



# REALTIME iCMR ABLATIONS GLOBAL SUMMIT

*Munich, March 18, 2023*

## **iCMR Program at Henry Dunant and Case Studies**

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Director, 1st Department of Cardiology  
Department of Electrophysiology & Pacing,  
"Henry Dunant" Hospital Center, Athens, Greece*

## Presenter Disclosure Information

*The presenter has received honoraria for participation in lectures and advisory boards from the following pharmaceutical and biotechnology companies:*

- *Abbot*
- *AstraZeneca,*
- *Bard,*
- *Bayer Healthcare,*
- *Boehringer Ingelheim,*
- *Boston Scientific,*
- *Bristol-Myers Squibb,*
- *ELPEN,*
- *Galenica,*
- *Lilly,*
- *Medtronic,*
- *Menarini,*
- *MSD,*
- *Pfizer,*
- *Sanofi,*
- *Servier,*
- *Unifarma,*
- *Vianex.*

## Asking Chat - Gpt



How many patients can be hospitalized at Henry Dunant Hospital Center in Athens?



As an AI language model, I do not have access to real-time information about the capacity of Henry Dunant Hospital Center in Athens. However, according to sources dated from 2021, the hospital has a capacity of around **1,000 beds**, which suggests that it can potentially hospitalize a large number of patients. It's worth noting that the actual number of patients that can be hospitalized at any given time may depend on various factors such as the availability of medical staff, equipment, and resources. For more accurate and up-to-date information on the hospital's capacity, it would be best to contact the hospital directly.

**Built in 2000**

**Located at the center of Athens**

**Biggest private hospital in Greece (477 beds)**

**2<sup>nd</sup> EP center in the country (800 cases annually)**





 **ΕΠΙΚΟΣ ΝΤΥΝΝΑΝ**  
Hospital Center

 **ΕΠΙΚΟΣ ΝΤΥΝΝΑΝ**  
Hospital Center





# Interventional cardiac magnetic resonance (iCMR) Ablation



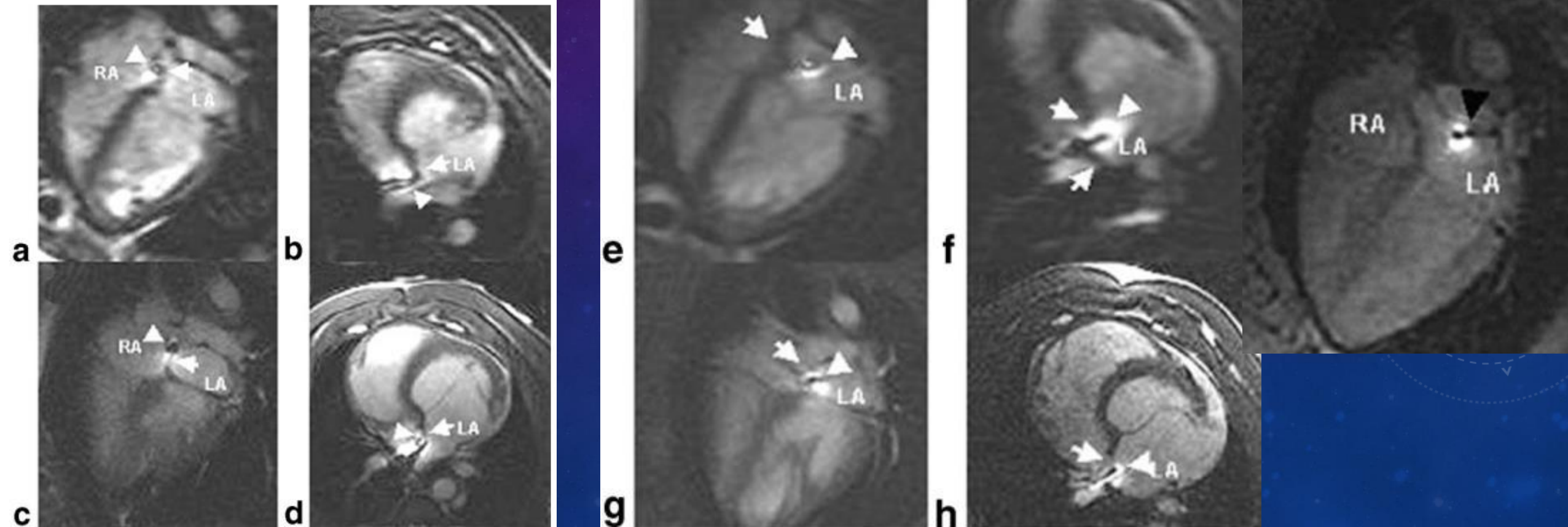
Original Research

# Magnetic Resonance Image-Guided Trans-Septal Puncture in a Swine Heart

Aravind Arepally, MD,<sup>1\*</sup> Parag V. Karmarkar, MS,<sup>1</sup> Clifford Weiss, MD,<sup>1</sup>  
E. Rene Rodriguez, MD,<sup>2</sup> Robert J. Lederman, MD,<sup>3</sup> and Ergin Atalar, PhD<sup>1</sup>

MRI Guided Trans-Septal Punctures

<sup>1</sup>The Russell H. Morgan Department of Radiology and Radiological Science, The Johns Hopkins Medical Institutions, Baltimore, Maryland.

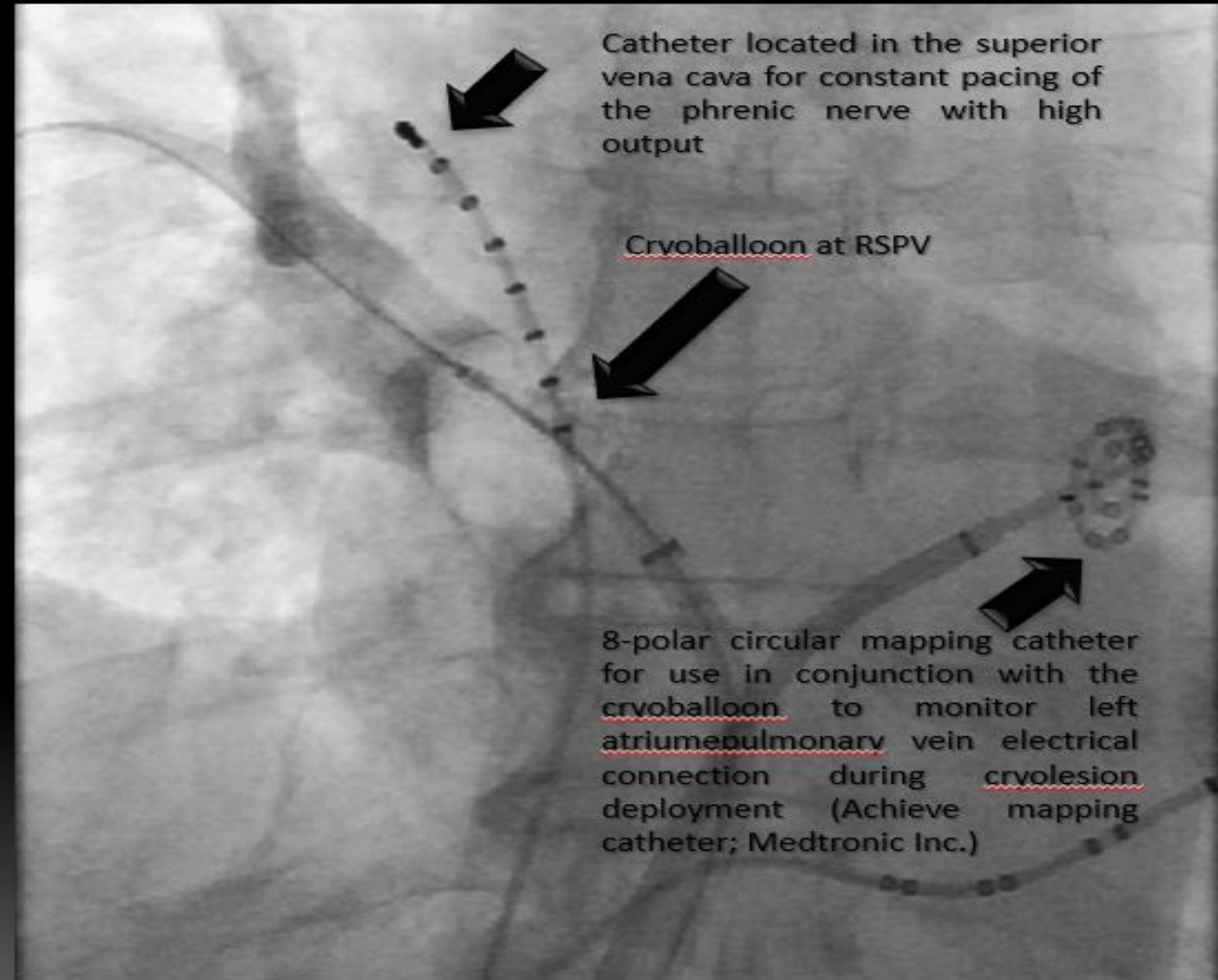




# Invasive therapy for atrial fibrillation: recent developments in ablation, navigation and mapping technology

## Ablation of the right superior pulmonary vein with the use of the cryoballoon system

1. Chun KR, Schmidt B, Metzner A, et al. The 'single big cryoballoon' technique for acute pulmonary vein isolation in patients with paroxysmal atrial fibrillation: a prospective observational single centre study. Eur Heart J 2009;30:699e709
2. Linhart M, Bellmann B, Mittmann-Braun E, et al. Comparison of cryoballoon and radiofrequency ablation of pulmonary veins in 40 patients with paroxysmal atrial fibrillation: a casecontrol study. J Cardiovasc Electrophysiol 2009;20:1343e8.
3. 20. Klein G, Oswald H, Gardiwal A, et al. Efficacy of pulmonary vein isolation by cryoballoon ablation in patients with paroxysmal atrial fibrillation. Heart Rhythm 2008;5:802e6.



# Real-time magnetic resonance imaging-guided cryoablation of the pulmonary veins with acute freeze-zone and chronic lesion assessment

Justin Lichter<sup>1,2,3</sup>, Eugene G. Kholmovski<sup>4,5</sup>, Nicolas Coulombe<sup>6</sup>, Elyar Ghafoori<sup>1,2,3</sup>,  
Roya Kamali<sup>1,2,3</sup>, Rob MacLeod<sup>1,2,3</sup>, and Ravi Ranjan<sup>1,2,3\*</sup>

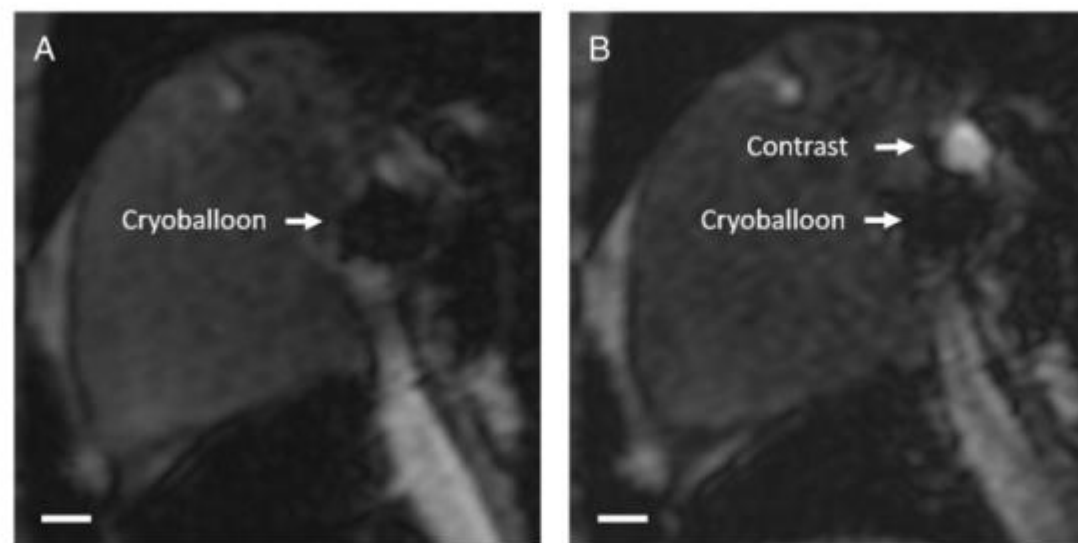
## Conclusion

This study reports on the development of an MRI-based cryoablation system and shows that with acute cryolesions there is a large area of reversible injury. Real-time MRI provides the ability to visualize the freeze-zone formation during the freeze cycle and for focal lesions reaches a maximum after 120 s suggesting that for maximizing lesion size 120 s might be the lower limit for dosing duration.

*“As previously described, we had developed investigational MRI-compatible cryoablation devices for animal use by removing or replacing all ferromagnetic components from 23 and 28 mm Arctic Front Advance cryoballoons and the Freezor MAX cryocatheter with an 8 mm ablation tip (Medtronic CryoCath, Montreal, Canada)”*

## What's new?

- This study demonstrates and evaluates the implementation of real-time magnetic resonance imaging (MRI)-guided cryoablation of the pulmonary veins in a canine model.
- Using MRI to visualize the freeze-zone formation in real-time allowed novel insights to the time to max freeze-zone area and potential lesion formation.
- Focal point cryoablations in the ventricular tissue showed maximum freeze-zone area after just 120 s of cryoablation.
- Visualizing the freeze-zone growth in real-time allowed for careful monitoring of the cardiac and non-cardiac anatomy as the tissue was frozen, this could lead to lower rates of complications such as atrio-oesophageal fistula.
- Characterizing the MR images of lesions at acute and chronic time points provides observations of oedema and inflammation that occurs during cryoablation and how it subsides over time to create permanent scar.



**Figure 2** Real-time MRI validation of PV occlusion. (A) Placement of the catheter and cryoballoon before injection of contrast. (B) Contrast injected from the distal tip of the balloon and confirms occlusion of the RSPV by the inflated cryoballoon. Scale bar is 1 cm. See [Supplementary material online](#) for the full video of contrast injection. MRI, magnetic resonance imaging; PV, pulmonary vein; RSPV, right superior pulmonary vein.



# Interventional cardiac magnetic resonance (iCMR) Ablation



**ANATOMY**

# Anatomy of patients undergoing ablation – “Uncommon is common”

18-year old pt with persistent AF



Right Coronary Artery draining into RA appendage







## Correspondence

# 3D printing for ablation planning in patients undergoing atrial fibrillation ablation: Preliminary results of the pilot randomized 3D GALA trial

Terentes-Printzios D, Xydis P, Gourgouli I, Tampakis K, Pastromas S, Sikiotis A, Antonopoulos A,

**Andrikopoulos G**, Tsioufis K, Vlachopoulos C.

Hellenic J Cardiol. 2022 Dec 9;S1109-9666(22)00178-6. doi: 10.1016/j.hjc.2022.12.004. Online ahead of

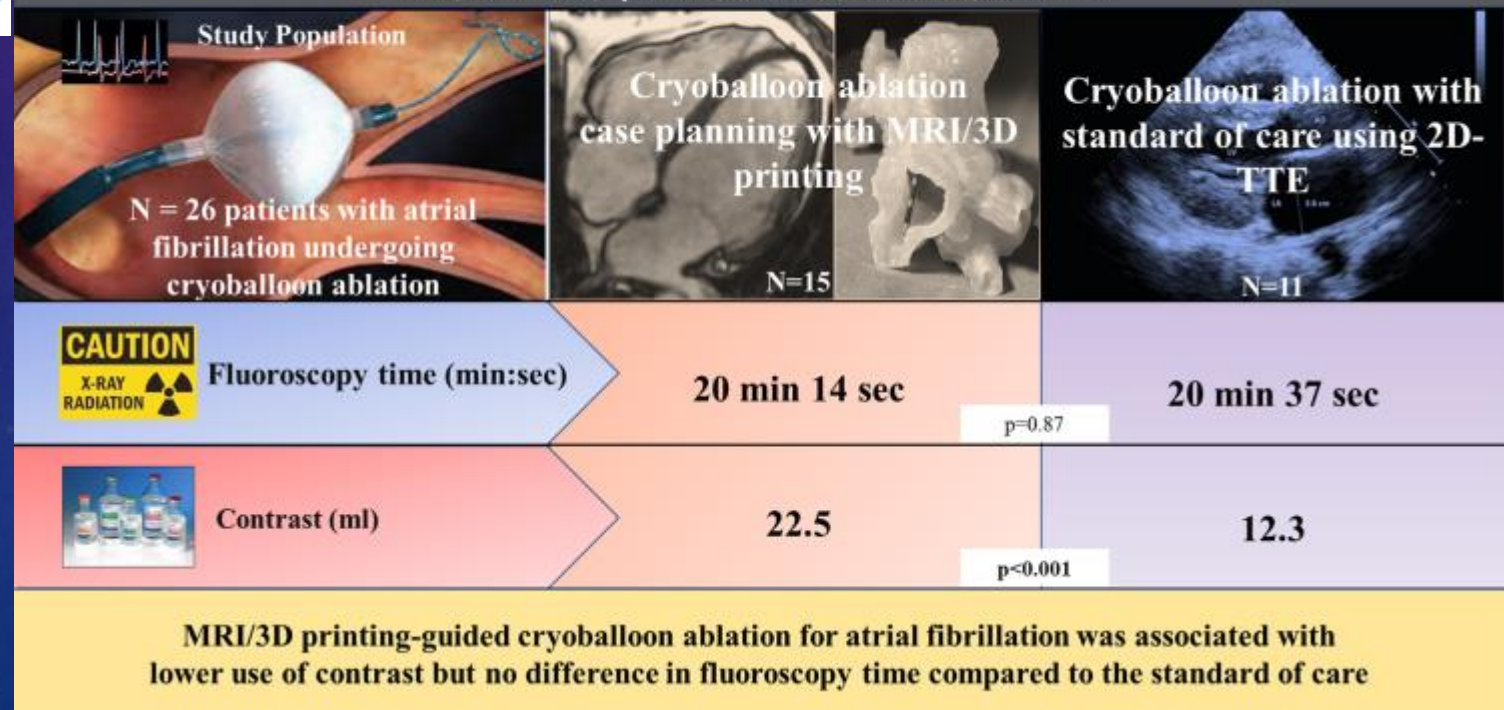
**Table 1**

Baseline characteristics and procedural results and variables reflecting relative procedural efficiency between case planning with combined MRI/3D printing versus standard of care using 2D-TTE.

Variables	No preprocedural imaging n = 11	MRI+3D model n = 15	p value
Age (years)	61.4 (13.3)	58.2 (13.4)	0.56
Gender, male	7 (64)	11 (73)	0.60
Weight (kg)	77.5 (13.4)	86.2 (12.4)	0.10
Height (cm)	172.6 (9.8)	176.7 (8.6)	0.28
Obesity, n (%)	4 (36)	4 (27)	0.60
Diabetes, n (%)	4 (36)	3 (20)	0.37
Hypertension, n (%)	5 (45)	6 (40)	0.78
Smoking, n (%)	6 (55)	2 (13)	<b>0.024</b>
History of CAD, n (%)	4 (36)	1 (7)	0.06
Persistent AF, n (%)	2 (18)	3 (20)	0.91
LVEF (%)	56.3 (4.9)	55.6 (11.1)	0.85
Left atrium size (mm)	38.6 (4.0)	40.6 (4.1)	0.23
Presence of MR, n	3 (27)	3 (20)	0.66
Presence of TR, n	2 (18)	1 (7)	0.36
<i>Primary and secondary procedural outcomes</i>			
Fluoroscopy time (min:sec)	20:14 (05:58)	20:37 (05:07)	0.87
Contrast (ml)	22.5 (6.5)	12.3 (4.7)	<b>&lt;0.001</b>
Air Kerma (mGy)	495.1 (142.8)	483.4 (198.9)	0.87
Cryoballoon applications, n	4.7 (0.8)	5 (0.7)	0.36

## 3D-printing for Ablation Planning in Patients Undergoing Atrial Fibrillation Ablation (3D-GALA trial)

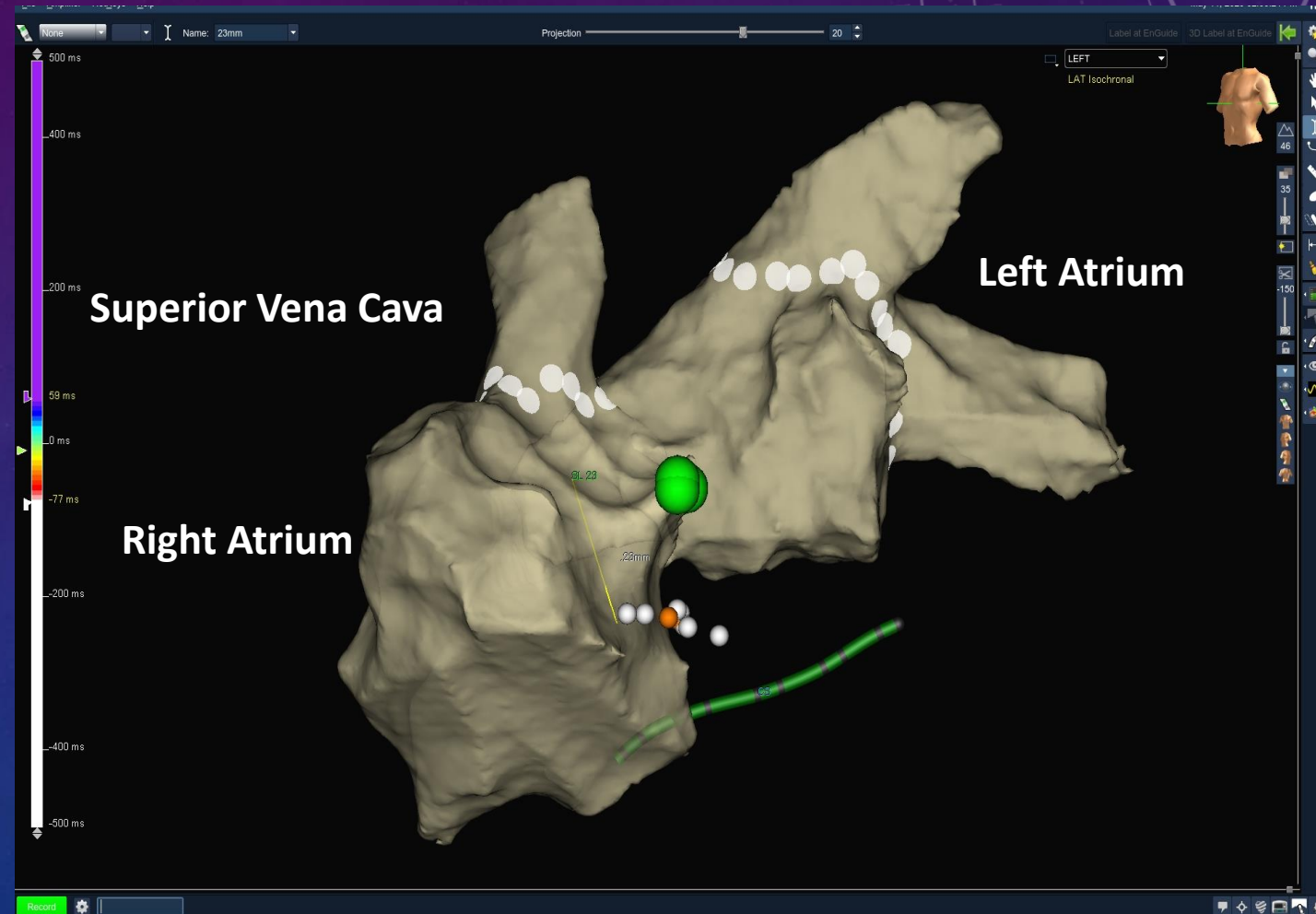
Pilot, randomized, open-label, controlled, multicentre, clinical trial



