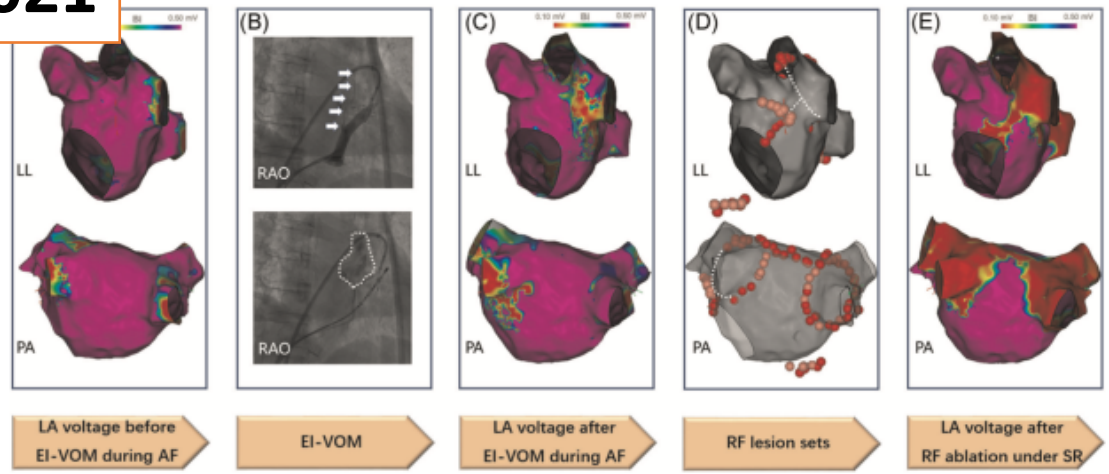
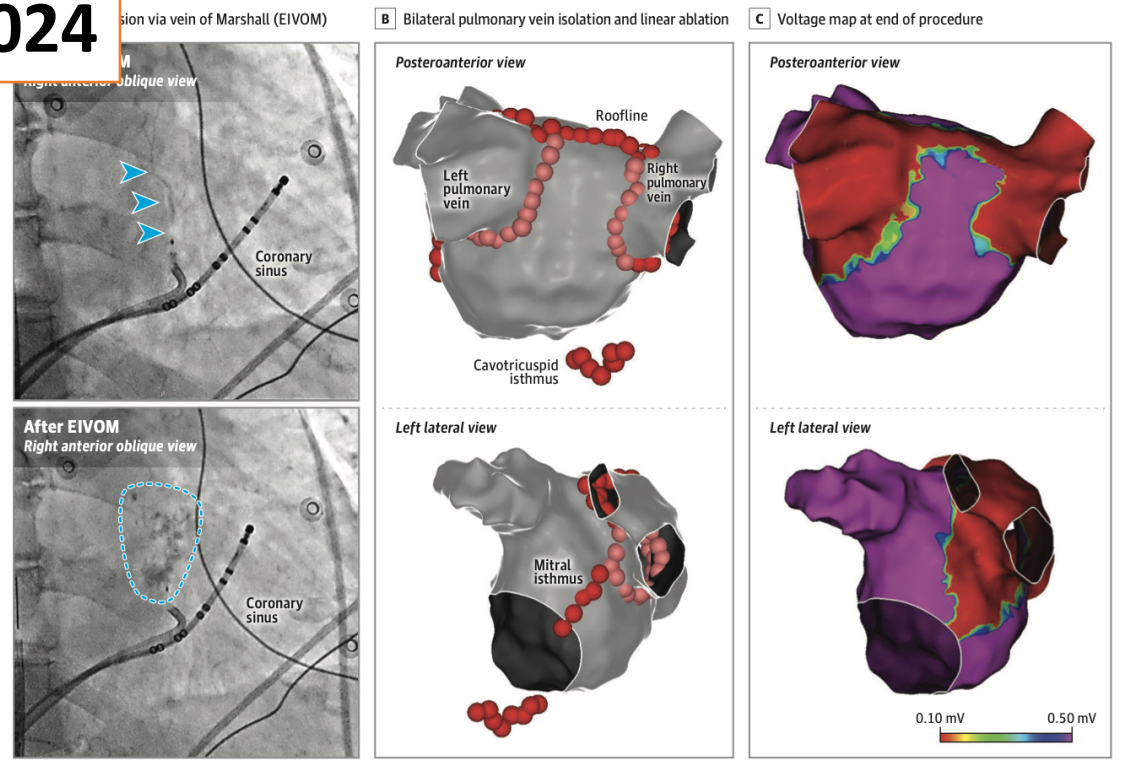
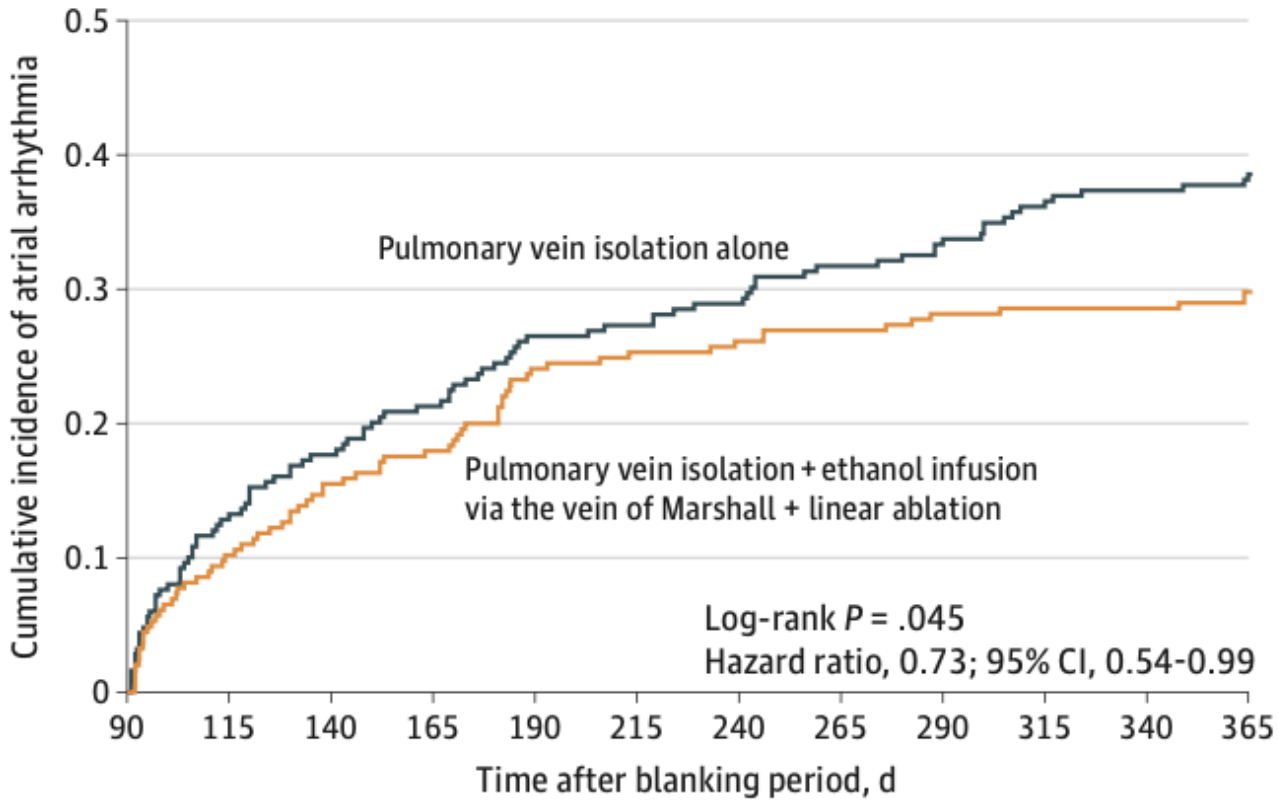


