The top banner features the 'PHYSIO DAY' logo in a stylized, outlined font. Below it, the text 'JOURNÉES DE PHYSIOLOGIE EN CARDIOLOGIE INTERVENTIONNELLE' is written in a smaller, sans-serif font. The background of the banner is a dark teal color with a complex, white, branching network of lines that resembles a vascular or neural structure. On the right side, there is a faint, light-colored image of a human head in profile, showing the brain and facial features, overlaid on the network.

PHYSIO DAY

JOURNÉES DE PHYSIOLOGIE
EN CARDIOLOGIE INTERVENTIONNELLE

Comment évaluer une hypertension pulmonaire en 2024

Baptiste Mossaz

Institut Arnault Tzanck – Saint-Laurent du Var

5 & 6 AVRIL 2024

HÔTEL SHERATON · NICE



Plan

1

Pourquoi s'intéresser à l'hypertension pulmonaire ?

2

Comment évoquer une hypertension pulmonaire ?

3

Comment confirmer une hypertension pulmonaire ?

4

Pourquoi ça ne plaît pas aux cardiologues interventionnels ?

5

Comment la rendre intéressante ?



Pourquoi s'intéresser à l'hypertension pulmonaire ?



Épidémiologie

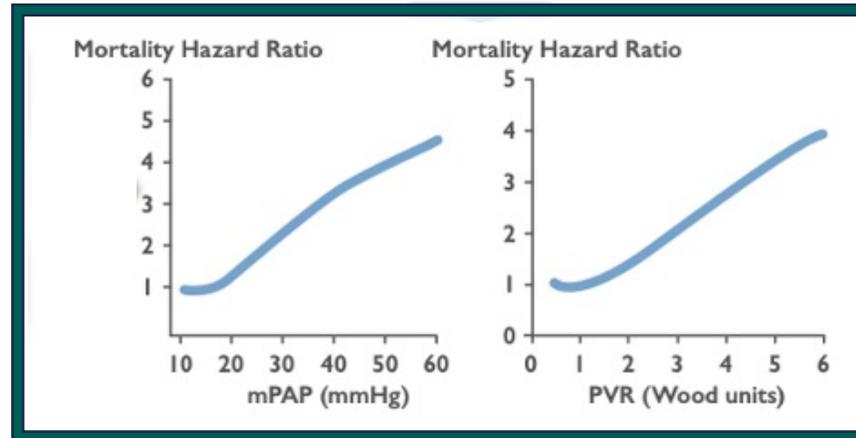
PULMONARY HYPERTENSION

Prevalence



1%

Global population



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Multitude de pathologies

GROUP 1 Pulmonary arterial hypertension (PAH)

- 1.1 Idiopathic
 - 1.1.1 Non-responders at vasoreactivity testing
 - 1.1.2 Acute responders at vasoreactivity testing
- 1.2 Heritable^a
- 1.3 Associated with drugs and toxins^a
- 1.4 Associated with:
 - 1.4.1 Connective tissue disease
 - 1.4.2 HIV infection
 - 1.4.3 Portal hypertension
 - 1.4.4 Congenital heart disease
 - 1.4.5 Schistosomiasis
- 1.5 PAH with features of venous/capillary (PVOD/PCH) involvement
- 1.6 Persistent PH of the newborn

GROUP 2 PH associated with left heart disease

- 2.1 Heart failure:
 - 2.1.1 with preserved ejection fraction
 - 2.1.2 with reduced or mildly reduced ejection fraction^b
- 2.2 Valvular heart disease
- 2.3 Congenital/acquired cardiovascular conditions leading to post-capillary PH

GROUP 3 PH associated with lung diseases and/or hypoxia

- 3.1 Obstructive lung disease or emphysema
- 3.2 Restrictive lung disease
- 3.3 Lung disease with mixed restrictive/obstructive pattern
- 3.4 Hypoventilation syndromes
- 3.5 Hypoxia without lung disease (e.g. high altitude)
- 3.6 Developmental lung disorders

GROUP 4 PH associated with pulmonary artery obstructions

- 4.1 Chronic thrombo-embolic PH
- 4.2 Other pulmonary artery obstructions^c

GROUP 5 PH with unclear and/or multifactorial mechanisms

- 5.1 Haematological disorders^d
- 5.2 Systemic disorders^e
- 5.3 Metabolic disorders^f
- 5.4 Chronic renal failure with or without haemodialysis
- 5.5 Pulmonary tumour thrombotic microangiopathy
- 5.6 Fibrosing mediastinitis



Multitude de traitements

	Starting dose	Target dose
Calcium channel blockers		
Amlodipine	5 mg o.d.	15–30 mg o.d. ^a
Diltiazem	60 mg b.i.d. ^b	120–360 mg b.i.d. ^b
Felodipine	5 mg o.d.	15–30 mg o.d. ^a
Nifedipine	10 mg t.i.d.	20–60 mg b.i.d. or t.i.d.
Endothelin receptor antagonists (oral administration)		
Ambrisentan	5 mg o.d.	10 mg o.d.
Bosentan	62.5 mg b.i.d.	125 mg b.i.d.
Macitentan	10 mg o.d.	10 mg o.d.
Phosphodiesterase 5 inhibitors (oral administration)		
Sildenafil	20 mg t.i.d.	20 mg t.i.d. ^c
Tadalafil	20 or 40 mg o.d.	40 mg o.d.
Prostacyclin analogues (oral administration)		
Beraprost sodium	20 µg t.i.d.	Maximum tolerated dose up to 40 µg t.i.d.
Beraprost extended release	60 µg b.i.d.	Maximum tolerated dose up to 180 µg b.i.d.
Treprostinil	0.25 mg b.i.d. or 0.125 mg t.i.d.	Maximum tolerated dose

	Starting dose	Target dose
Prostacyclin receptor agonist (oral administration)		
Selexipag	200 µg b.i.d.	Maximum tolerated dose up to 1600 µg b.i.d.
Soluble guanylate cyclase stimulator (oral administration)		
Riociguat ^d	1 mg t.i.d.	2.5 mg t.i.d.
Prostacyclin analogues (inhaled administration)		
lloprost ^e	2.5 µg 6–9 times per day	5.0 µg 6–9 times per day
Treprostinil ^e	18 µg 4 times per day	54–72 µg 4 times per day
Prostacyclin analogues (i.v. or s.c. administration)		
Epoprostenol i.v.	2 ng/kg/min	Determined by tolerability and effectiveness; typical dose range at 1 year is 16–30 ng/kg/min, with wide individual variability
Treprostinil s.c. or i.v.	1.25 ng/kg/min	Determined by tolerability and effectiveness; typical dose range at 1 year is 25–60 ng/kg/min, with wide individual variability

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Recherche



ClinicalTrials.gov

● NOT YET RECRUITING

NCT06176118 **NEW**

Clinical Trial of 2-HOBA in **Pulmonary Arterial Hypertension**

● NOT YET RECRUITING

NCT04915300

Apabetalone for **Pulmonary Arterial Hypertension**

● RECRUITING

NCT05975905

A Study to Investigate the Safety and Efficacy of KER-012 in Combination With Background Therapy in Adult Participants With **Pulmonary Arterial Hypertension** (PAH) (TROPOS Study).

