



Imagerie avant traitement des FA et TV

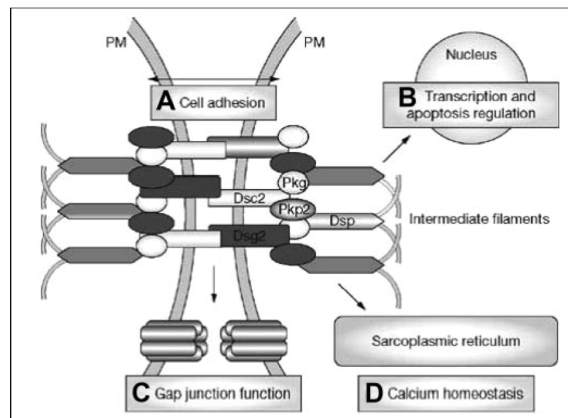
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Caza, G. Landes
Hôpital Laennec, CHU Nantes
Hôpital X. Bichat, Paris

Mort subite, centre de référence

- QT Long
- TV cathécholergiques
- Brugada
- DAVD
- MEPCC
- ...

DAVD : Anomalie du desmosome

Rôles du desmosome



- Autosomique dominant
- Récessif si Naxos et Carvajal
- 8 gènes identifiés :
 - JUP
 - PKP2
 - DSP
 - DSG2
 - DSC2
 - TGFB3
 - TMEM43.20
 - RYR2

Marcus FI, Circ 2010

Mécanisme pathologique

- Mutation génétique → altération desmosome → altération des jonctions communicantes (gap jonctions)
- → arythmies (avant perte myocytaire ou dysfonction VD)
- 3 phases :
 - **Contenue** : risque de Msubite, mais pas de dysfonction VD (durant l'effort +++)
 - **Électrique** : arythmies symptomatiques + anomalies VD (Cs pour palpitations syncopes)
 - **Tardif** : +- arythmies, ICD et/ou ICG → CMD

Fat

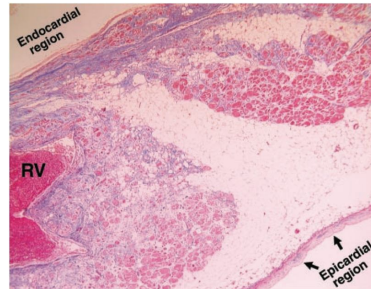
RadioGraphics

CARDIAC IMAGING 1587

Myocardial Fat at Cardiac Imaging: How Can We Differentiate Pathologic from Physiologic Fatty Infiltration?¹

TEACHING POINTS
See last page

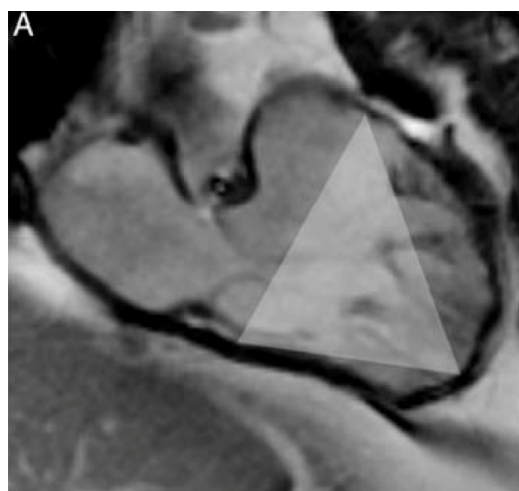
Fumiko Kimura, MD, PhD • Yuka Matsuo, MD • Takatomo Nakajima, MD
Toshio Nishikawa, MD, PhD • Shunji Katsomura, MD, PhD • Seiya Satochi,
MD • Nobuhisa Hagiwara, MD, PhD • Fumikazu Sakai, MD, PhD



- Fibro-fatty replacement: Progression from epicardium to endocardium
- Localization : Triangle of dysplasia, moderator band, RV trabeculations, septum on the right side, free wall of LV

Kimura F, Radiographics 2002

Triangle of dysplasia



Critères diagnostiques

- Task force 1994 basée sur les signes cliniques d'une cohorte de patients atteints symptomatiques ou juste avant leur décès
- signes tardifs de la maladie
- stade avancé de la maladie

Nouvelle classification 2010

Critères familiaux - génétiques

VI. Family history

Major

- Familial disease confirmed at necropsy or surgery

- ARVC/D confirmed in a first-degree relative who meets current Task Force criteria
- ARVC/D confirmed pathologically at autopsy or surgery in a first-degree relative
- Identification of a pathogenic mutation† categorized as associated or probably associated with ARVC/D in the patient under evaluation

Minor

- Family history of premature sudden death (<35 years of age) due to suspected ARVC/D
- Familial history (clinical diagnosis based on present criteria)

- History of ARVC/D in a first-degree relative in whom it is not possible or practical to determine whether the family member meets current Task Force criteria
- Premature sudden death (<35 years of age) due to suspected ARVC/D in a first-degree relative
- ARVC/D confirmed pathologically or by current Task Force Criteria in second-degree relative

Marcus FI, Circ 2010

		ECG	
		TV	
V. Arrhythmias			
Major			<ul style="list-style-type: none"> • Nonsustained or sustained ventricular tachycardia of left bundle-branch morphology with superior axis (negative or indeterminate QRS in leads II, III, and aVF and positive in lead aVL)
Minor	<ul style="list-style-type: none"> • Left bundle-branch block–type ventricular tachycardia (sustained and nonsustained) (ECG, Holter, exercise) • Frequent ventricular extrasystoles (>1000 per 24 hours) (Holter) 		<ul style="list-style-type: none"> • Nonsustained or sustained ventricular tachycardia of RV outflow configuration, left bundle-branch block morphology with inferior axis (positive QRS in leads II, III, and aVF and negative in lead aVL) or of unknown axis • >500 ventricular extrasystoles per 24 hours (Holter)
		Dépolariation, Epsilon, conduction	
IV. Depolarization/conduction abnormalities			
Major	<ul style="list-style-type: none"> • Epsilon waves or localized prolongation (>110 ms) of the QRS complex in right precordial leads (V₁ to V₃) 		<ul style="list-style-type: none"> • Epsilon wave (reproducible low-amplitude signals between end of QRS complex to onset of the T wave) in the right precordial leads (V₁ to V₃)
Minor	<ul style="list-style-type: none"> • Late potentials (SAECG) 		<ul style="list-style-type: none"> • Late potentials by SAECG in ≥1 of 3 parameters in the absence of a QRS duration of ≥110 ms on the standard ECG • Filtered QRS duration (fQRS) ≥114 ms • Duration of terminal QRS <40 μV (low-amplitude signal duration) ≥38 ms • Root-mean-square voltage of terminal 40 ms ≤20 μV • Terminal activation duration of QRS ≥55 ms measured from the nadir of the S wave to the end of the QRS, including R', in V₁, V₂, or V₃, in the absence of complete right bundle-branch block

		Repolarisation	
		Ondes T	
III. Repolarization abnormalities			
Major			<ul style="list-style-type: none"> • Inverted T waves in right precordial leads (V₁, V₂, and V₃) or beyond in individuals >14 years of age (in the absence of complete right bundle-branch block QRS ≥120 ms)
Minor	<ul style="list-style-type: none"> • Inverted T waves in right precordial leads (V₂ and V₃) (people age >12 years, in absence of right bundle-branch block) 		<ul style="list-style-type: none"> • Inverted T waves in leads V₁ and V₂ in individuals >14 years of age (in the absence of complete right bundle-branch block) or in V₄, V₅, or V₆ • Inverted T waves in leads V₁, V₂, V₃, and V₄ in individuals >14 years of age in the presence of complete right bundle-branch block
		Biopsie	
II. Tissue characterization of wall			
Major	<ul style="list-style-type: none"> • Fibrofatty replacement of myocardium on endomyocardial biopsy 		<ul style="list-style-type: none"> • Residual myocytes <60% by morphometric analysis (or <50% if estimated), with fibrous replacement of the RV free wall myocardium in ≥1 sample, with or without fatty replacement of tissue on endomyocardial biopsy
Minor			<ul style="list-style-type: none"> • Residual myocytes 60% to 75% by morphometric analysis (or 50% to 65% if estimated), with fibrous replacement of the RV free wall myocardium in ≥1 sample, with or without fatty replacement of tissue on endomyocardial biopsy

I. Global or regional dysfunction and structural alterations*		Morphologie imagerie
Major	<ul style="list-style-type: none"> Severe dilatation and reduction of RV ejection fraction with no (or only mild) LV impairment Localized RV aneurysms (akinetic or dyskinetic areas with diastolic bulging) Severe segmental dilatation of the RV 	<p>By 2D echo:</p> <ul style="list-style-type: none"> Regional RV akinesia, dyskinesia, or aneurysm and 1 of the following (end diastole): <ul style="list-style-type: none"> PLAX RVOT ≥ 32 mm (corrected for body size [PLAX/BSA] ≥ 19 mm/m²) PSAX RVOT ≥ 36 mm (corrected for body size [PSAX/BSA] ≥ 21 mm/m²) or fractional area change $\leq 33\%$ <p>By MRI:</p> <ul style="list-style-type: none"> Regional RV akinesia or dyskinesia or dyssynchronous RV contraction and 1 of the following: <ul style="list-style-type: none"> Ratio of RV end-diastolic volume to BSA ≥ 110 mL/m² (male) or ≥ 100 mL/m² (female) or RV ejection fraction $\leq 40\%$ <p>By RV angiography:</p> <ul style="list-style-type: none"> Regional RV akinesia, dyskinesia, or aneurysm
Minor	<ul style="list-style-type: none"> Mild global RV dilatation and/or ejection fraction reduction with normal LV Mild segmental dilatation of the RV Regional RV hypokinesia 	<p>By 2D echo:</p> <ul style="list-style-type: none"> Regional RV akinesia or dyskinesia and 1 of the following (end diastole): <ul style="list-style-type: none"> PLAX RVOT ≥ 29 to < 32 mm (corrected for body size [PLAX/BSA] ≥ 16 to < 19 mm/m²) PSAX RVOT ≥ 32 to < 36 mm (corrected for body size [PSAX/BSA] ≥ 18 to < 21 mm/m²) or fractional area change $> 33\%$ to $\leq 40\%$ <p>By MRI:</p> <ul style="list-style-type: none"> Regional RV akinesia or dyskinesia or dyssynchronous RV contraction and 1 of the following: <ul style="list-style-type: none"> Ratio of RV end-diastolic volume to BSA ≥ 100 to < 110 mL/m² (male) or ≥ 90 to < 100 mL/m² (female) or RV ejection fraction $> 40\%$ to $\leq 45\%$

