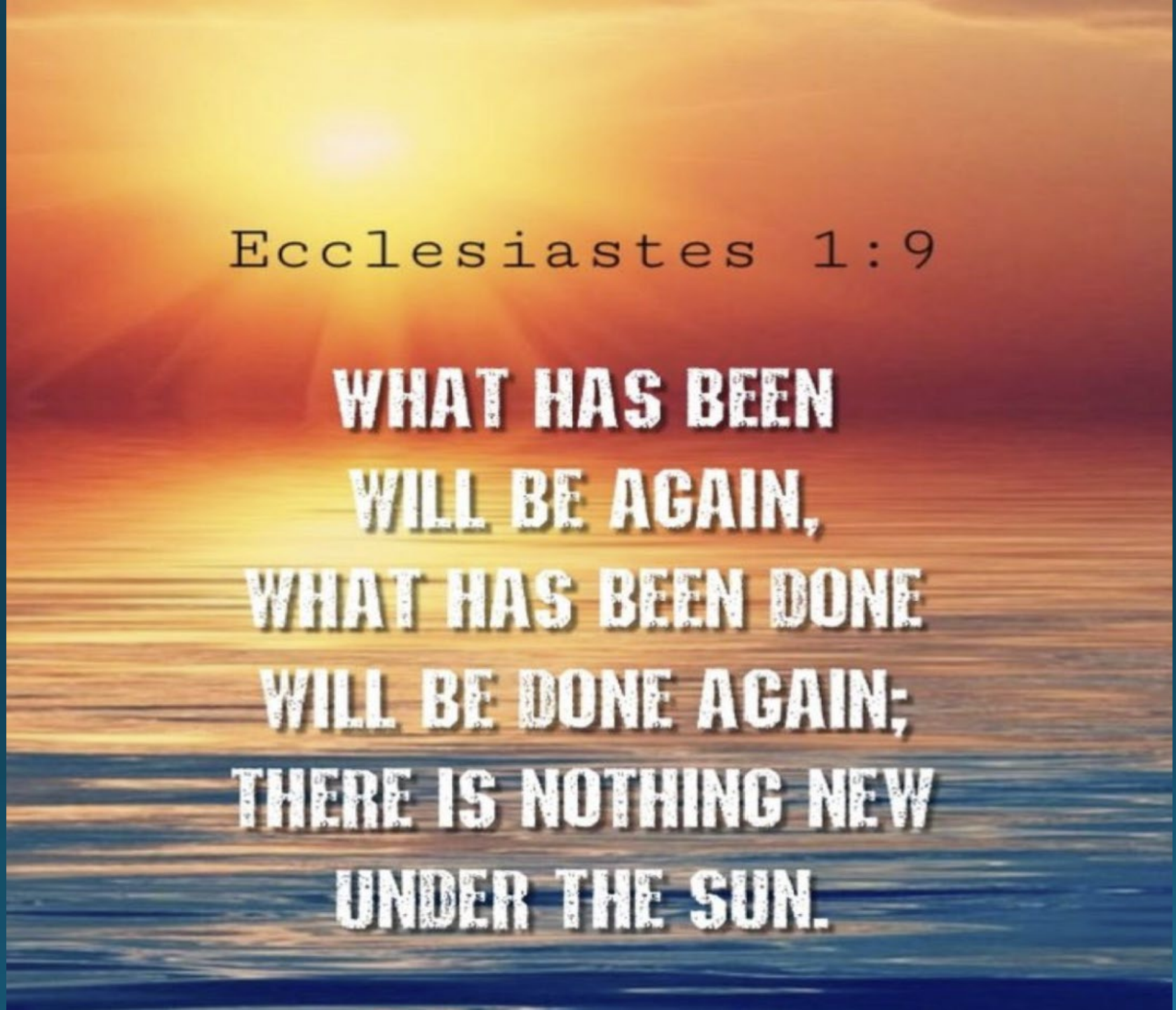
David Luria, MD
Hadassah Medical Center

Persistent Atrial Fibrillation Ablation
What's new?


Ecclesiastes 1:9
WHAT HAS BEEN
WILL BE AGAIN,
WHAT HAS BEEN DONE
WILL BE DONE AGAIN;
THERE IS NOTHING NEW
UNDER THE SUN.

ESC European Society of Cardiology

Europace (2024) **26**, 1–107
https://doi.org/10.1093/europace/euae043

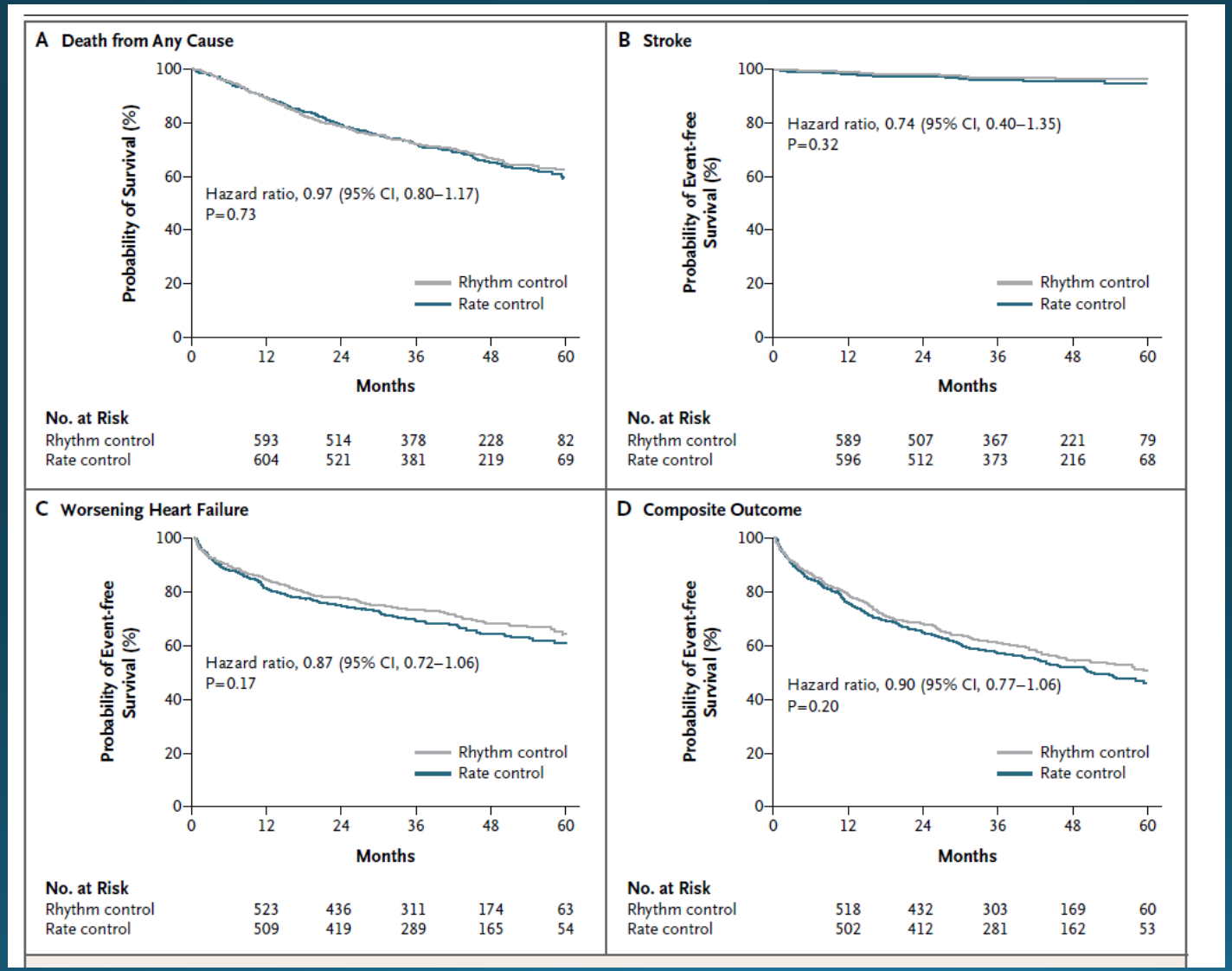
EHRA DOCUMENT

EHRA European Heart Rhythm Association

2024 European Heart Rhythm Association/ Heart Rhythm Society/Asia Pacific Heart Rhythm Society/Latin American Heart Rhythm Society expert consensus statement on catheter and surgical ablation of atrial fibrillation

Indications for catheter ablation of atrial fibrillation	Category of advice	Type of evidence
Patients with AF-related symptoms		
Catheter ablation of AF is beneficial in symptomatic patients with recurrent paroxysmal or persistent AF resistant or intolerant to previous treatment with at least one Class I or III antiarrhythmic drug	Advice TO DO	META[236–242]
Catheter ablation of AF is beneficial as first-line treatment in symptomatic patients with recurrent paroxysmal AF	Advice TO DO	META[243–249]
Catheter ablation of AF may be reasonable as first-line treatment in symptomatic patients with persistent AF	Area of uncertainty	OPN
Patients with AF and heart failure		
Catheter ablation is beneficial in patients with AF and left ventricular systolic dysfunction, suspected to be related to arrhythmia-mediated cardiomyopathy, to improve left ventricular function	Advice TO DO	META[250–254]
It is reasonable to perform catheter ablation in selected patients with AF and heart failure with reduced ejection fraction to reduce cardiovascular hospitalizations and prolong survival, regardless of previous antiarrhythmic drug failure or intolerance	May be appropriate to DO	META[254–260]
Patients without AF-related symptoms		
Catheter ablation of AF may be reasonable in selected asymptomatic patients with recurrent paroxysmal or persistent AF following thorough discussion of potential risks and associated benefits	Area of uncertainty	OPN

AF CHF study: 1400 pts



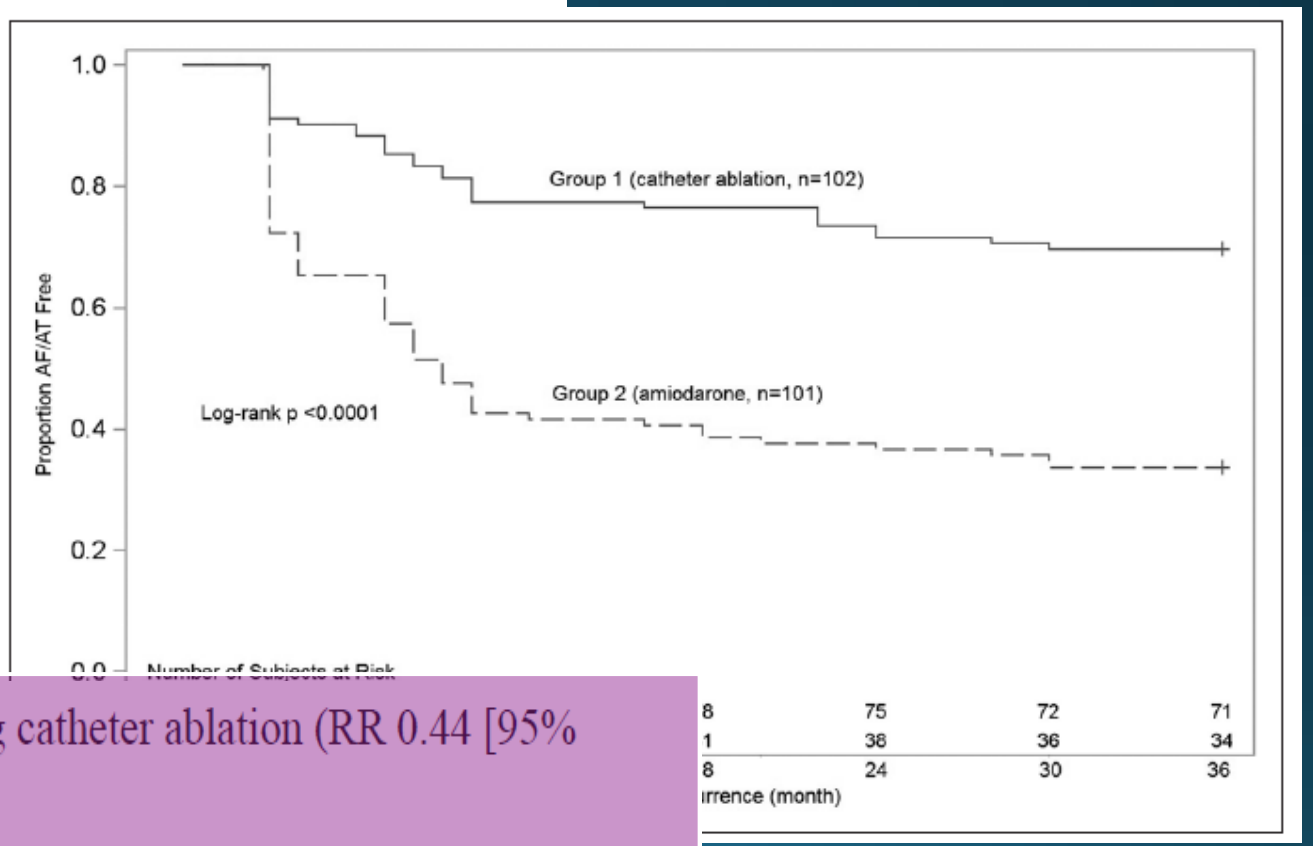
Roy et al. *NEJM* 2008;358;25

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION
2016
American Heart Association®

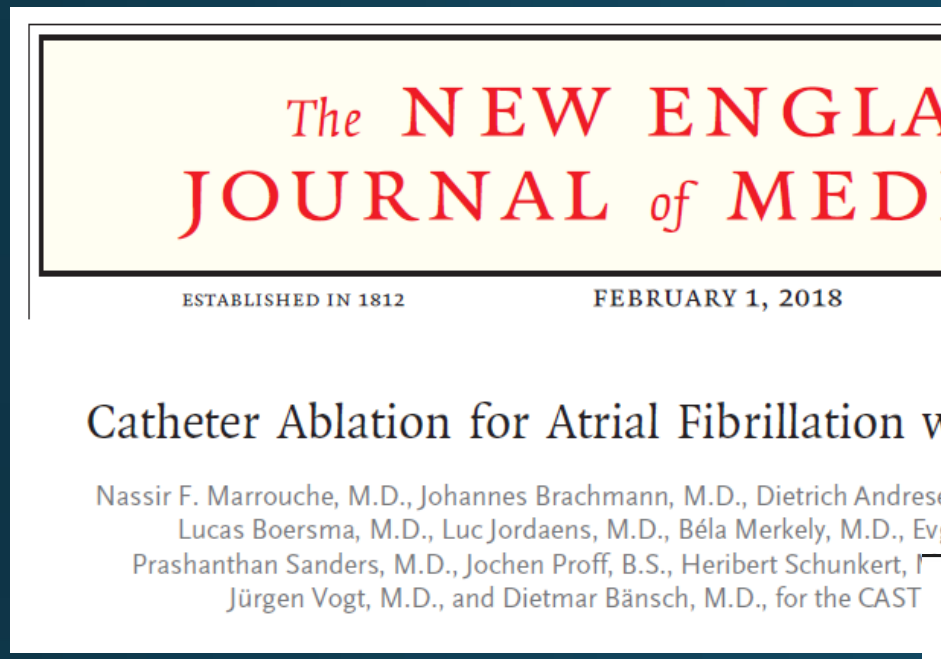
Ablation vs. Amiodarone for Treatment of Persistent Atrial Fibrillation in Patients With Congestive Heart Failure and an Implanted Device: Results From the AATAC Multicenter Randomized Trial

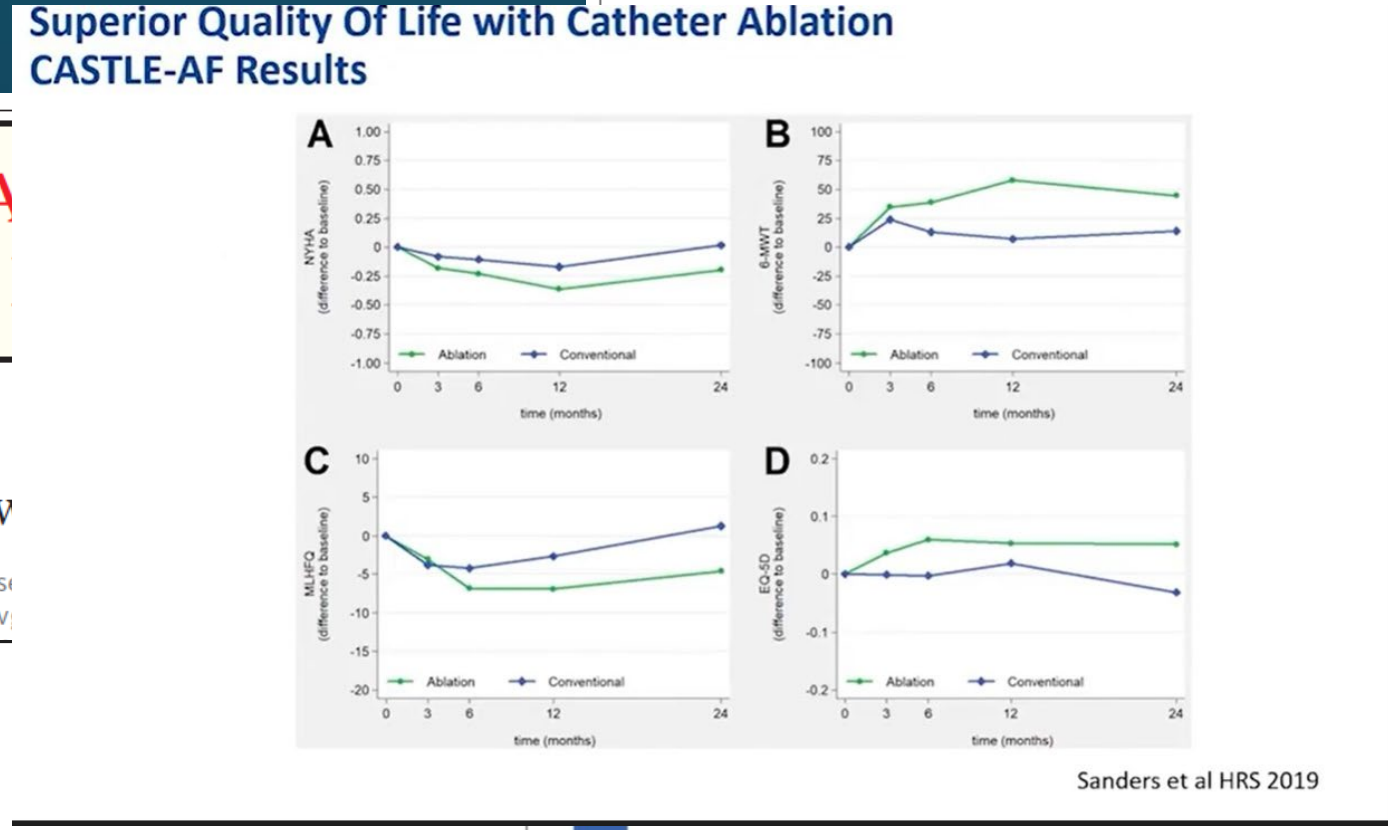
Luigi Di Biase, Prashant Mohanty, Sanghamitra Mohanty, Pasqua
Dhanunjaya Lakkireddy, Madhu Reddy, Pierre Jais, Sakis Themis
Michela Casella, Gemma Pelargonio, Maria Lucia Narducci, Rober
Sanchez, Rodney Horton, Salwa Beheiry, Richard Hongo, Steven F
Forleo, Claudio Tondo, J. David Burkhardt, Michel Haissag

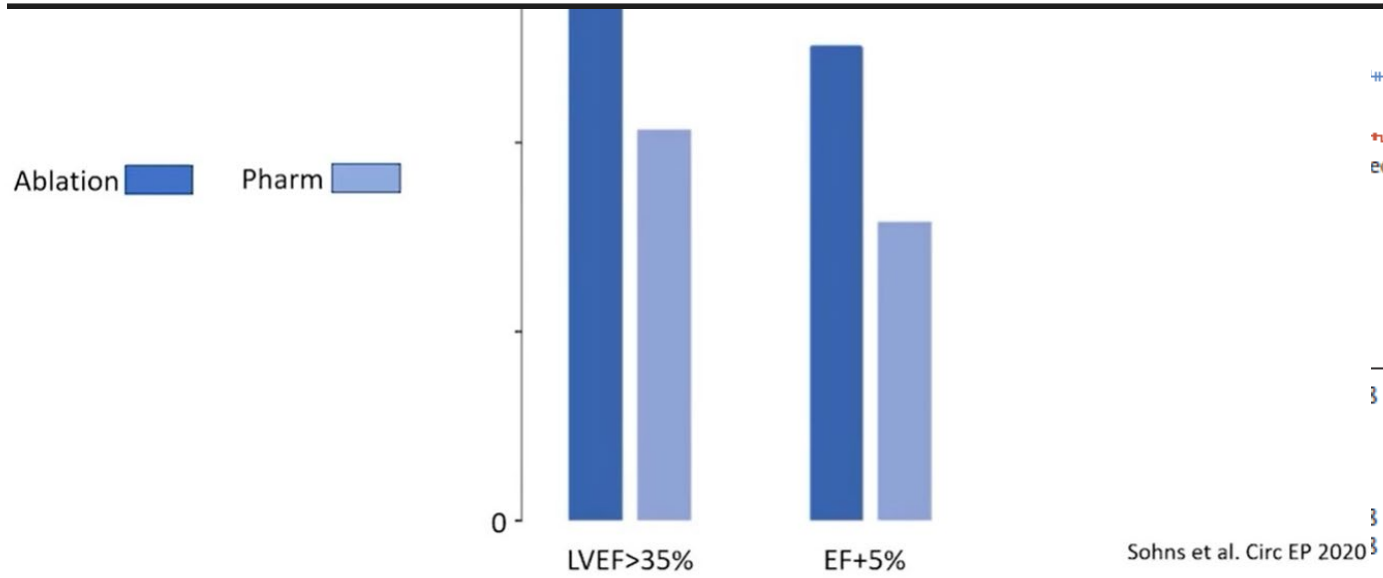
200 pts
EF=30%
Persistent AF for 8 mo
ICD/CRTD



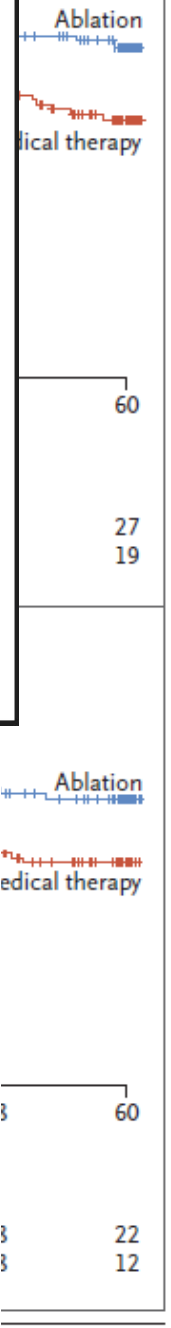
56% relative risk reduction for mortality in patients receiving catheter ablation (RR 0.44 [95% CI -0.20 to 0.96], NNT 10 patients).







360 pts
EF=30%
Persistent AF -70%
Failed antiarrhythmic drugs
ICD/CRTD



sence of any atrial arrhythmia lasting >30 s off AADs. Overwhelming evidence indicates that this 30 s cutoff does not correlate with symptom severity, is not associated with cardiovascular outcomes, and results in marked underestimation of treatment efficacy.[19] There is still

den as a procedural endpoint of catheter ablation. By studying AF burden, a striking AF reduction is often observed following ablation despite AF recurrences being recorded.[622] Reduced AF burden following AF ablation is also associated with improvement in QoL.[1188] In

CASTLE-AF, a trial of patients with AF and HFrEF randomized to catheter ablation or drug therapy, a 50% lower AF burden at 6 months was associated with a decrease in the primary endpoint of all-cause mortality and HF hospitalization and a reduction in all-cause mortality.

