

TRAITEMENT DES TROUBLES DU RYTHME CARDIAQUE

FIBRILLATION ATRIALE
&
TACHYCARDIE VENTRICULAIRE

DÉCLARATION DE LIENS D' INTÉRÊT

Consulting fees: Boston Scientific, Saint Jude Medical

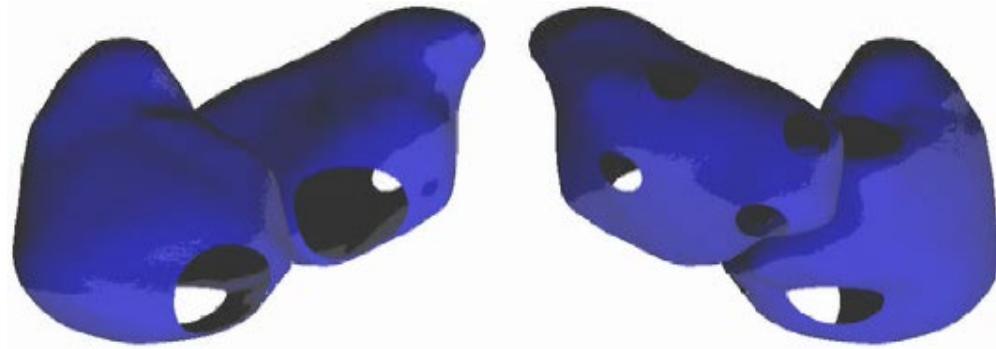
Speaking honorarium: Daiichi Sankyo, Medtronic, MEDA pharma

Fibrillation atriale

N Derval
CHU Bordeaux
IHU LIRYC

PHYSIOPATHOLOGIE

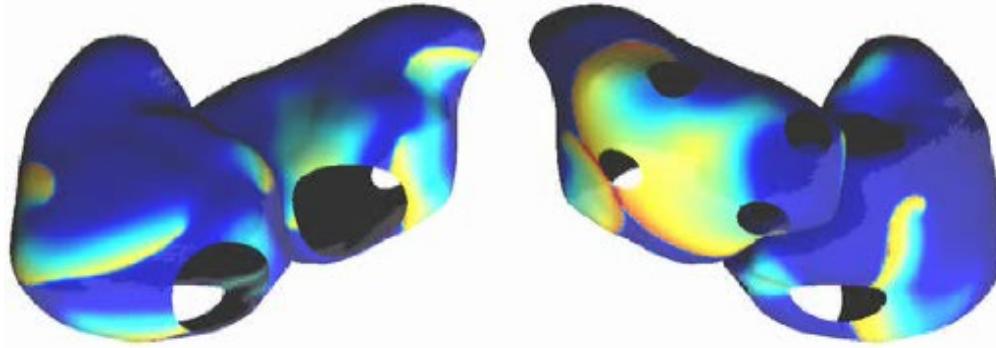
Rythme Sinusal



Onde P=Contraction Atriale



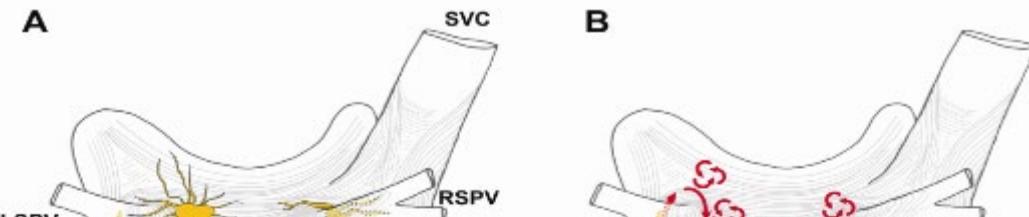
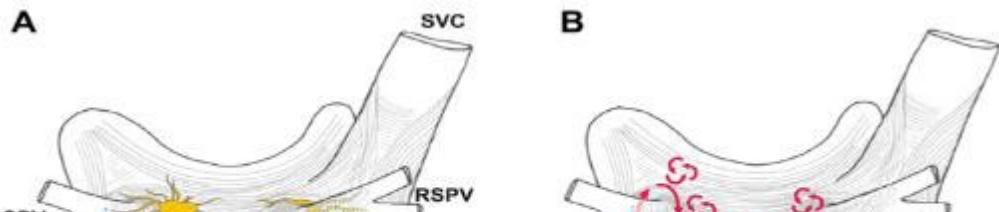
Fibrillation Atriale



Pas Onde P=Contraction
Anarchique

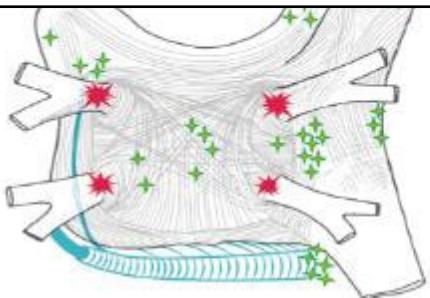


PHYSIOPATHOLOGIE

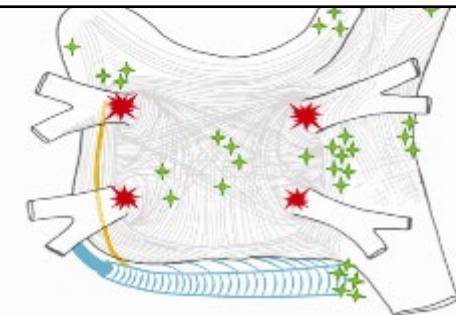
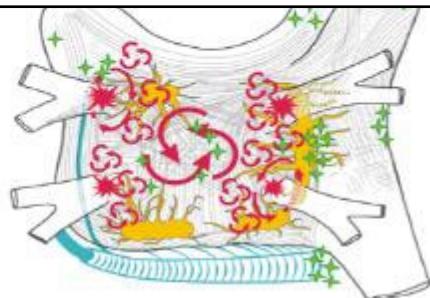


3 grands "courants de pensée" pendant de nombreuses années:

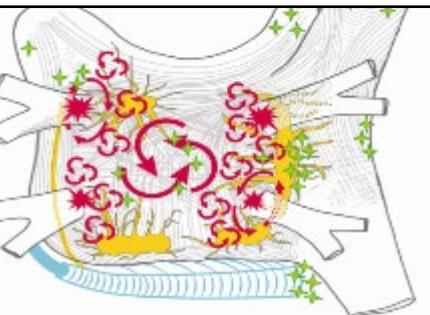
- les multiples vaguelettes à propagation aléatoires (Moe, Alessie...)
- Les foyers ectopiques
- Les réentrées localisées avec conduction fibrillatoire



2007

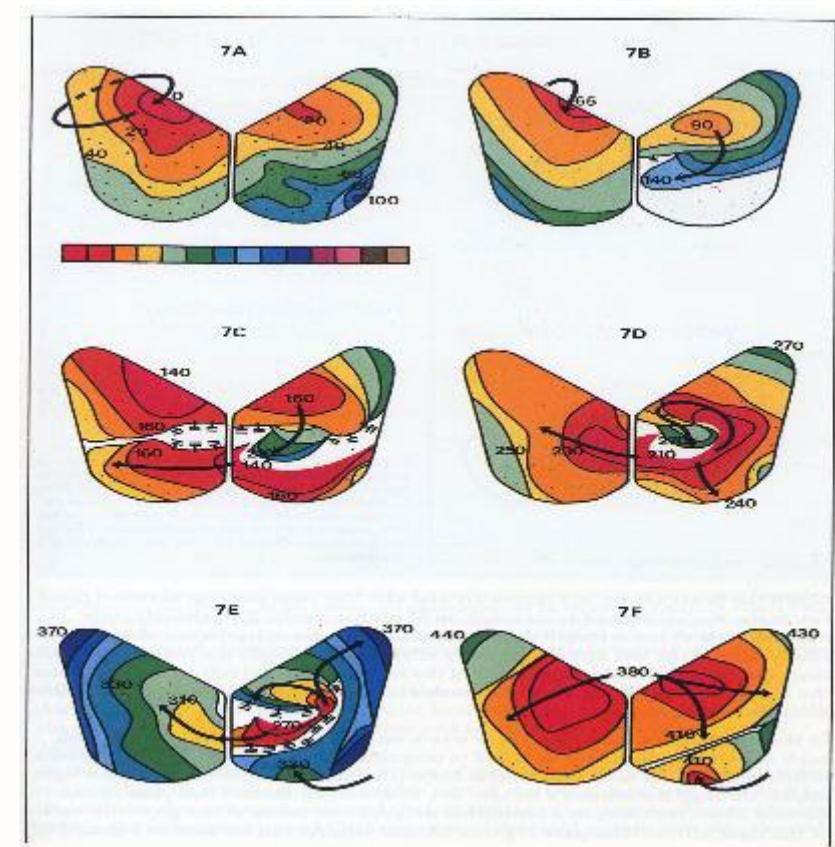
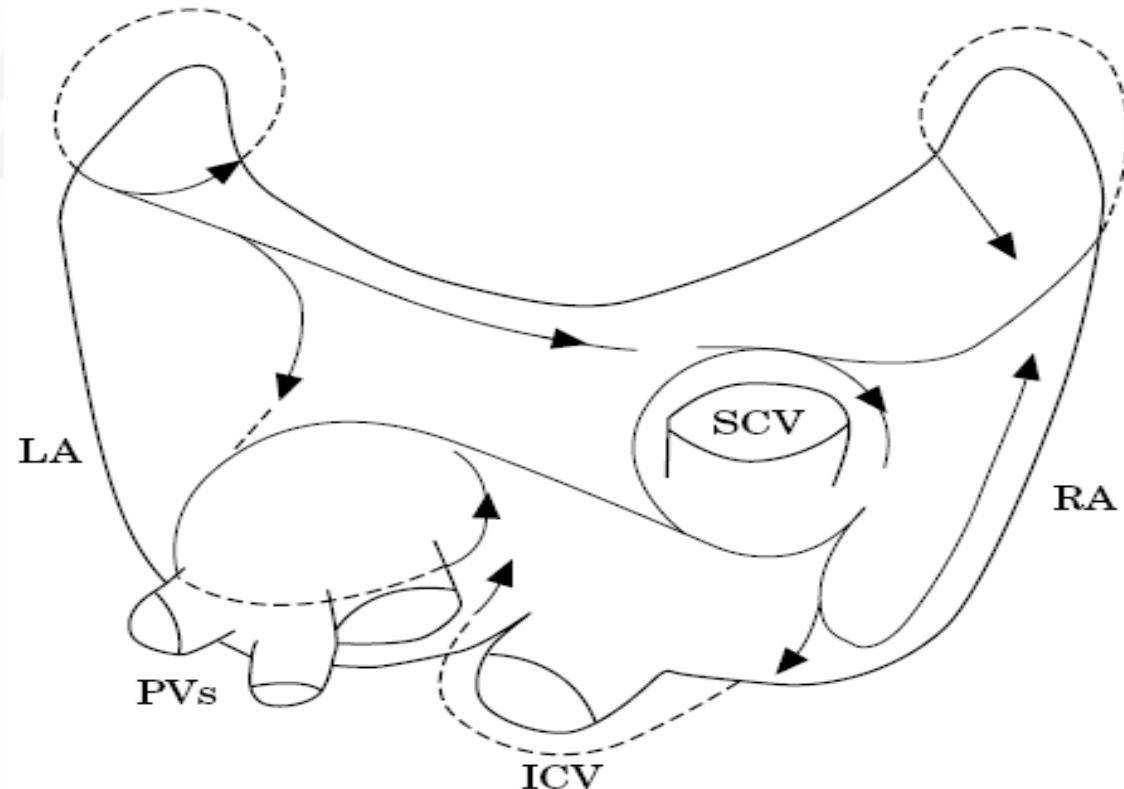


2012

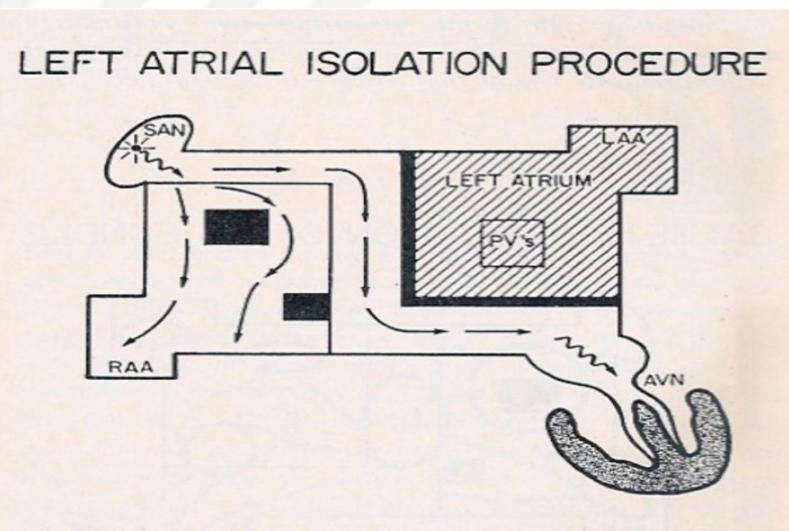


PHYSIOPATHOLOGIE

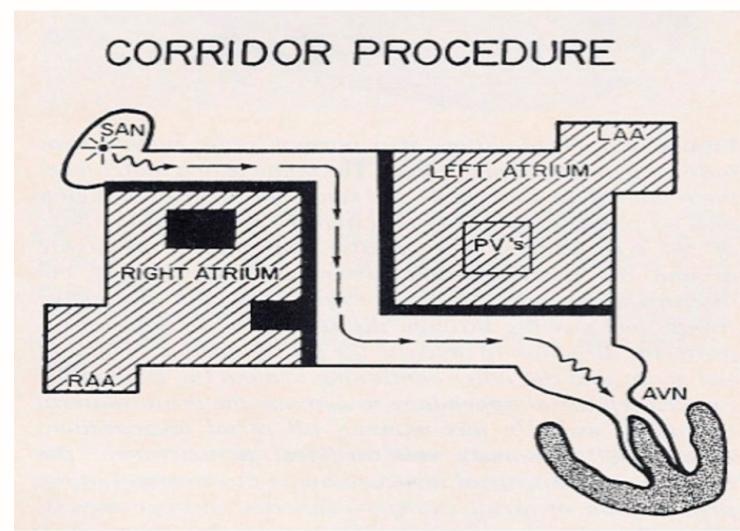
- Théories des "vaguelettes" multiples et réentrantantes
- Moe (1959) et Allessie (1994)



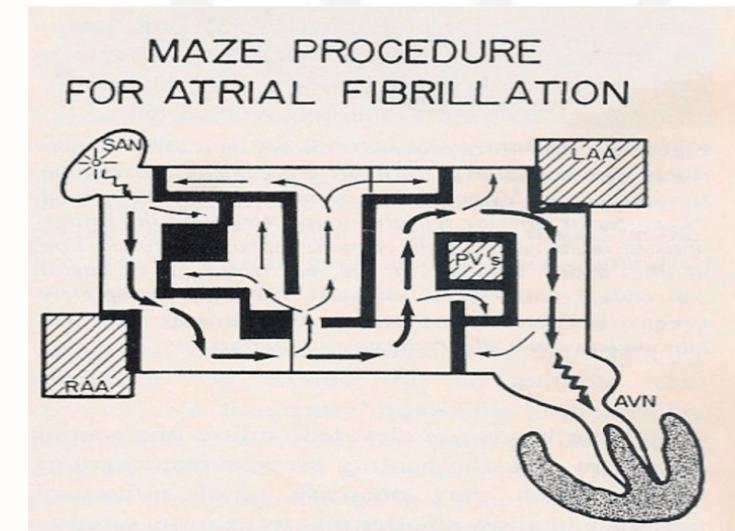
Surgical treatment of AF



Williams
1980
73% success

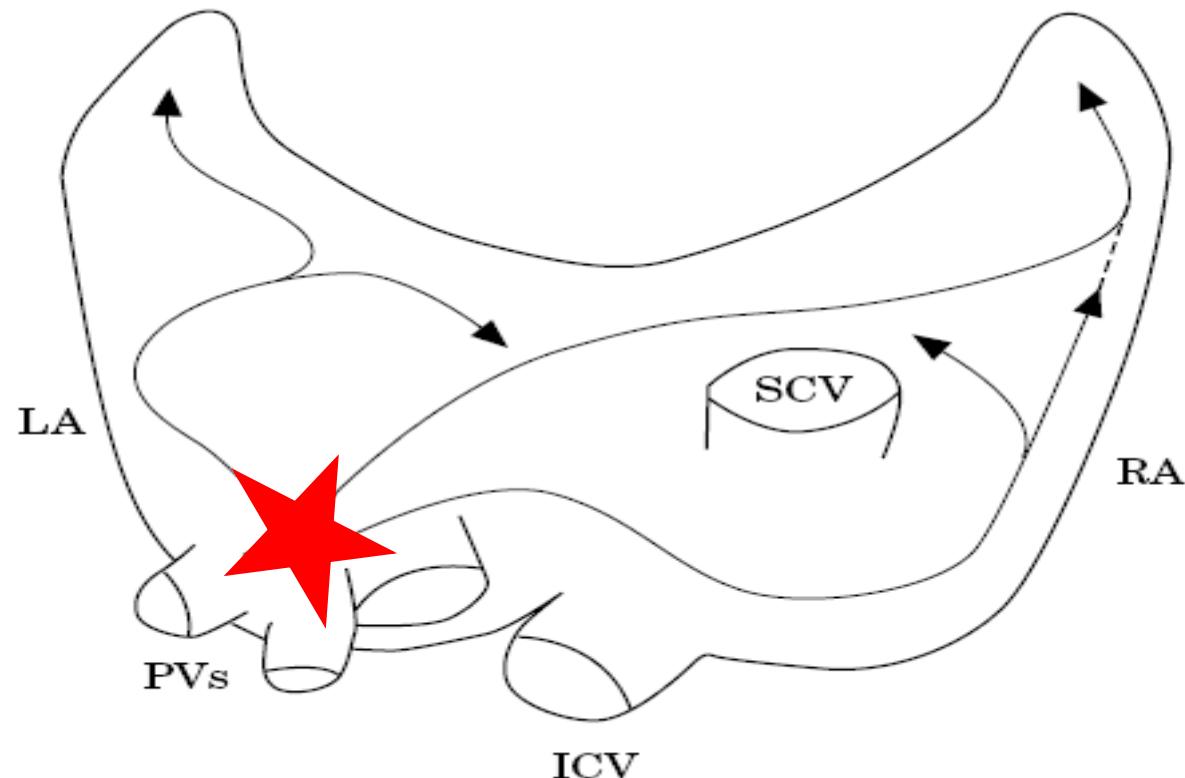


Guiraudon
1985
69% success at 3y

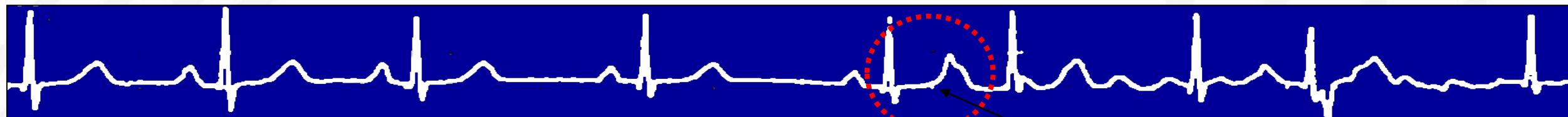


Cox
1993
89% success

- Activation d'origine focale
- Haïssaguerre 1996

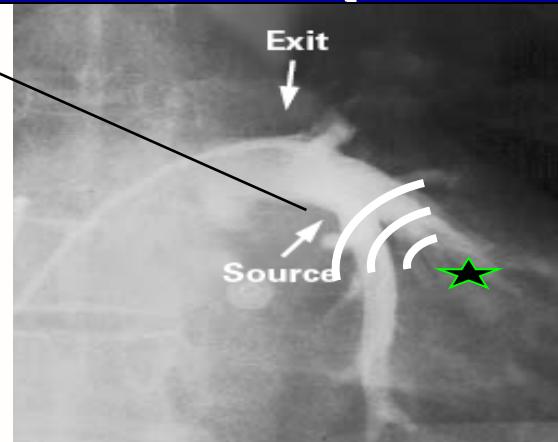


1- De 1994 à 1998 , nous avons **recherché la source** des fibrillations auriculaires ie cartographié les millisecondes (cercle rouge) précédant l' éclosion de l' arythmie



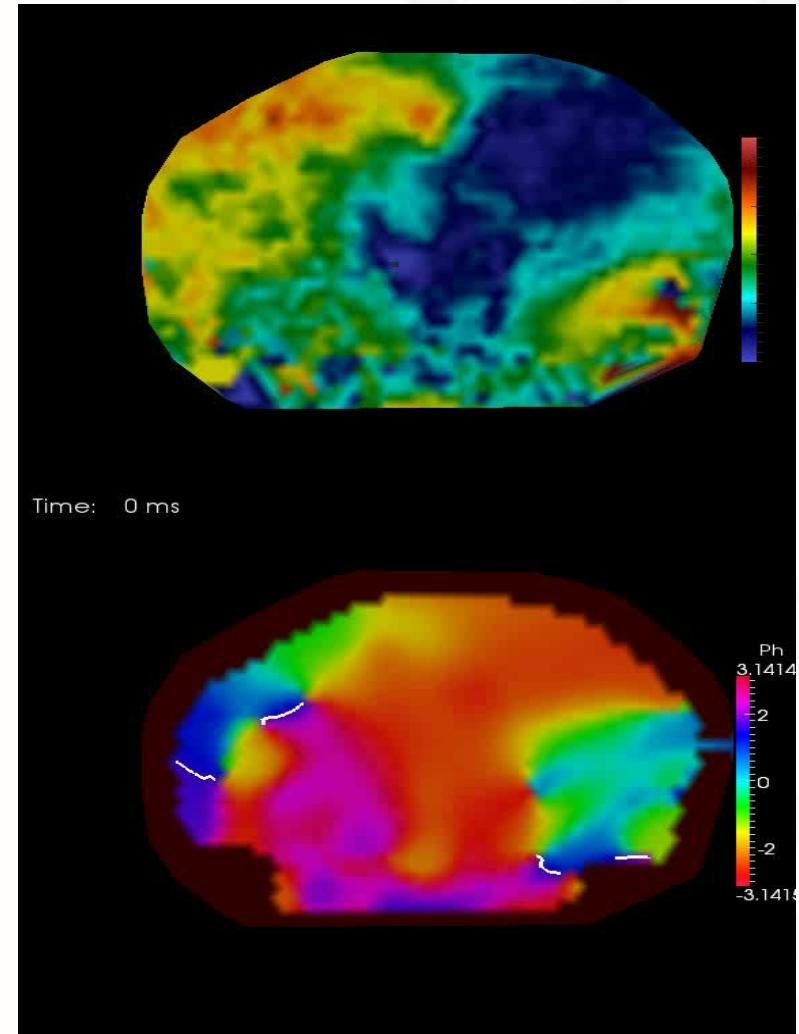
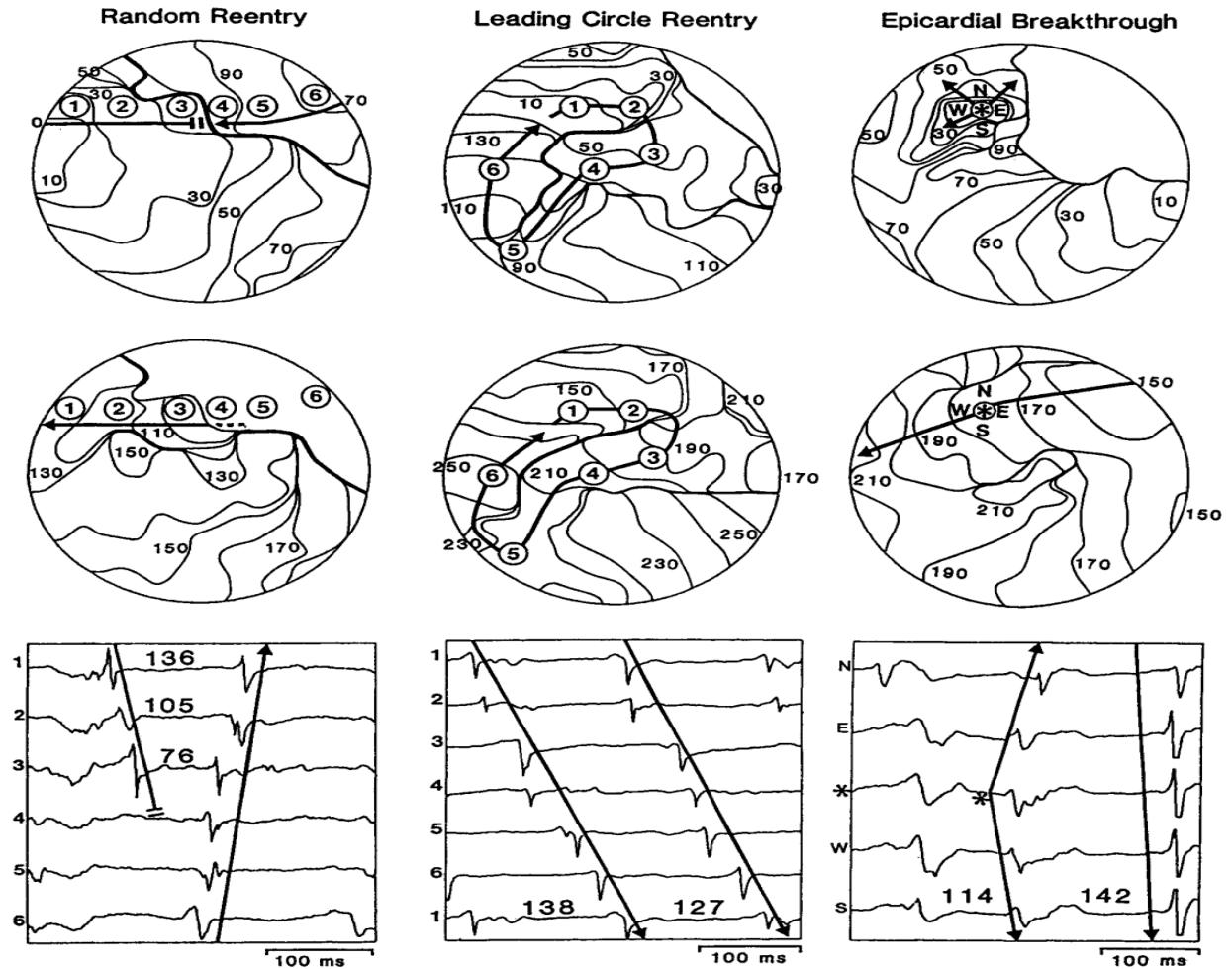
2- Les sources ont été découvertes **en dehors du cœur dans une paroi vasculaire** (veines pulmonaires)

3- Ces sources émettent des **impulsions/décharges ultrarapides**
400/min qui provoquent instantanément la fibrillation



4- La publication NEJM 1998 a eu un impact considérable avec 22000 communications ultérieures- 2300 publications : confirmant cette Source des FA paroxystiques dans de multiples conditions naturelle ou chimioinduite, cœur sain ou pathologique

RÉENTRÉES LOCALISÉES ET CONDUCTION FIBRILLATOIRE



FIBROSE ATRIAL

PAROXYSMAL AF (n=20)

aDE extent

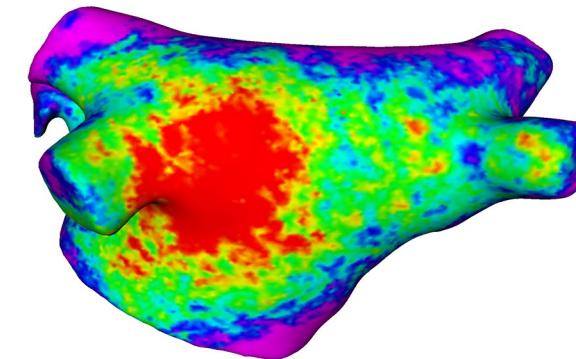
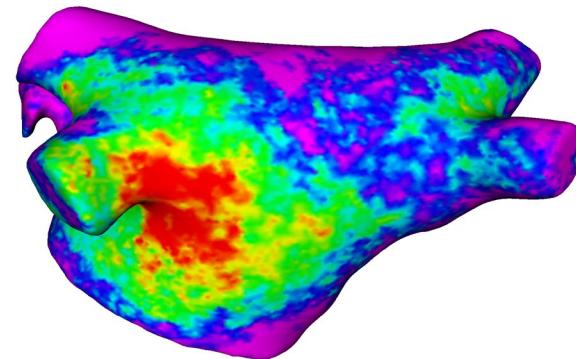
 $21.9 \pm 8.6 \%$

P = 0.03

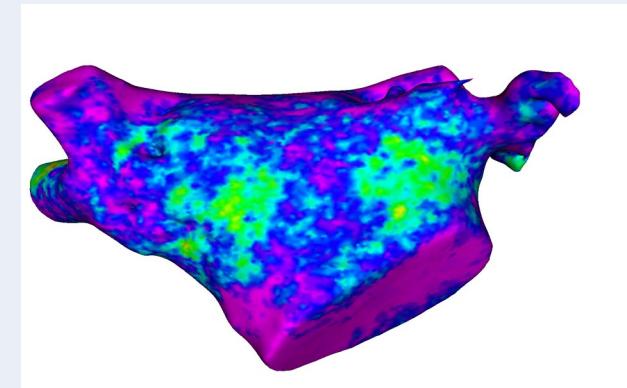
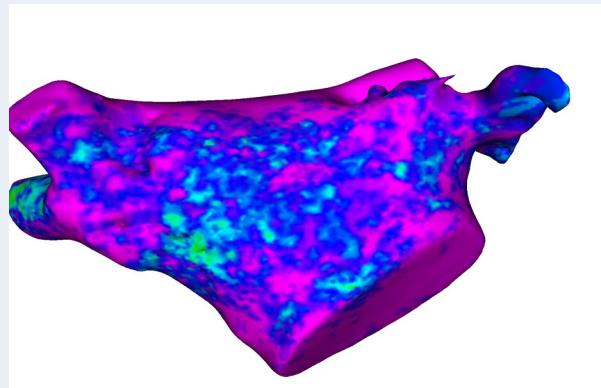
PERSISTENT AF (n=21)