# 36 year-old female patient that was scheduled for AF ablation (Right upper pulmonary vein draining into superior vena cava)

## Cardiac MRI multiplanar reconstruction

Arrow: right upper pulmonary vein draining into superior vena cava



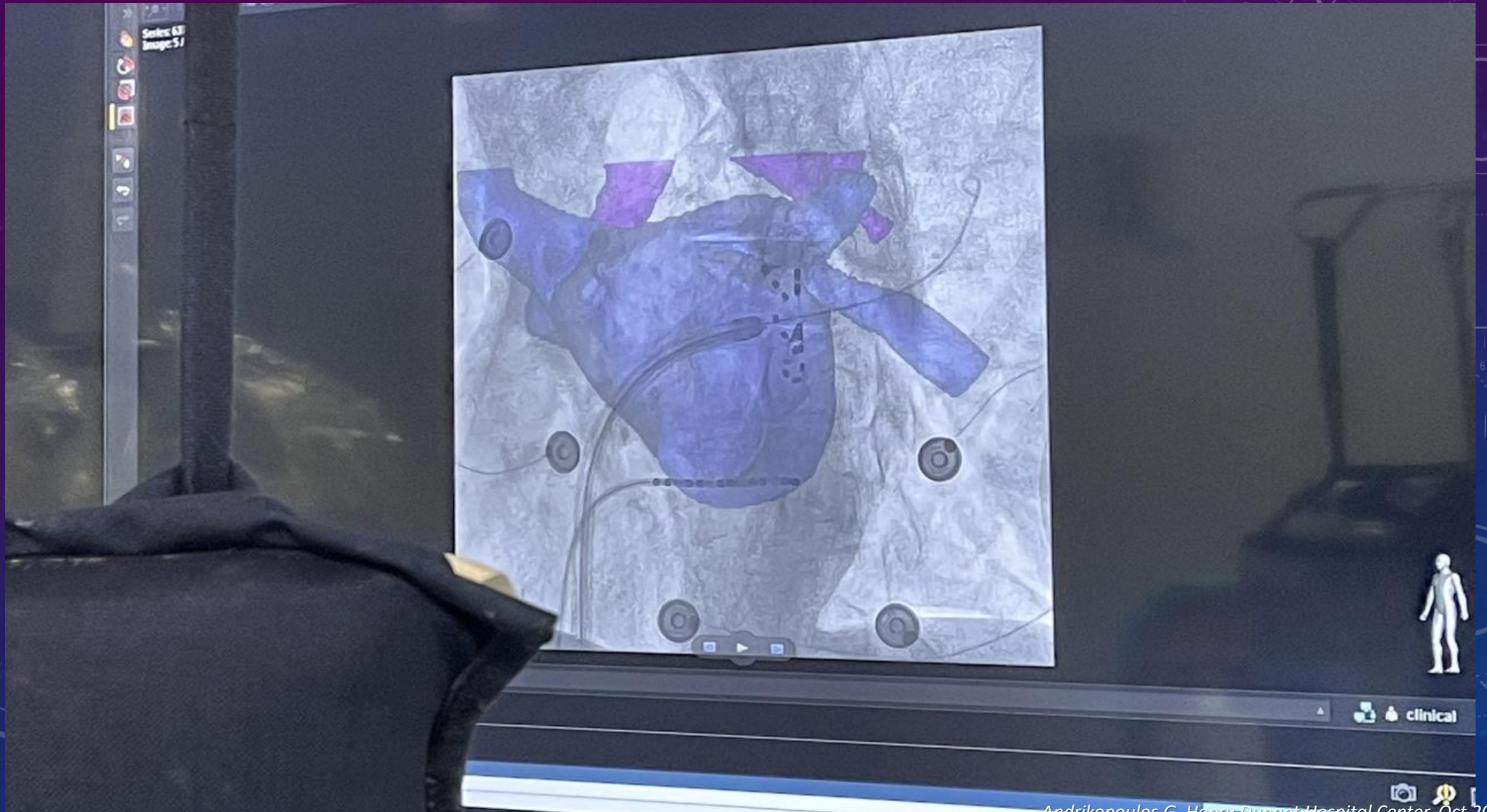


# CT imaging integrated into Fluoroscopy





# CT imaging integrated into Fluoroscopy





# Interventional cardiac magnetic resonance (iCMR) Ablation



**EFFICACY**



1987

# AN ADVENTURE OF INCREDIBLE PROPORTIONS



Steven Spielberg presents

# INNER SPACE

A Joe Dante Film

*This summer take a trip you'll never forget.*

Innerspace A Guber-Peters Production

Starring Dennis Quaid Martin Short Meg Ryan Kevin McCarthy

Director of Photography Andrew Laszlo, A.S.C. Production Designer James H. Spencer

Music by Jerry Goldsmith Co-Produced by Chip Proser

Co-Executive Producers Frank Marshall and Kathleen Kennedy

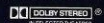
Executive Producers Steven Spielberg, Peter Guber and Jon Peters

Story by Chip Proser Screenplay by Jeffrey Boam and Chip Proser

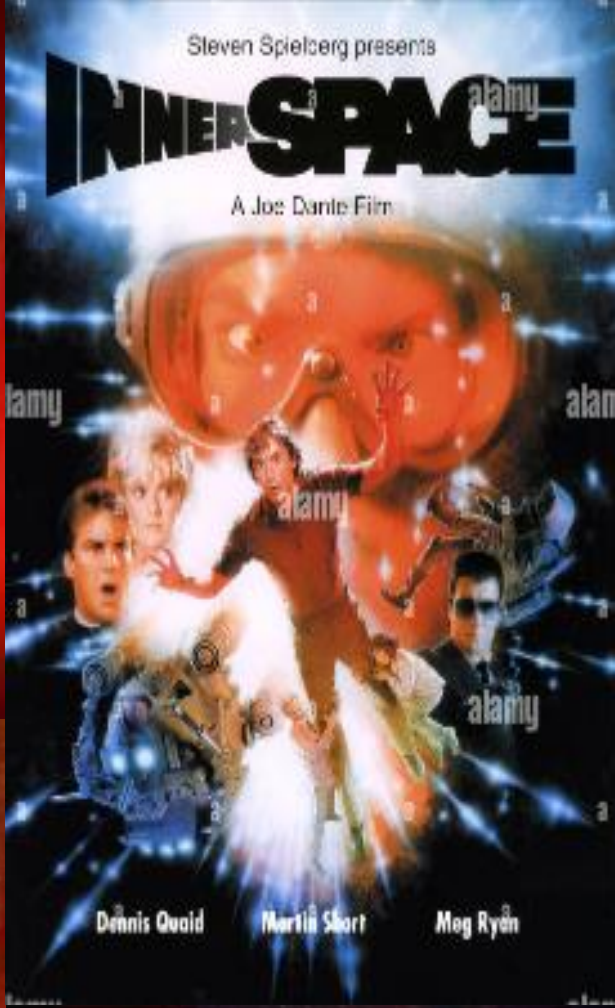
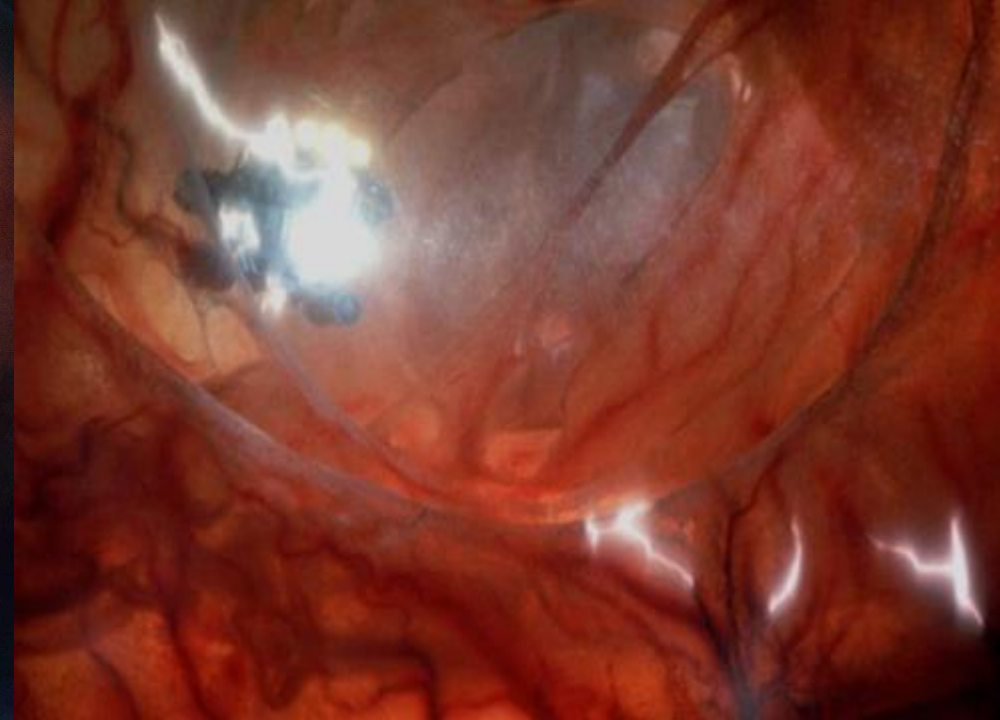
Produced by Michael Finnell Directed by Joe Dante



Original Soundtrack Available on Geffen Records, Cassettes & CDs



WARNER BROS. A WARNER COMMUNICATIONS COMPANY

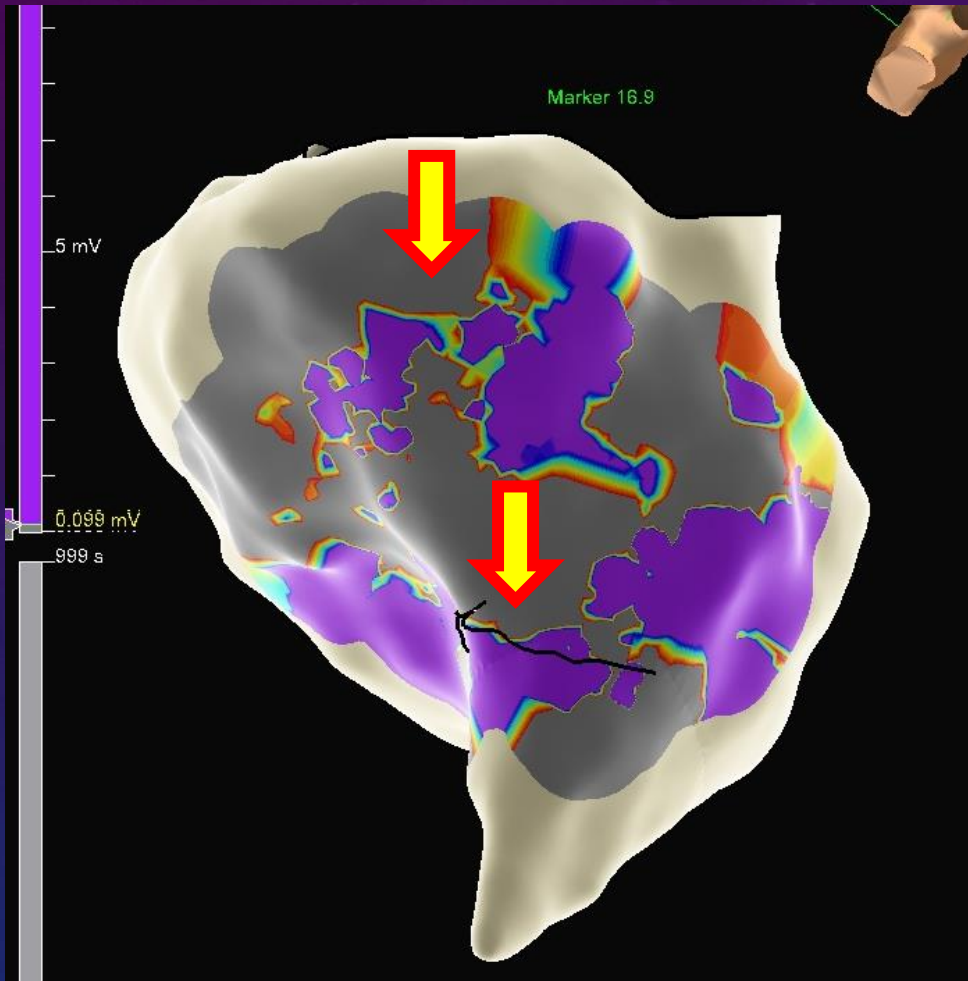




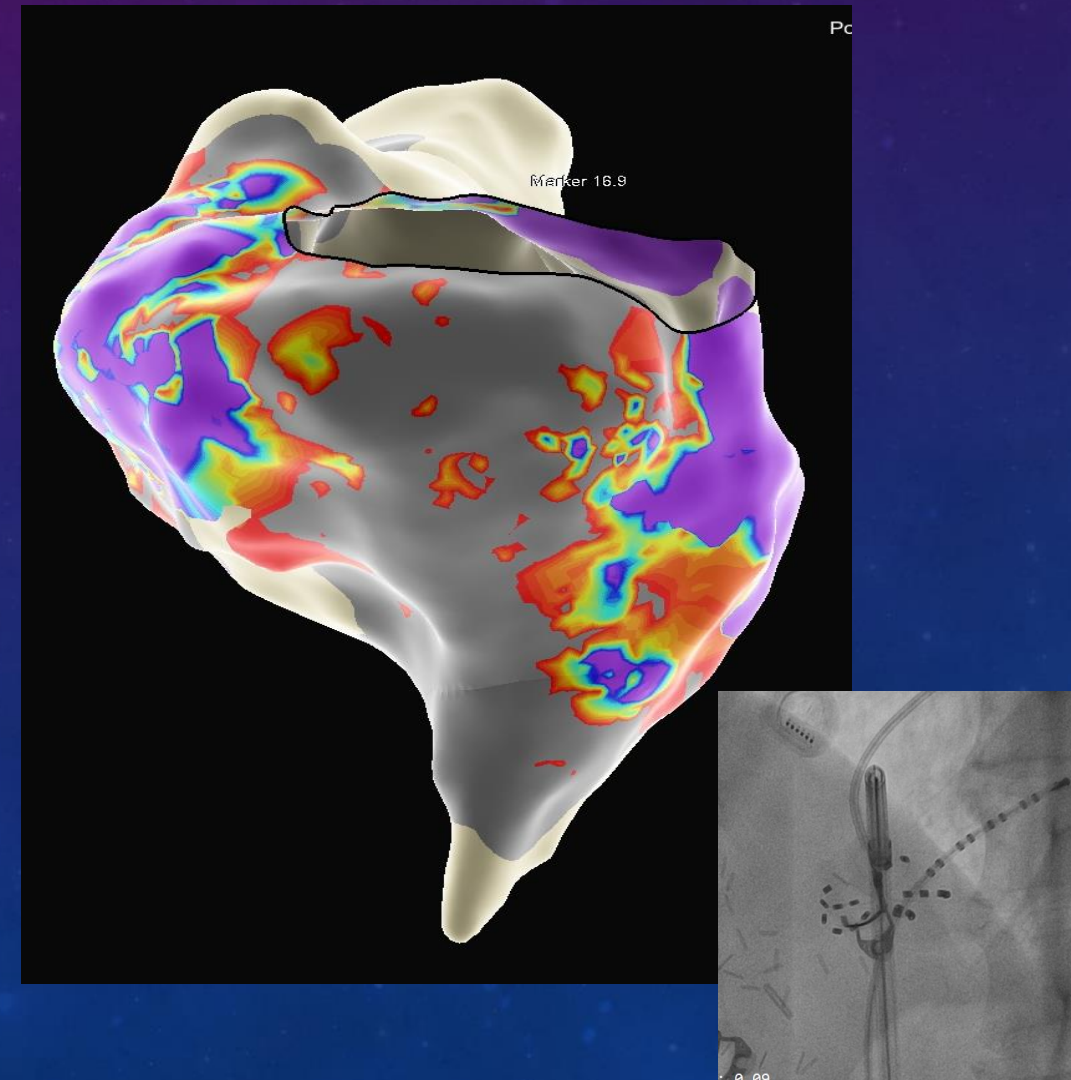
# Fluoroscopy guided WITH Electroanatomic mapping CTI ablation NOT feasible

*(CTI bidirectional block NOT feasible with irrigated catheter and electroanatomic mapping)*

## Post CTI Catheter Ablation with irrigated catheter

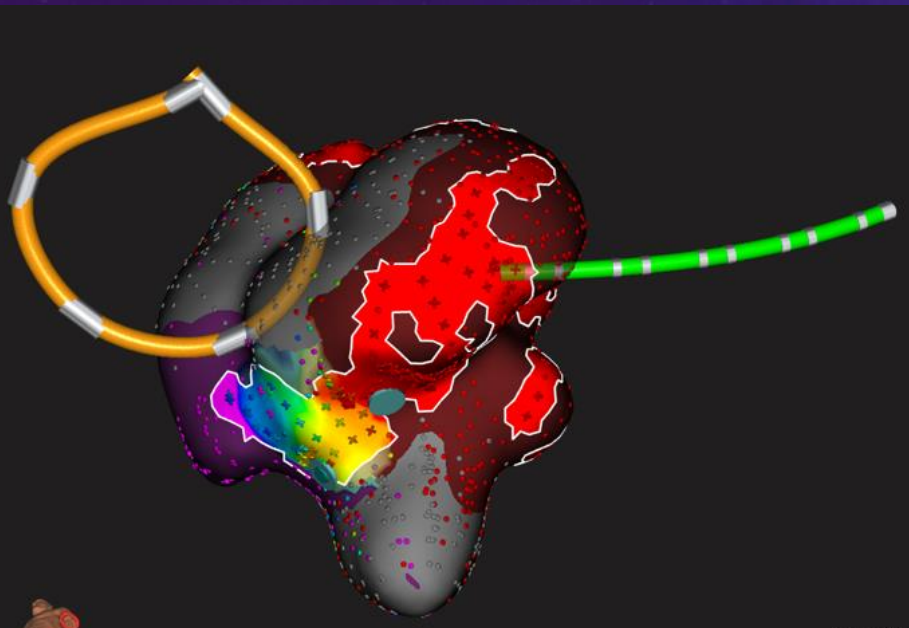
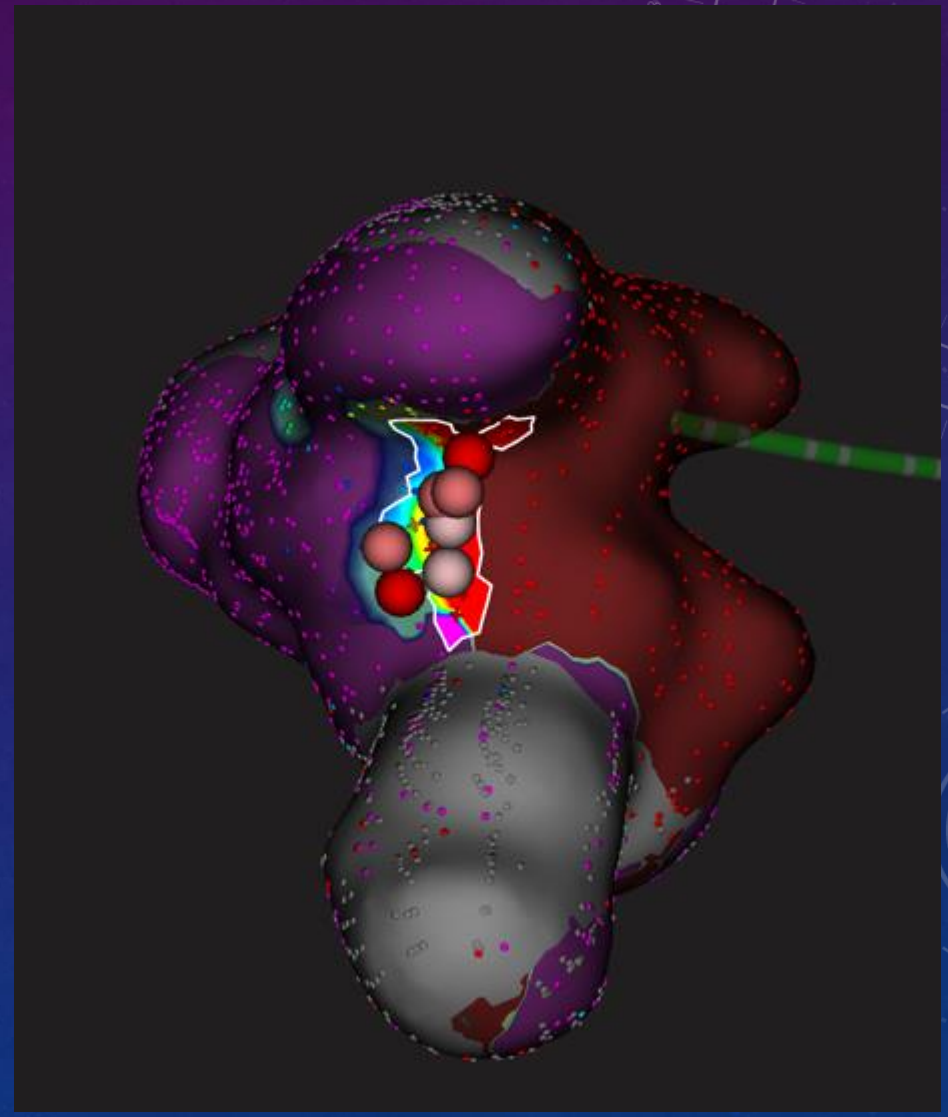
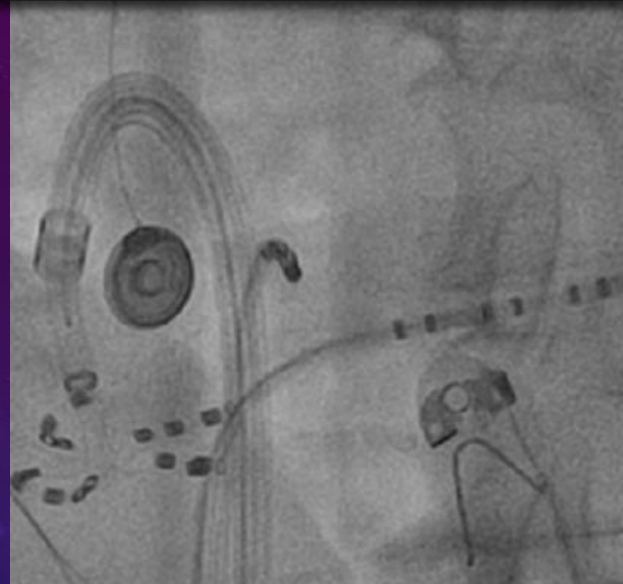
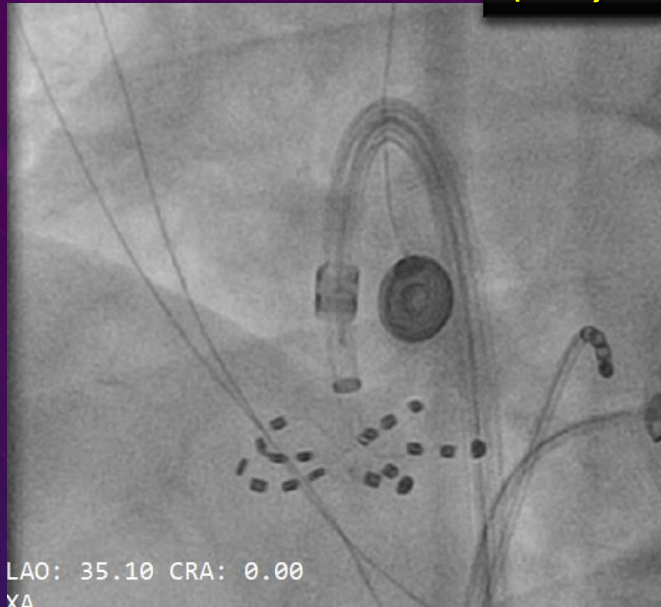