The NEW ENGLAND JOURNAL of MEDICINE

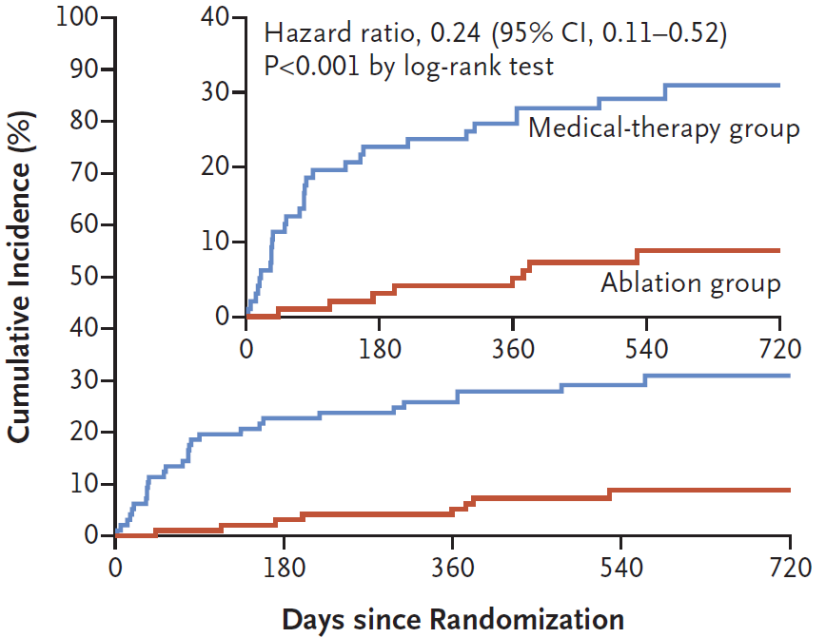
ORIGINAL ARTICLE

Catheter Ablation in End-Stage Heart Failure with Atrial Fibrillation 2023

Christian Sohns, M.D., Henrik Fox, M.D., Nassir F. Marrouche, M.D.,
Harry J.G.M. Crijns, M.D., Ph.D., Angelika Costard-Jaeckle, M.D.,
Leonard Berg... Gerhard Hindricks, M.D., Nikolaos Dagres, M.D.
Samuel Sos...
Mustapha El Ha...
Frank Kon...
J...

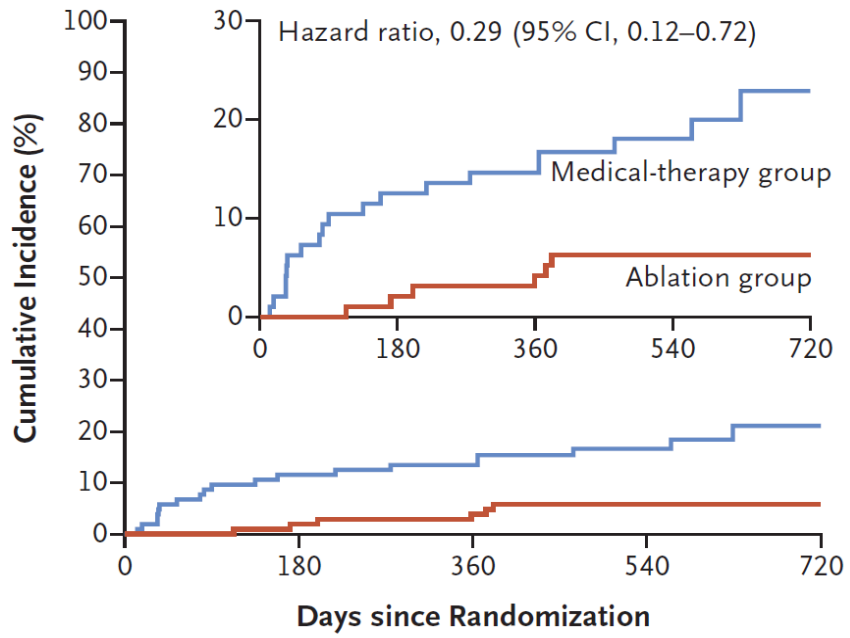
* 20 % absolute risk reduction
* 8% increase EF
* 30% decrease AF burden

A Primary End Point



No. at Risk					
Medical-therapy group	97	75	72	41	12
Ablation group	97	94	88	50	20

B Death from Any Cause



No. at Risk					
Medical-therapy group	97	85	83	45	13
Ablation group	97	95	93	51	20

Circulation 2021

ORIGINAL RESEARCH ARTICLE

Ablation Versus Drug Therapy for Atrial Fibrillation in Heart Failure

Results From the CABANA Trial

Douglas L. Packer, MD
Jonathan P. Piccini, MD
Kristi H. Monahan, RN
Hussein R. Al-Khalidi, PhD
Adam P. Silverstein, MS
Peter A. Noseworthy, MD
Jeanne E. Poole, MD
Tristram D. Bahnson, MD
Kerry L. Lee, PhD
Daniel B. Mark, MD
For the CABANA Investigators

800 pts
NYHA ≥ II
EF >50% in 80% pts
(HFpEF !)

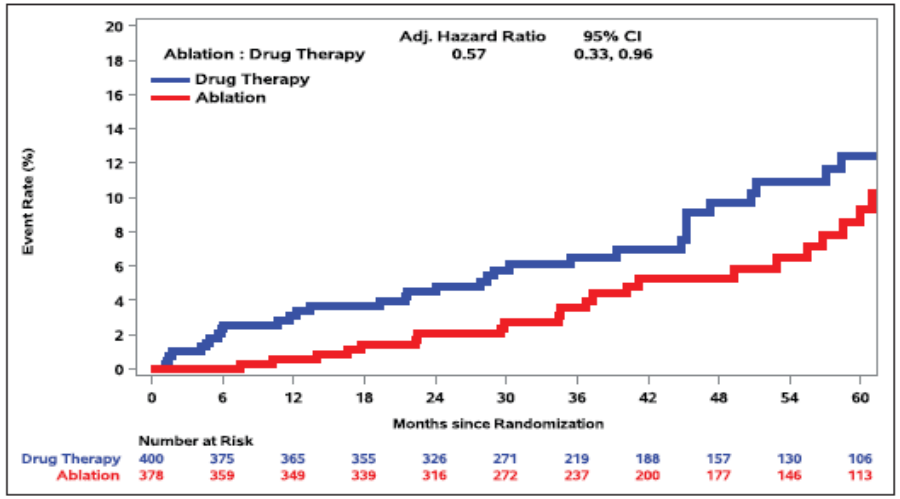


Figure 2. All-cause mortality Kaplan-Meier curves by intention-to-treat among CABANA heart failure patients.
CABANA indicates Catheter Ablation Versus Antiarrhythmic Drug Therapy for Atrial Fibrillation.

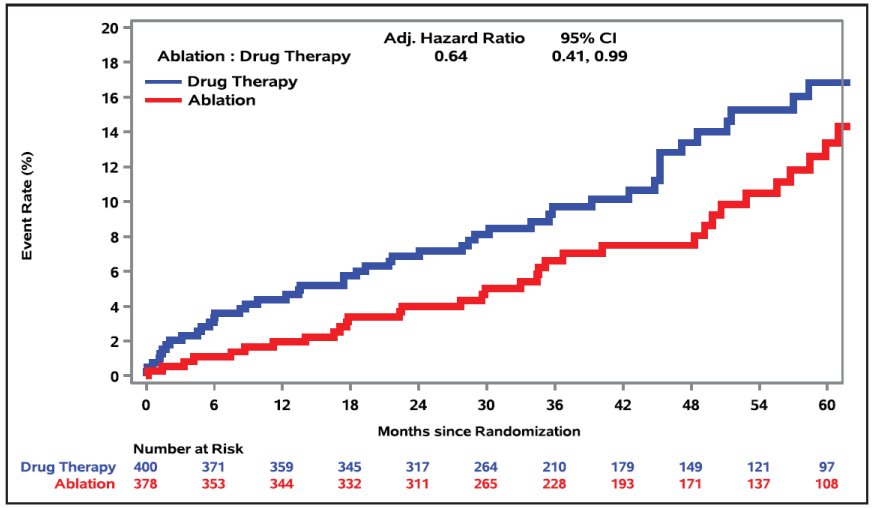


Figure 1. Primary composite end point (death, disabling stroke, serious bleeding, or cardiac arrest) Kaplan-Meier curves by intention-to-treat among CABANA heart failure patients.
CABANA indicates Catheter Ablation Versus Antiarrhythmic Drug Therapy for Atrial Fibrillation.

Catheter Ablation Versus Medic Control in Atrial Fibrillation and Systolic Dysfunction

The CAMERA-MRI Study

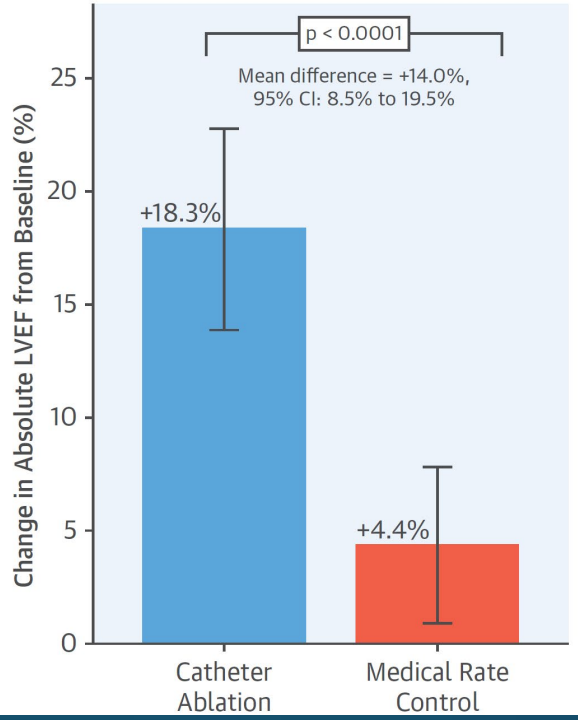
JACC 2017

Sandeep Prabhu, MBBS,[a,b,c,d] Andrew J. Taylor, MBBS, PhD,[a,b,e] Ben T. Costello, David M. Kaye, MBBS, PhD,[a,b,e] Alex J.A. McLellan, MBBS, PhD,[a,b,c,d] Aleksandr Hariharan Sugumar, MBBS,[a,b,c,d] Siobhan M. Lockwood, MBBS,[f] Michael B. Stokes Chrishan J. Nalliah, MBBS,[c,d] Geoff R. Wong, MBBS,[c,d] Sonia M. Azzopardi, RN,[a] Geoffrey Lee, MBBS, PhD,[c] Jamie Layland, MBCHB, PhD,[e] Justin A. Mariani, MB Liang-han Ling, MBBS, PhD,[a,b,d] Jonathan M. Kalman, MBBS, PhD,[c,d] Peter M. Ki

- 66 pts , ICMP, randomized 1:1
- Persistent AF : 2 ± 1 year
- **Excellent RATE CONTROL!**
- EF=35 ± 10%
- LV LGE in 36 % pts
- MRI x2 & ILR

CENTRAL ILLUSTRATION Change in Absolute LVEF From Baseline According to Treatment Arm

A Primary Endpoint: Change in LVEF at Baseline and 6 Months by Treatment Arm



B Catheter Ablation Lesion Set in Left Atrium: Pulmonary Vein and Posterior Wall Isolation

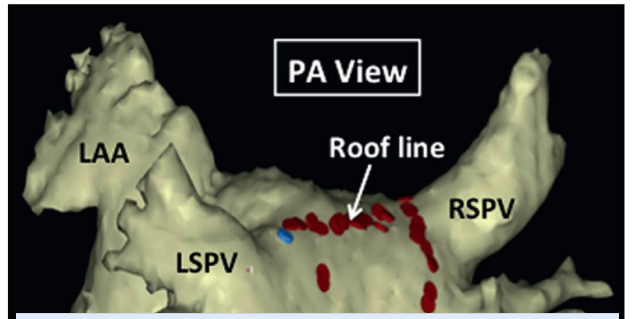
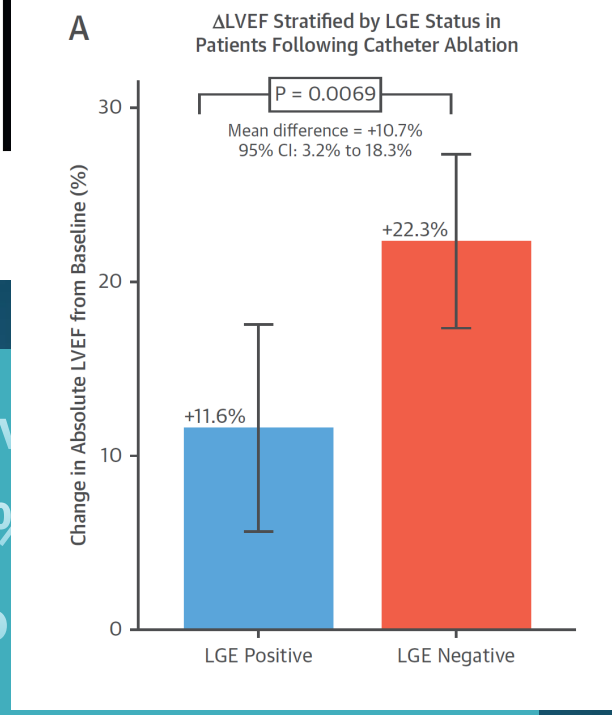


FIGURE 3 LGE and Change in Absolute LVEF

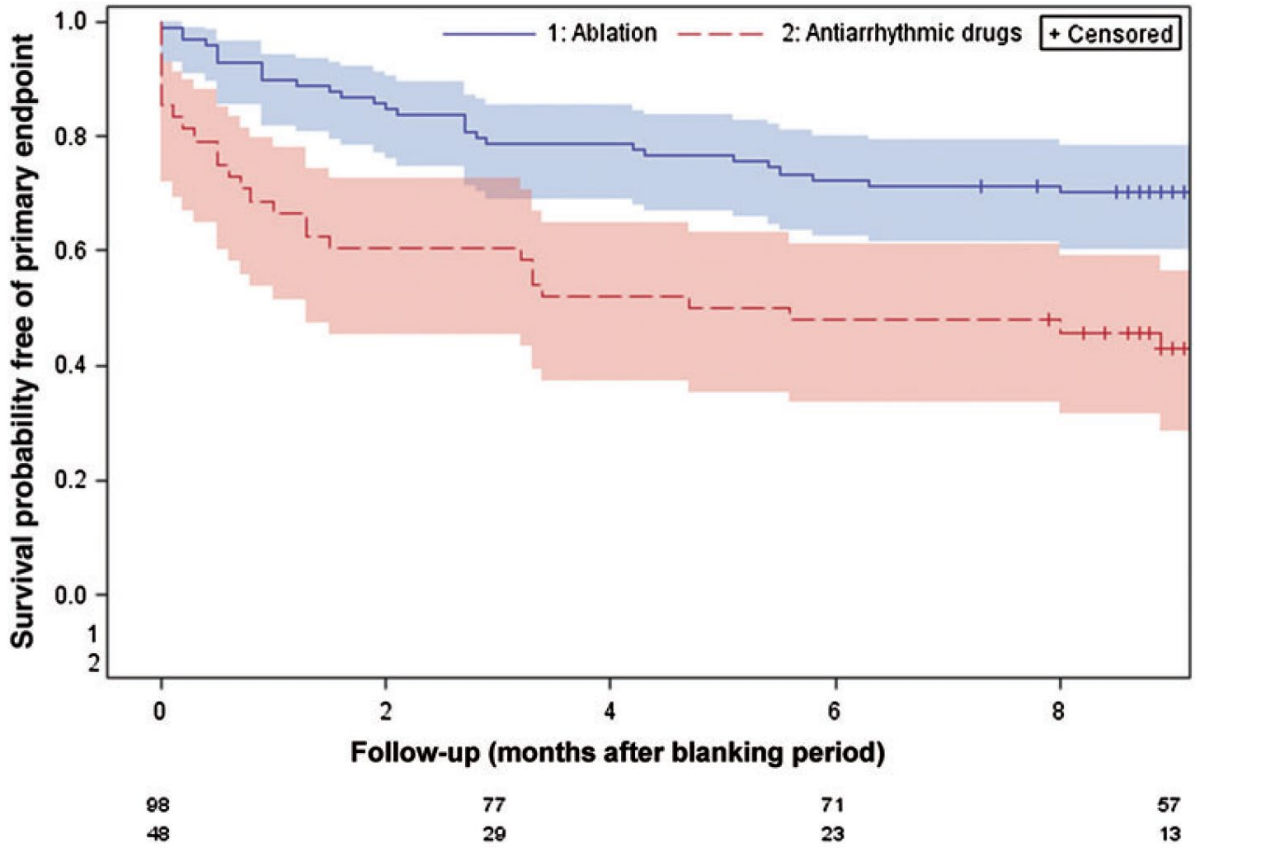


- Six month follo
- AF burden =1.5%
- EF normalizatio

Catheter ablation vs. antiarrhythmic drug treatment of persistent atrial fibrillation: a multicentre, randomized, controlled trial (SARA study) EHJ 2014

Lluís Mont[1*], Felipe Bisbal[1], Antonio Hernández-Madrid[2], Nicasio Pérez-Castellano[3], Xavier Viñolas[4], Angel Arenal[5], Fernando Arribas[6], Ignacio Fernández-Lozano[7], Andrés Bodegas[8], Albert Cobos[9], Roberto Matía[2], Julián F José M. Guerra[4], Pablo Ávila[5], María López-Gil[6], Victor C and Josep Brugada[1], on behalf of SARA investigators

- 150 pts, 2:1 randomization
- 1 year f/u
- 70% free of AF >24 h, comp to 44%



Circulation: Arrhythmia and Electrophysiology

ORIGINAL ARTICLE

2020

Positive Clinical Benefit on Patient Care, Quality of Life, and Symptoms After Contact Force–Guided Radiofrequency Ablation in Persistent Atrial Fibrillation

Analyses From the PRECEPT Prospective Multicenter Study

Andrea Natale, MD; Hugh Calkins, MD; Jose Osorio, MD; Scott J. Pollak, MD; Daniel Melby, MD; Francis E. Marchlinski, MD; Charles A. Athill, MD; Craig Delaughter, MD, PhD; Anshul M. Patel, MD; Philip J. Gentlesk, MD; Brian DeVille, MD; Laurent Macle, MD; Kenneth A. Ellenbogen, MD; Srinivas R. Dukkipati, MD; Vivek Y. Reddy, MD; Moussa Mansour, MD; on behalf of the PRECEPT Investigators*

- 333 pts
- AF 15 months
- 27 centers

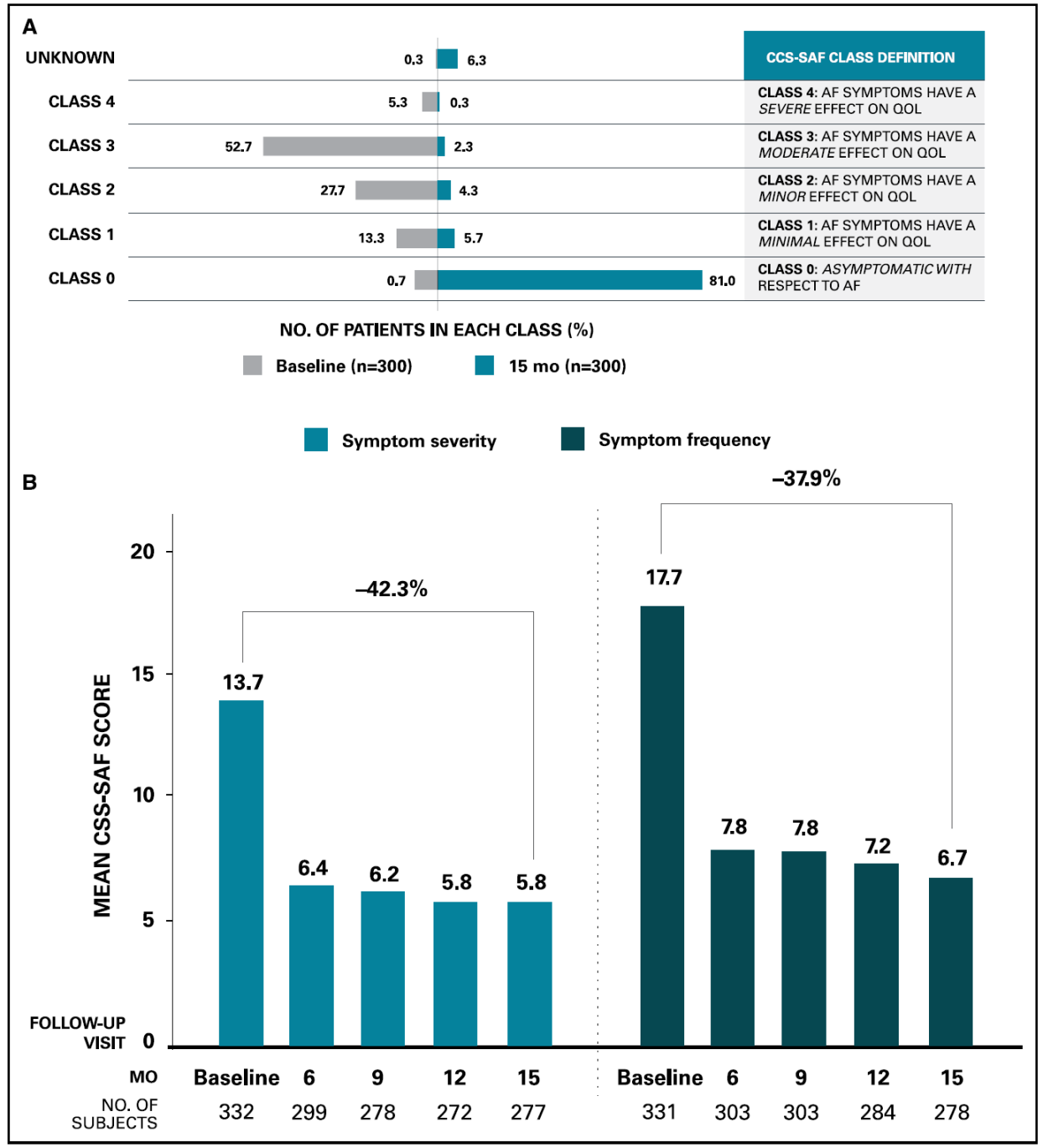


Figure 5. Symptom severity and frequency assessment by Canadian Cardiovascular Society Severity of Atrial Fibrillation (CCS-SAF).