2021



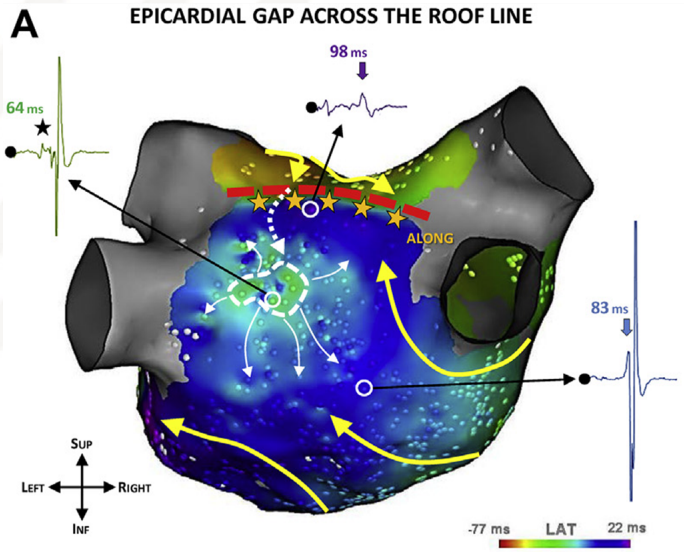
2024

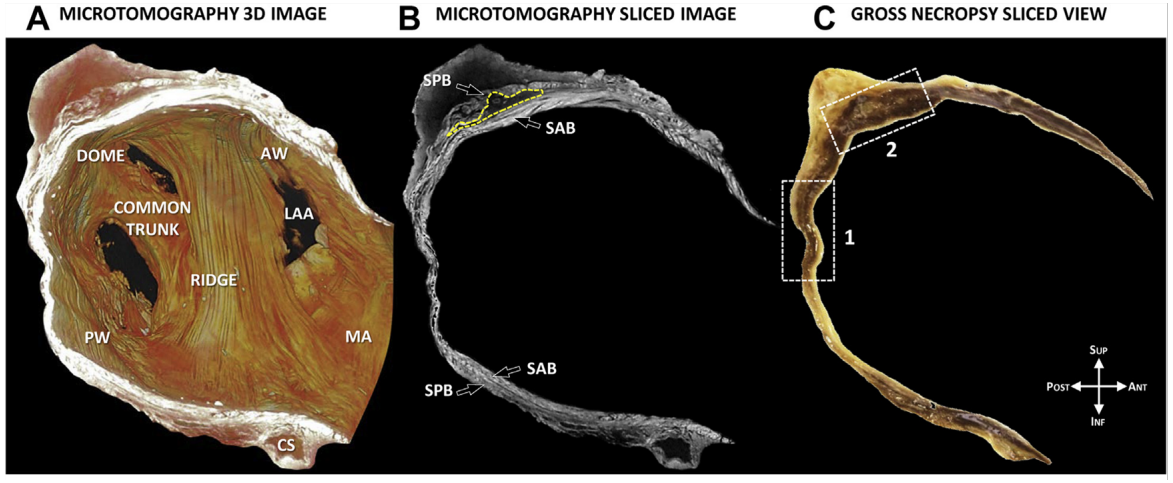




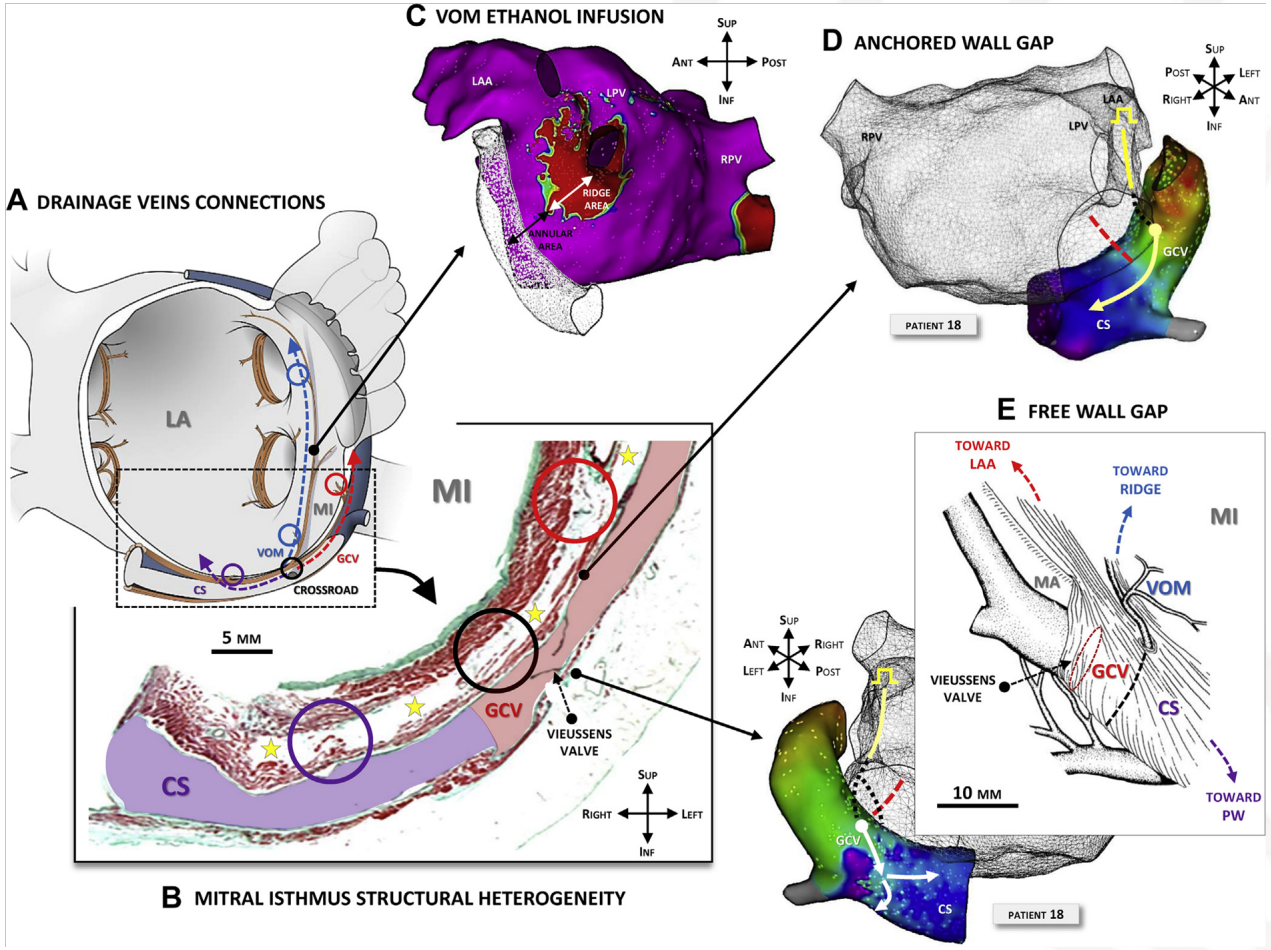
Cumulative No.												
Pulmonary vein isolation + ethanol infusion via the vein of Marshall + linear ablation												
Event	0	25	38	44	59	62	64	66	69	70	70	72
Death	0	0	0	0	0	0	0	0	0	0	0	2
Atrial fibrillation	0	23	36	41	47	50	51	53	56	56	57	58
Redo procedure	0	1	5	6	7	8	9	10	10	10	11	11
Pulmonary vein isolation alone												
Event	0	33	44	53	66	68	72	79	84	91	93	96
Death	0	0	0	0	0	1	2	2	2	2	2	2
Atrial fibrillation	0	27	34	42	48	49	54	62	64	70	74	75
Redo procedure	0	7	7	9	9	9	10	16	17	17	18	20

Epicardial course of the septopulmonary bundle: Anatomical considerations and clinical implications for roof line completion





Epicardial course of the musculature related to the great cardiac vein: Anatomical considerations and clinical implications for mitral isthmus block after vein of Marshall ethanol infusion