 $27.2 \pm 8.1 \%$

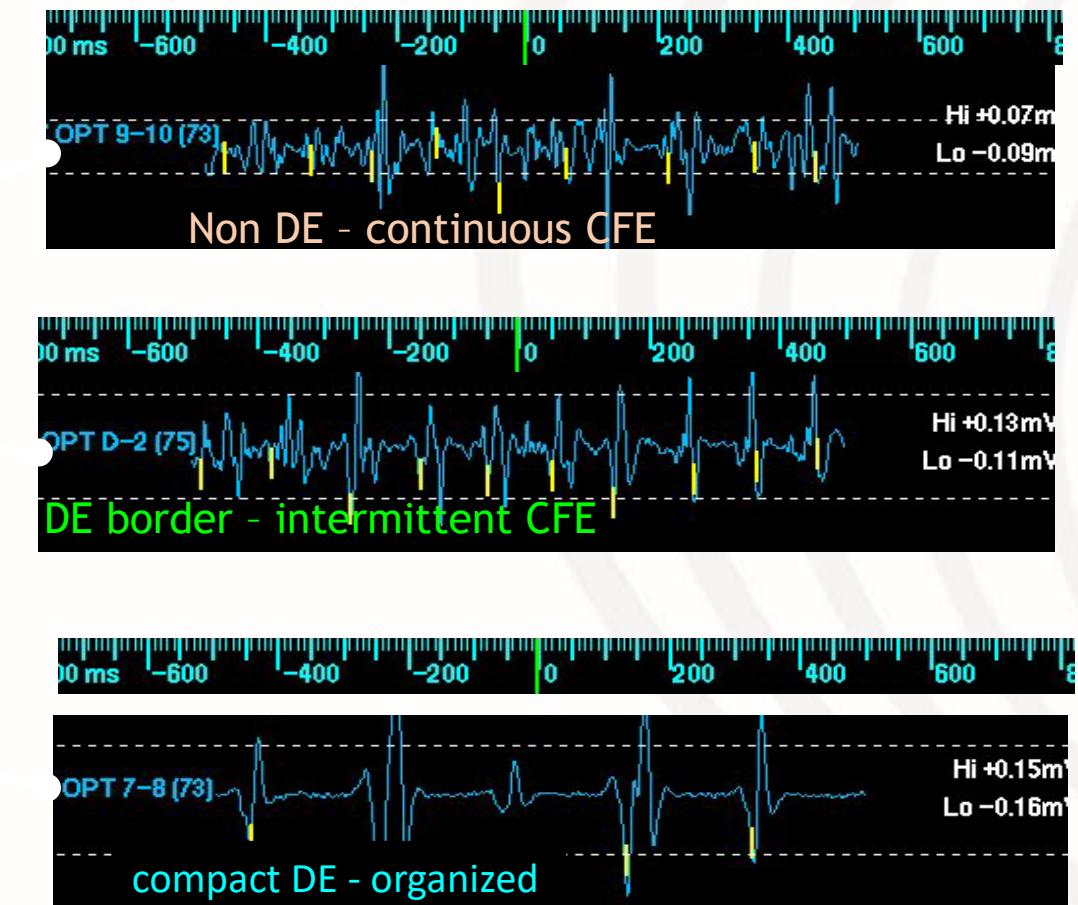
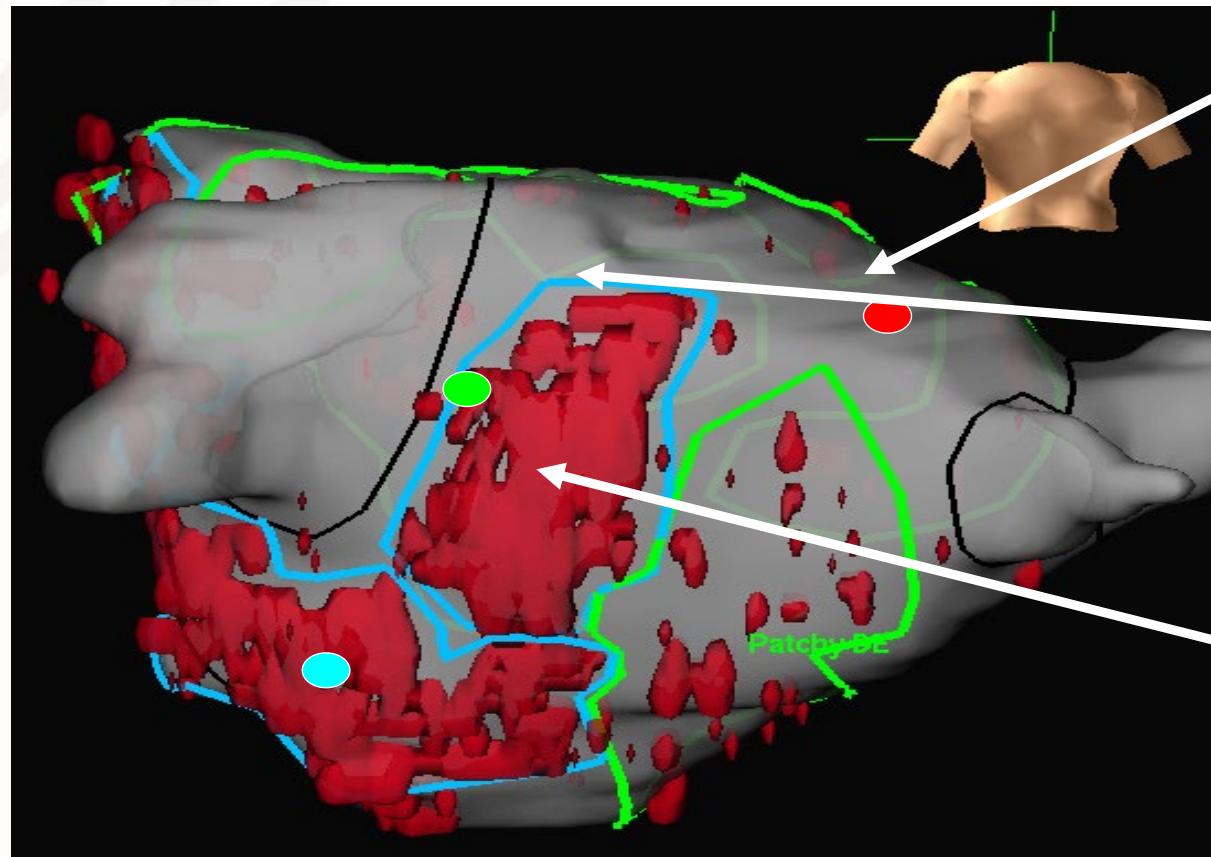
POSTERIOR VIEW



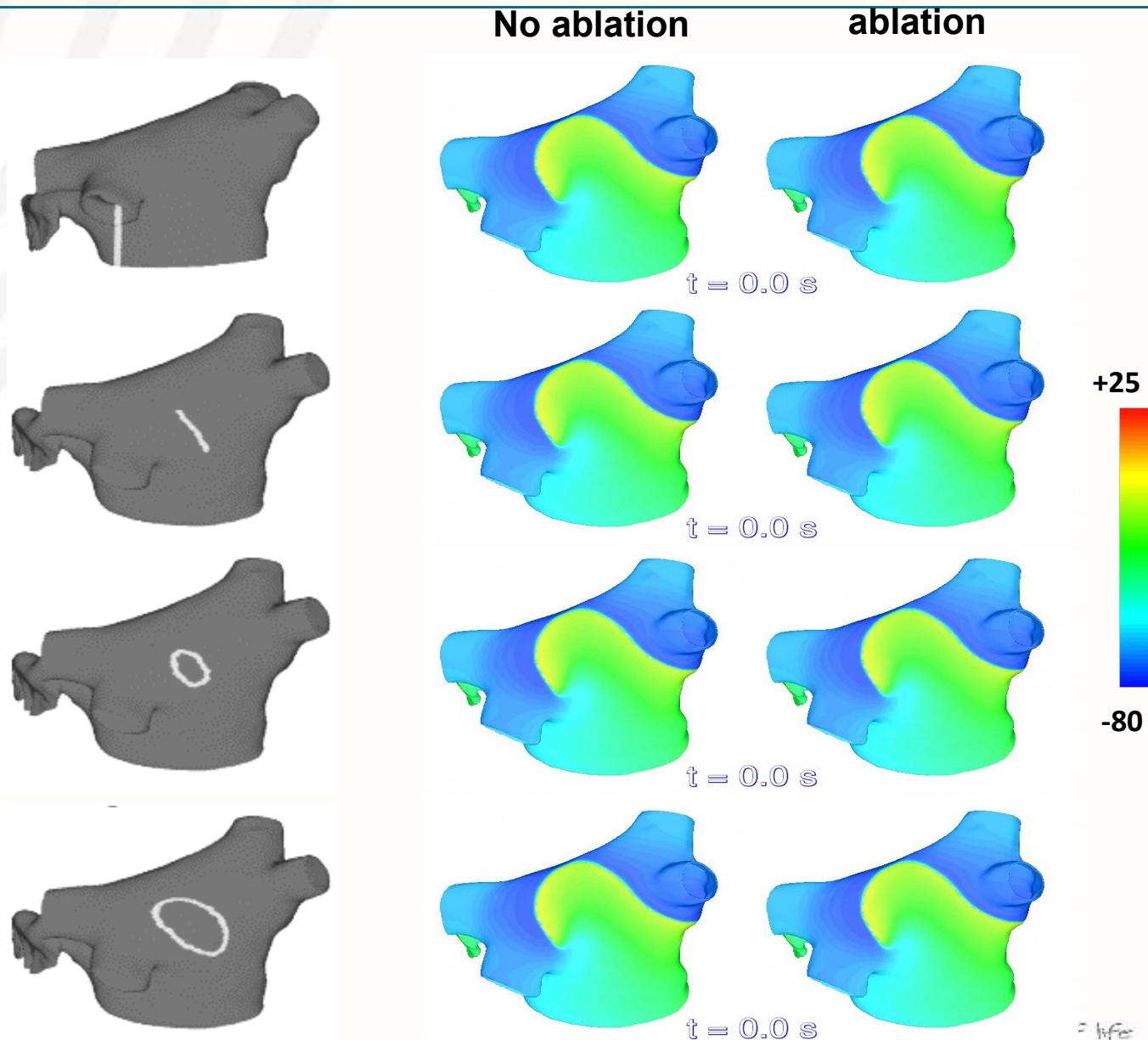
ANTERIOR VIEW



RELATION FIBROSE - FA



ABLATING AT AF ROTOR HIGHWAYS



Far away: minimal change

Near: anchors (unstable)

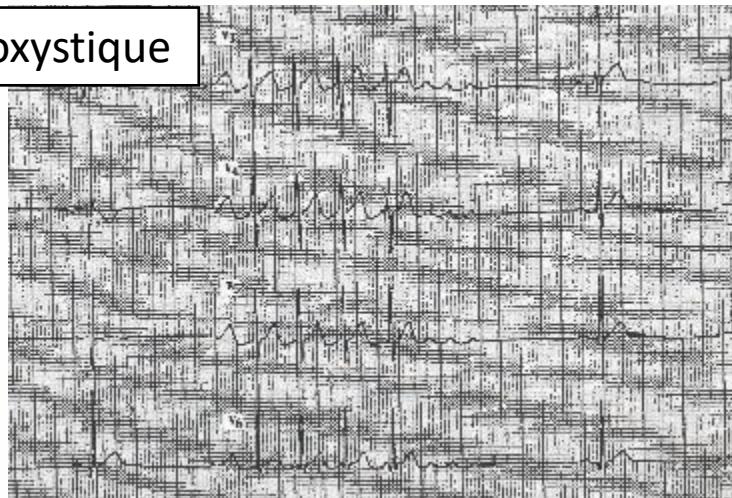
Near: anchors (unstable)

Near: anchors (stable)

Table 1 Types and classification of atrial fibrillation**

Atrial Fibrillation Episode	An atrial fibrillation episode is defined as AF that is documented by ECG monitoring and has a duration of at least 30 seconds, or if less than 30 seconds, is present continuously throughout the ECG monitoring tracing. The presence of subsequent episodes of AF requires that sinus rhythm be documented by ECG monitoring between AF episodes.
Paroxysmal AF*	Paroxysmal AF is defined as recurrent AF (≥ 2 episodes) that terminates spontaneously within 7 days. Episodes of AF of ≤ 48 hours' duration that are terminated with electrical or pharmacologic cardioversion should also be classified as paroxysmal AF episodes.
Persistent AF*	Persistent AF is defined as continuous AF that is sustained beyond seven days. Episodes of AF in which a decision is made to electrically or pharmacologically cardiovert the patient after ≥ 48 hours of AF, but prior to 7 days, should also be classified as persistent AF episodes.
Longstanding Persistent AF	Longstanding persistent AF is defined as continuous AF of greater than 12 months' duration.
Permanent AF	The term permanent AF is not appropriate in the context of patients undergoing catheter or surgical ablation of AF, as it refers to a group of patients for which a decision has been made not to restore or maintain sinus rhythm by any means, including catheter or surgical ablation. If a patient previously classified as having permanent AF is to undergo catheter or surgical ablation, the AF should be reclassified.

FA paroxystique



FA persistante

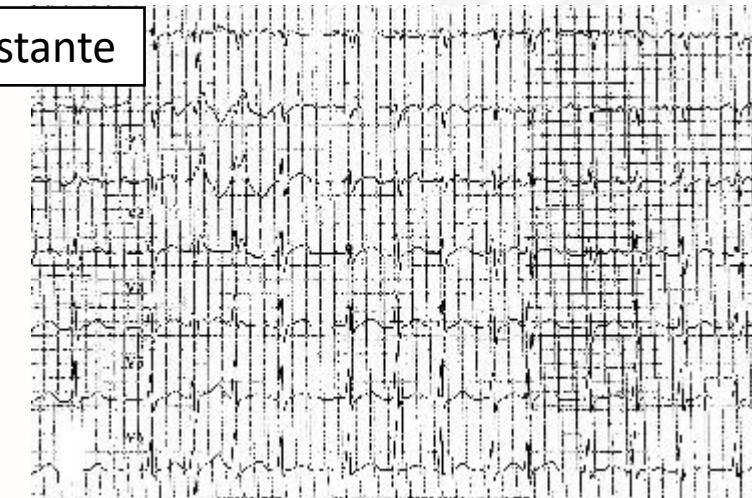
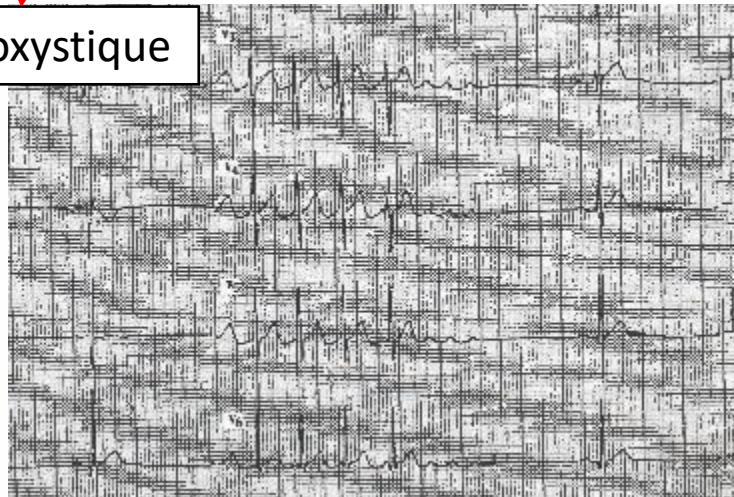


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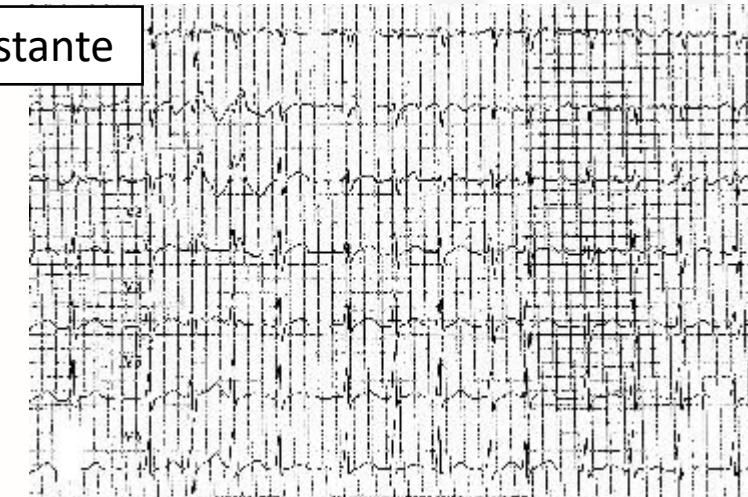
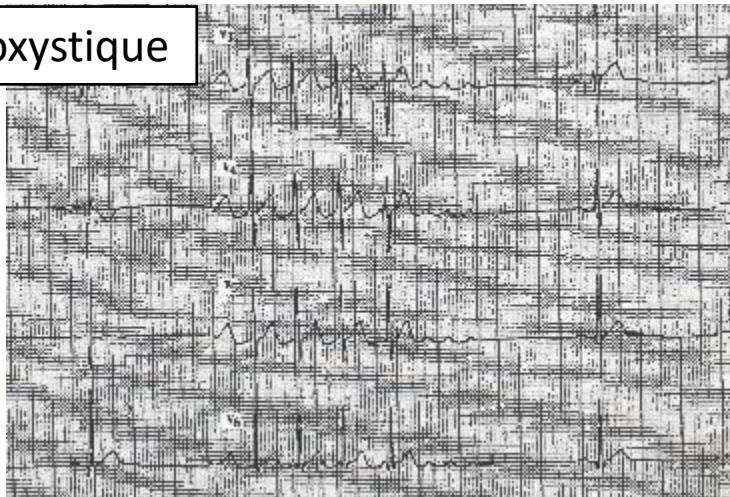


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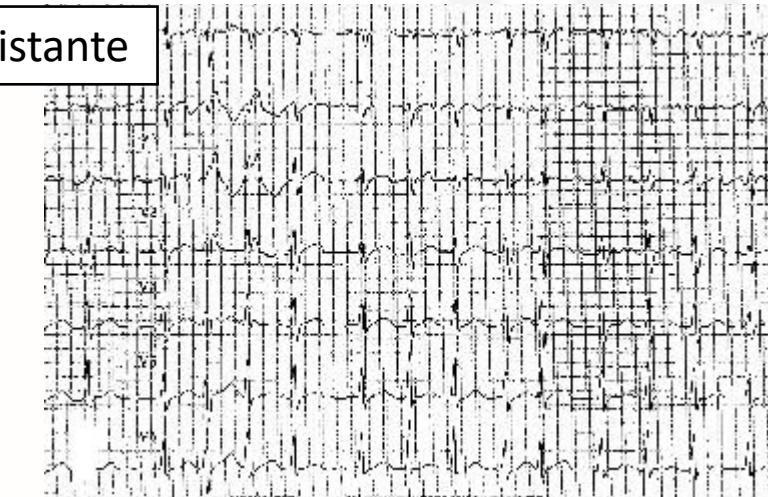
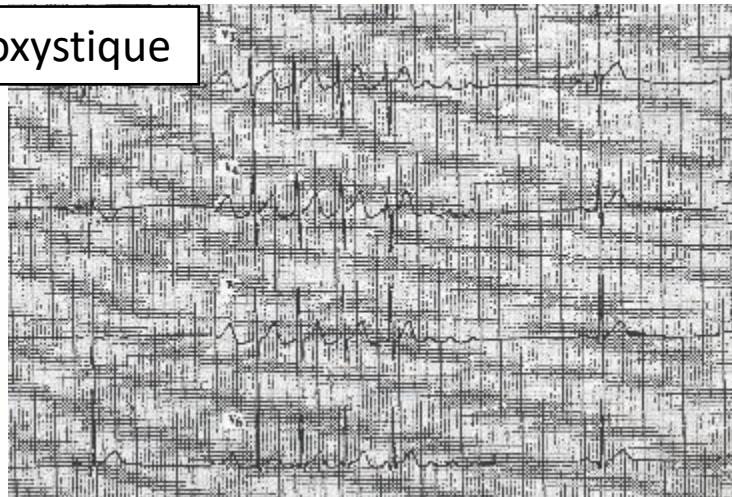


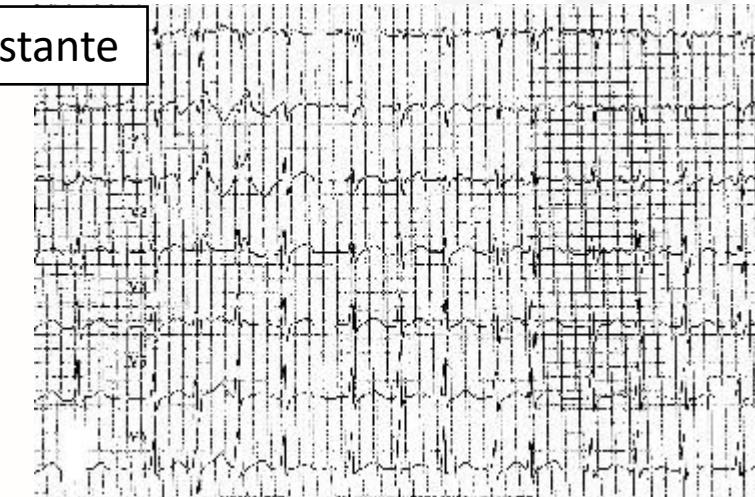
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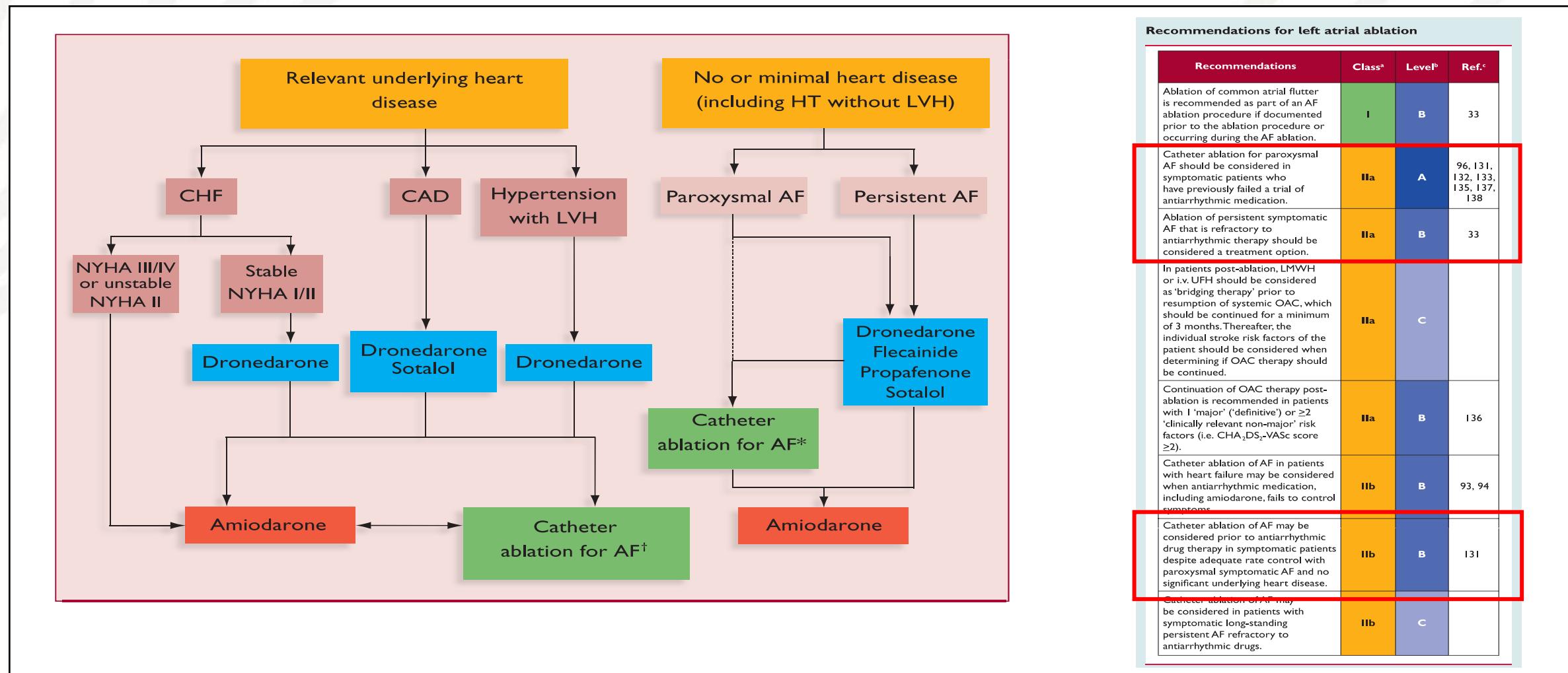
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FA paroxystique



FA persistante





INDICATIONS FOR CATHETER ABLATION OF ATRIAL FIBRILLATION

Indications for catheter ablation of AF	Class	Level
Symptomatic AF refractory or intolerant to at least one Class 1 or 3 antiarrhythmic medication		
Paroxysmal: Catheter ablation is recommended*	I	A
Persistent: Catheter ablation is reasonable	IIa	B
Longstanding Persistent: Catheter ablation may be considered	IIb	B
Symptomatic AF prior to initiation of antiarrhythmic drug therapy with a Class 1 or 3 antiarrhythmic agent		
Paroxysmal: Catheter ablation is reasonable	IIa	B
Persistent: Catheter ablation may be considered	IIb	C
Longstanding Persistent: Catheter ablation may be considered	IIb	C

II Ablation endocavitaire par cathéter

La **catéterisation endocavitaire** est une procédure invasive souvent efficace dans les FA paroxysmiques et persistantes mais elle comporte un risque de complications immédiates parfois graves et un risque de récidive notable durant la première année :

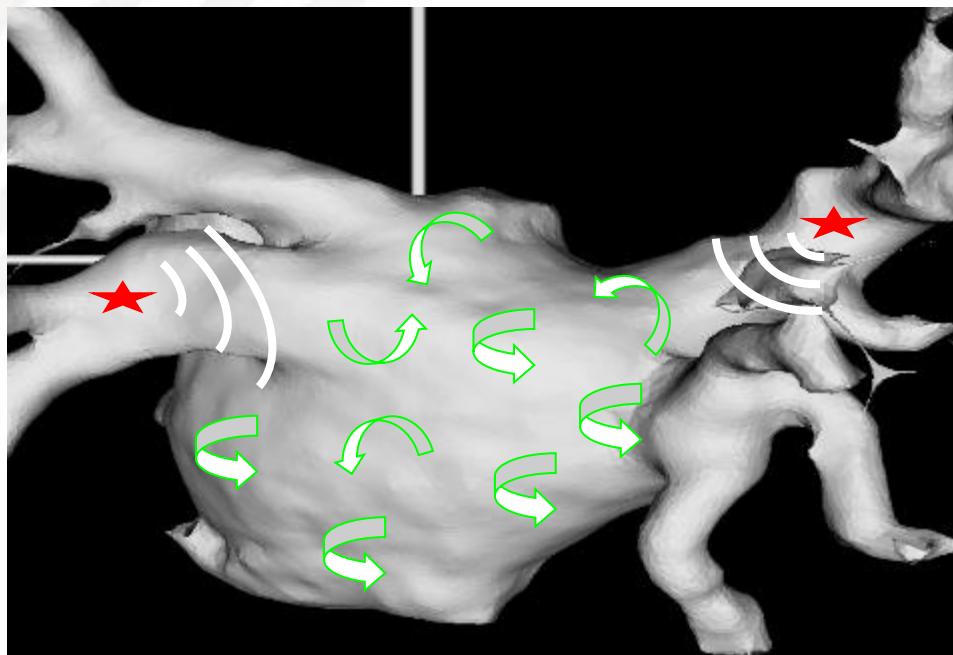
- option thérapeutique de 2^e intention, réservée aux patients dont la FA reste symptomatique malgré un traitement médical optimal (contrôle du rythme et de la FC) ;
- envisagée en première intention chez des patients avec FA paroxystique préférant un geste interventionnel et présentant un faible risque associé à la procédure ;
- traitement de première intention en cas de flutter isthmique-dépendant.