## Post CTI Pulsed Field Ablation (Farapulse)



# PFA CTI ablation NOT feasible

(52 year-old patient who had undergone AF+Afl ablation 3 years ago)



**CTI bidirectional block was achieved only with Catheter Ablation**

Time: 02:33 Beats: 189 EGMs: 15  
Volume: 39



# Interventional cardiac magnetic resonance (iCMR) Ablation



**SAFETY**

# X-Ray Exposure in Cardiac Electrophysiology: A Retrospective Analysis in 8150 Patients Over 7 Years of Activity in a Modern, Large-Volume Laboratory

Michela Casella, MD, PhD, FAIC; Antonio Dello Russo, MD, PhD; Eleonora Russo, MD, PhD; Valentina Catto, PhD; Francesca Pizzamiglio, MD; Martina Zucchetti, MD; Benedetta Majocchi, MD; Stefania Riva, MD; Giulia Vettor, MD, PhD; Maria Antonietta Dessanai, MD; Gaetano Fassini, MD; Massimo Moltrasio, MD; Fabrizio Tundo, MD, PhD; Carlo Vignati, MD; Sergio Conti, MD; Alice Bonomi, MSc; Corrado Carbuicchio, MD, FESC; Luigi Di Biase, MD, PhD; Andrea Natale, MD, FHRS, FACC; Claudio Tondo, MD, PhD, FESC

## Clinical Perspective

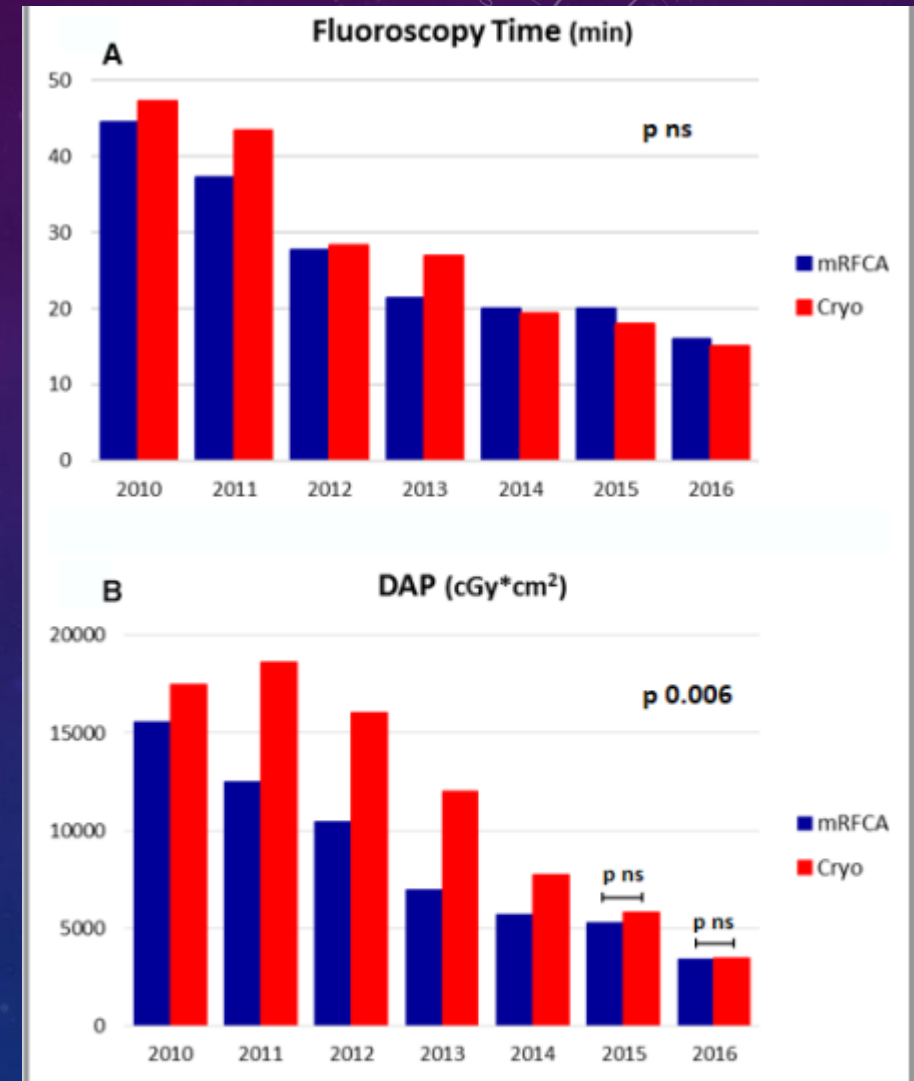
### What Is New?

- Comprehensive fluoroscopy data (fluoroscopy time, dose-area product, effective dose) for electrophysiological procedures are reported in a large “real-life” electrophysiological population.
- An assumption for the lifetime attributable risk was assessed.
- The analysis of the x-ray use in 7 experienced operators performing AF ablation showed an overall significant difference in fluoroscopy use among them.

### What Are the Clinical Implications?

- Awareness and culture of radiation-related risk and technological advances can successfully optimize fluoroscopy use.

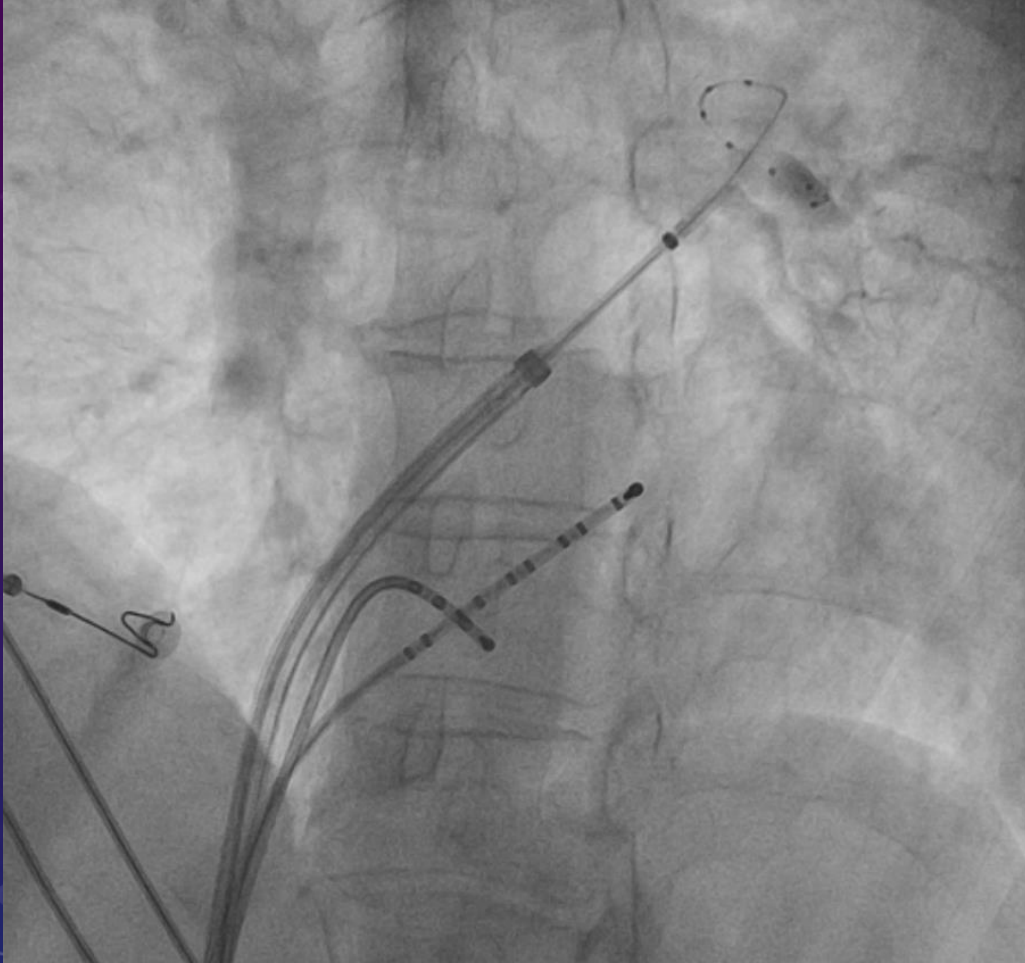
interquartile range ED value). This results in a nonnegligible estimated excess risk of cancer malignancy induction ranging from 36 in 100 000 treated patients up to 1 in 100.



**Figure 2.** Comparison of fluoroscopy time and DAP between mRFCA and Cryo over time. A, Reduction of fluoroscopy time associated with mRFCA ( $\Delta = -56\%$ ) and Cryo ( $\Delta = -67\%$ ) procedures over time. There is no difference between the 2 techniques. B, The radiation dose reduction associated with

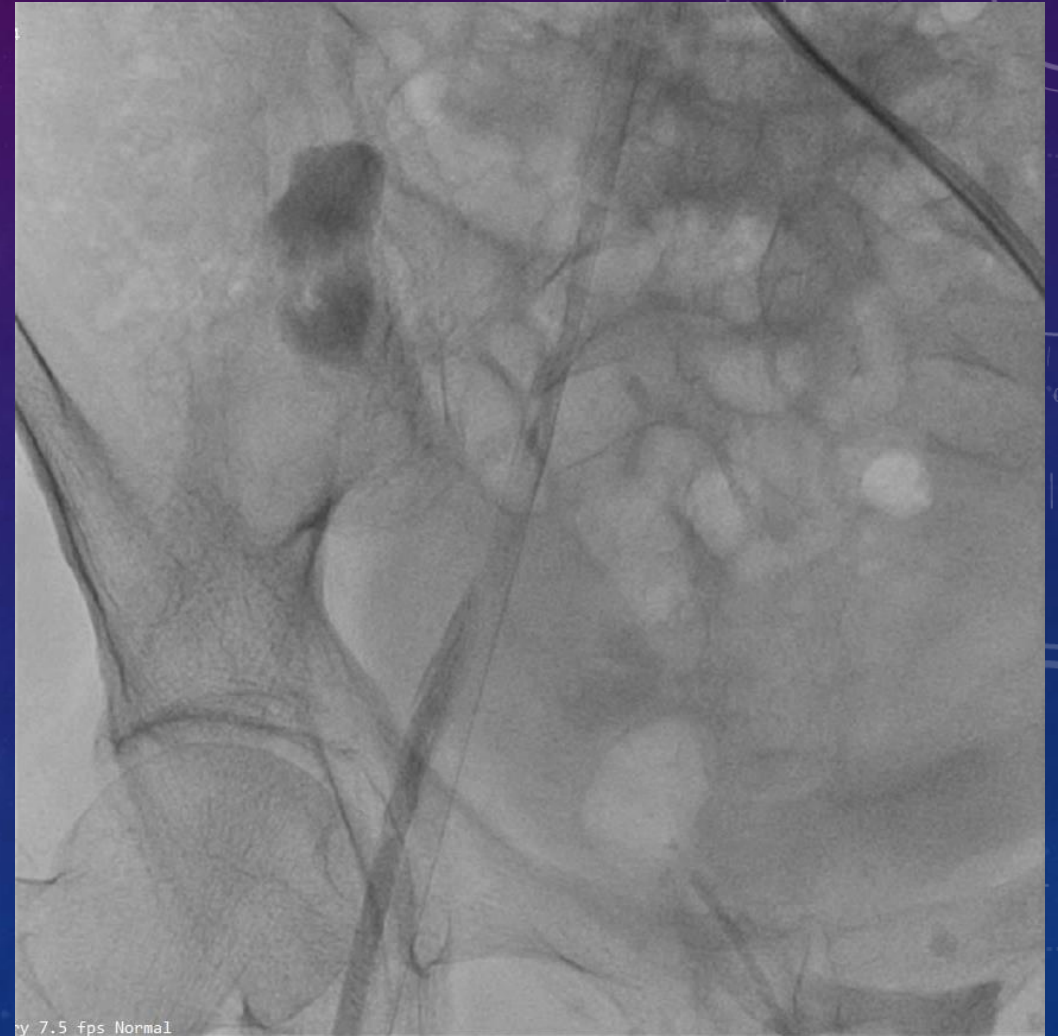


# ICE guided transeptal puncture in a fragile female patient



During occlusion of the LSPV the patient presented blood pressure 50/30 mmHg

# ICE guided transeptal puncture in a fragile female patient





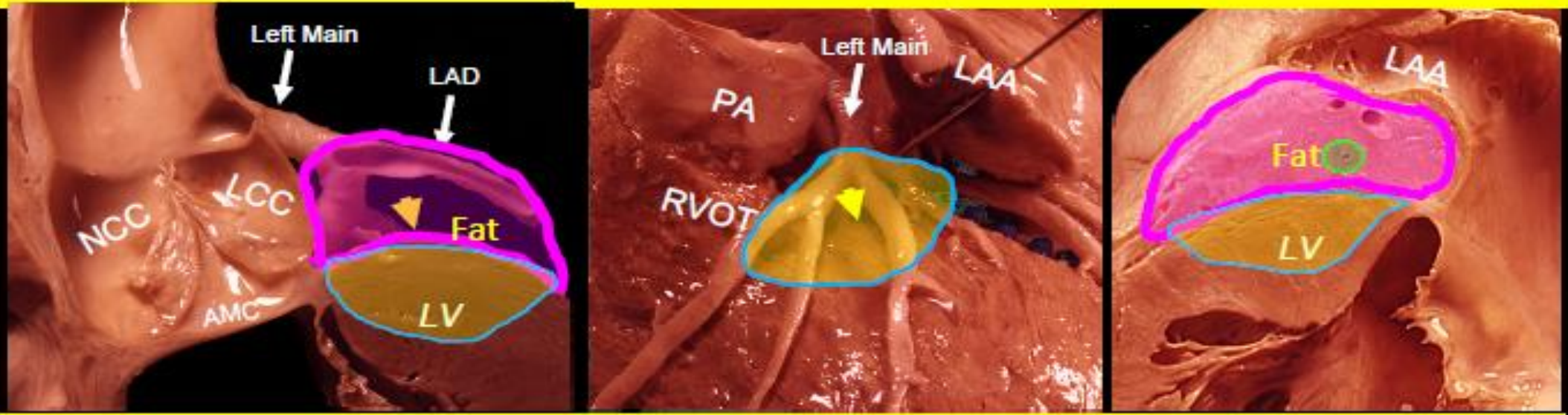
# Interventional cardiac magnetic resonance (iCMR) Ablation



**WE WANT TO BE ON BOARD A PROMISING TECHNOLOGY**

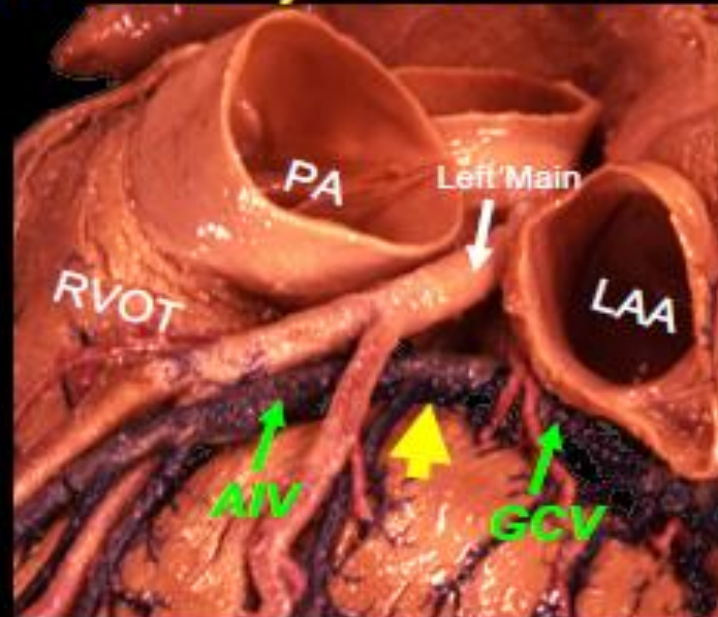


# Epicardial LV SUMMIT (Top of LV) – Proximal Aspect Inaccessible Coronary Arteries and Epicardial Fat



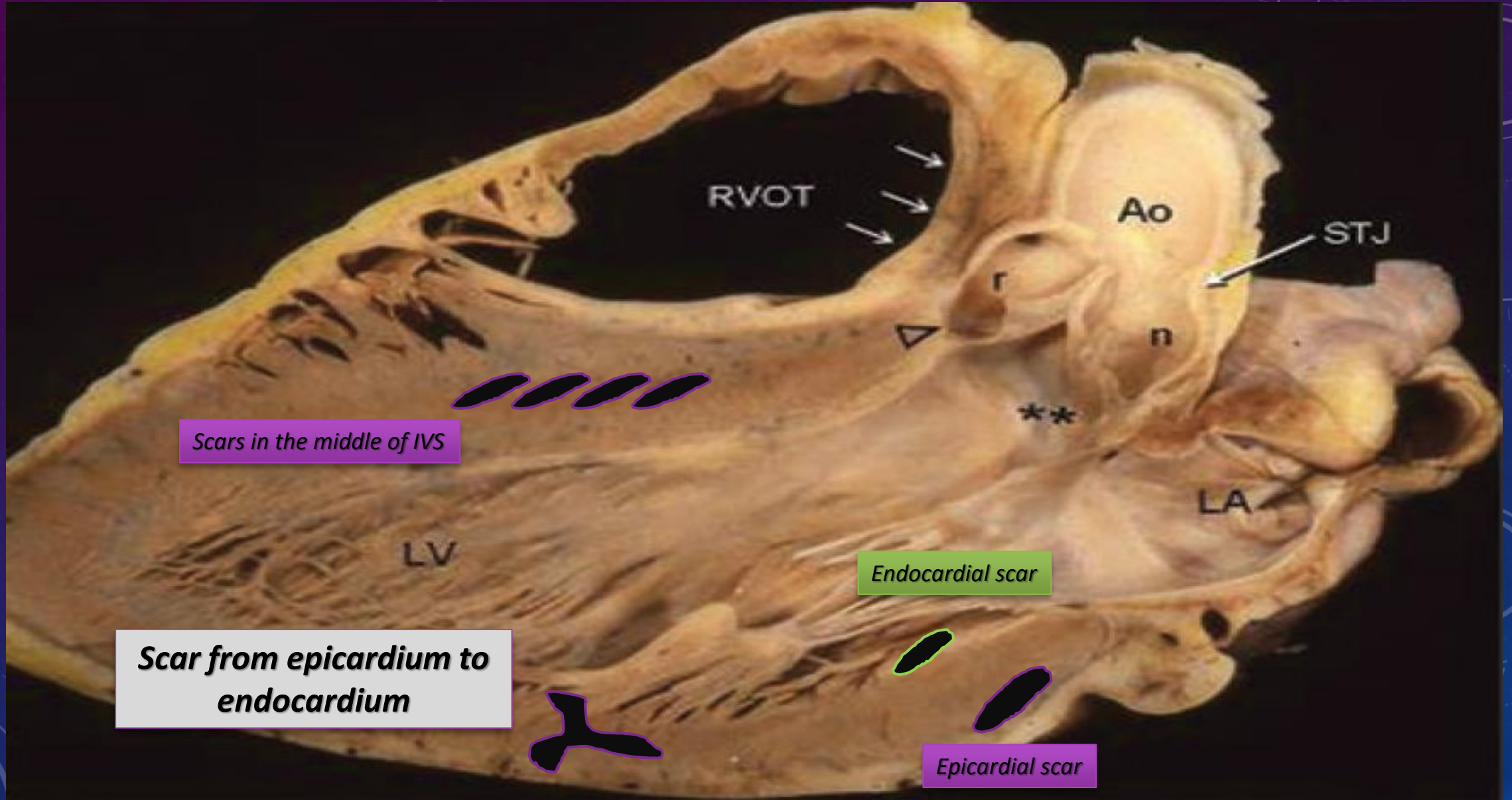
## Map from the Coronary Venous Circulation (AIV/GCV)

Santangeli et al. Circulation  
EP 2015;8:337-43  
Yamada et al. Circulation  
EP 2010;3:616-23  
W.A. McAlpine Collection-  
UCLA Cardiac Arrhythmia  
Center (with permission)





# If only we could ablate VTs in 3D dimensions through living anatomy



# *Predicting arrhythmia recurrence following catheter ablation for ventricular tachycardia using late gadolinium enhancement magnetic resonance imaging: Implications of varying scar ranges*

Pranav Bhagirath, MD, PhD, Fernando O. Campos, PhD, Caroline M. Costa, PhD, Arthur A.M. Wilde, MD, PhD, Anton J. Prassl, PhD, Aurel Neic, PhD, Gernot Plank, PhD, Christopher A. Rinaldi, MD, PhD, FHRS, Marco J.W. Götze, MD, PhD, Martin J. Bishop, PhD