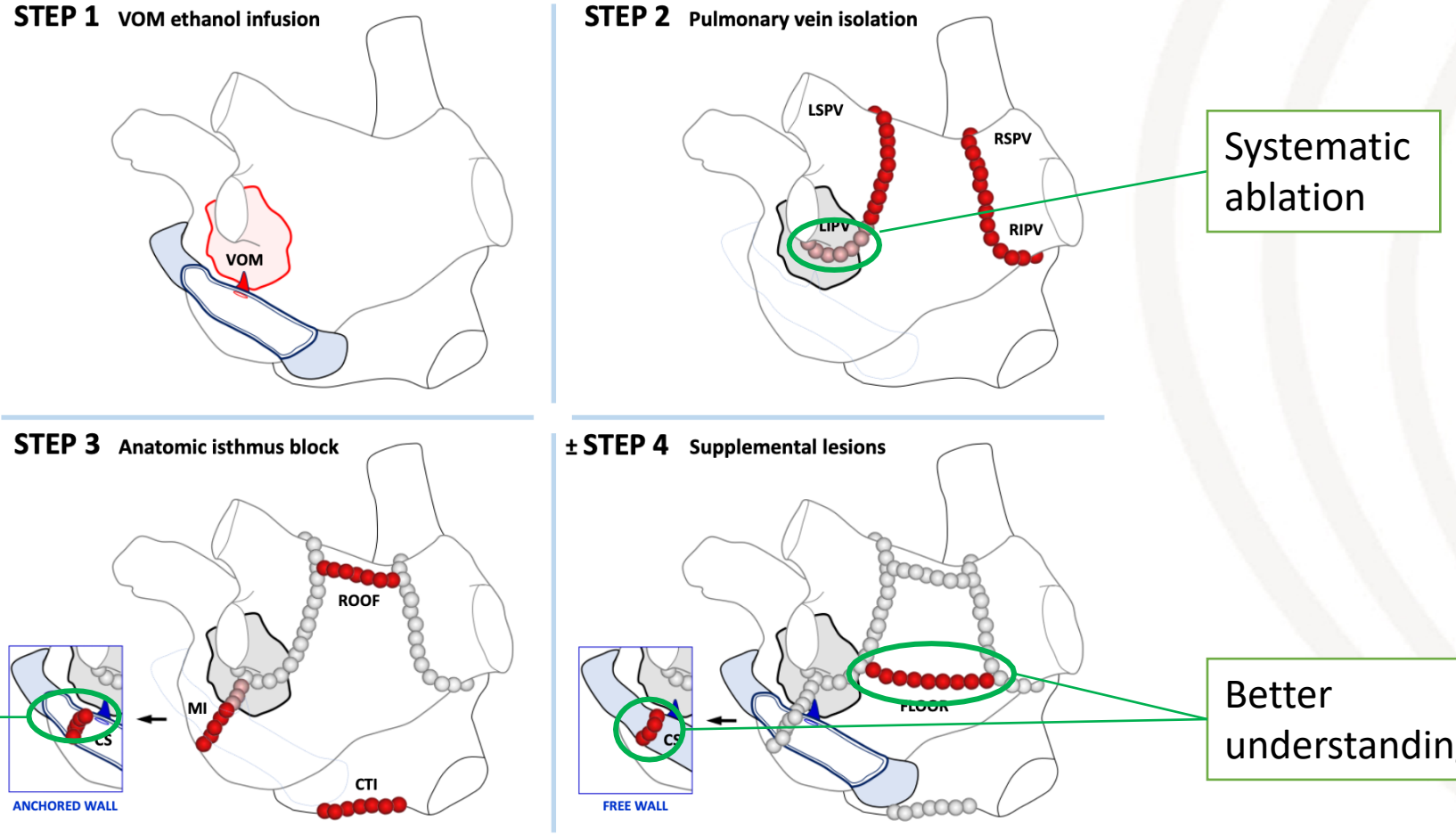


Pambrun et al. Heart Rhythm 2021

HeartRhythm

PLAN-MARSHALL STRATEGY

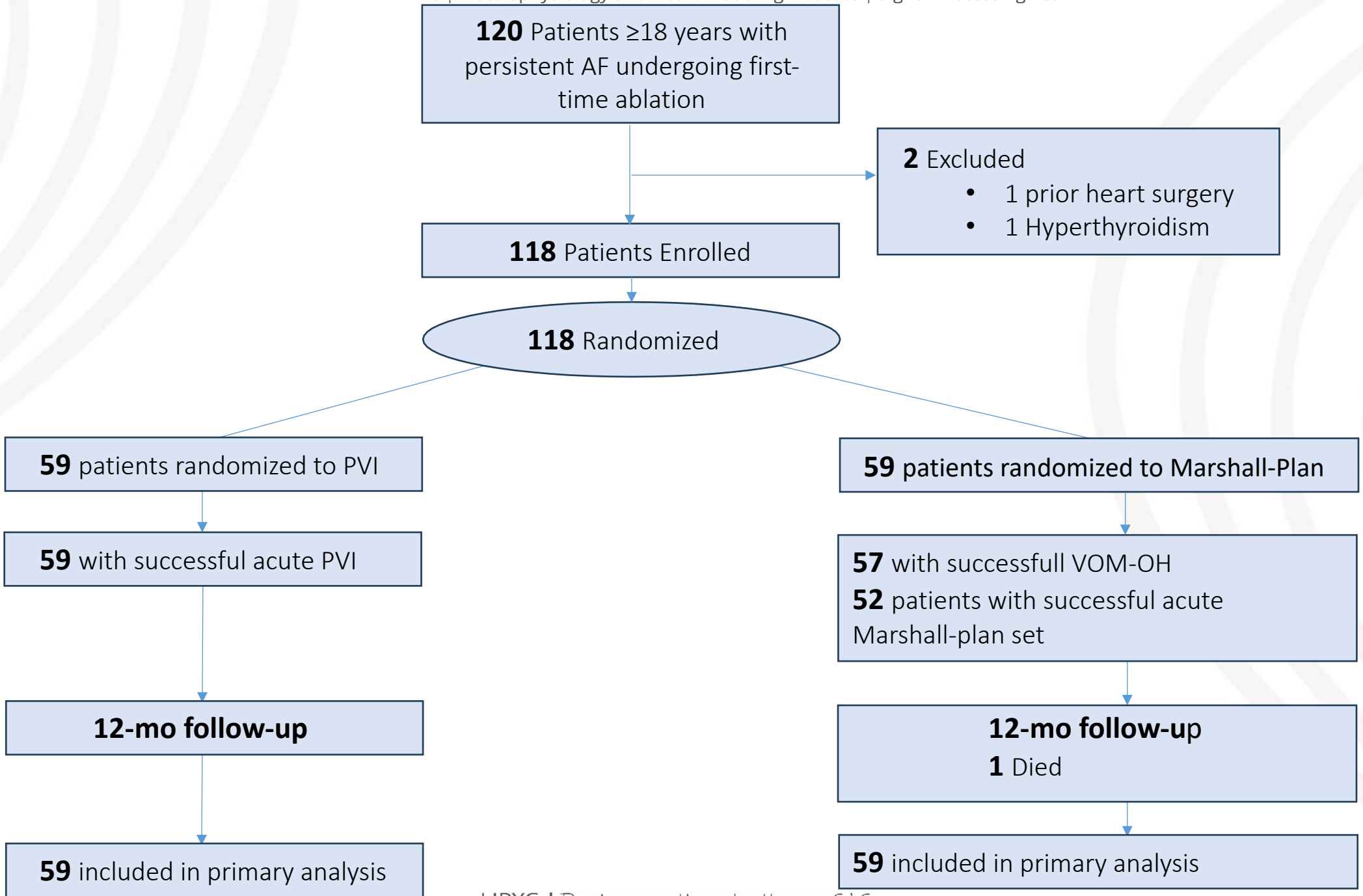
↗ success rate
↘ dissection



Systematic ablation

Systematic ablation

Better understanding


120 Patients ≥18 years with persistent AF undergoing first-time ablation
2 Excluded
• 1 prior heart surgery
• 1 Hyperthyroidism
118 Patients Enrolled
118 Randomized
59 patients randomized to PVI
59 with successful acute PVI
12-mo follow-up
59 included in primary analysis
59 patients randomized to Marshall-Plan
57 with successfull VOM-OH
52 patients with successful acute Marshall-plan set
12-mo follow-up
1 Died
59 included in primary analysis

RESULTS

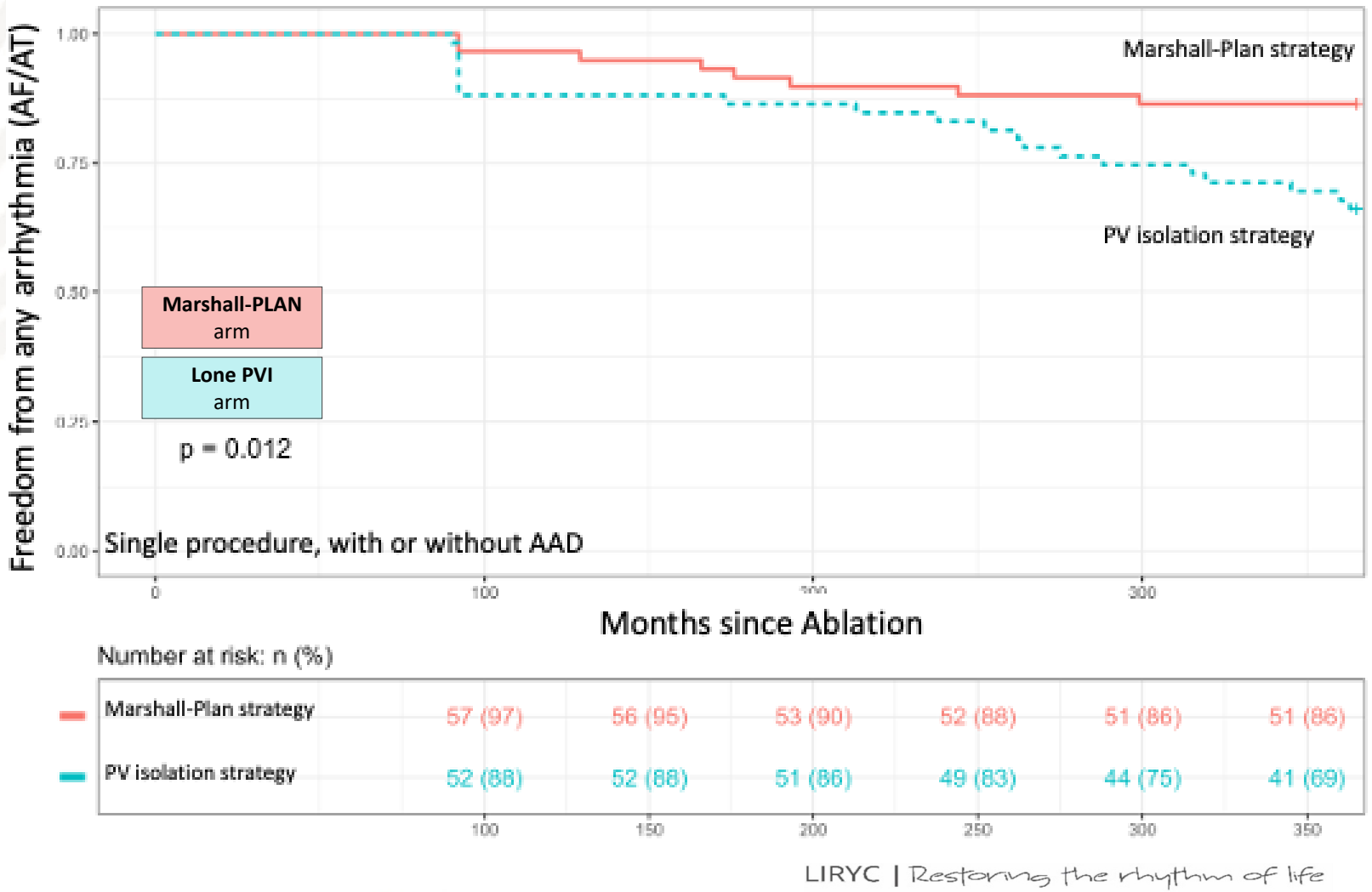
Characteristics	Marshall-Plan N=60	PV Isolation N=60	p-value
Demographics			
Age (y)	66±8	65±8	0.21
Gender			0.47
F	12 (20%)	9 (15%)	
M	48 (80%)	51 (85%)	
CHA_2DS_2-Vasc	2±1	2±1	0.04
Hypertension	36 (60%)	25 (42%)	0.04
Diabetes	9 (15%)	3 (5%)	0.07
Previous Stroke	5 (8.3%)	2 (3.3%)	0.44
History of Amiodarone	54 (90%)	49 (82%)	0.19
LVEF (%)	51±12	56±10	0.12
SHD	6 (10%)	6 (10%)	0.99
AF Characteristics			
Maximum AF length (m)	10±18	7±6	0.86
Current AF length (m)	9±19	6±7	0.77
Long-standing AF>1y	11 (18%)	11 (18%)	1.00
History of DCC	1±1	1±1	0.32
Rhythm at inclusion			0.19
AF	32 (53%)	39 (65%)	
SR	28 (47%)	21 (35%)	
Left atrial volume (ml)	187±53	192±53	0.31