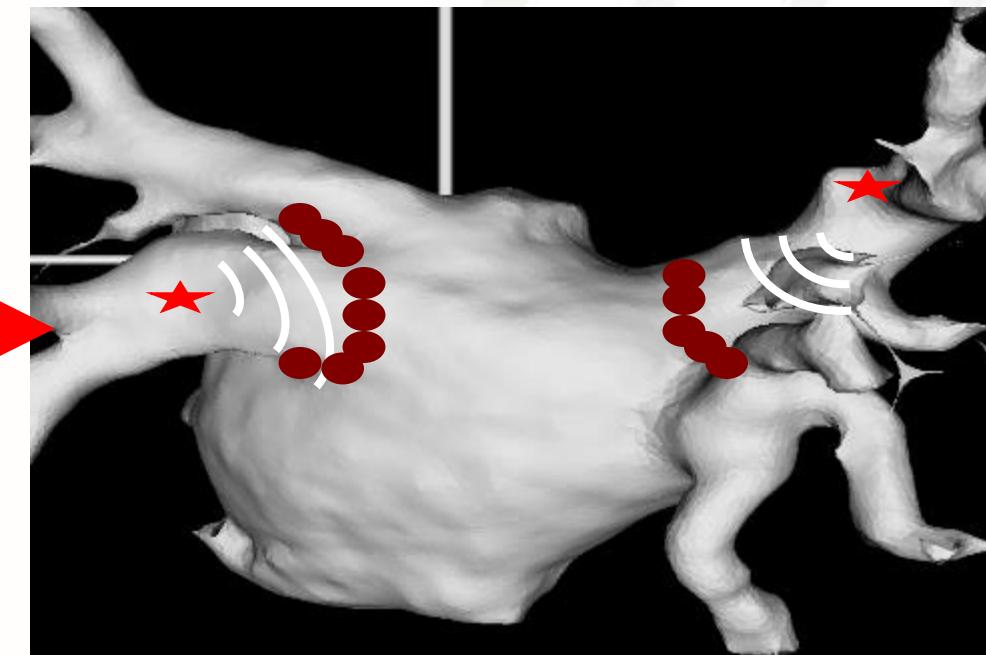
FA PAROXYSMIQUE

*150 000 patients/an- croit de
20% chaque année*

La fibrillation atriale

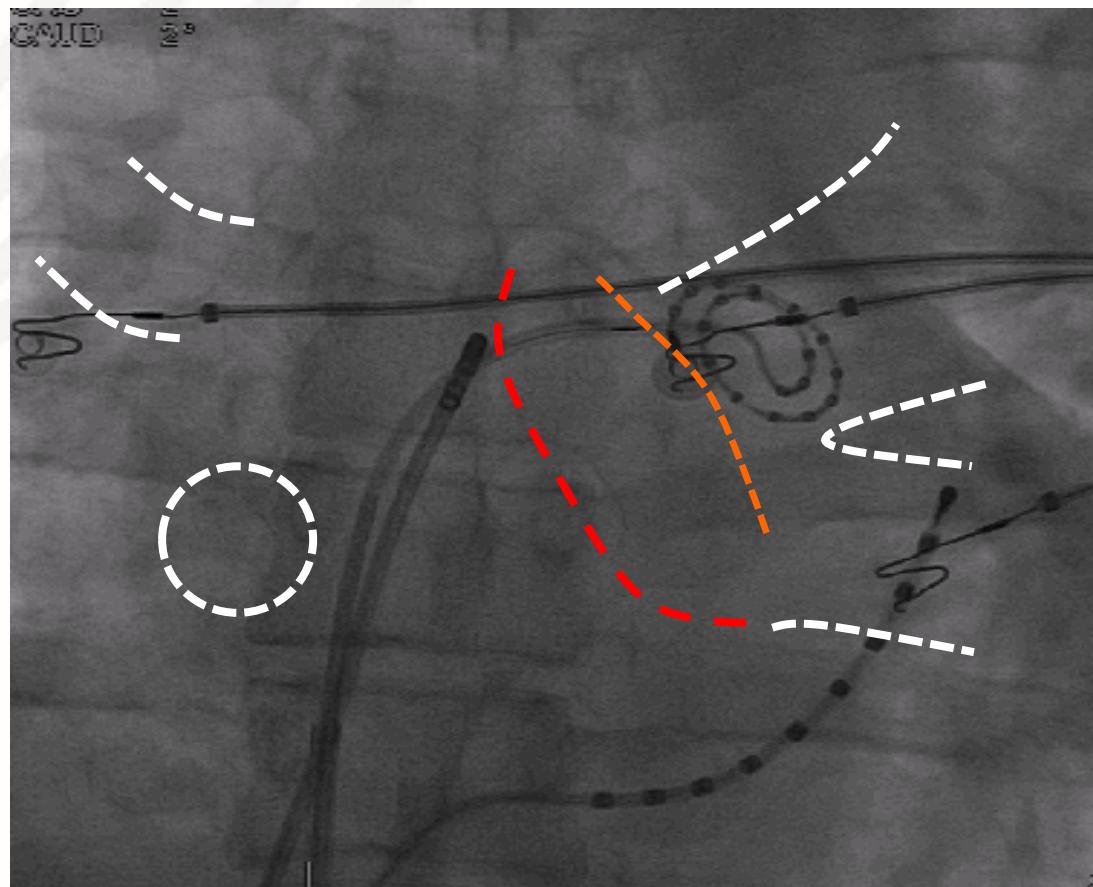


Traitement par exclusion des foyers

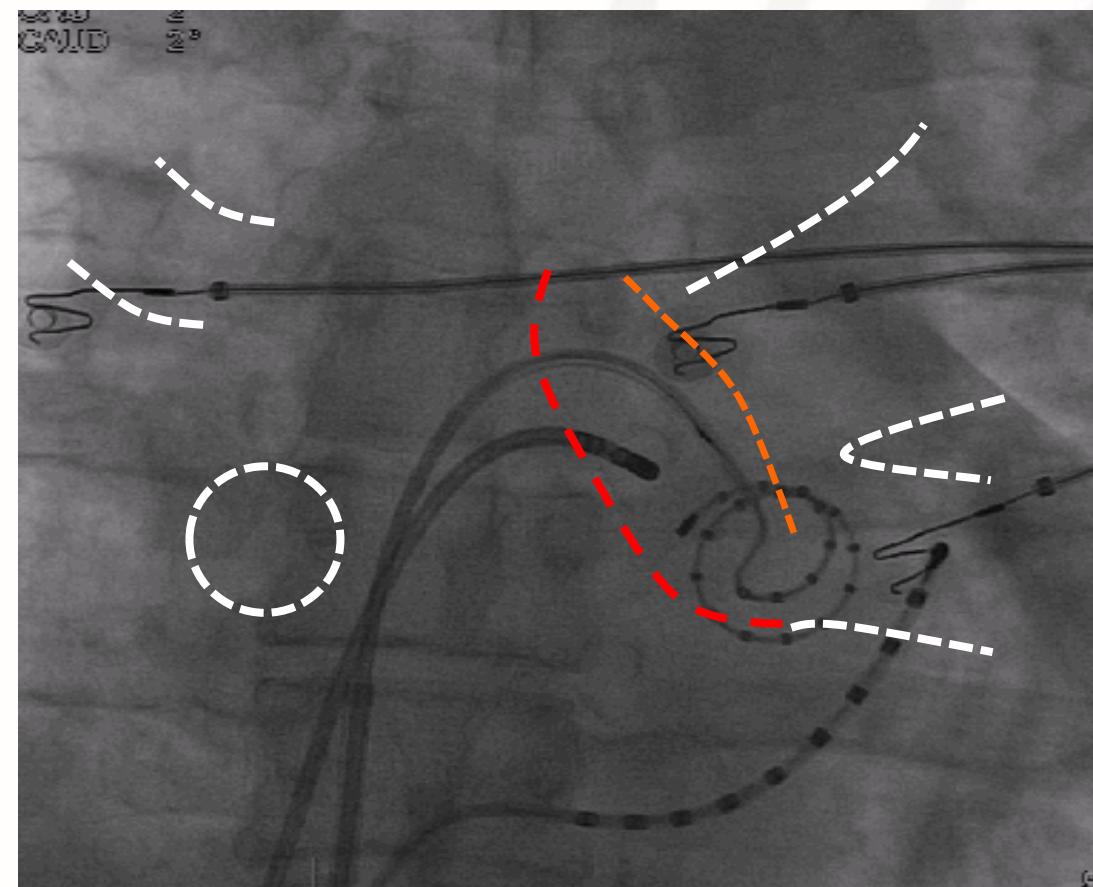


ISOLATION DES VEINES PULMONAIRES

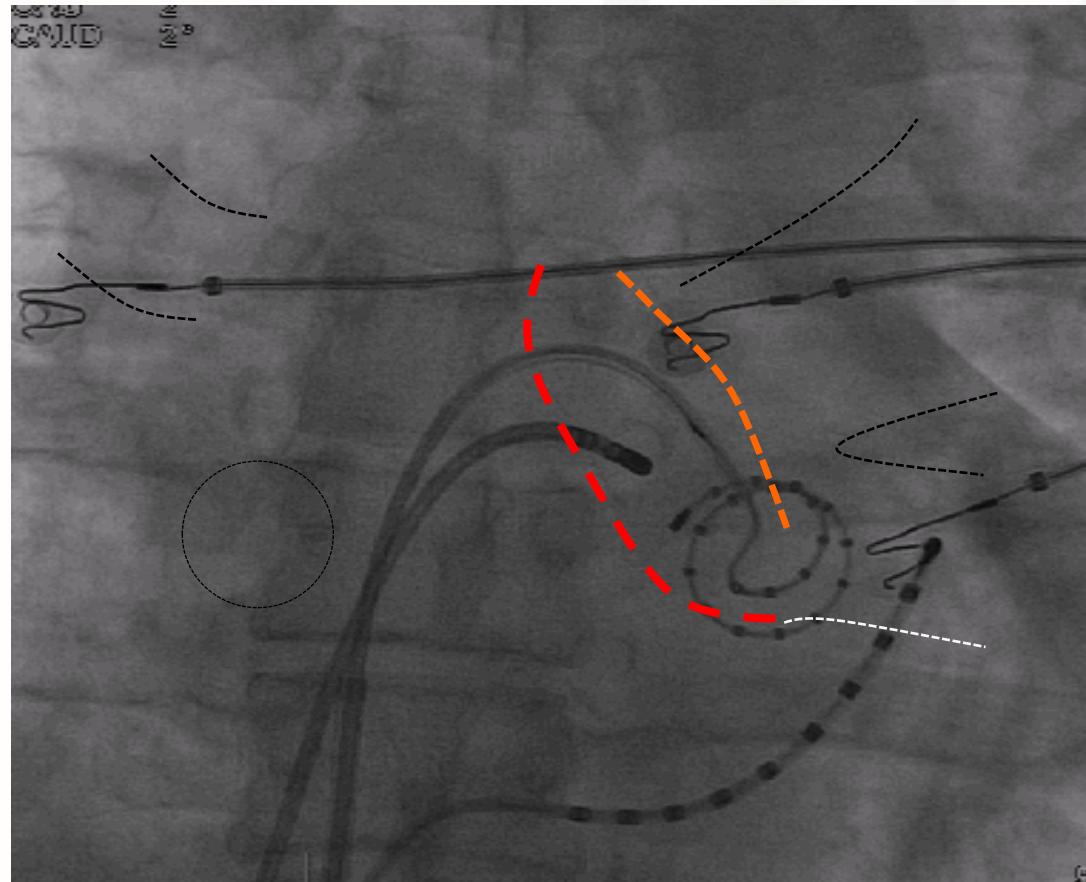
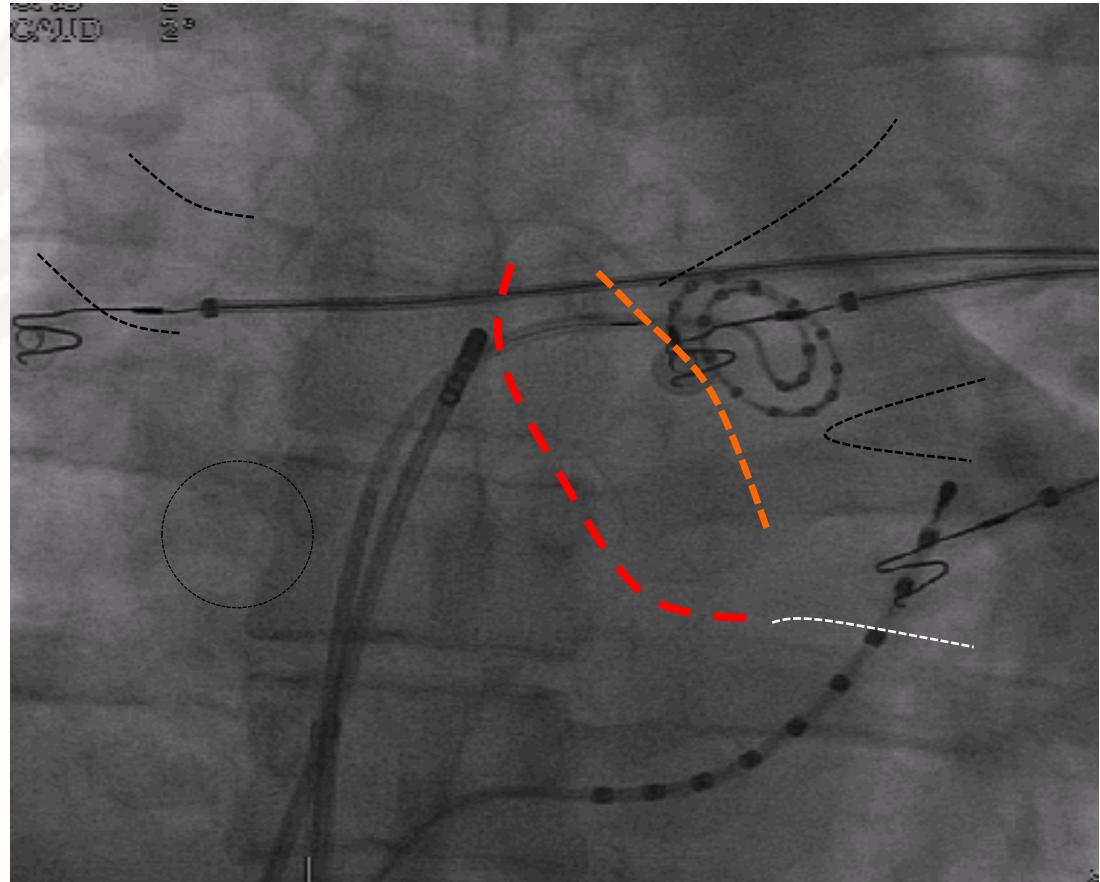
Veine Pulmonaire
supérieure gauche



Veine Pulmonaire
supérieure gauche



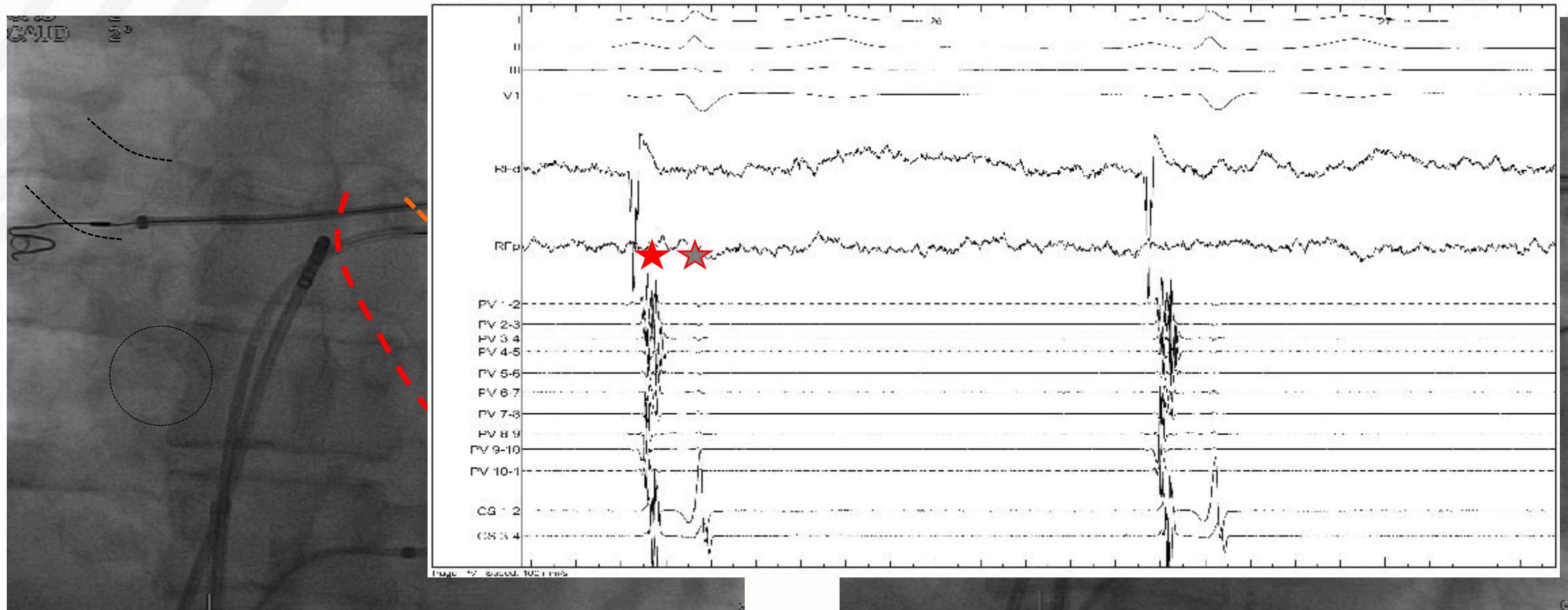
Ablation par radiofréquence de la FA => Déconnexion des Veines Pulmonaires



RF ablation of the Left Veins

Post wall: 25W, painful, 1min max at each spot

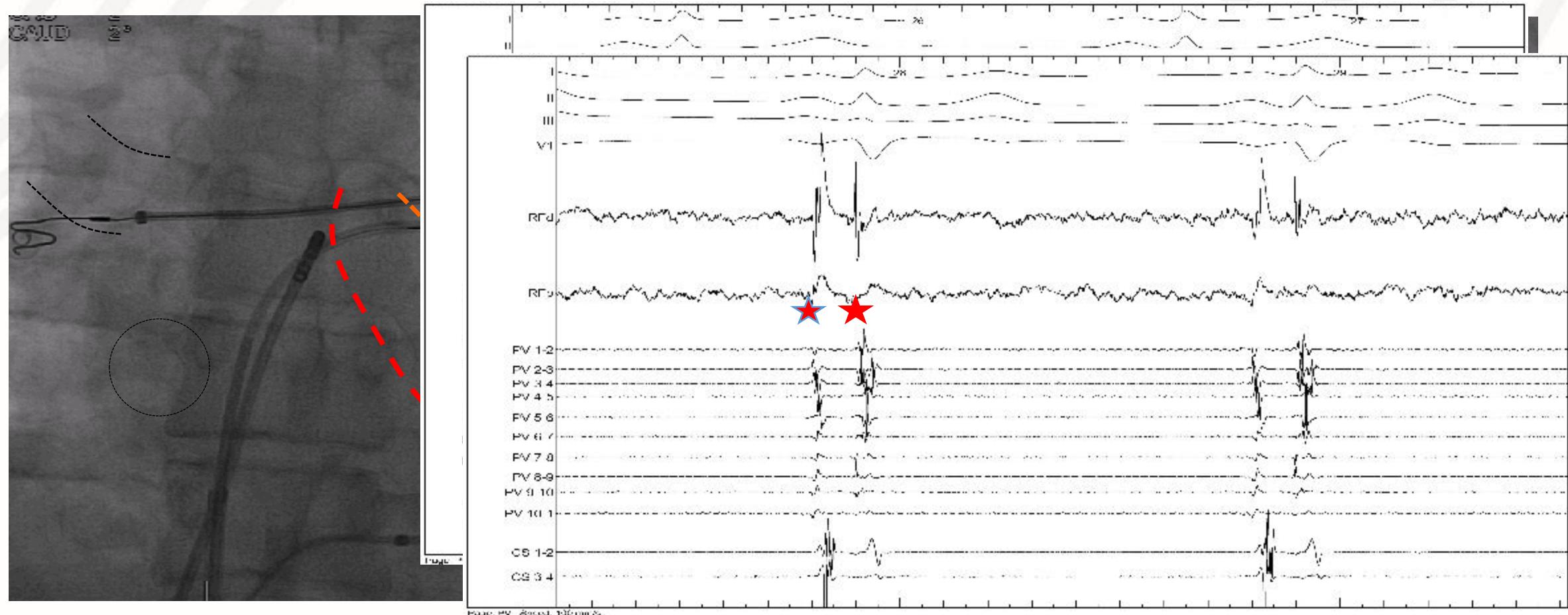
Ridge: 25-30W. Unstable, locate and ablate prox vein side



RF ablation of the Left Veins

Post wall: 25W, painful, 1min max at each spot

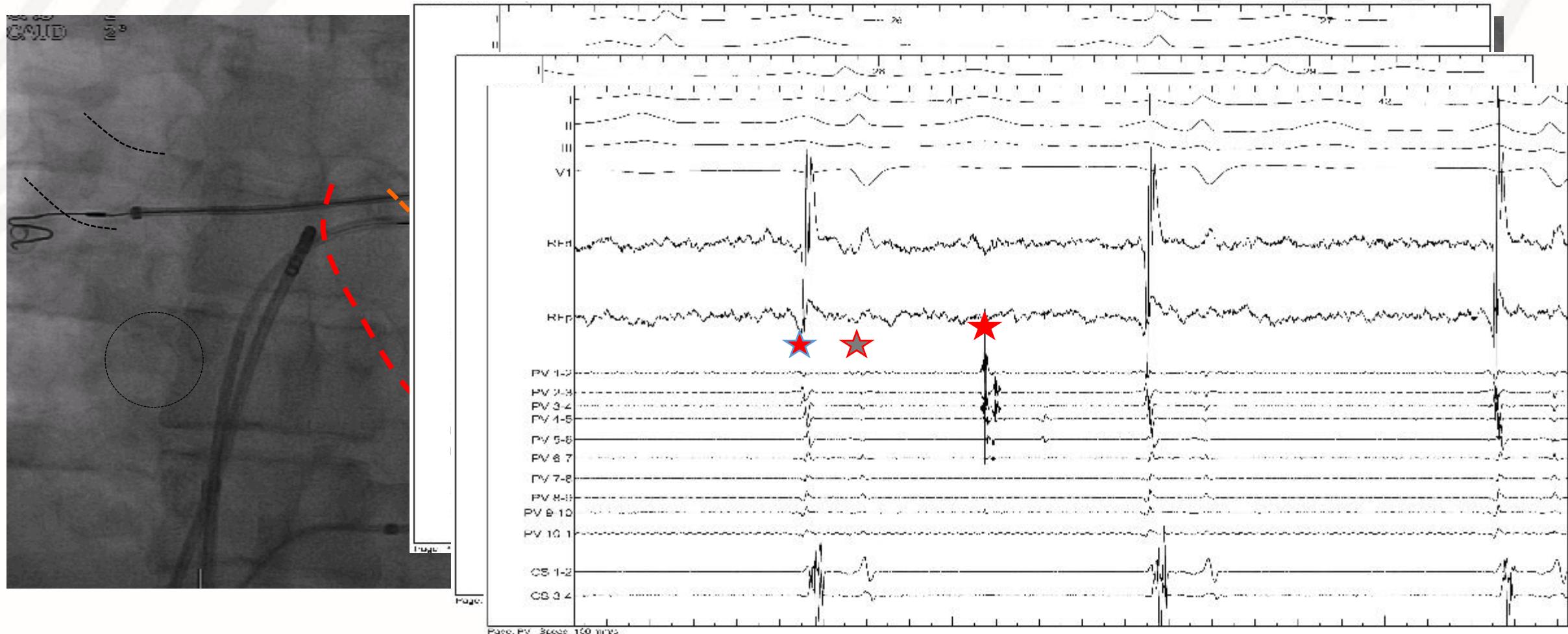
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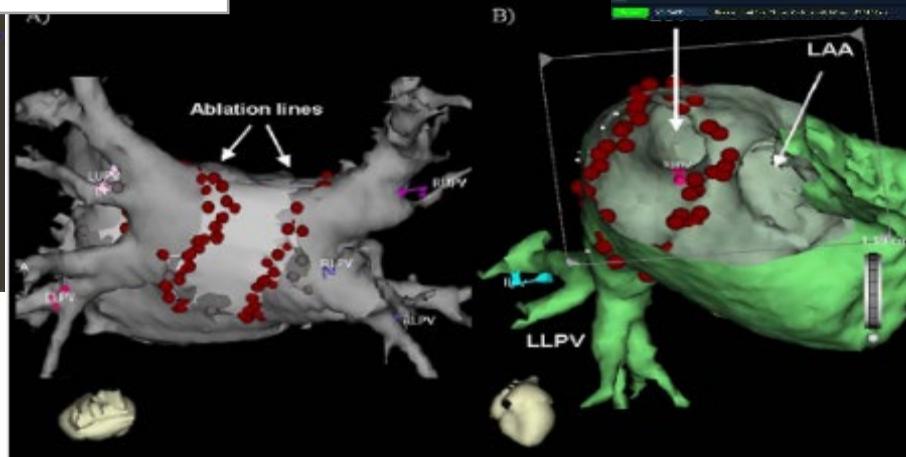
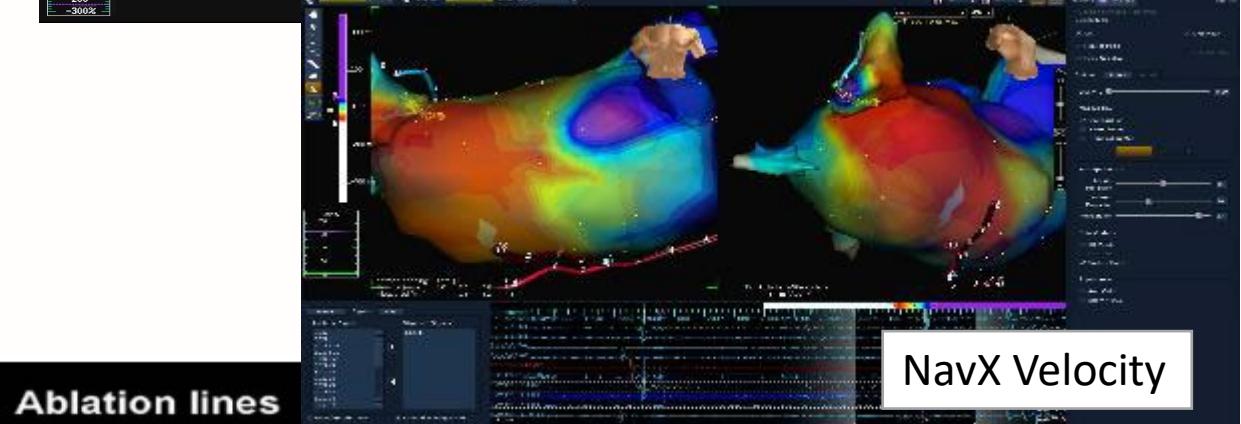
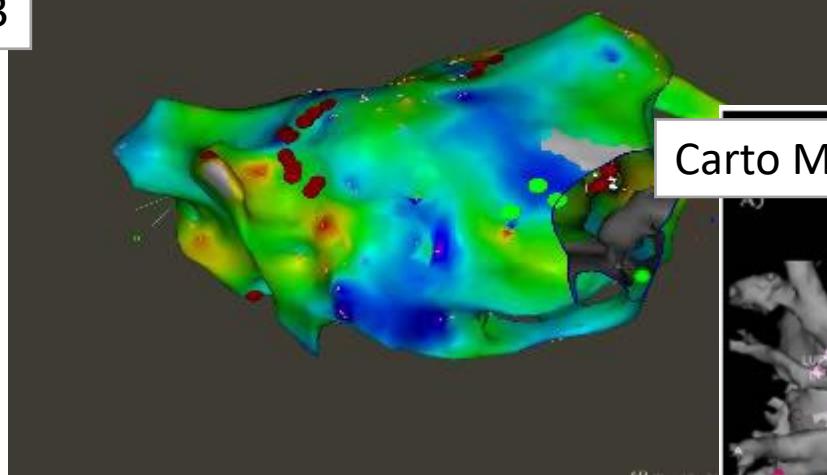


Cartographies 3D pour ablation de la FA

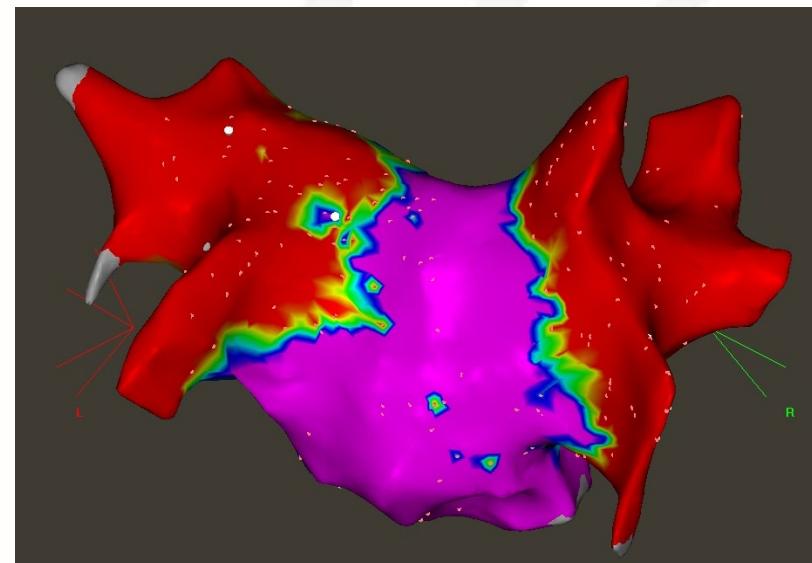
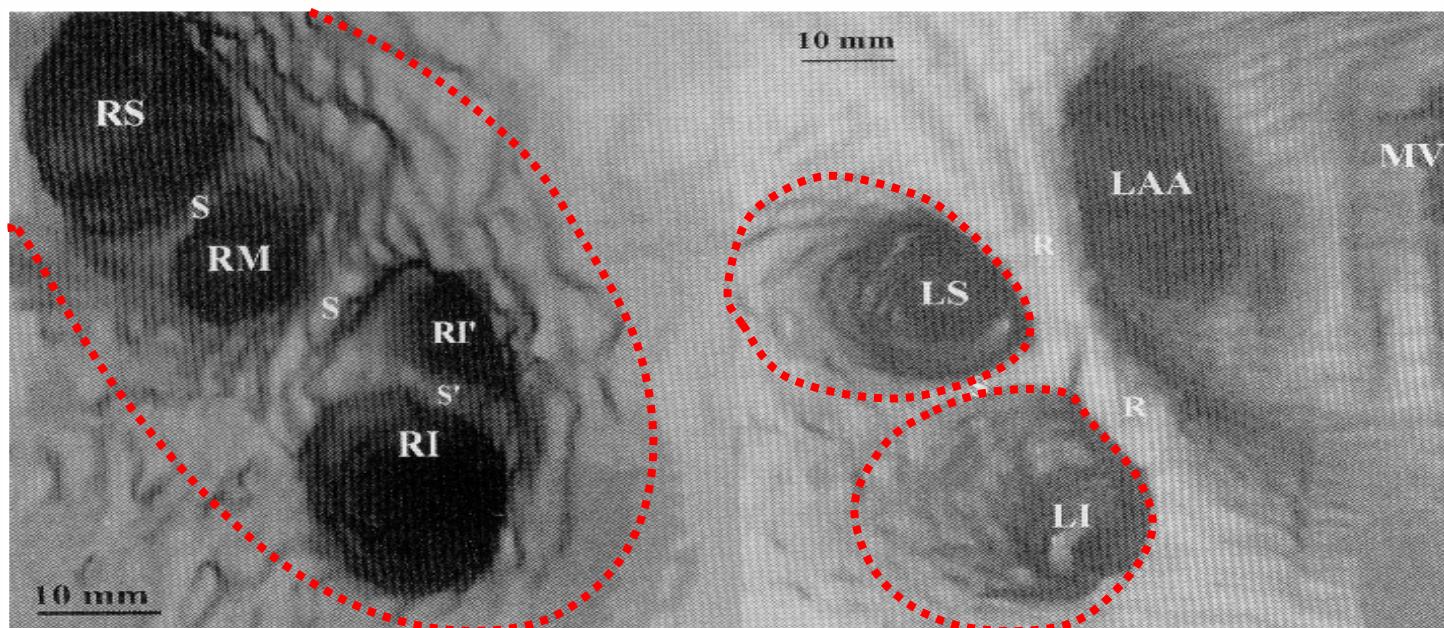
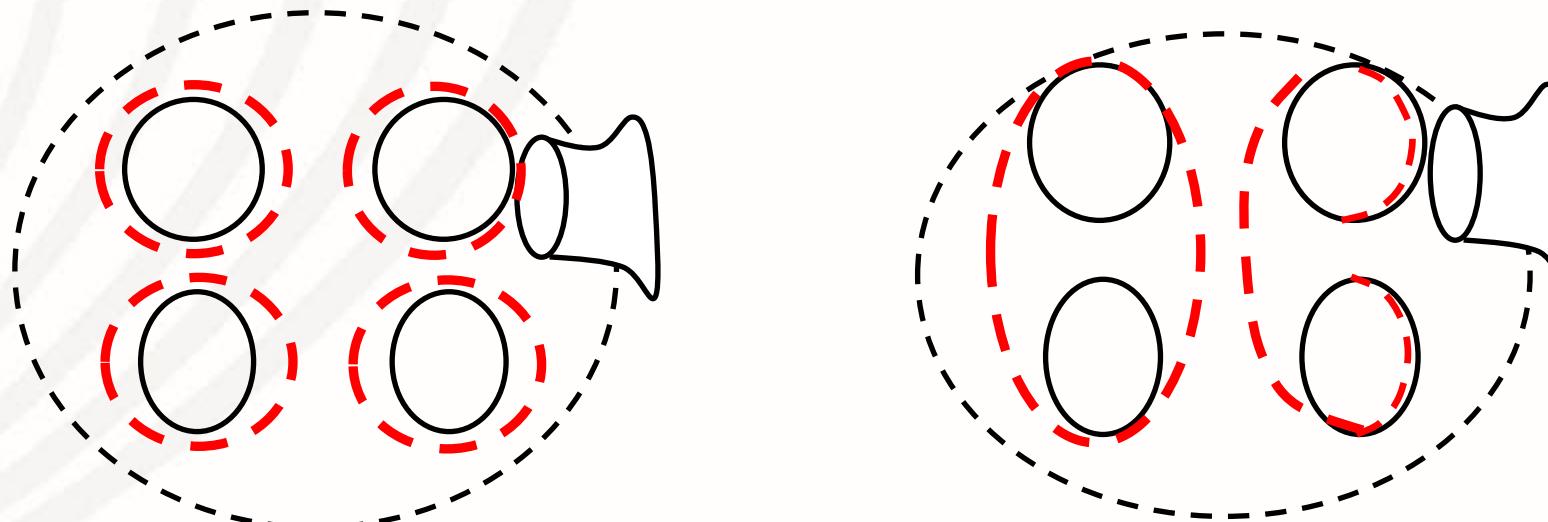
Modeling Institute | Signal Processing Team