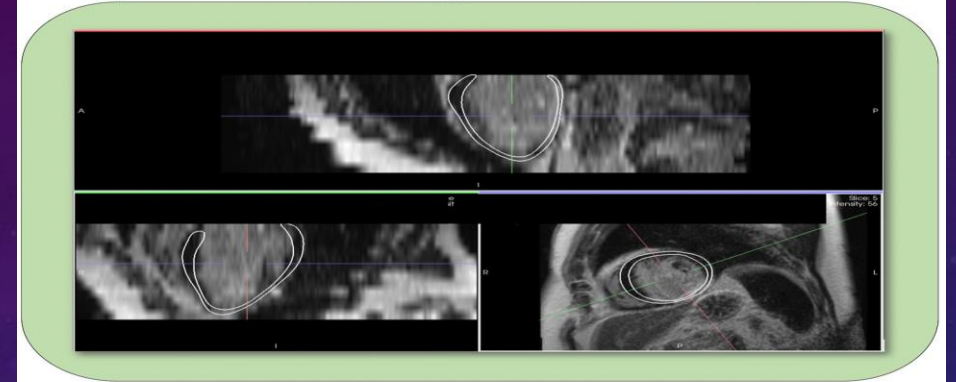
*Heart Rhythm*

Volume 19 Issue 10 Pages 1604-1610 (October 2022)

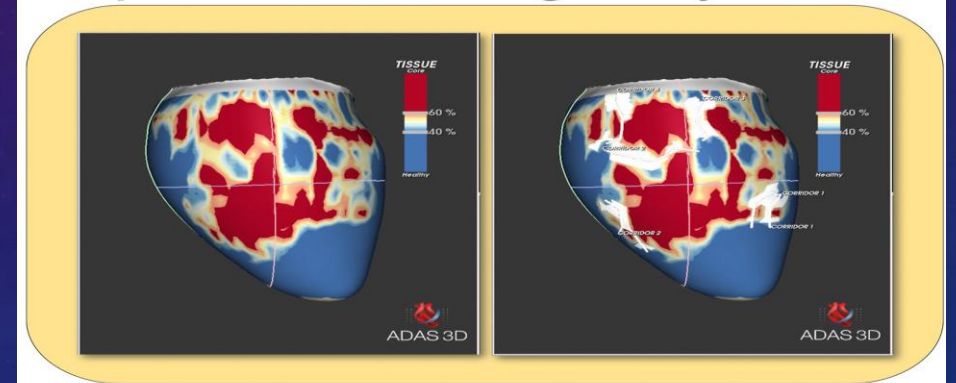
DOI: 10.1016/j.hrthm.2022.05.021



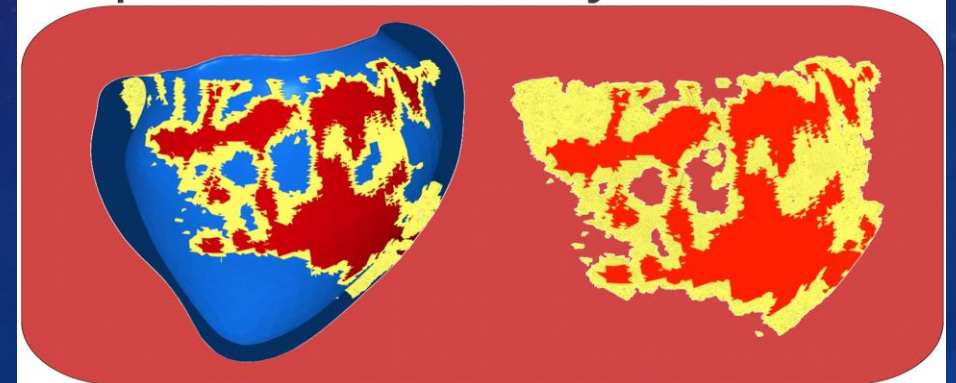
## Step 1. CMR segmentation



## Step 2. Thresholding analysis

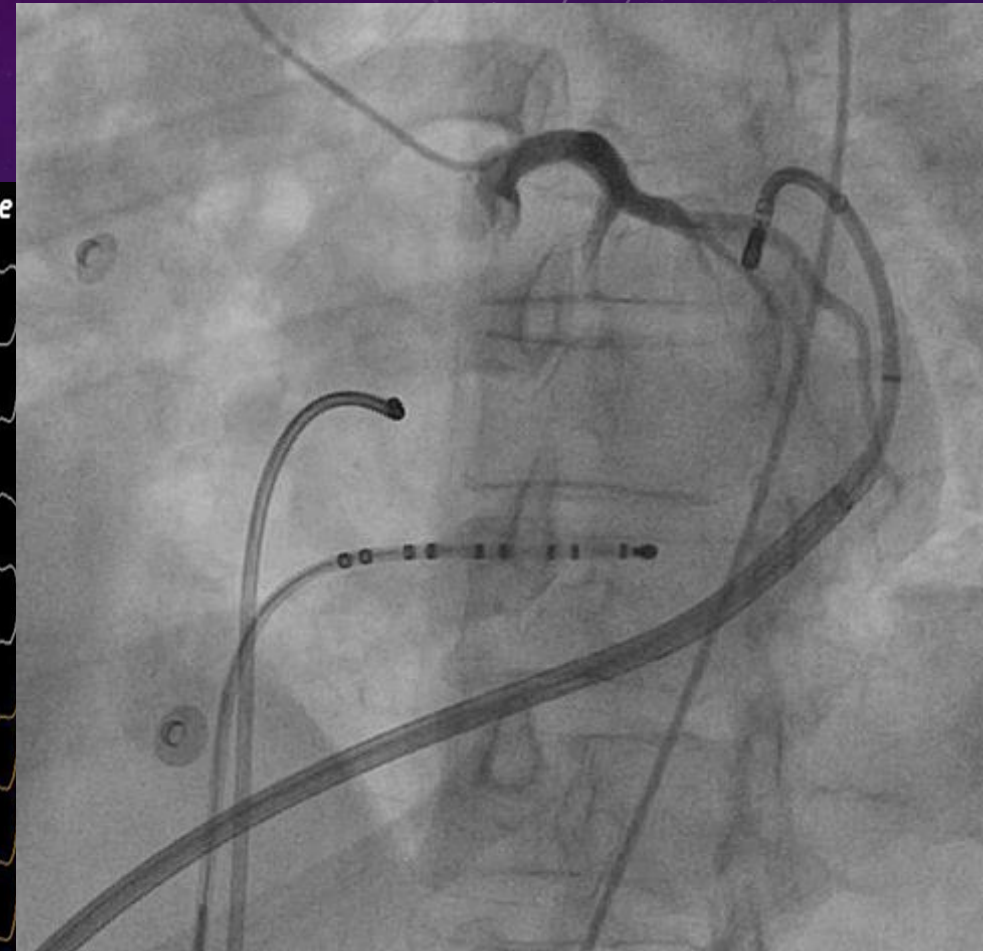
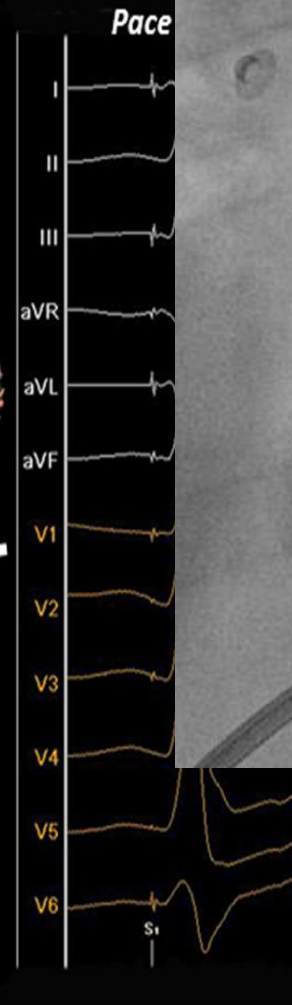
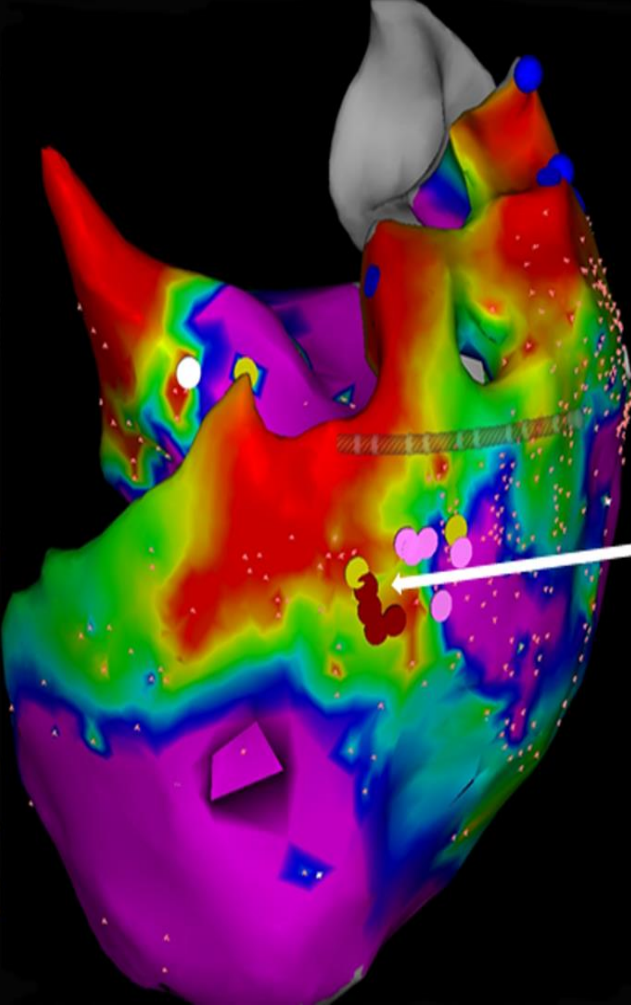
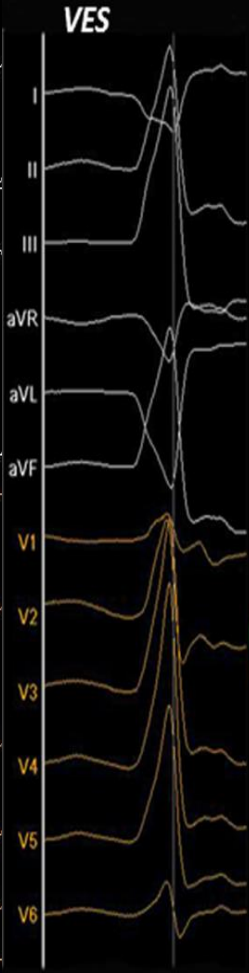
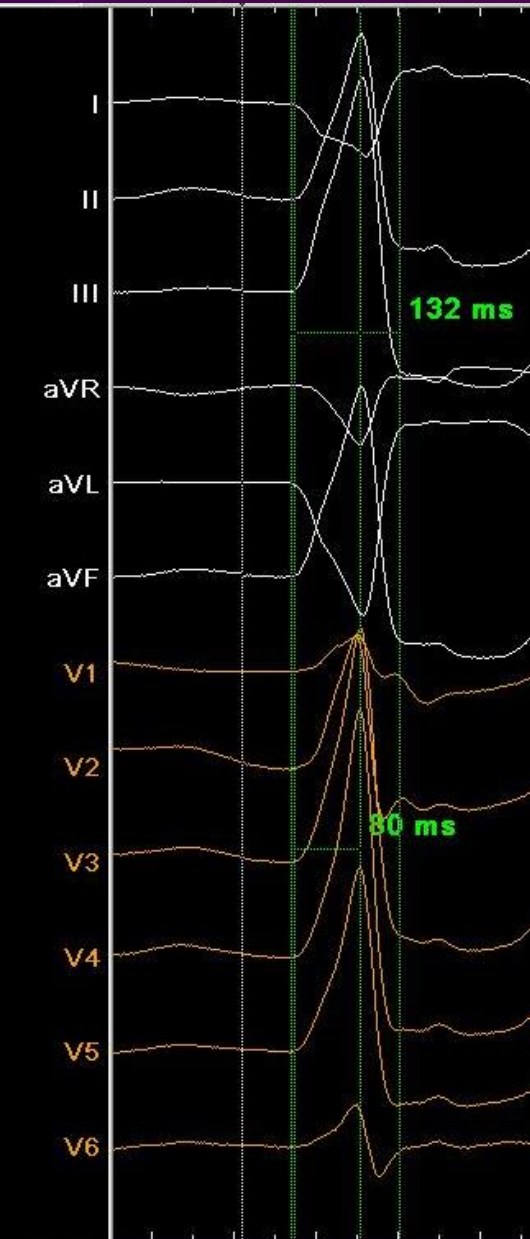


## Step 3. Interface analysis





# If only we could ablate VTs in 3D dimensions through living anatomy



# Interventional cardiac magnetic resonance (iCMR) Ablation



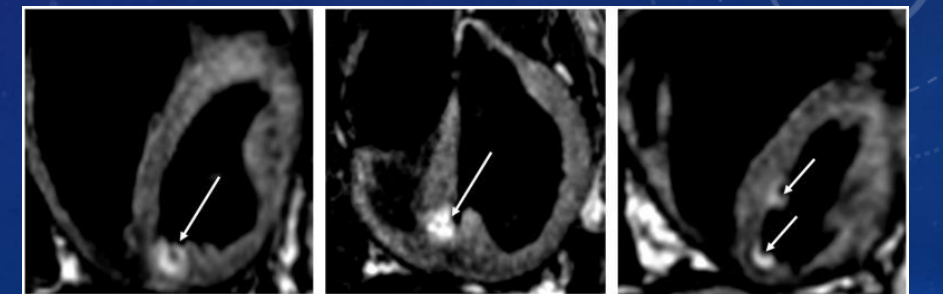
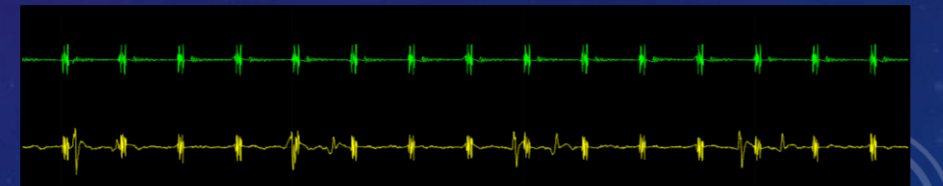
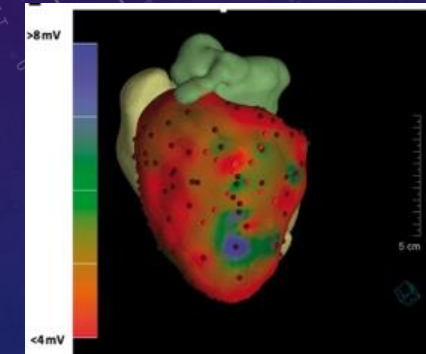
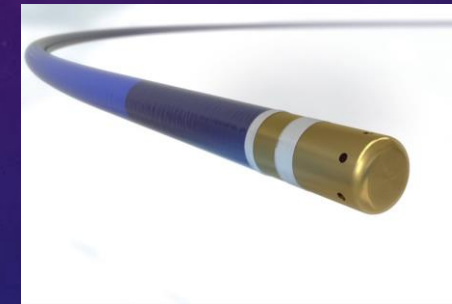
**IT IS FEASIBLE**



# Real-time Cardiovascular Magnetic Resonance-Guided Radiofrequency Ablation: a comprehensive review

Tampakis K<sup>1</sup>, Pastromas S<sup>1</sup>, Sykiotis A<sup>1</sup>, Kourgiannidis G<sup>1</sup>, Kampanarou S<sup>2</sup>, Mpousoula M<sup>3</sup>, Rozakis D<sup>3</sup>, Andrikopoulos G<sup>1</sup>.

Animal studies					
	N	Subject	Cardiac chamber/site	Procedure type	Publication year
Lardo et al. <sup>21</sup>	6	mongrel dog	RV apex	Ablation	2000
Nazarian et al. <sup>15</sup>	10	mongrel dog	RA, His bundle, RV	EP study	2008
Nordbeck et al. <sup>30</sup>	8	swine	RA, RV, AV node	Ablation	2009
Hoffmann et al. <sup>31</sup>	20	swine	CTI	Ablation	2010
Nordbeck et al. <sup>32</sup>	9	swine	CTI	Ablation	2011
Vergara et al. <sup>33</sup>	6	swine	RA, LA	Ablation	2011
Ranjan et al. <sup>34</sup>	7	mongrel dog	RA	Ablation	2011
Ganesan et al. <sup>35</sup>	11	sheep	PV, CTI	Ablation	2012
Grothoff et al. <sup>36</sup>	14	swine	RA, LA, AV node	Ablation	2017
Krahn et al. <sup>24</sup>	12	swine	LV	Ablation	2018
Mukherjee et al. <sup>37</sup>	6	swine	LV epicardium	Ablation	2018
Chubb et al. <sup>10</sup>	5	swine	CTI	Ablation	2017
Lichter et al. <sup>38</sup>	8	canine	PV, SVC, focal	(Cryo)ablation	2019
Human studies					
	N	Cardiac chamber/site	Procedure type	Publication year	
Nazarian et al. <sup>15</sup>	2	RA	EP study	2008	
Sommer et al. <sup>9</sup>	5	RA	EP study	2013	
Grothoff et al. <sup>7</sup>	10	CTI	Ablation	2014	
Hilbert et al. <sup>18</sup>	6	CTI	Ablation	2016	
Chubb et al. <sup>10</sup>	10	CTI	Ablation	2017	
Paetsch et al. <sup>28</sup>	30	CTI	Ablation	2019	
Ulbrich et al. <sup>29</sup>	15	CTI	Ablation	2022	



## KEY FINDINGS

- Real-time magnetic resonance (MR)-guided ablation procedures for atrial flutter can be safely and successfully performed completely in the interventional cardiac magnetic resonance (iCMR) environment.
- Real-time MR-guided ablation procedures can be completed using active catheter tracking, without the need for mapping or navigation software enhancement.
- Real-time MR imaging provides additional information (eg, anatomic characteristics, acute lesion assessment, detection of procedure-related complications) to guide physicians in therapy delivery.
- This procedure represents a radiation-free ablation method.

## Magnetic resonance imaging–guided conventional catheter ablation of isthmus-dependent atrial flutter using active catheter imaging

Stefan Ulbrich, MD,\* Yan Huo, MD, PhD,\* Jakub Tomala, MD,\* Michael Wagner, MD, PhD,\* Utz Richter, MD,\* Liying Pu, MD,\* Julia Mayer, MD,\* Angela Zedda, MD,\* Axel Joachim Krafft, PhD,<sup>†</sup> Katherine Lindborg, PhD,<sup>‡</sup> Christopher Piorkowski, MD,\* Thomas Gaspar, MD\*


*From the \*Department of Electrophysiology, Heart Center University Dresden, Dresden, Germany, <sup>†</sup>Siemens Healthcare GmbH, Erlangen, Germany, and <sup>‡</sup>Imricor Medical Systems, Burnsville, Minnesota.*

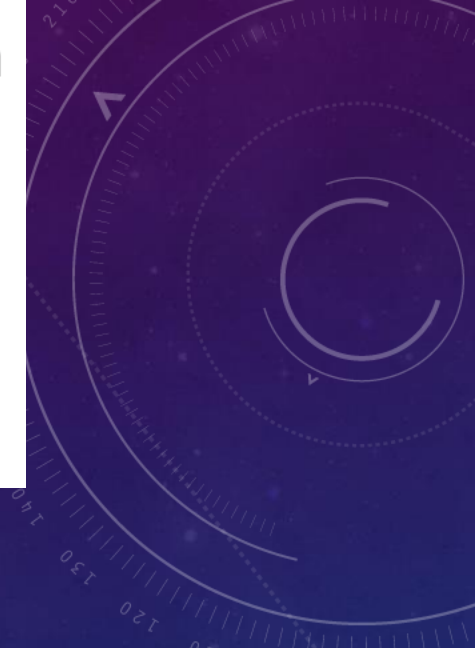
**RESULTS** All patients (N = 15; 73% male; median age 70 years; interquartile range [67–82]) achieved acute procedural success

**CONCLUSION** In the iCMR suite, CTI-dependent atrial flutter ablation could be achieved safely using active catheter imaging without any complication. It further allows detailed anatomic visualization of the CTI, intraprocedural lesion visualization, and exclusion of pericardial effusion.



# Transforming a pre-existing MRI environment into an interventional cardiac MRI suite

Geertruida P. Bijvoet<sup>1,2,3</sup>  | Robert J. Holtackers<sup>1,4</sup> | Jouke Smink<sup>5</sup> |  
Tom Lloyd<sup>6</sup> | Cristy L. M. van den Hombergh<sup>7</sup> | Luuk J. B. M. Debie<sup>2</sup> |  
Joachim E. Wildberger<sup>1,4</sup> | Kevin Vernooy<sup>1,2,3</sup> | Casper Muhl<sup>1,4</sup> |  
Sevasti-Maria Chaldoupi<sup>2,3</sup>



- RESUSCITATION PROCEDURE: When cardiac or respiratory arrest occurs within the iCMR suite (MRI zone 4), the patient is immediately moved to the patient preparation zone (MRI zone 3) where resuscitation is initiated. An automatic external defibrillator should always be present in zone 3. Advanced life support can be carried out immediately, led by the anesthesiologist and cardiologist that are already present. The hospital incident response team should be warned instantly for assistance.
- QUENCH PROCEDURE: In case of a life-threatening situation caused by the magnetic field, the MRI system should be "quenched" using the quench button to eliminate the magnetic field. Alternatively, although extremely rare, the system might quench spontaneously. In both cases, the magnet temperature increases and loses its superconducting properties. The electrical energy is turned into heat which evaporates the liquified helium that is drained from the area by the quench pipe. In case the evaporated helium is incompletely eliminated from the MRI system, dangerously high levels of helium may build up in the scanner room leading to a sudden drop in oxygen level that may cause suffocation. All MRI authorized staff is aware of the "Emergency Quench Procedure" and a mandatory oxygen depletion alarm may go off.

- EMERGENCY BAILOUT STRATEGY: When performing EP procedures in a pre-existing diagnostic MRI environment away from the conventional fluoroscopic lab, a well-defined roadmap is required for the scenario where the patient must be transferred to the conventional EP lab, or in exceptionally extreme cases to the surgical theatre. This emergency bailout strategy should be described in detail in the safety protocol and be simulated during a mock-up procedure. In our hospital, one EP lab is kept available during iCMR procedures for potential bailout procedures. In our opinion, the precautionary blocking of an entire operating theatre is unnecessary as the incidence of complications during atrial flutter ablations requiring surgical intervention is low.

**Conclusion:** Transforming a pre-existing diagnostic MRI environment into an iCMR suite is feasible and safe. However, performing iCMR procedures outside the conventional fluoroscopic lab, poses challenges with technical, practical, and safety aspects that need to be addressed by a dedicated multi-disciplinary iCMR team.