	Marshall-Plan N=59	PV isolation N=59	p-value
Rhythm in EP lab			0 .19
AF	32 (54%)	39 (66%)	
SR	27 (46%)	20 (34%)	
LAA cycle length (if AF) (ms)	206±138	176±26	0.88
LA volume (ml)	182±52	192±53	0.22
PVI	59	59	1.00
Total RF LPV (min)	9.5±4.3	13.0±3.7	0.001
Total RF RPV (min)	13.4±5.1	15.8±5.5	0.012
Total RF PVs (min)	23±8	29±8	0.001
VOM-OH	57 (97%)	-	-
OH volume (ml)	10±2	-	-
Time for OH (min)	22.5±15.4	-	-
Xray time for OH (min)	6.3±6±8	-	-
Mitral isthmus line attempt	56 (95%)	-	-
Mitral isthmus block (% per attempt; %total)	55 (98%; 93%)	-	-
RF mitral line (min)	7.2±6.2	-	-
Posterior wall line attempt	56 (95%)	-	-
Posterior wall block (% per attempt; %total)	54 (96%; 92%)	-	-
Roof line block (% per attempt; %total)	30 (54%; 51%)	-	-
RF roof line (min)	6.3±4.4	-	-
Floor line attempt	26 (46%)	-	-
Floor line block (% per attempt; %total)	24 (92%; 43%)	-	-
RF floor line (min)	4.8±2.6	-	-
CTI line attempt	56 (95%)	-	-
CTI line block(% per attempt; %total)	55 (93%; 98%)	-	-
RF CTI line (min)	5.9±4.5	-	-
AF termination	1 (2%)	3 (5%)	0.43
Ablation set complete	52 (88%)	59 (100%)	0.058
Total Procedure time (min)	157±53	125±31	0.001
Total RF time (min)	36.8±16.0	29.6±8.1	0.001
Total X-Ray time (min)	21±16	11±6	0.001