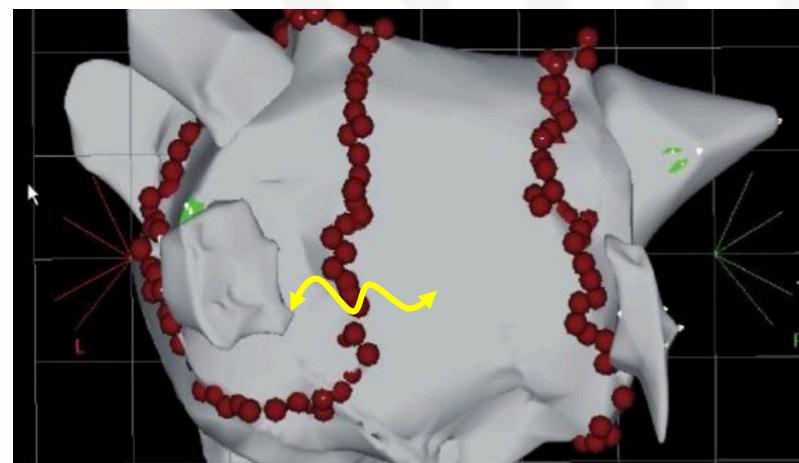
Carto 3



FA PAROXYSMIQUE

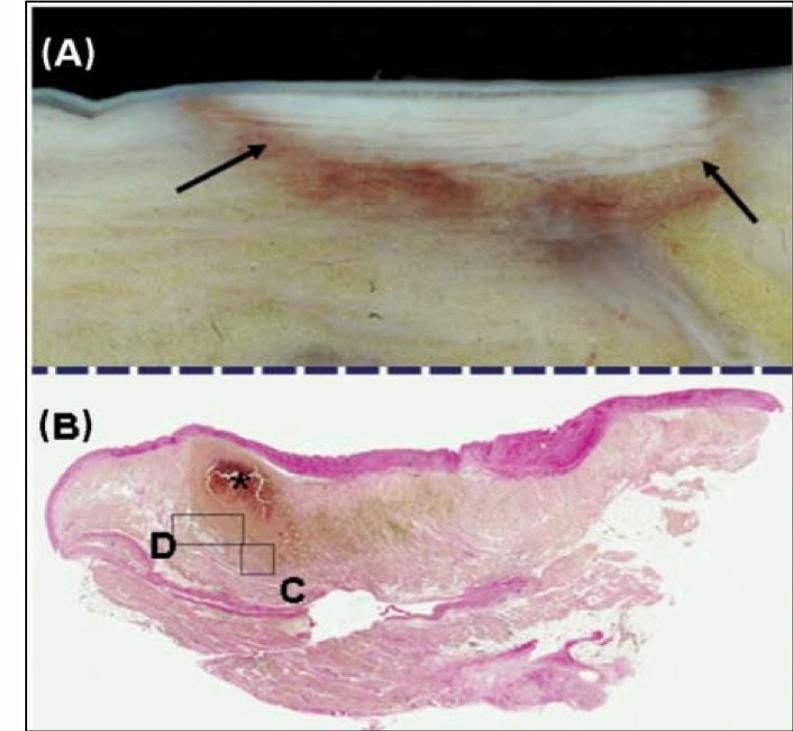
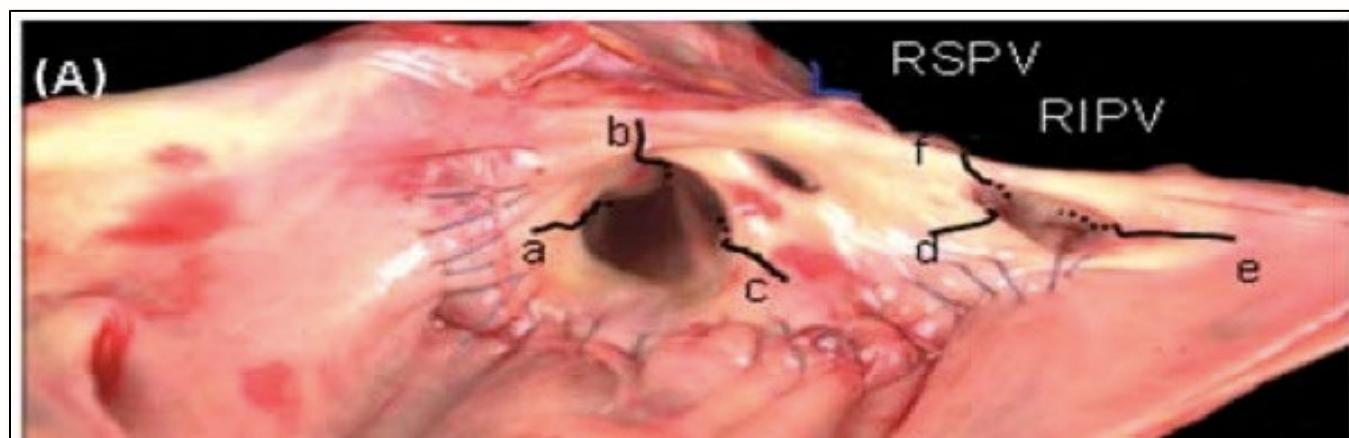


LE Problème = "Gap"



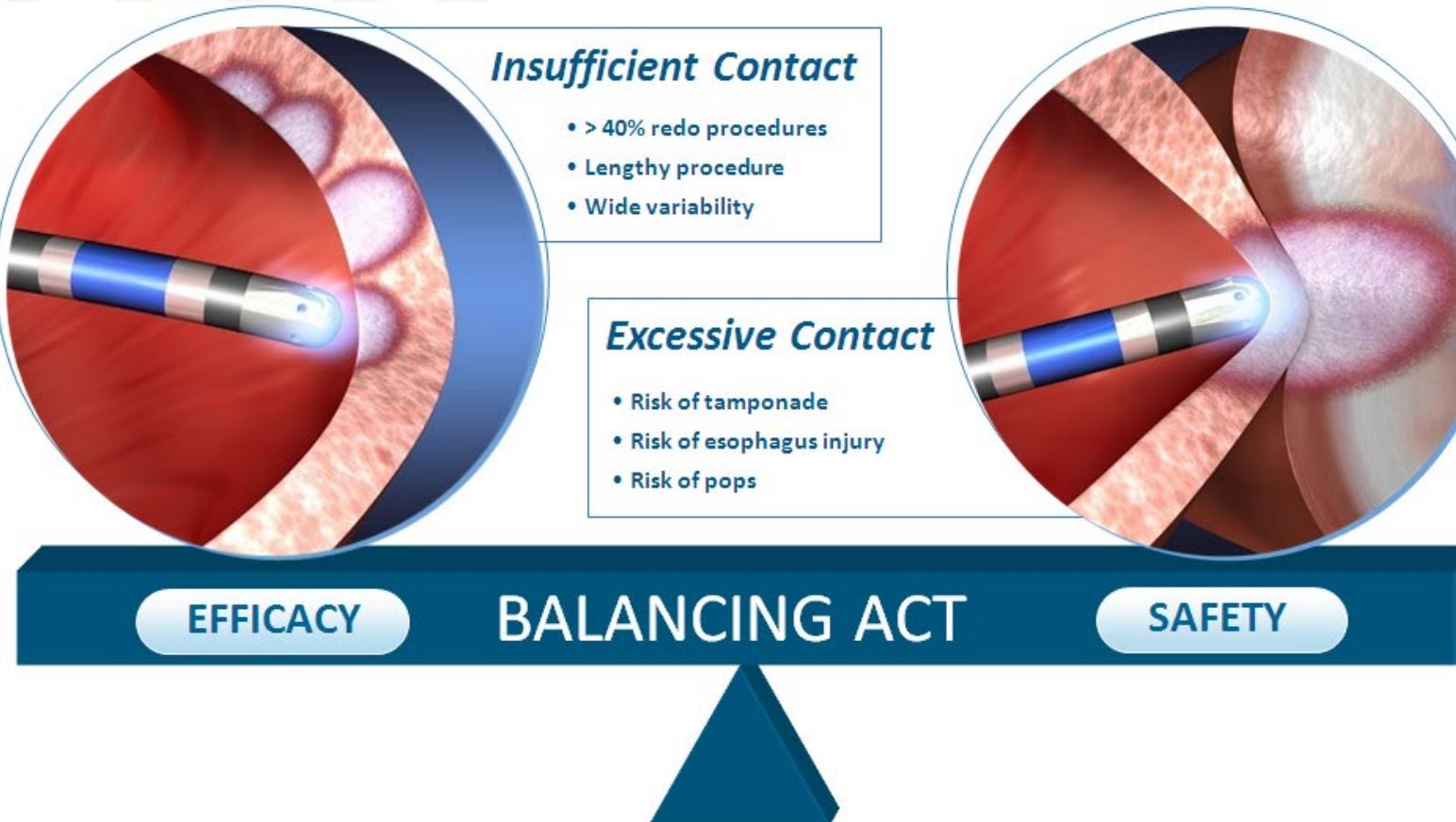
DURABLE PVI: TRANSMURAL LESIONS NEEDED

- Post mortem analysis of 59 ablation lesions from 7 pts who died 2 - 22 days post PVI
- Transmural lesions **only found in 75%** of the ablation lesions (diseased + fibrosed hearts)
- Lower rates of transmurality between LPVs / LAA and at the mitral isthmus



(A) Macroscopic
(B) Histologic (Masson Trichome staining)

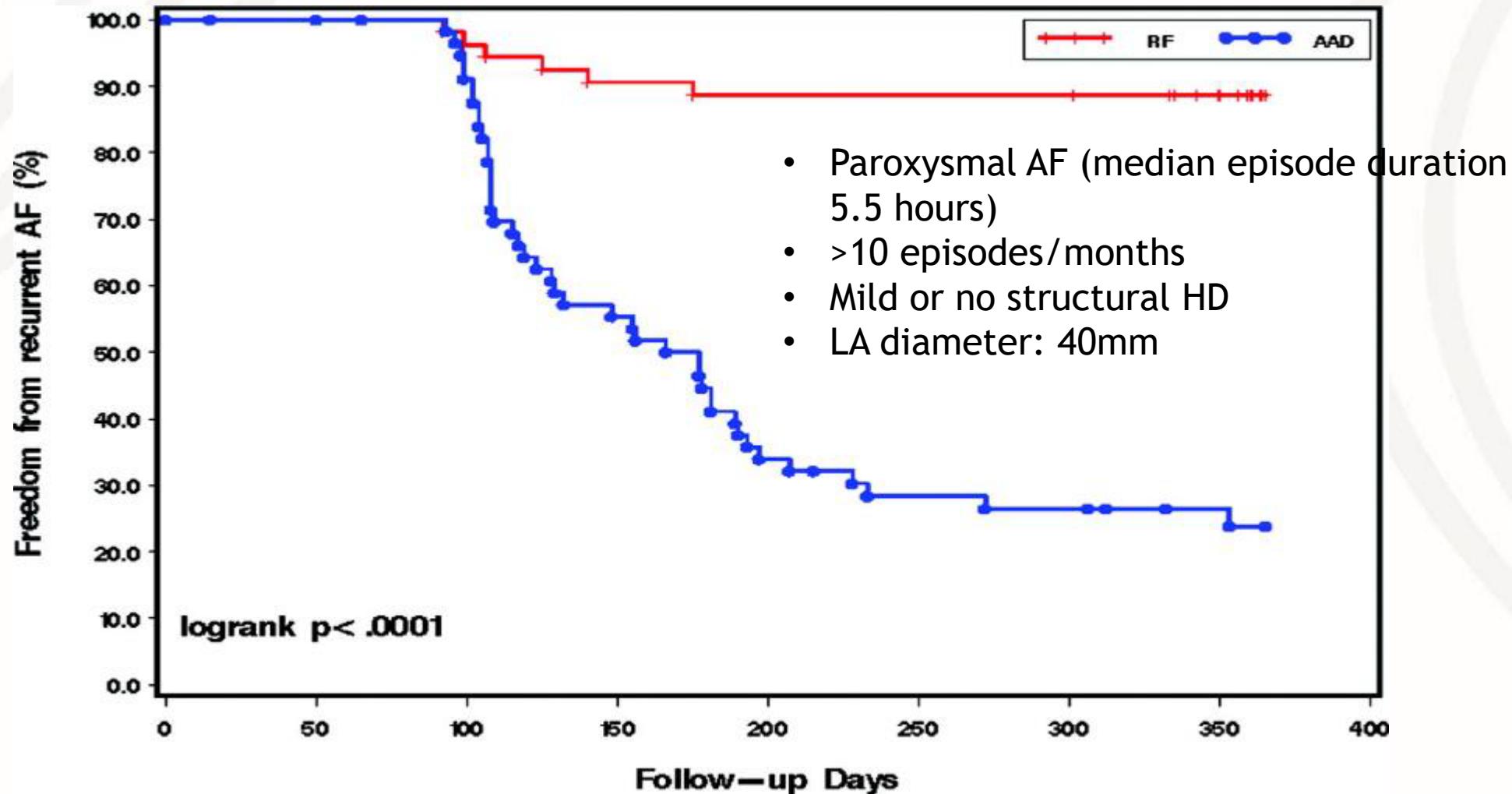
CONTACT-FORCE SENSOR



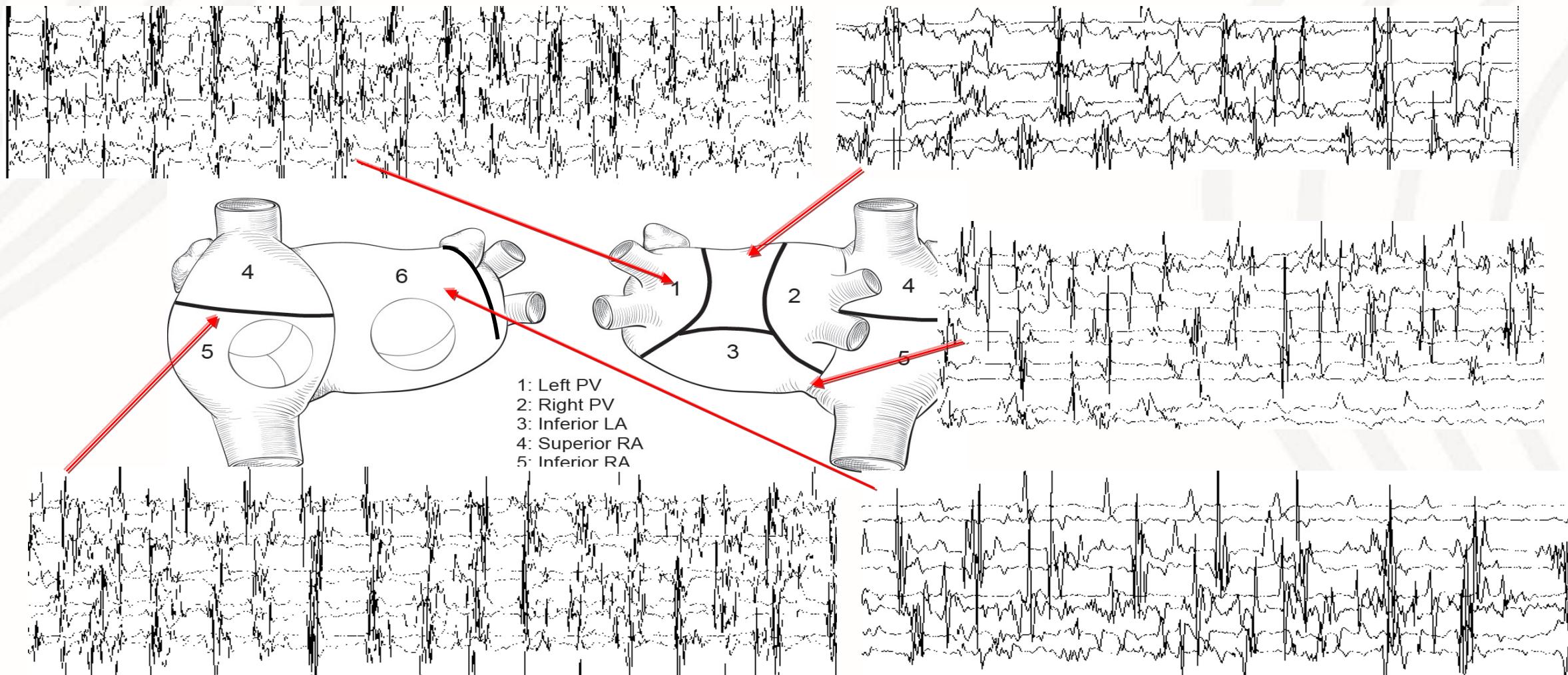
Biosense Webster

FA PAROXYSТИQUE

Kaplan-Meier analysis for time to recurrent AF after the 90-day treatment adjustment period for both groups

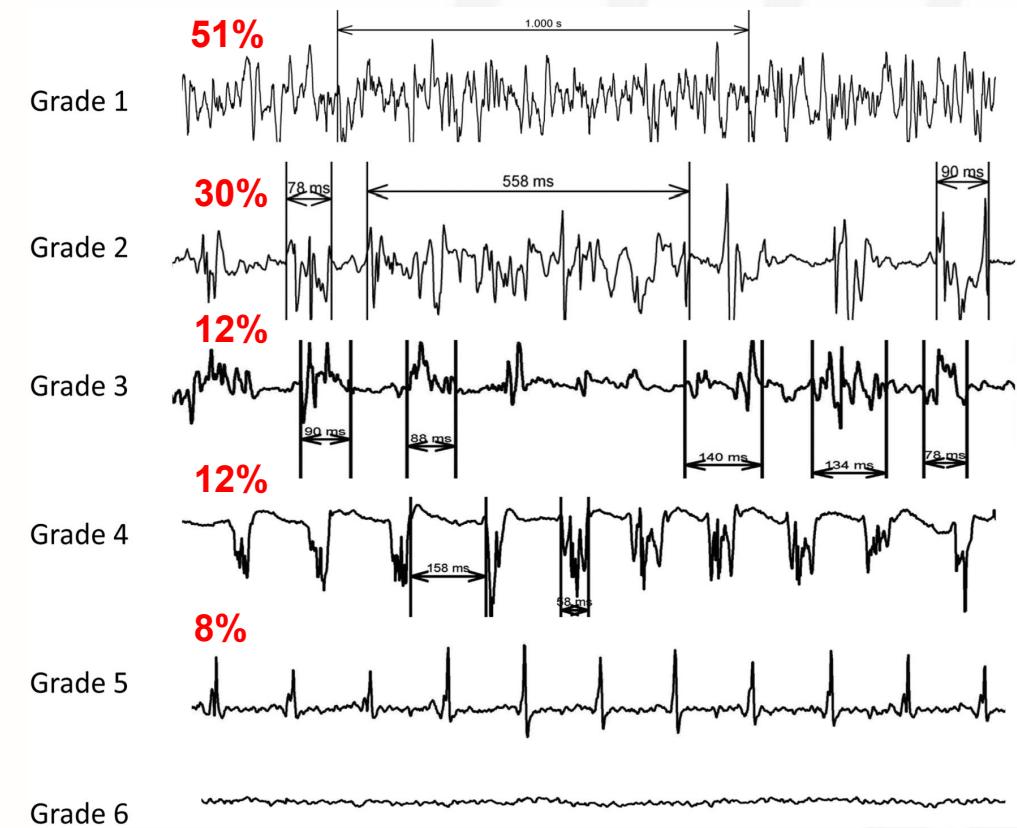


TARGET FOR SUBSTRATE ABLATION ?



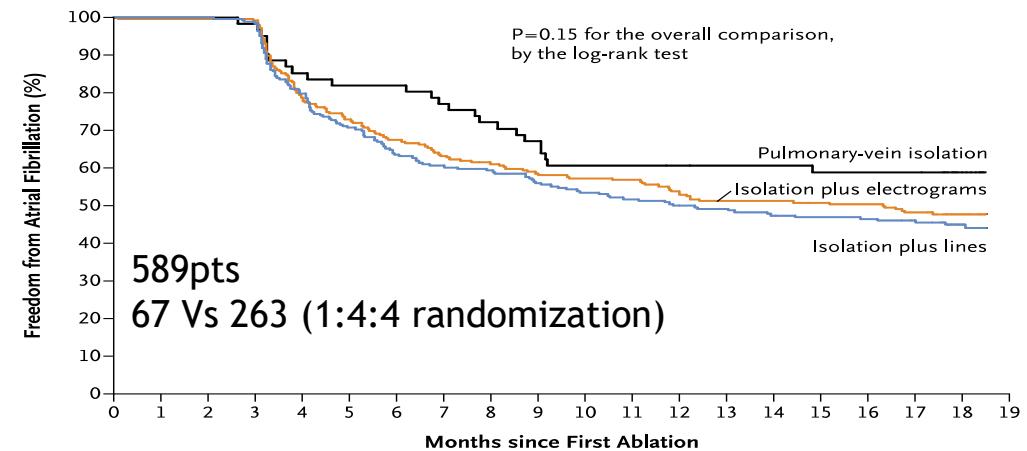
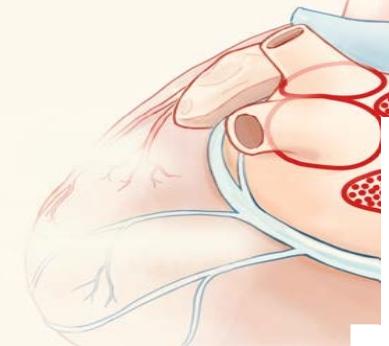
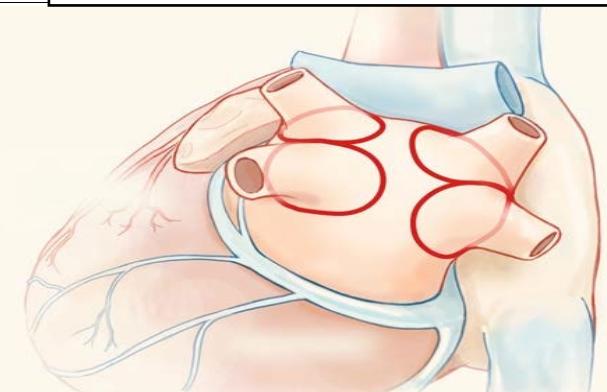
Cibles d'ablation après l'isolation des veines pulmonaires

- Signaux fragmentés et bas voltés
- Ablation linéaire
- Foyers extra-veineux
- Sinus coronaire
- **Tous (stepwise procedure)**
- Isolation auricule gauche/VCS
- Isolation de l'OG postérieur
- Plexus ganglionnaire
- Endpoints
 - Arrêt de la FA, CEE, Non-inductibilité



Approaches to Catheter Ablation for Persistent Atrial Fibrillation

Verma et al. nejm 2015



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

Table 2. Major Efficacy Outcomes.

Variable	Isolation Alone (N = 61) number (percent)	Isolation plus Electrograms (N = 244) number (percent)	Isolation plus Lines (N = 244) number (percent)	P Value
Freedom from documented atrial fibrillation after one procedure, with or without antiarrhythmic drugs	36 (59)	119 (49)	112 (46)	0.15
Freedom from documented atrial fibrillation after one procedure, without antiarrhythmic drugs*	29 (48)	90 (37)	81 (33)	0.11
Freedom from documented atrial arrhythmia after one procedure, with or without antiarrhythmic drugs	30 (49)	100 (41)	90 (37)	0.15
Freedom from documented atrial arrhythmia after one procedure, without antiarrhythmic drugs*	25 (41)	81 (33)	71 (29)	0.08
Freedom from documented atrial fibrillation after two procedures, with or without antiarrhythmic drugs	44 (72)	146 (60)	142 (58)	0.18
Freedom from documented atrial arrhythmia after two procedures, with or without antiarrhythmic drugs	37 (61)	122 (50)	117 (48)	0.24
Documented atrial flutter or tachycardia after one procedure, with or without antiarrhythmic drugs	7 (11)	27 (11)	34 (14)	0.57
Documented atrial flutter or tachycardia after two procedures, with or without antiarrhythmic drugs	7 (11)	32 (13)	29 (12)	0.98
Patients undergoing a second ablation procedure	13 (21)	63 (26)	81 (33)	0.10

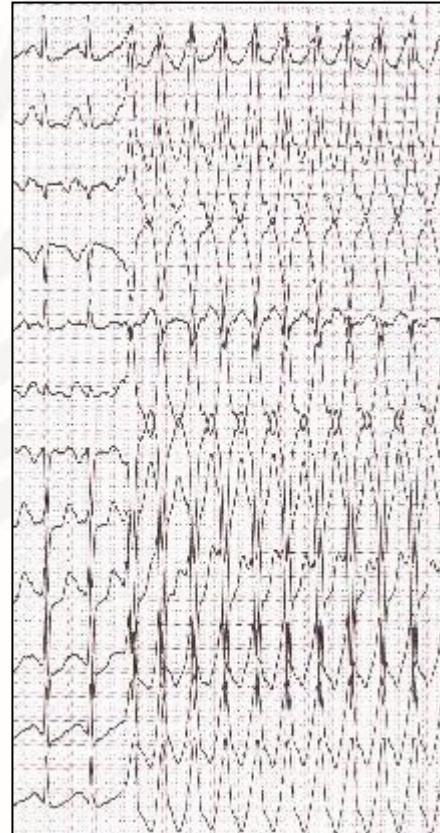
CONCLUSIONS

- La FA est un problème majeur de santé publique responsable d'un nombre élevé d'hospitalisation, de complications (AVC+++).
- Elle est associée à une surmortalité cardio-vasculaire.
- Elle nécessite le plus souvent des traitements chroniques.
- Coût important pour la société (13 M€ en EU)
- Traitements curatifs par ablation ont révolutionné la prise en charge:
 - FA paroxystique: procédure bien définie, maintenant partie des soins courants
 - FA persistante/chronique: progrès encore nécessaire pour mieux définir la stratégie et diminuer les taux de récidive (FA chronique).