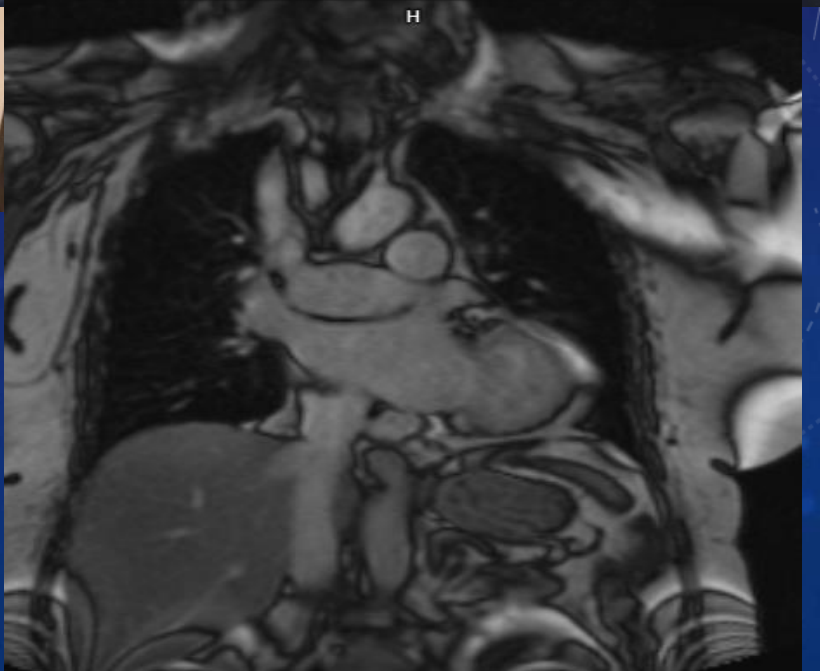
1. Dr Georgiadis (Head of Radiology)
2. Dr Kambanarou (Radiologist)
3. Dr Sykiotis (Electrophysiologist)
4. Dr Tambakis (Electrophysiologist)
5. Dr Pastromas (Electrophysiologist, Deputy director)
6. Mrs Pырpyri, (Head Technician)
7. Dr Andrikopoulos, (Director of EP&Pacing)







**1<sup>st</sup> case**  
A well-organized chaos









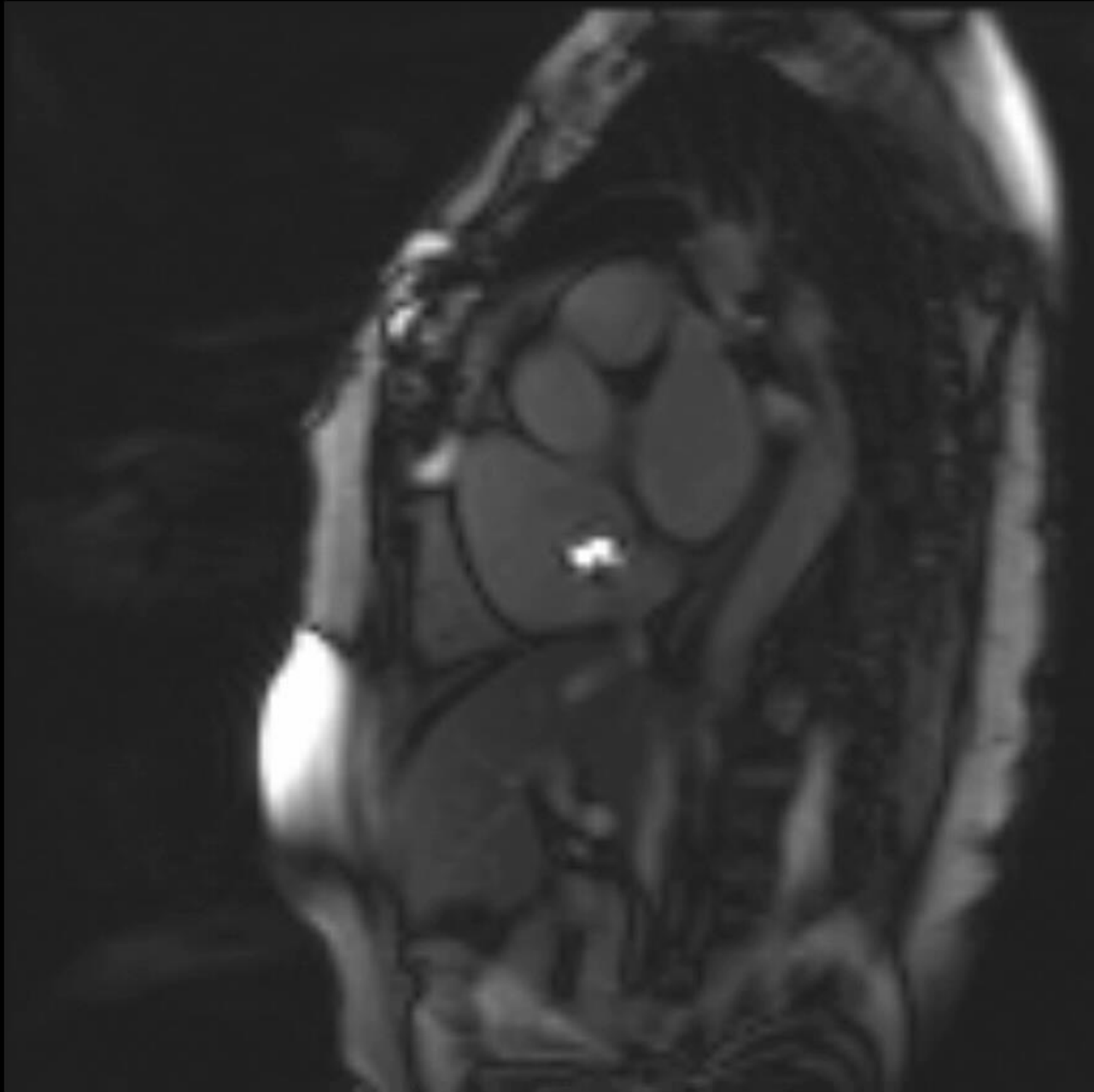
The patient is transferred in the MRI lab



The patient is prepared by EP nurses



First case:  
77-year old female  
with common atrial  
flutter





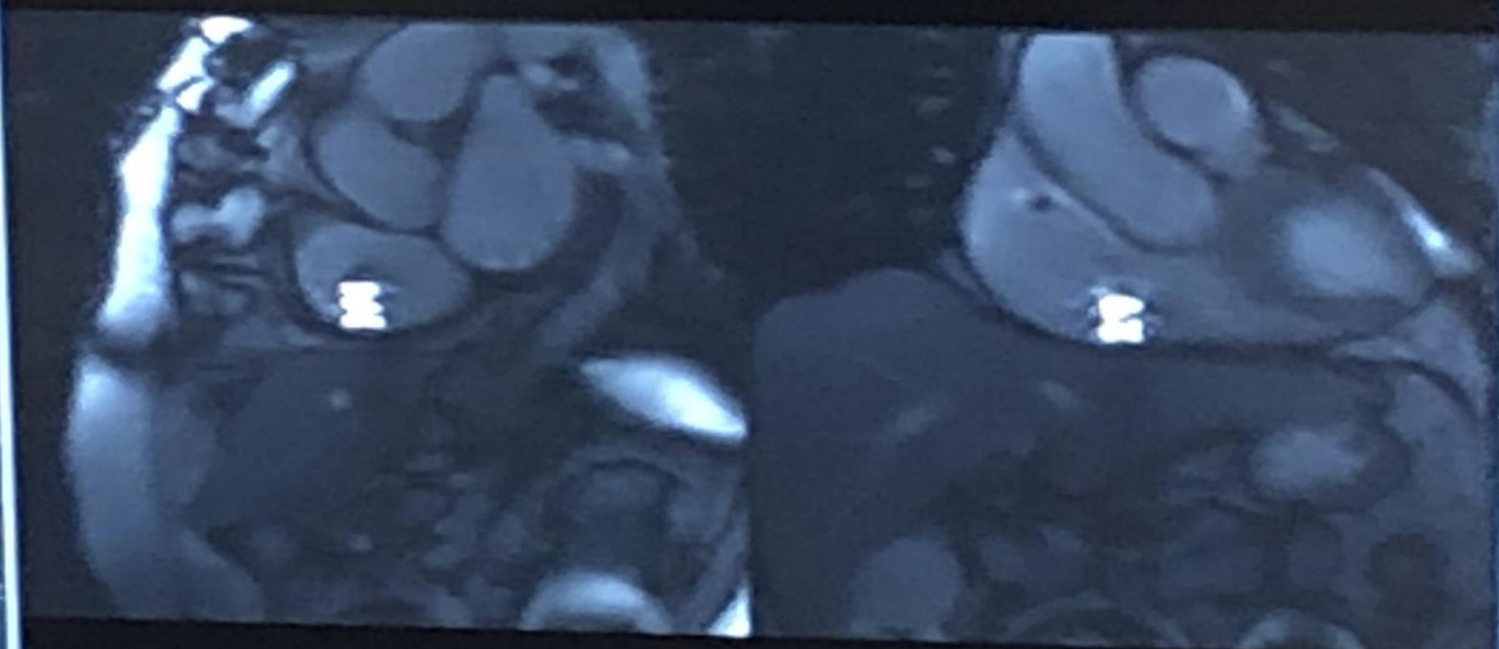
First case: 77-year old female with common atrial flutter



Step 72 - BEAT\_interactive\_1SL\_Ablation

LIRAKI, VASILIKI

IMA.290



002d1\_04 / 70

W 375  
C 141

- LIRAKI, VASILIKI
- 56 / BEAT\_interactive\_1SL\_A
  - 57 / scaling@100\_mode
  - 58 / scaling@100\_mode
  - 60 / BEAT\_interactive\_1SL\_A
  - 70 / scaling@100\_mode
  - 71 / BEAT\_interactive\_1SL\_A
  - 72 / BEAT\_interactive\_1SL\_A
  - 73 / BEAT\_interactive\_1SL\_A

00:00

Waiting for user to continue.

Stop-IRM SAR-IRM Measurement stopped by user.



15-April-1945 F  
Imricor\_import iCMR  
BEAT\_interactive\_1SL\_Diagnostic  
original image

**First case:**

**77-year old female with  
common atrial flutter**

**An organized chaos that  
lasted 3 hours but we  
did achieve bidirectional  
block**

ST: 10.00 SL: -19.66

RT: 199.40 ET: 1.58

FS: 1.50

MR

LittleEndianExplicit

Images: 49/66

Series: 42

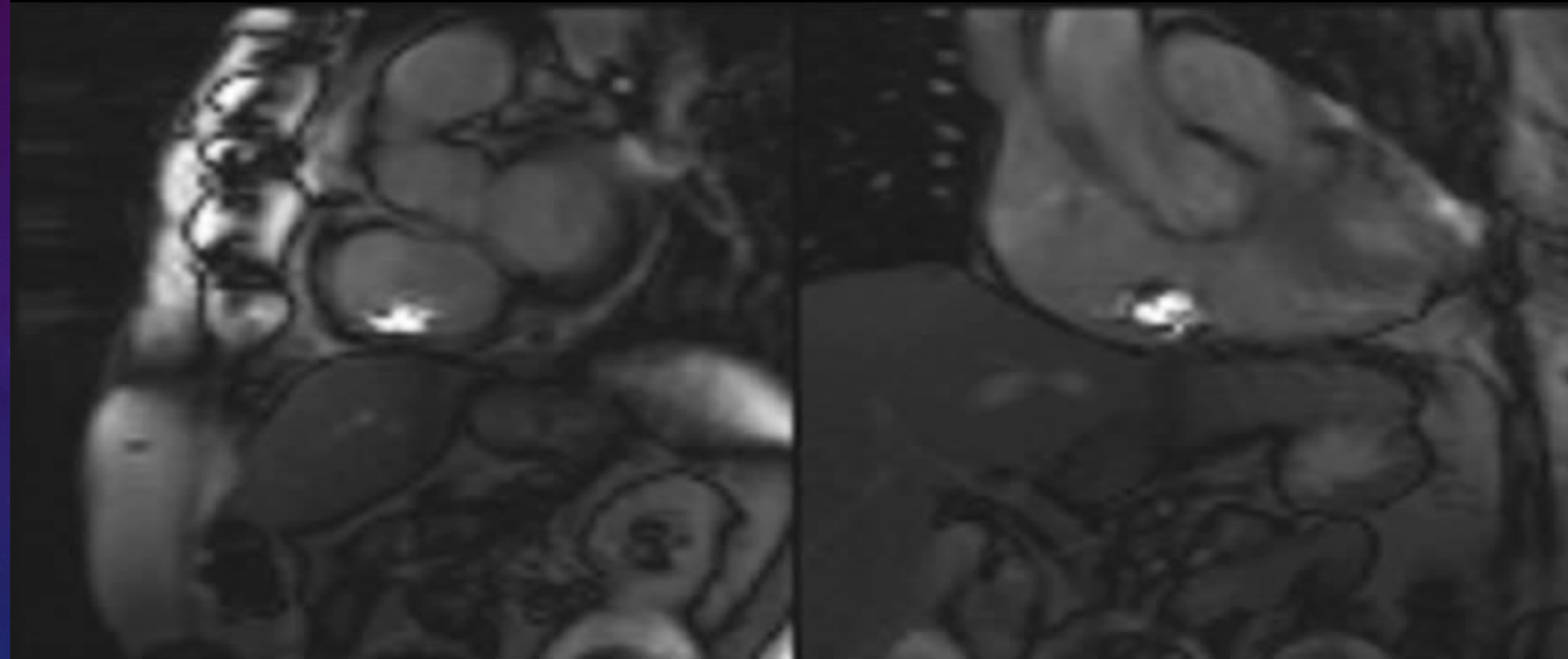
Zoom: 664%

WL: 174 WW: 469

15-April-1945 F  
Imricor\_import iCMR  
BEAT\_interactive\_1SL\_Ablation\_MOSAIC  
mosaic image

**First case:  
77-year old female with  
common atrial flutter**

**An organized chaos that  
lasted 3 hours but we  
did achieve bidirectional  
block**



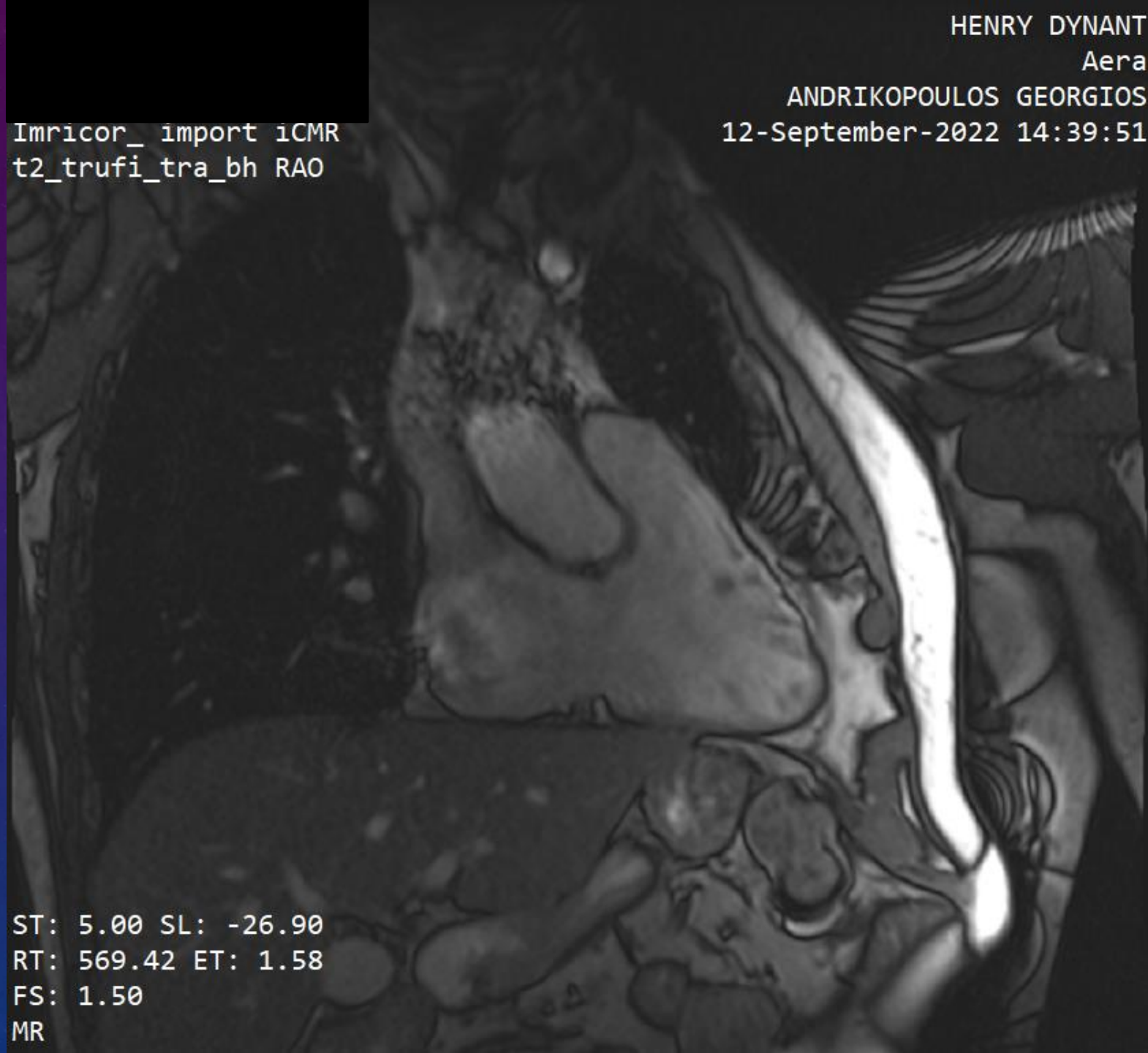
MR  
LittleEndianExplicit  
Images: 1/243  
Series: 43



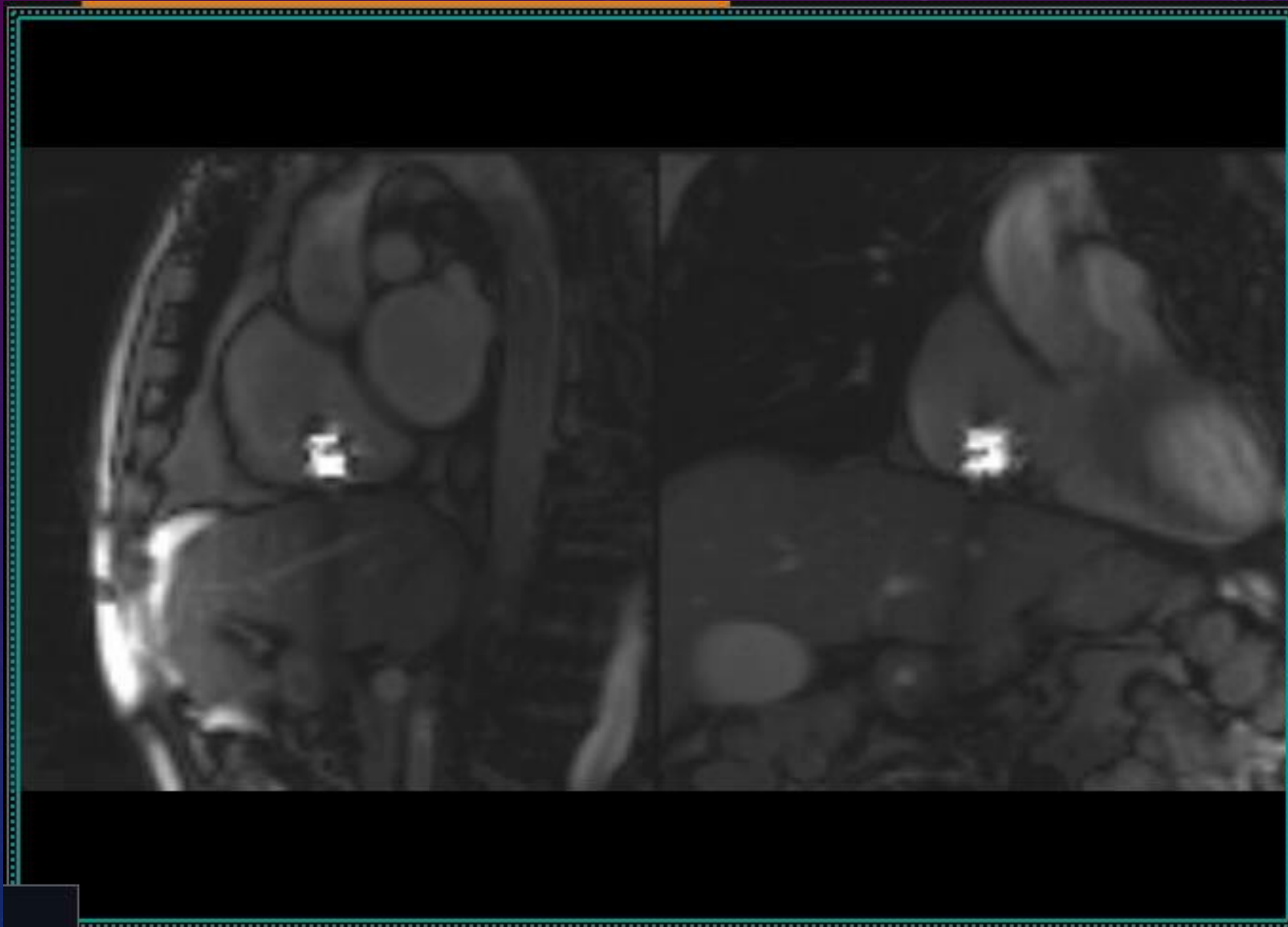
Imricor\_import iCMR  
t2\_trufi\_tra\_bh RAO

**Second case: 78-year old male with  
common atrial flutter**

ST: 5.00 SL: -26.90  
RT: 569.42 ET: 1.58  
FS: 1.50  
MR



Second case: 78-year old male with common atrial flutter





# Clinical workflow and applicability of electrophysiological cardiovascular magnetic resonance-guided radiofrequency ablation of isthmus-dependent atrial flutter

**Table 2** EP-CMR procedure duration

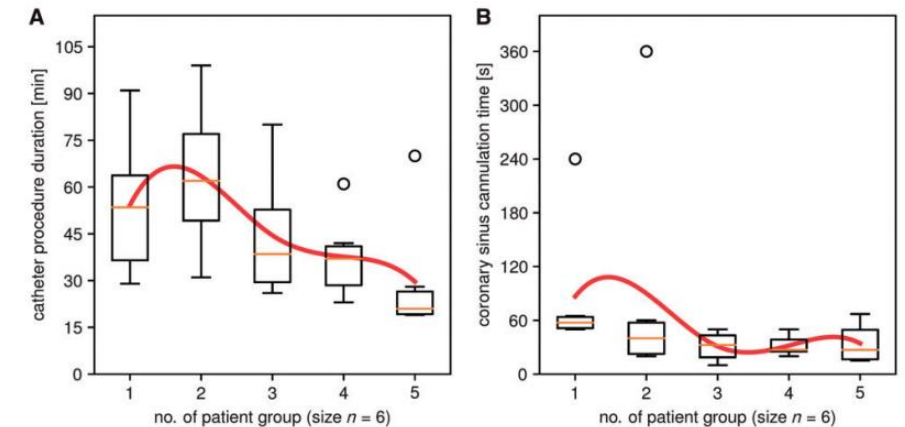
	EP-CMR intervention (n = 30)	Controls (n = 30)	P-value
Pre-procedural CMR imaging (min)	29.9 ± 4.7	NA	NA
Interventional procedure duration (min)	45.9 ± 22.8	48.4 ± 20.7	0.654
Post-procedural CMR imaging (min)	23.1 ± 9.5	NA	NA
Coronary sinus cannulation time (s)	54.5 ± 70.5	97.4 ± 49.8	0.009
Total RF pulse duration (s)	742.0 ± 385.3	912.4 ± 660.9	0.229
Maximal temperature (°C)	38.6 ± 1.1	38.9 ± 3.0	0.529

Values are represented as mean ± SD.