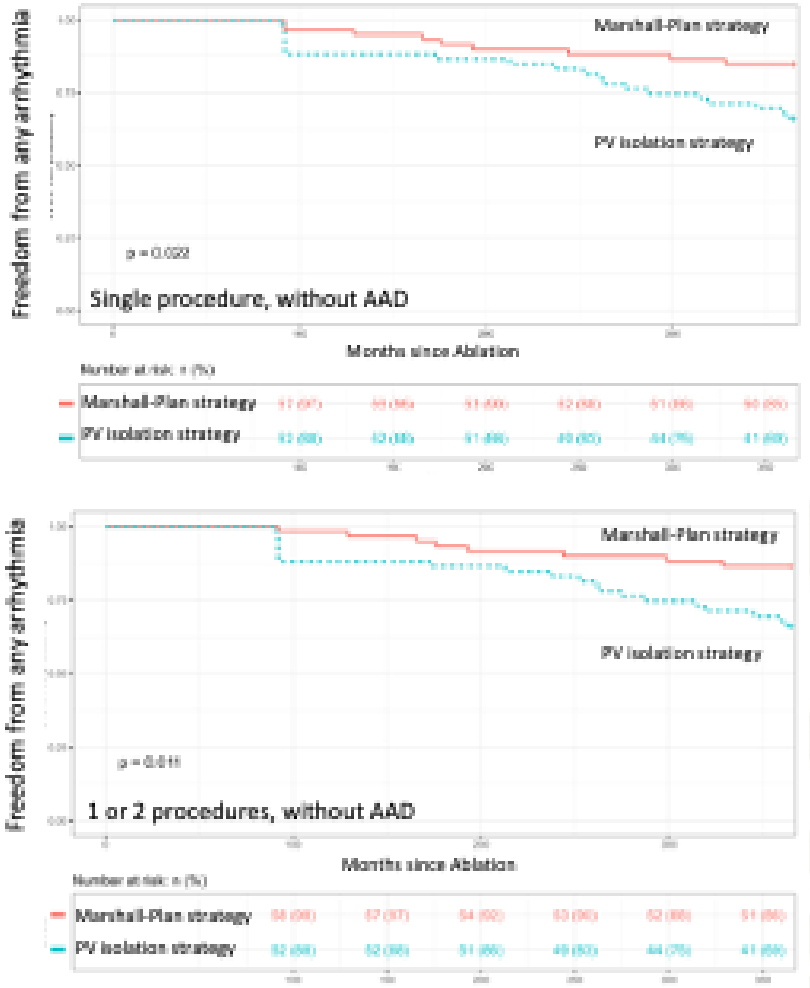
RESULTS

Intention-to-treat analysis

Primary Outcome

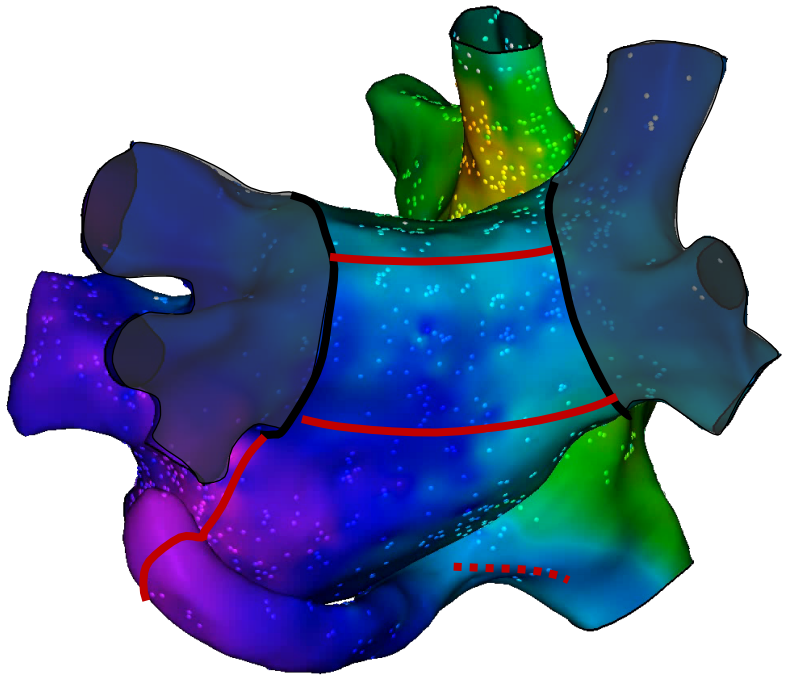


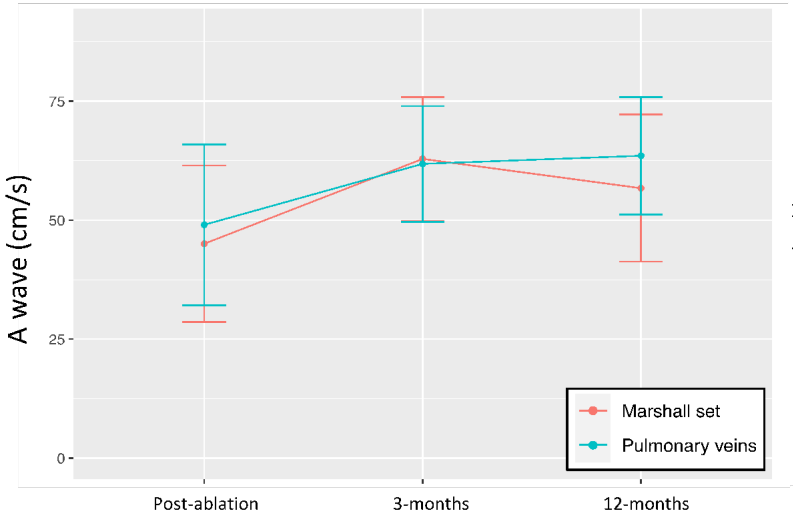
Secondary Outcome

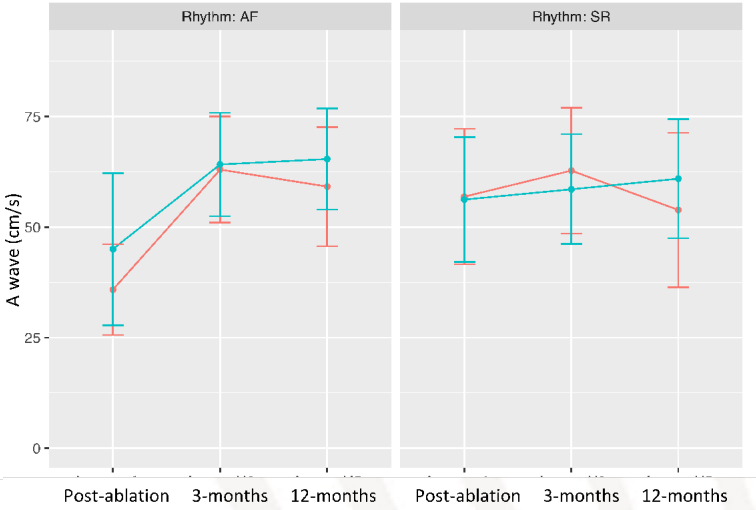


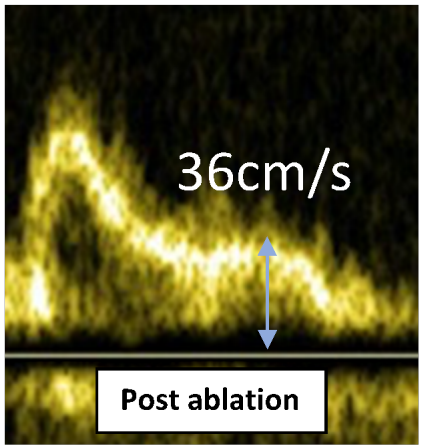
RESULTS

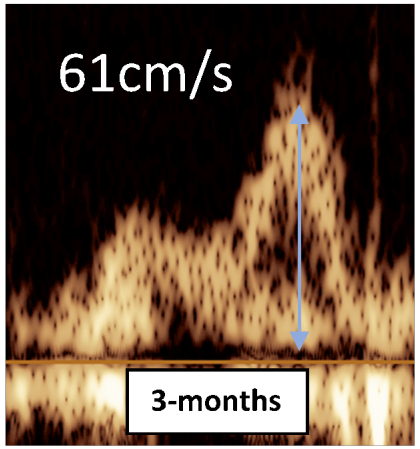
Preservation of LA function

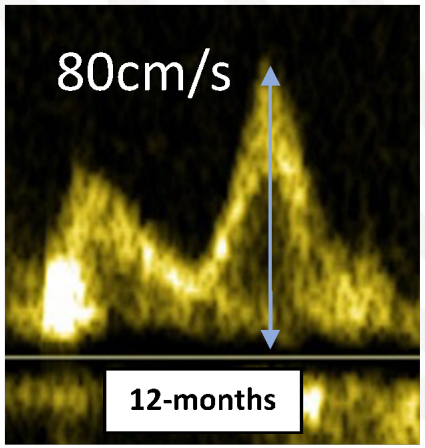




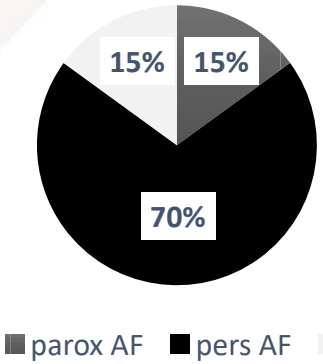
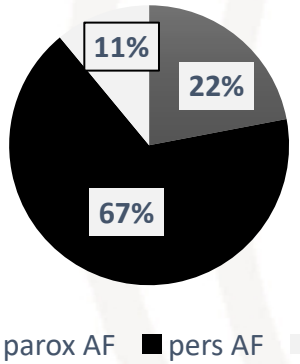








RESULTS: FOLLOW-UP

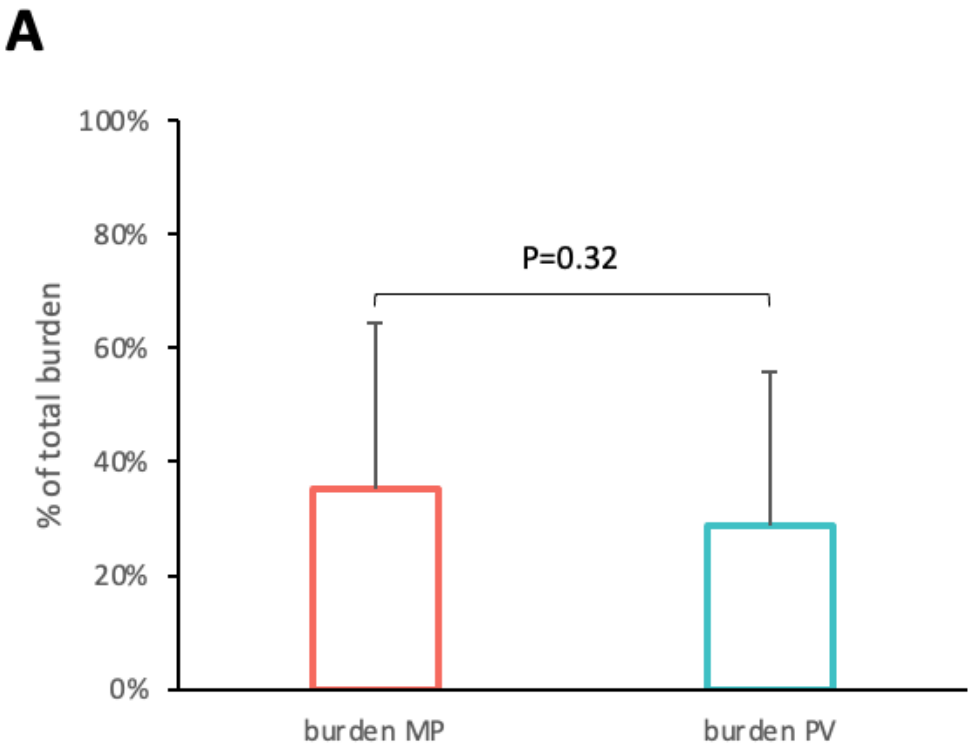
PV Isolation **20 patients with clinical recurrence**	**Recurrence type**	**"Marshall Plan"** **9 patients with clinical recurrence**
		

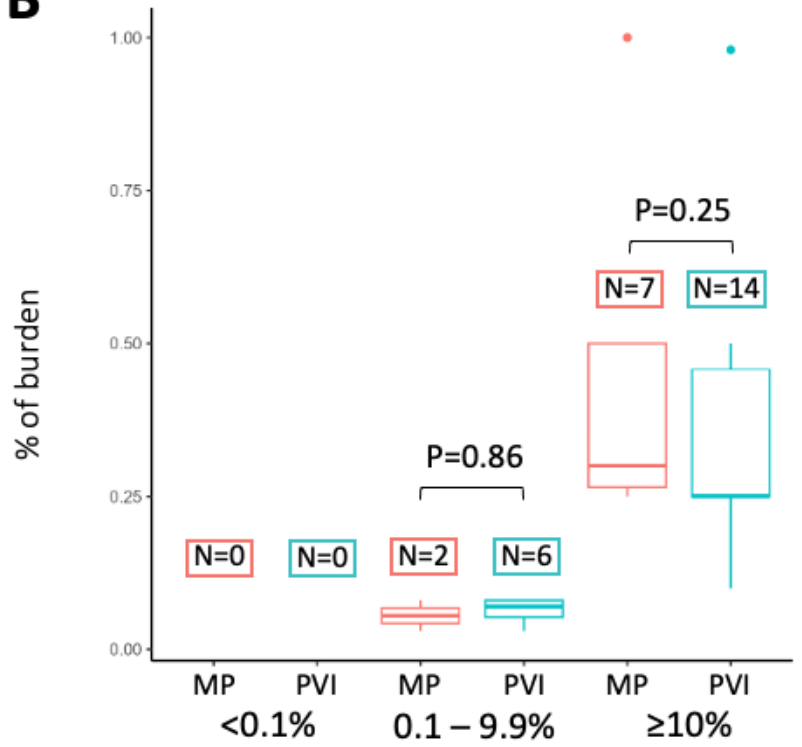
7 patients with redo (during f/u period)
• All 4 PV isolated in 100% (cross-over to Marshall lesion set)
	Redo during F/U	**4 patients** with redo (during f/u period)
		• No patients with complete set
		  • Mitral line: 4 (epi, CS)
		  • Roof: 2
		  • CTI: 3

1 oeso-pericardial fistula	**complications**	1 severe Vascular complication

RESULTS: FOLLOW-UP

AF burden in patients with clinical recurrence





7 p

-

1 oeso-pericardial fistula

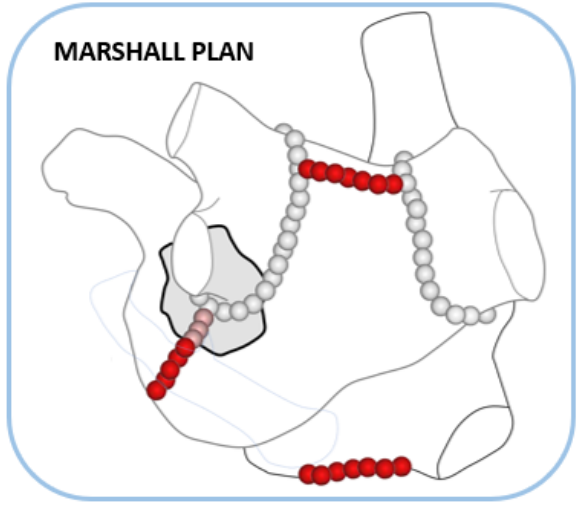
complications

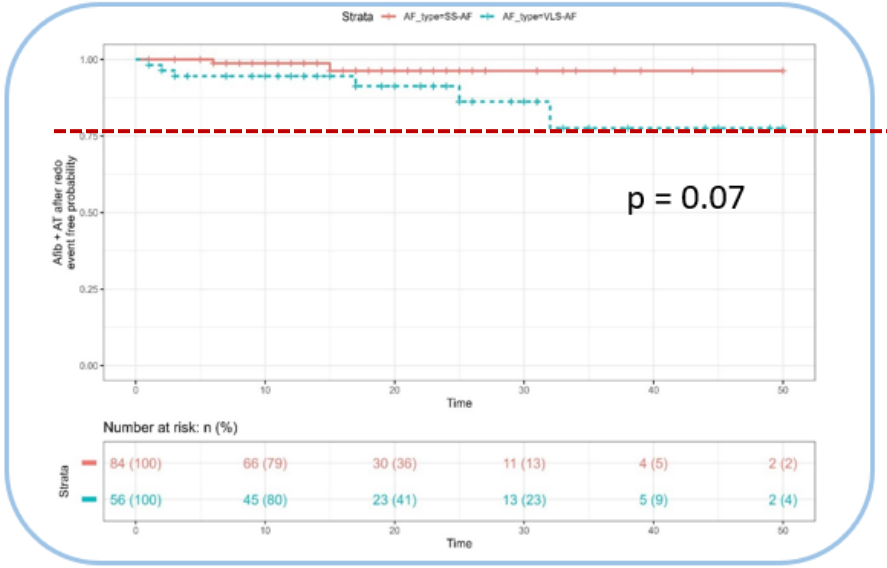
1 Vascular complication

VERY-LONG STANDING PERS AF

>2years
continuous AF

160 patients
Very long standing AF
and short-standing AF
Mean follow-up 18.6
+/- 11.52 months





76%

NUMBER NEEDED TO TREAT (NNT)