Diagnostic positif DVDA : classification 2010

Diagnostic + si	Majeur	Mineur
	2 ou +	0
	1	2 ou +
	0	4 ou +

Borderline si	Majeur	Mineur
	1	1
	0	3

Possible si	Majeur	Mineur
	1	0
	0	2

→ Rôle important de l'imagerie qui peut apporter un des deux critères M requis

Méthode

- Comparaison de :
 - 108 probands
 - 462 patients sains
- Inclusion si diagnostic récent de DVDA
- Exclusion si la méthode d'imagerie étudiée était cruciale au diagnostic de DVDA
 - 44 probands retenus
- Objectif
 - Spécificité > 95% (courbe ROC)

Marcus FI, Circ 2010

Résultats de l'IRM

- Pour une spécificité > 95%
- Sensibilité variant entre :
 - 79% to 89% pour les critères majeurs
 - 68% to 78% pour les critères mineurs
- Pris seuls, les critères aboutissent à une sensibilité < 50%

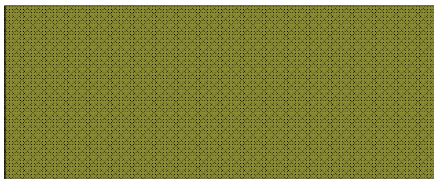
Marcus FI, Circ 2010

Proposal for modification ARVD diagnostic criteria

Major criteria

By MRI:

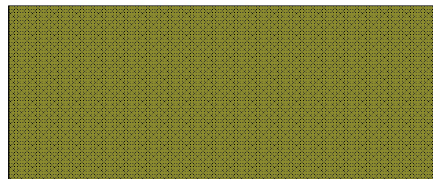
- Regional RV akinesia or dyskinesia or dyssynchronous RV contraction



Minor criteria

By MRI:

- Regional RV akinesia or dyskinesia or dyssynchronous RV contraction



Markus FI, Eur H J, 2010

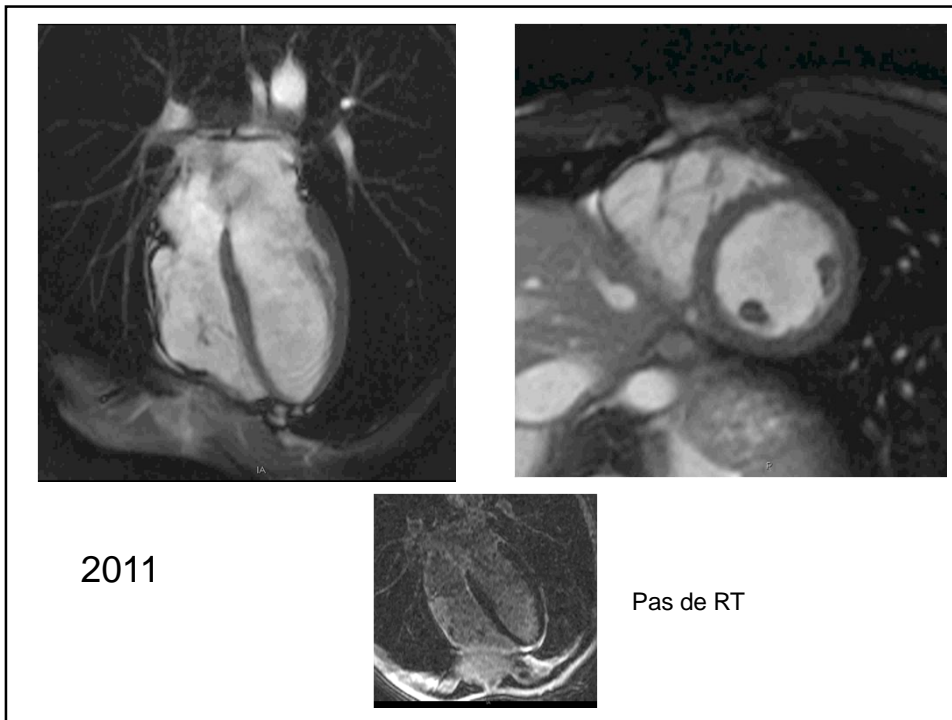
Mr C...

Homme 35 ans

2011 : douleur thoracique, avec petite élévation de la troponine et palpitations. Contexte rhinite, CRP22. Coro Nle.

IRM → myocardite sans séquelle

2013 : Apparition de 5 épisodes de palpitations récentes avec retard G axe G réduits par choc électrique externe → suspicion de DVDA

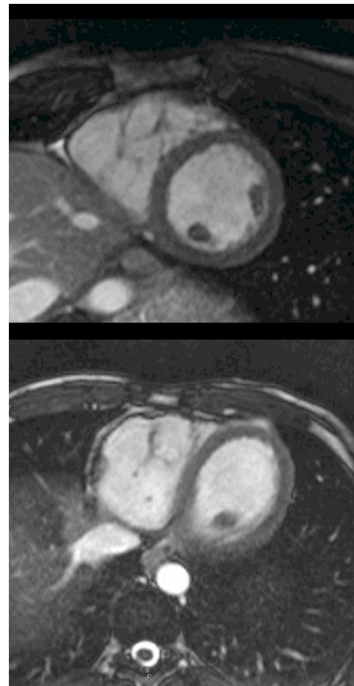


	2011
Volume VD TD	93ml/m ²
FEVD	50%
Volume VG TD	92ml/m ²
FEVG	67%



2013

Pas de RT sur le myocarde



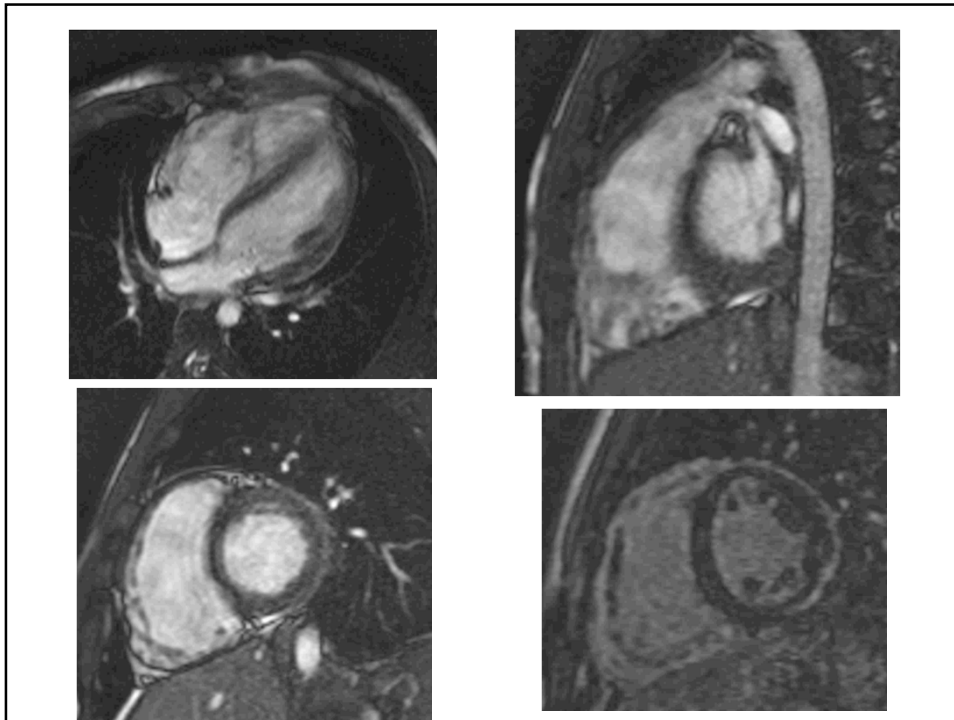
	2011	2013
Volume VD TD	93ml/m ²	111ml/m ²
FEVD	50%	41%
Volume VG TD	92ml/m ²	84ml/m ²
FEVG	67%	64%

Compte rendu final

- Critère majeur en IRM pour le diagnostic de DAVD
 - Hypokinésie – akinésie paroi latérale VD
 - Volume VD TD > 110ml/m²
- Evolutivité :
 - Augmentation du Volume VD TD en 2 ans
 - Diminution de la fonction VD en 2 ans

Mr N.