● RECRUITING

NCT05147805

A Study to Evaluate the Efficacy, Safety and Pharmacokinetics of Treprostinil Palmitil Inhalation Powder in Participants With **Pulmonary Arterial Hypertension**

● RECRUITING

NCT05679570

Satralizumab in the Treatment of **Pulmonary Arterial Hypertension** (SATISFY-JP Trial)

● RECRUITING

NCT04811092

Study of Sotatercept in Newly Diagnosed Intermediate- and High-Risk PAH Participants (MK-7962-005/A011-13)

● ACTIVE, NOT RECRUITING

NCT05135000

Study of Efficacy and Safety of LTP001 in **Pulmonary Arterial Hypertension**

Conditions

● COMPLETED [WITH RESULTS](#)

NCT04576988

A Study of Sotatercept for the Treatment of **Pulmonary Arterial Hypertension** (MK-7962-003/A011-11)(STELLAR)



Comment évoquer une hypertension pulmonaire ?



Algorithme

1

Suspicion clinique

2

Vmax IT

3

Centre de compétence / référence

> 3,4 m/s : Probabilité élevée → Étape 3

> 2,8 m/s - ≤ 3,4 m/s : Probabilité intermédiaire → Étape 3 SI

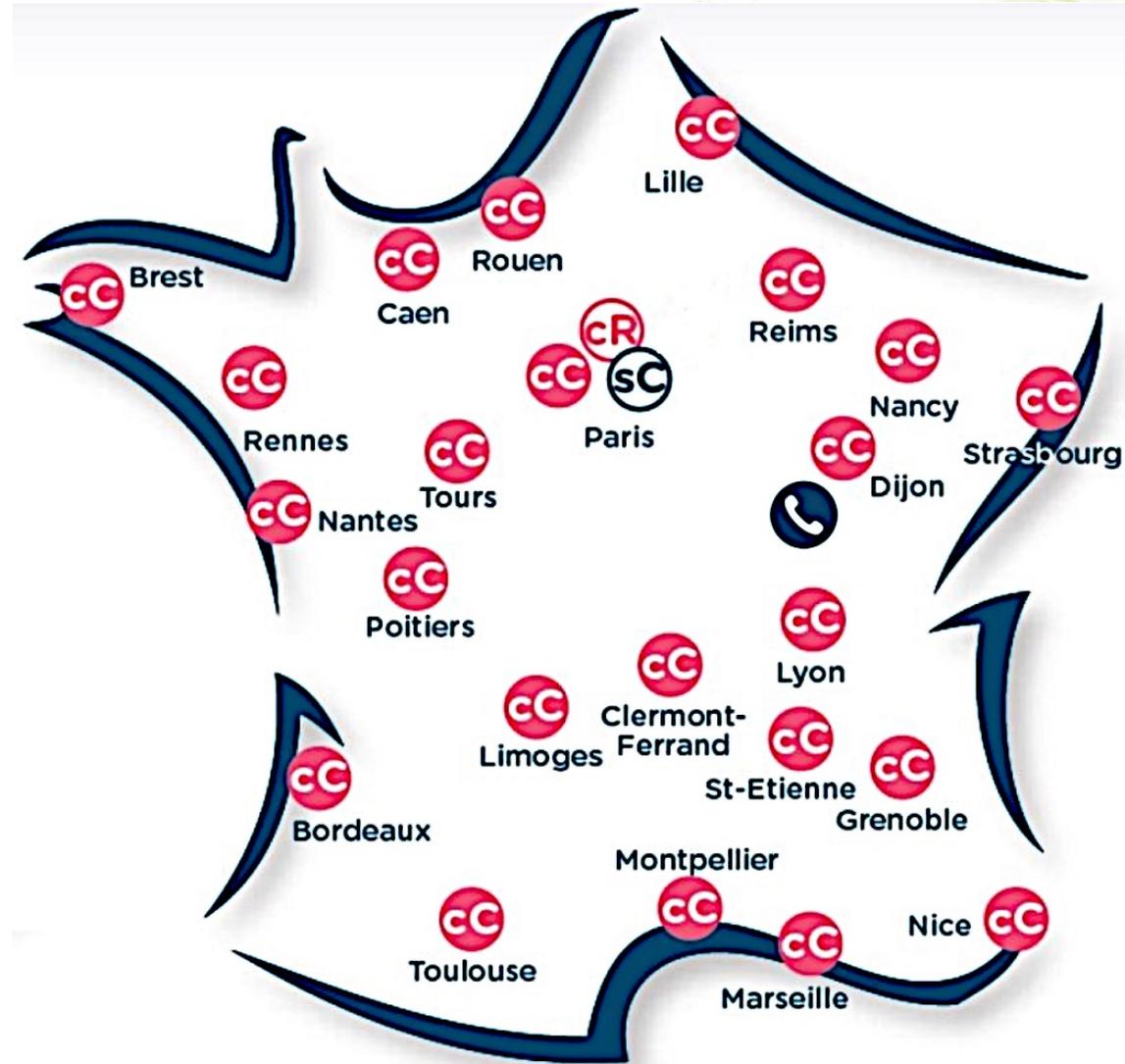
- Présence d'autre signe échographique d'HTP
- OU Présence d'arguments pour une étiologie pré-capillaire potentiellement curable (groupe 1 – post-embolique)

≤ 2,8 m/s : Probabilité faible → Étape 3 SI

- Présence d'autre signe échographique d'HTP
- ET Présence d'arguments pour une étiologie pré-capillaire potentiellement curable (groupe 1 – groupe 4)



L'offre de soins



CC
CHU de la
Martinique

CC
CHU de la
Réunion



ETT : Pas que les PAPs !