Blood pressure medecines for 5 years to prevent Death, Heart Attacks and Strokes:

- 125 pts (prevent death)
- 67 pts (prevent strokes)

Warfarin for AF to prevent Stroke

- 25 pts (prevent stroke)

RE-LY: 167pts (prevent stroke)

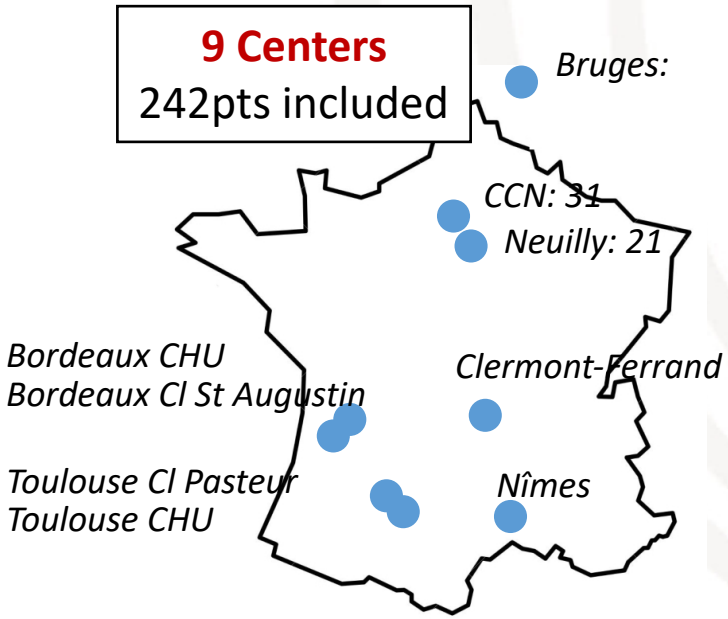
- PROMPT-AF: 10,9 pts
- Marshall-Plan: 4,9 pts

CONCLUSIONS

- The Marshall-plan is a comprehensive ablation strategy for persistent AF based on **anatomical** principles.
- Aim is a **complete** lesion set performed systematically in all persistent AF patients.
- Accumulating evidence supporting superiority against PV isolation:
  - Marshall-plan mono
  - PROMPT-AF
- Marshall-plan strategy respect LA function
- This clear and predefined strategy should:
  - Help to obtained reproducible results
  - Stimulate industry to facilitate achievement

PERSPECTIVES

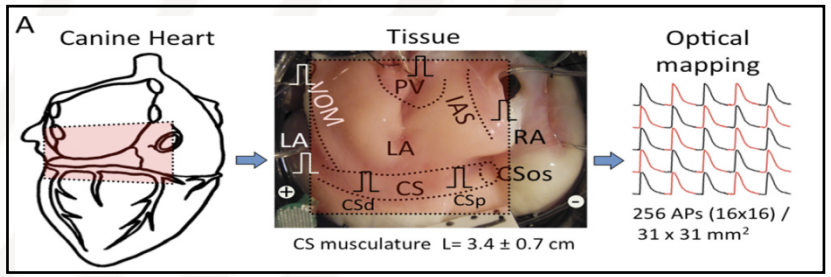
- Multicentric study
- "Marshall"-Plan ablation Vs. PV isolation (262pts)
- Single procedure, off AAD
- 24m f/u
- *NCT: 04681872*