- 16 ans
- Sportif
- Palpitation
- Echographie → dilatation du VD
- IRM :
 - FEVD, 21%, FEVG : 51%
 - Volume TD VD : 110ml/m², VG : 70ml/m²



Compte rendu final

- Critère majeur en IRM pour le diagnostic de DAVD
 - Hypokinésie – akinésie paroi latérale VD
 - Volume VD TD > 110ml/m²
 - FEVD < 40%
- Atteinte concomitante du VG (R tardif)
 - FEVG : 51%

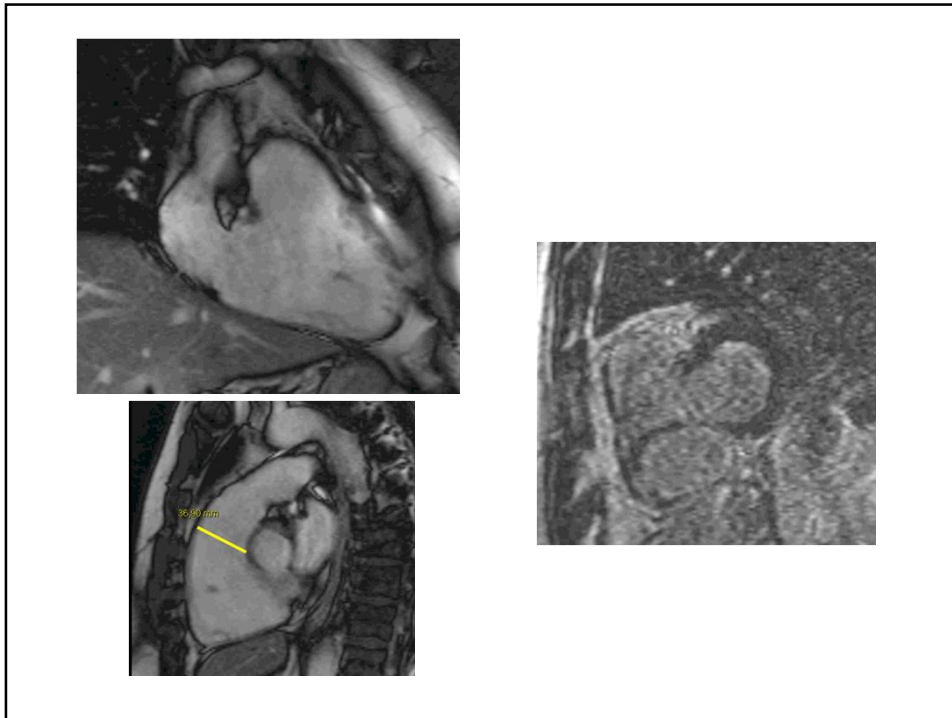
DAVD et sarcoidose

- Philips et al, Circ AE 2014
 - Registre JHU, 1140 patients → 15 patients diagnostiqués DVDA
→ sarcoidose pdt suivi
 - Pour les différencier (hors CT) :

	Sarcoidose : 15	DVDA probands : 42
Age	23	45
Flutter, FA	0	33%
Insuf Card (NYHA 2-4)	0	33%
Histoire familiale DAVD	40%	0%
Histoire familiale M subite	19%	0%
BAV	0	67%
PR interval	159	211
QRS interval	89	132
FE VG <50%	7%	53%
Graisse intra-myocardique	67%	8%

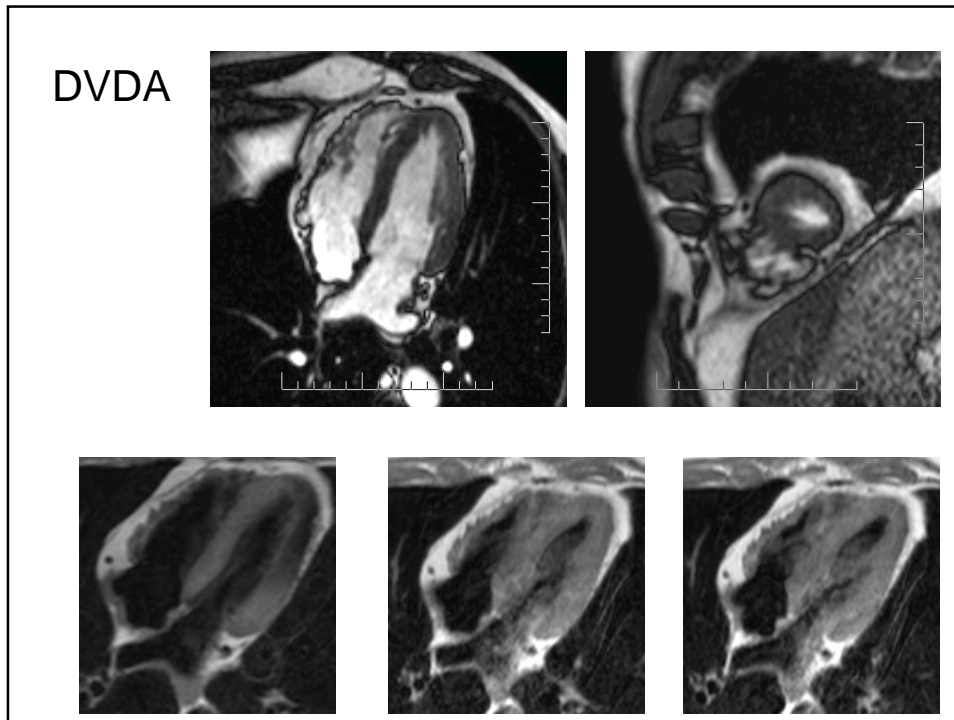
Mr. J

- Homme 59 ans
- Exploration d'une syncope avec triplets ventriculaires et morphologie évoquant une origine infundibulaire.
- → fibrose myocardique ? DAVD ?
- FEVG : 55%, VTD-VG : 90ml/m²
- FEVD : 43%, VTD-VD : 90ml/m²
- Diamètre TD Chambre de chasse VD : 37mm



Compte rendu final

- Absence de critère majeur en IRM pour le diagnostic de DAVD
 - Volume VD TD < 100ml/m²
 - FEVD > 45%
- Mais,
 - dilatation inhabituelle de la Ch Ch du VD mesurée à 37mm
 - RT sur le VG paroi inférieure transmural.



FA

Cibler la gâchette dans la FA focale

The diagram illustrates the anatomical layout of the heart's atria. The Right Atrium is on the left, and the Left Atrium is on the right. Key structures labeled include the Superior vena cava, Inferior vena cava, Septum, Fossa ovalis, and Coronary sinus. The Pulmonary Veins are shown entering the Left Atrium, with four specific veins labeled with numbers: 17, 31, 6, and 11. To the left of the diagram, ECG traces are shown for leads I, II, III, V1, and two pairs of Pulmonary vein recordings (1-2 and 3-4). A vertical dashed line in the top ECG trace indicates the 'Source' of the signal. Arrows in the Pulmonary vein recordings point to specific P waves labeled 'A'.

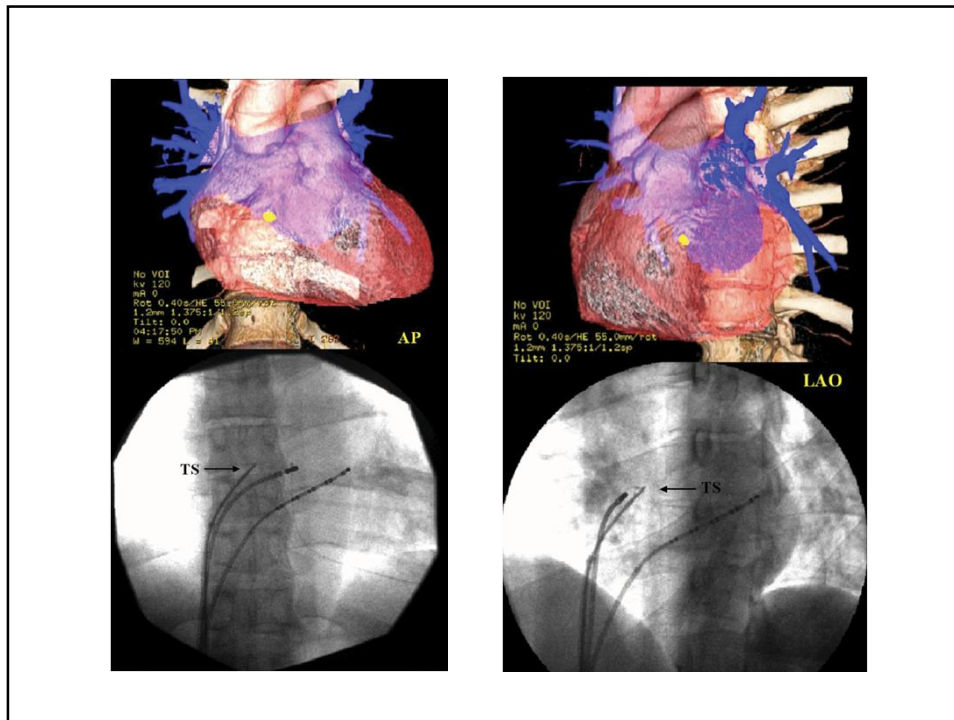
Haissaguerre et al. N Engl J Med. 1998;339:659-66