A Enlarged right ventricle; parasternal long-axis view

B Dilated RV with basal RV/LV ratio >1.0 ; four-chamber view

C Flattened interventricular septum (arrows) leading to 'D-shaped' LV; decreased LV eccentricity index; parasternal short-axis view

D Distended inferior vena cava with diminished inspiratory collapsibility; subcostal view

E RVOT AT <105 ms 'notch'

F Reduced right ventricular fractional area change ($<35\%$); four-chamber view

G Decreased tricuspid annular plane systolic excursion (TAPSE) measured with M-Mode (<18 mm)

H Decreased peak systolic (S') velocity of tricuspid annulus (<9.5 cm/s) measured with tissue Doppler

I End-systolic RA >18 cm²

J Increased systolic peak tricuspid regurgitation velocity (peak TRV); measured with continuous wave Doppler

K Estimation of systolic pulmonary artery pressure (sPAP); sPAP = TR pressure gradient + estimated RAP

IVC Collapse*	eRAP
<2.1 cm	$>50\%$ 3 (0-5)
>2.1 cm	$>50\%$ 8 (5-10)
>2.1 cm	$<50\%$ 15 (10-20)

L Presence of pericardial effusion; four-chamber view; parasternal short-axis view; other views (e.g. subcostal view)



Comment confirmer une hypertension pulmonaire ?

Comment confirmer une hypertension pulmonaire ?

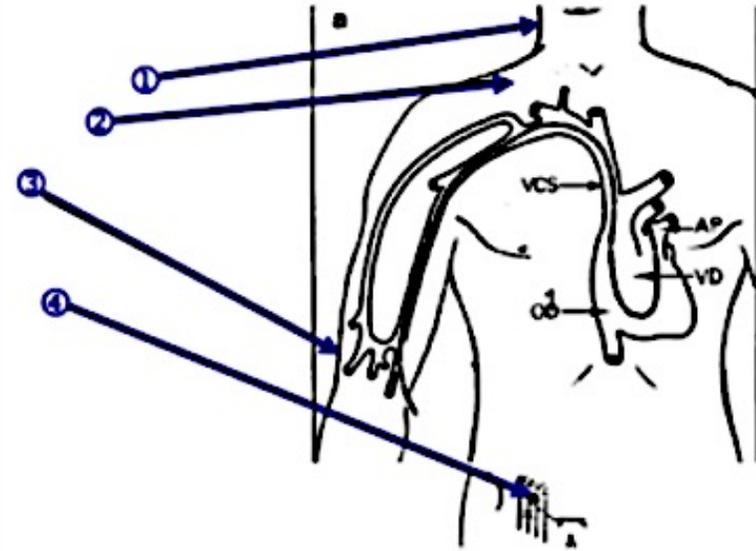
Cathétérisme cardiaque droit

○



Voie d'abord

- Multiples
- Désilet 6 ou 7F
- Avantage de la voie brachiale :
 - $\geq 92\%$ de succès
 - Moins de complications
 - Examen facilité (sonde de Swan conçue pour la voie haute)

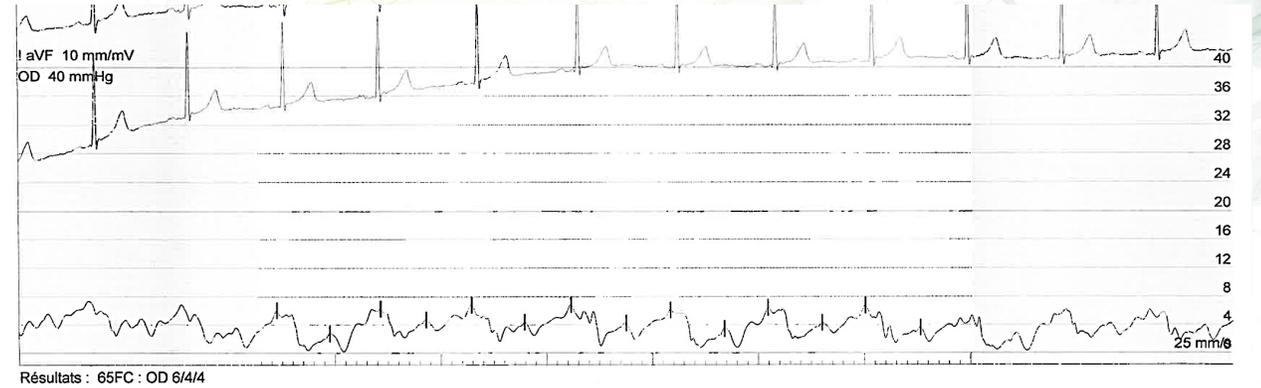




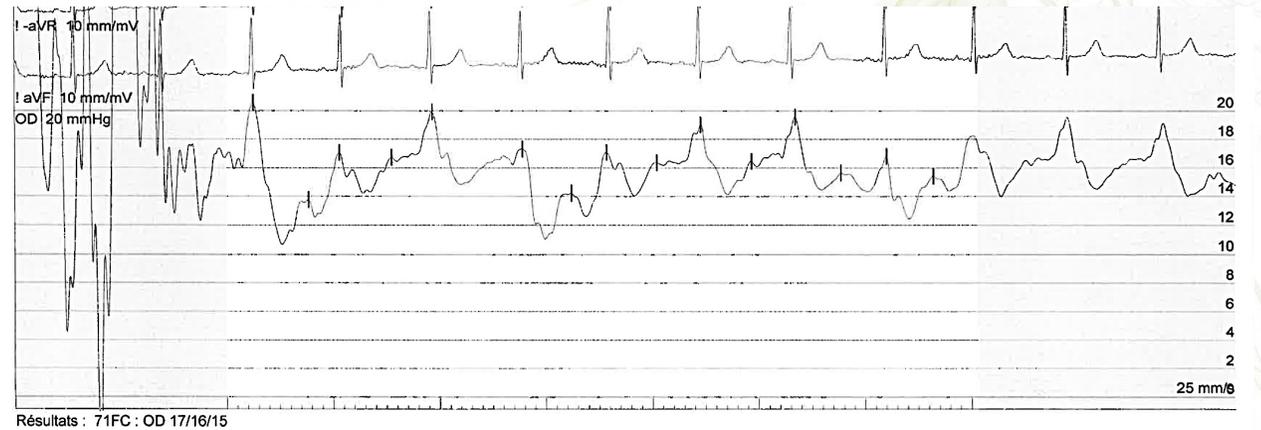
Oreillette droite



Non pathologique :



Pathologique :