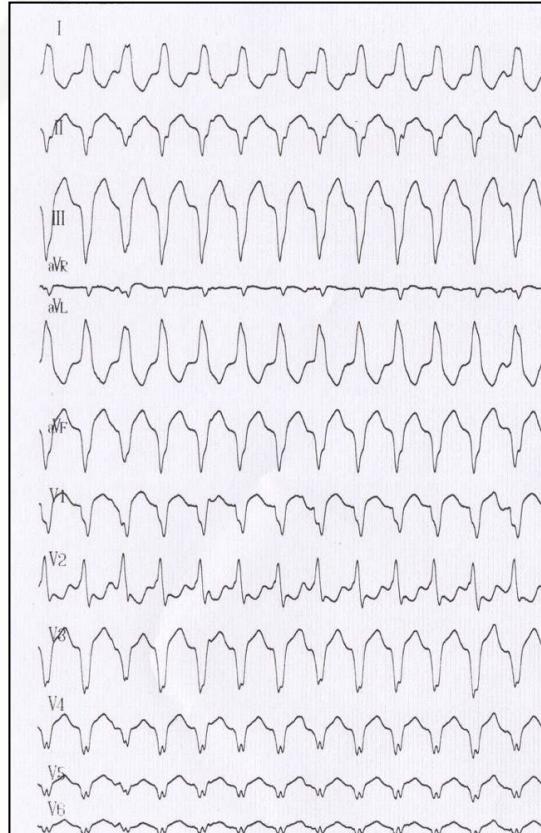
Tachycardie ventriculaire

N Derval
CHU Bordeaux
IHU LIRYC

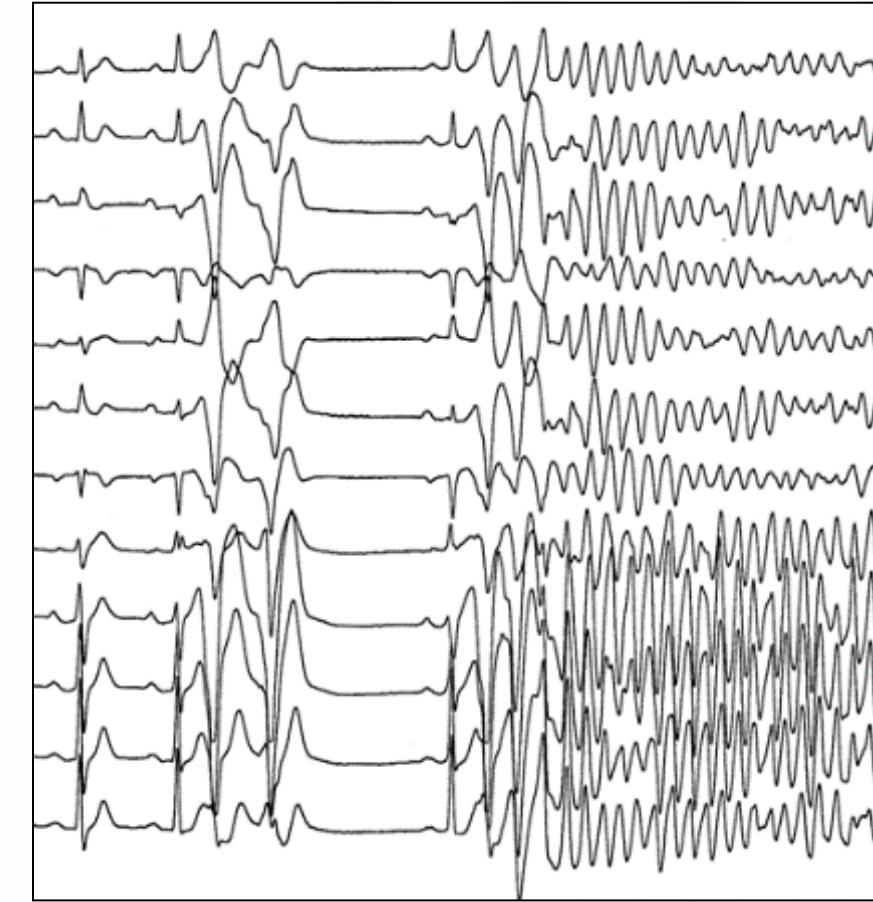
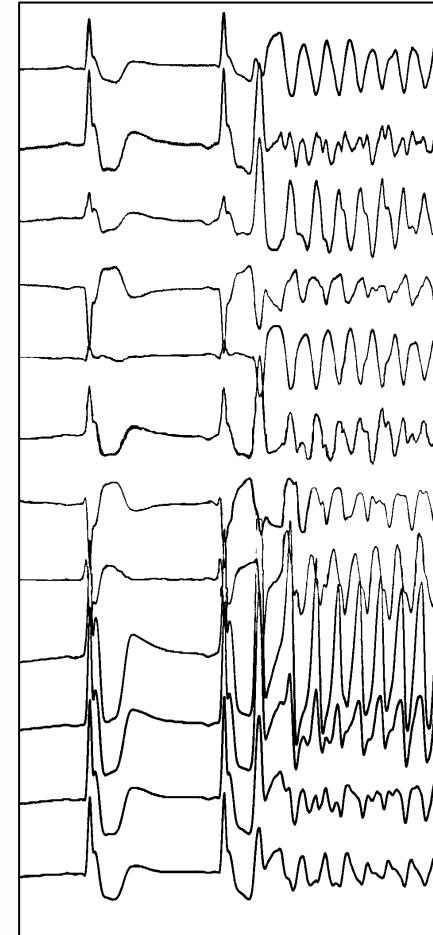
PHYSIOPATHOLOGIE



Tachycardie ventriculaire
monomorphe

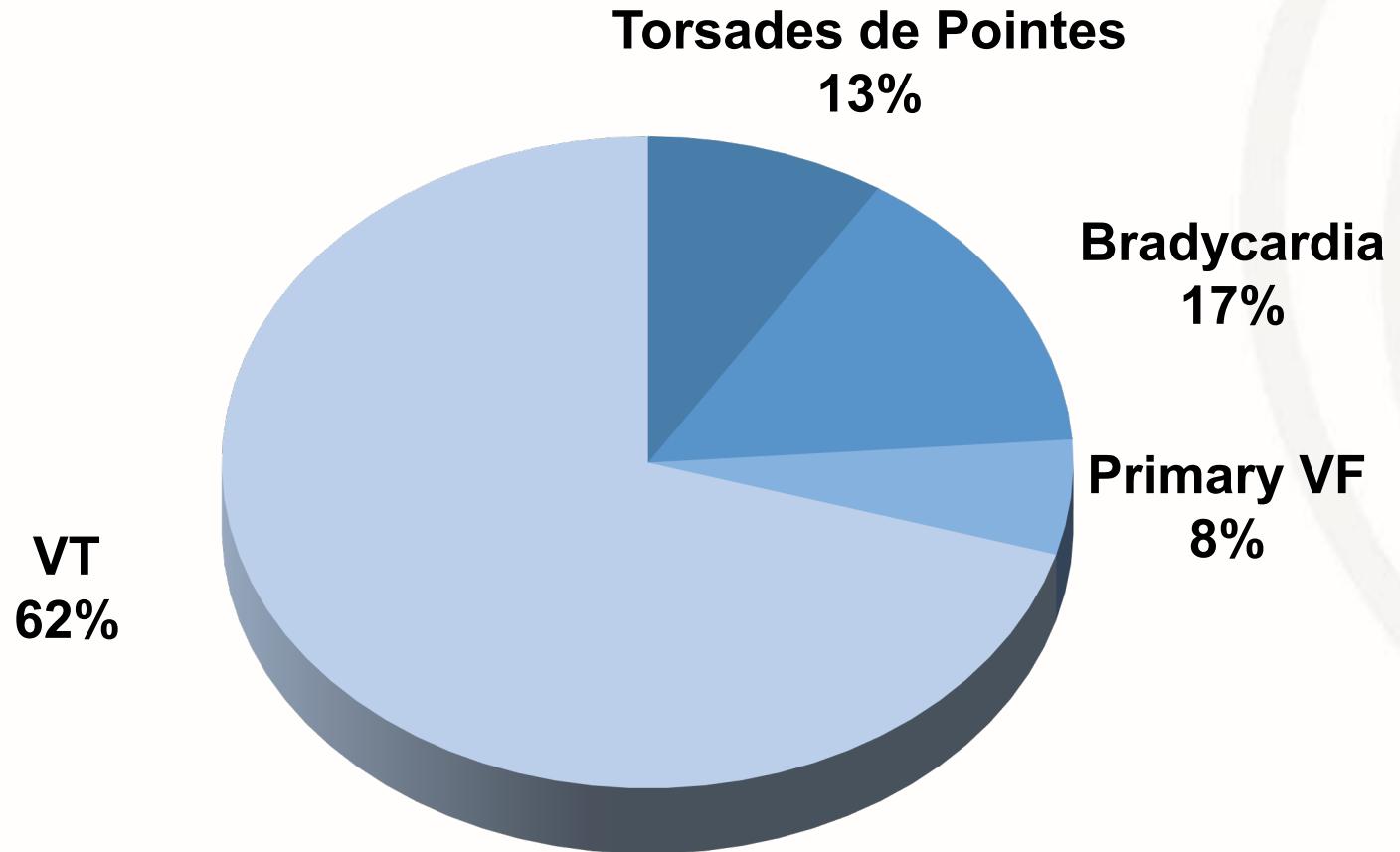


Tachycardie ventriculaire
polymorphe



Fibrillation ventriculaire

CAUSES DE MORT SUBITE

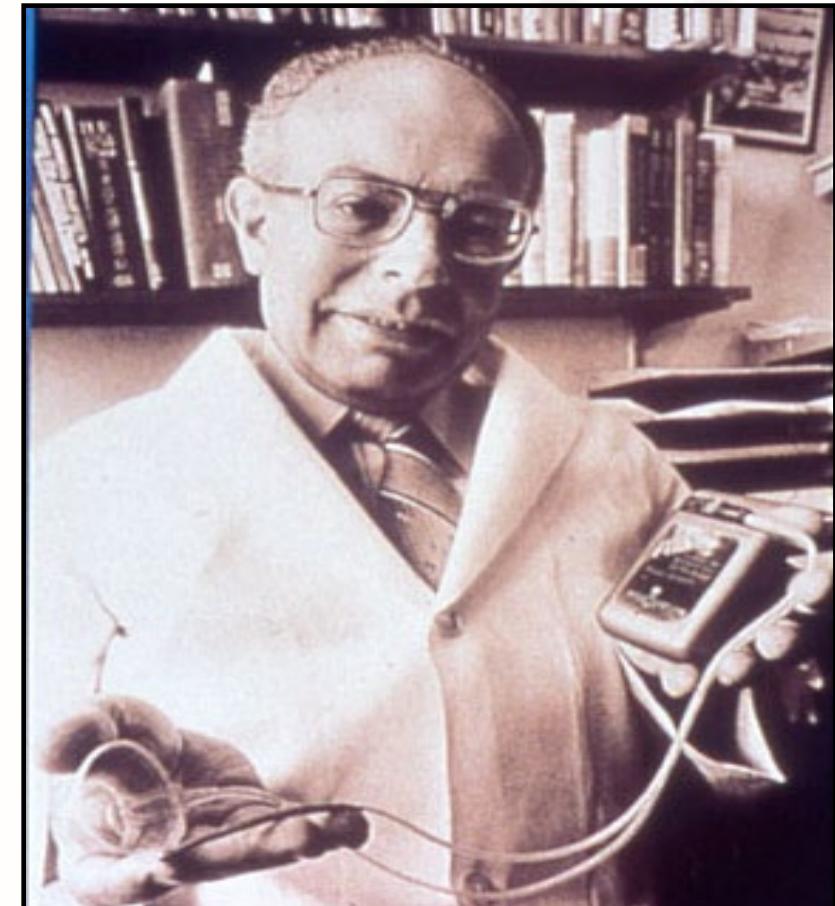


Adapted from Bayés de Luna A. *Am Heart J.* 1989;117:159.

LA FIBRILLATION VENTRICULAIRE

- Le Défibrillateur Automatique Implantable

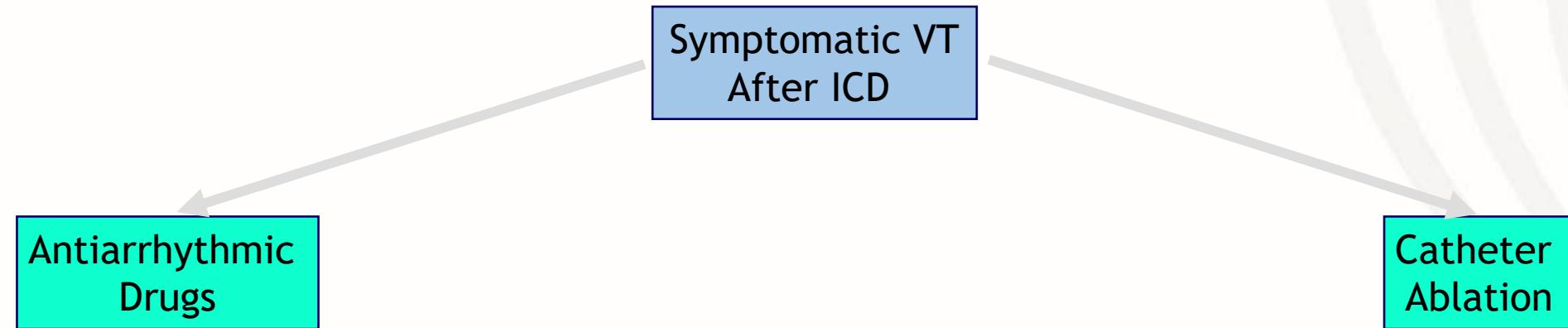
- Michel Mirowski
- 1^{ère} implantation chez l'homme en 1980
- Indications initiales (!!)
 - 2 morts subites
 - Pas d'ATCD d'IDM
 - 1 épisode documenté
 - Ttt antiarhythmique pour un des épisodes



NEED FOR ARRHYTHMIA MANAGEMENT AFTER ICD PLACEMENT

Primary Prevention ICD
shocks for VT - 5% year
Inappropriate shocks - 2.5%/yr
Need for AA drugs - 14%

Secondary Prevention ICD
shocks for VT: 40 - 60%
>3 shocks in 24 hrs: 20%
Need for AADs - 20%



SCD-HeFT Bardy, G. H. et al. N Engl J Med 2005;352:225-237

MADIT II N Engl J Med 202;346:877

AVID VT storm, Exner et al Circ 2001;103:201

AVID Quality of life, Schron Circ 2002;105:589

ARRHYTHMIC EVENTS IN ICD RECIPIENTS

■ Ischemic CMP

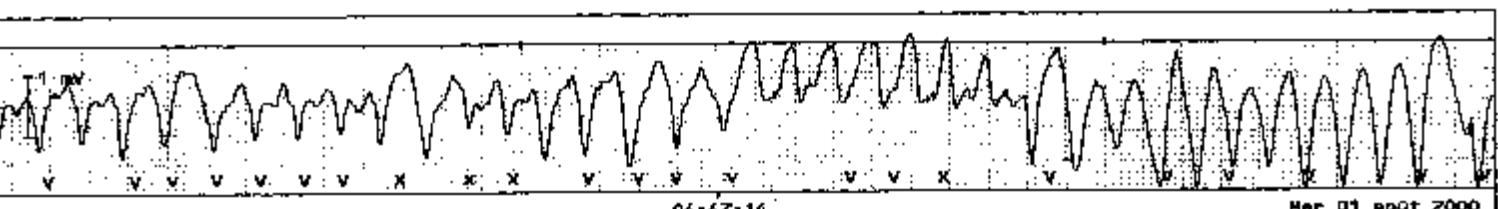
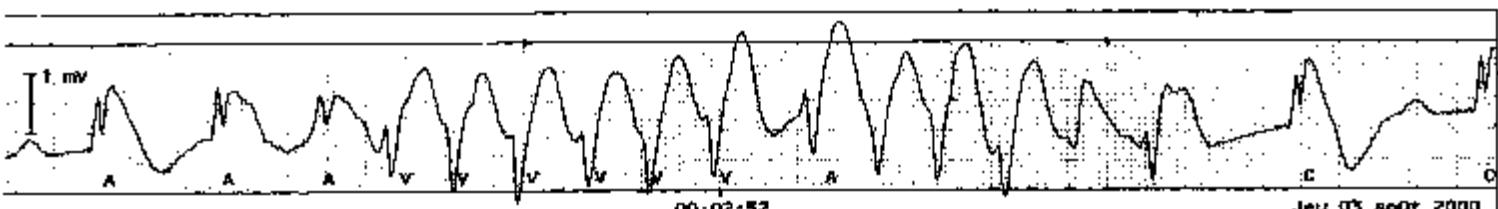
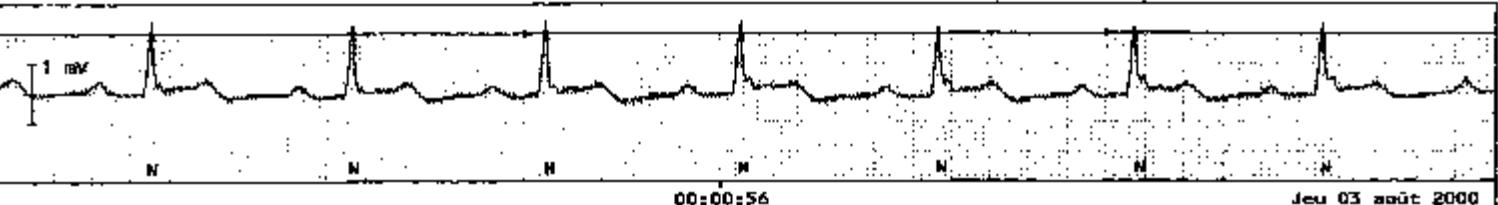
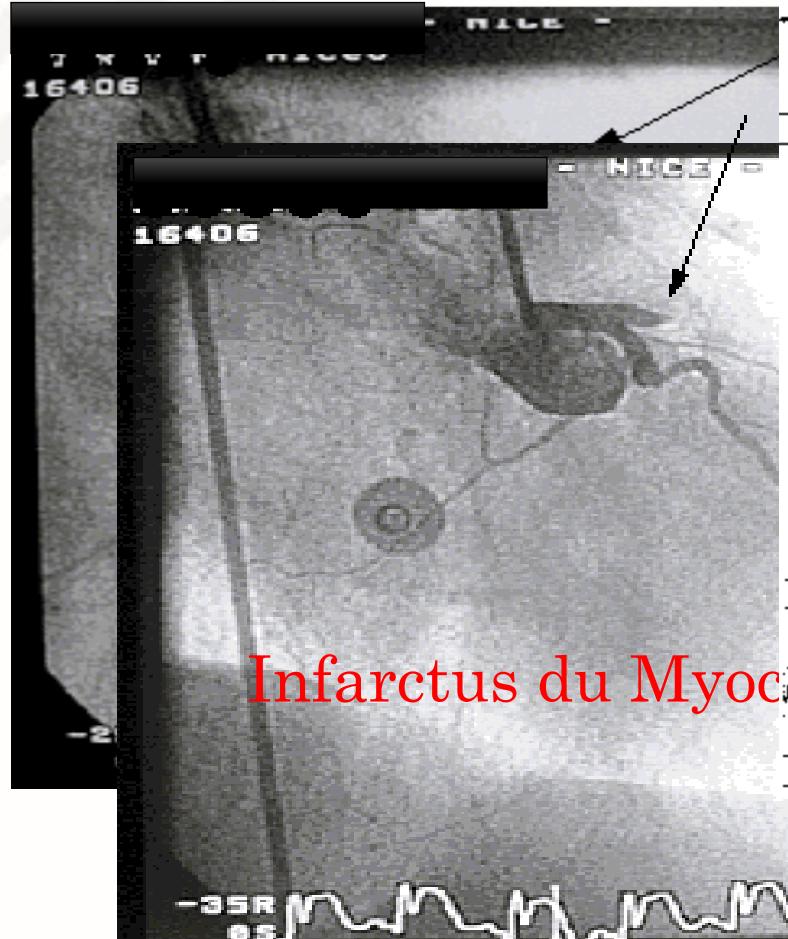
- **Primary prevention pts** (EF<0.3% - MADIT II)
 - *Follow-up 20months*
 - 4% Arrhythmic storm
 - HR mortality 17.8** (<3months after event)
 - HR mortality 3.5 (>3months after event)
 - 20% Isolated VT/VF
 - HR mortality 2.5**
- **Secondary prevention pts** (EF<40% - AVID)
 - *Follow-up 31months*
 - 20% Arrhythmic storm (n=90)
 - HR mortality 5.6** (<3months after event)
 - HR mortality 2.4 (>3months after event)
 - 40% Isolated VT/VF (n=184)
 - No increase of mortality**

Sesselberg HW et al. Heart Rhythm 2007

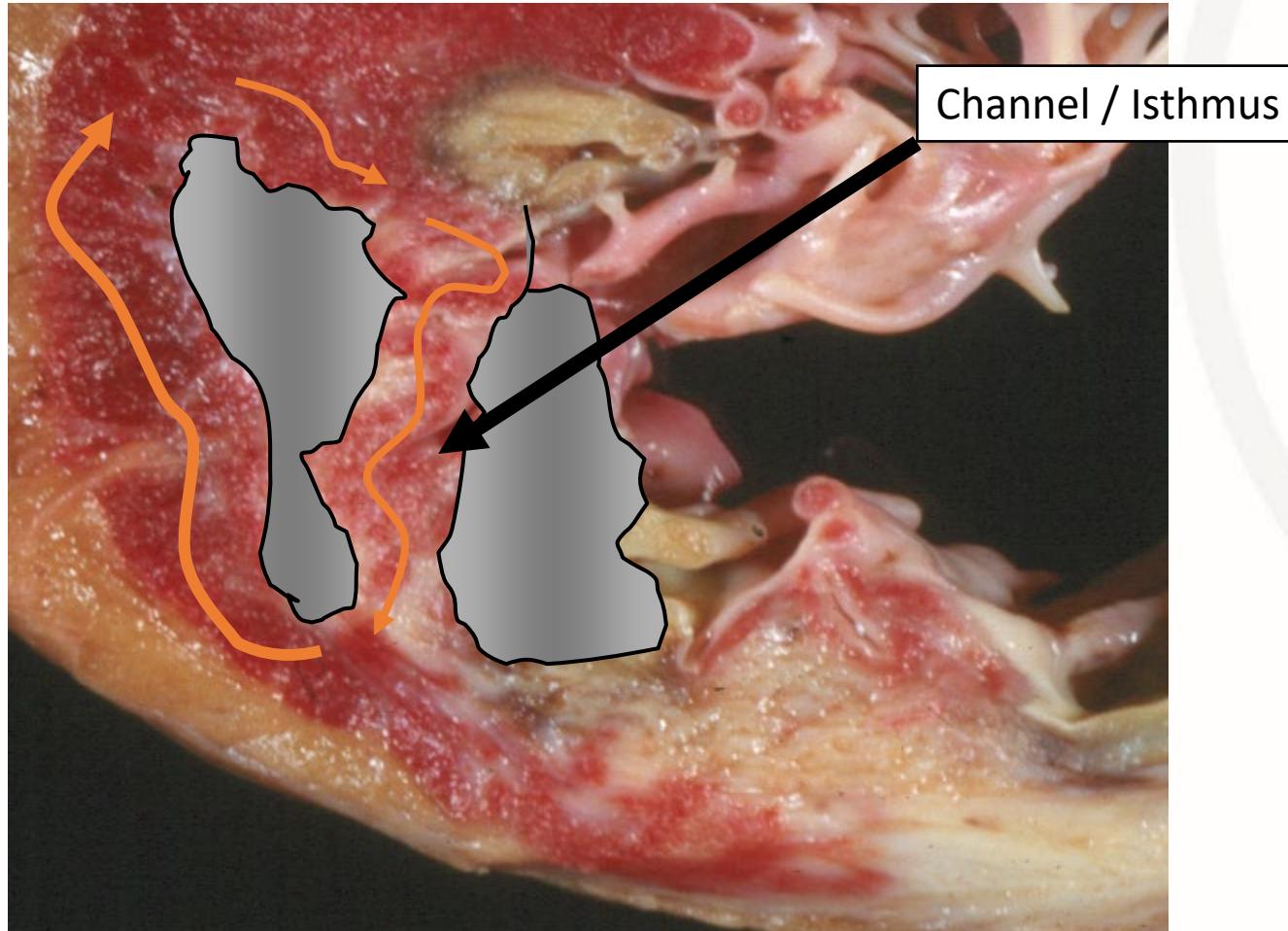
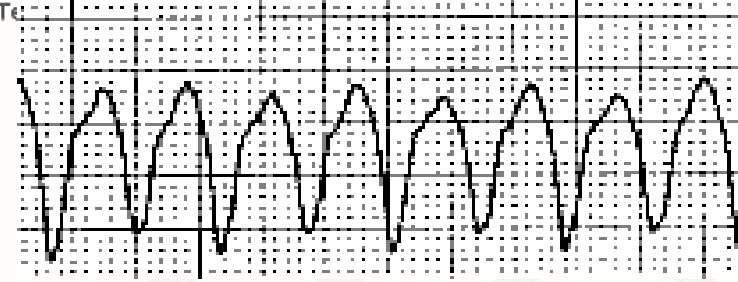
In the absence of reversible cause

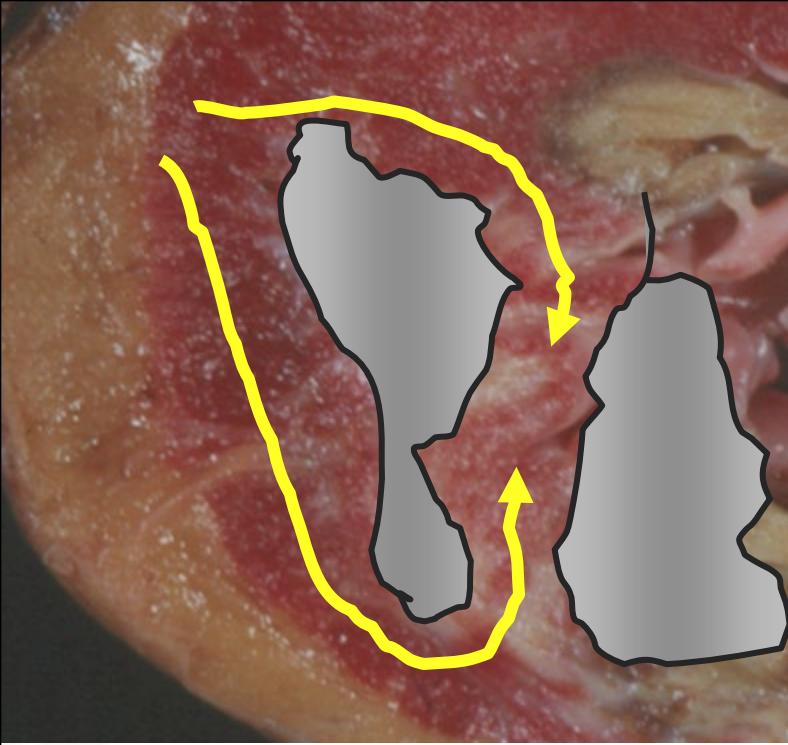
Recommendations	Class ^a	Level ^b	Ref. ^c
Urgent catheter ablation is recommended in patients with scar-related heart disease presenting with incessant VT or electrical storm.	I	B	183
Catheter ablation is recommended in patients with ischaemic heart disease and recurrent ICD shocks due to sustained VT.	I	B	184–186
Catheter ablation should be considered after a first episode of sustained VT in patients with ischaemic heart disease and an ICD.	IIa	B	184–186

LA CARDIOPATHIE ISCHEMIQUE: Cas de l'Infarctus du Myocarde

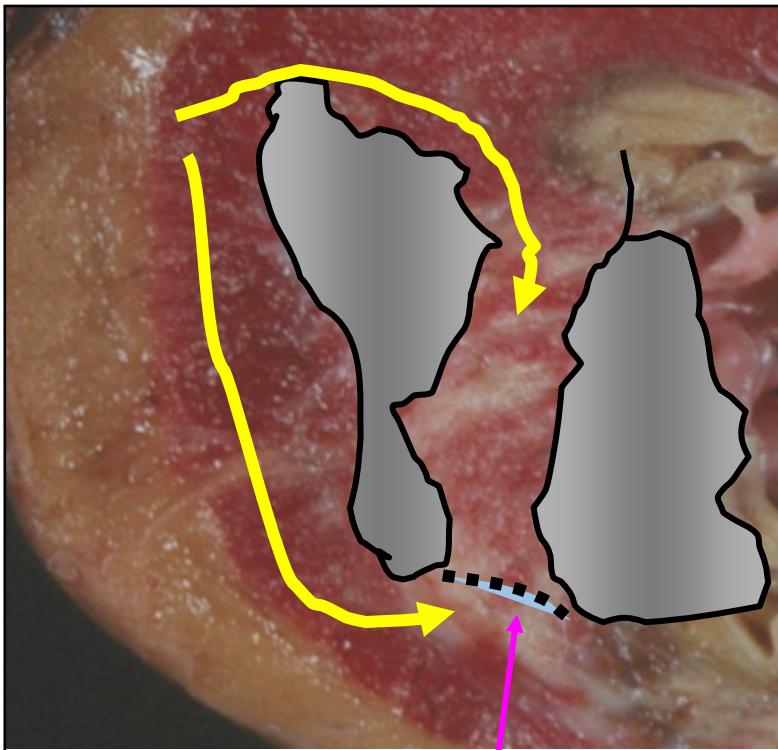


Sustained Monomorphic VT: Reentry in an infarct scar

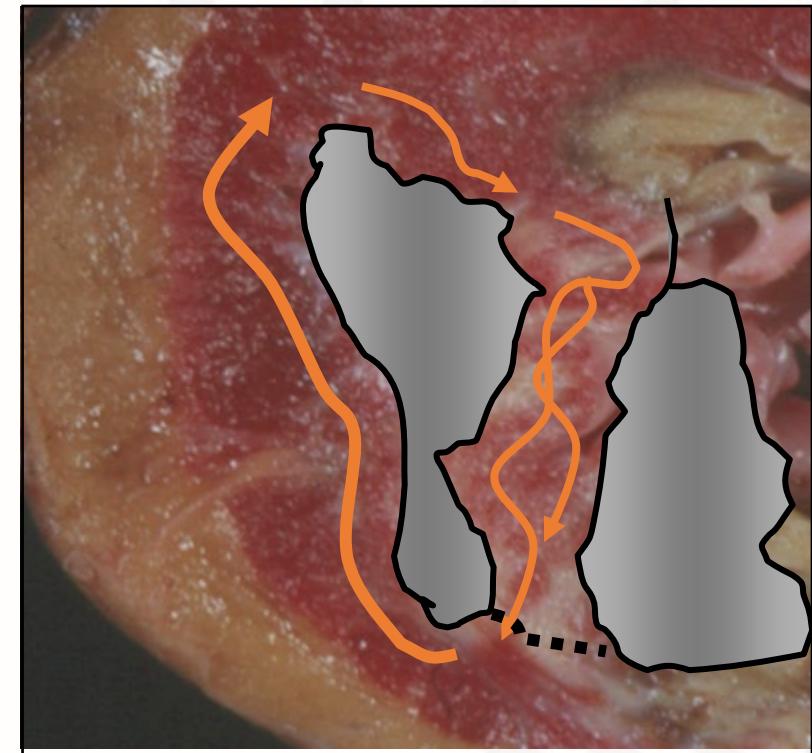




sinus
rhythm



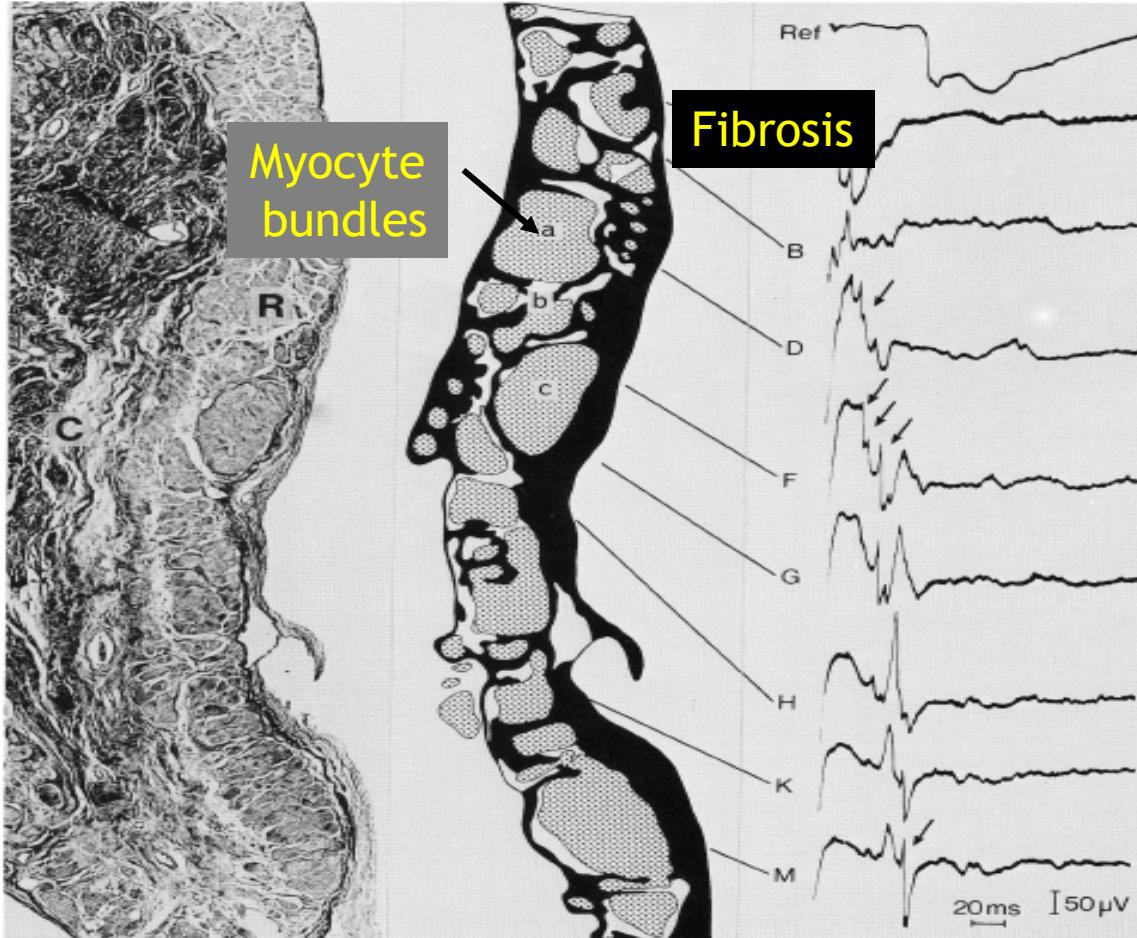
Focal region of conduction block



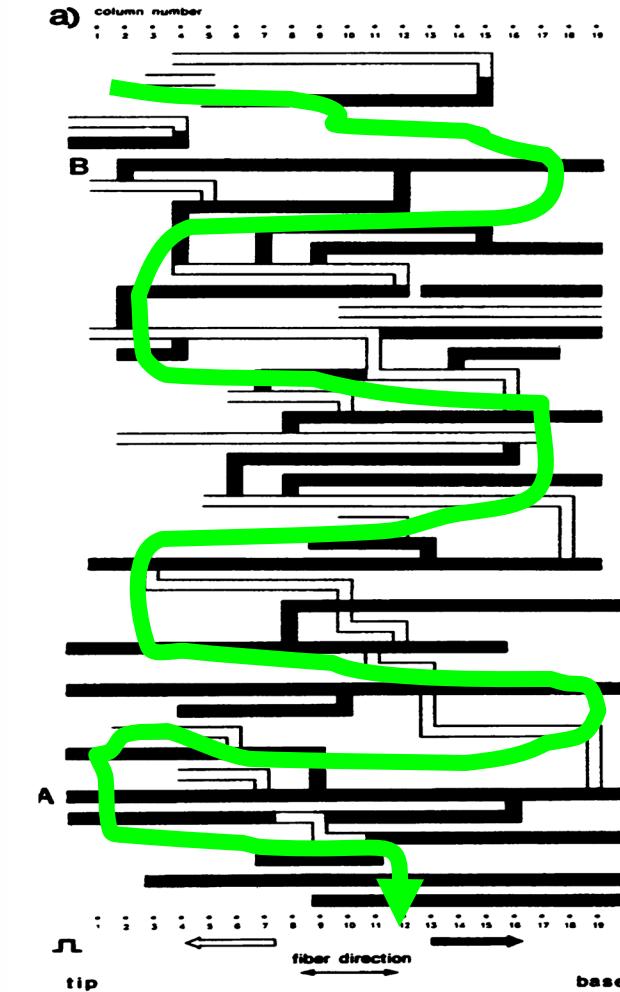
Slow conduction
to allow recovery from block

SLOW CONDUCTION: ZIG - ZAG CONDUCTION CAUSED BY FIBROTIC SEPARATION OF MYOCYTE BUNDLES

DE BAKKER, ET AL. CIRCULATION 1988; 77:589. CIRCULATION 1993;88:915.