Abord de l' OG: transfixion



Graham LN, Europace 2007



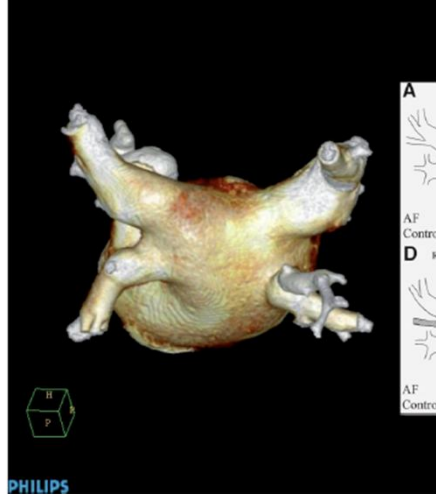


Graham L.N., Europace 2007

- Etude
 - 14 patients
 - Anatomie normale
 - ACFA
- Résultats
 - Modification position cathéter: 36%
 - Ressenti aide au geste: 93%
 - TP time: 13min +- 5
 - Scopie: 7min +- 3
 - Succès : 100%
- Limites : Scanner acquis 24h
 - Problème si les volumes cardiaques sont différents
 - Problème si le rythme cardiaque est différent

l'Institut du thorax

Variabilité Veines Pulmonaires



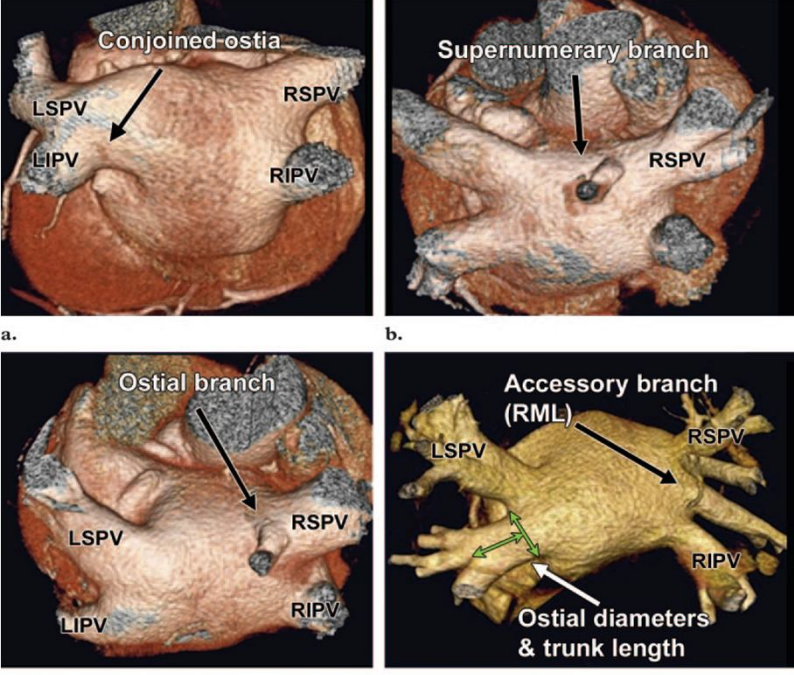
	A Typical	B Short Common Left Trunk	C Long Common Left Trunk
AF	N = 16	N = 7 (including 3 of D)	N = 2
Control	N = 18	N = 5 (including 2 of D)	N = 2

	D Right Middle PV	E Two Right Middle PVs	F Right Middle PV and Right "upper" PV
AF	N = 4	N = 1	N = 1
Control	N = 3	N = 0	N = 1

PHILIPS

Kato R et al. *Circulation*.2003; 107: 2004-2010

CENTRE HOSPITALIER UNIVERSITAIRE DE BRUXELLES



14%


a. Conjoined-ostia
LSPV, LIPV, RSPV, RIPV

b. Supernumerary branch
RSPV

c. Ostial branch
LSPV, LIPV, RSPV, RIPV

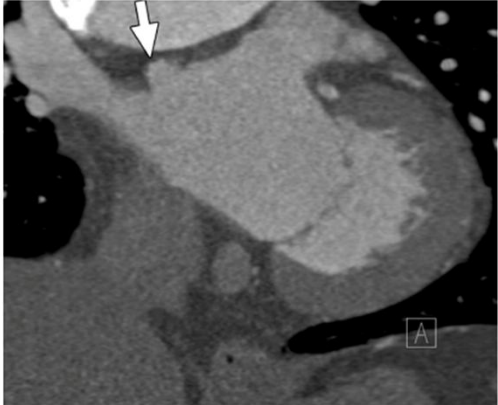
d. Accessory branch (RML)
LSPV, RSPV, RIPV
Ostial diameters & trunk length

28%


 Institut du thorax

Radio Anatomie Oreillette Gauche

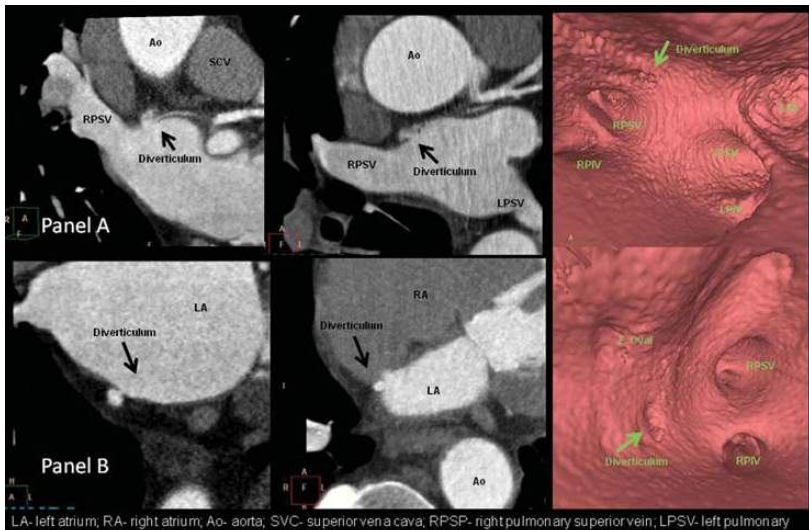
- Diverticule 19% population



Cardiac CT assessment of left atrial accessory appendages and diverticula
Abbara S, AJR 2009; 193:8077-812

 Centre Hospitalier Universitaire de Nantes

Oreillette Gauche – diverticules

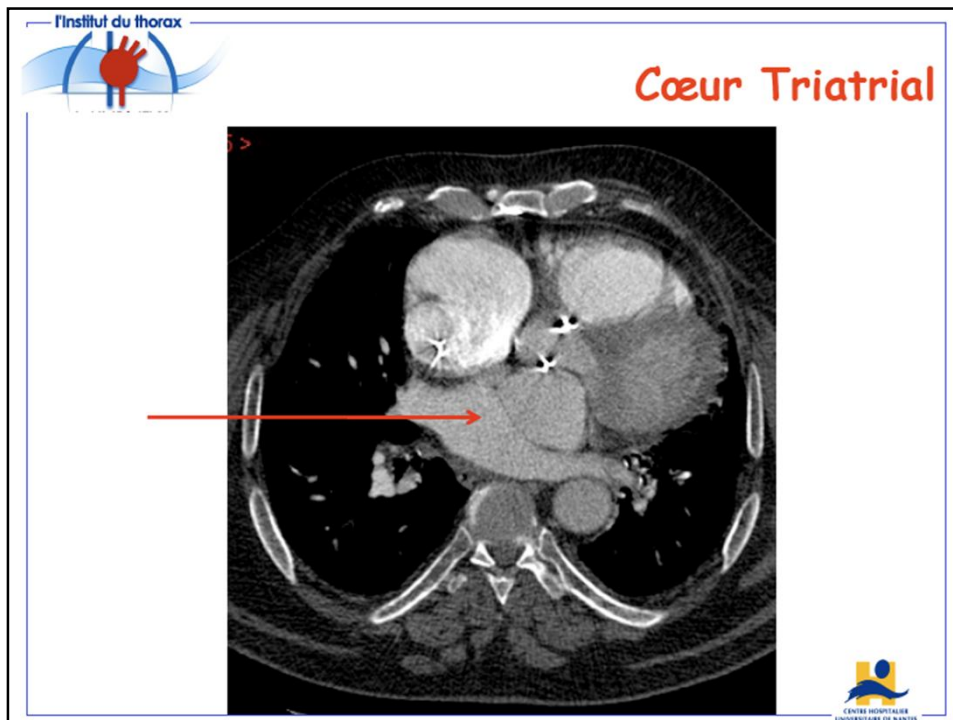


Panel A

Panel B

LA- left atrium, RA- right atrium, Ao- aorta, SVC- superior vena cava, RPSV- right pulmonary superior vein, LPSV- left pulmonary superior vein, RPIV- right pulmonary inferior vein, LPIV- left pulmonary inferior vein;

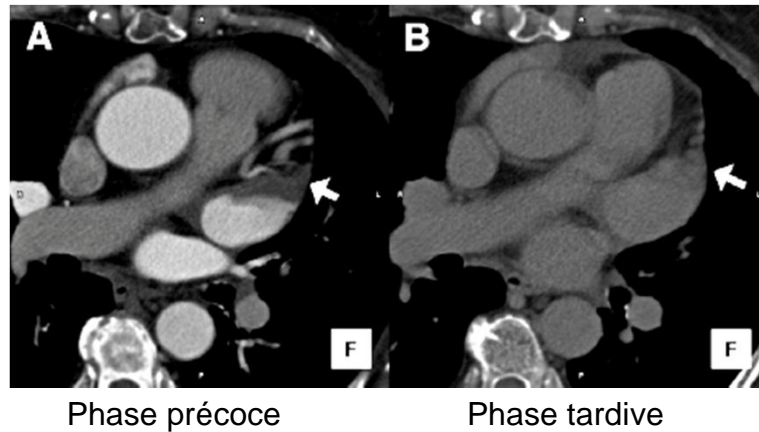
Goncalves et al. Eur Heart J 2009



Recherche de thrombus IA

- Fréquent dans les ACFA
- ETO: méthode de référence mais
 - Examen semi-invasif
 - Coût (cardiologue, infirmier +- med anesthésiste)
 - Examen douloureux parfois mal toléré et nécessité d' une surveillance après l' examen (sédation)
 - Scanner fait systématiquement avant ablation de FA

Détection des thrombus au scanner



Scanner : études publiées

- Martinez MW (JACC imaging 2009).
 - Population : ACFA avant choc, 402 patients
 - Technique : scanner non synchronisé monophasé
 - Résultats :
 - 362 (auricule libre CT-ETO)
 - 40 auricule plein CT, 9 confirmés en ETO
 - Se 100%, Sp 92%, VPN 100%, VPP 23%

- Hur J (Radiology 2009)
 - Population : AVC récent (55 patients)
 - Technique : CT double phase retrospectif
 - Phase tardive : 30 sec post injection
 - Irradiation : 7 à 11mSv en tout
 - Résultats : Se 100, Sp 98, VPP 93, VPN 100%.
 - Kappa (ETO vs CT) : 0,953
 - Absence de donnée sur la taille des thrombi.