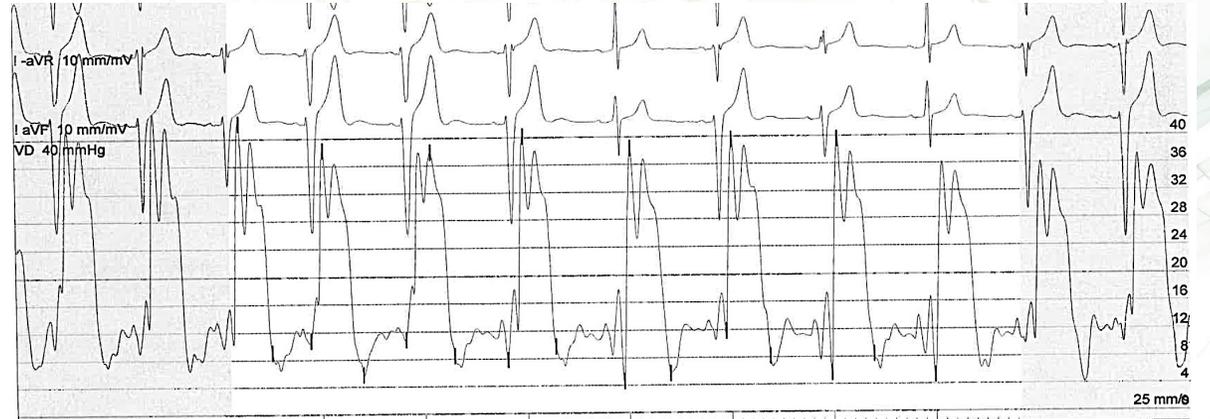




Ventricule droit

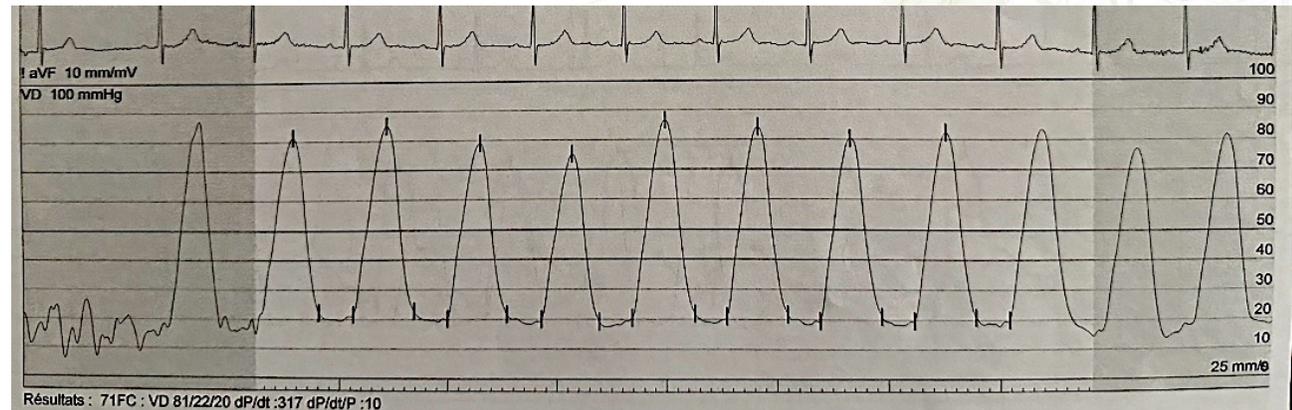


Non pathologique :



Résultats : 59FC : VD 39/8/8 dP/dt : 710 dP/dt/P : 37

Pathologique :



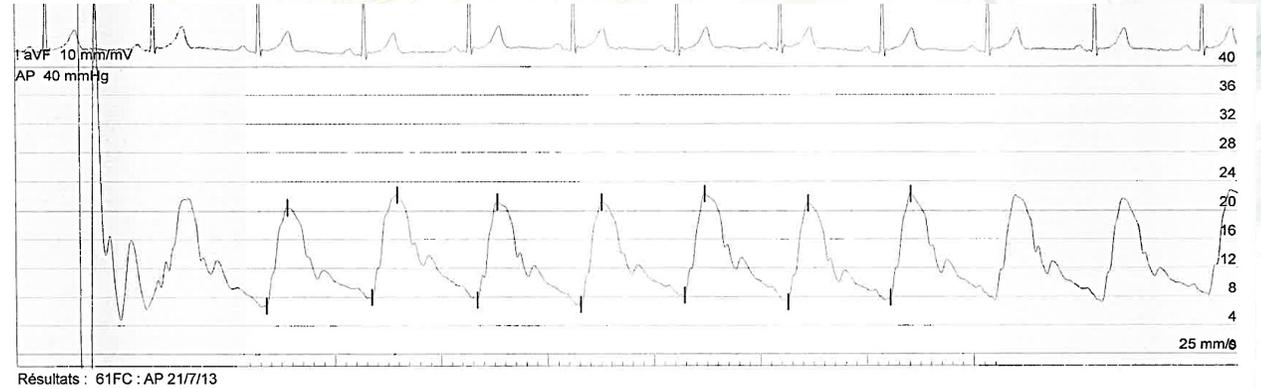
Résultats : 71FC : VD 81/22/20 dP/dt : 317 dP/dt/P : 10



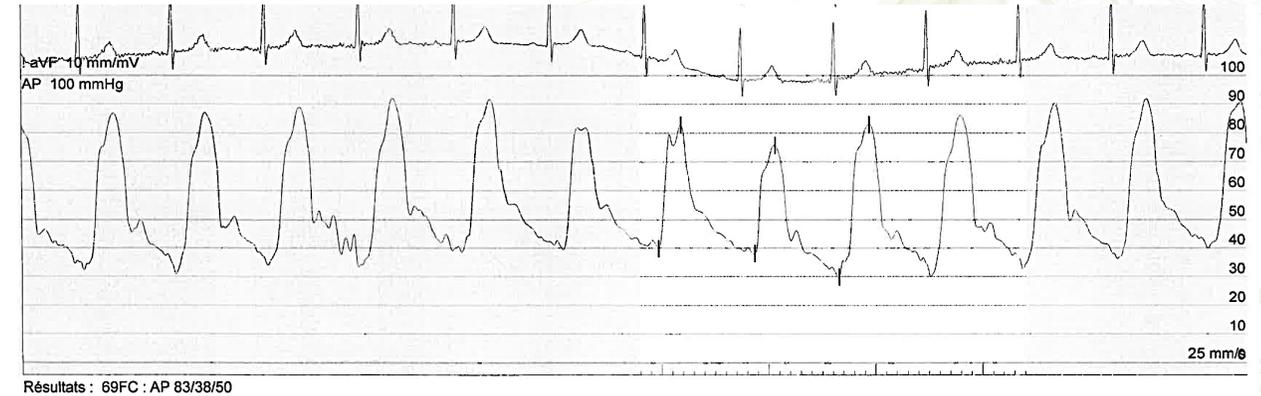
Artère pulmonaire



Non pathologique :