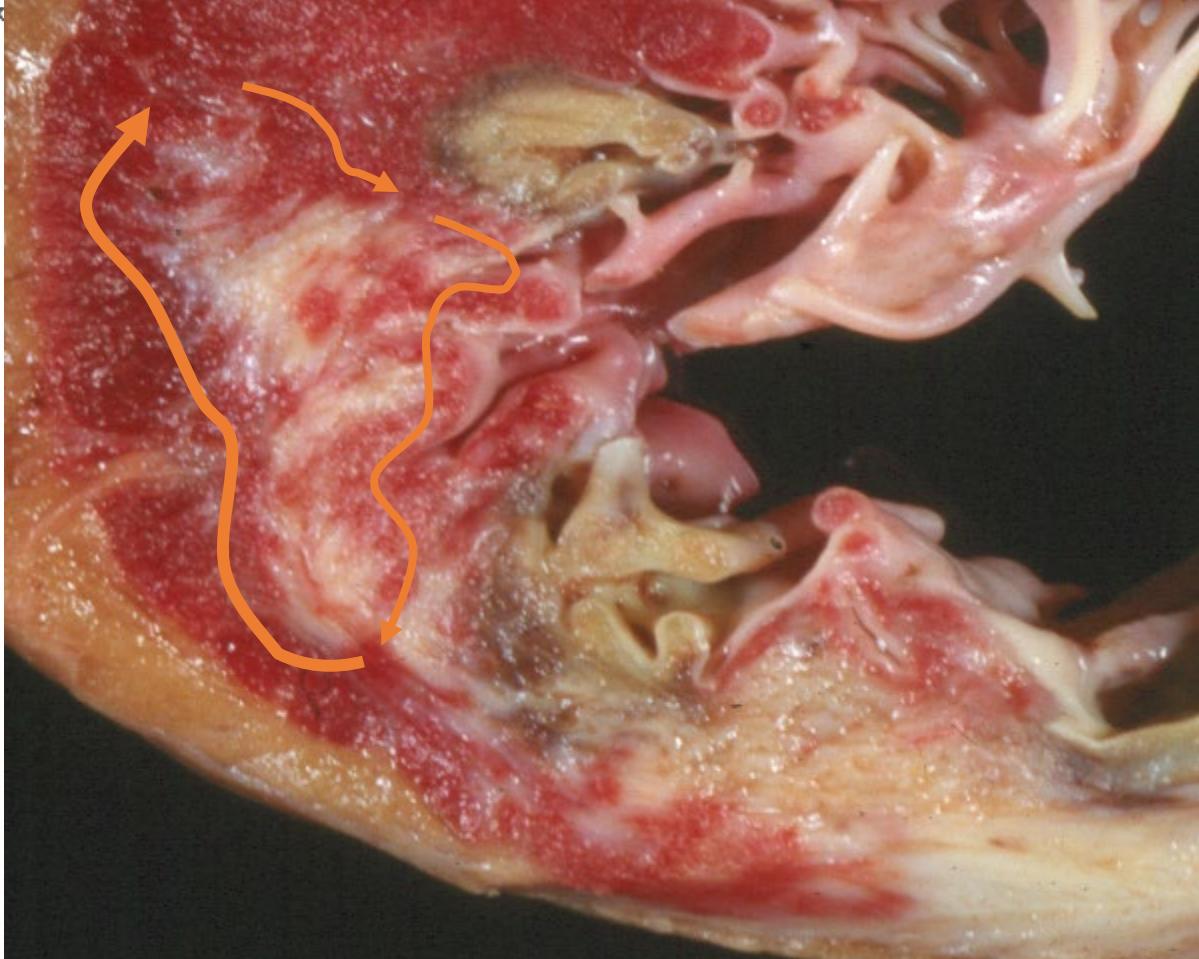


Human papillary muscle in cross section

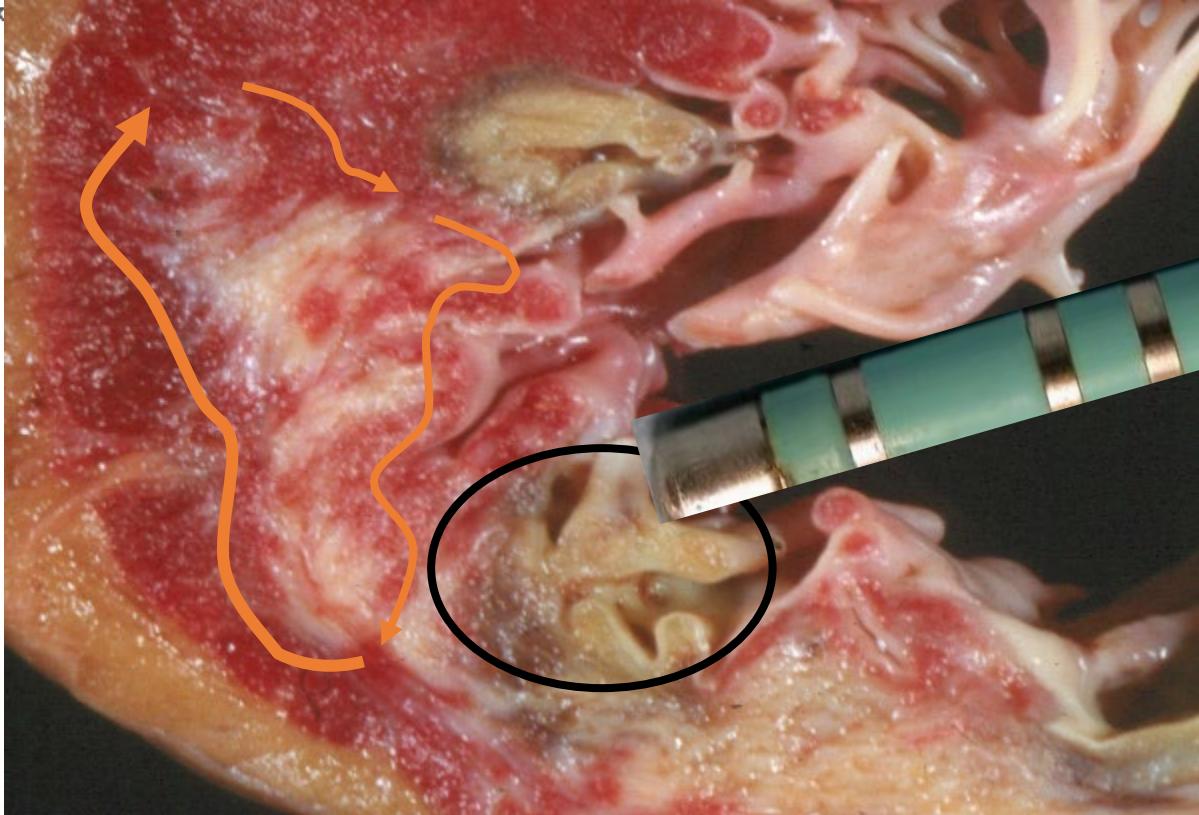


Scar-related Reentry

- Substrate is “relatively fixed”
- Stable reentry circuits cause repeated VT episodes over yrs
- VT is inducible at EP study
- Drugs efficacy is poor
 - decreasing membrane currents is usually insufficient to block conduction and prevent reentry



Catheter ablation for scar-related reentry: Challenges

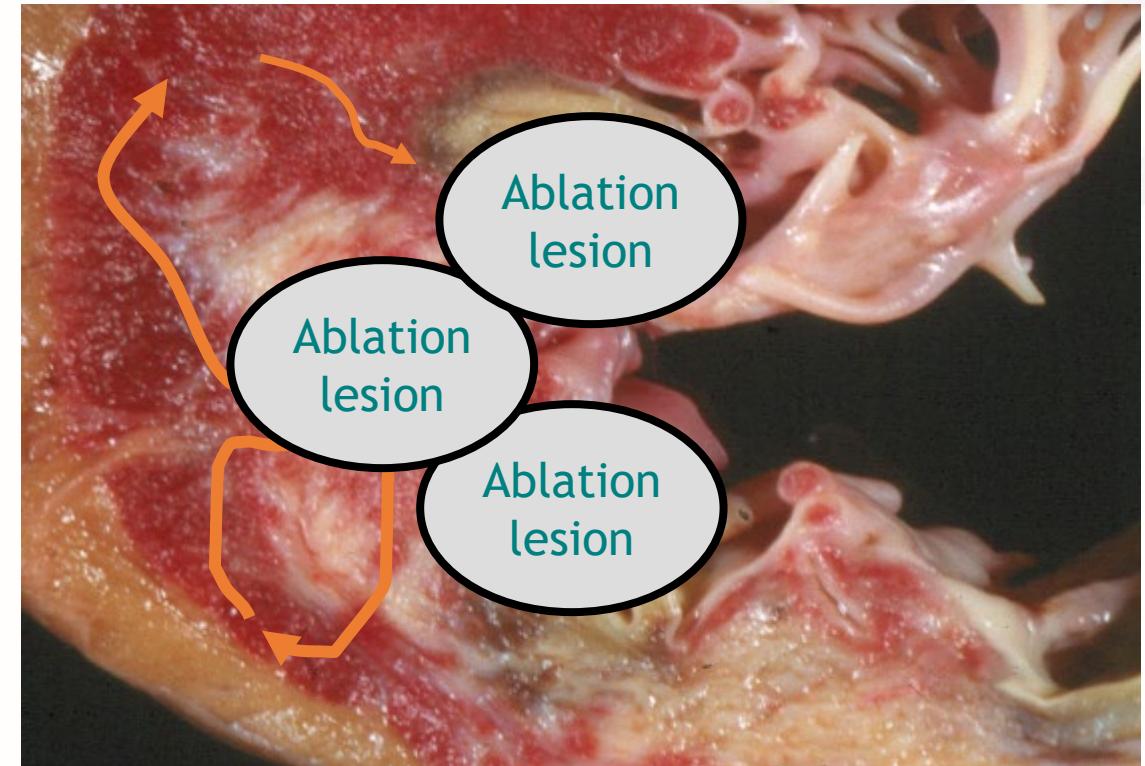
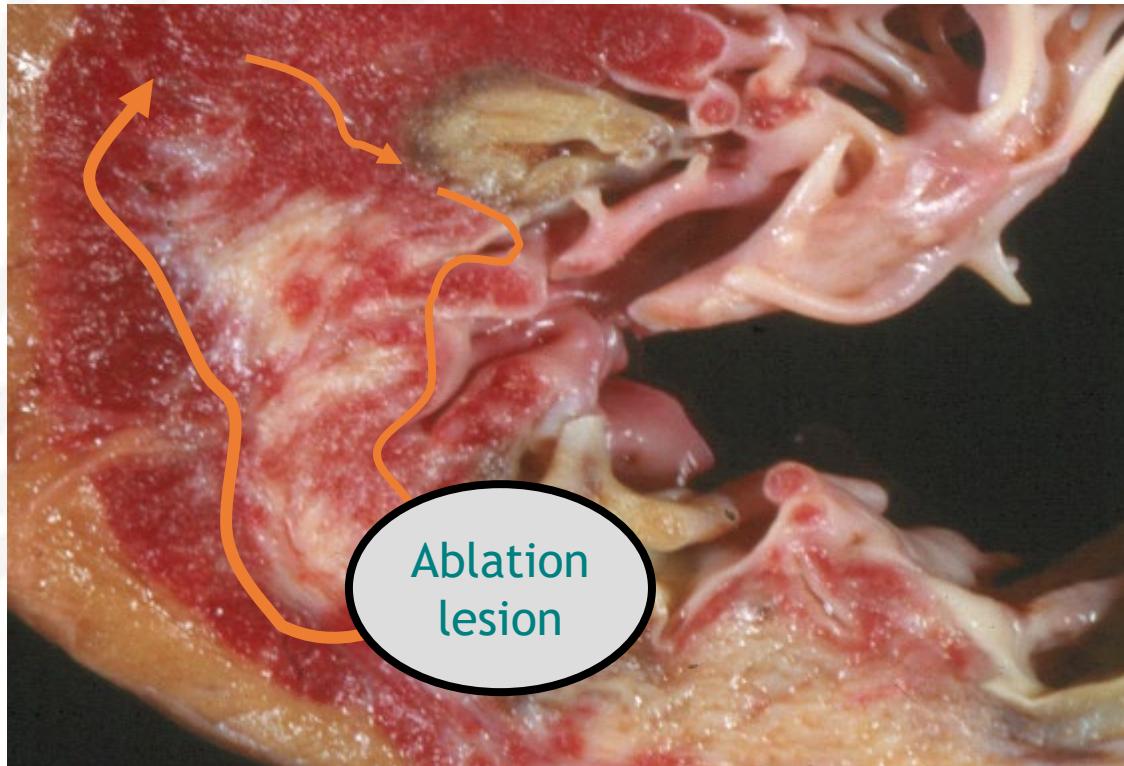


- Areas of scar are often large
- Reentry circuits can be large
- Ablation lesions are relatively small



Requires localization
of critical reentry
circuit sites

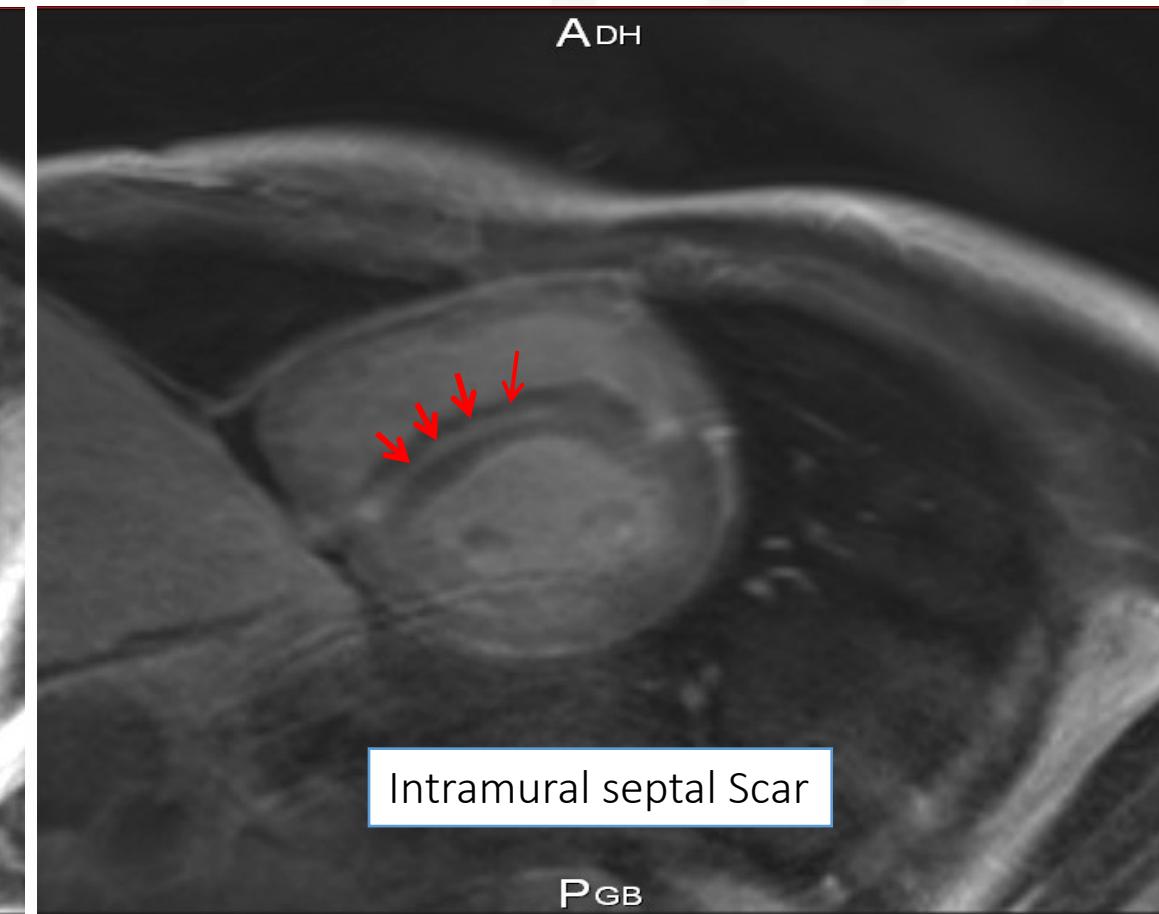
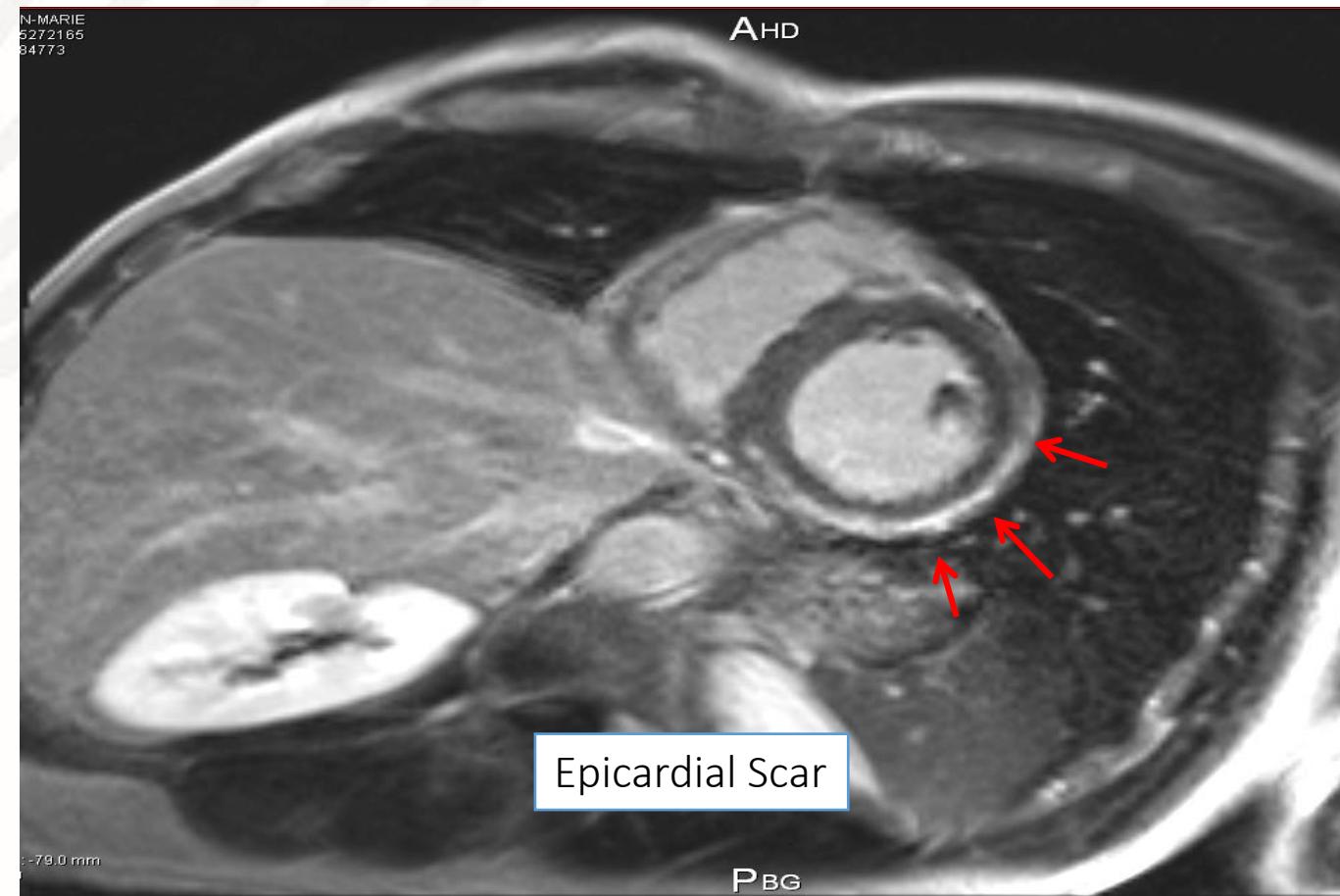
Challenges for catheter



- Multiple circuits are common
- Unstable VTs prevent extensive mapping during VT
“Unmappable VT”

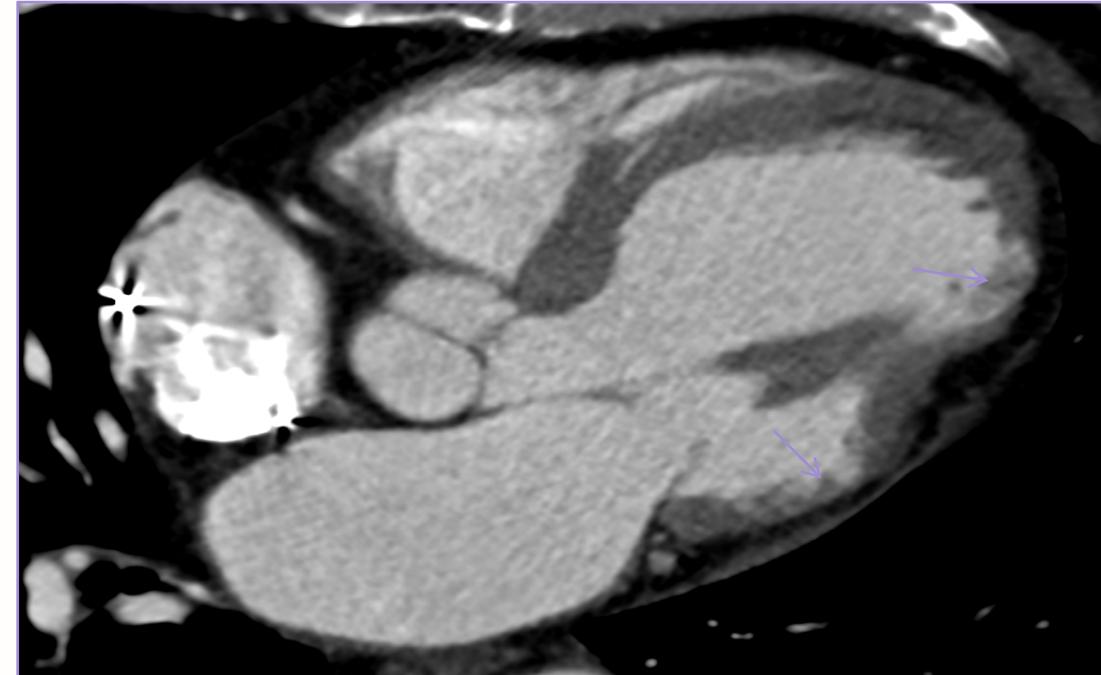
VT ABLATION: PRE-PROCEDURE

Scar location on MRI



PATIENT 1: SCAR-RELATED VT

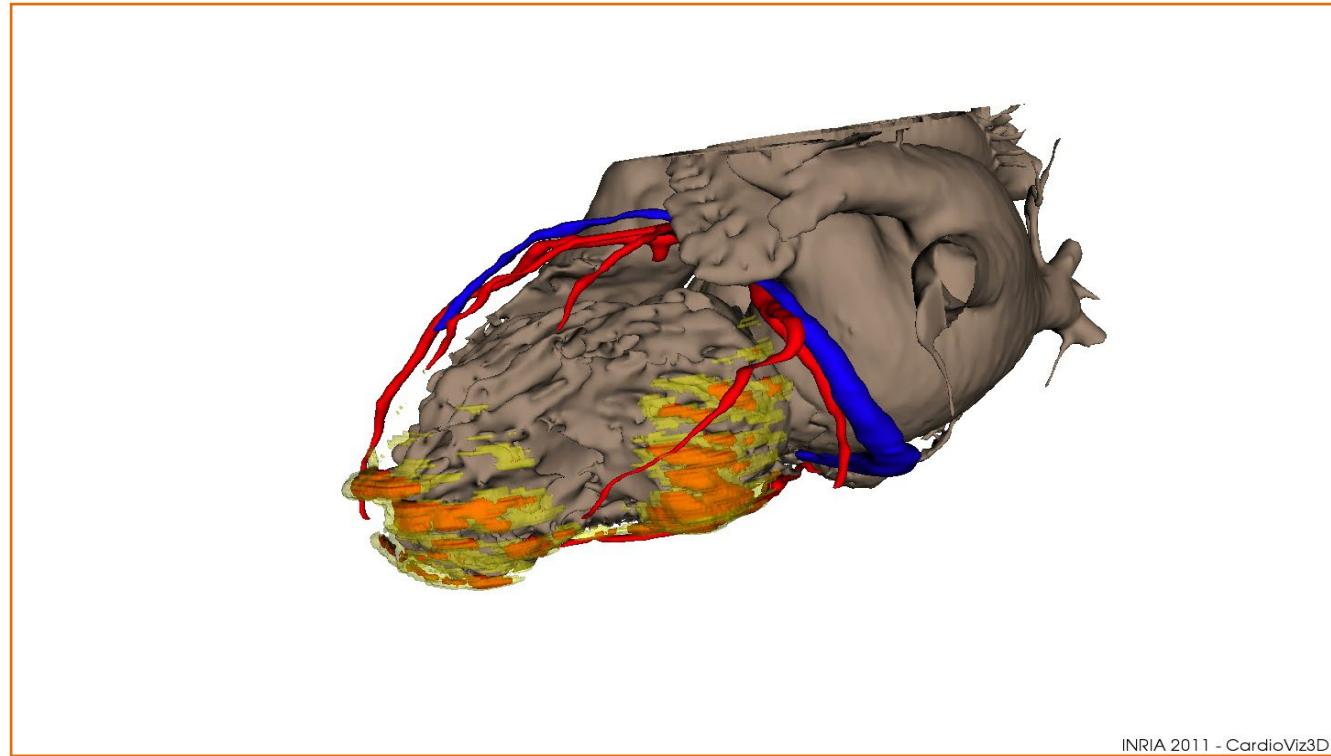
History: 70 yo man with history of non-ischemic dilated cardiomyopathy and ICD implantation. Monomorphic VT responsible for recurrent shocks.



MDCT: Enlarged LV with 2 focal areas of severe wall thinning separated by an anatomical isthmus of remote myocardium (normal thickness).

Hypothesis: LV remodeling secondary to lateral myocarditis.

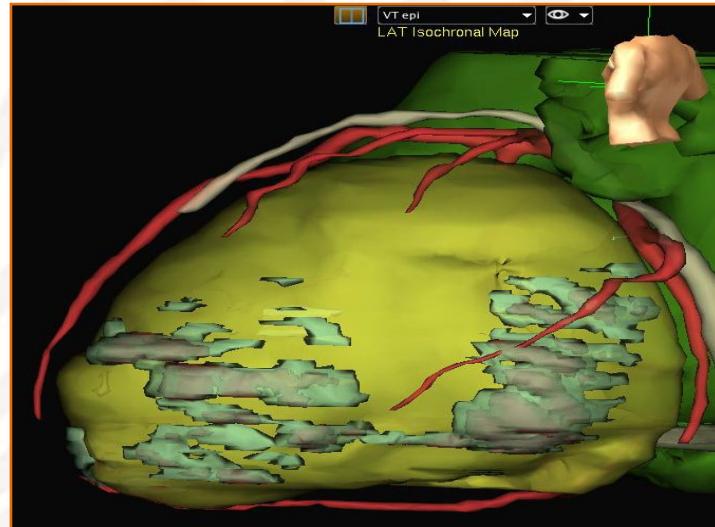
PATIENT 1: SCAR-RELATED VT



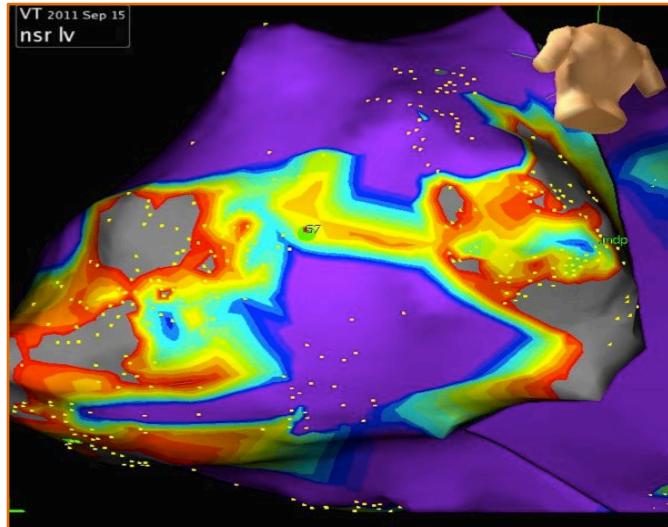
INRIA 2011 - CardioViz3D

Image post-processing: segmentation and modeling of endocardium, epicardium, coronary vessels and areas of wall thinning (substrate) for the guidance of ablation.