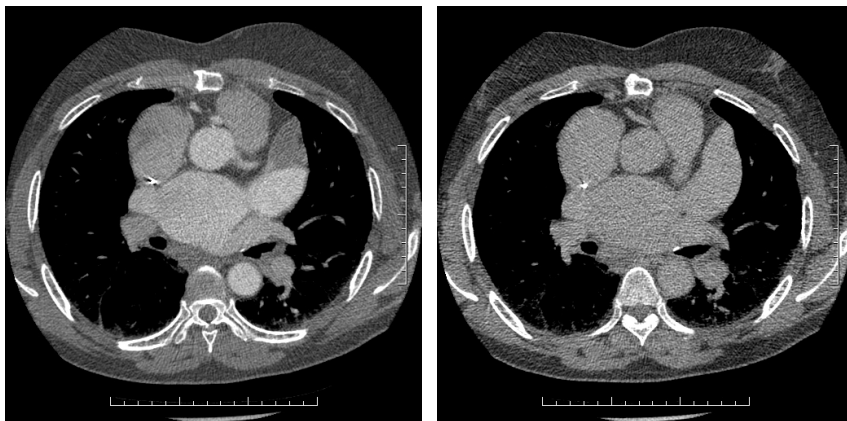
Scanner irradiation

- Scanner séquentiel prospectif :
 - 140x2 mGy.cm (4,76 mSv) en tout (seconde acquisition sur tout le coeur.
 - Équivalent d' un scanner thoracique.

Technique : Scanner avant ablation atriale : ECG ou pas?

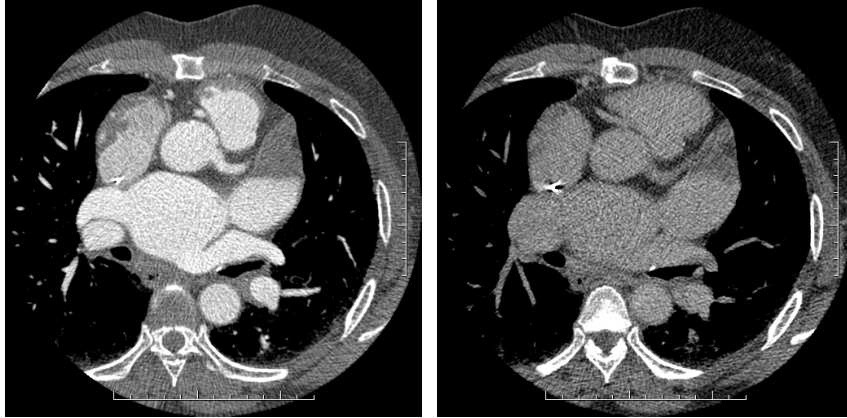
- Wagner M, Europace 2010:
 - no significant difference in the registration error
 - Radiation dose
 - Non-gated MDCT < gated
 - $4.6 \pm 1.4 < 13.4 \pm 3.6$ mSv ($p < 0.001$)

ETO : bon gold standard ?



Patient 55 ans avant ablation ACFA, ETO +

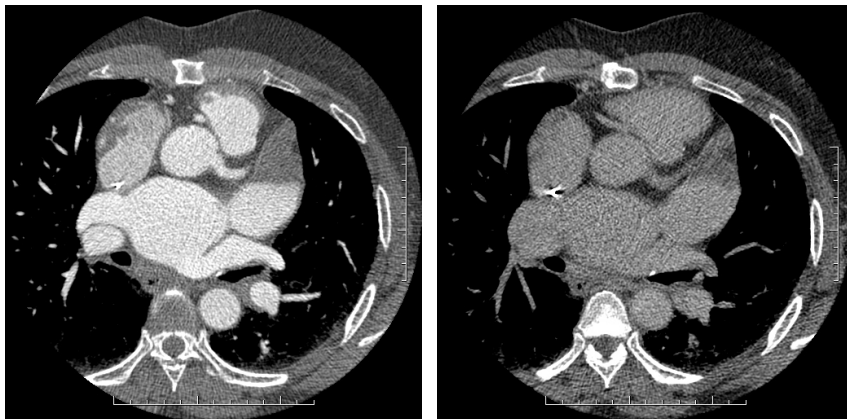
Contrôle à 1 mois



Patient 55 ans avant ablation ACFA, ETO -

0 min

1min 30



Patient 55 ans avant ablation ACFA, ETO -

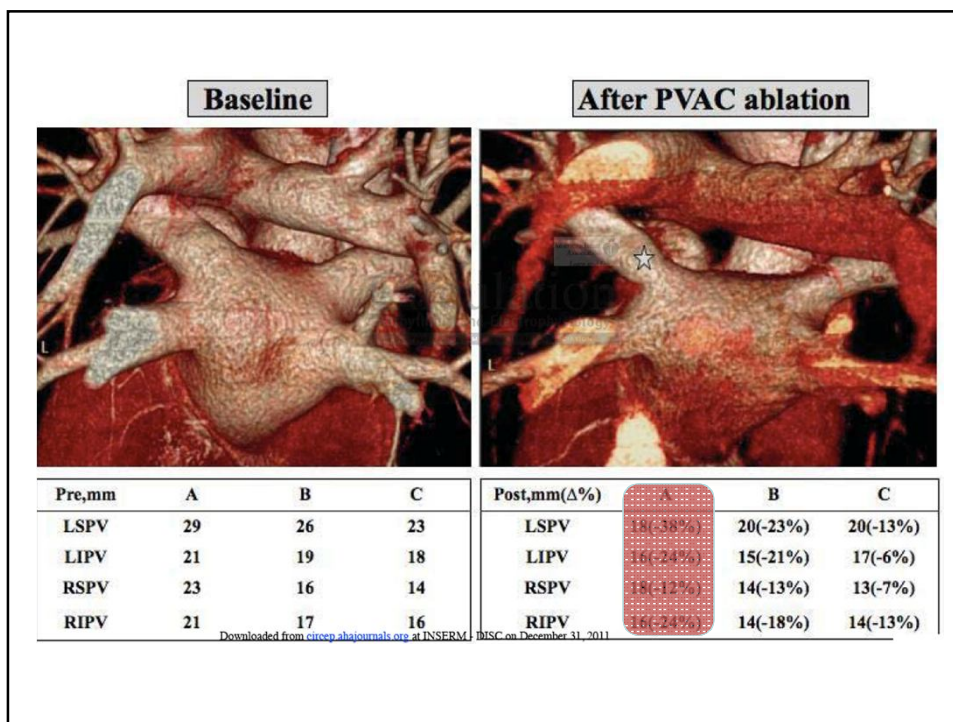
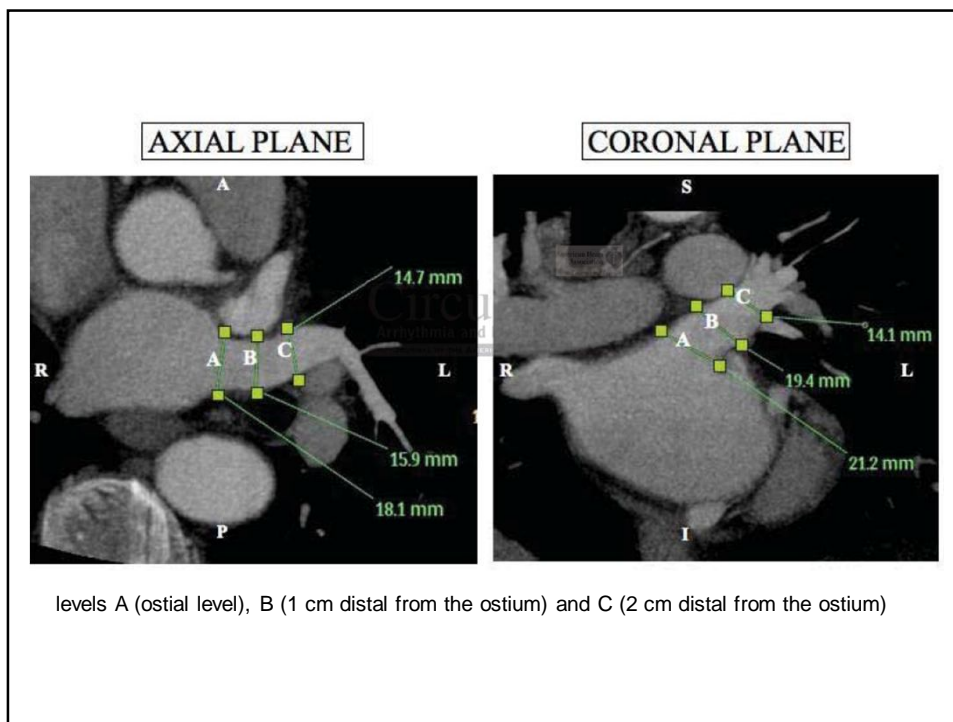
Sténoses veines pulmonaires