Pathologique :

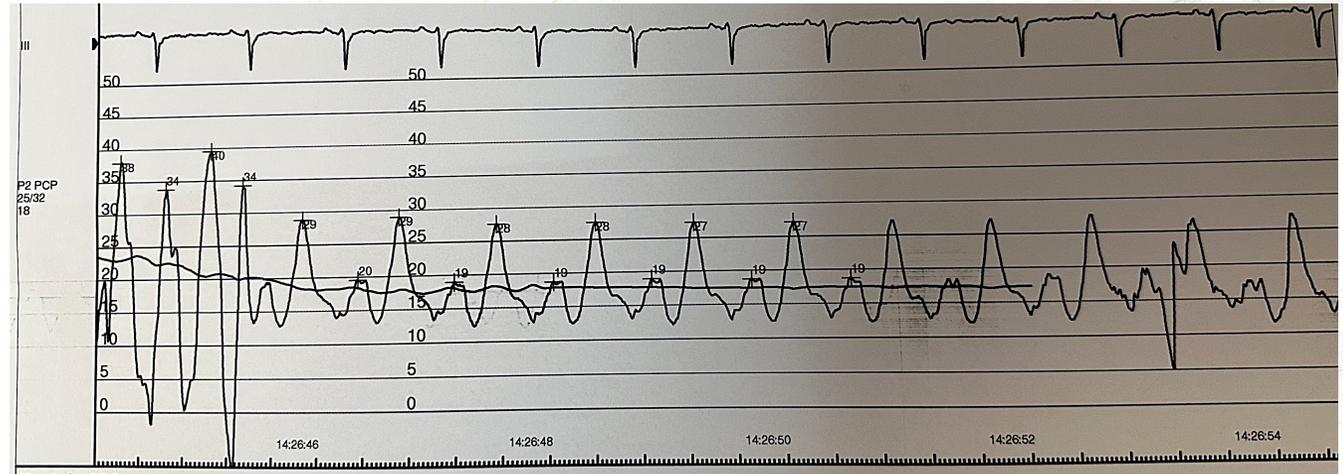




Pression capillaire

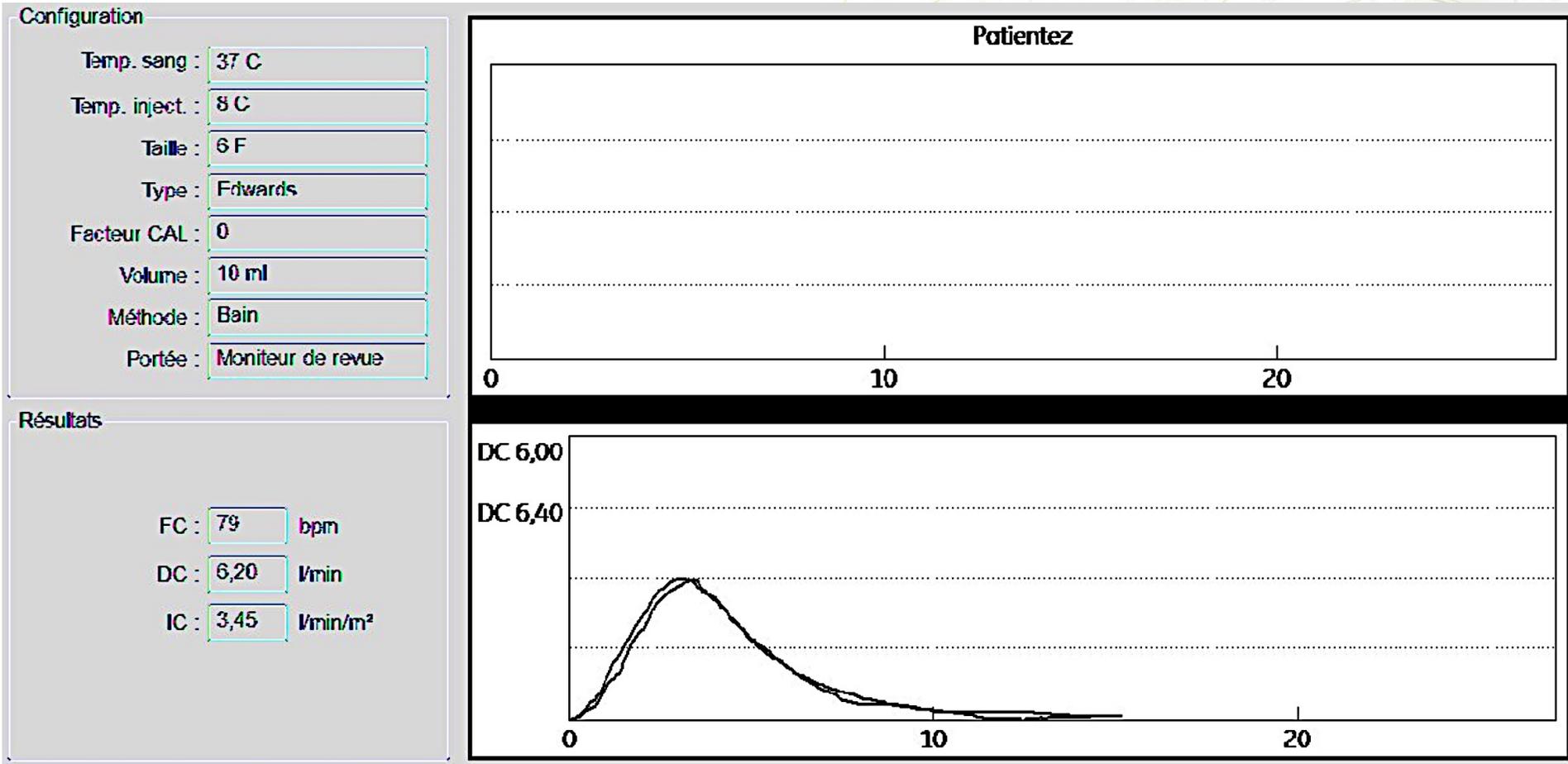


Pathologique :