CMR, cardiovascular magnetic resonance; EP-CMR, electrophysiological cardiovascular magnetic resonance; NA, not applicable

## Conclusion

In a routine clinical setting, EP-CMR demonstrated its safety and high efficacy for the treatment of typical right atrial flutter with performance and outcome measures similar to conventional, fluoroscopy-guided flutter ablation. Hence, EP-CMR represents a valid alternative to conventional right atrial flutter ablation.



**Figure 3** Box-and-whisker plots illustrating the learning experience of the EP-CMR interventionalist using procedural duration as performance metrics (A, catheter procedure duration; B, coronary sinus cannulation time); the red line represents the spline fit (third order polynomial) of the mean values with each subgroup consisting of n = 6 patients.

# The role of interventional cardiac magnetic resonance (iCMR) in a typical atrial flutter ablation: The shortest path may not always be the fastest

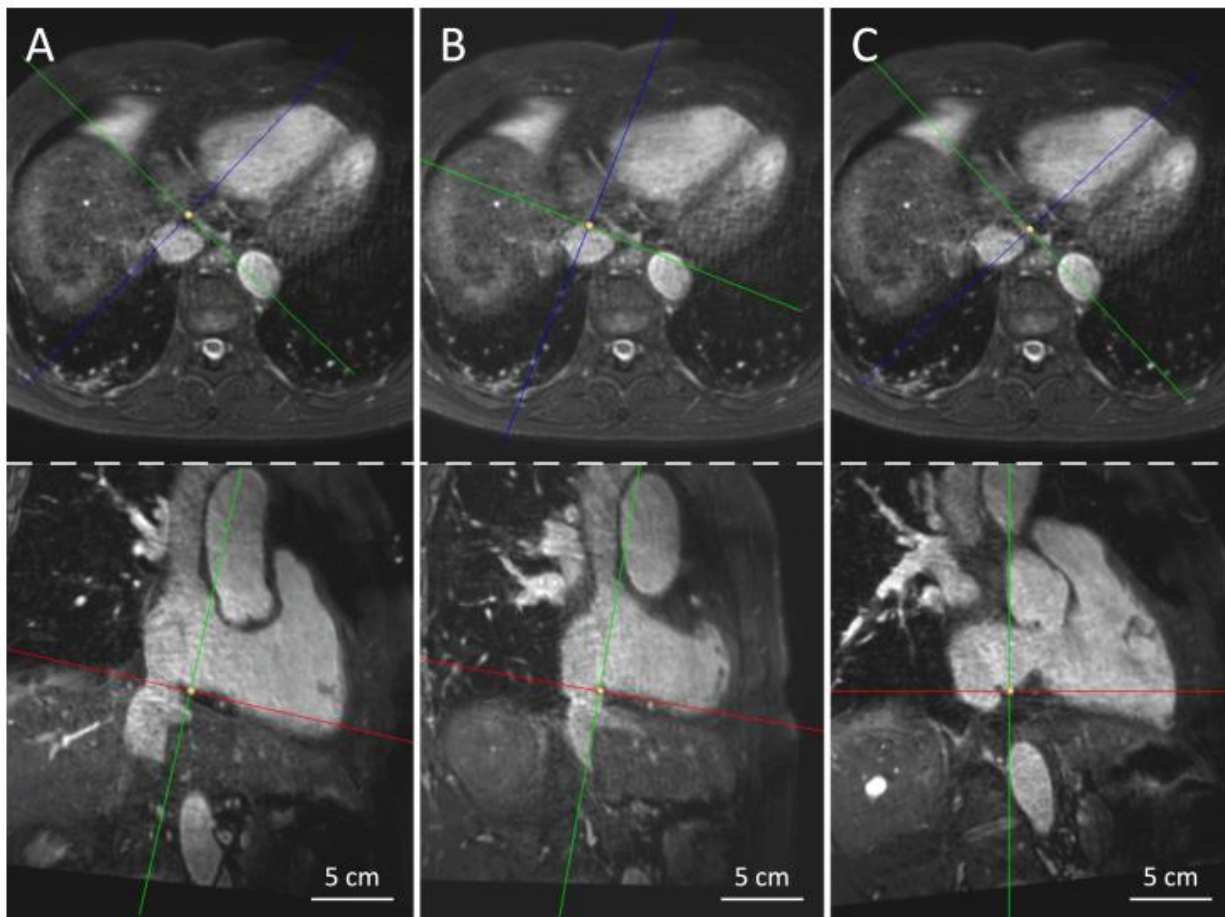
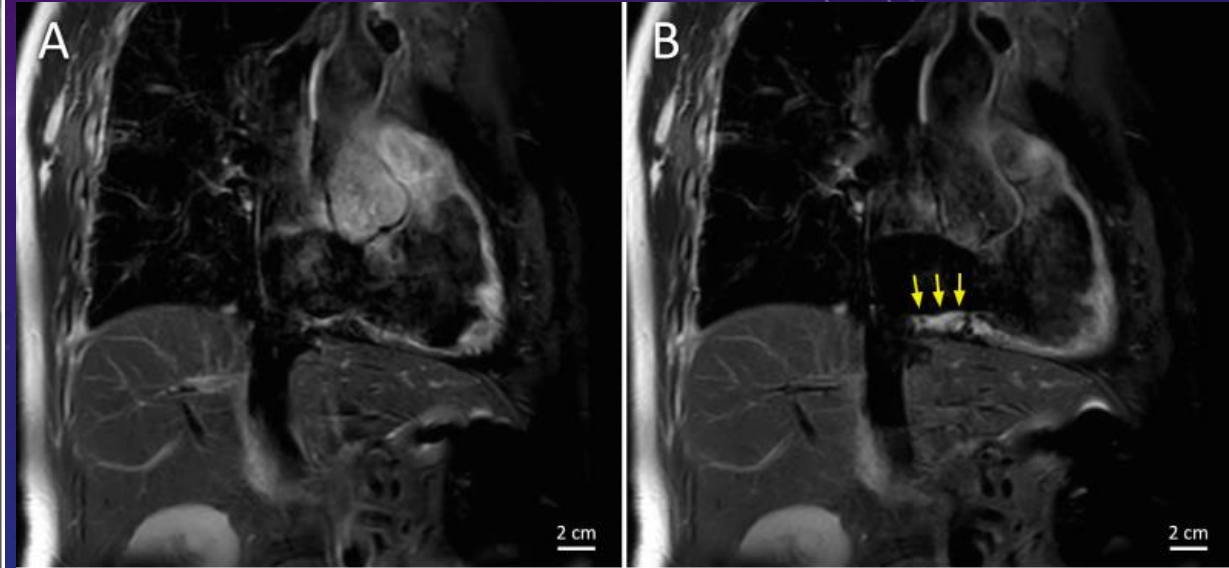


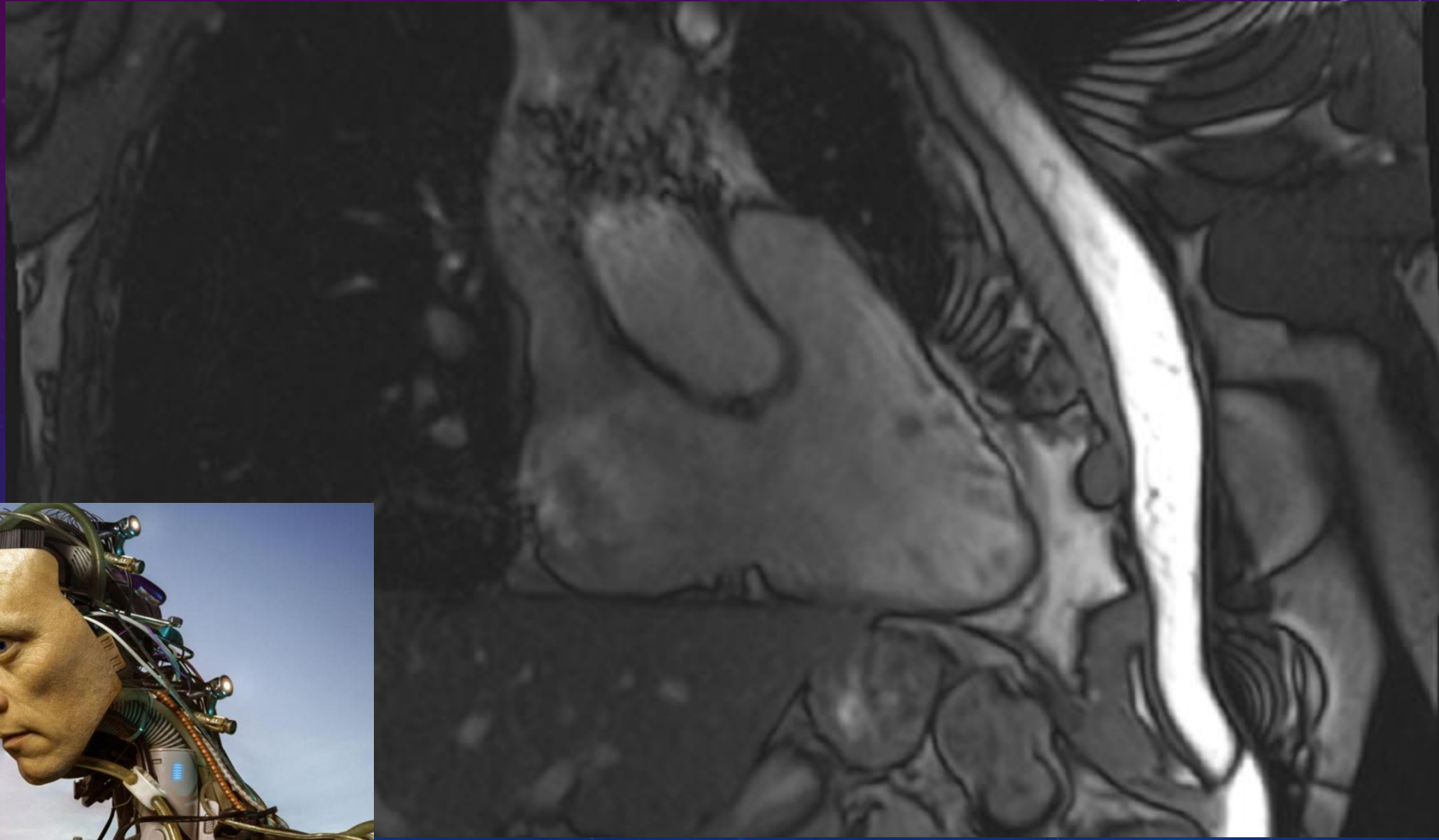
Fig. 1. Panels A, B, and C show three potential locations of the CTI ablation line in the transversal view (top row) and the LAO view. Panel E shows the 3D anatomical shell.



panel). During a 30-minute waiting period, additional ECG-triggered breath-hold black-blood T2-weighted MR imaging was performed to visualize edema in the ablation region (Fig. 2B). These images clearly show edema at the location of the CTI ablation line. The entire procedure was performed successfully with no signs of pericardial effusion or valvular damage, as confirmed by CMR imaging just before removing the catheters.



# iCMR guided AF ablation – A glimpse to the future



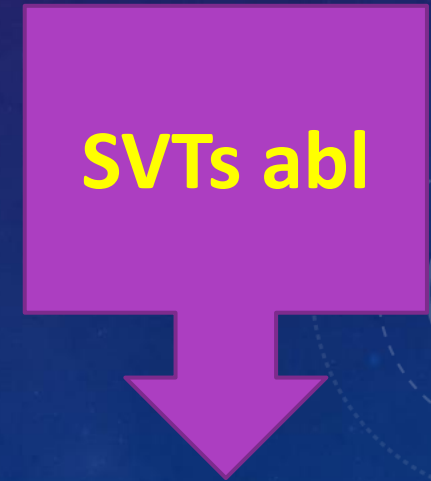
# WHAT HAPPENED IN ELECTROPHYSIOLOGY DURING THE LAST 2 YEARS?



**AF abl**



**VT  
abl**



**SVTs abl**

(65% of ablations in our center is AF or AF related)



# Repeat catheter ablation for recurrent atrial fibrillation: Electrophysiologic findings and clinical outcomes

<sup>1</sup>Division of Cardiology, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

<sup>2</sup>Department of Biostatistics, Johns Hopkins University Bloomberg School of Public Health, Baltimore, Maryland, USA

- ❖ 300 patients who underwent their first repeat AF ablations for symptomatic, recurrent AF
- ❖ All repeat ablations were performed using RF energy, 78% RF for 1<sup>st</sup> ablation
- ❖ 67% at SR before repeat ablation

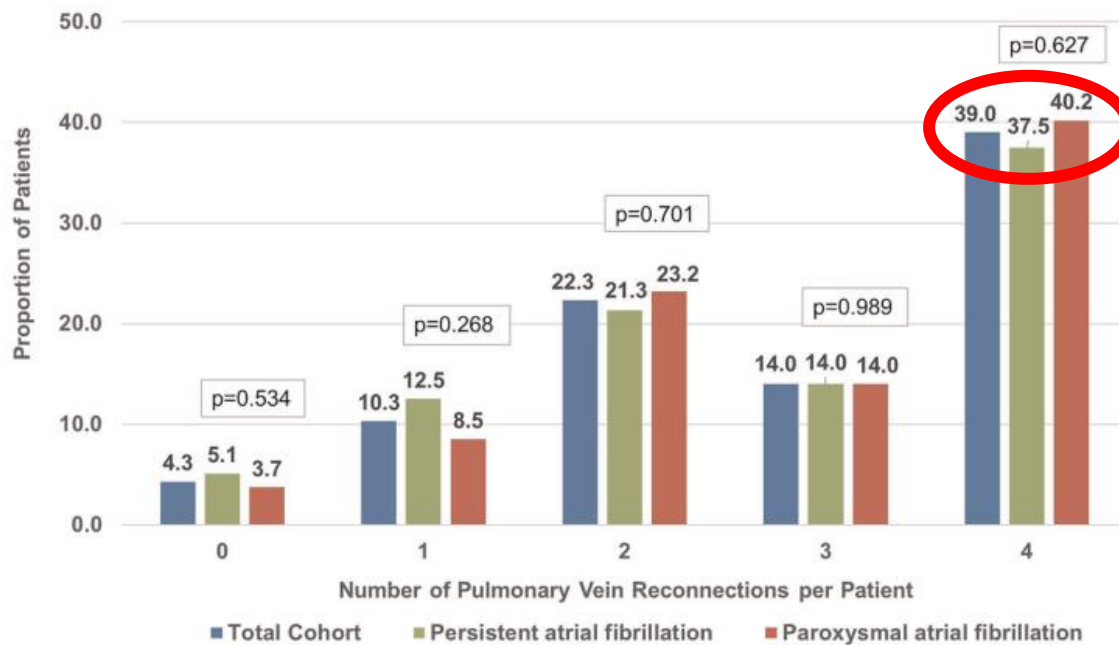


FIGURE 1 Number of pulmonary vein reconnections per patient discovered during repeat ablation for all patients and stratified by persistent versus paroxysmal atrial fibrillation at presentation for repeat ablation

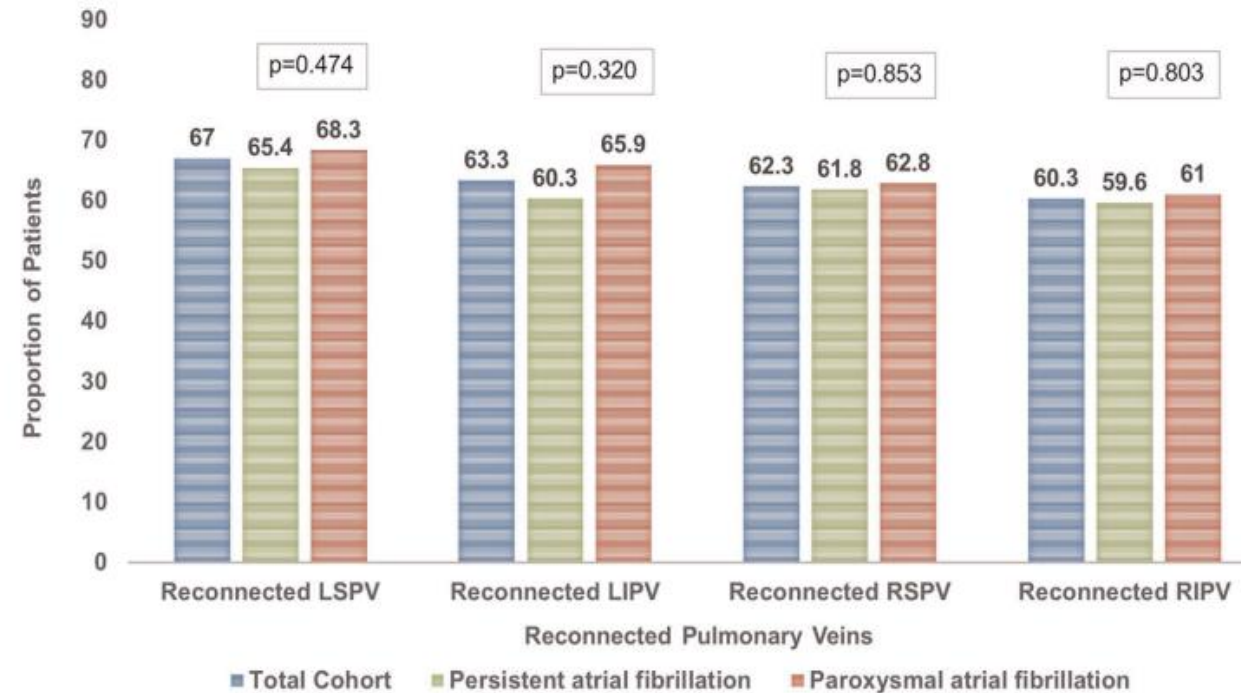


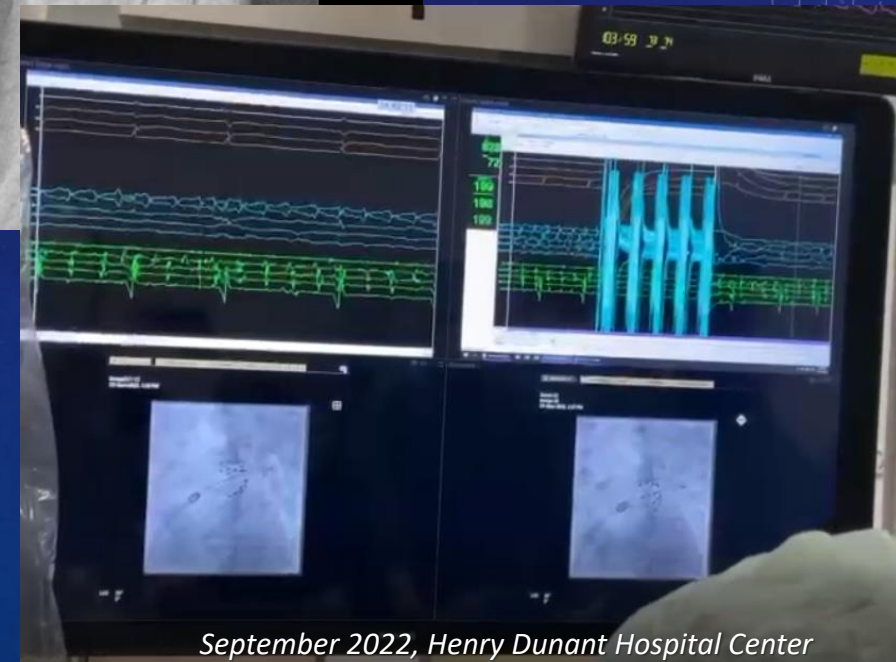
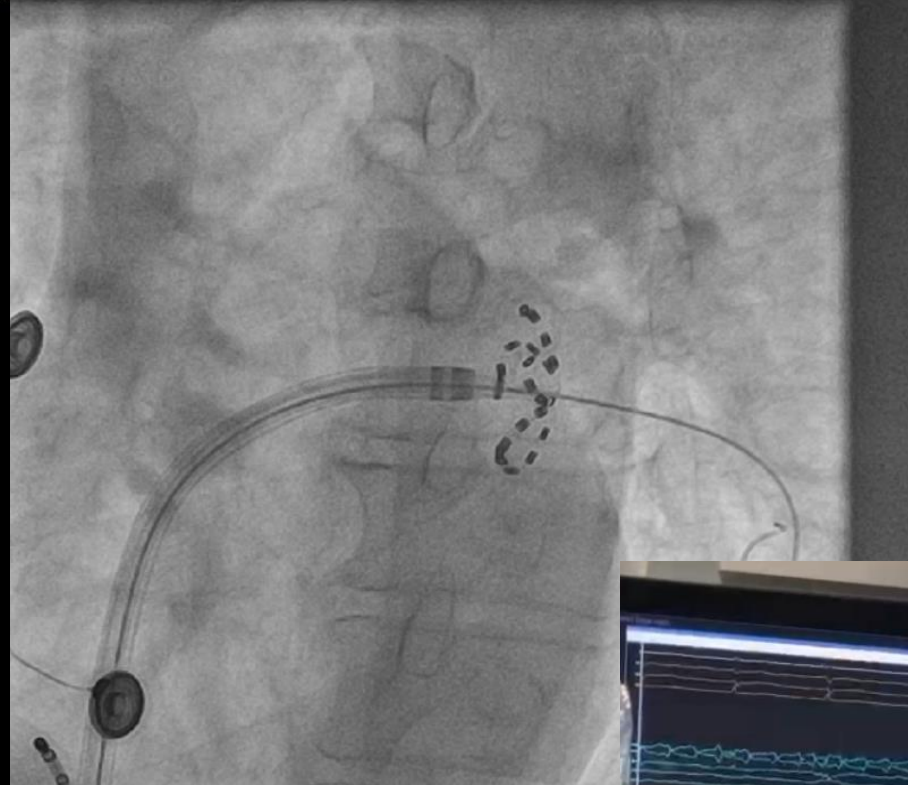
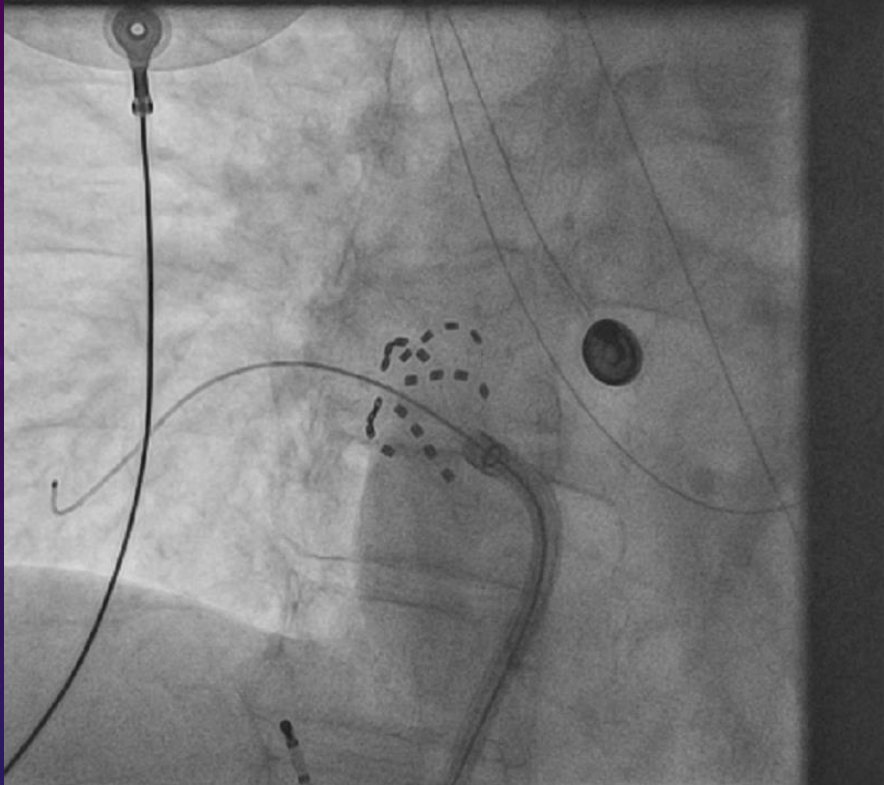
FIGURE 2 Anatomic distribution of pulmonary vein reconnections discovered during repeat ablation