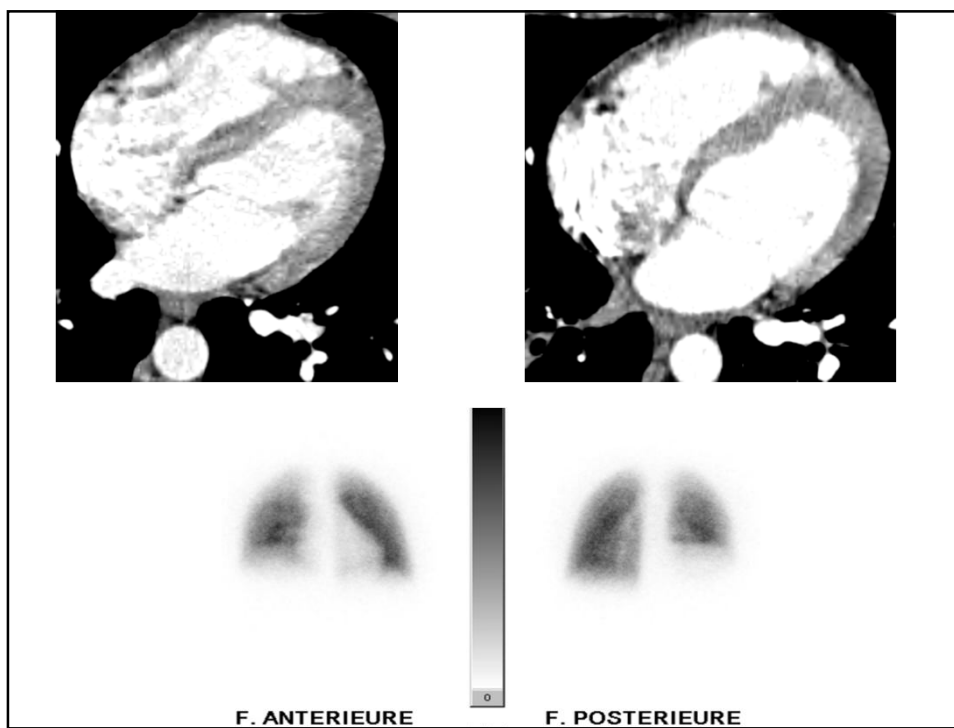
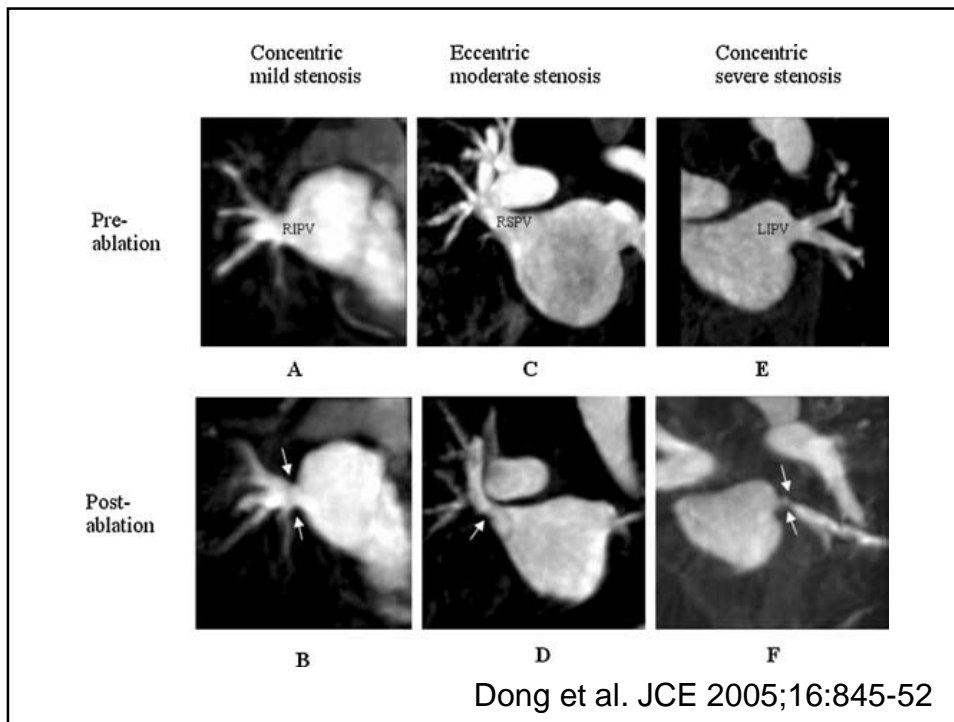
- 50 patients
- Objectifs : complications du multi-electrode ablation catheter (PVAC, Medtronic).
- Scanner avant la procédure et à 3 mois.
- Résultats
 - Complication clinique de sténose veineuse : 1 patient
 - Sténose sévère d' au moins une VP (>50% : 15%)
 - Sténose modérée (25-50%) : 78%
 - Sténose légère (0-25%): 100%
- SVP peut être ratée s' il n' existe pas de mesures réalisée avant intervention.

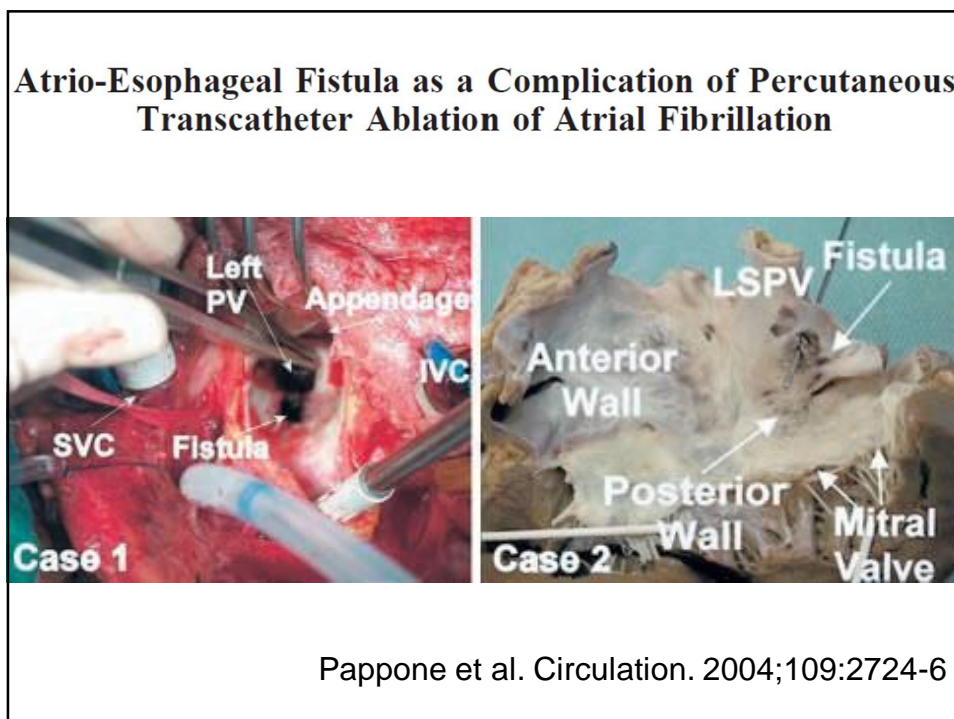
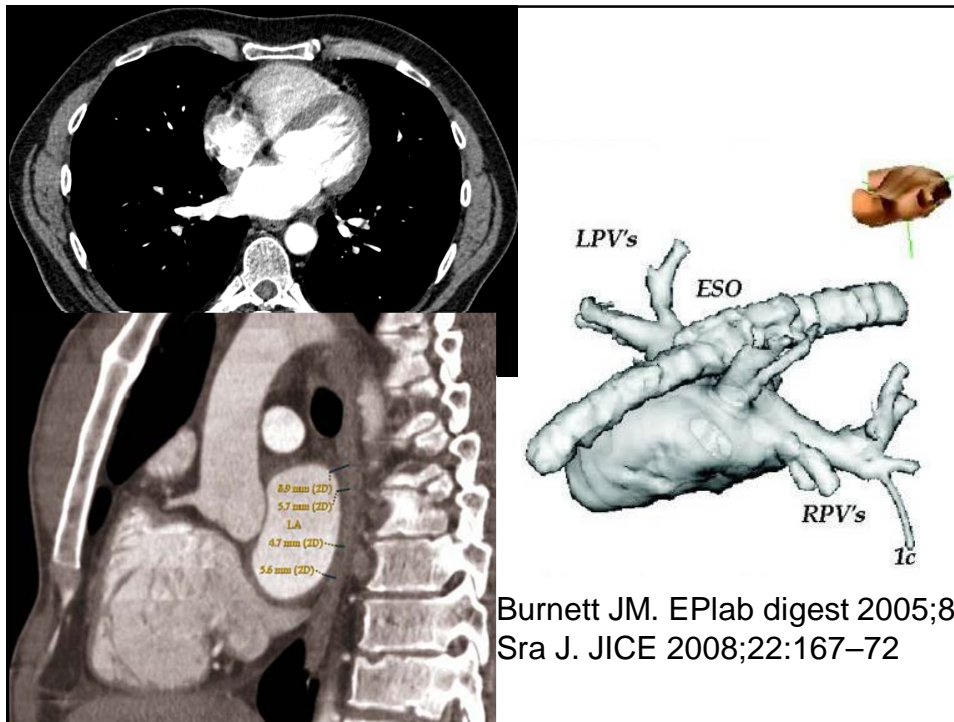
De Greef Y, Circ Elphysiol, 2012

- Undiagnosed PV narrowing might account for **unexplained dyspnoea, cough, chest pain, hemoptysis**, or an X-ray image consistent with **bronchitis or pneumonia**, leading to unnecessary potentially dangerous invasive diagnostic procedures.
- Furthermore, in the presence of a asymptomatic PV stenosis, cessation of anticoagulation after a apparently successful PVI can result in a acute **thrombotic occlusion** with adverse effect on pulmonary perfusion.
- Finally, some clinicians feel that an early intervention in the presence of a severe asymptomatic pulmonary vein stenosis leads to a clinical benefit