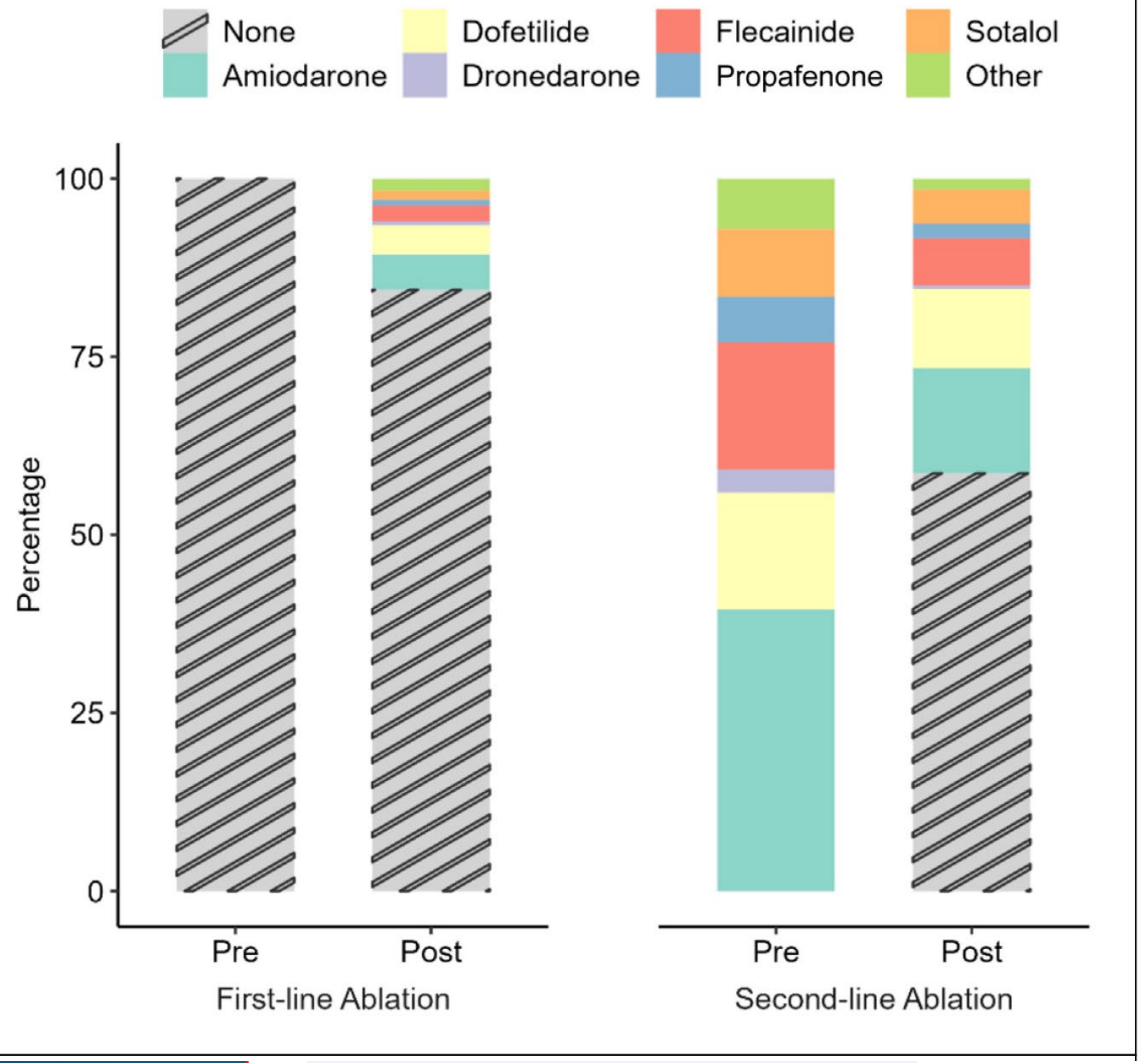
Catheter
Persister

Patient Char

Michael Barkagan, MI
Sanjay Dixit, MD,[d] Ch
Jared T. Bunch, MD,[g]
Usman R. Siddiqui, M

)hakal, MD,[d]
ıD,[f]
,[j]
Anter, MD[a]

FIGURE 5 Comparison of Antiarrhythmic Drug Therapy Between Groups That Underwent Catheter Ablation as First- or Second-Line Therapy



24

First or Second Line Therapy in Persistent AF

e Ablation

line Ablation

Results

- ~50% of pts with PerAF underdo ablation before AADs trial
- AF-free survival is similar among pts who undergo ablation as first or second-line Rx
- pts referred to ablation as first-line Rx were healthier male

Barkagan M, et al. J Am Coll Cardiol EP. 2024;■(■):■-■.

Ablation Strategy

- CONSENSUS
  - Wide PV Isolation is cornerstone stage
  - Repetitive (“focal “) AF allow mapping and ablation of the focus
- NOT IN CONSENSUS – EMPIRIC EXTRA PV ablation
  - Empiric anatomical approach – ABLATION LINES
  - Anatomical SUBSTRATE (scar) mapping and ablation
  - Physiological SUBSTRATE (CFAE) mapping and ablation

Empiric anatomical approach – ABLATION LINES

- PW isolation
- Empiric Lines
- Stepwise app
- LAA isc
- V Marshall Ethanol Ablation
- "Marshall Plan" ablation

LOW PRIORITY

- Derived from MAZE procedure
- " ONE SIZE FITS ALL" concept
- Technical challenge
  - Long Lines
  - Epicardial bridges
- Ptential for PROARRHYTHMIA

THE LESS WE LEARN, THE MORE WE BURN

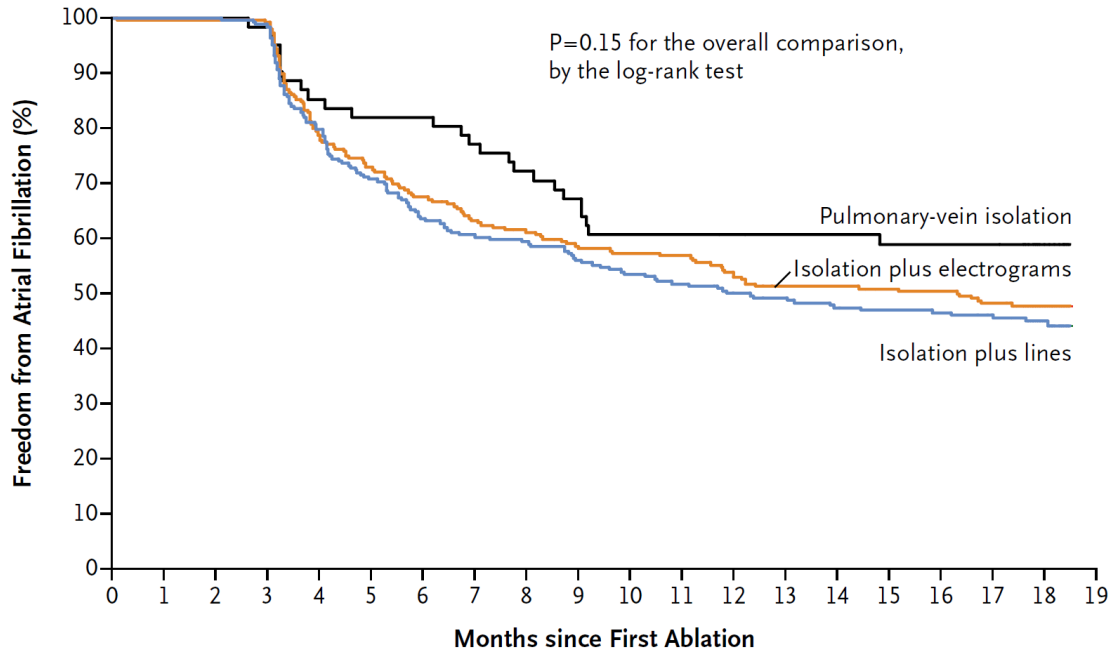
The NEW ENGLAND JOURNAL of MEDICINE
2015

ORIGINAL ARTICLE

Approaches to Catheter Ablation for Persistent Atrial Fibrillation

Atul Verma, M.D., Chen-yang Jiang, M.D., Timothy R. Betts, M.D., M.B., Ch.B
Jian Chen, M.D., Isabel Deisenhofer, M.D., Roberto Mantovan, M.D., Ph.D.,
Laurent Macle, M.D., Carlos A. Morillo, M.D., Wilhelm Haverkamp, M.D., Ph.I
Rukshen Weerasooriya, M.D., Jean-Paul Albenque, M.D., Stefano Nardi, M.D
Endrj Menardi, M.D., Paul Novak, M.D., and Prashanthan Sanders, M.B., B.S., Ph.
for the STAR AF II Investigators*

- Total 590 pts, 1:4:4 randomization (70/260/260)
- 48 centers from 12 countries
- ROOF and MITRAL VALVE LINES



No. at Risk

Pulmonary-vein isolation	61	60	50	41	36	23
Isolation plus electrograms	244	242	161	137	124	72
Isolation plus lines	244	240	152	133	115	57

Figure 2. Freedom from Atrial Fibrillation.

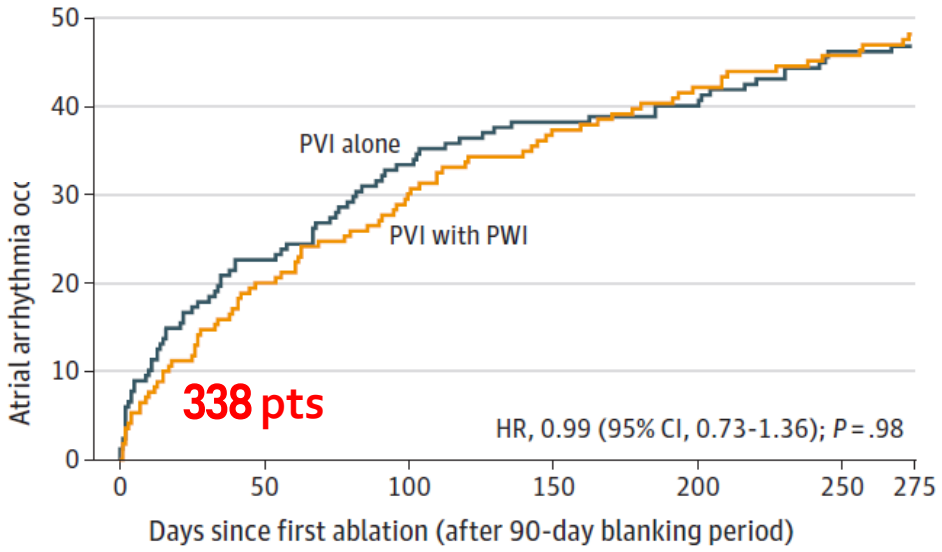
JAMA | Original Investigation 2023

Effect of Catheter Ablation Using Pulmonary Vein Isolation With vs Without Posterior Left Atrial Wall Isolation on Atrial Arrhythmia Recurrence in Patients With Persistent Atrial Fibrillation

The CAPLA Randomized Clinical Trial

Peter M. Kistler, MBBS, PhD; David Chieng, MBBS; Hariharan Sugumar, MBBS, PhD; Liang-Han Ling, MBBS, PhD; Louise Segan, MBBS; Sonia Azzopardi, RN; Ahmed Al-Kaisey, MBBS; Ramanathan Parameswaran, MBBS, PhD; Robert D. Anderson, MBBS, PhD; Joshua Hawson, MBB Sandeep Prabhu, MBBS, PhD; Aleksandr Voskoboinik, MBBS, PhD; Geoffrey Wong, MBBS, PhD; Joseph B. Morton, MBBS, PhD; Bhupesh Pathik, MBBS, PhD; Alex J. McLellan, MBBS, PhD; Geoffrey Lee, MBChD, PhD; Michael Wong, MBBS, PhD; Sue Finch, PhD; Rajeev K. Pathak, MBBS, PhD; Deep Chandh Raja, MBBS, MD; Laurence Sterns, MD; Matthew Ginks, MD; Christopher M. Reid, MBBS, PhD; Prashanthan Sanders, MBBS, PhD; Jonathan M. Kalman, MBBS, PhD

. Any Atrial Arrhythmia Recurrence, Without Antiarrhythmic
ion, After a Single Ablation Procedure



Cumulative No. of events							
PVI alone	0	46	61	65	72	78	78
PVI with PWI	0	42	58	66	74	81	81

Received: 1 November 2018 | Revised: 10 November 2018 | Accepted: 16 November 2018
DOI: 10.1111/jce.13797

ORIGINAL ARTICLE

10 pts

WILEY

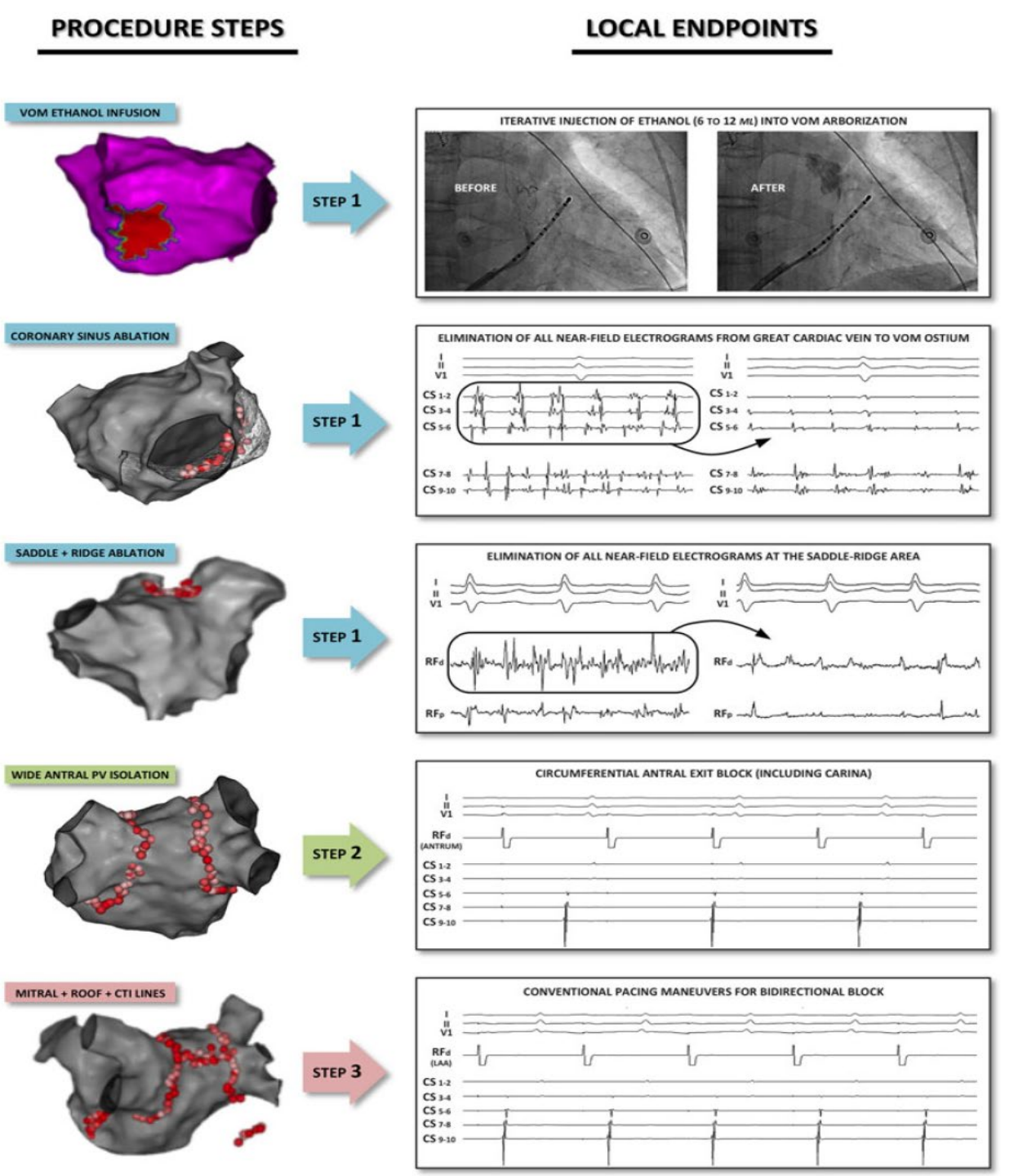
MARSHALL bundles elimination, Pulmonary veins isolation and Lines completion for ANatomical ablation of persistent atrial fibrillation: MARSHALL-PLAN case series

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

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 • ...
Michel Haïssaguerre, MD • Pierre Jaïs, MD, PhD • Thomas Pambrun, MD • Show all authors

75 PTS, persistent AF
ONE Year f/u
72% free of arrhythmia



Ablation Strategy – patient tailored

- Anatomical SI… …L mapping and ablation
  - MRI defi… … fibrosis
  - Elect… …al mapping definition: Low Voltage Area = fibrosis

- F… …cal (functional) SUBSTRATE mapping and ablation --
  -
    - By visual assessment
    - By algorithm assessment
    - By AI assessment

Promissing, yet need more developement

THE MORE WE LEARN, THE LESS WE BURN

JACC: CLINICAL ELECTROPHYSIOLOGY
VOL. 8, NO

PUBLISHED BY ELSEVIER

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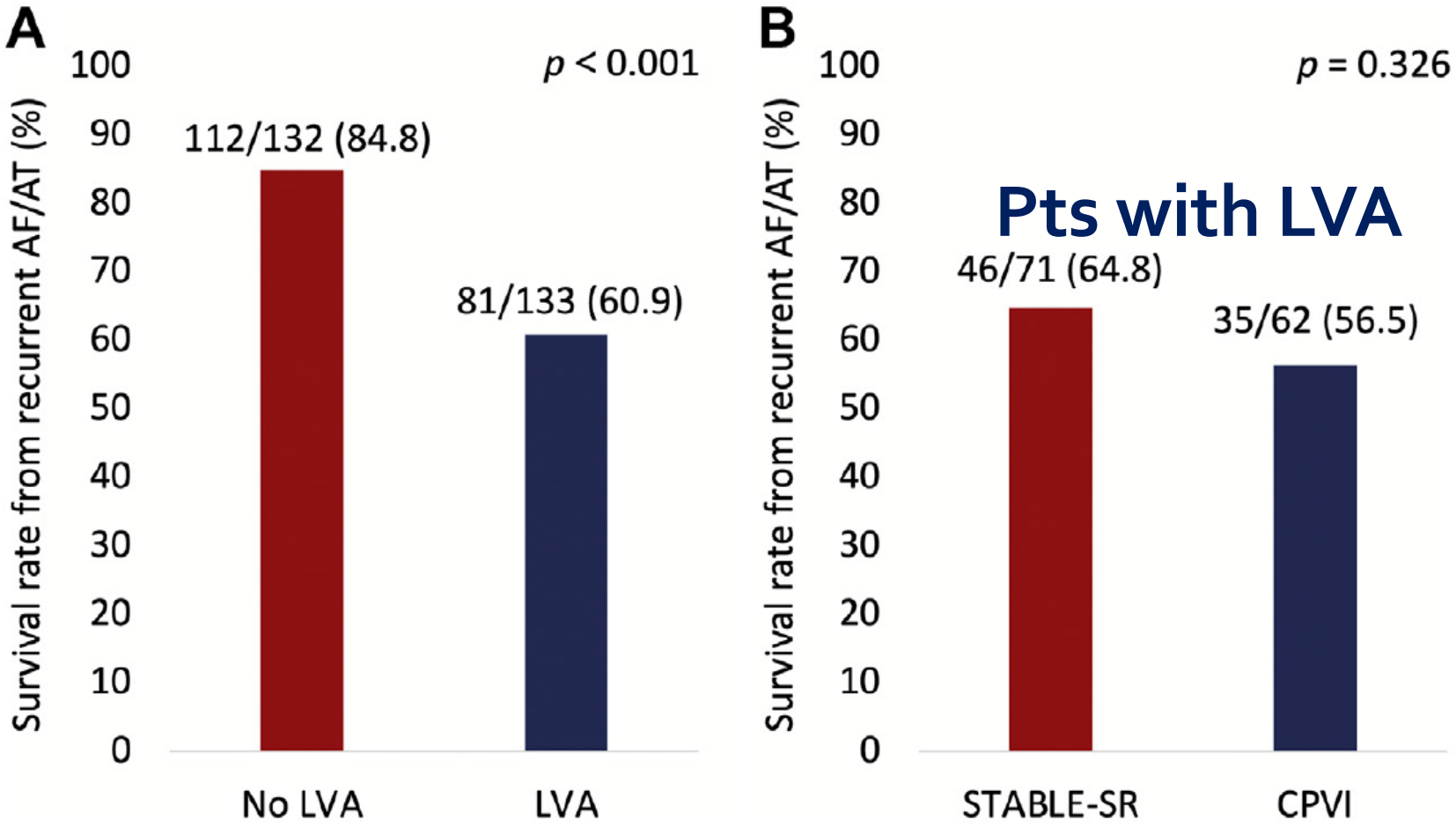
FIGURE 4 The Impact of the Low-Voltage Area on Clinical Outcomes



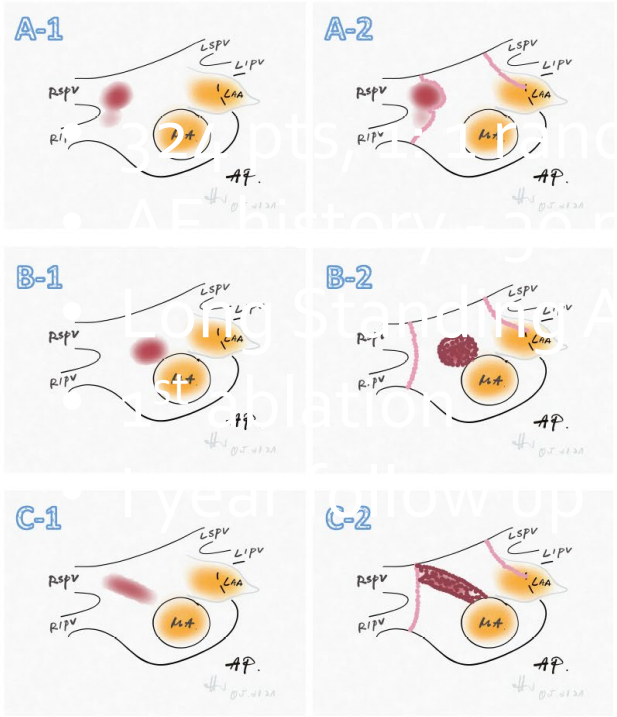
NEJM Evidence

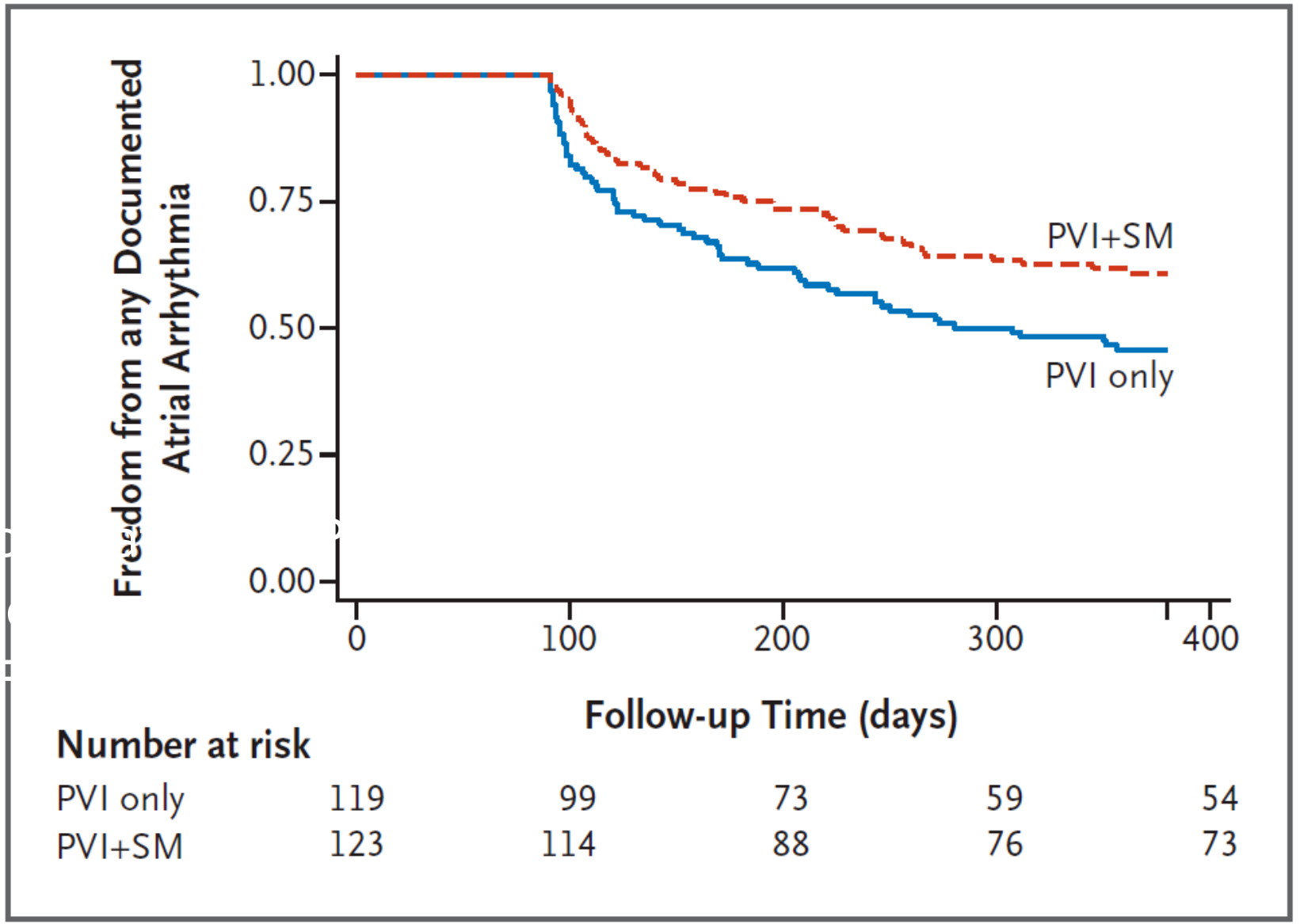
Published October 19, 2022

ORIGINAL ARTICLE

Low-Voltage Myoca
of Persistent Atrial

Yan Huo, M.D., Ph.D.,[1] Thomas Gaspar, M.D.
Franz Xaver Roithinger, M.D.,[4] Martin Martine
Stefan Ulbrich, M.D.,[1] Julia Mayer, M.D.,[1] Olaf
Judith Piorkowski, M.D.,[9] and Christopher Pior