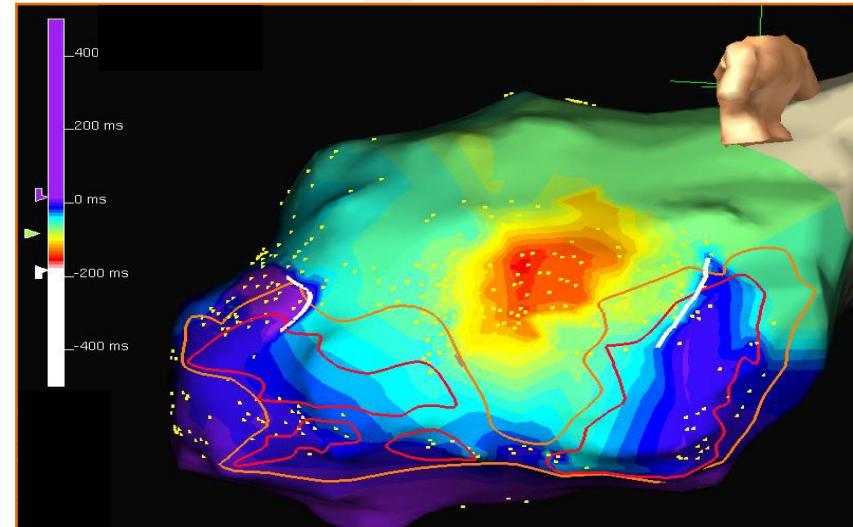
PATIENT 1: SCAR-RELATED VT



MDCT WALL THINNING

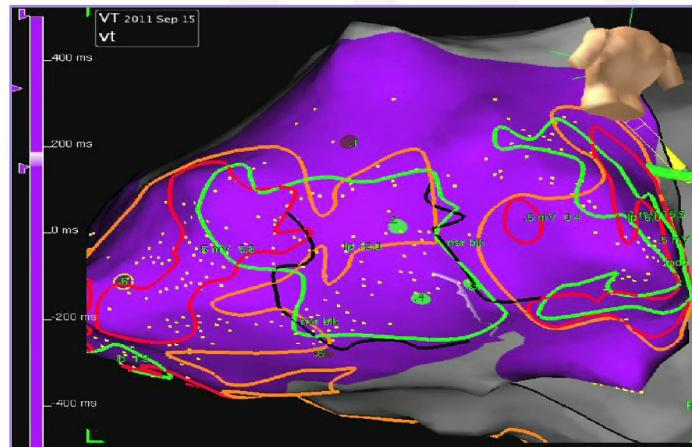


EPI SR VOLTAGE

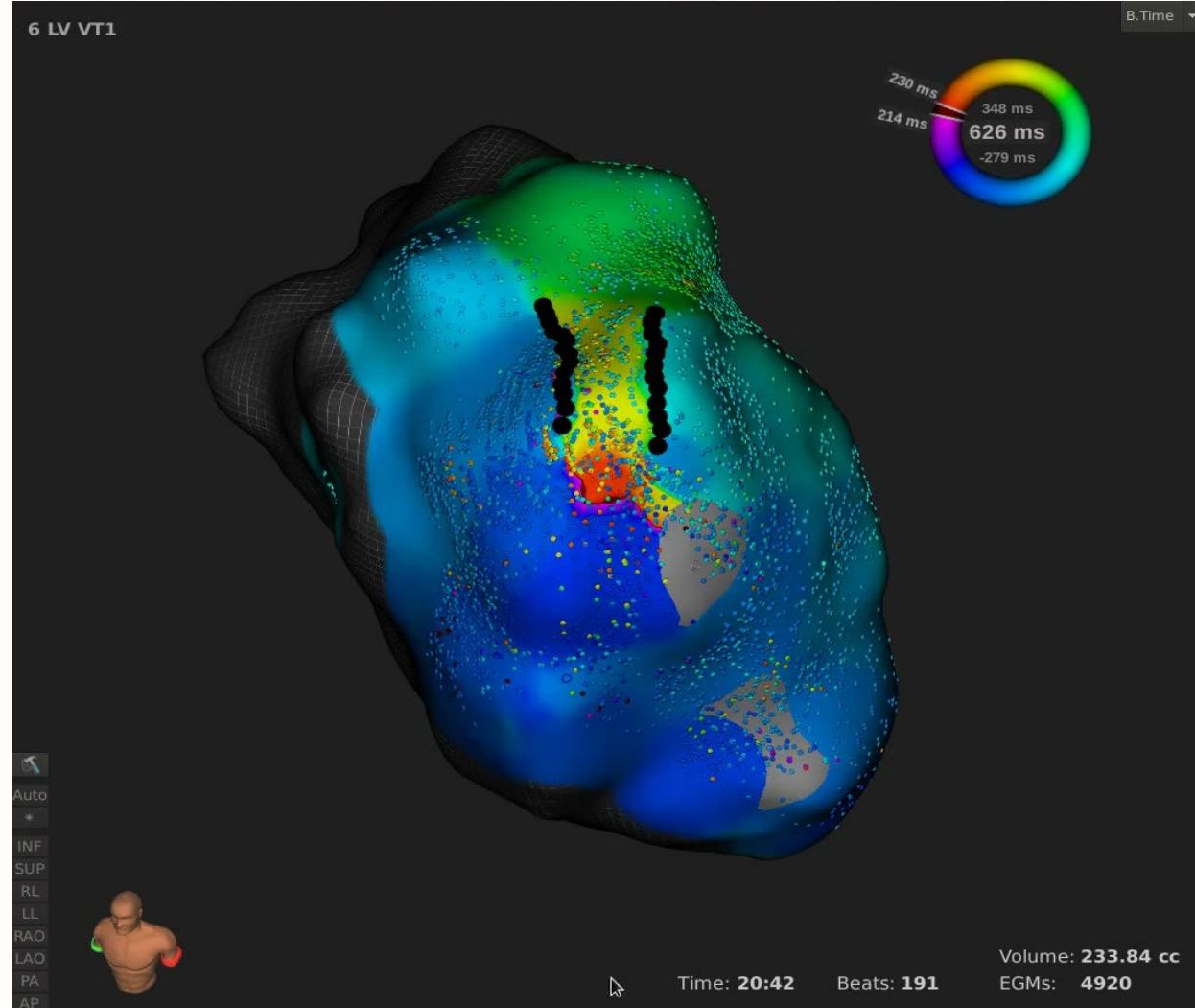


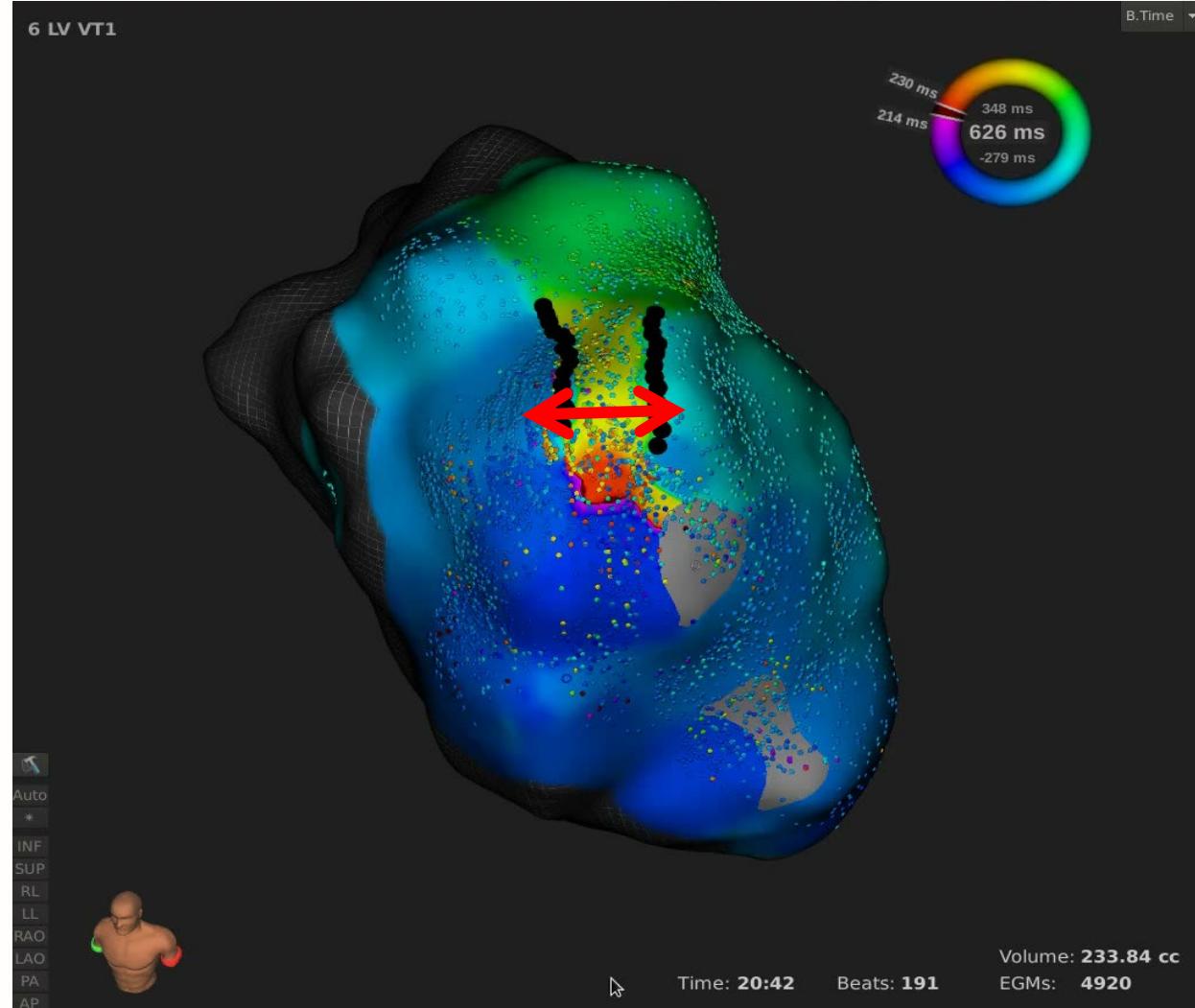
EPI VT ACTIVATION

Invasive contact mapping with image integration: Epicardial isochronal map showing a similar pattern of lateral conduction block during VT. Critical isthmus site was located in the anatomical isthmus between thinned areas (ablation at this site terminated VT)

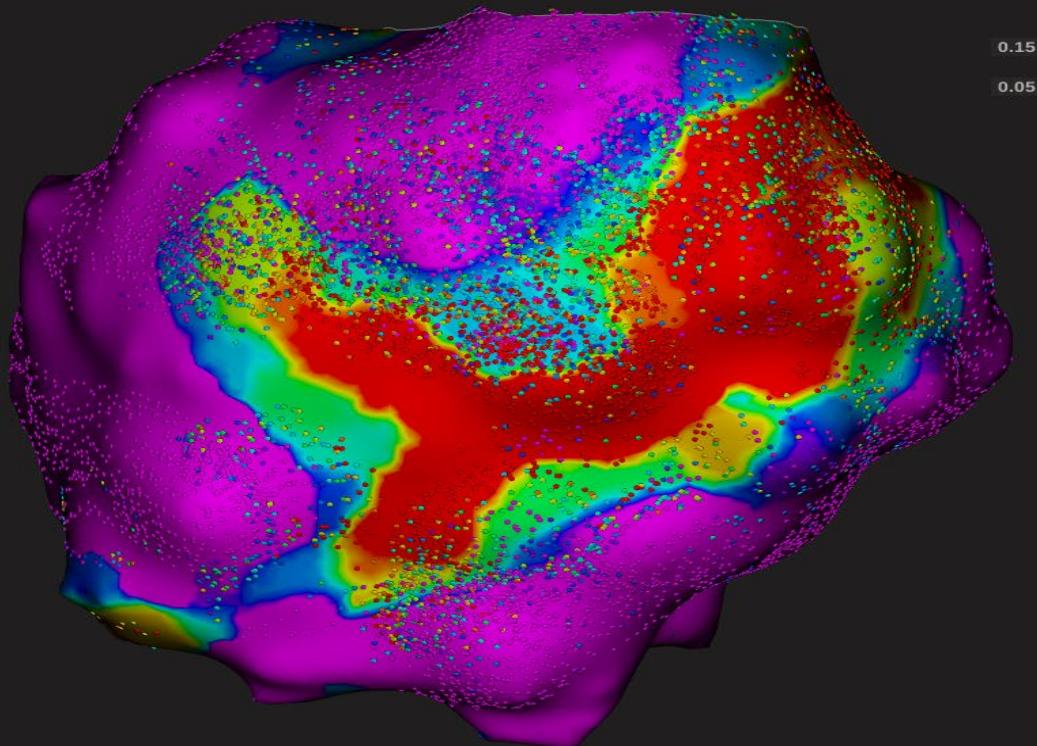


EPI VT CIRCUIT





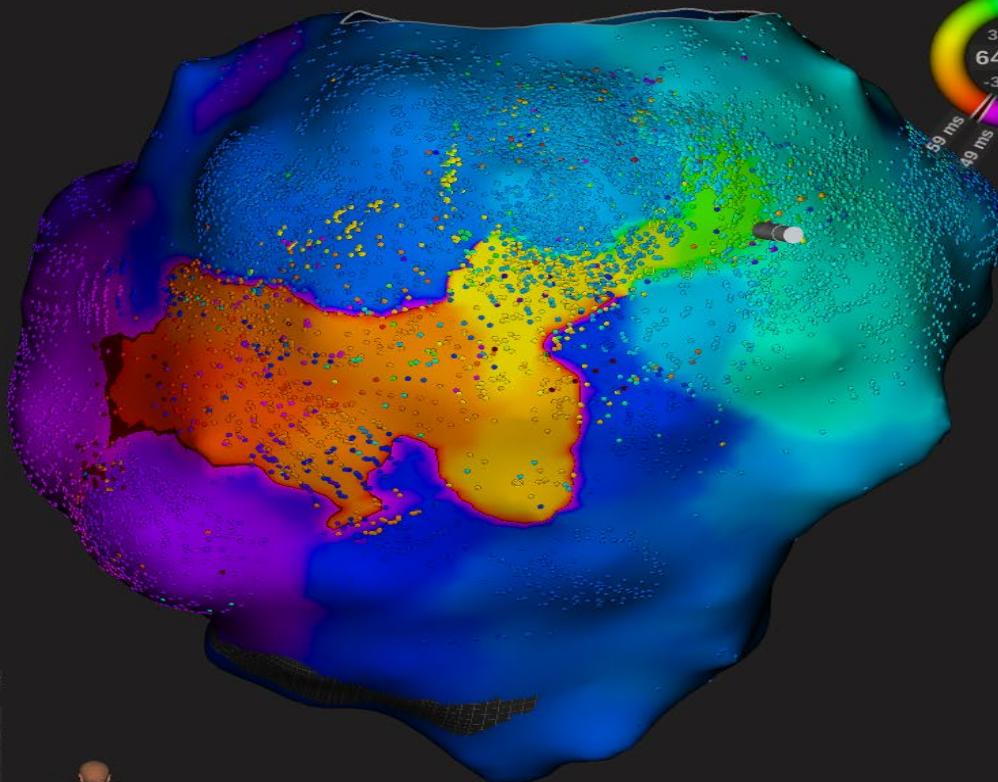
2 LV sinus ...



Volt
20 mV
0.15 mV
0.05 mV
0.01 mV

1 LV VT 6...

Study Log



322 ms
644 ms
-322 ms
59 ms
49 ms

Auto
INF
SUP
RL
LL
RAO
LAO
PA
AP



Time: 28:12 Beats: 525

Volume: 344.21 cc
EGMs: 15042

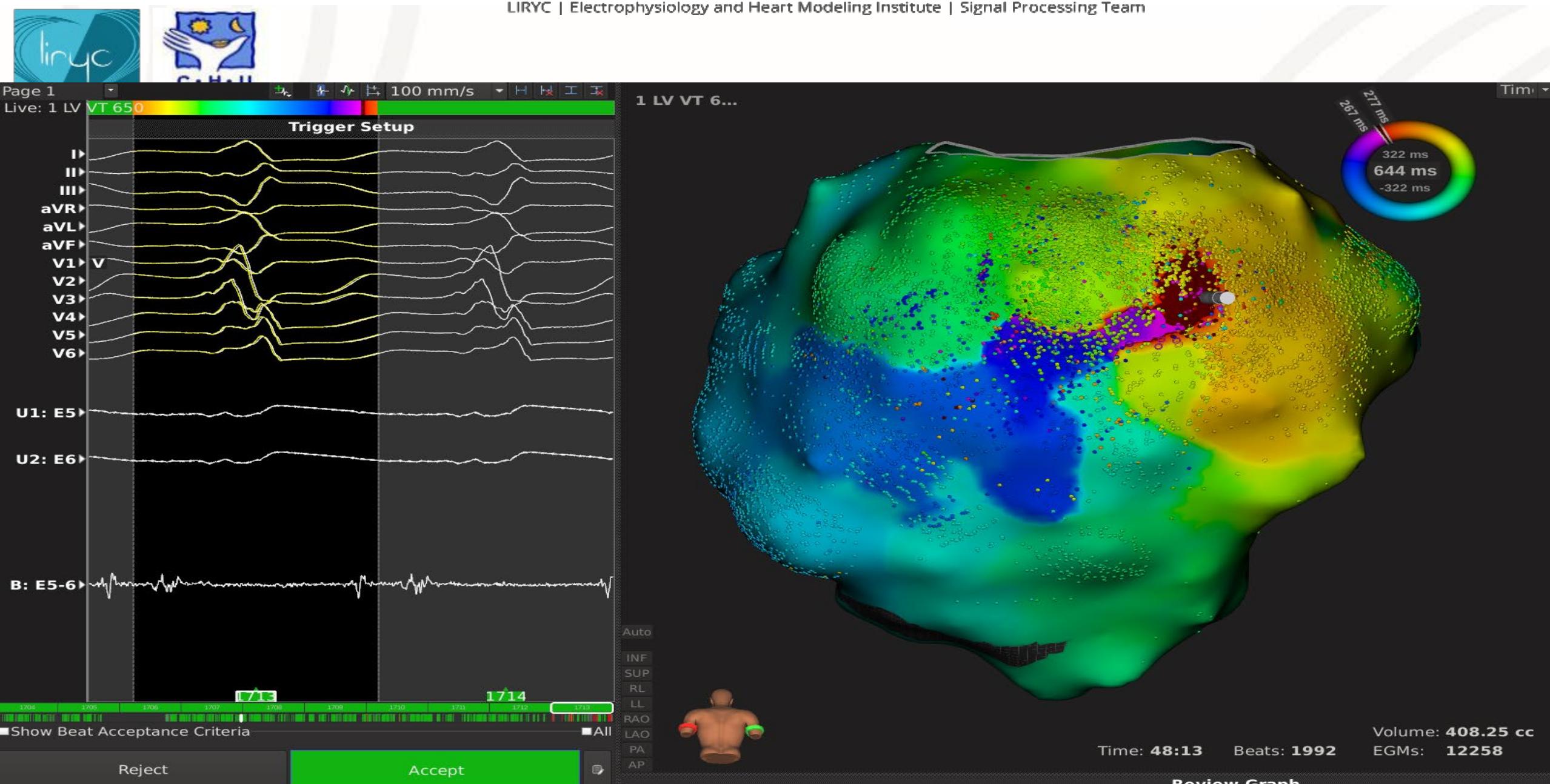
Auto
INF
SUP
RL
LL
RAO
LAO
PA
AP



Time: 48:13 Beats: 1992

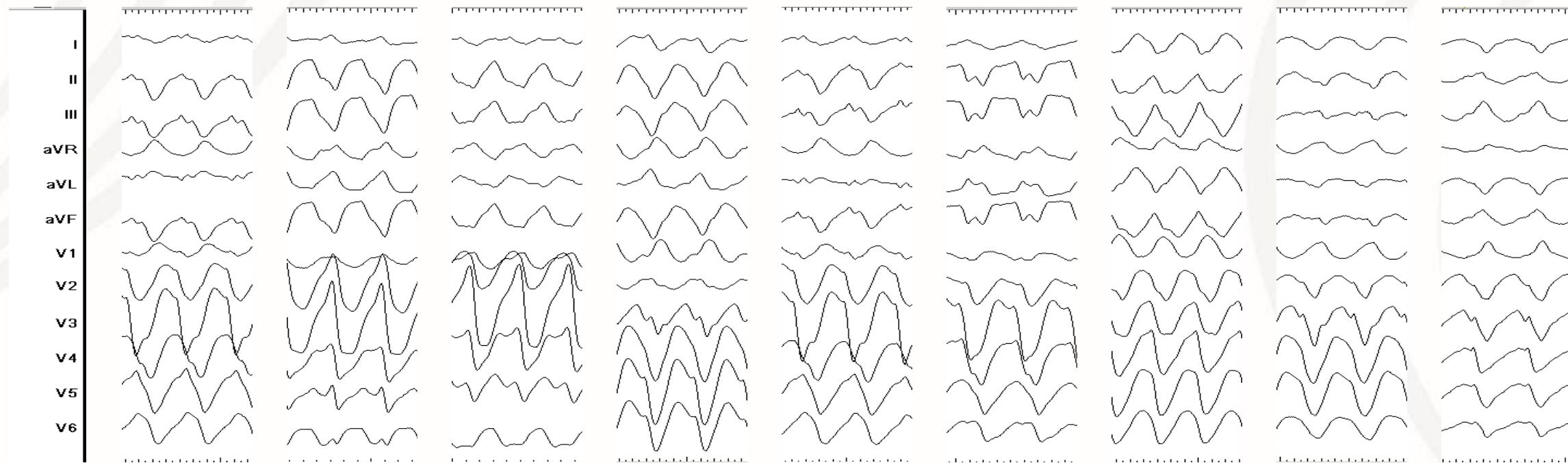
Volume: 408.25 cc
EGMs: 12258





LIMITATIONS WITH CONVENTIONAL STRATEGY

Multiple (n=9) morphologies: 3D EA mapping time consuming if performed for every morphology!



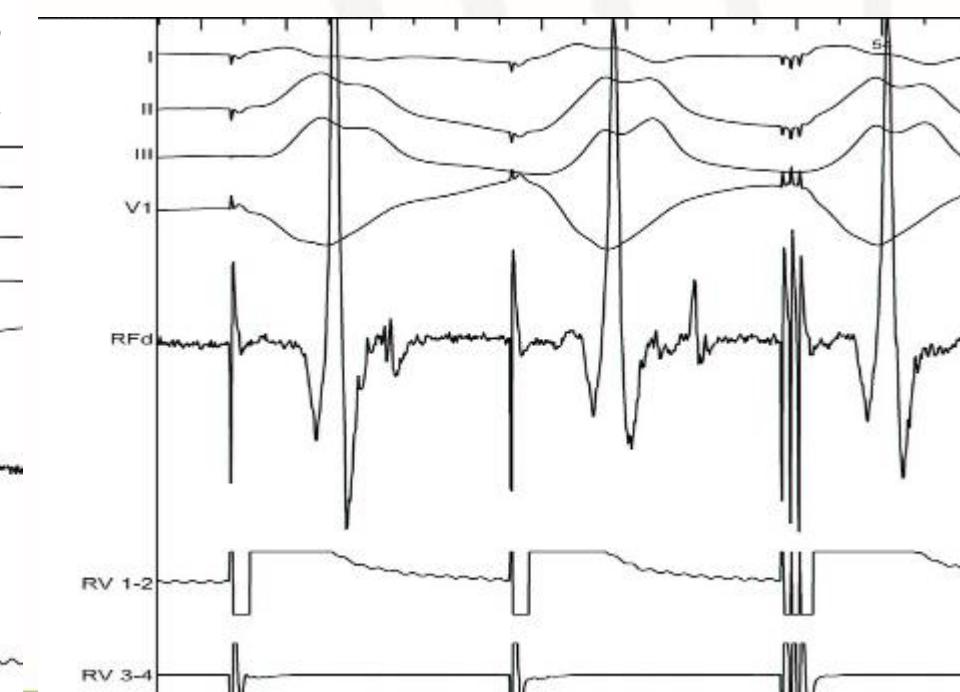
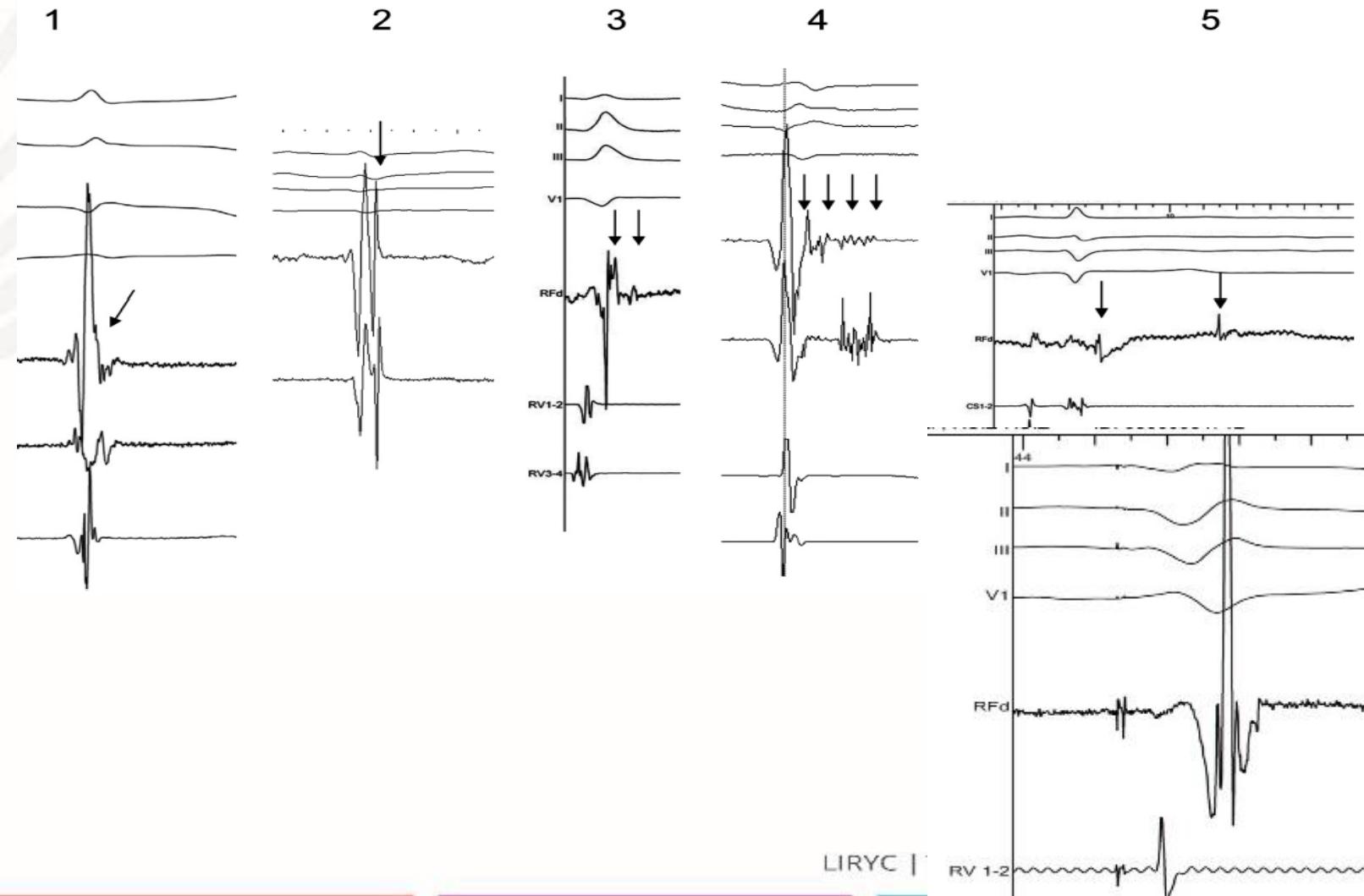
- Poorly tolerated VT
- Non inducible VT
- Limited reproducibility of inducibility
- Clinical arrhythmia

Elimination of Local Abnormal Ventricular Activities A New End Point for Substrate Modification in Patients With Scar-Related Ventricular Tachycardia

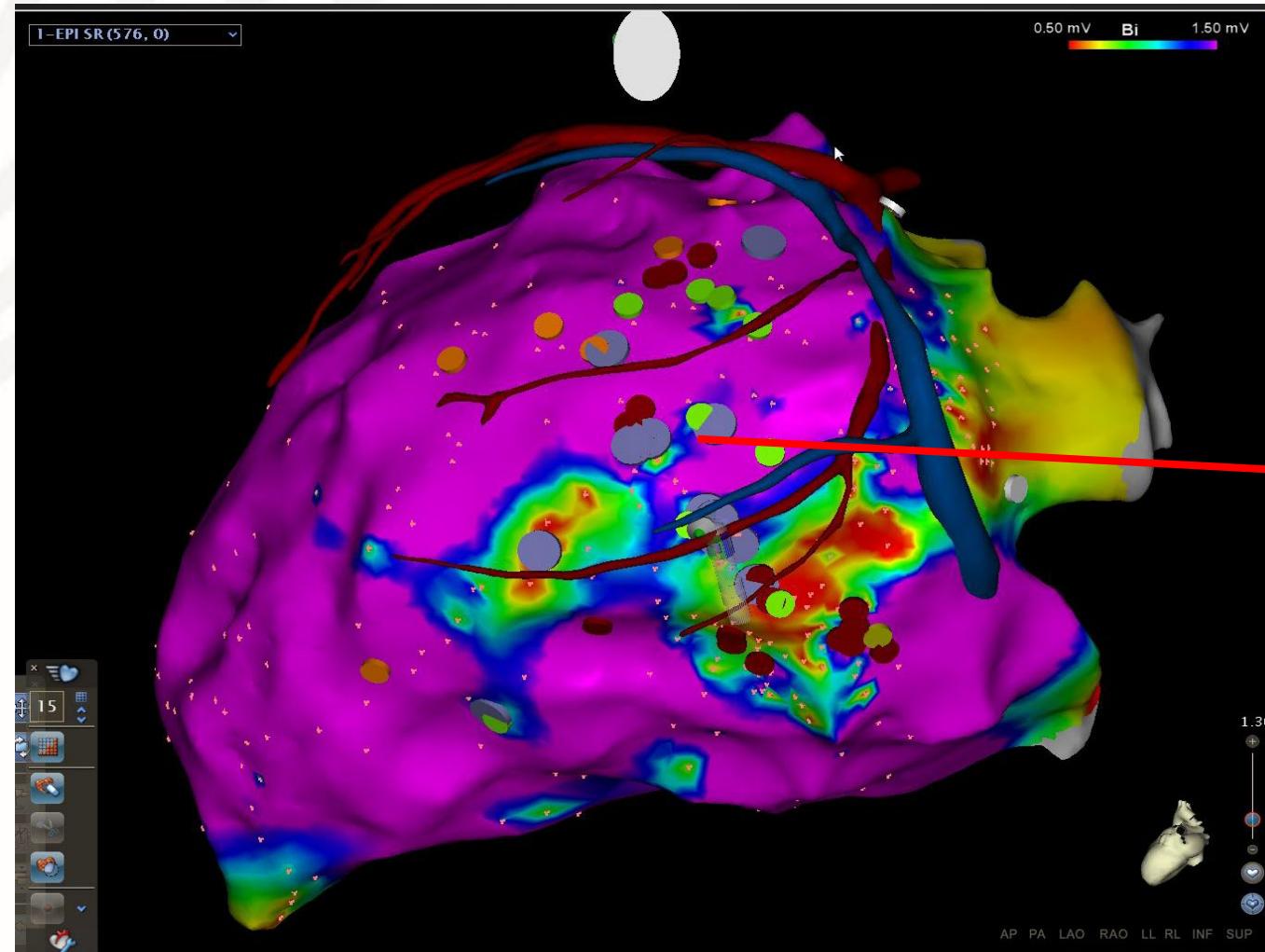
Pierre Jaïs, MD; Philippe Maury, MD; Paul Khairy, MD, PhD; Frédéric Sacher, MD;