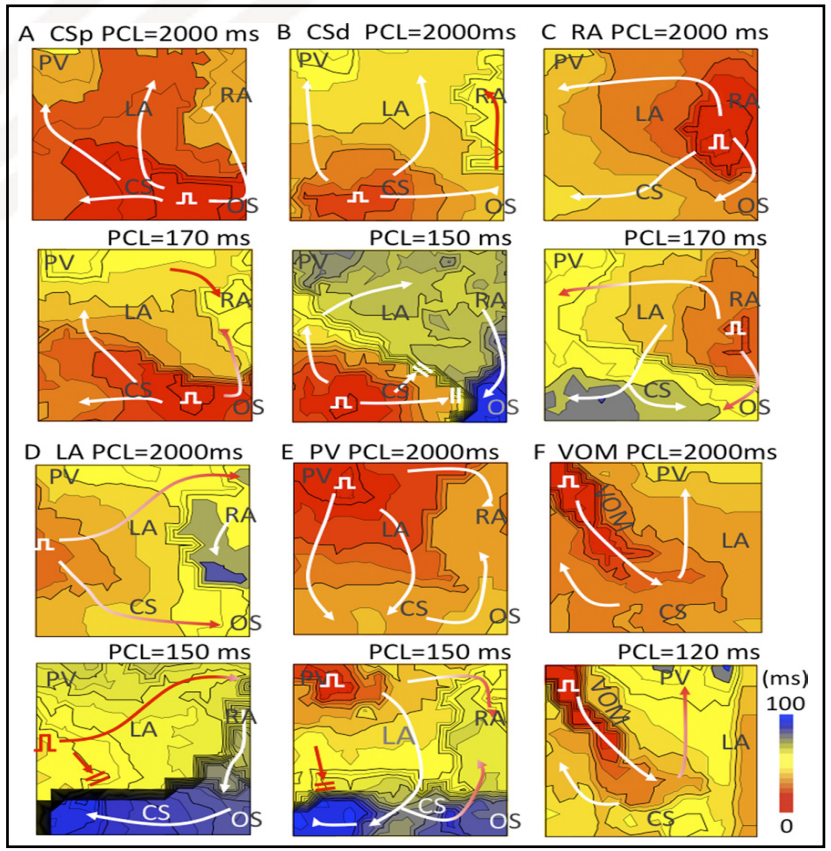


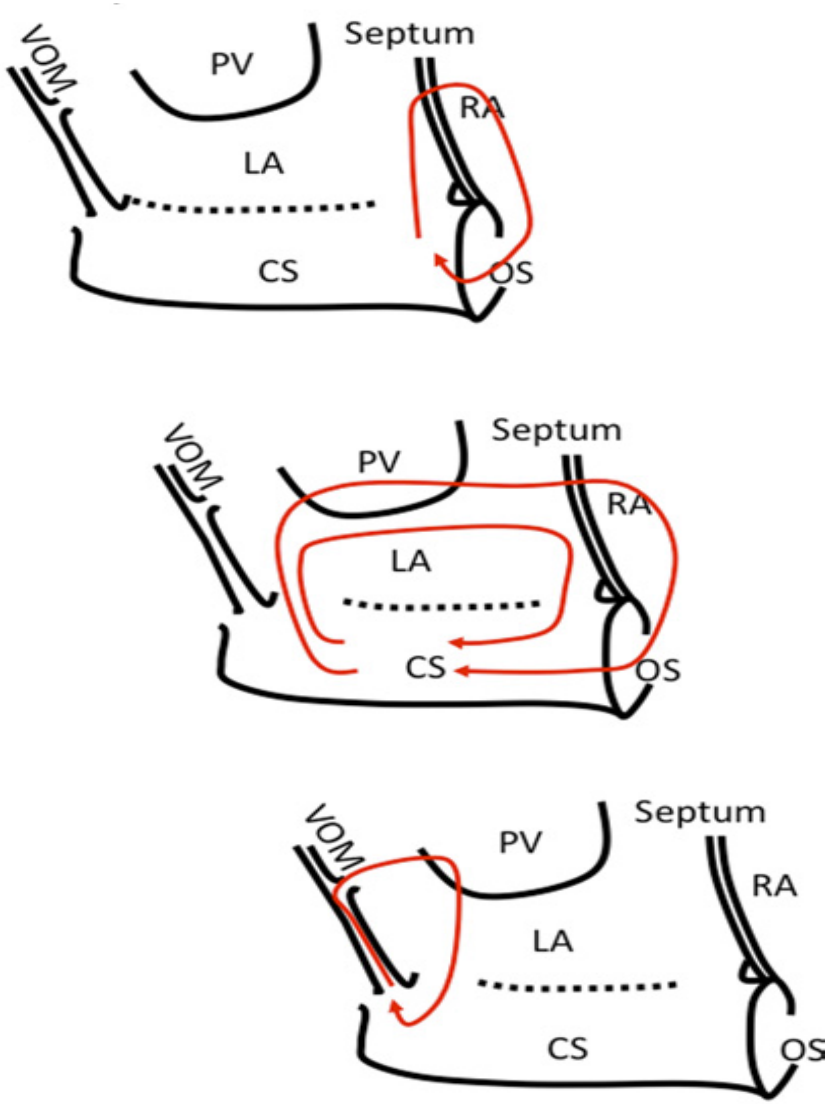
RESULTS

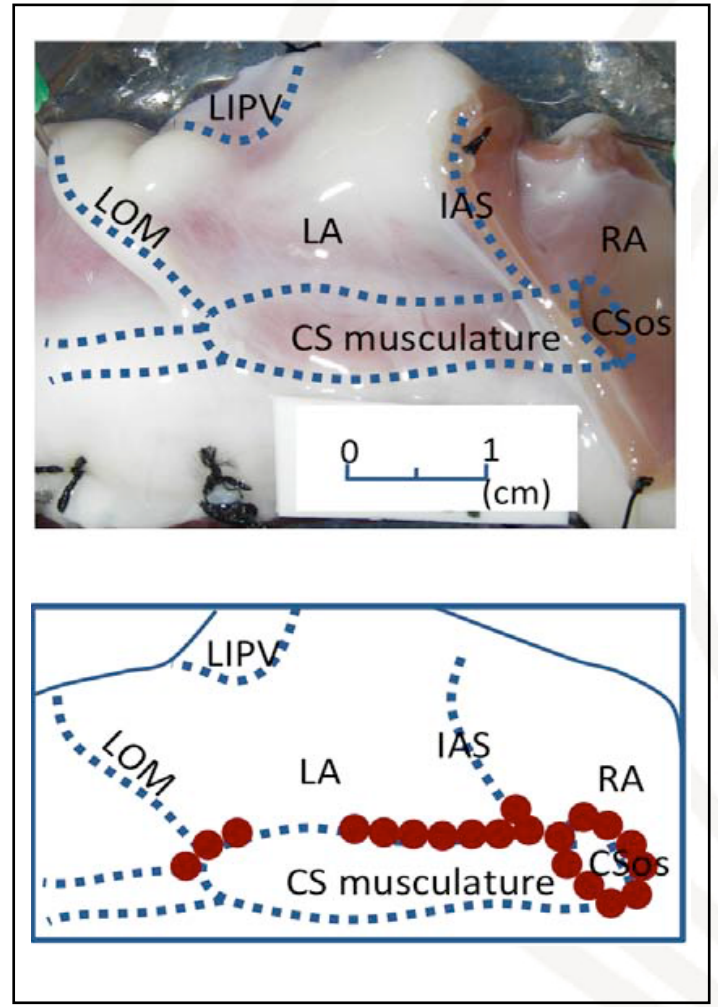
	No (%)			
	Marshall-Plan (n=59)	PV Isolation (n=59)	Absolute difference	P value
Primary outcome				
➢ Freedom from any arrhythmias (AF/AT), after a single ablation procedure with or without antiarrhythmic medication at 12 mo	51 (86.4)	39 (66.1)	+ 12 (+ 20.3)	.012
Secondary outcomes				
➢ Freedom from any arrhythmias (AF/AT), after a single ablation procedure without antiarrhythmic medication at 12 mo	50 (84.7)	39 (66.1)	+ 11 (+ 18.6)	.022
➢ Freedom from any arrhythmias (AF/AT), after 1 or 2 ablation procedures without antiarrhythmic medication at 12 mo	51 (86.4)	39 (66.1)	+ 12 (+ 20.3)	.011
➢ Freedom from any arrhythmias (AF/AT), after 1 or 2 ablation procedures with or without antiarrhythmic medication at 12 mo	52 (88.1)	39 (66.1)	+ 13 (+ 22.0)	.005

ROLE OF THESE EPICARDIAL STRUCTURE IN AF MECHANISM









Morita et al – *Heart Rhythm* 2012;9:581-589

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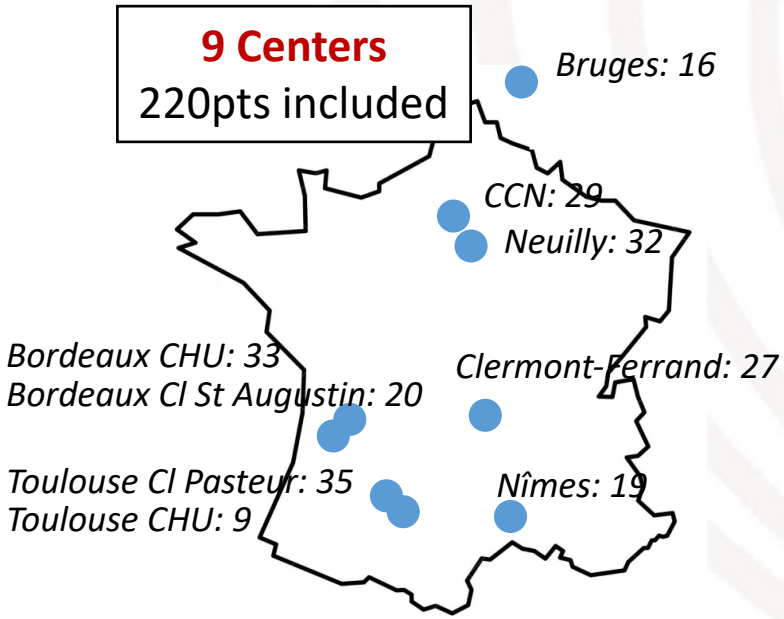
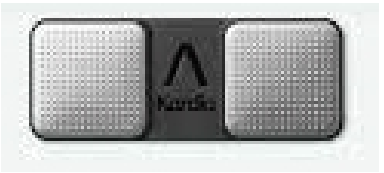


METHODS

- Prospective, randomized, parallel-group, monocentric trial of superiority
- Intention-to-treat analysis
- **Inclusion criteria**
  - >18 yo
  - Symptomatic Persistent AF (>1month) with documented ECG
- **Primary endpoint**
  - Freedom from **any arrhythmias** (AF/AT), after a **single** ablation procedure **without** antiarrhythmic medication at **12 months**
- **Follow-up protocol**
  - Weekly ECG transmission with Alivecor® system



  - Visit at 3, 6, 9 and 12 months with 24 hours holter monitoring, TTE at 3 and 12 monts

RESULTS

Characteristics	Marshall-Plan N=60	PV Isolation N=60	p-value
Demographics			
Age (y)	66±8	65±8	0.21
Gender			0.47
F	12 (20%)	9 (15%)	
M	48 (80%)	51 (85%)	
CHA_2DS_2-Vasc	2±1	2±1	0.04
Hypertension	36 (60%)	25 (42%)	0.04
Diabetes	9 (15%)	3 (5%)	0.07
Previous Stroke	5 (8.3%)	2 (3.3%)	0.44
History of Amiodarone	54 (90%)	49 (82%)	0.19
LVEF (%)	51±12	56±10	0.12
SHD	6 (10%)	6 (10%)	0.99
AF Characteristics			
Maximum AF length (m)	10±18	7±6	0.86
Current AF length (m)	9±19	6±7	0.77
Long-standing AF>1y	11 (18%)	11 (18%)	1.00
History of DCC	1±1	1±1	0.32
Rhythm at inclusion			0.19
AF	32 (53%)	39 (65%)	
SR	28 (47%)	21 (35%)	
Left atrial volume (ml)	187±53	192±53	0.31

	Marshall-Plan N=59	PV isolation N=59	p-value
Rhythm in EP lab			0 .19
AF	32 (54%)	39 (66%)	
SR	27 (46%)	20 (34%)	
LAA cycle length (if AF) (ms)	206±138	176±26	0.88
LA volume (ml)	182±52	192±53	0.22
PVI	59	59	1.00
Total RF LPV (min)	9.5±4.3	13.0±3.7	0.001
Total RF RPV (min)	13.4±5.1	15.8±5.5	0.012
Total RF PVs (min)	23±8	29±8	0.001
VOM-OH	57 (97%)	-	-
OH volume (ml)	10±2	-	-
Time for OH (min)	22.5±15.4	-	-
Xray time for OH (min)	6.3±6±8	-	-
Mitral isthmus line attempt	56 (95%)	-	-
Mitral isthmus block (% per attempt; %total)	55 (98%; 93%)	-	-
RF mitral line (min)	7.2±6.2	-	-
Posterior wall line attempt	56 (95%)	-	-
Posterior wall block (% per attempt; %total)	54 (96%; 92%)	-	-
Roof line block (% per attempt; %total)	30 (54%; 51%)	-	-
RF roof line (min)	6.3±4.4	-	-
Floor line attempt	26 (46%)	-	-
Floor line block (% per attempt; %total)	24 (92%; 43%)	-	-
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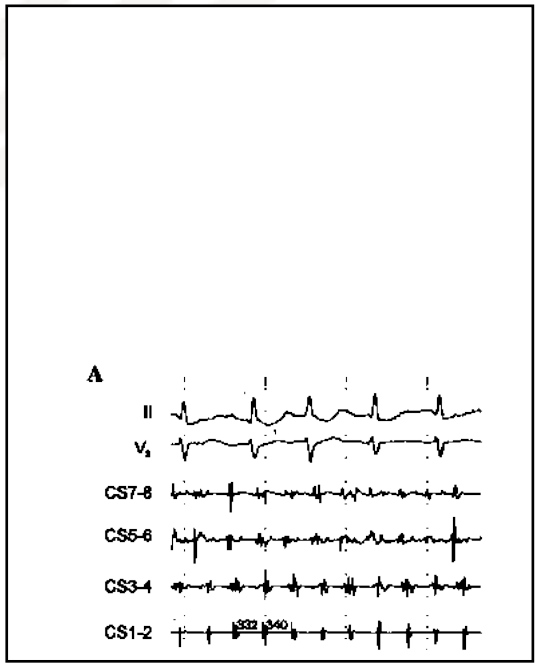
CTI line attempt	56 (95%)	-	-
CTI line block(% per attempt; %total)	55 (93%; 98%)	-	-
RF CTI line (min)	5.9±4.5	-	-
AF termination	1 (2%)	3 (5%)	0.43
Ablation set complete	52 (88%)	59 (100%)	0.058
Total Procedure time (min)	157±53	125±31	0.001
Total RF time (min)	36.8±16.0	29.6±8.1	0.001
Total X-Ray time (min)	21±16	11±6	0.001

DEFINITIONS

- Electrograms with 2 or more deflections and/or baseline perturbation with continuous activity over 10sec

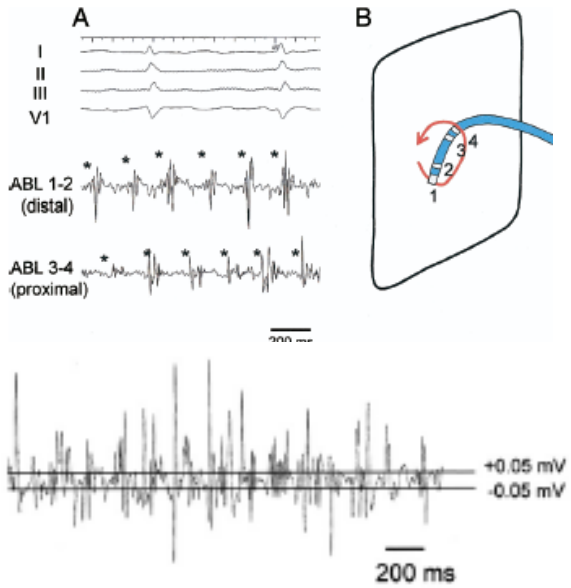
And/or

- Electrograms with a mean CL<120ms over 10sec.