Mesure du débit cardiaque



○

Les examens associés au cathétérisme cardiaque

1

Test de vaso-réactivité au NO

- Patient avec suspicion d'HTP du groupe 1
- Positif : Réduction des PAPm ≥ 10 mmHg ET PAPm ≤ 40 mmHg

2

Test de remplissage « Fluid challenge »

- Patient avec suspicion d'une composante post-capillaire
- Positif : 500 mL de sérum salé sur 5-10 min \rightarrow Pcap ≥ 18 mmHg

3

Oxymétries étagées



Les normes au KT en 2024 → ESC 2022

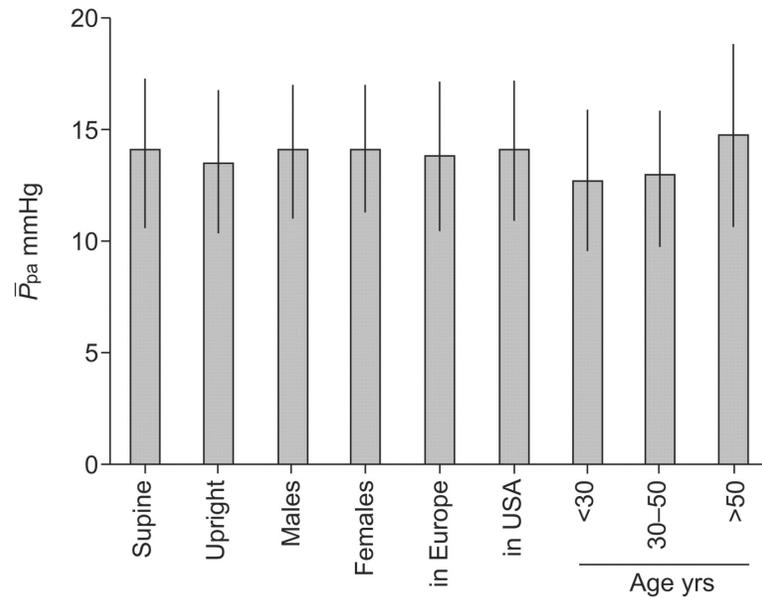
- Hypertension pulmonaire : PAPm > **20** mmHg
- Pré-capillaire :
 - RVP > **2** UW
 - Pcap < 15 mmHg
- Post-capillaire :
 - RVP ≤ **2** UW
 - Pcap ≥ 15 mmHg
- Mixte :
 - RVP > **2** UW ○ Pcap ≥ 15 mmHg

- **Définition 2015:**
 - PAPm ≥ 25 mmHg
 - PAPO ≤ 15 mmHg
- **Définitions 2018**
 - PAPm > 20 mmHg
 - RVP > 3 UW
 - PAPO ≤ 15 mmHg