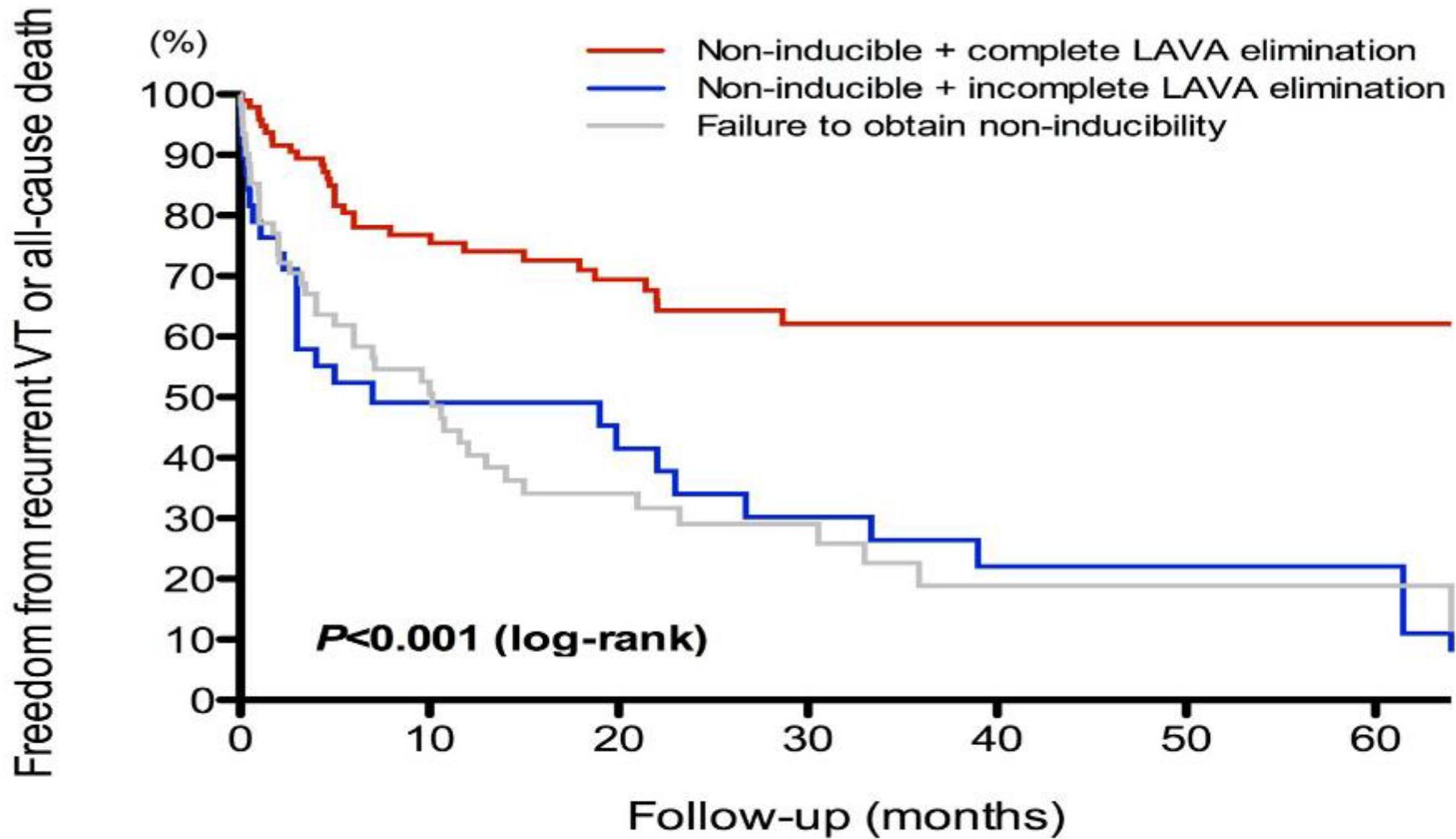
The Key Point: Poorly Coupled Signals

Circ 2012



TAGGING LAVA DURING SR MAP



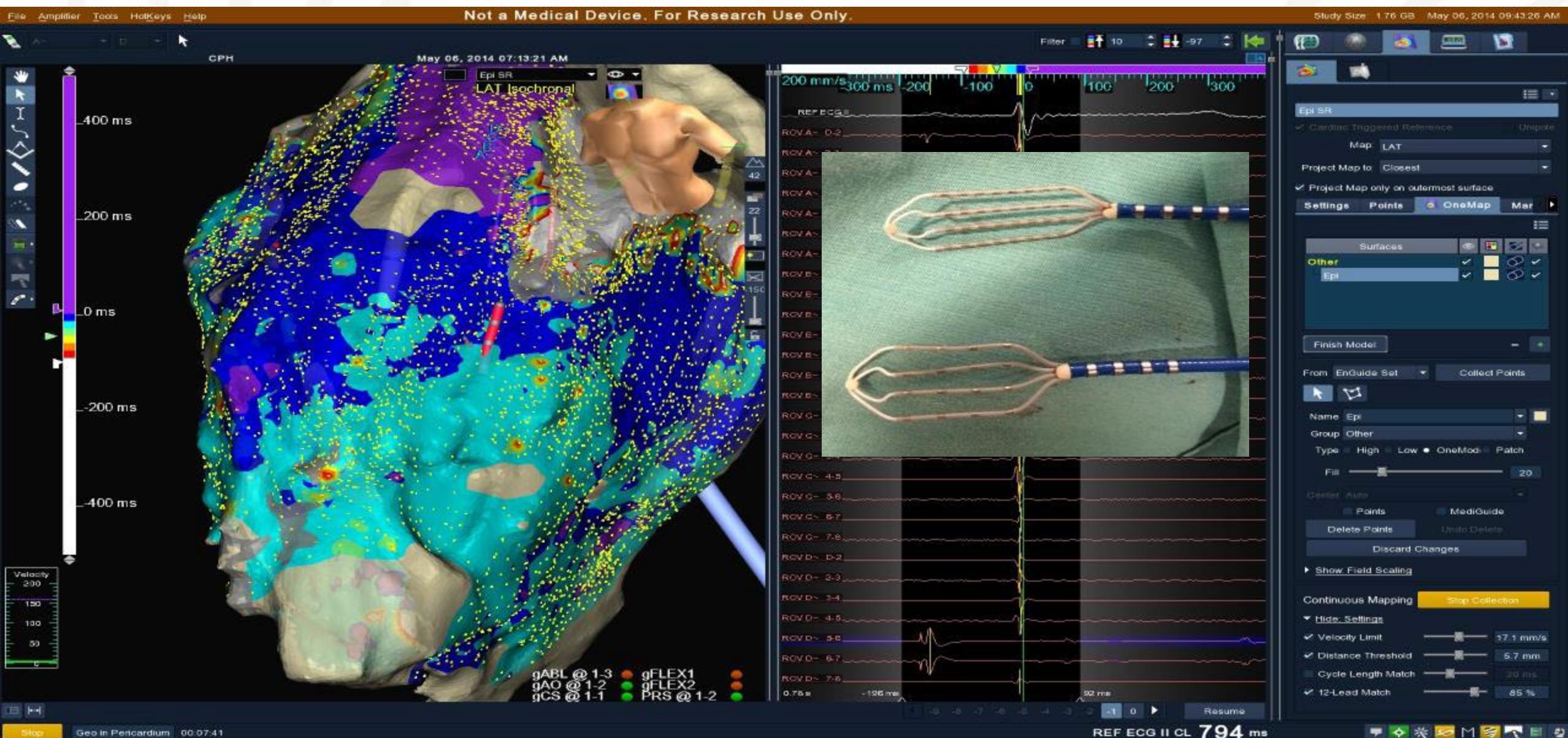
Number at risk

	0	10	20	30	40	50	60
Non-inducible + complete elimination	95	58	42	27	16	11	7
Non-inducible + incomplete elimination	38	16	12	9	6	5	2
Failure to obtain non-inducibility	61	26	15	10	5	3	3

HIGH DENSITY MAPPING

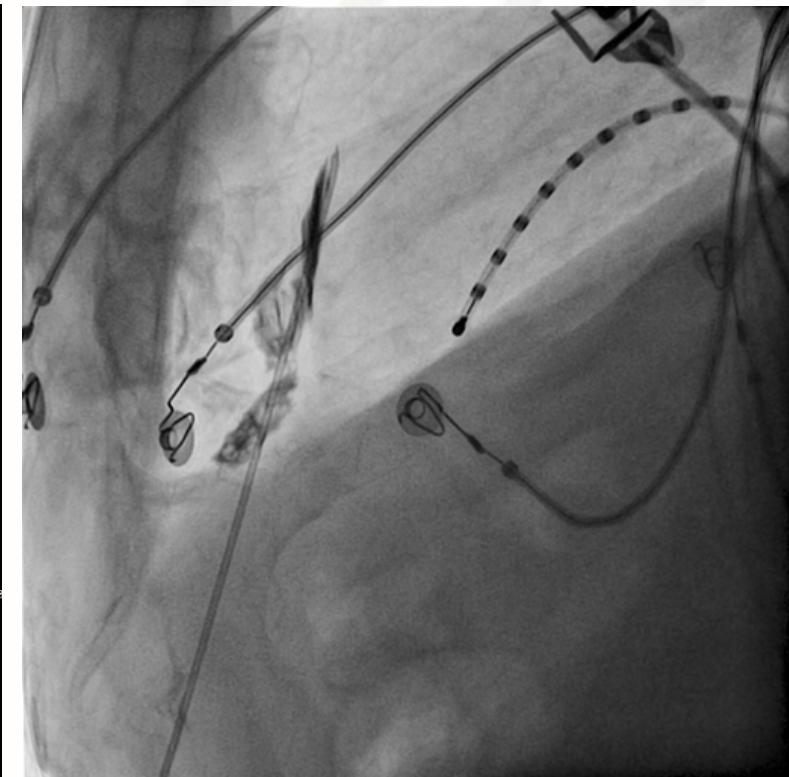
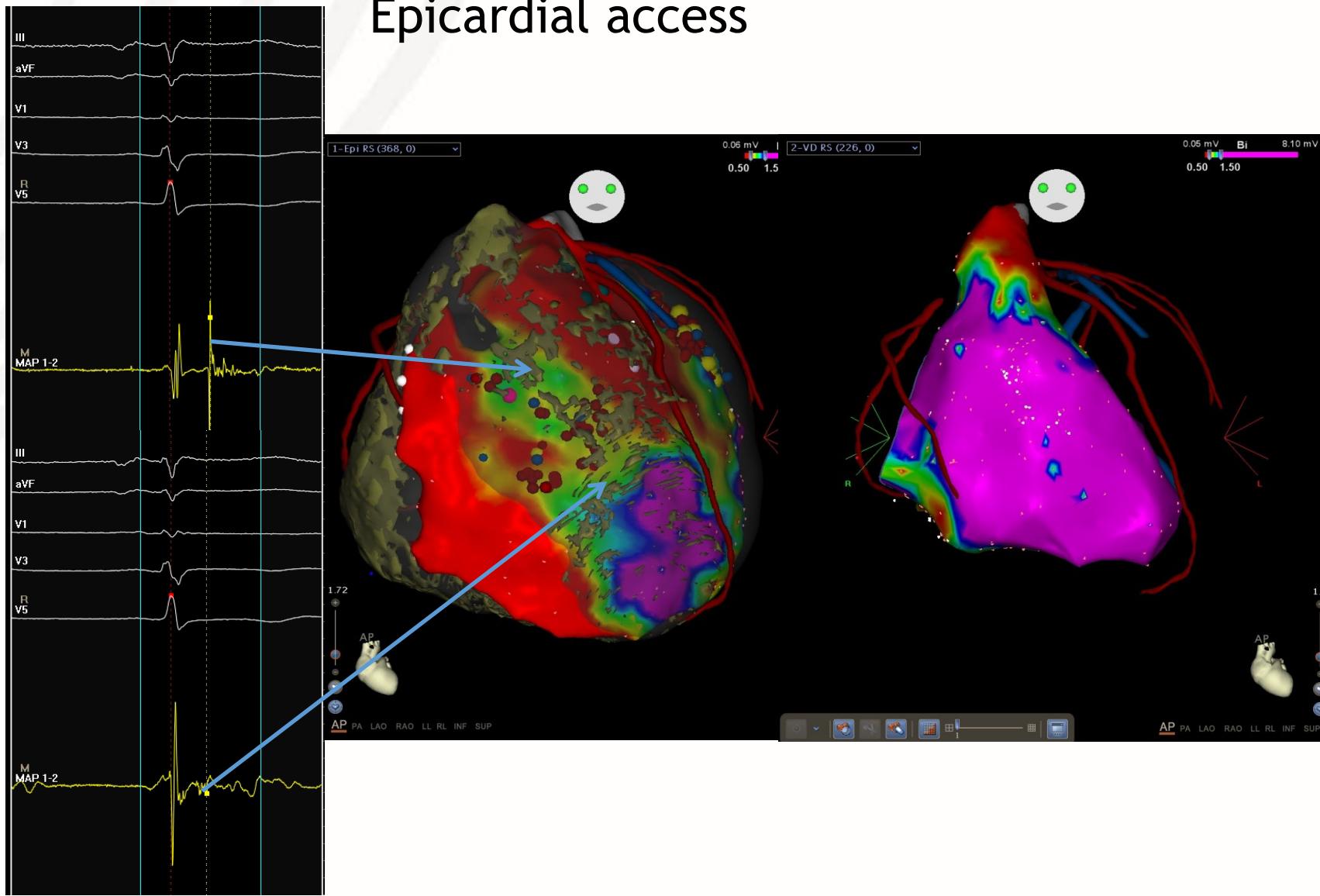
- Multipolar catheter with smaller electrodes and shorter interelectrodes distances





LIMITATIONS WITH CONVENTIONAL STRATEGY

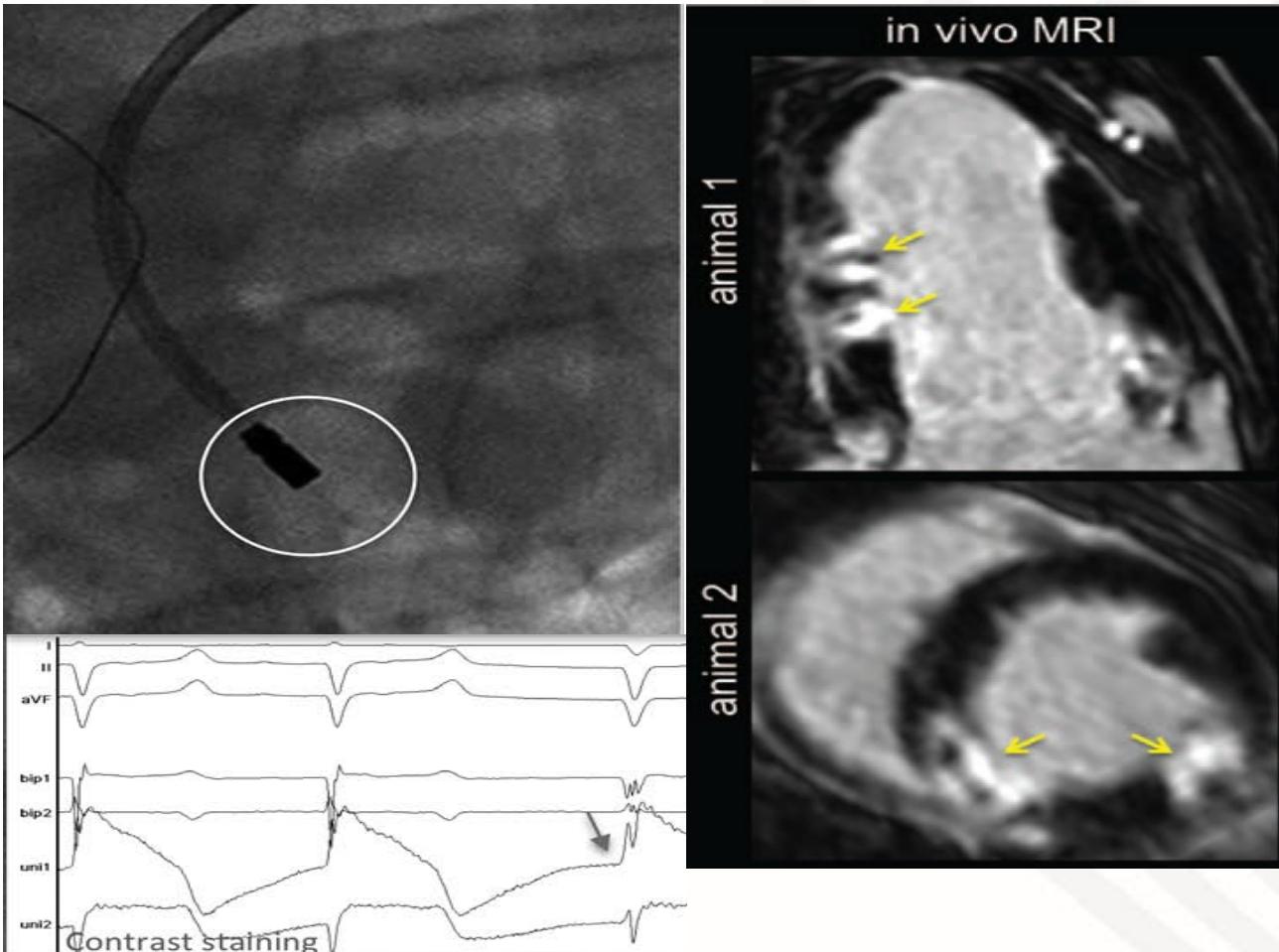
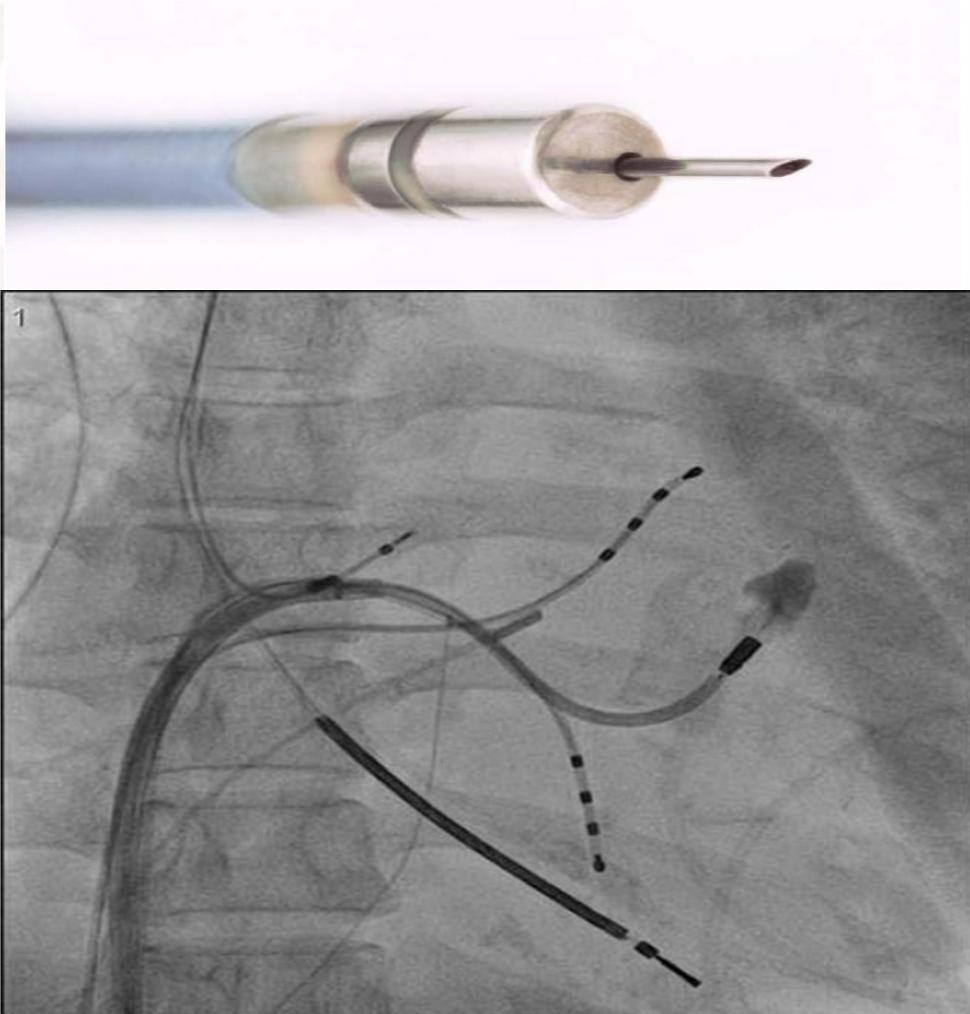
Epicardial access



LIMITATIONS WITH CONVENTIONAL STRATEGY

Increasing Lesion depth: needle catheter

A



CONCLUSIONS

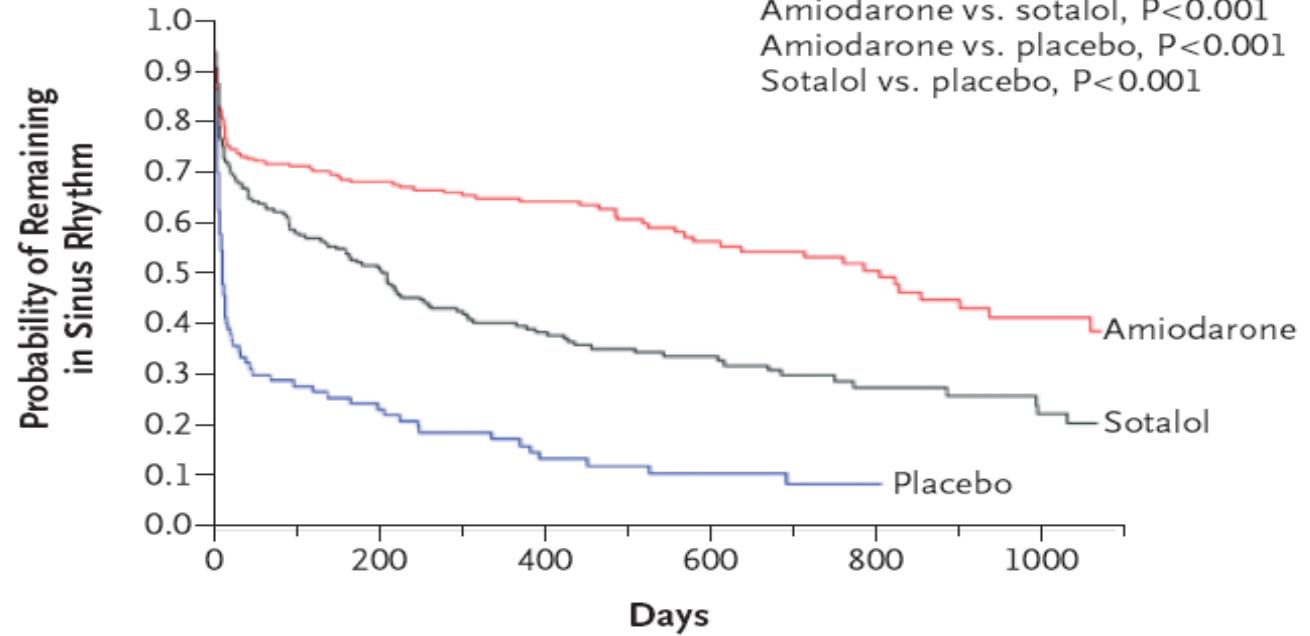
- La tachycardie ventriculaire est une complications sévère et potentiellement létale de toutes les myocardiopathies.
- La cardiopathie ischémique est la cause la plus fréquente des TV.
- L'ablation par radiofréquence est un traitement complémentaire à la mise en place du défibrillateur automatique implantable
 - DAI: prévention/traitement de la mort subite
 - Ablation: traitement de l'arythmie pour limiter l'utilisation du DAI
- Procédure souvent complexe nécessitant un environnement spécialisé, habitué à ce type de procédure.
- Progrès important techniques et stratégiques améliorent considérablement les résultats

NEJM

Amiodarone versus Sotalol for Atrial Fibrillation

Bramah N. Singh, M.D., D.Sc., Steven N. Singh, M.D., Domenic J. Reda, Ph.D.,
 X. Charlene Tang, M.D., Ph.D., Becky Lopez, R.N., Crystal L. Harris, Pharm.D.,
 Ross D. Fletcher, M.D., Satish C. Sharma, M.D., J. Edwin Atwood, M.D.,
 Alan K. Jacobson, M.D., H. Daniel Lewis, Jr., M.D., Dennis W. Raisch, Ph.D.,
 and Michael D. Ezekowitz, M.B., Ch.B., Ph.D.,
 for the Sotalol Amiodarone Atrial Fibrillation Efficacy Trial (SAFE-T) Investigators*

A All Patients

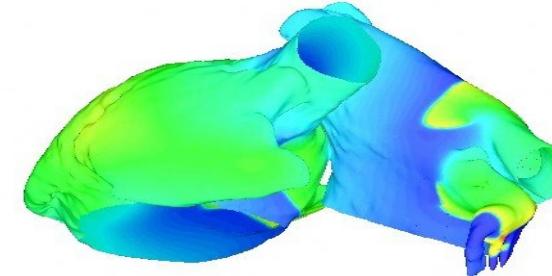
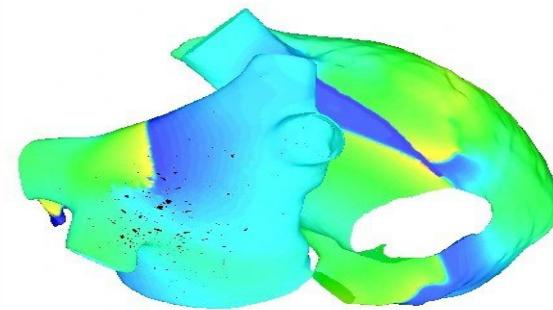
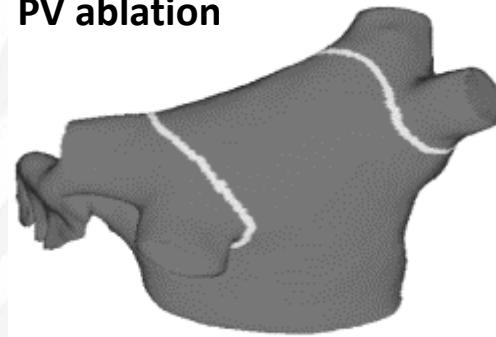


No. at Risk

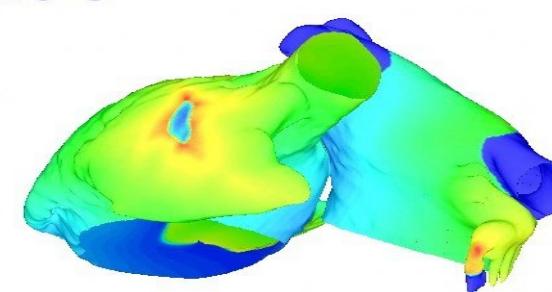
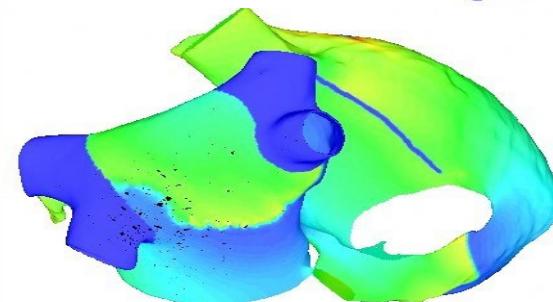
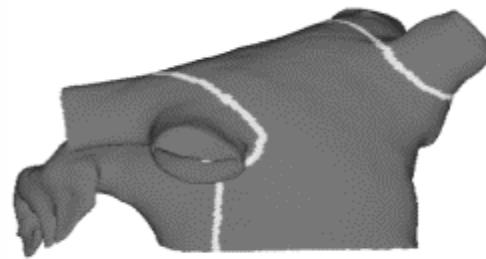
	0	120	240	360	480	600
Amiodarone	206	131	98	60	38	18
Sotalol	195	97	61	38	21	13
Placebo	90	21	11	8	5	2

ARBITRARY ABLATION STRATEGY

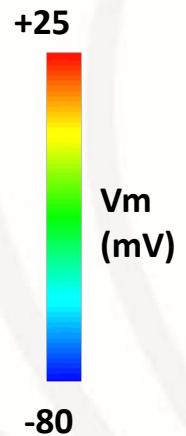
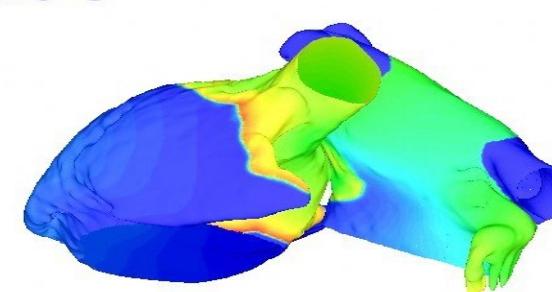
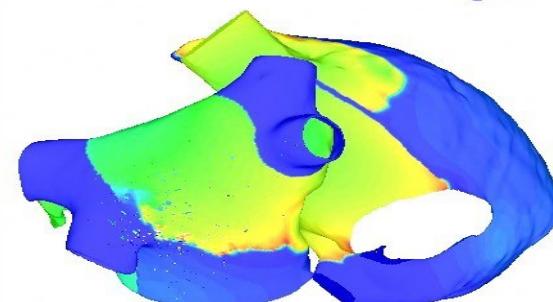
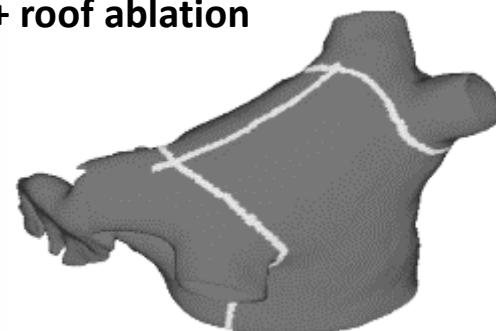
PV ablation



+ mitral ablation



+ roof ablation

 $t = 0.0 \text{ s}$ $t = 0.0 \text{ s}$ $t = 0.0 \text{ s}$