Nademanee et al. JACC 2004

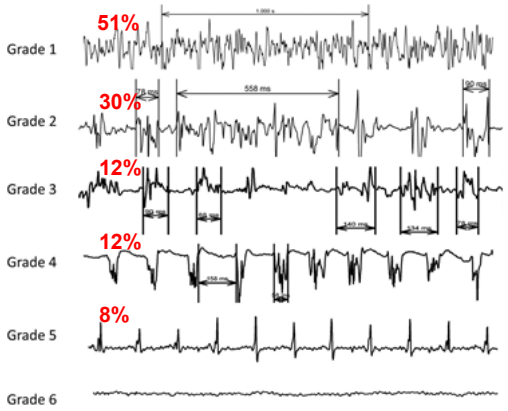
- Temporal activation gradient
- EGMs with continuous electrical activity
- Fast activities



Takahashi Y et al. JACC 2008

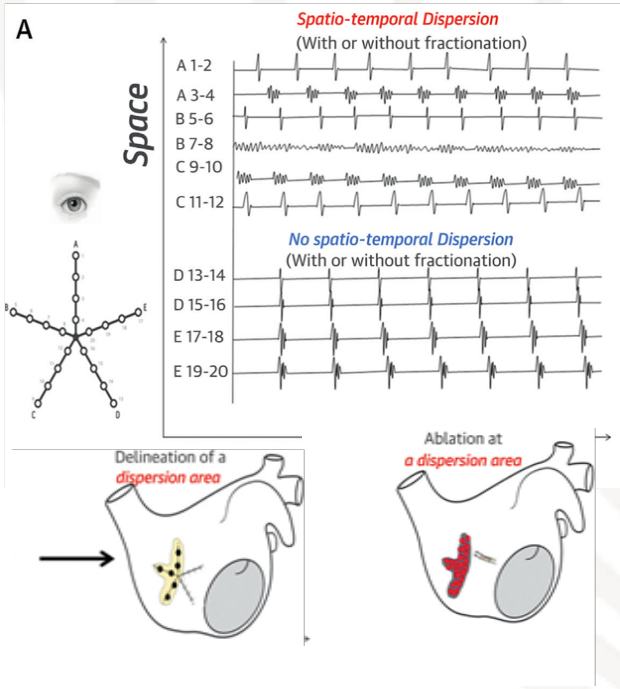
- Classification of Fractionated atrial electrograms (CFAE AF trial)

Grade	Electrogram Criteria
1	Uninterrupted fractionated activity Fractionated activity (defined as continuous deflections without pause at the isoelectric line for ≥70 ms) occupying ≥70% of sample, and at least 1 uninterrupted episode of fractionated activity lasting ≥1 second
2	Interrupted fractionated activity Fractionated activity occupying ≥70% of sample
3	Intermittent fractionated activity Fractionated activity occupying 30–70% of sample
4	Complex electrograms Discrete electrograms (<70 ms) and complex (≥5 direction changes), with any fractionated activity occupying <30% of sample (otherwise grade 3)
5	Normal electrogram Discrete electrograms (<70 ms) and simple (≤4 direction changes)
6	Scar No discernible deflections



Hunter RJ et al. CircAE 2011

- **Spacio-temporal dispersion**: Dispersion areas were defined as clusters of electrograms, either fractionated or nonfractionated, that displayed interelectrode time and space dispersion at a minimum of 3 adjacent bipoles such that activation spread over all the AFCL

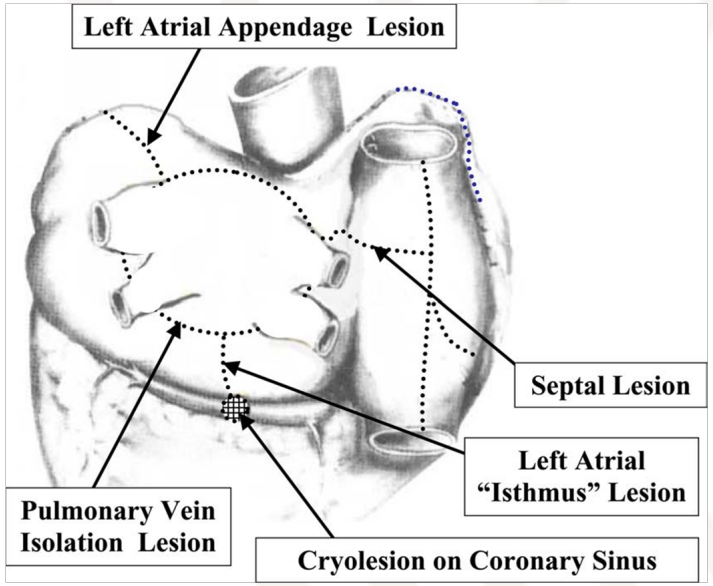


Seitz J et al. JACC 2017

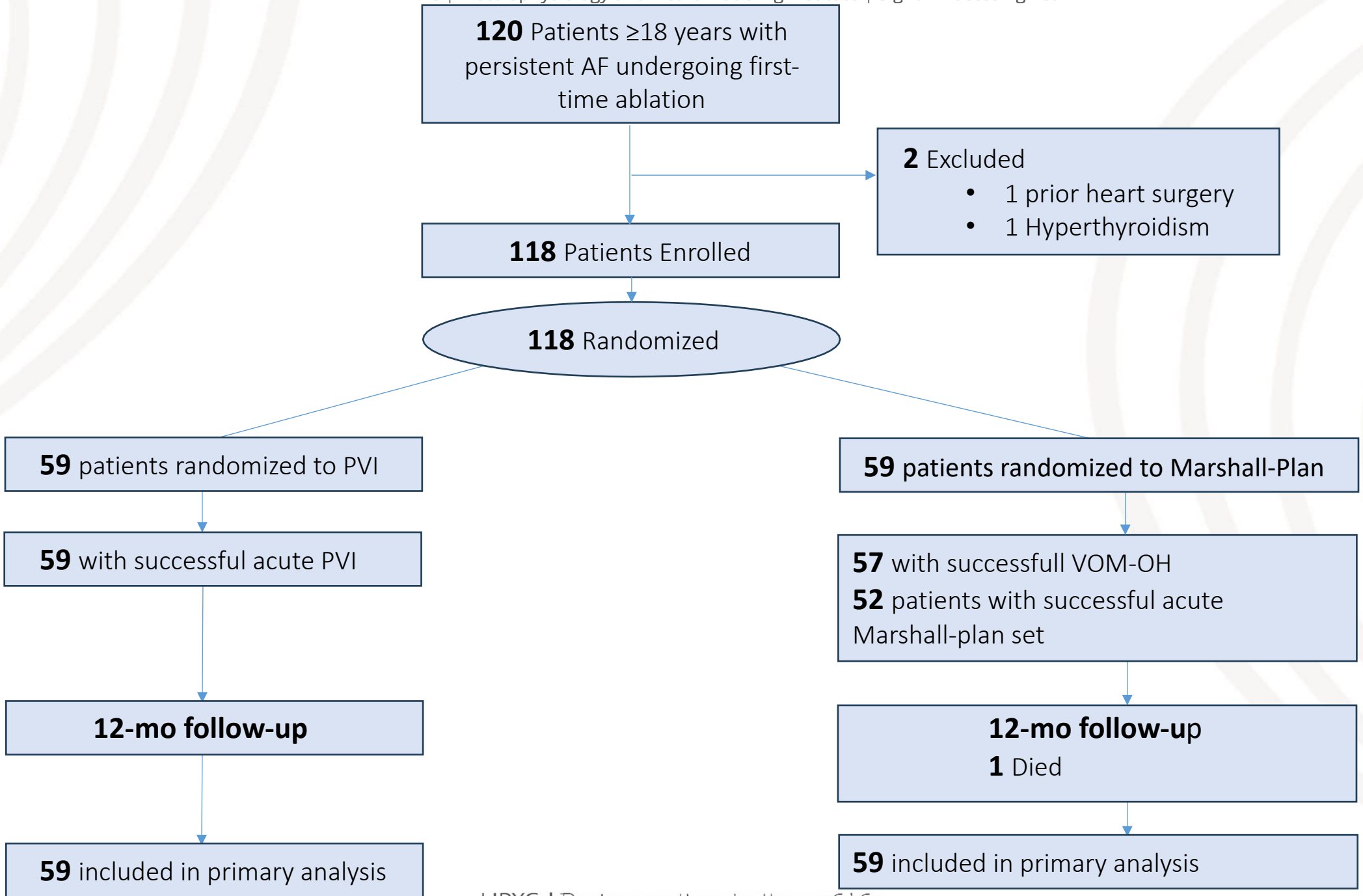
ANATOMICAL APPROACH

Volume 101
Number 4
April 1991

… perhaps the only way to prevent the atrium from fibrillating is to **interrupt *all* of the potential pathways for atrial macroreentrant circuits** that have been identified by intraoperative mapping either experimentally or clinically, and our eventual surgical approach was based on this principle…



Cox J of Thoracic and Cardiovascular surgery 1991


120 Patients ≥18 years with persistent AF undergoing first-time ablation
2 Excluded
• 1 prior heart surgery
• 1 Hyperthyroidism
118 Patients Enrolled
118 Randomized
59 patients randomized to PVI
59 with successful acute PVI
12-mo follow-up
59 included in primary analysis
59 patients randomized to Marshall-Plan
57 with successfull VOM-OH
52 patients with successful acute Marshall-plan set
12-mo follow-up
1 Died
59 included in primary analysis