JACC: CLINICAL ELECTROPHYSIOLOGY

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ORIGINAL RESEARCH

CATHETER ABLATION - ATRIAL FIBRILLATION

Posterior Wall Isolation Improves Outcomes for Persistent AF With Rapid Posterior Wall Activity

CAPLA Substudy

3 Examples of Rapid and Slower Posterior Wall Activity

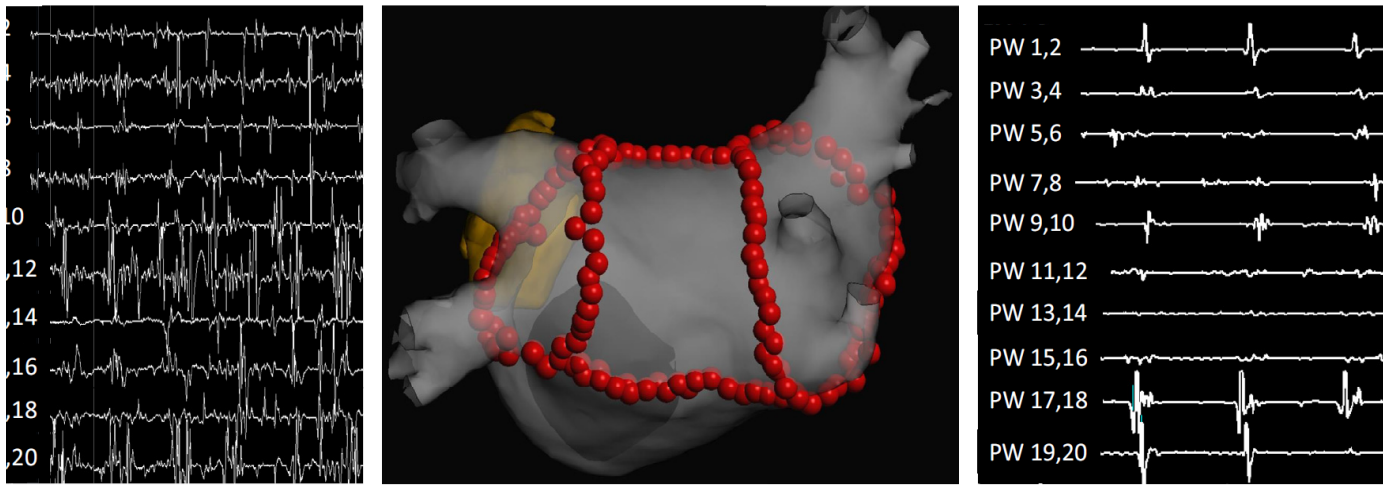
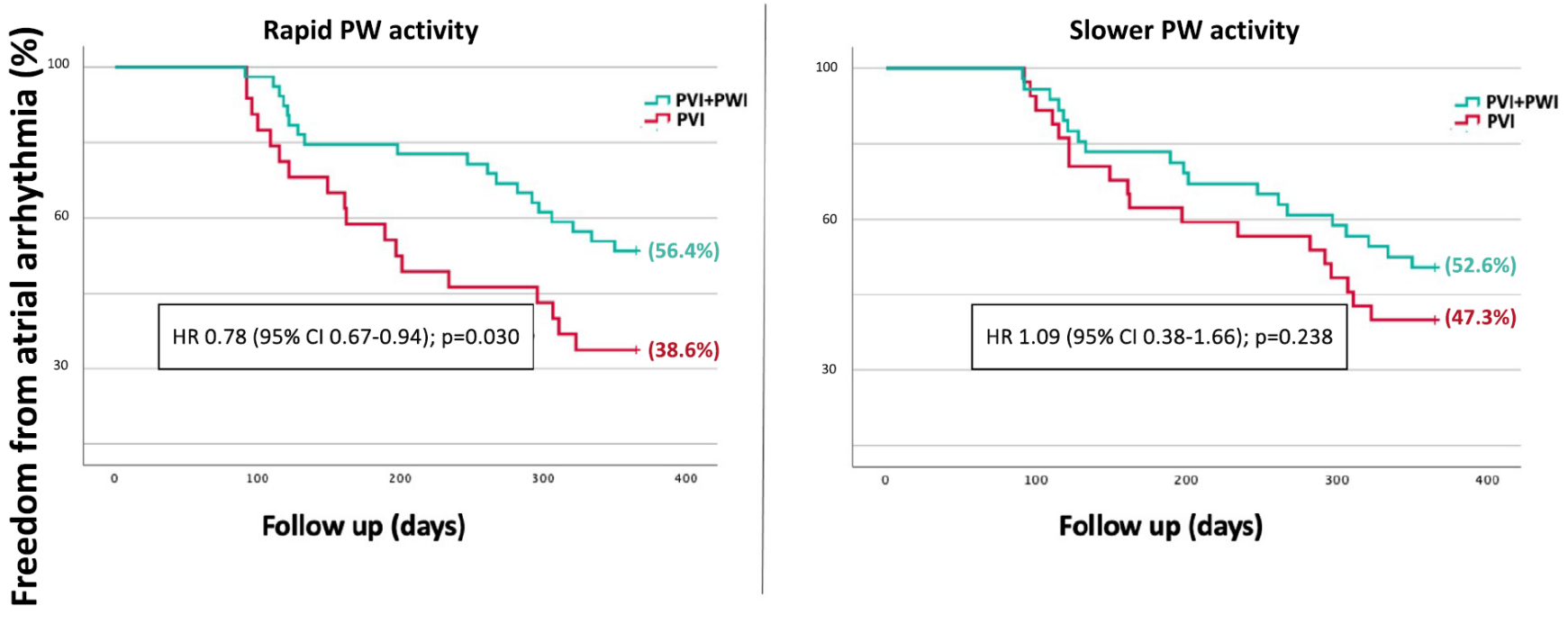
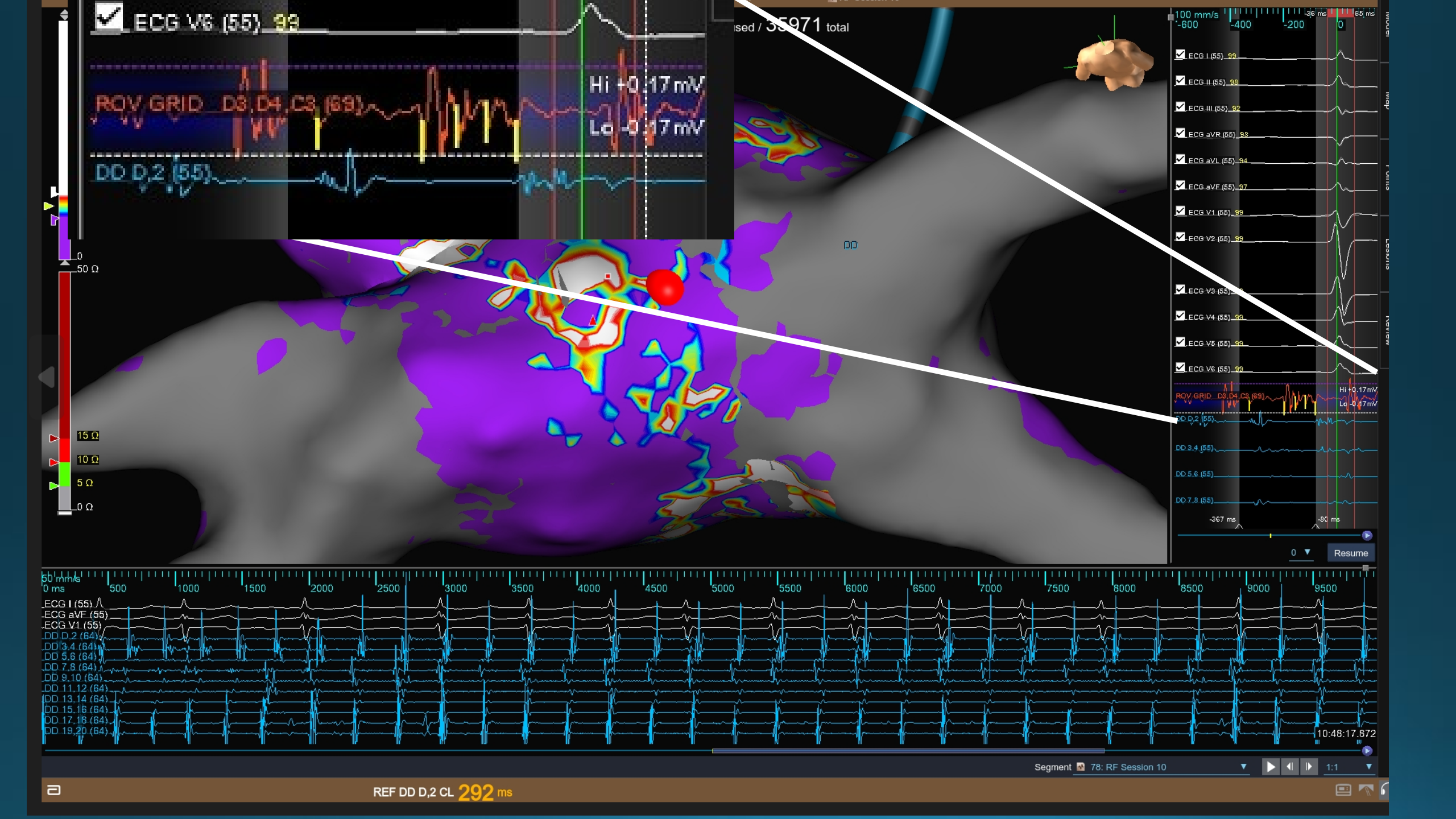


FIGURE 4 Kaplan-Meier Estimate of Arrhythmia Free Survival Stratified by PW Activity




ECG V6 (55) 99
ROV GRID D3,D4,C3 (69)
Hi +0.17 mV
Lo -0.17 mV
DD D,2 (55)
sed / 35971 total
100 mm/s
-600
-400
-200
0
ECG I (55) 99
ECG II (55) 98
ECG III (55) 92
ECG aVR (55) 98
ECG aVL (55) 94
ECG aVF (55) 97
ECG V1 (55) 99
ECG V2 (55) 99
ECG V3 (55)
ECG V4 (55) 99
ECG V5 (55) 99
ECG V6 (55) 99
ROV GRID D3,D4,C3 (69)
Hi +0.17 mV
Lo -0.17 mV
DD D,2 (55)
DD 3,4 (55)
DD 5,6 (55)
DD 7,8 (55)
-367 ms
-80 ms
Resume
0
50 Ω
15 Ω
10 Ω
5 Ω
0 Ω
50 mm/s
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500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
9500
ECG I (55)
ECG aVF (55)
ECG V1 (55)
DD D,2 (64)
DD 3,4 (64)
DD 5,6 (64)
DD 7,8 (64)
DD 9,10 (64)
DD 11,12 (64)
DD 13,14 (64)
DD 15,16 (64)
DD 17,18 (64)
DD 19,20 (64)
10:48:17.872
Segment
78: RF Session 10
1:1
REF DD D,2 CL 292 ms

HEART RHYTHM

Tailored Cardiac Ablation Procedure for Persistent Atrial Fibrillation Guided by Artificial Intelligence

The TAILORED-AF Randomized Clinical Trial

Isabel Deisenhofer MD, Jean-Paul Al
Gitenay MD, Stavros E Mountantonak
Horvilleur MD, Babé Bakouboula MD
Guillaume Theodore MD, Antoine Le
Bessiere MD, PhD, Paola Milpied
Guerrero, Tom De Potter MD, Christi
Atul Verma MD, John Hummel MD

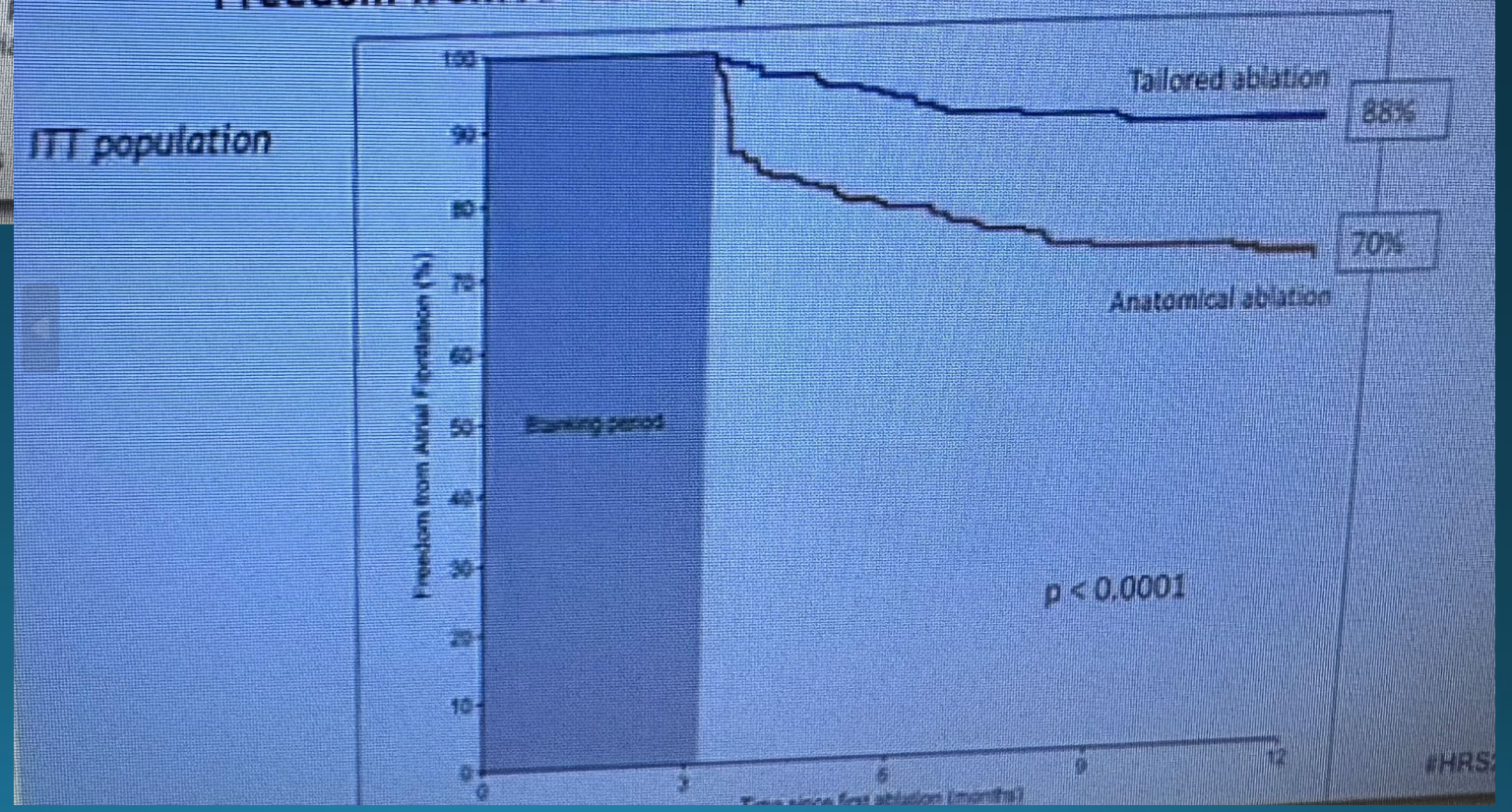
Late Breaking Clinical Trials

TAILORED-AF

Primary Endpoint

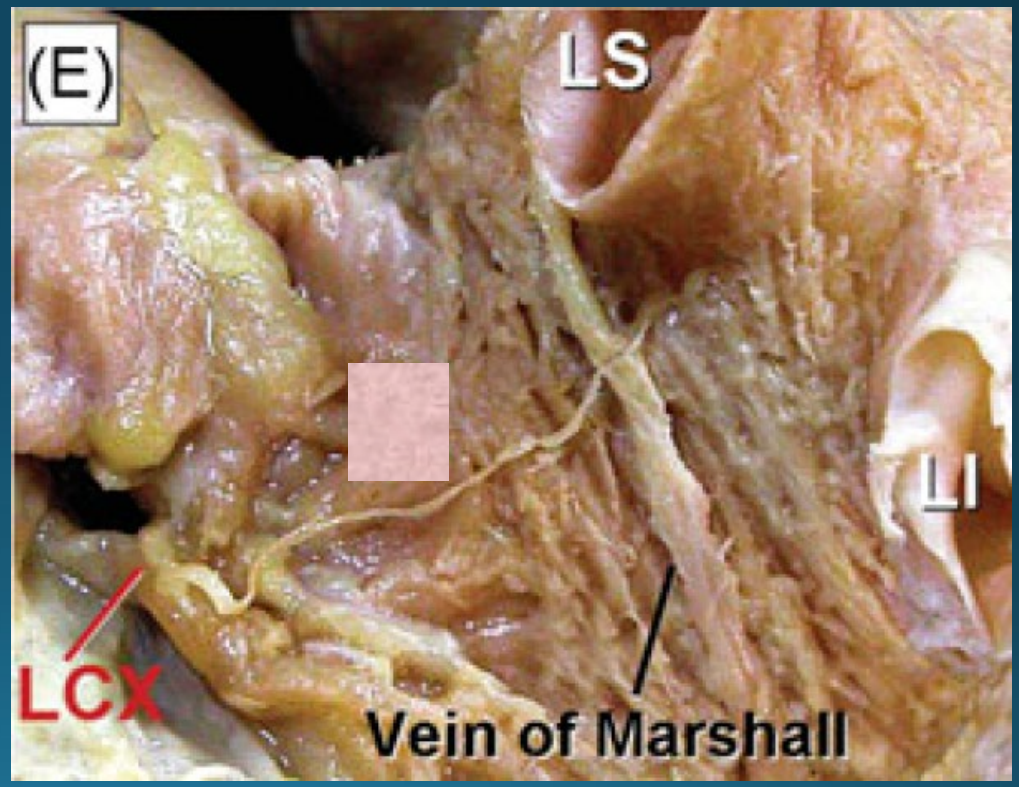
Freedom from AF after 1 procedure, on/off AADs, at 12 months

ITT population



What about Fairytale of Vein of Marshall?