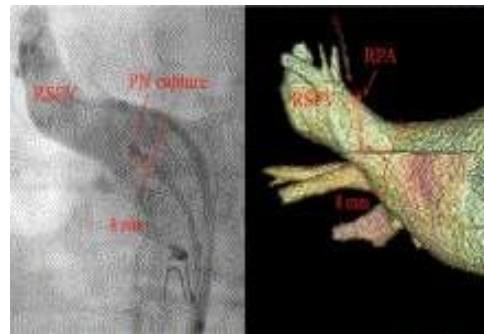
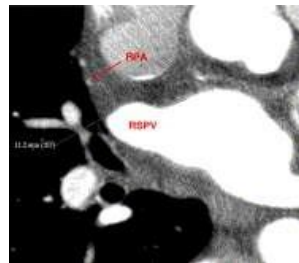
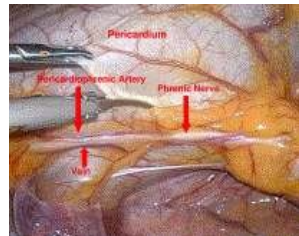
Based upon these elements some investigators suggest to screen actively for pulmonary vein stenosis in every patients using CT, MRI or TEE







Complications de l' ablation : Le nerf phrénique D

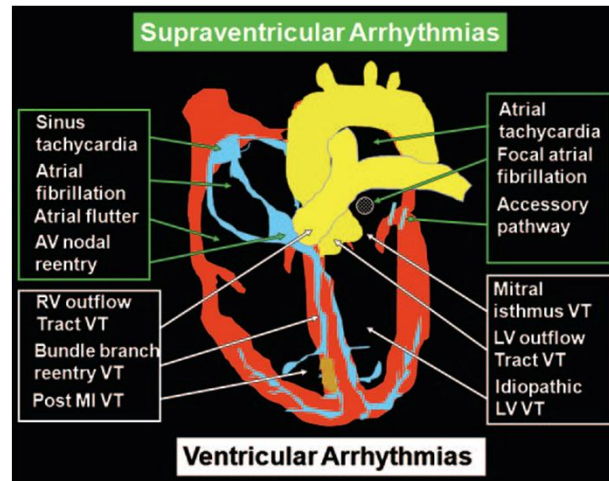


Horton, Heart Rhythm 2010;7:937-41

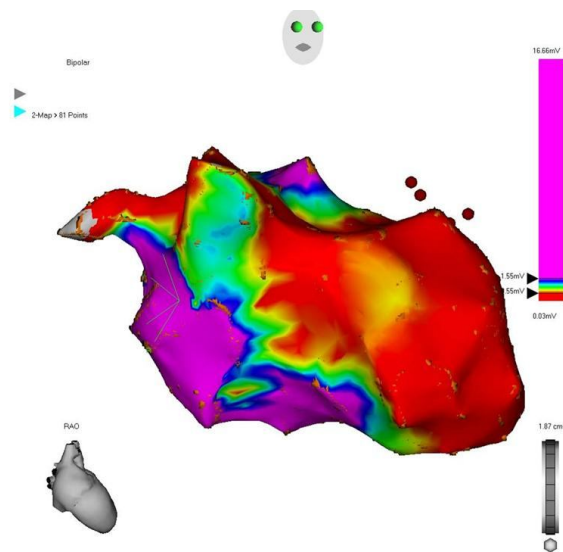
Conclusion FA

- Nombre et position des veines pulmonaires
- Diamètres ostium → choix matériel de RF
- Sténoses si interventions antérieures
- Thrombus intra-auriculaire
- Complications
 - Sténoses
 - Œsophage

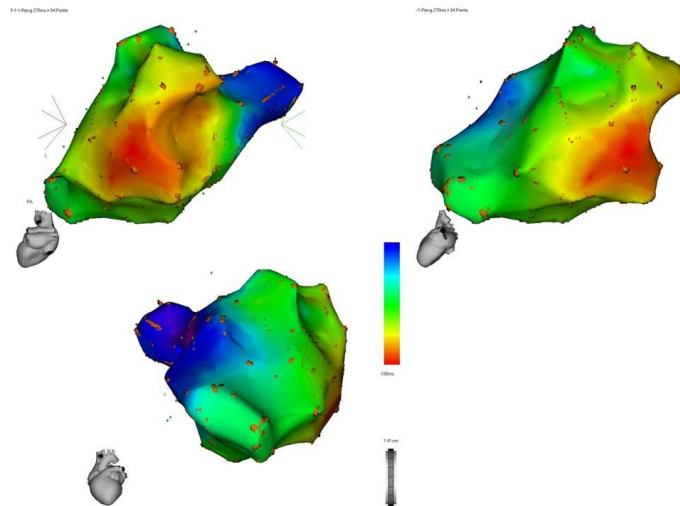
Tachycardie ventriculaire



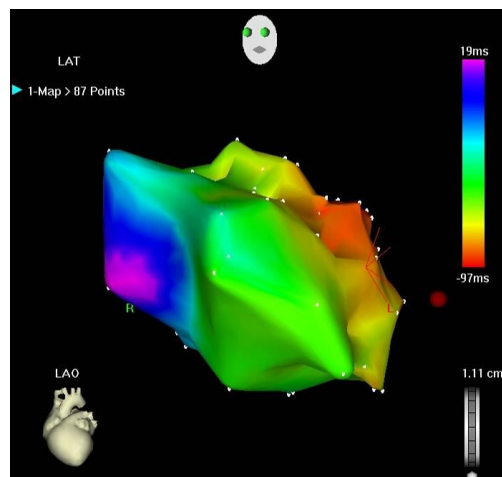
TV focale sur séquelle IDM antéro-apical



TV focale sur séquelle épiscopordique

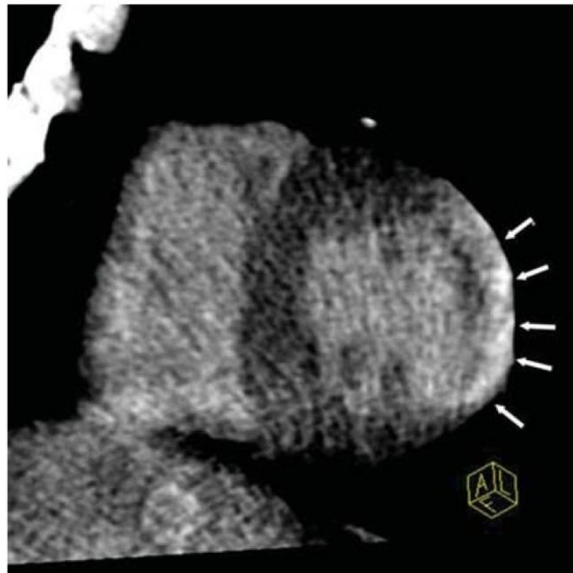
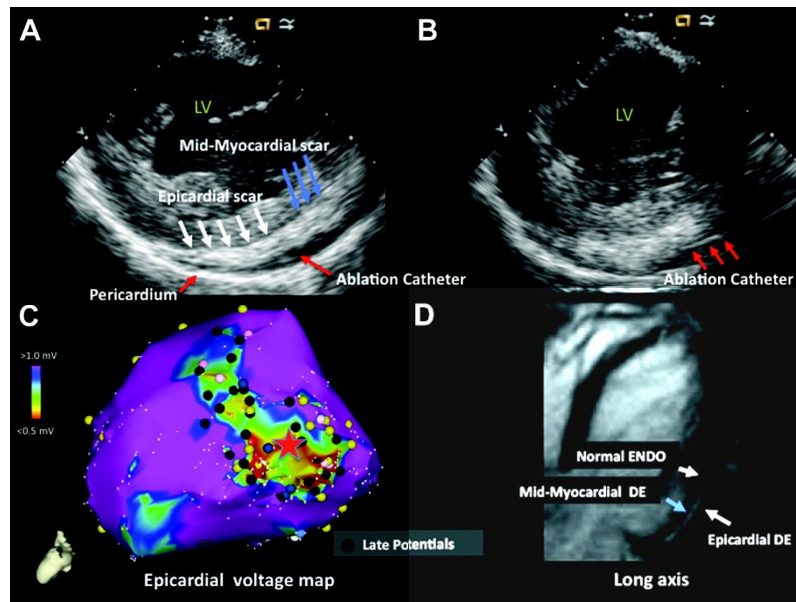