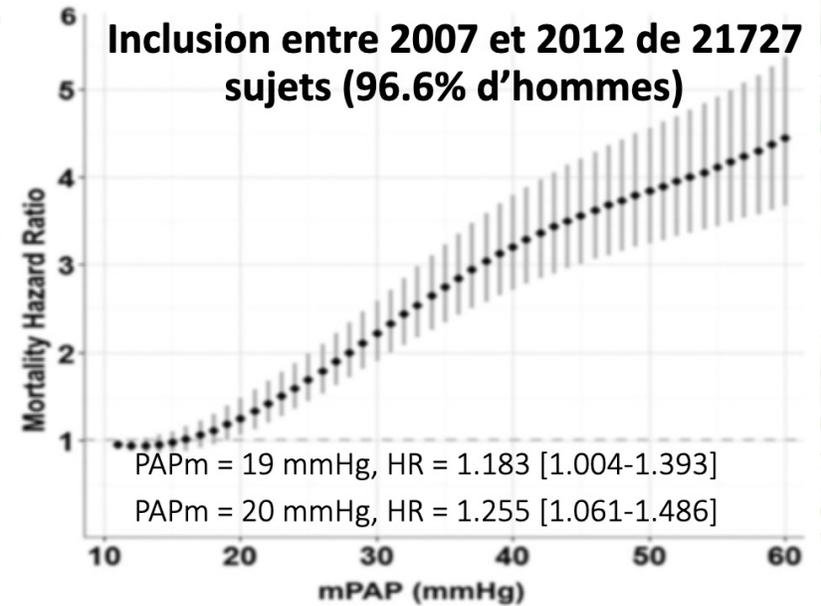


Pourquoi PAPm > 20 et plus 25 mmHg

- 25 mmHg → Date de 1973 et était empirique



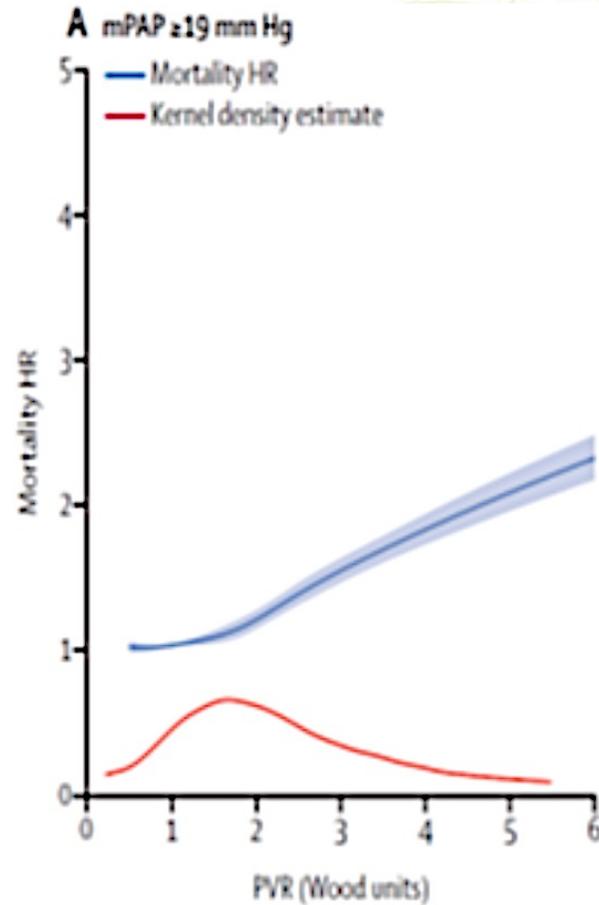
Kovacs G. Eur Respir J 2012



Maron BA. Circulation 2016



Pourquoi RVP < 2 et plus 3 UW



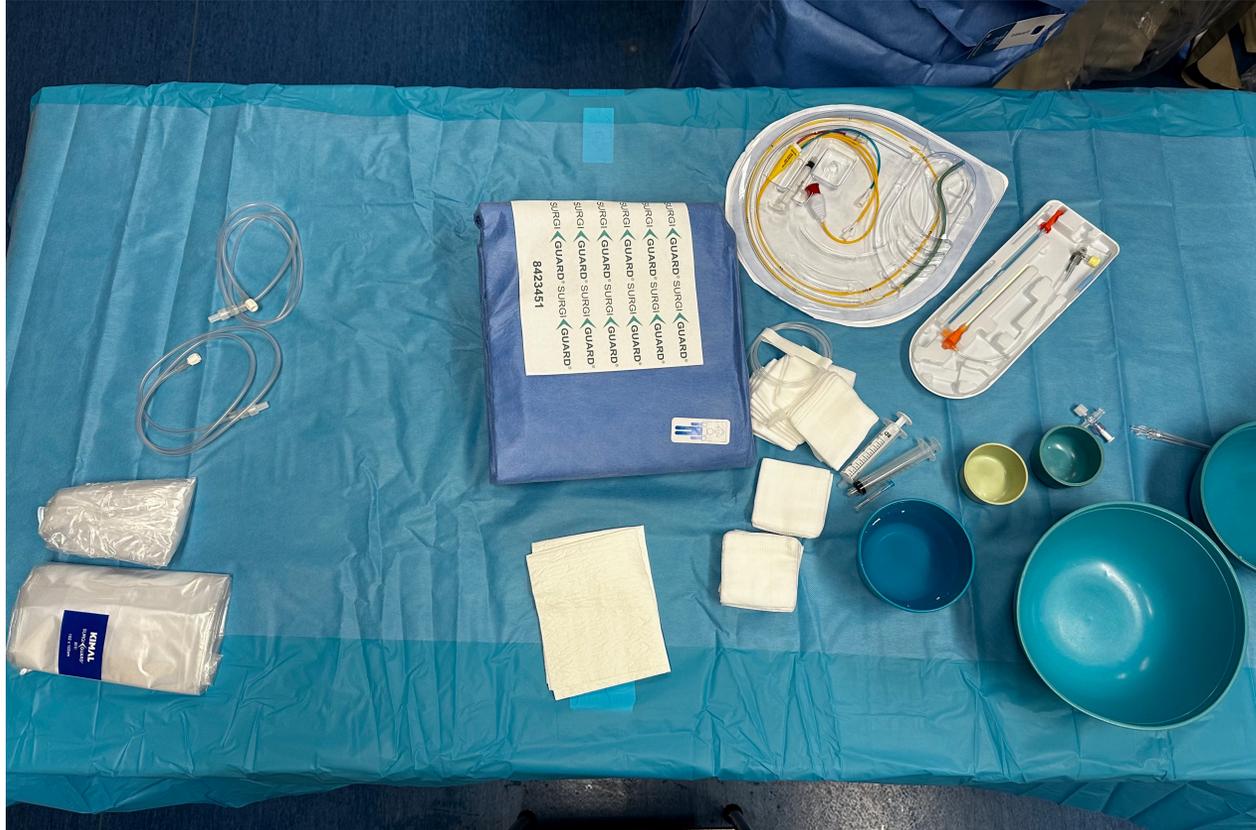
Maron BA. Lancet 2020



Pourquoi ça ne plaît pas aux cardiologues interventionnels ?



Coût VS cotation



81,67 euros

+ une salle de KT pendant 30 min
+ un médecin / 1 manip / 1 IDE



EQQF006 : 96 euros

Code	Intitulé CCAM	Arbre	Tarif
EQQF006	Mesure et enregistrement des pressions du coeur droit et de l'artère pulmonaire, sans injection de produit de contraste, par voie veineuse transcutanée	4.1.2.1	96,00 € Remboursement



Temps de procédure

DOSIMETRIE

**Temps de scopie : 1,1 mn,
PDS cumulé : 163 $\mu\text{Gy.m}^2$.**

DOSIMETRIE

**Temps de scopie : 5,1 mn,
PDS cumulé : 246 $\mu\text{Gy.m}^2$.**

DOSIMETRIE

**Temps de scopie : 16 mn,
PDS cumulé : 1048 cGy.cm^2 .**

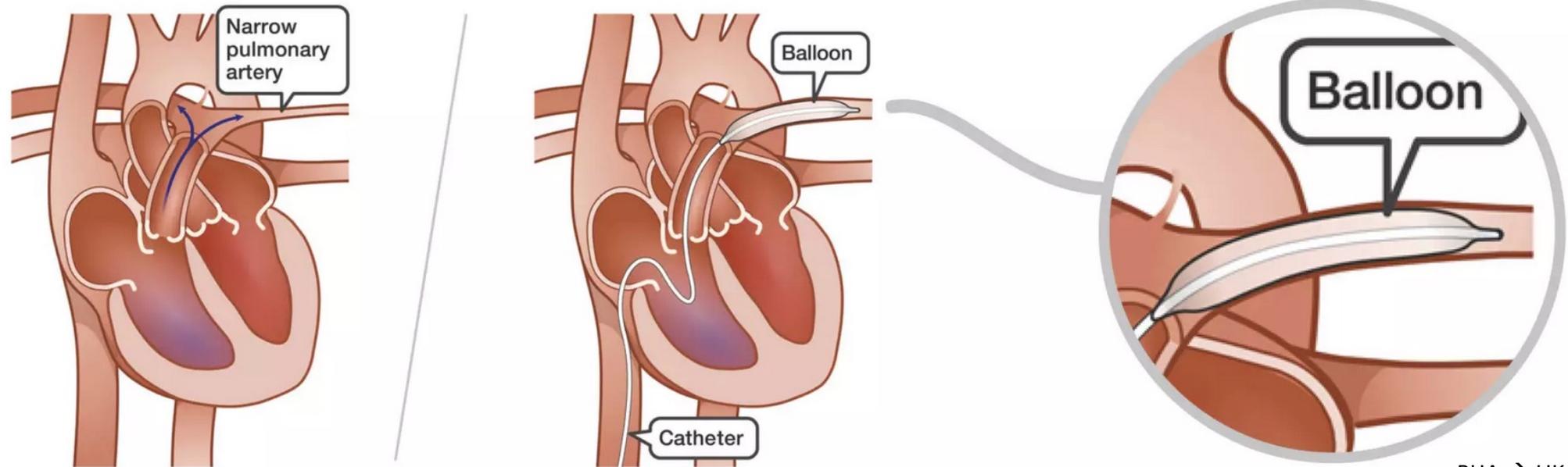


Comment la rendre intéressante ?