- Vein to Myocardium interface
- Ganglionic tissue
- Part of mitral isthmus
- Access to Epicardial layer



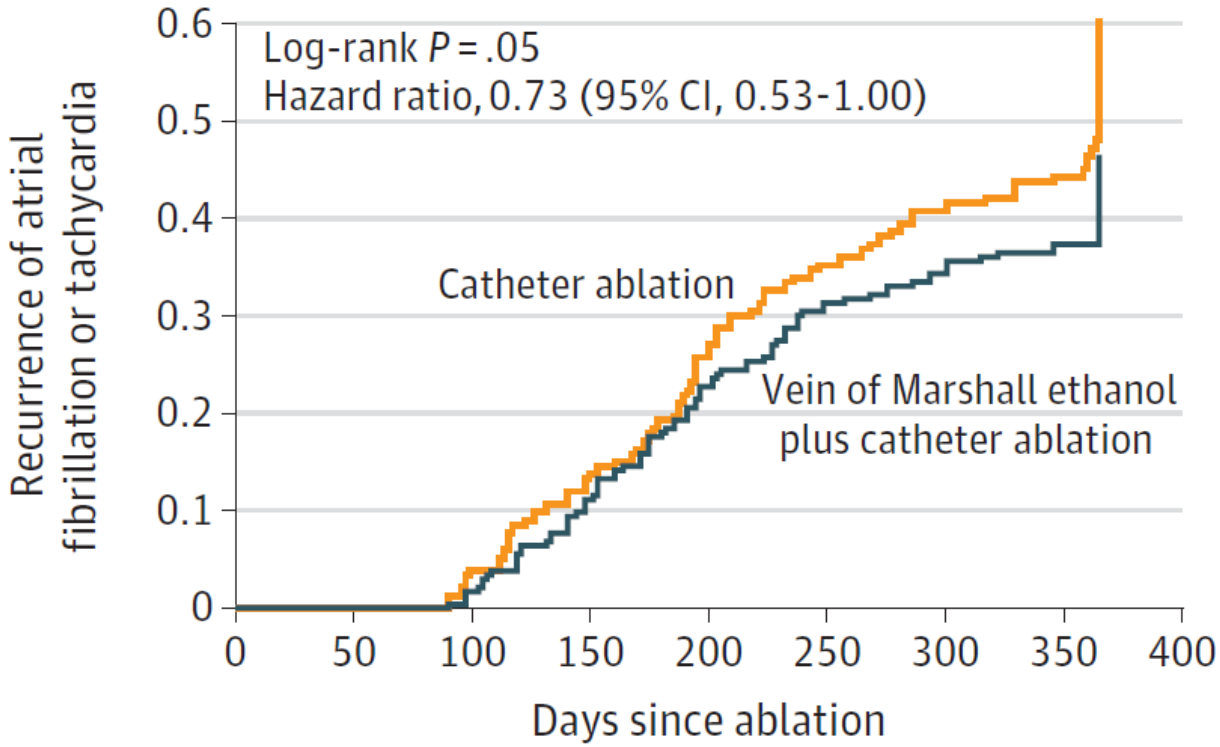
Cabrera J et al, EHJ 2008, 29:356-62

JAMA | Original Investigation

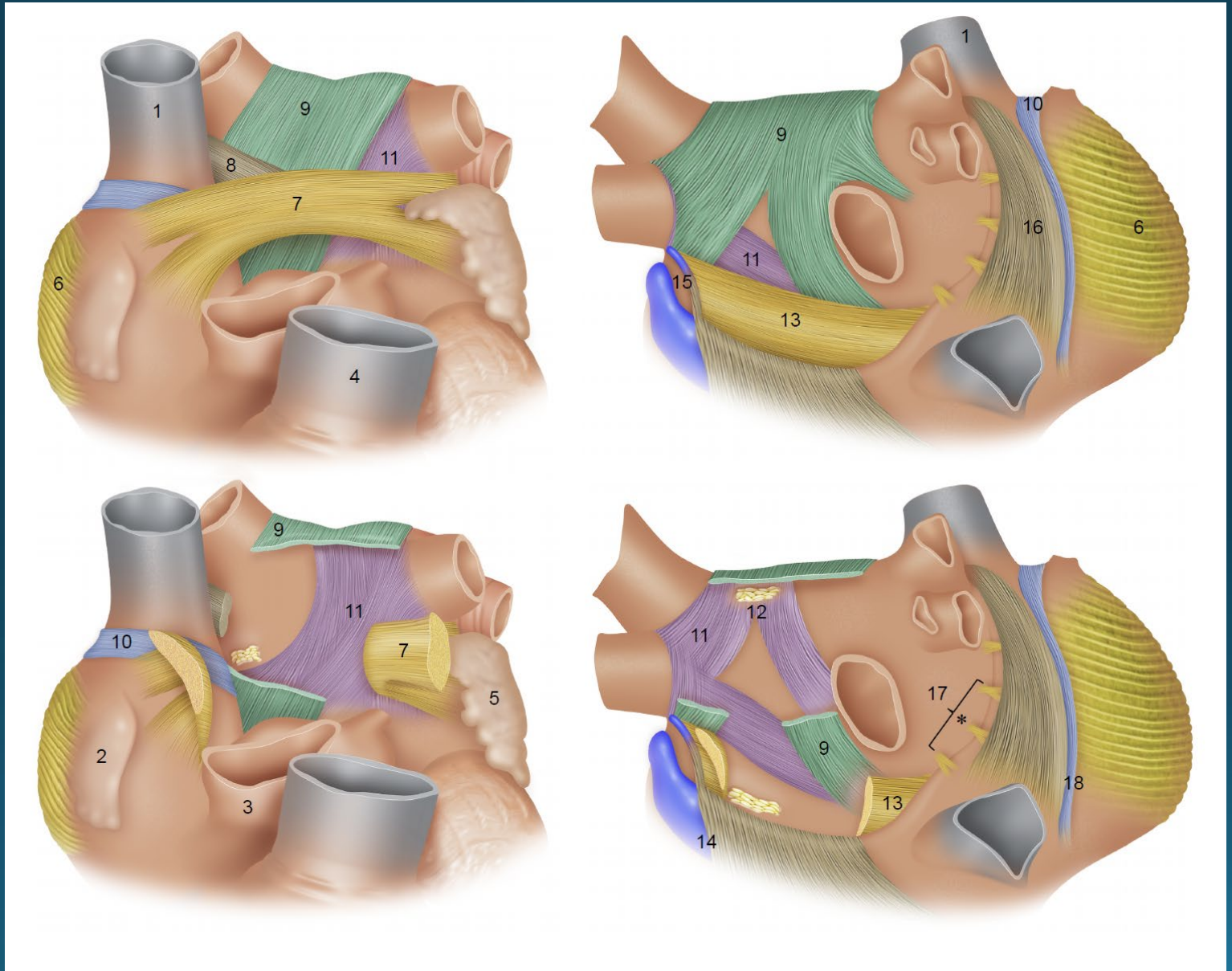
Effect of Catheter Ablation With Vein of Marshall Ethanol Infusion vs Catheter Ablation Alone on Persistent Atrial Fibrillation
The VENUS Randomized Clinical Trial

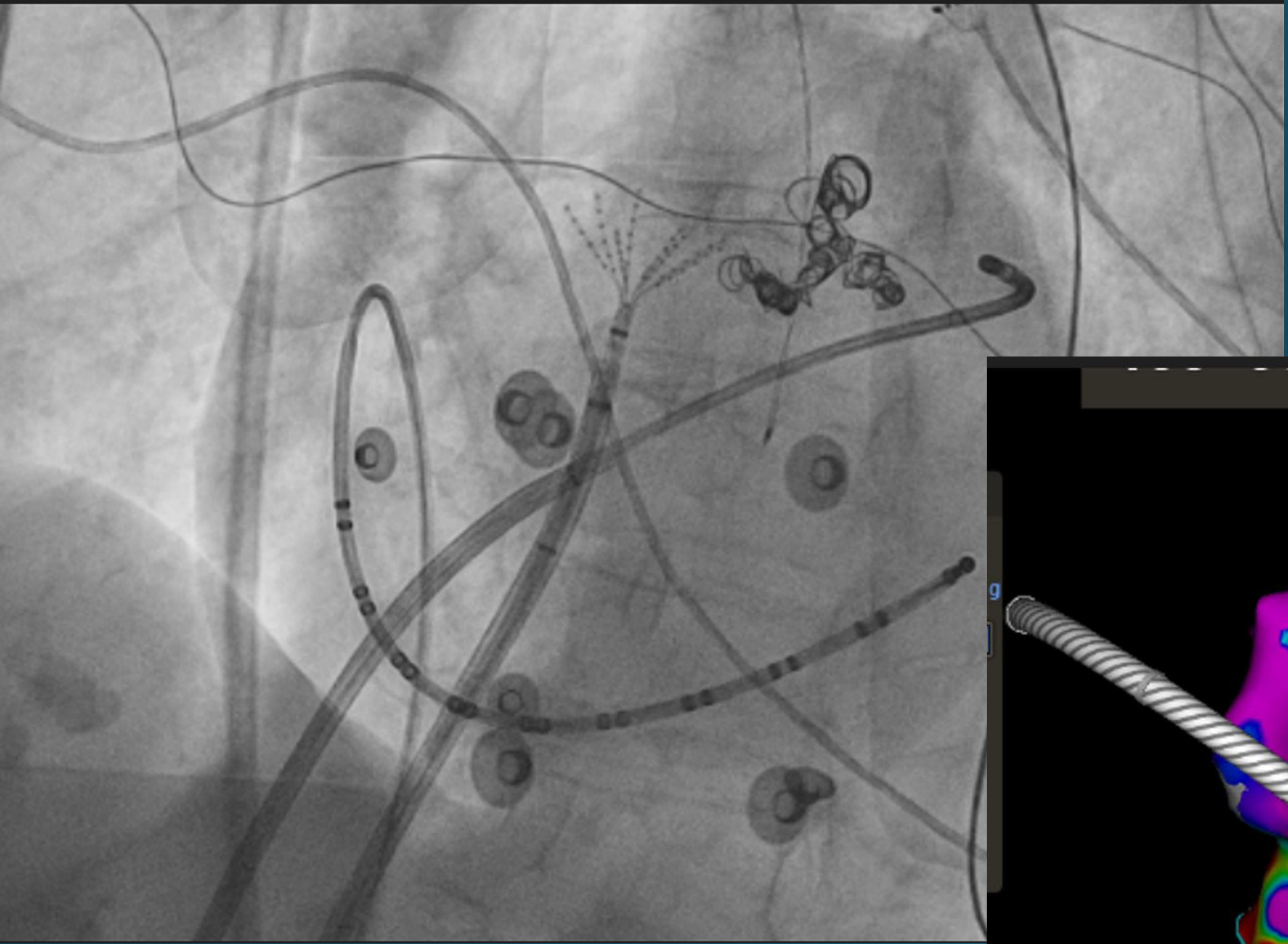
Miguel Valderrábano, MD; Leif E. Peterson, PhD; Vijay Swarup, MD; Paul A. Schurmann, MD; Akash Makkar, MD; Rahul N. Doshi, MD; David DeLurgio, MD; Charles A. Athill, MD; Kenneth A. Ellenbogen, MD; Andrea Natale, MD; Jayanthi Koneru, MD; Amish S. Dave, MD, PhD; Irakli Giorgberidze, MD; Hamid Afshar, MD; Michelle L. Guthrie, RN; Raquel Bunge, RN; Carlos A. Morillo, MD; Neal S. Kl

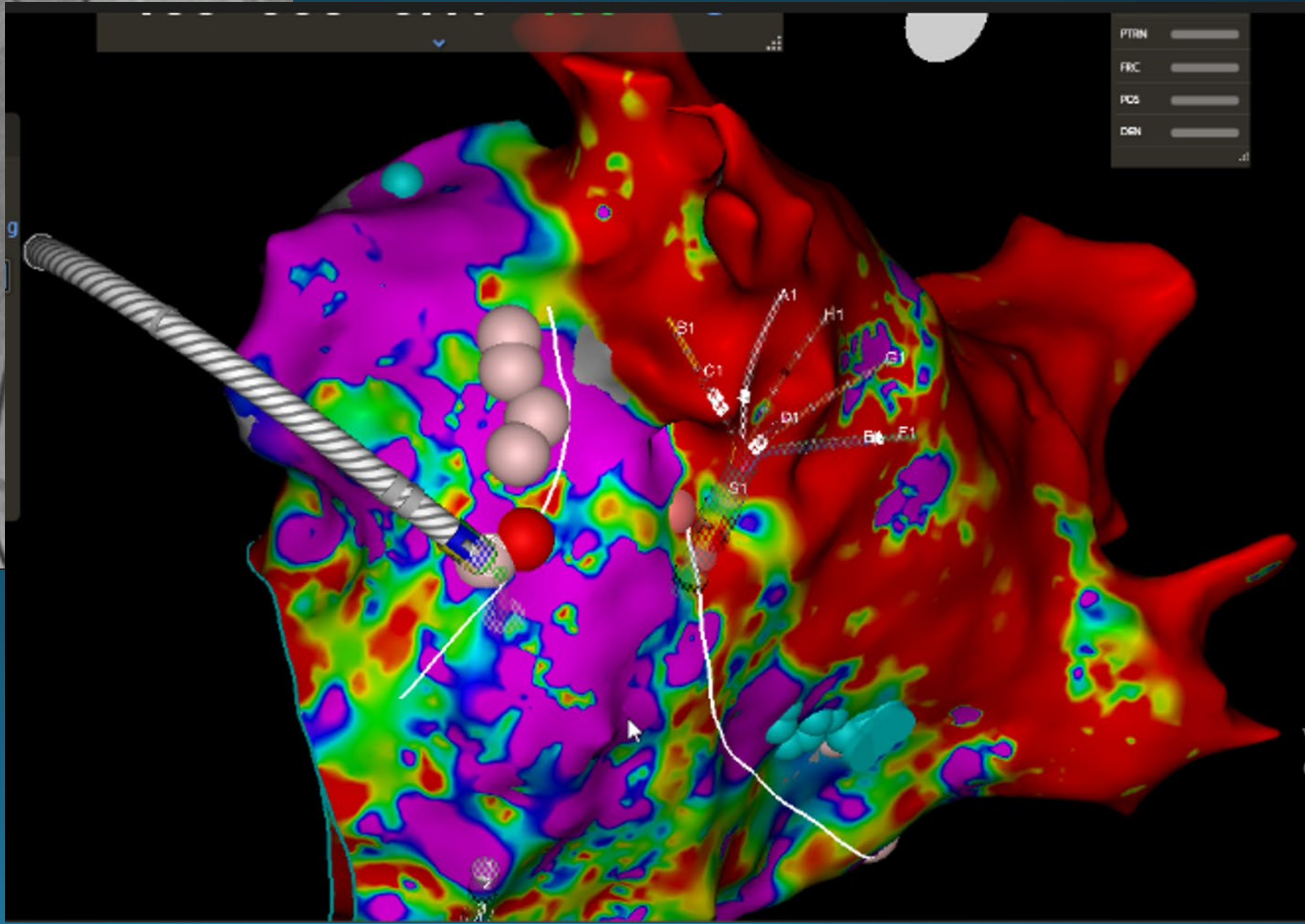
- 350 pts, randomization 1:1
- Persistent first RFA
- VOM success 84%
- 40 min add
- Modest procedural success

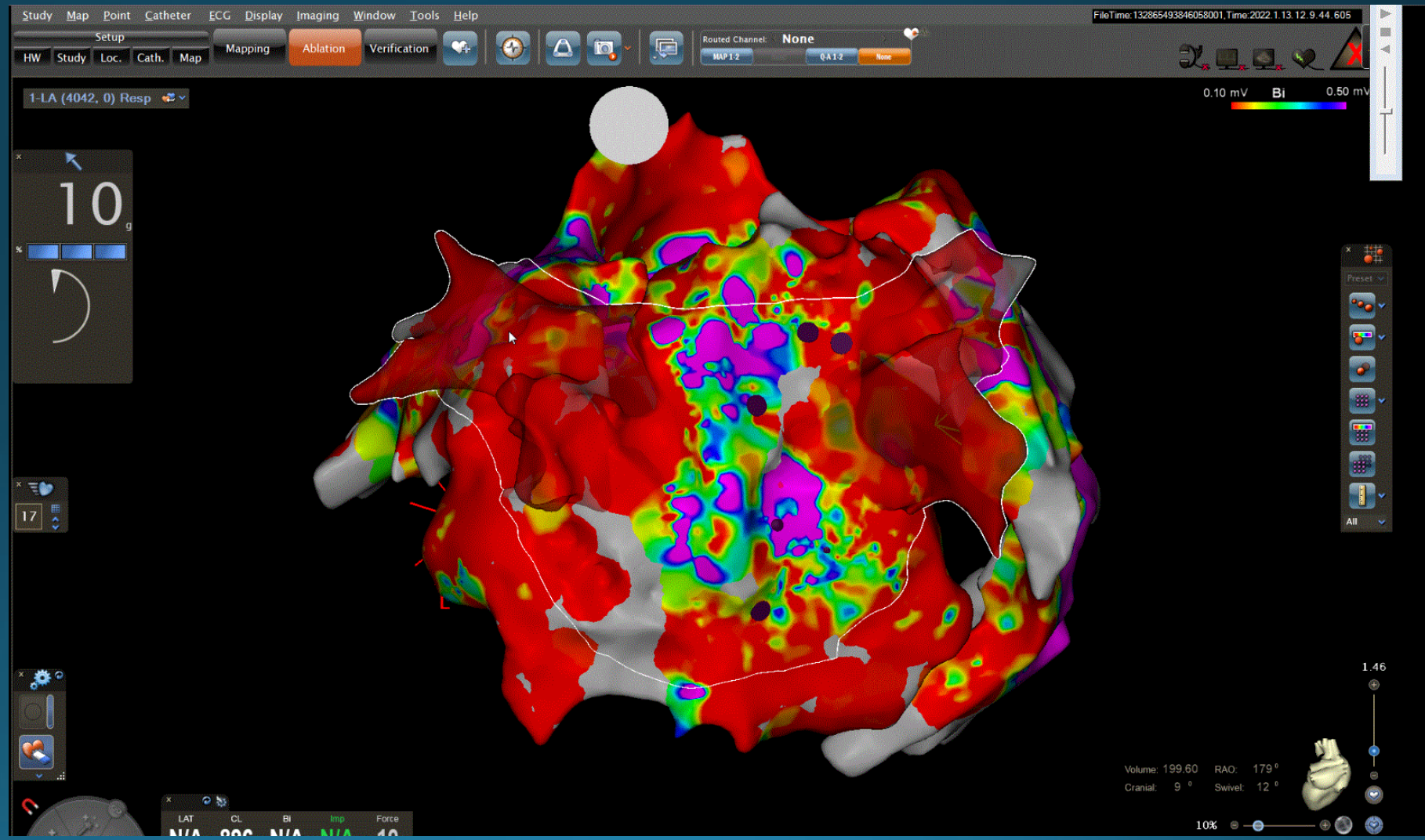


Role of Epicardial Layer- Hybrid ablation?






PTRN
FRC
PDS
DRN
A1
H1
G1
C1
D1
F1


Study Map Point Catheter ECG Display Imaging Window Tools Help
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Setup
HW Study Loc. Cath. Map
Mapping
Ablation
Verification
Routed Channel: None
1-LA (4042, 0) Resp
0.10 mV Bi 0.50 mV
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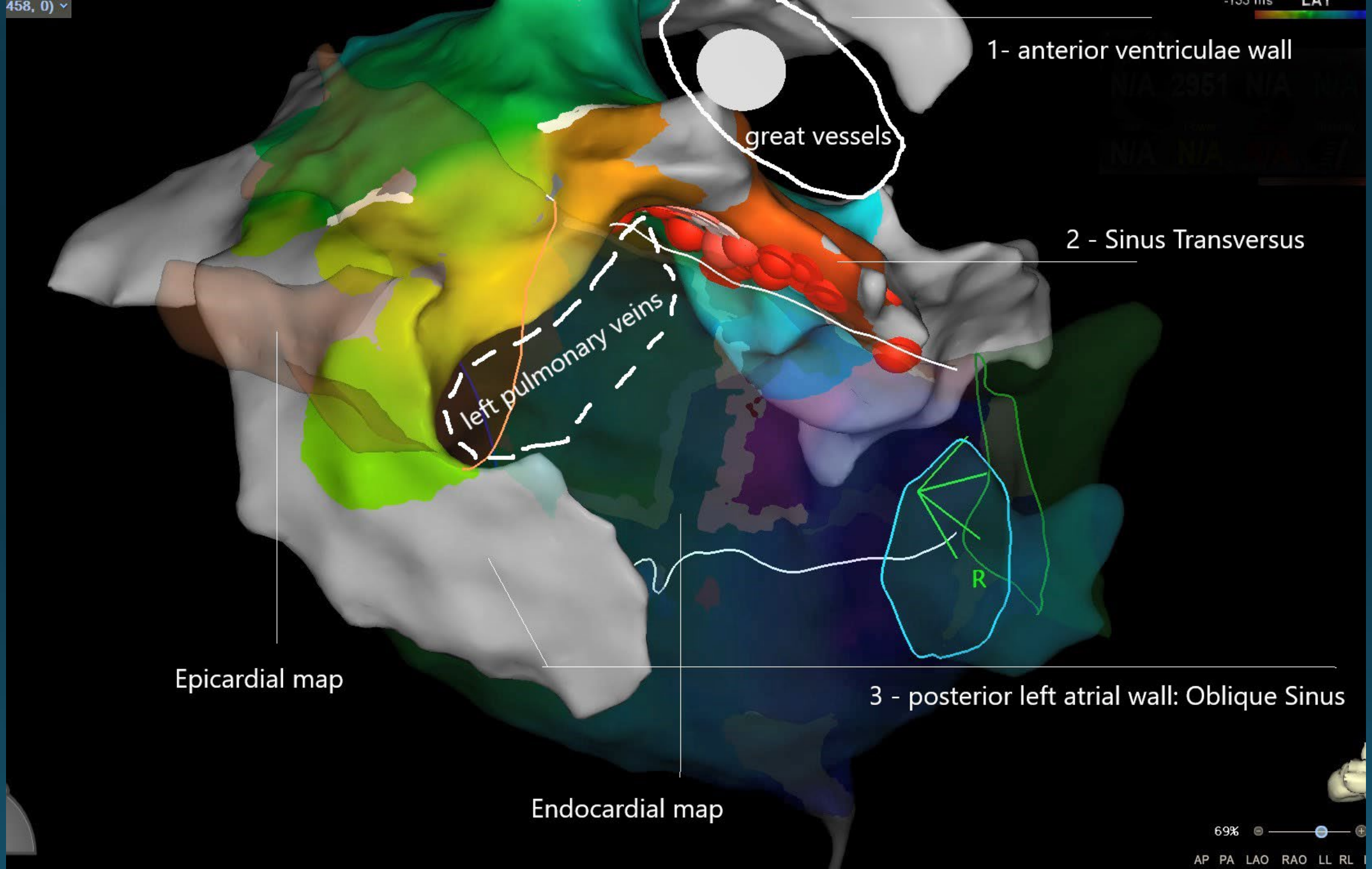
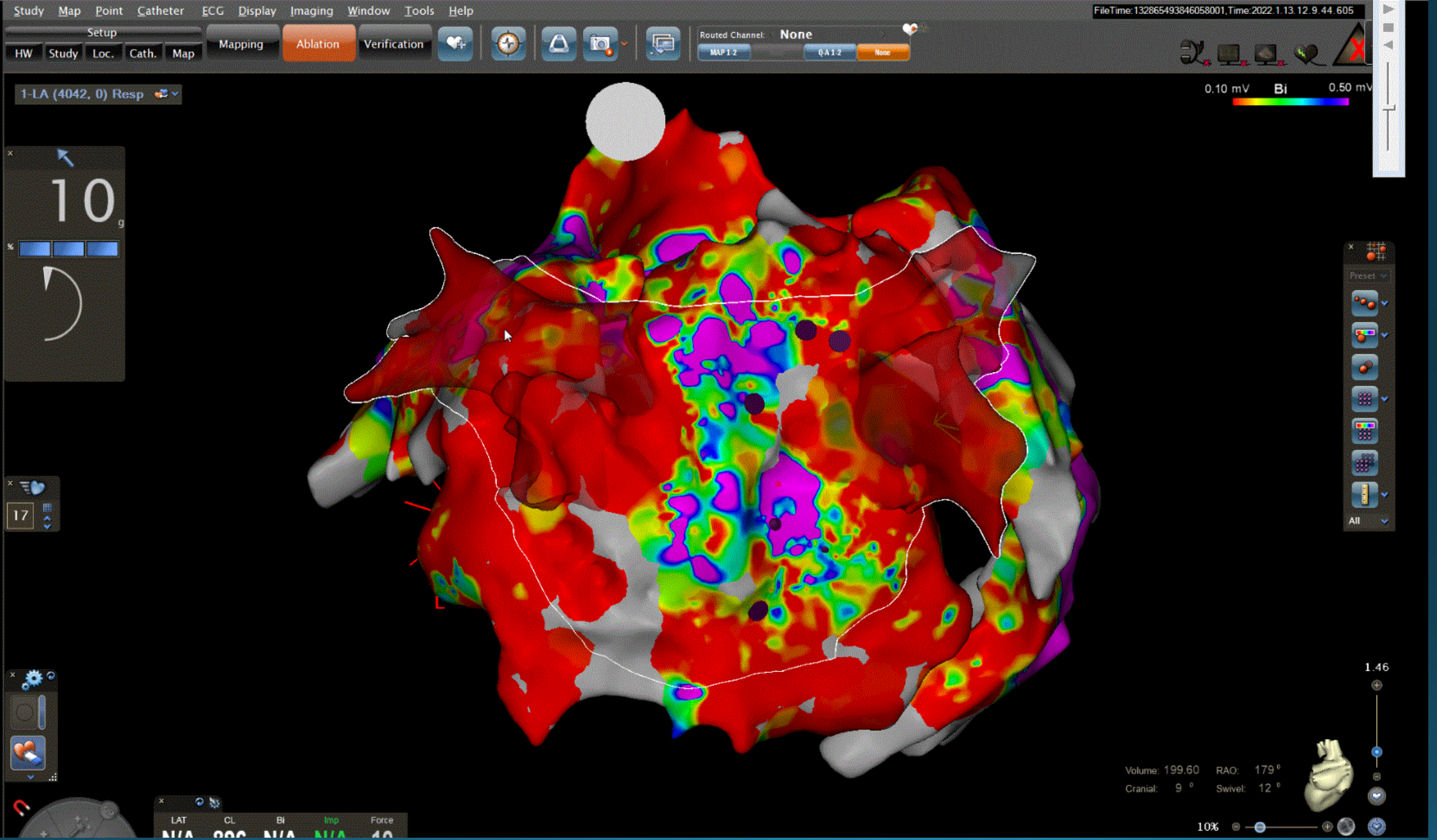
17
Preset
All
LAT CL Bi Imp Force
Volume: 199.60 RAO: 179 °
Cranial: 9 ° Swivel: 12 °
1.46
10%