**“During repeat ablation, at least one PV reconnection was found in 257 (85.6%) patients, while 159 (53%) had three to four reconnections”**

# PFA for AF ablation

Henry Dunant Hospital  
Azurion  
19-September-2022  
8:26:19

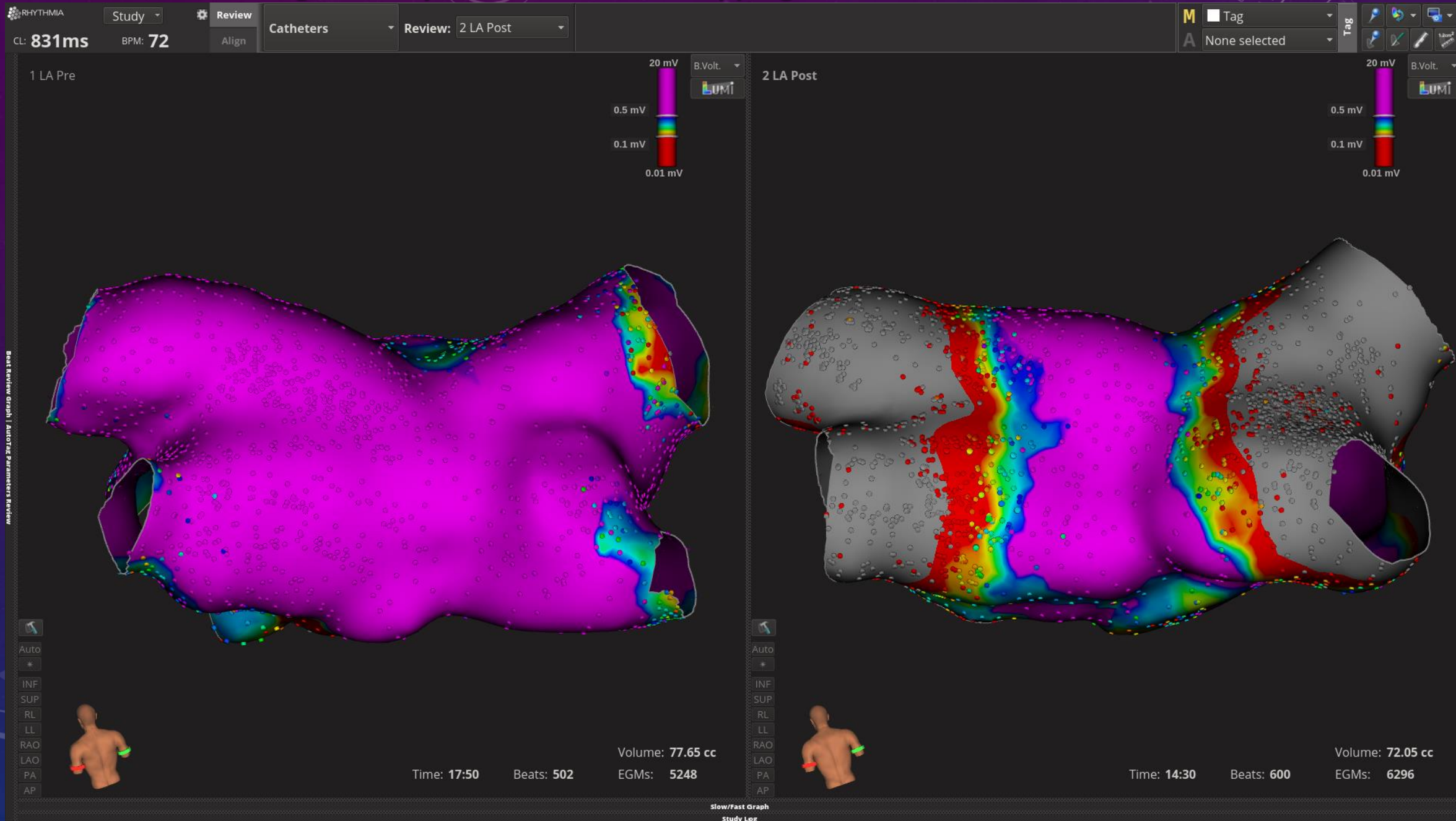
Henry Dunant Hospital  
Azurion  
19-September-2022



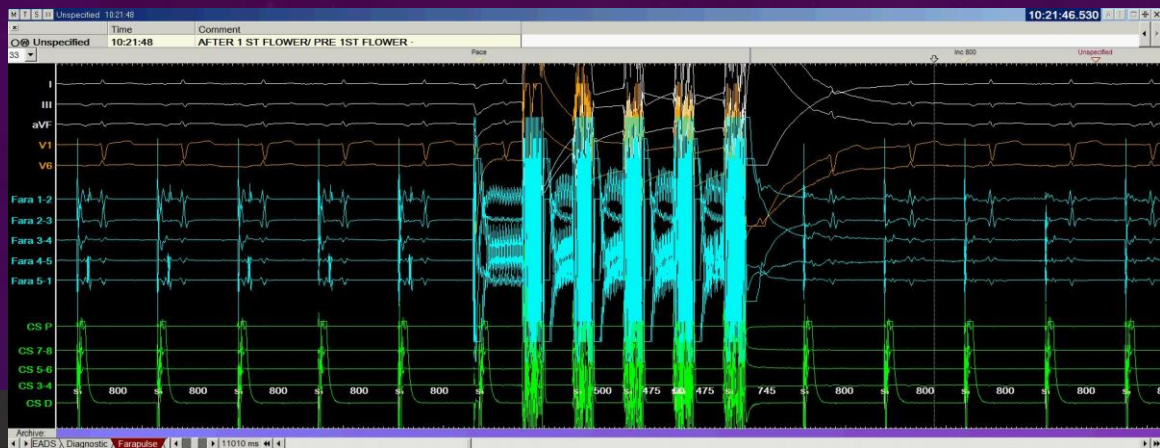
September 2022, Henry Dunant Hospital Center



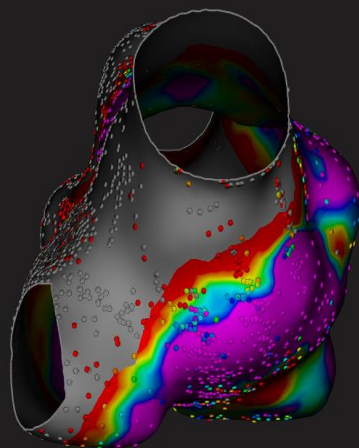
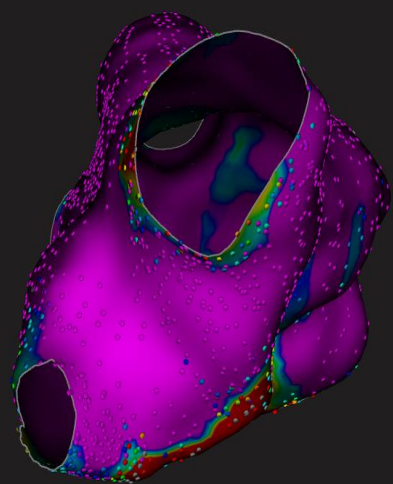
# High density electroanatomic mapping before and after PFA ablation



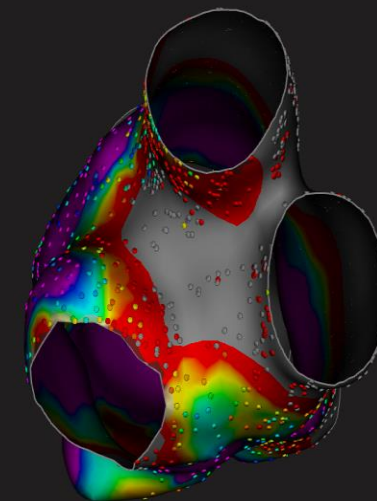
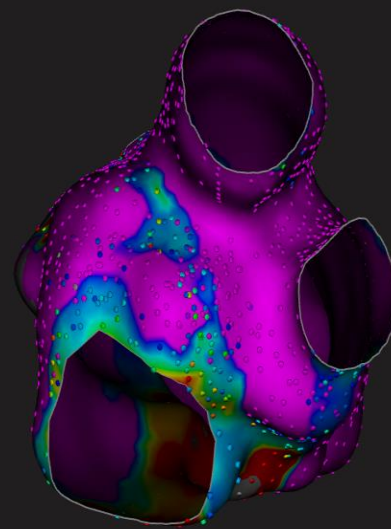
# Electroanatomic mapping before and after PFA ablation – proof of concept



## Right veins Before and After PFA



## Left veins Before and After PFA

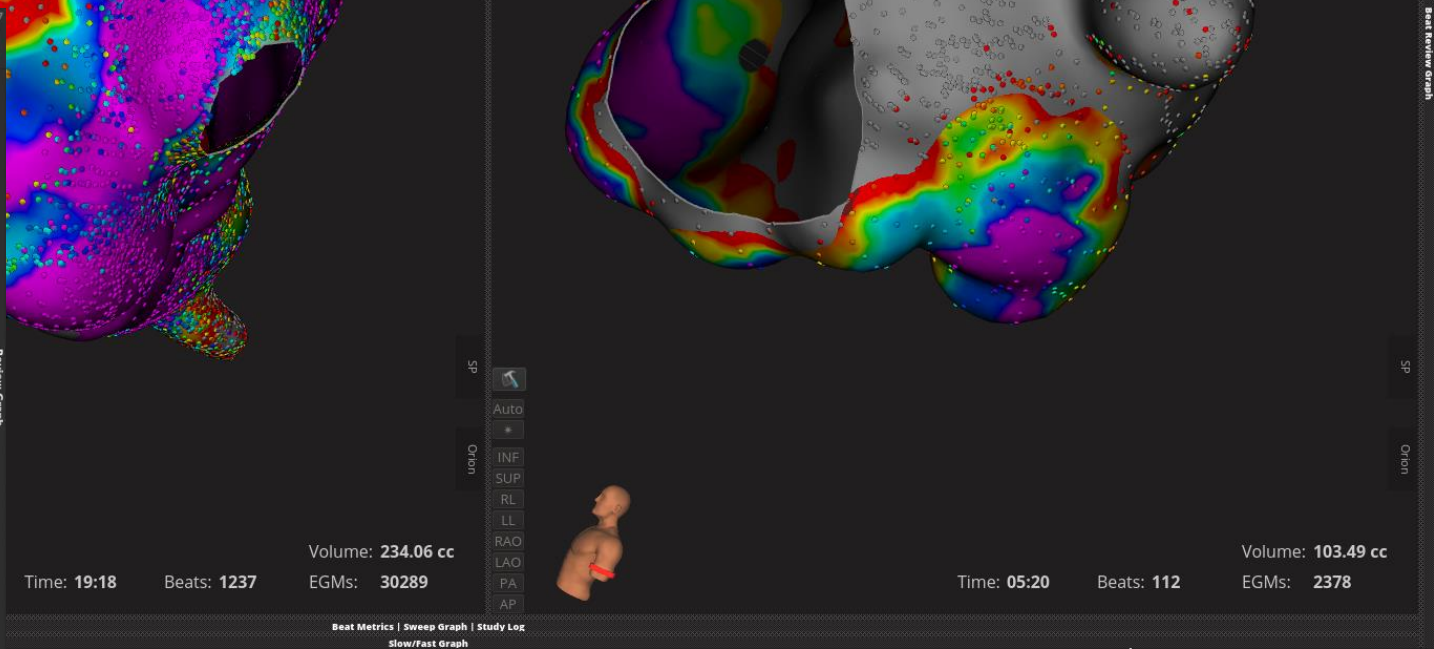
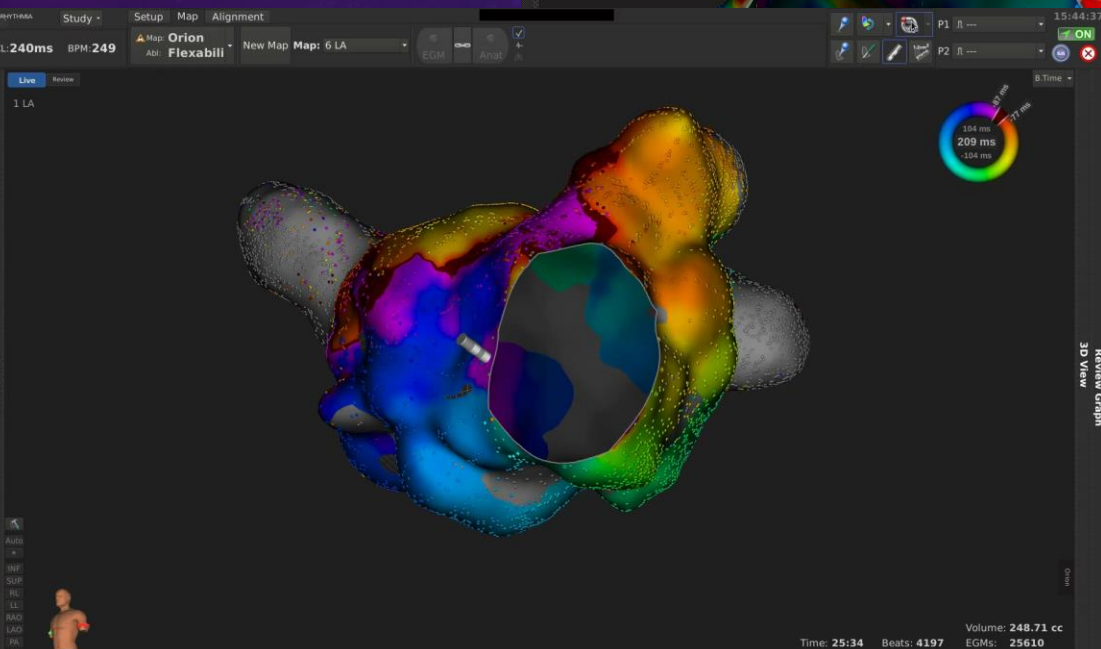
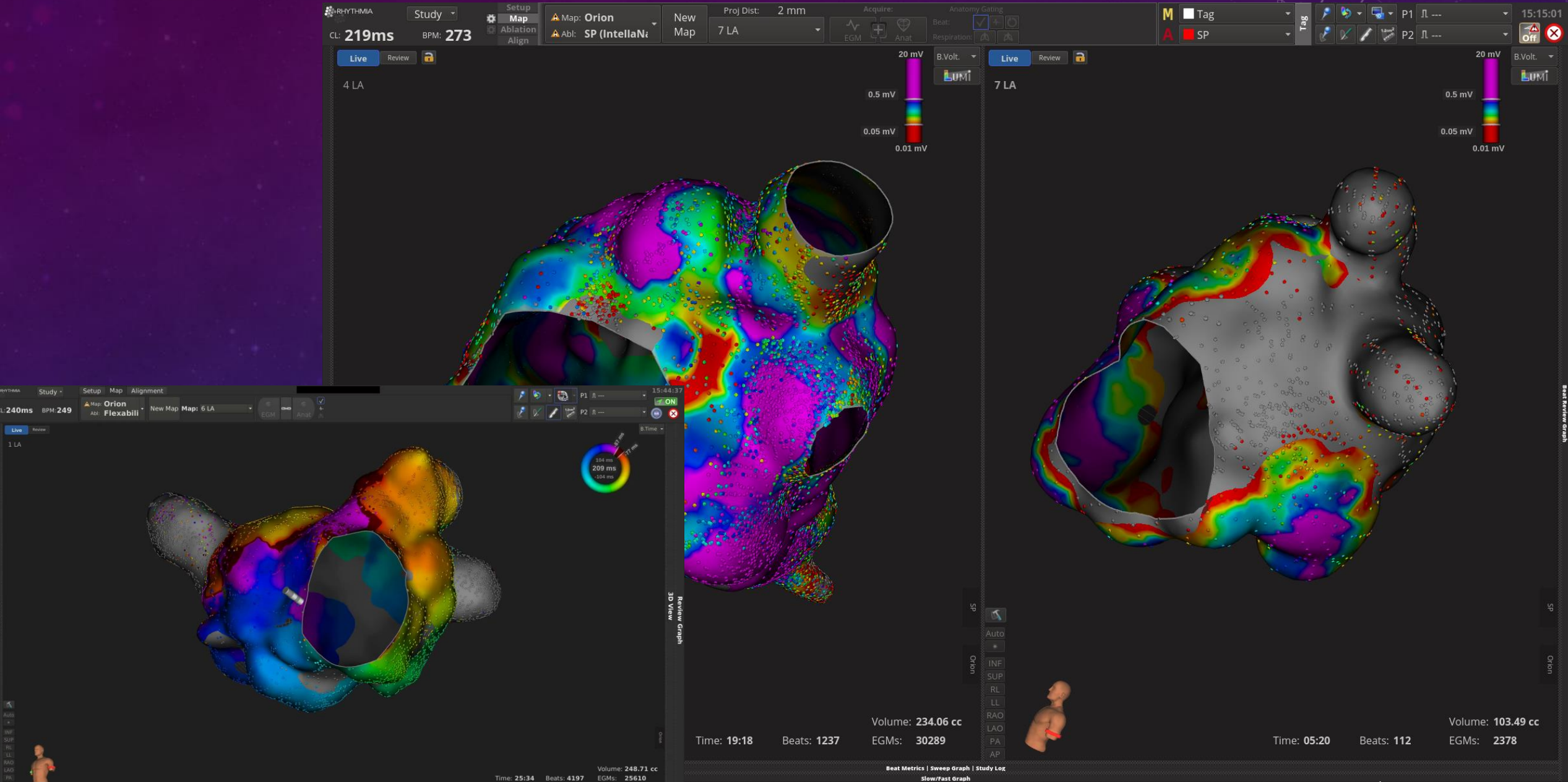