TV focale sur séquelle épiscopordique

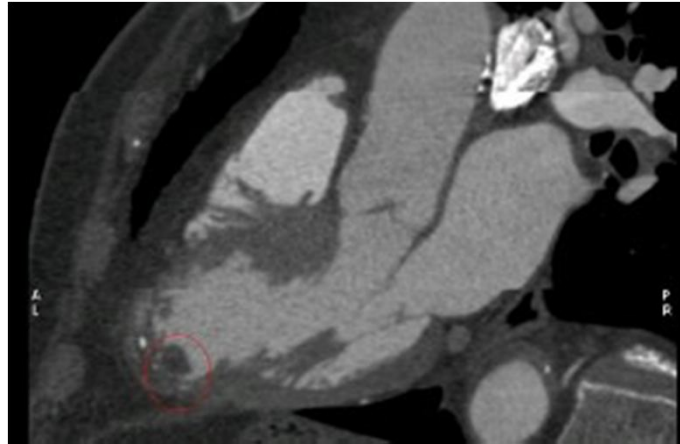


Ablation par **sinus coronaire sinon péricardique**

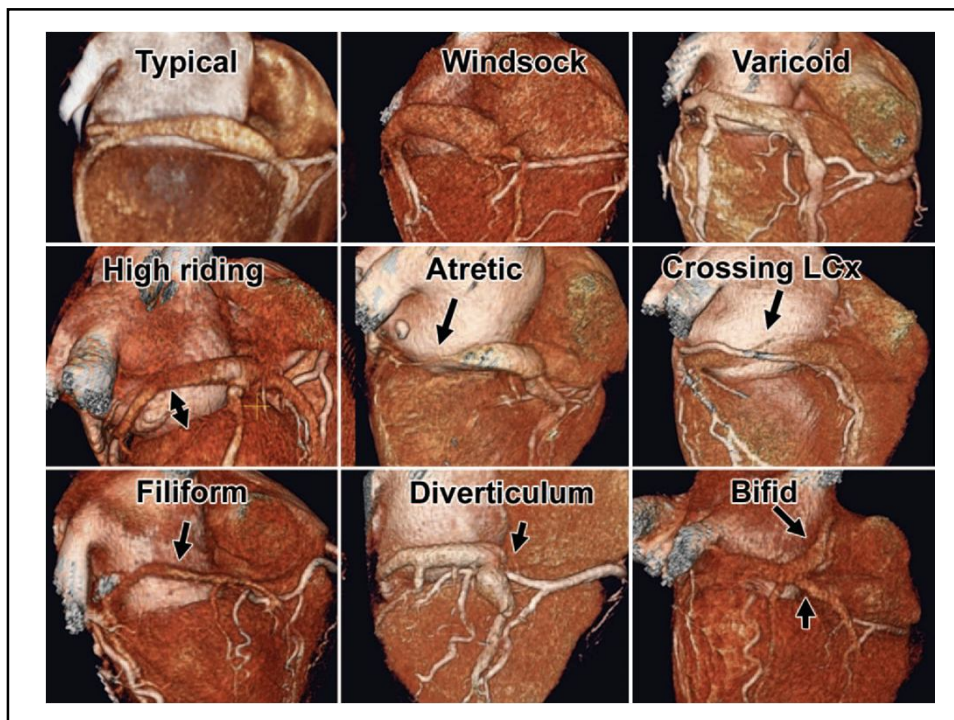
IRM et cartographie avant ablation TV

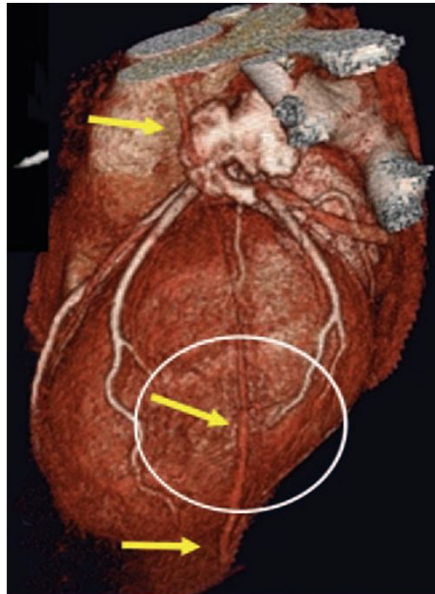


Thrombus intra-ventriculaire ?



L' échographie suffit-elle ? Le thrombus est-il frais ? Risque embolique ?





left phrenic neurovascular bundle.

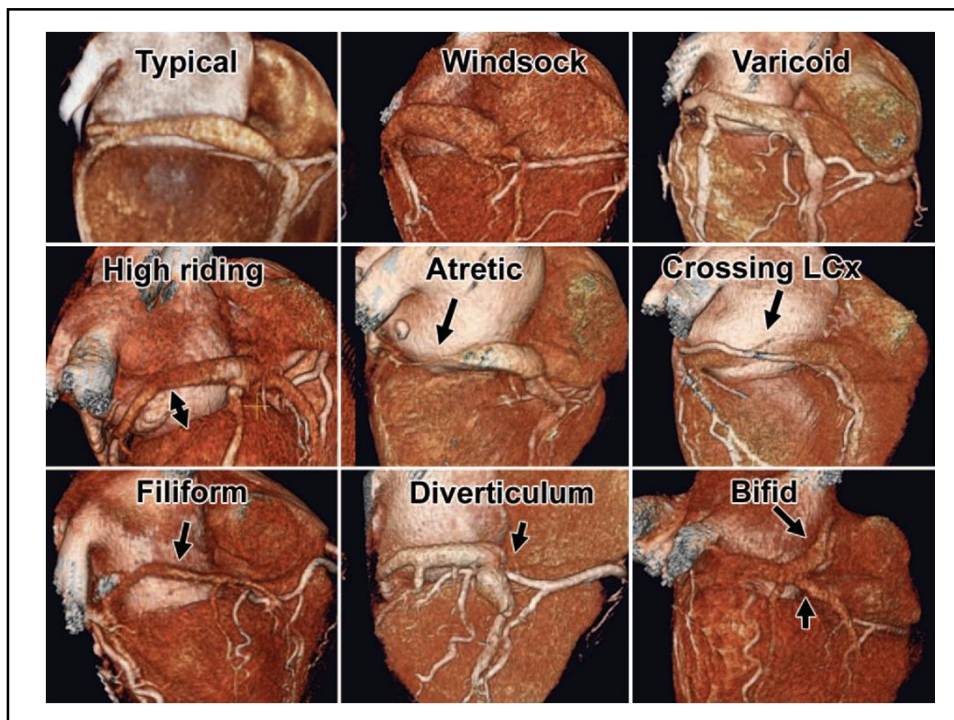
d.

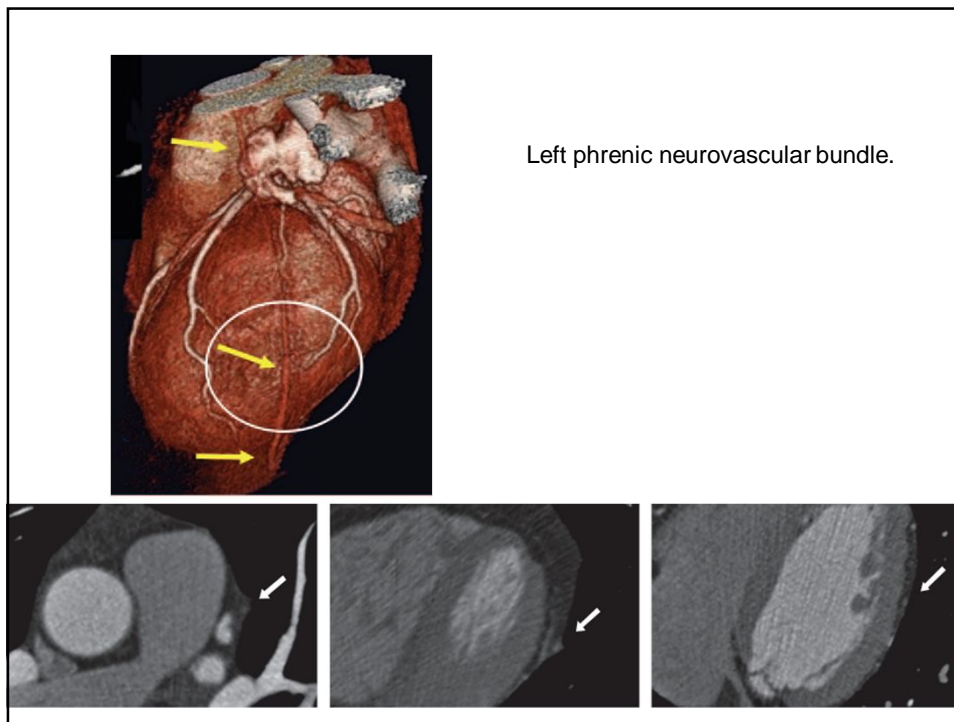
Sondes de stimulation

- Pace maker
- Stimulation multi-sites: OD / VD / v. coronaire

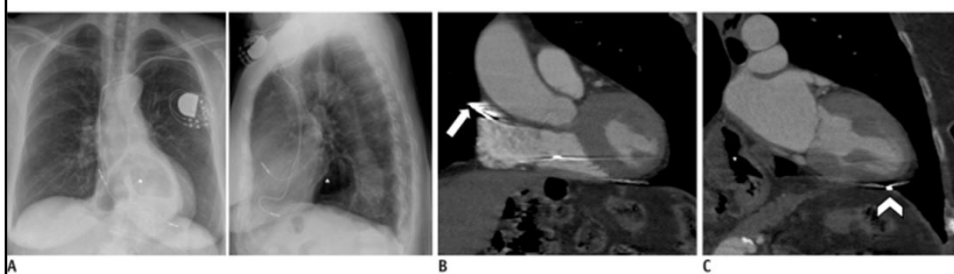


Perméabilité voie d'abord

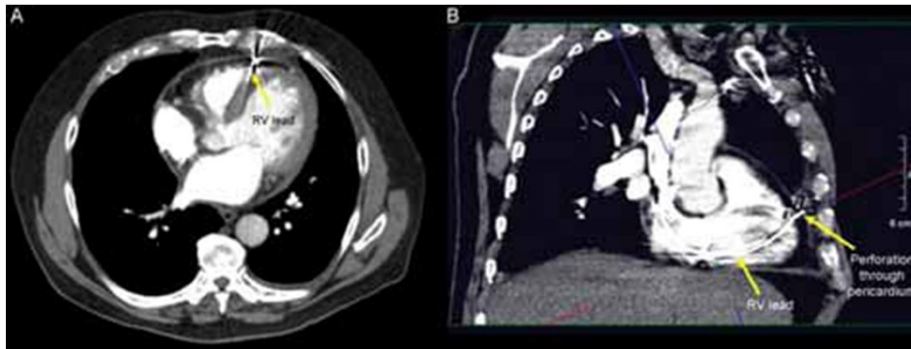




84-year-old female patient with DDD pacemaker suffering from diaphragmatic stimulation.



PA and lateral chest radiographs (A) indicate correct lead positions. However, asymptomatic perforation of atrial (arrow) and ventricular (arrowhead) lead is seen on contrast-enhanced CT scans (B, C). Note upside-down stomach (*).



Perforation VD par électrode ventriculaire droite