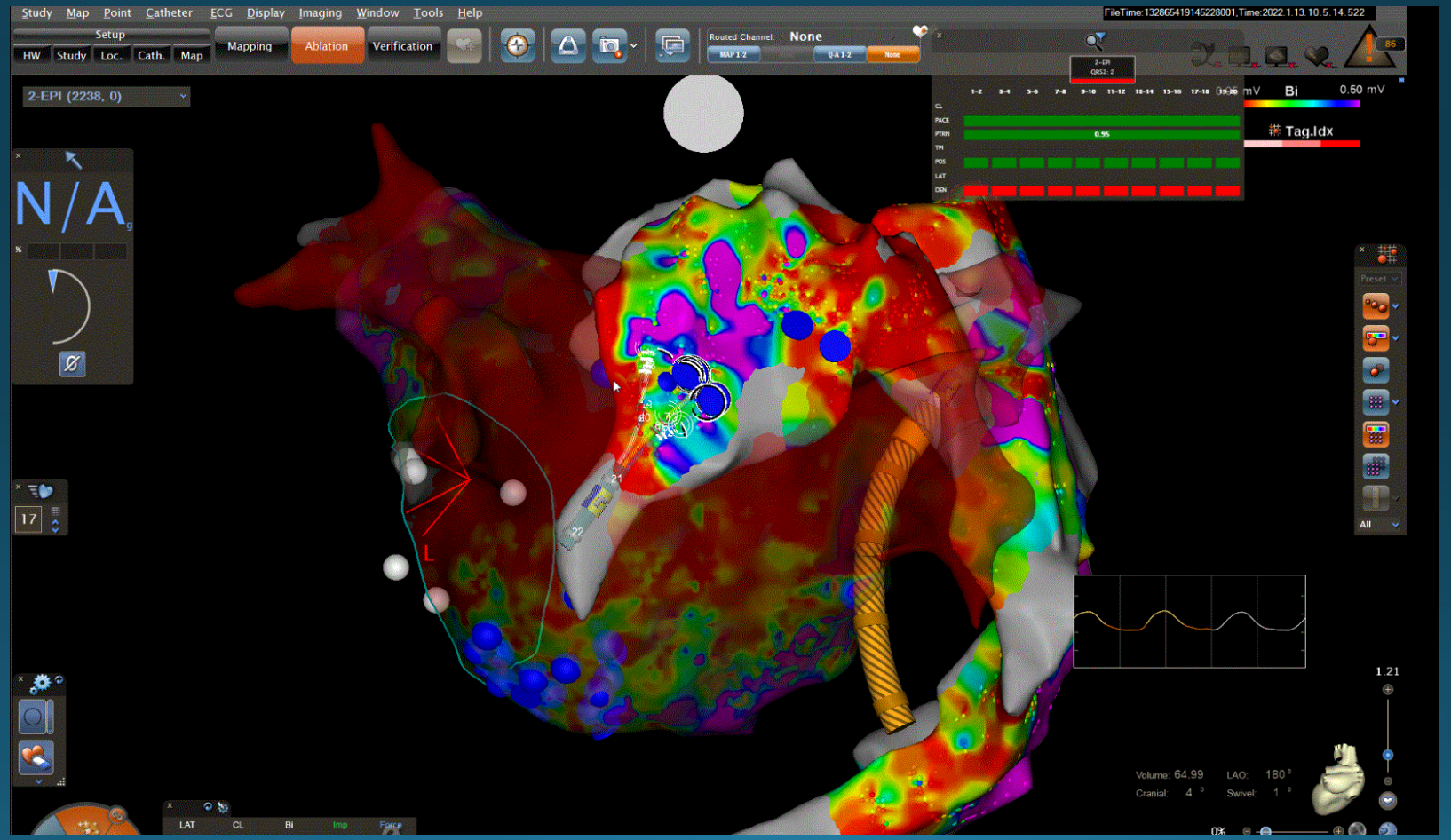

CardioLab - [Administrator] - ABU KAF, LUBNA 300501269
Study Study Configuration Measurements Windows Administration Help
Real-Time
CRYO
Real-Time: Page 3
100
I
II
aVF
V1
Penta 1,2
Penta 3,4
Penta 5,6
Penta 7,8
Penta 9,10
Penta 11,12
Penta 13,14
Penta 15,16
Penta 17,18
Penta 19,20
CS 1,2
ABL d
ABL p
ABU KAF, LUBNA
HR 1 76
HR 2
Ablation
Duration
Impedance
110
Power
Temp
Power (W)
Imp (O)
Temp (C)
75
400
100
Ablation 1 (Stockert)
0
10
20
30
40
50
60
RVa : 2-1
RVa : 2-1
RVA : 18-17
CS : 2-1
Car : 16-15
1000 ms
2000 ms
ABU KAF, LUBNA
HR 1 79
HR 2
BP ***/***/***
NBP
SpO2 :
Temp
11:57:44 AM

You cannot step into the same river twice.

~ Heraclitus


1- anterior ventriculae wall
great vessels
2 - Sinus Transversus
left pulmonary veins
R
Epicardial map
3 - posterior left atrial wall: Oblique Sinus
Endocardial map
69%
AP PA LAO RAO LL RL

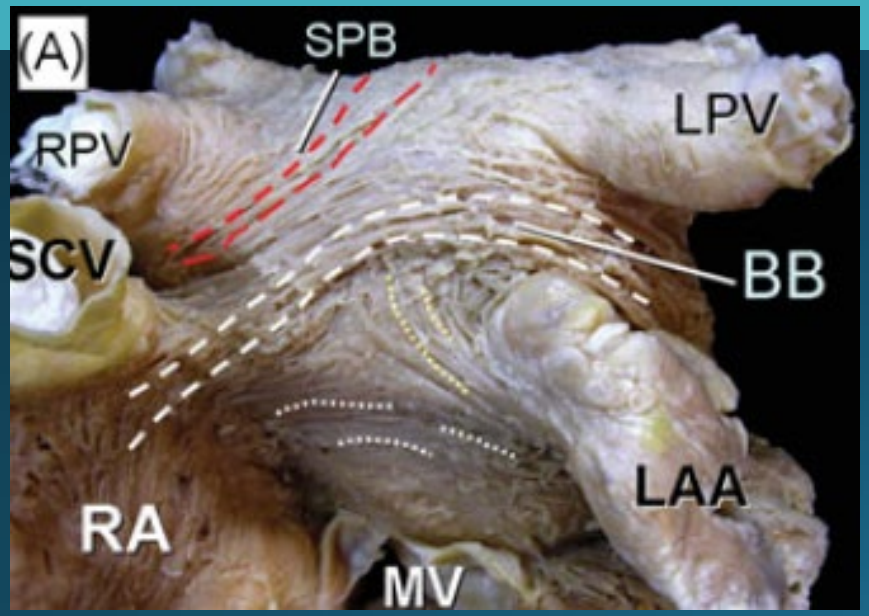

Study Map Point Catheter ECG Display Imaging Window Tools Help
FileTime:132865493846058001,Time:2022.1.13.12.9.44.605
Setup
HW Study Loc. Cath. Map
Mapping
Ablation
Verification
Routed Channel: None
MAP 1-2
QA 1-2
None
1-LA (4042, 0) Resp
0.10 mV Bi 0.50 mV
10 g
%
17
Preset
All
1.46
Volume: 199.60 RAO: 179 °
Cranial: 9 ° Swivel: 12 °
10%
LAT CL Bi Imp Force
N/A N/A N/A


Study Map Point Catheter ECG Display Imaging Window Tools Help
Setup
HW Study Loc. Cath. Map
Mapping
Ablation
Verification
Routed Channel: None
2-EPI (2238, 0)
N/A
Bi
0.50 mV
Tag.Idx
LAT CL Bi Imp Force
Volume: 64.99
Cranial: 4 °
LAO: 180 °
Swivel: 1 °

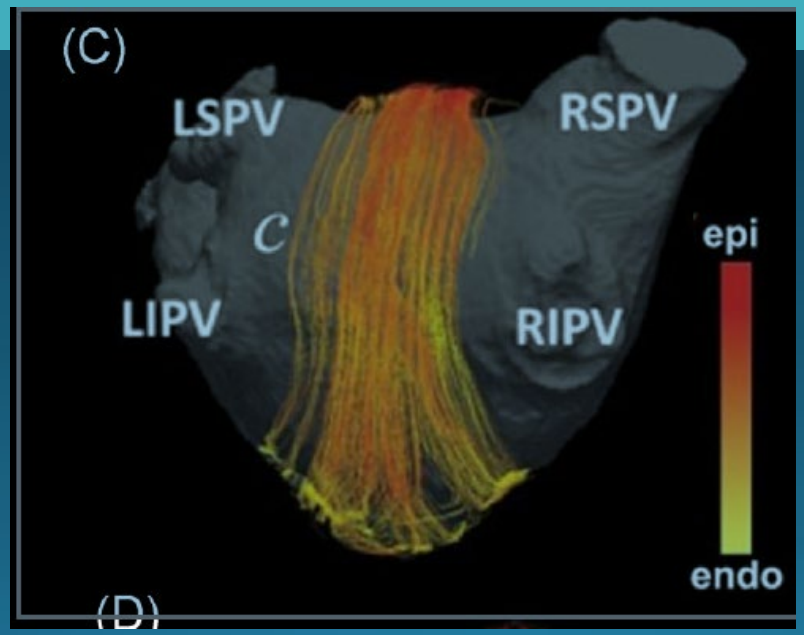
Why Epicardial?

Recurrent arrhythmia, resistant to endocardial ablation

- Epicardial fibers may participate in macro-reentry circuit (Buchman bundle, Septo-pulmonary bundle)



Cabrera J et al, EHJ 2008, 29:356-62



Garsia F et al, JCE 2019

- Endocardial ablation may be not transmural, especially in thick area of atrium such as anterior wall and Left Lateral Ridge

Glover B et al. JACC EP 2018, 4: 557-8

Cabrera J et al, EHJ 2008, 29:356-62

- In one study as much as 78 % of anterior ablation lines required epicardial completion after endocardial RF applications

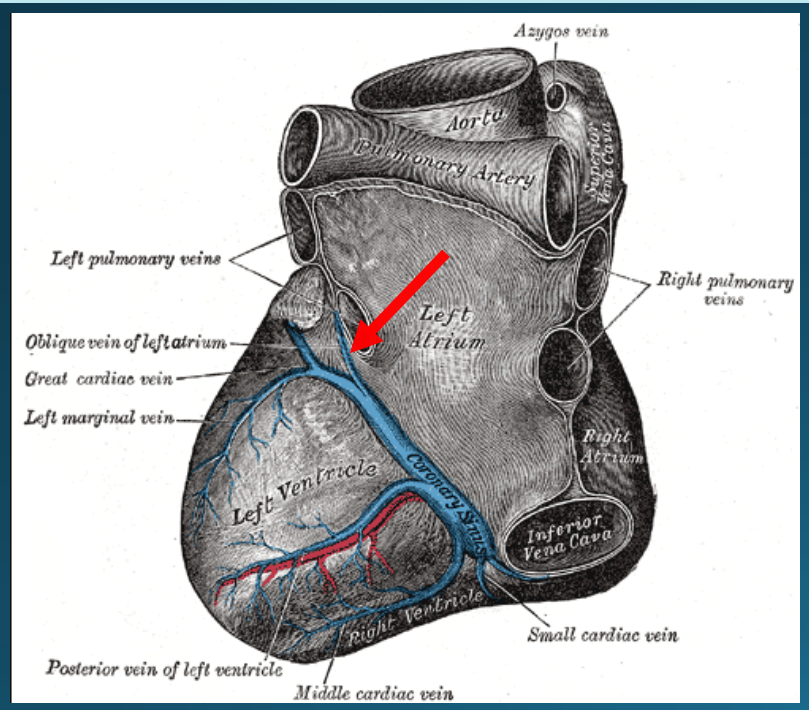
Piorkowski C et al. Circulation EP 2018;11.

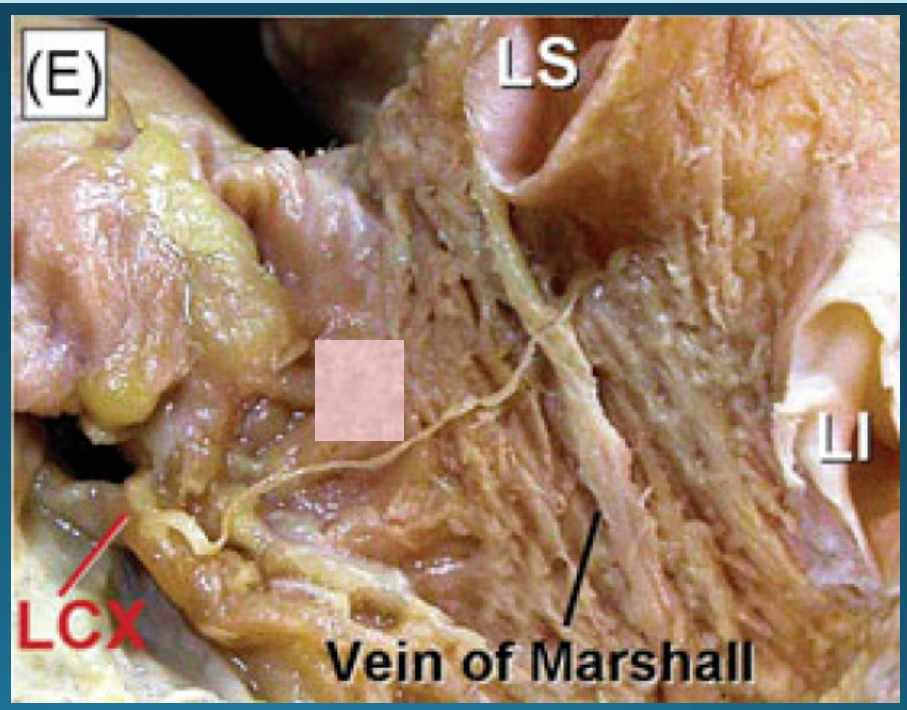
- Epicardial parasympathetic ganglia were demonstrated to play important role in initiation and maintenance of AF

Stavrakis S et al. JACC 2015;1

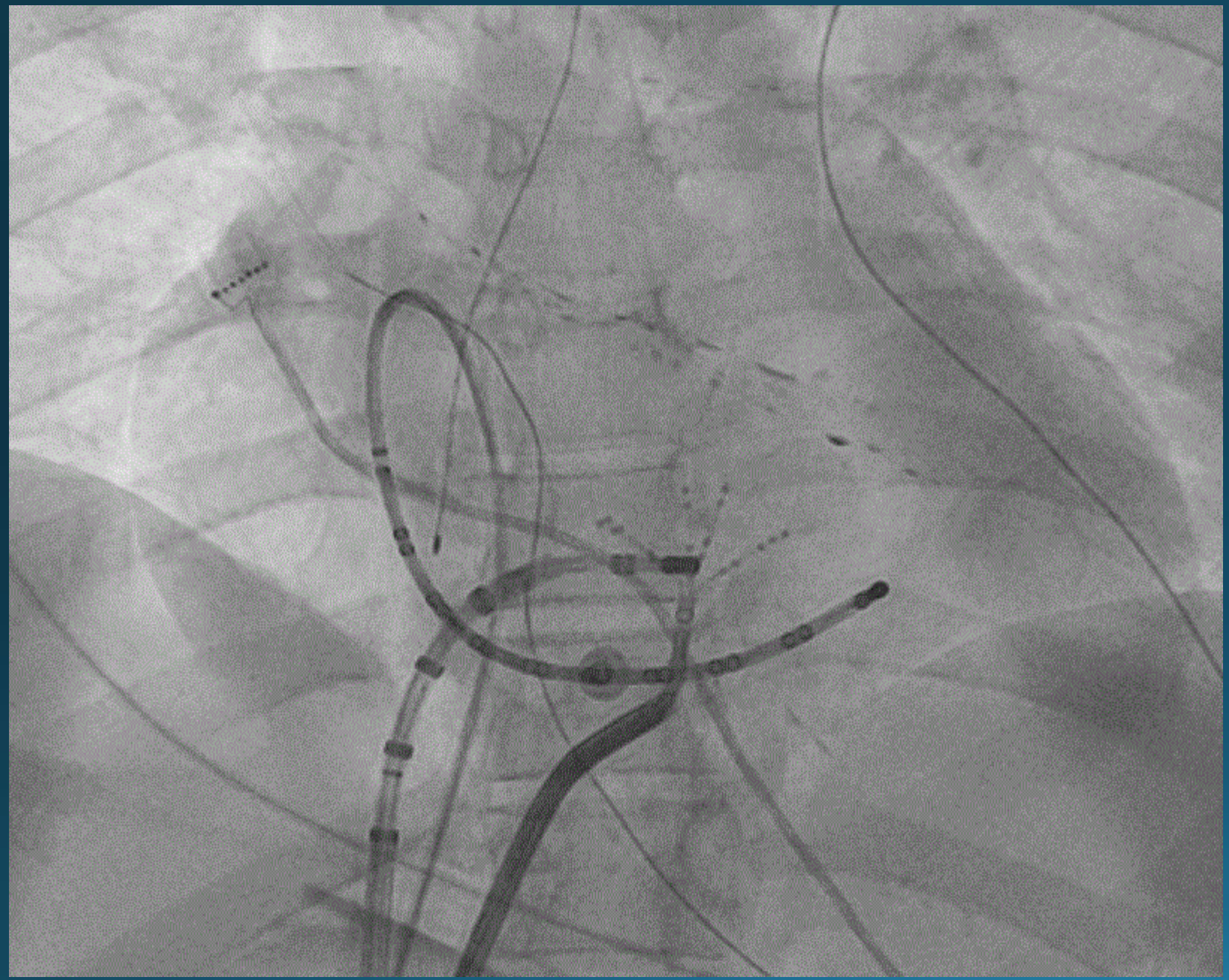
LIGAMENT/VEIN OF MARSHALL – EPICARDIAL STRUCTURE

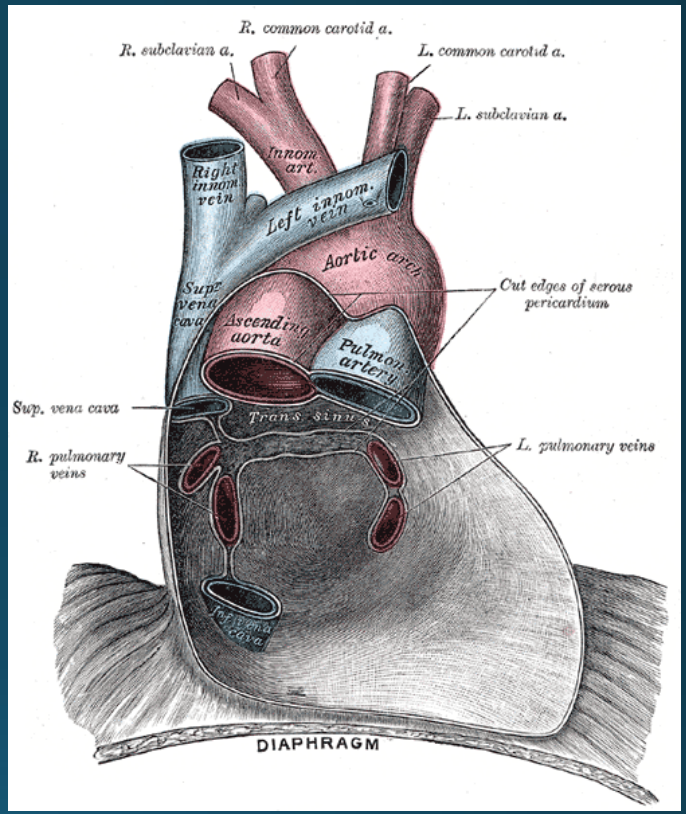
- The source of focal/micro re-entry atrial arrhythmia Viachos K et al , HRJ 2019
- Mitral isthmus bypass – support peri-mitral flutter
  - ablation of mitral isthmus required intra-CS ablation in 75% cases
- Ethanol infusion inside VOM may abolished atrial arrhythmia