# LA Roof "Line" with PFA



# Fluoroscopy guided "modified anterior line" with PFA





# CTI PFA ablation

0000099810  
4-October-1953 F  
Cardiac EP ECO  
EP 7.5 fps

HENRY DUNANT Hospital Center  
AlluraXper  
14-November-2022 10:42:02

LAO: 38.60 CAU: 0.55  
XA  
LittleEndianExplicit  
Images: 1/3  
Series: 20

900 mA 76.56kV  
Zoom: 165%  
WL: 128 WW: 256

# SCV PFA Isolation

Henry Dunant H

31-October-2022

4-January-1989 M  
Left Coronary 7.5 fps Low

RAO: 8.70 CRA: 1.40  
XA

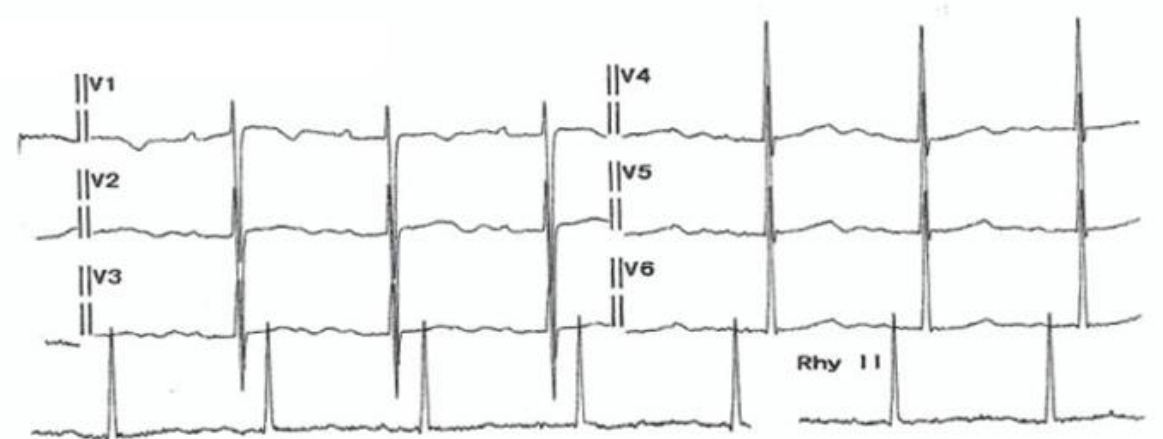
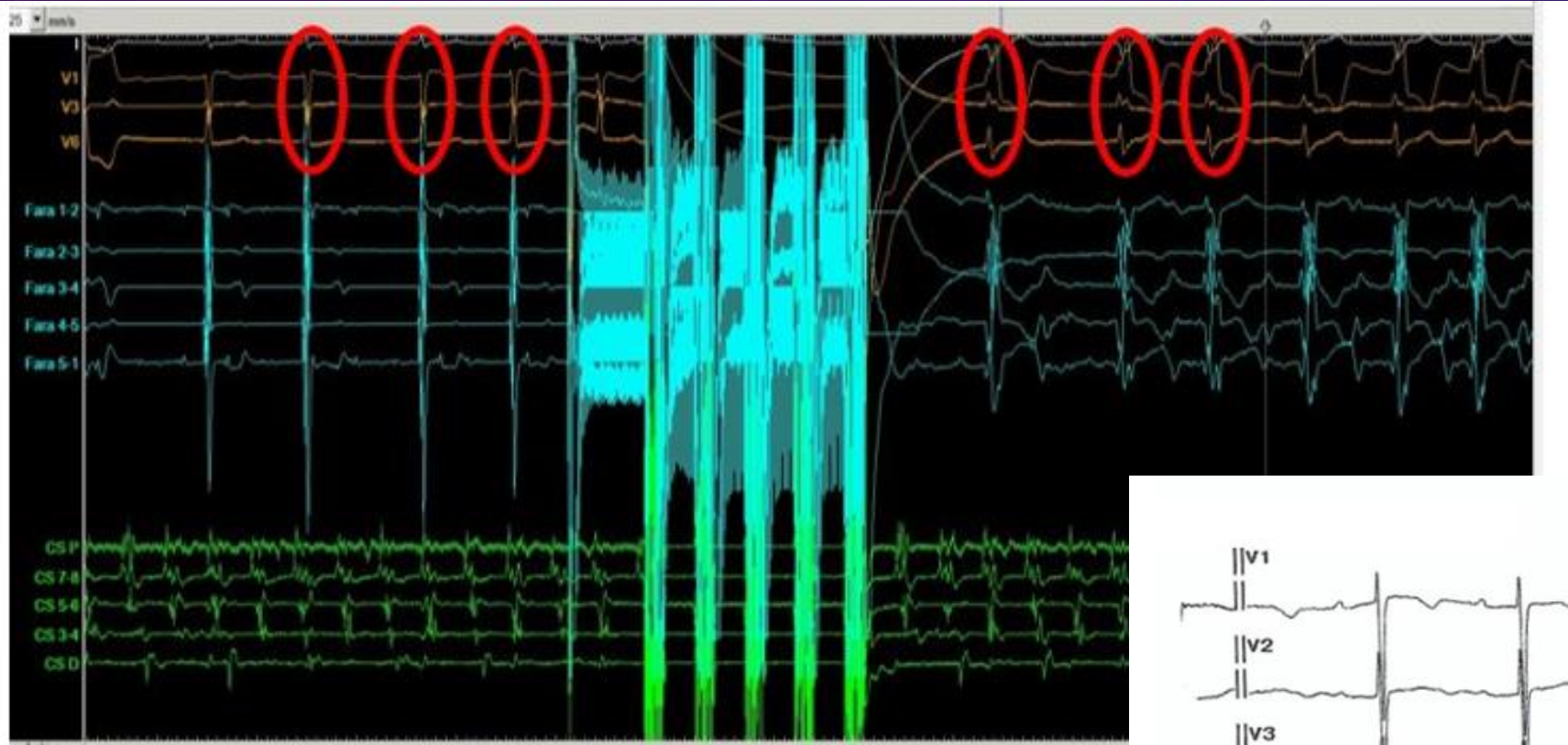
JPEGLossless:Non-hierarchical-1stOrderPrediction  
Images: 1/3  
Series: 26

554 mA  
Zoo  
WL: 128

## Pulsed-field ablation at the cavotricuspid isthmus may induce right bundle branch block

George Andrikopoulos<sup>1</sup>, Konstantinos Tampakis<sup>1</sup>, Alexandros Sykiotis<sup>1</sup>, Maria Mpousoula<sup>1</sup>, Dimitris Alexakis<sup>1</sup>, Socratis Pastromas<sup>1</sup>.

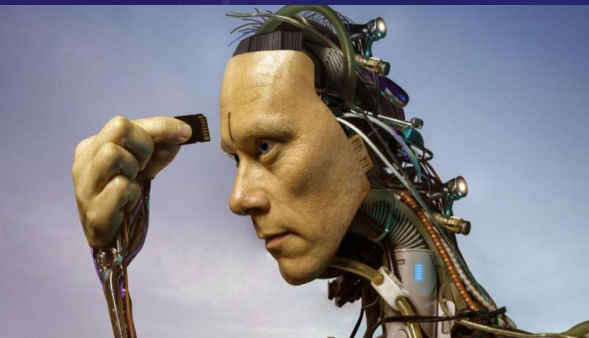
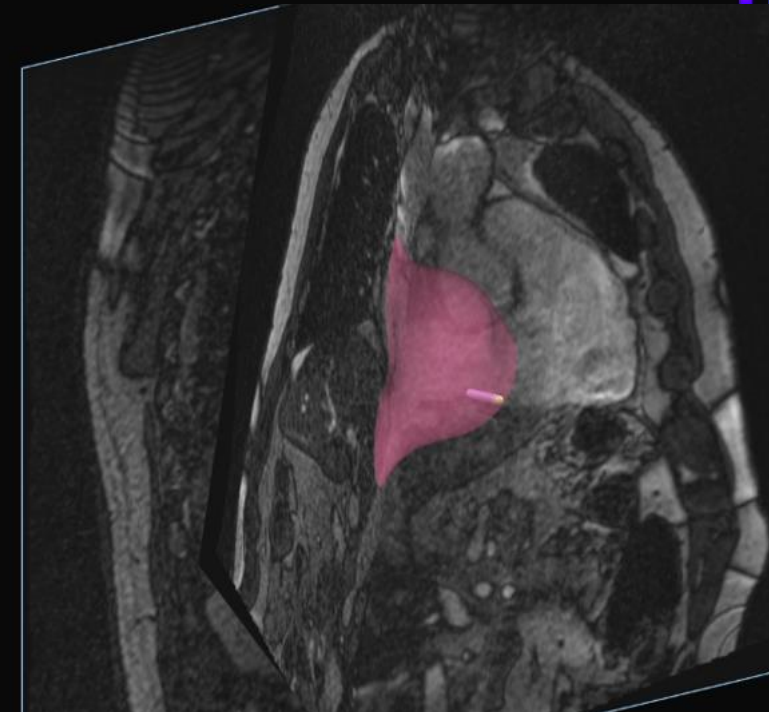
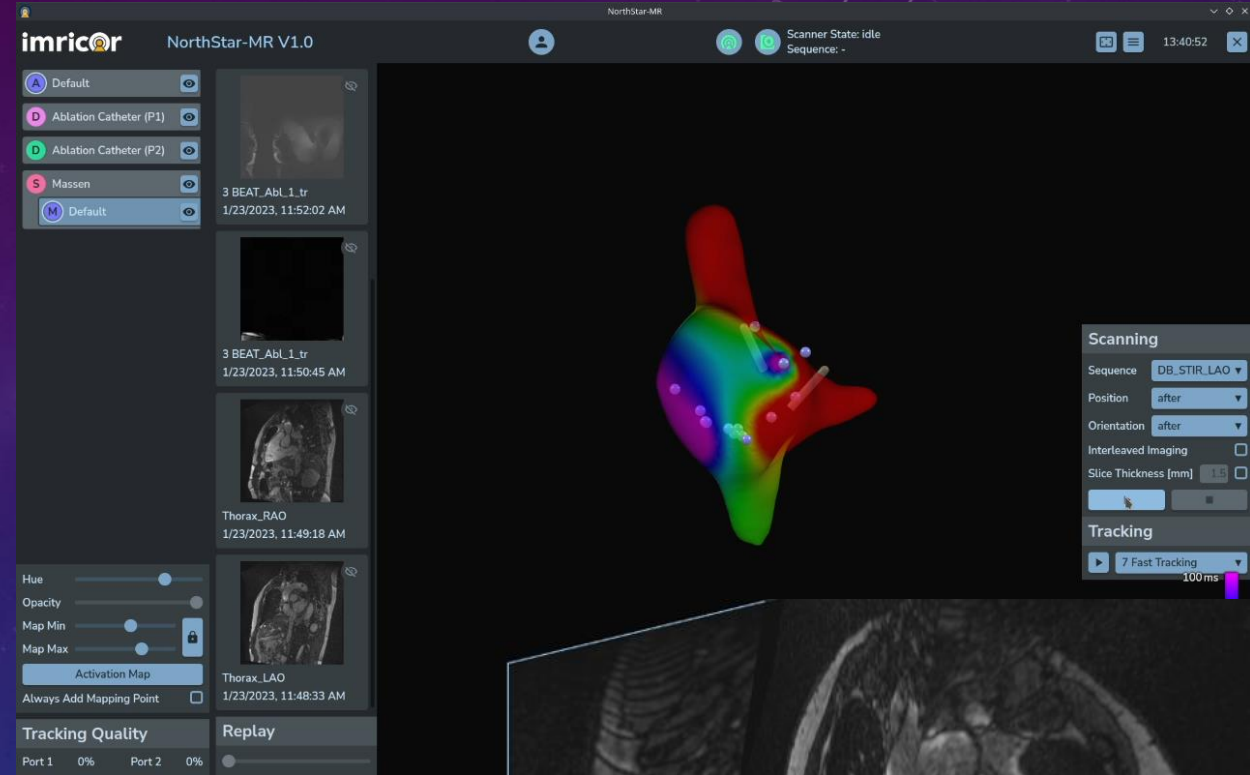
<sup>1</sup>First department of Cardiology/Electrophysiology and Pacing, Henry Dunant Hospital Center, 107 Mesogeion ave, 11526 Athens, Greece





# iCMR guided AF ablation – A glimpse to the future

- ❖ MRI guided transeptal
- ❖ MRI guided PFA isolation
- ❖ Electroanatomic mapping post AF ablation
- ❖ Other tachycardias MRI guided ablation
- ❖ Real-time visualization of ablation lesions



# Cost-effectiveness of atrial fibrillation catheter ablation

George Andrikopoulos<sup>1</sup>, Stylianos Tzeis<sup>2</sup>, Nikos Maniadakis<sup>3</sup>, Hercules E. Mavrakis<sup>4</sup>, and Panos E. Vardas<sup>4\*</sup>

<sup>1</sup>First Cardiac Department, Evangelismos Hospital, Athens, Greece; <sup>2</sup>Deutsches Herzzentrum und 1. Medizinische Klinik, Faculty of Medicine, Technischen Universität München, Munich, Germany; <sup>3</sup>Department of Economics, Piraeus University, Piraeus, Greece; and <sup>4</sup>Cardiology Department, Heraklion University Hospital, PO Box 1352, 71110 Heraklion, Crete, Greece

Received 8 September 2008; accepted after revision 17 November 2008

Radiofrequency catheter ablation has become an established treatment option for the management of patients with atrial fibrillation (AF). Although the concept of a rhythm control strategy devoid of the adverse events related to antiarrhythmic treatment seems highly attractive, further steps are needed in order to improve our understanding and increase our therapeutic efficacy. Furthermore, the increased number of candidates also mandates the evaluation of this invasive treatment against the existing evidence pertaining to cost-effectiveness of AF catheter ablation. The purpose of this study was to perform a cost-to-benefit analysis of such a cost-effectiveness analysis.

VALUE OF INNOVATION

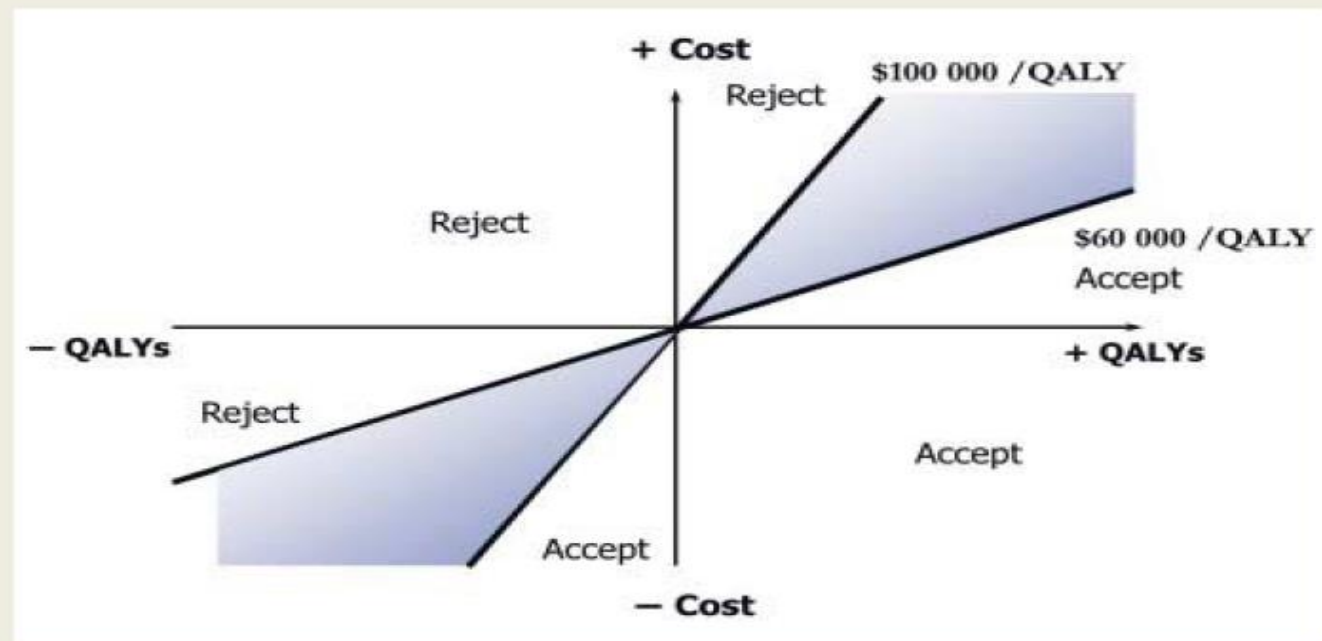
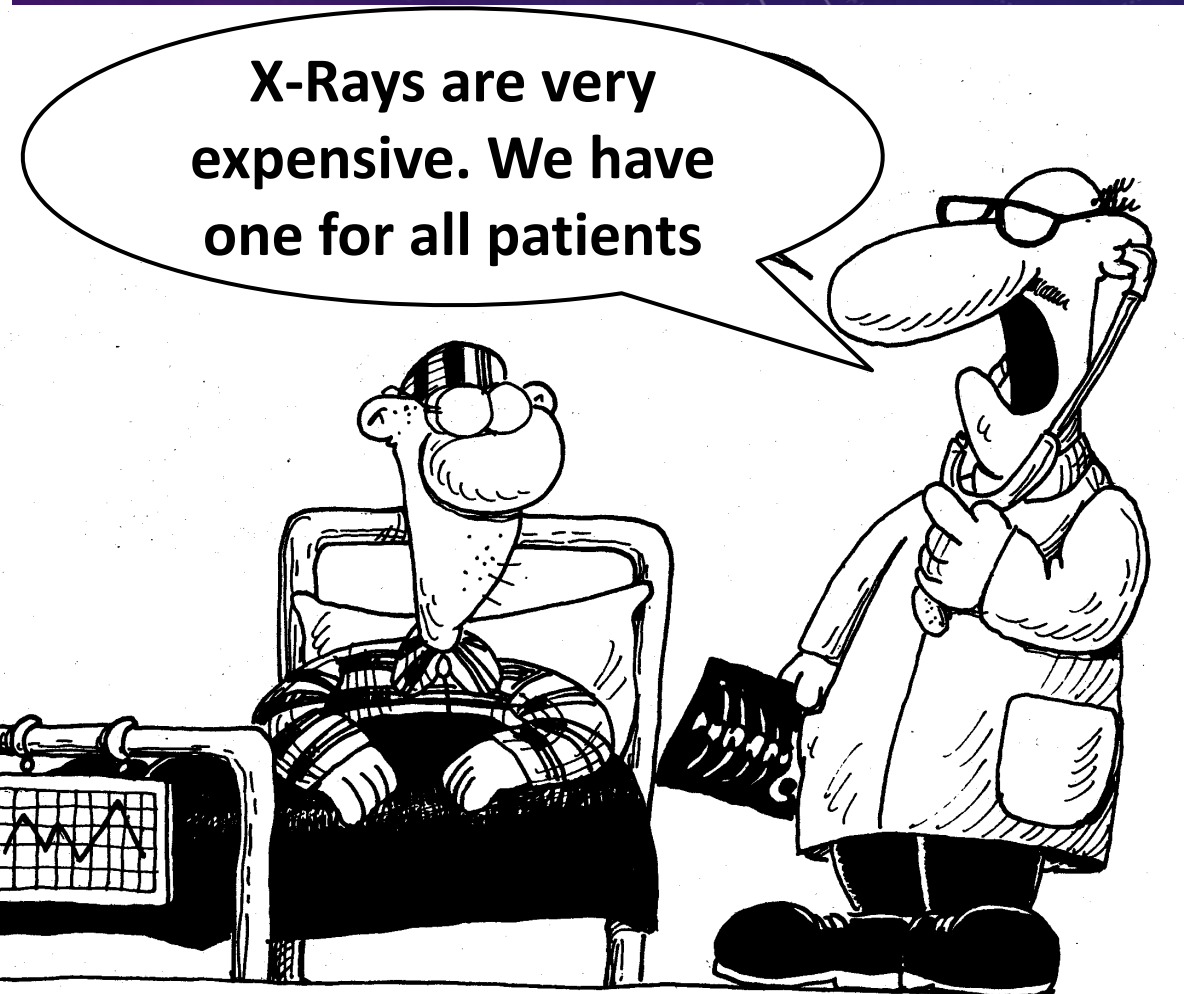
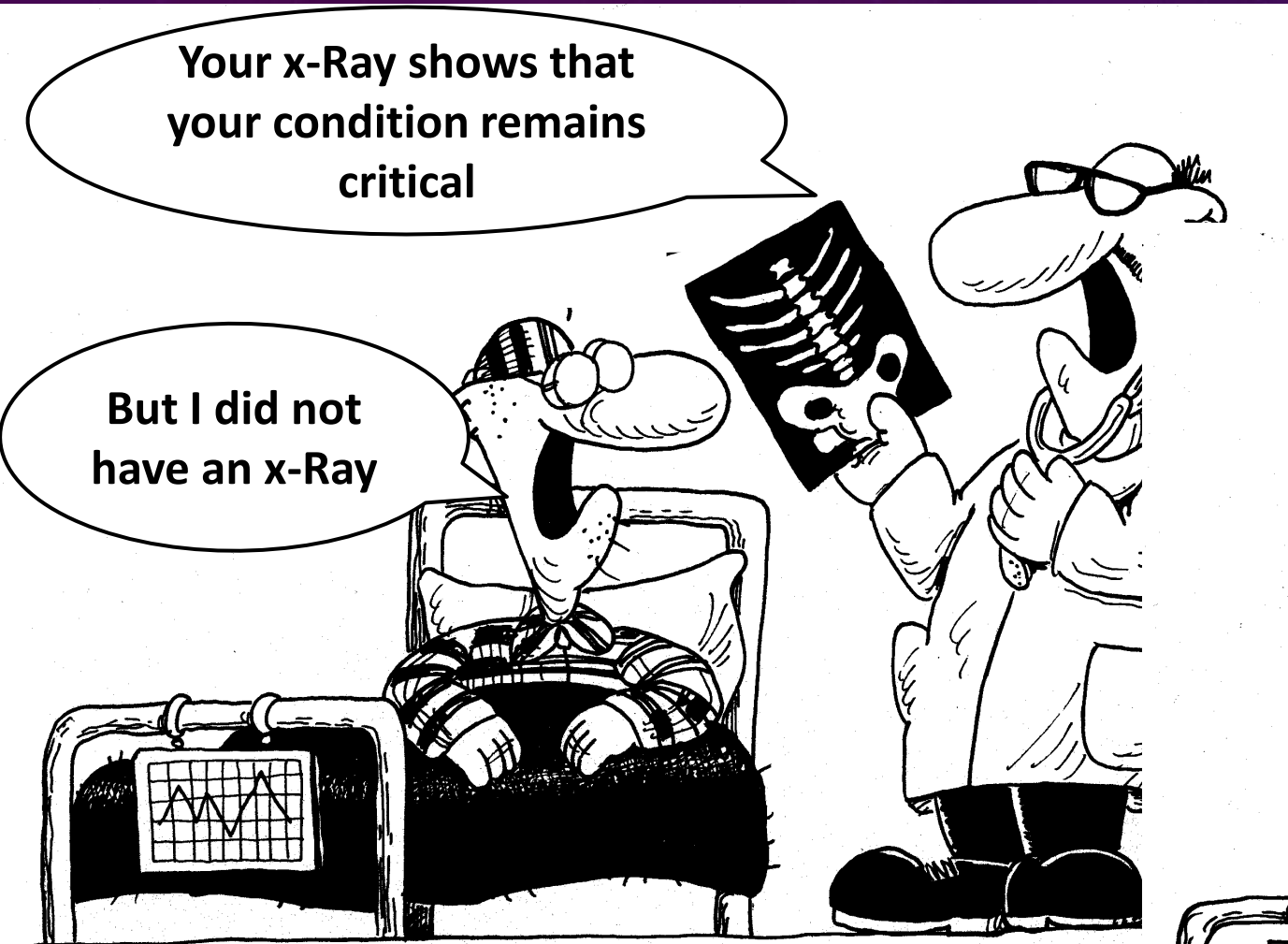


Figure 1 The cost-effectiveness plane.



# Is iCMR ablation cost-effective?



# THE DECALOGUE OF MRI-GUIDED ABLATION BEGINNERS

## *TIPS AND TRICKS ON STARTING AN iCMR ABLATION PROGRAM*

- 1.** Participate in an iCMR summit/meeting before making up your decision
- 2.** Ask questions and demand a sincere answer before starting your program
- 3.** Hands on the electrodes and the equipment involved in the procedure before the procedure
- 4.** Explore the limitations before starting (most of them are not visible in published papers)
- 5.** Train the key persons in advance (the key persons are the MRI radiologist and the MRI chief technician)
- 6.** Trust ONLY the EP nurses
- 7.** Be prepared for major complications (even if you have never seen them in Abl cases)
- 8.** Small things may be of huge importance (e.g. serum lines connectors)
- 9.** Reserve at least 3 hours for the first case (you are going to need half an hour for photos and social stuff)
- 10.** Don't be afraid of the catheters (they work much better than you think)



Thank you for your attention