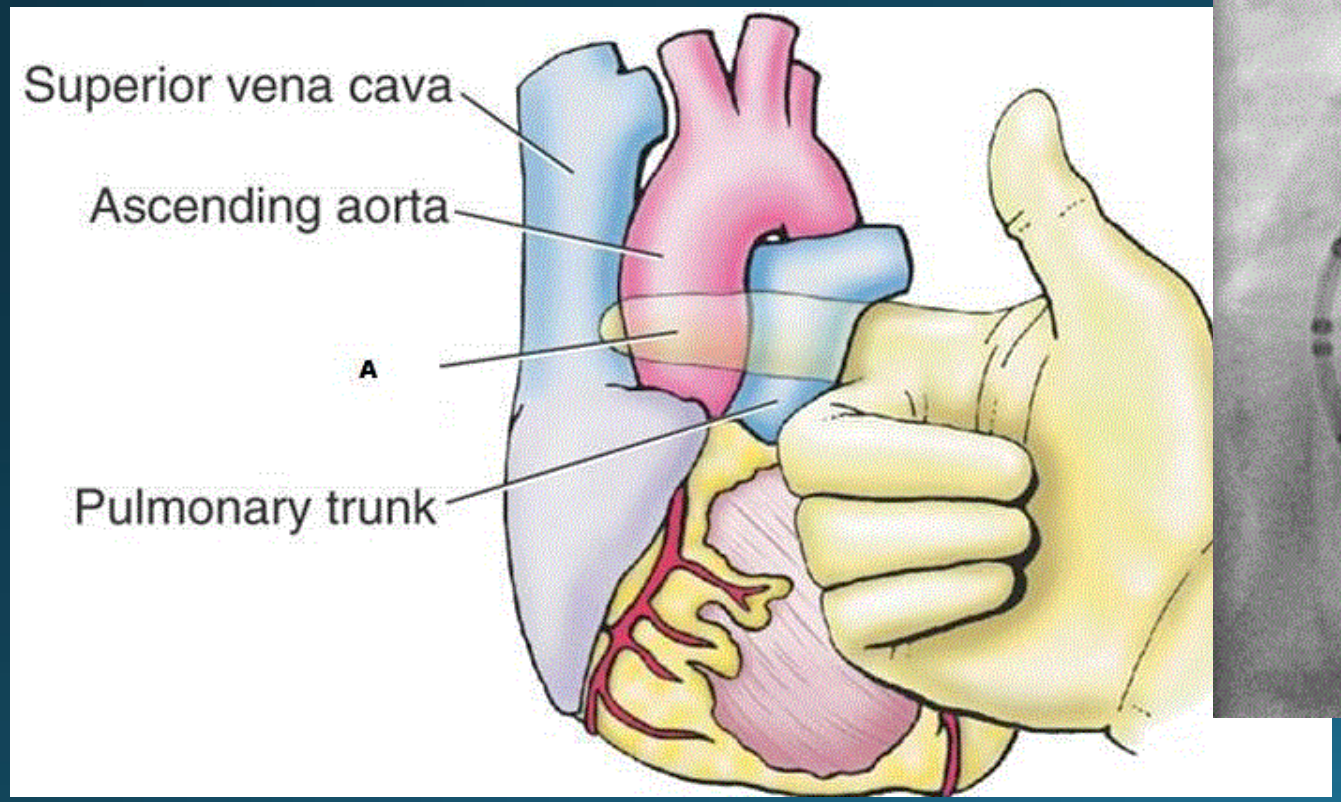
Cabrera J et al, EHJ 2008, 29:356-62

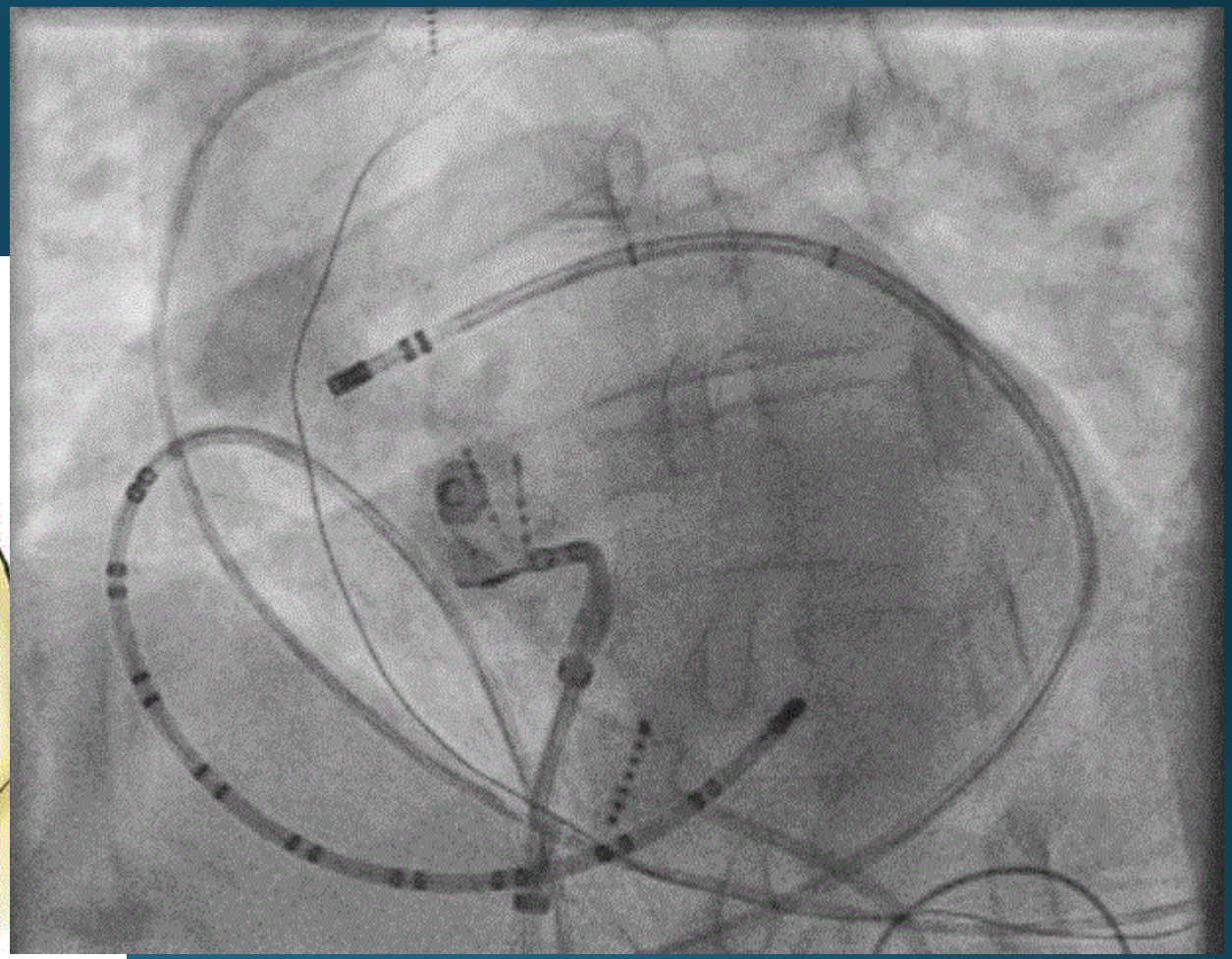



R. common carotid a.
R. subclavian a.
L. common carotid a.
L. subclavian a.
Innom. art.
Right innom. vein
Left innom. vein
Aortic arch
Sup. vena cava
Ascending aorta
Pulmonary artery
Cut edges of serous pericardium
Sup. vena cava
Trans. sinus
R. pulmonary veins
L. pulmonary veins
Inf. vena cava
DIAPHRAGM

- EPICARDIAL mapping of OBLIQUE SINUS may reveal arrhythmogenic substrate over "silent " endocardial voltage map
- Ablation from ENDOCARDIAL surface guided by EPICARDIAL map effectively eliminated epicardial fractionated electrograms
- Efficacy of this approach to treat atrial fibrillation required future assessment

- Sinus Transversus may be easily accessed during pericardial procedure





RE DO persistent AF – what's different?

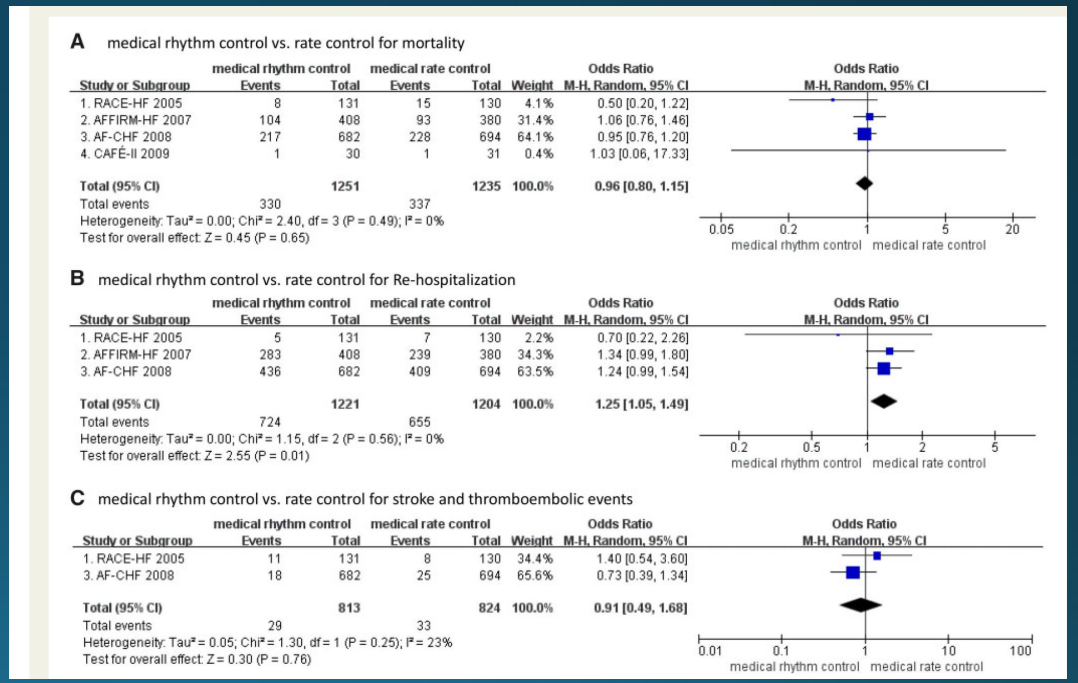
- PVI usually is accomplished
- Procedure is more extensive and more aggressive
- New technology
- Epicardial procedure ? (surgical or catheter)

ESC European Society of Cardiology
European Heart Journal (2020) **41**, 2863–2873
doi:10.1093/eurheartj/ehz443

CLINICAL RESEARCH
Arrhythmia/electrophysiology

Rhythm control for patients with atrial fibrillation complicated with heart failure in the contemporary era of catheter ablation: a stratified pooled analysis of randomized data

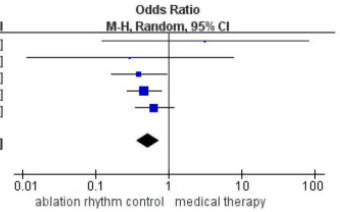
Shaojie Chen[1]*, Helmut Pürerfellner[2], Christian Meyer[3,4], Willem-Jan Acou[5], Alexandra Schratter[6], Zhiyu Ling[7], Shaowen Liu[8], Yuehui Yin[7], Martin Martinek[2], Marcio G. Kiuchi[9], Boris Schmidt[1]*, and K.R. Julian Chun[1]*



A catheter ablation rhythm control vs. medical therapy for all-cause mortality

Study or Subgroup	ablation rhythm control Events	Total	medical therapy Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
2. ARC-HF 2013	1	26	0	26	1.3%	3.12 [0.12, 80.12]
3. CAMTAF 2014	0	26	1	24	1.3%	0.30 [0.01, 7.61]
4. AATAC 2016	8	102	18	101	17.0%	0.39 [0.16, 0.95]
6. CASTLE-AF 2018	24	179	46	184	44.7%	0.46 [0.27, 0.80]
7. CABANA HF-subgroup 2019	21	174	29	163	35.9%	0.63 [0.35, 1.16]
Total (95% CI)		**507**		**498**	**100.0%**	**0.51 [0.36, 0.74]**
Total events	54		94			

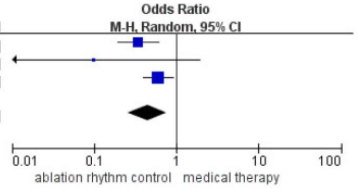
Heterogeneity: Tau² = 0.00; Chi² = 2.25, df = 4 (P = 0.69); I² = 0%
Test for overall effect: Z = 3.59 (P = 0.0003)



B catheter ablation rhythm control vs. medical therapy for re-hospitalization

Study or Subgroup	ablation rhythm control Events	Total	medical therapy Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
4. AATAC 2016	32	102	58	101	42.4%	0.34 [0.19, 0.60]
5. CAMERA-MRI 2017	0	33	4	33	3.2%	0.10 [0.01, 1.89]
6. CASTLE-AF 2018	64	179	89	184	54.4%	0.59 [0.39, 0.90]
Total (95% CI)		**314**		**318**	**100.0%**	**0.44 [0.26, 0.76]**
Total events	96		151			

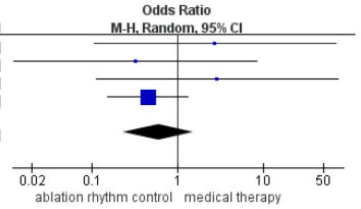
Heterogeneity: Tau² = 0.10; Chi² = 3.51, df = 2 (P = 0.17); I² = 43%
Test for overall effect: Z = 2.95 (P = 0.003)



C catheter ablation rhythm control vs. medical therapy for stroke

Study or Subgroup	ablation rhythm control Events	Total	medical therapy Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
1. MacDonald 2011	1	22	0	19	8.2%	2.72 [0.10, 70.79]
2. ARC-HF 2013	0	26	1	26	8.3%	0.32 [0.01, 8.24]
3. CAMTAF 2014	1	26	0	24	8.3%	2.88 [0.11, 74.21]
6. CASTLE-AF 2018	5	179	11	184	75.2%	0.45 [0.15, 1.33]
Total (95% CI)		**253**		**253**	**100.0%**	**0.59 [0.23, 1.51]**
Total events	7		12			

Heterogeneity: Tau² = 0.00; Chi² = 2.14, df = 3 (P = 0.54); I² = 0%
Test for overall effect: Z = 1.09 (P = 0.27)



ESC European Society of Cardiology

European Heart Journal (2020) **42**, 373–498
doi:10.1093/eurheartj/ehaa612

ESC GUIDELINES

2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS)

Table 4 Classification of AF

AF pattern	Definition
First diagnosed	AF not diagnosed before, irrespective of its duration or the presence/severity of AF-related symptoms.
Paroxysmal	AF that terminates spontaneously or with intervention within 7 days of onset.
Persistent	AF that is continuously sustained beyond 7 days, including episodes terminated by cardioversion (drugs or electrical cardioversion) after ≥7 days
Long-standing persistent	Continuous AF of >12 months' duration when decided to adopt a rhythm control strategy.

First-line therapy	
AF catheter ablation for PVI should/may be considered as first-line rhythm control therapy to improve symptoms in selected patients with symptomatic: • Paroxysmal AF episodes, or	**IIa**
• Persistent AF without major risk factors for AF recurrence as an alternative to AAD class I or III, considering patient choice, benefit, and risk.	**IIb**

Continued

Techniques and technologies	
Use of additional ablation lesions beyond PVI (low voltage areas, lines, fragmented activity, ectopic foci, rotors, and others) may be considered but is not well established.	**IIb**

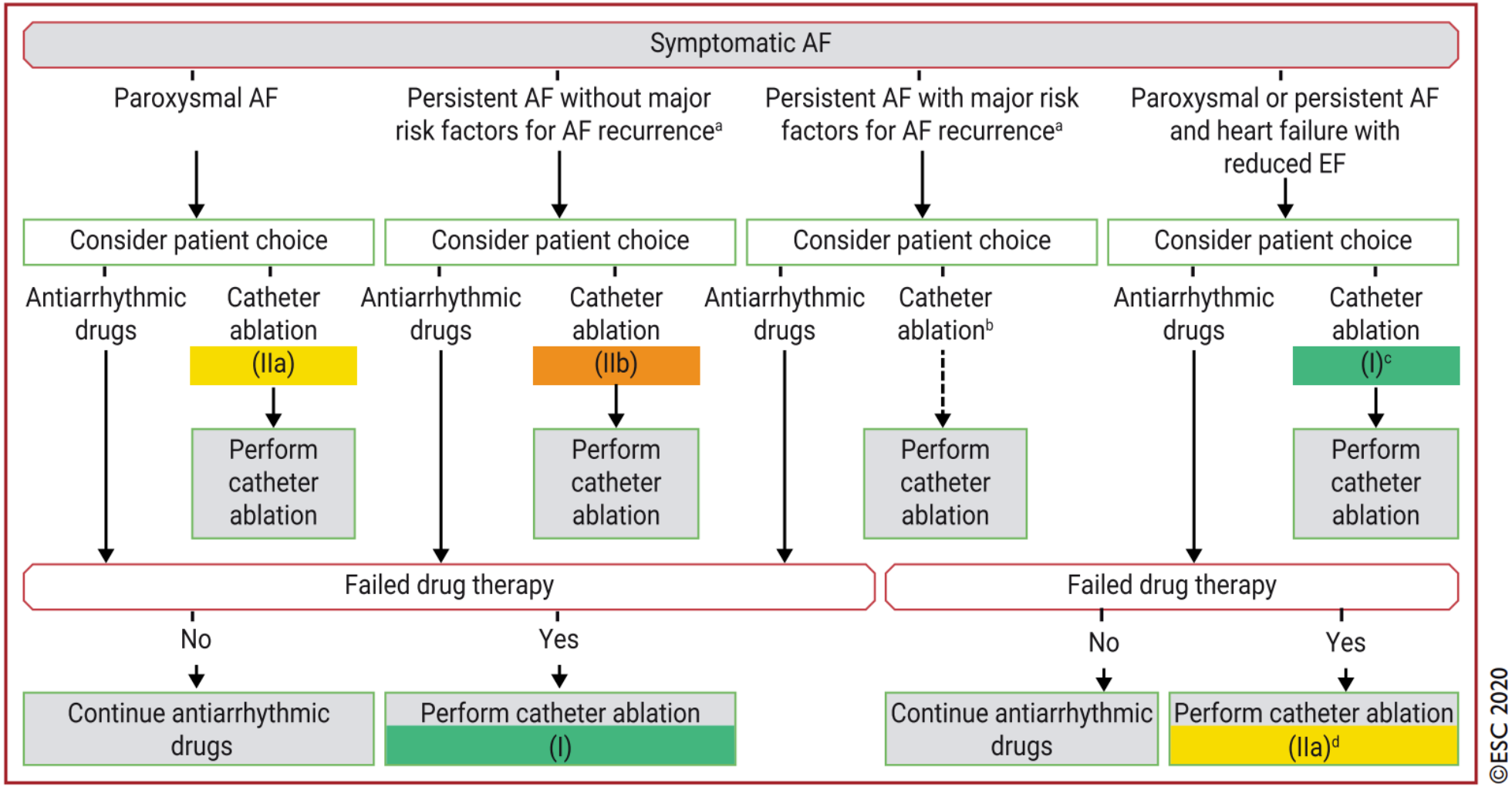


Figure 17 Indications for catheter ablation of symptomatic AF. The arrows from AAD to ablation indicate failed drug therapy. AAD = antiarrhythmic drug; AF = atrial fibrillation; EF = ejection fraction; LA = left atrial. [a]Significantly enlarged LA volume, advanced age, long AF duration, renal dysfunction, and other cardiovascular risk factors. [b]In rare individual circumstances, catheter ablation may be carefully considered as first-line therapy. [c]Recommended to reverse LV dysfunction when tachycardiomyopathy is highly probable. [d]To improve survival and reduce hospitalization.

AF catheter ablation after failure of drug therapy		
AF catheter ablation for PVI is recommended for rhythm control after one failed or intolerant class I or III AAD, to improve symptoms of AF recurrences in patients with[235–238,247,605–609,612,613,615–617,654,677,678,680,682,685,758,779,780,815]:	I	
• Paroxysmal AF, or		A
• Persistent AF without major risk factors for AF recurrence, or		A
• Persistent AF with major risk factors for AF recurrence.		B
AF catheter ablation for PVI should be considered for rhythm control after one failed or intolerant to beta-blocker treatment to improve symptoms of AF recurrences in patients with paroxysmal and persistent AF.[246]	IIa	B

First-line therapy		
AF catheter ablation for PVI should/may be considered as first-line rhythm control therapy to improve symptoms in selected patients with symptomatic:		
• Paroxysmal AF episodes,[240–242,614,615] or	IIa	B
• Persistent AF without major risk factors for AF recurrence.[253–255,264,598–601,609,610,633,636,641,724,745,746,832]	IIb	C
as an alternative to AAD class I or III, considering patient choice, benefit, and risk.		
AF catheter ablation:		
• Is recommended to reverse LV dysfunction in AF patients when tachycardia-induced cardiomyopathy is highly probable, independent of their symptom status.[666,675,676]	I	B
• Should be considered in selected AF patients with HF with reduced LVEF to improve survival and reduce HF hospitalization.[612,659,662–666,668–671,817–826]	IIa	B
AF catheter ablation for PVI should be considered as a strategy to avoid pacemaker implantation in patients with AF-related bradycardia or symptomatic pre-automaticity pause after AF conversion considering the clinical situation.[816–818]	IIa	C

Techniques and technologies		
Complete electrical isolation of the pulmonary veins is recommended during all AF catheter-ablation procedures.[235–237,239,606,608–610,613,614,678,679,681,683,684,686,713,731,759,780]	I	A
If patient has history of CTI-dependent AFL or if typical AFL is induced at the time of AF ablation, delivery of a CTI lesion may be considered.[731–733,819–821]	IIb	B
Use of additional ablation lesions beyond PVI (low voltage areas, lines, fragmented activity, ectopic foci, rotors, and others) may be considered but is not well established.[677,680,708,711–730]	IIb	B

Circulation

CLINICAL PRACTICE GUIDELINES

2023 ACC/AHA/ACCP/HRS Guideline for the Diagnosis and Management of Atrial Fibrillation: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

Developed in Collaboration With and Endorsed by the American College of Clinical Pharmacy and the Heart Rhythm Society

2a	**B-R**	5. In patients (other than younger with few comorbidities) with symptomatic paroxysmal or persistent AF who are being managed with a rhythm-control strategy, catheter ablation as first-line therapy can be useful to improve symptoms.[11–13,28]

2b	**B-NR**	7. In selected* patients with asymptomatic or minimally symptomatic AF, catheter ablation may be useful for reducing progression of AF and its associated complications.[31–39]

*Younger patients with few comorbidities and a moderate to high burden of AF or persistent AF and AFL.

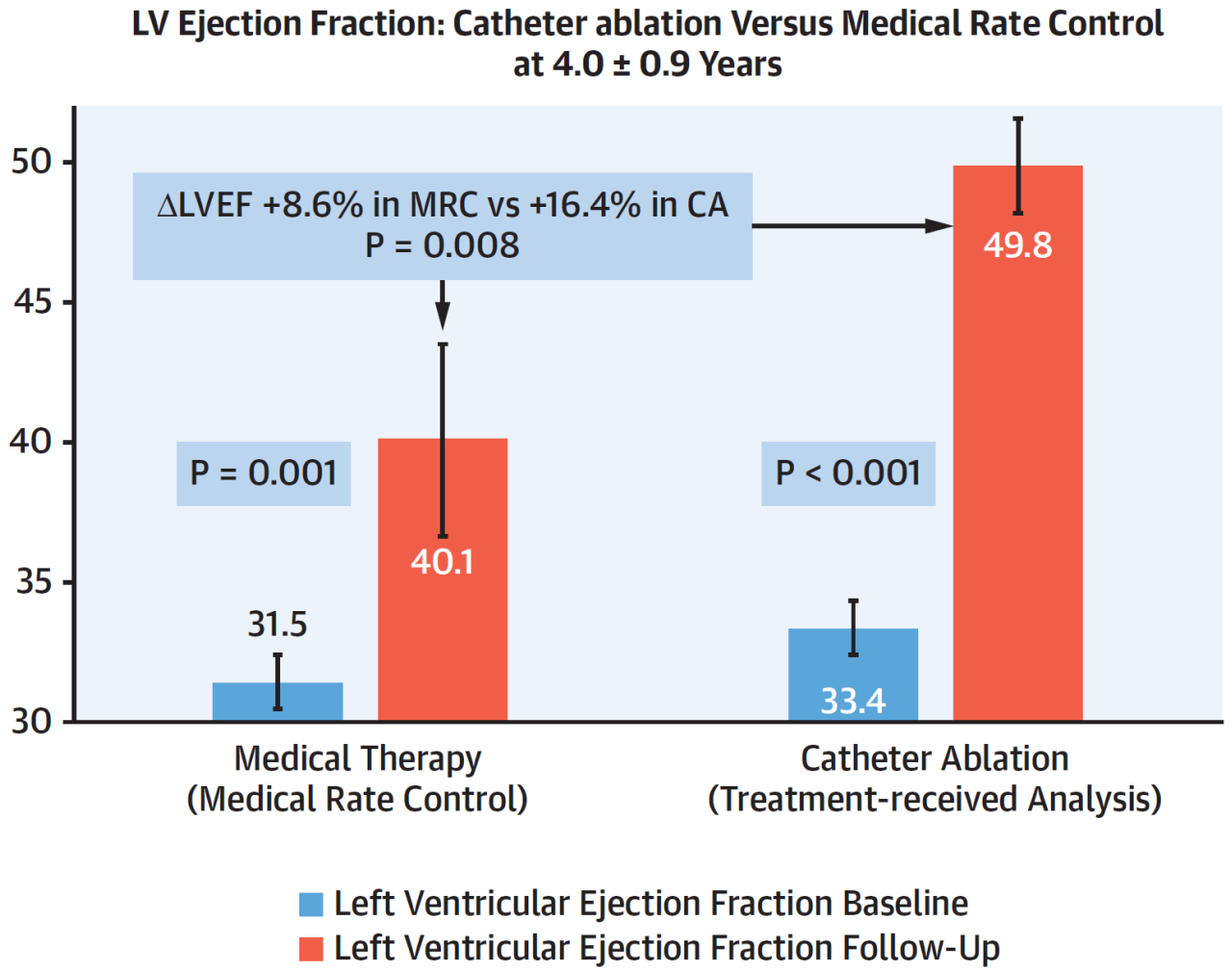
JACC: CLINICAL ELECTROPHYSIOLOGY VO

PUBLISHED BY ELSEVIER

Catheter Ablation
Atrial Fibrillation a
Dysfunction

Late Outcomes of CAMERA

CENTRAL ILLUSTRATION Impact of CA Versus Medical Therapy on LVEF in AF-HFrEF

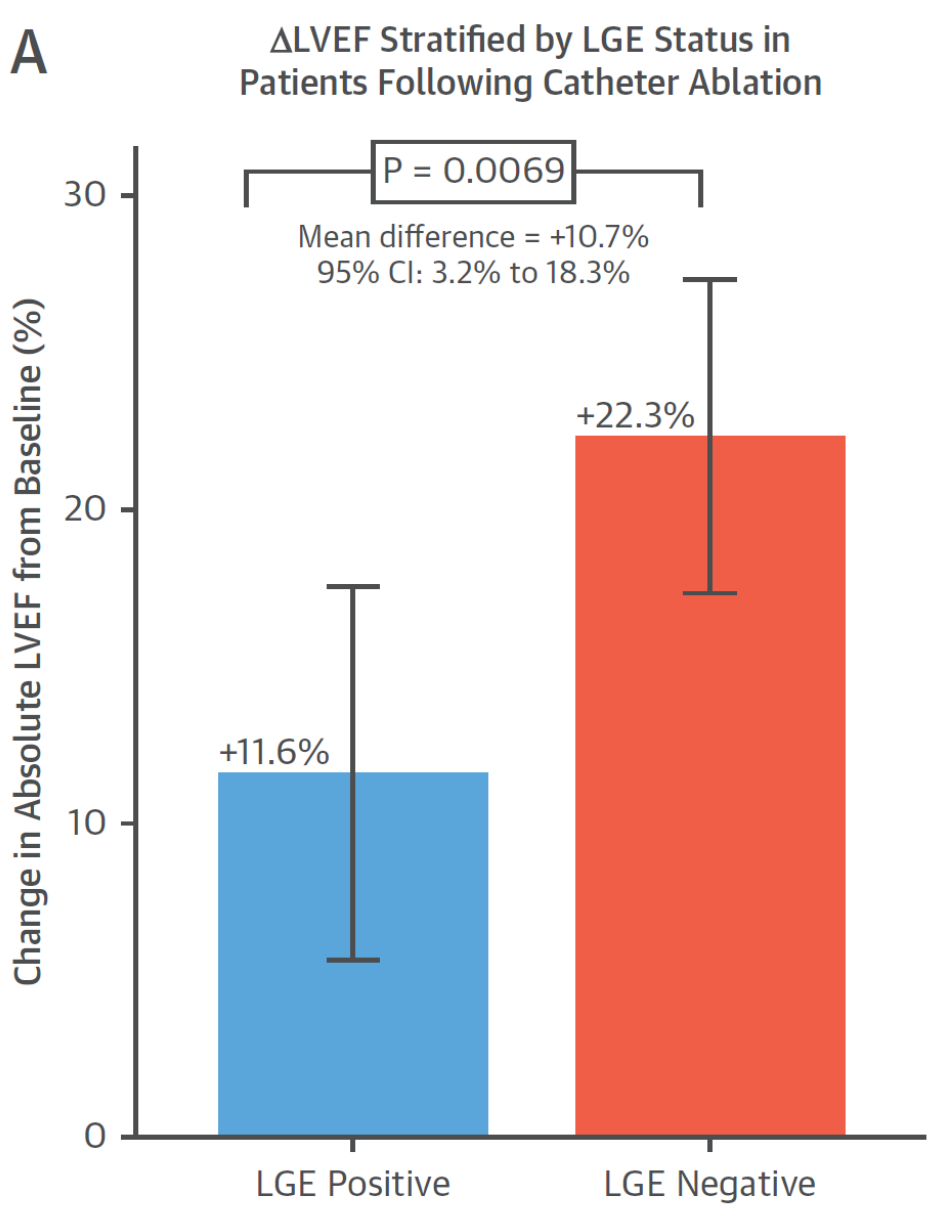


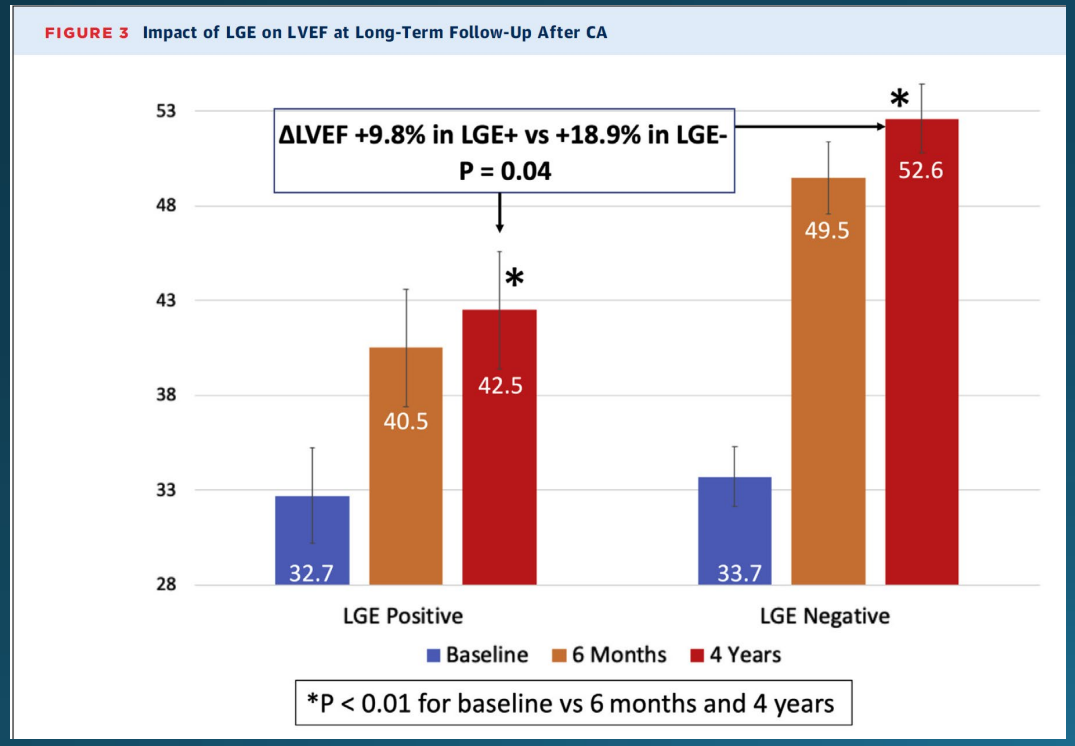
Sugumar, H. et al. J Am Coll Cardiol EP. 2020;6(13):1721-31.

TABLE 1 Baseline Characteristics (N = 66)

	Catheter Ablation (n = 33)	Medical Rate Control (n = 33)
Demographics		
Age, yrs	59 ± 11	62 ± 9.4
Male	94 (31)	88 (29)
CHA_2DS_2VASc score	2.42 ± 0.87	2.36 ± 0.96
Hypertension	39 (13)	36 (12)
Diabetes	12 (4)	15 (5)
Hyperlipidemia	27 (9)	27 (9)
Body mass index, kg/m^2	30 ± 7.5	31 ± 4.1
Obstructive sleep apnea	36 (12)	21 (7)
Stroke/transient ischemic attack	6.1 (2)	0 (0)
Medications		
ACE inhibitor or ARB	94 (31)	94 (31)
Cardioselective beta-blocker	88 (29)	85 (28)
Any beta-blocker	97 (32)	97 (32)
Spironolactone	33 (11)	48 (16)
Antiarrhythmic therapy	24 (8)	24 (8)
Anticoagulation	100 (33)	100 (33)
AF history		
Mean duration of continuous AF, months	23 ± 18	21 ± 15
Longstanding persistent AF	72 (24)	76 (25)
Previous DCCV	97 (32)	94 (31)
Average no. of DCCV attempts per patient	2.1 ± 0.8	2.0 ± 0.7
Amiodarone therapy ineffective or intolerant	91 (30)	82 (27)
Resting HR, beats/min	79 ± 17	77 ± 19
24-h average HR, beats/min	86 ± 14	85 ± 17
Post-6MWT HR, beats/min	93 ± 23	95 ± 20
LV systolic dysfunction history		
Co-diagnosis of AF and LV systolic dysfunction	70 (23)	67 (22)
AF preceded LV systolic dysfunction	24 (8)	27 (9)
LV systolic dysfunction preceded AF	6.1 (2)	6.1 (2)
Cardiac MRI findings		
LVEF, %	32 ± 9.4	34 ± 7.8
LVEF <35%	52 (17)	45 (15)
Late gadolinium enhancement present	36 (12)	36 (12)
Echocardiography findings		
LVEF, %	35 ± 9.8	35 ± 9.3
Fractional shortening, %	20 ± 8.4	18 ± 8.8
LV end-diastolic diameter, mm	59 ± 7.7	59 ± 6.4

FIGURE 3 LGE and Change in Absolute LVEF

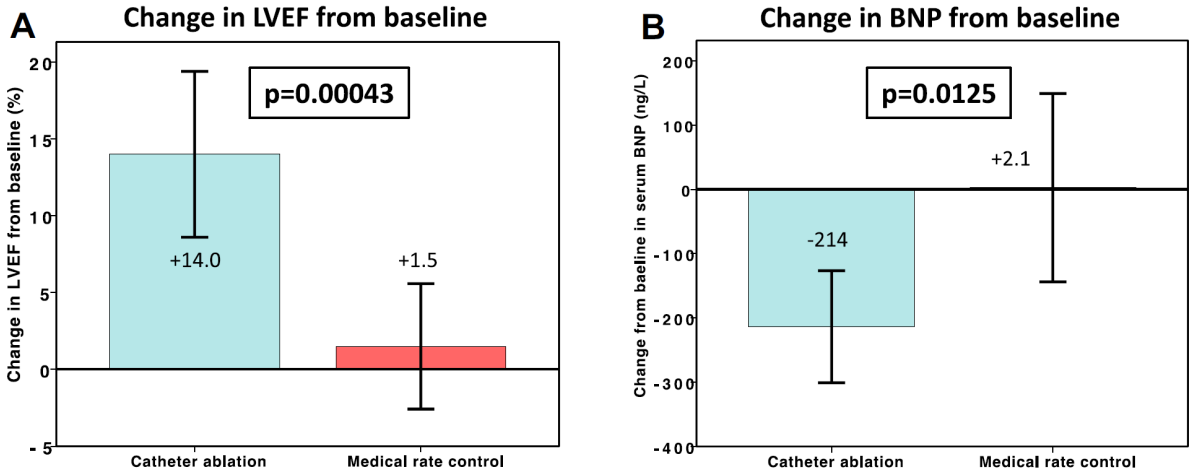


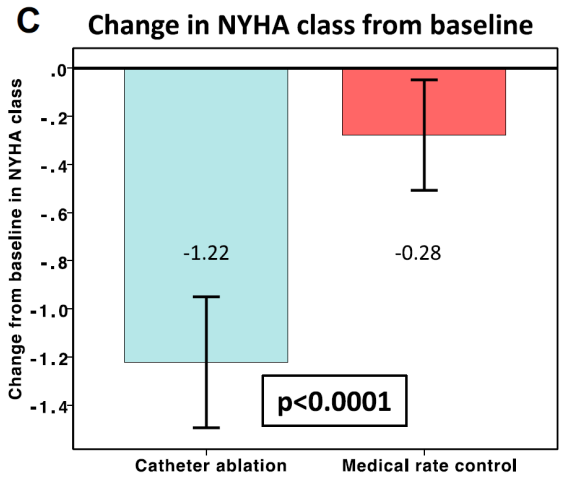


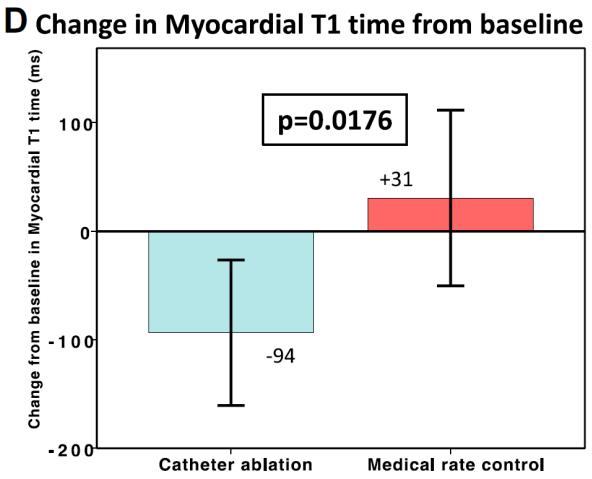
"COST" of long term success

- DC in 13/64 pts
- Total 1.4 procedures (40% second procedure)
- RESULT in four years:
  - "success" 50%
  - "burden" 10.6 +/- 21 %

Ventricular remodeling and diffuse fibrosis – Comparison between treatment arms







JACC: CLINICAL ELECTROPHYSIOLOGY

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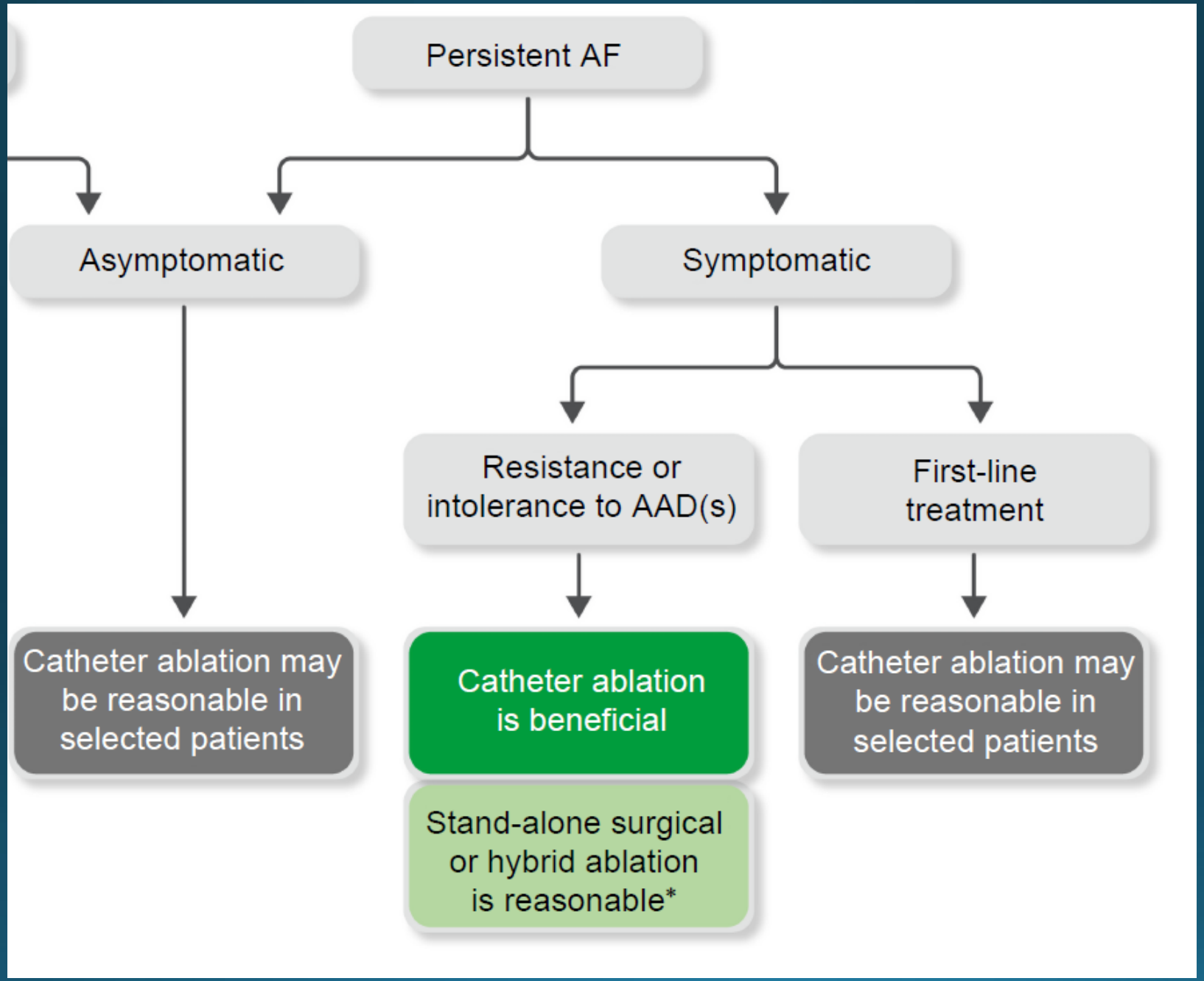
Regression of Diffuse Ventricular Fibrosis Following Restoration of Sinus Rhythm With Catheter Ablation in Patients With Atrial Fibrillation and Systolic Dysfunction

A Substudy of the CAMERA MRI Trial


Persistent AF
Asymptomatic
Symptomatic
Resistance or intolerance to AAD(s)
First-line treatment
Catheter ablation may be reasonable in selected patients
Catheter ablation is beneficial
Stand-alone surgical or hybrid ablation is reasonable*
Catheter ablation may be reasonable in selected patients

- PERSISTENT AF thoughts\

1) Definition, not all the same:
    a. Time
    b. Disease
    c. LA size
    d. Scar tissue (LVA)
    e. Previous a/ar or ABL
2) ABLATION STRATEGY
    a. Anatomically guided
        i. PVI only
        ii. Lines
    b. Mapping of arrhythmia (CFAE)
        i. Visual
        ii. Algorithm assisted
    c. Mapping of substrate (LVA)
    d. Energy used (RF, CRYO, PF, ALCOHOL)
    e. Epicardial
3) CASES
    a. conversion to AFL during CFAE
    b. Conversion to NSR during CFAE
    c. Epicardial (post wall)
        -

1) Papers for reference
    a. Anter
    b. Guidelines

What is the association between Atrial Fibrillation Arrhythmic Burden and CV Outcomes?

Study Cohort

Paroxysmal AF

&

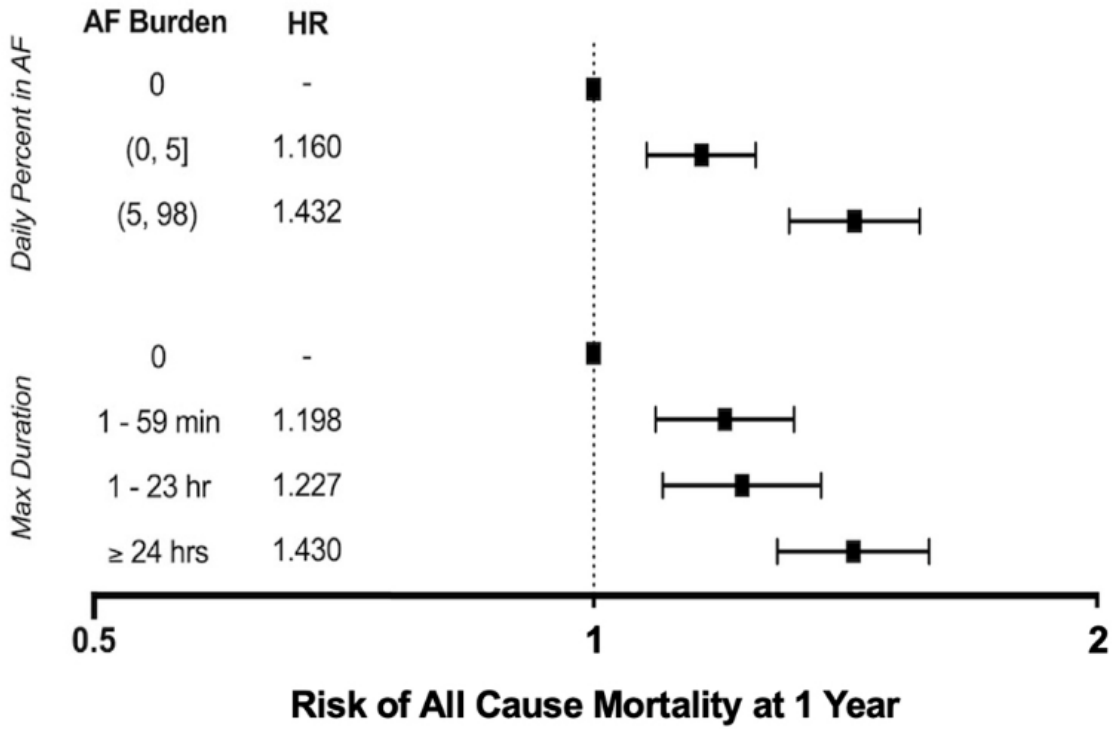
New cardiac implantable electronic devices (2010-2016)

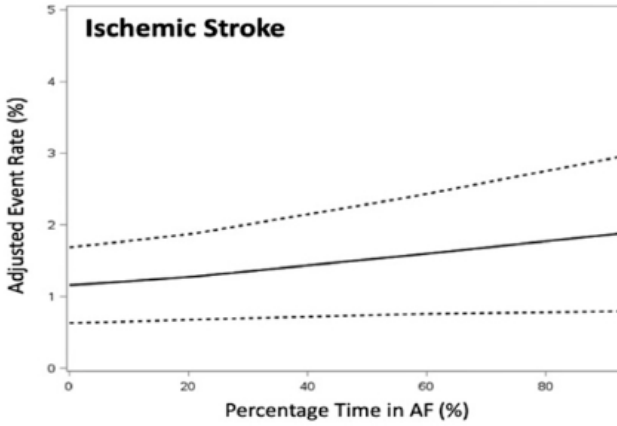
Exposure

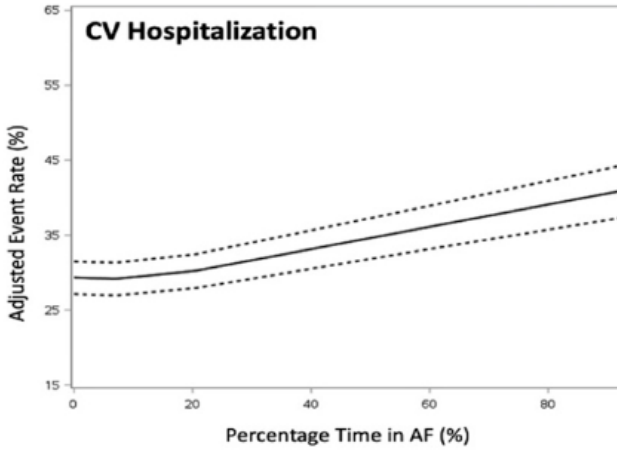
AF Arrhythmic Burden

(a) % daily in AF
(b) Max duration of AF episode

Results







Conclusions

Among **39,710** patients with paroxysmal AF and cardiac implantable devices, there was ar
exposure-response relationship between device-based AF burden and clinical outcome

- Left Lateral Sinus Transverses contained Vestigeal Fold (Ligament of Marshall)