L'angioplastie pulmonaire

- L'angioplastie pulmonaire pour les HTP du groupe 4 (post-embolique)

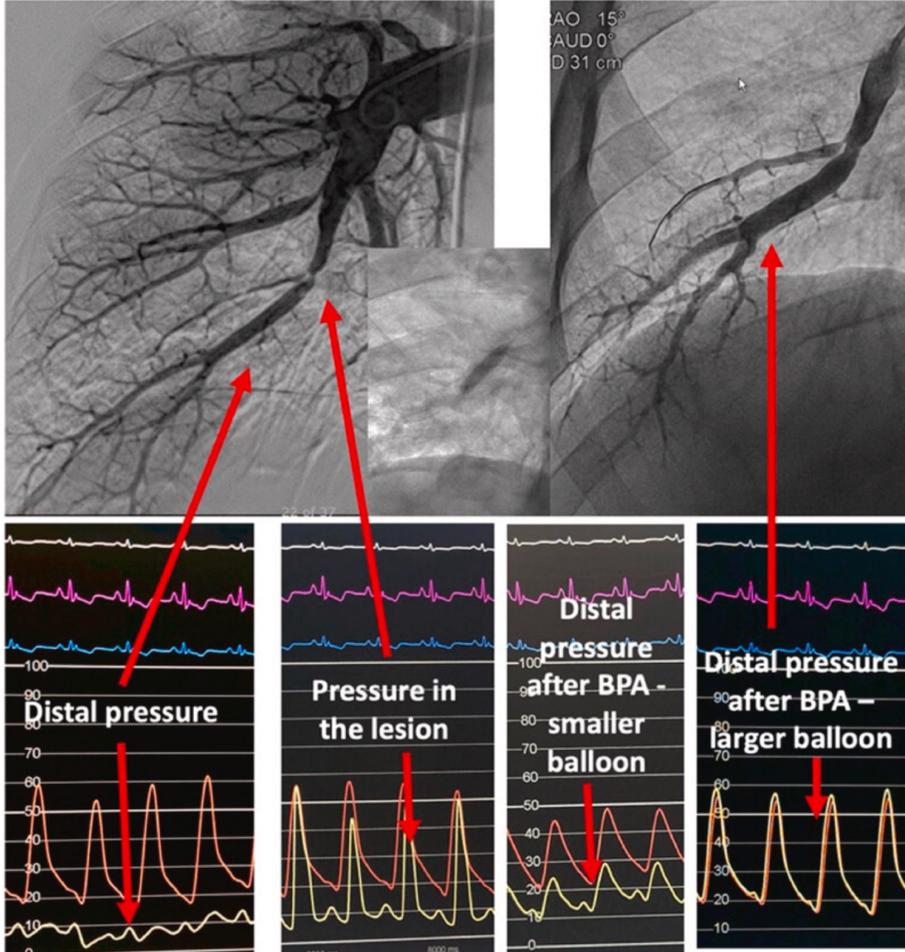


PHA → UK

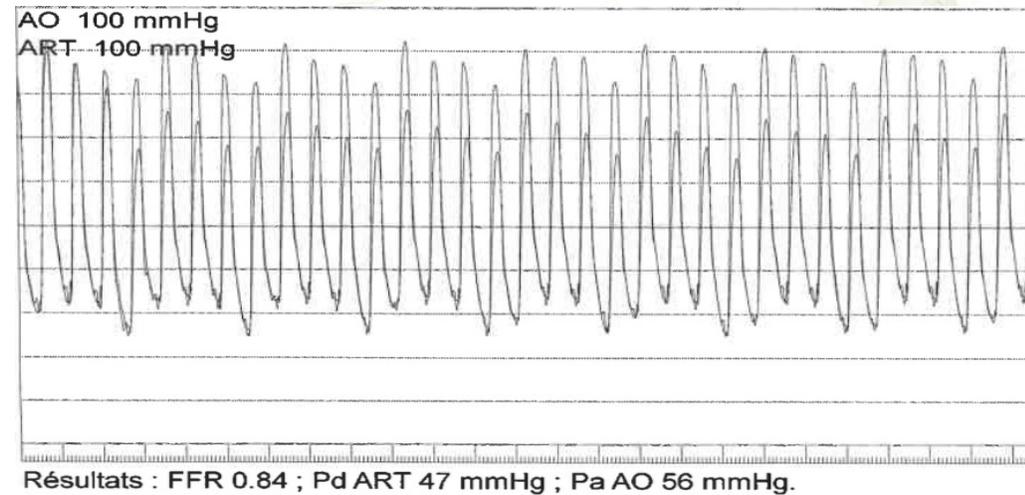
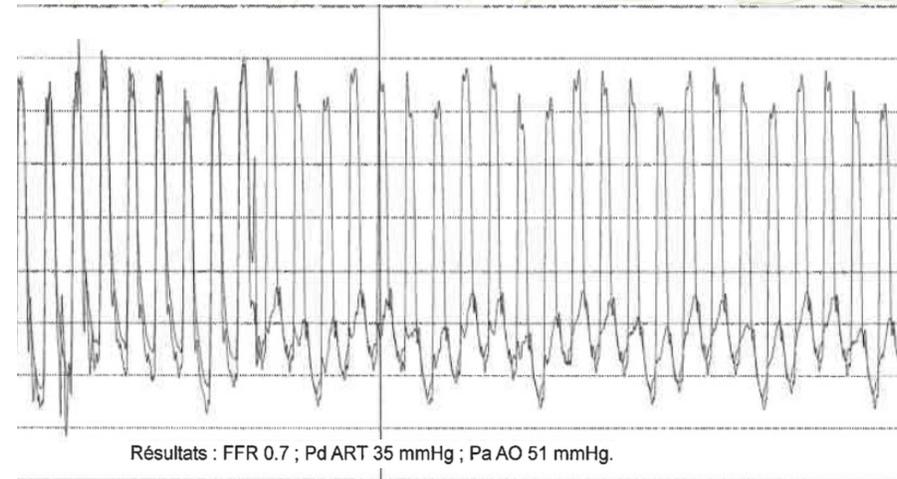


FFR

- FFR : Ratio de pression pulmonaire (Pd/Pp)



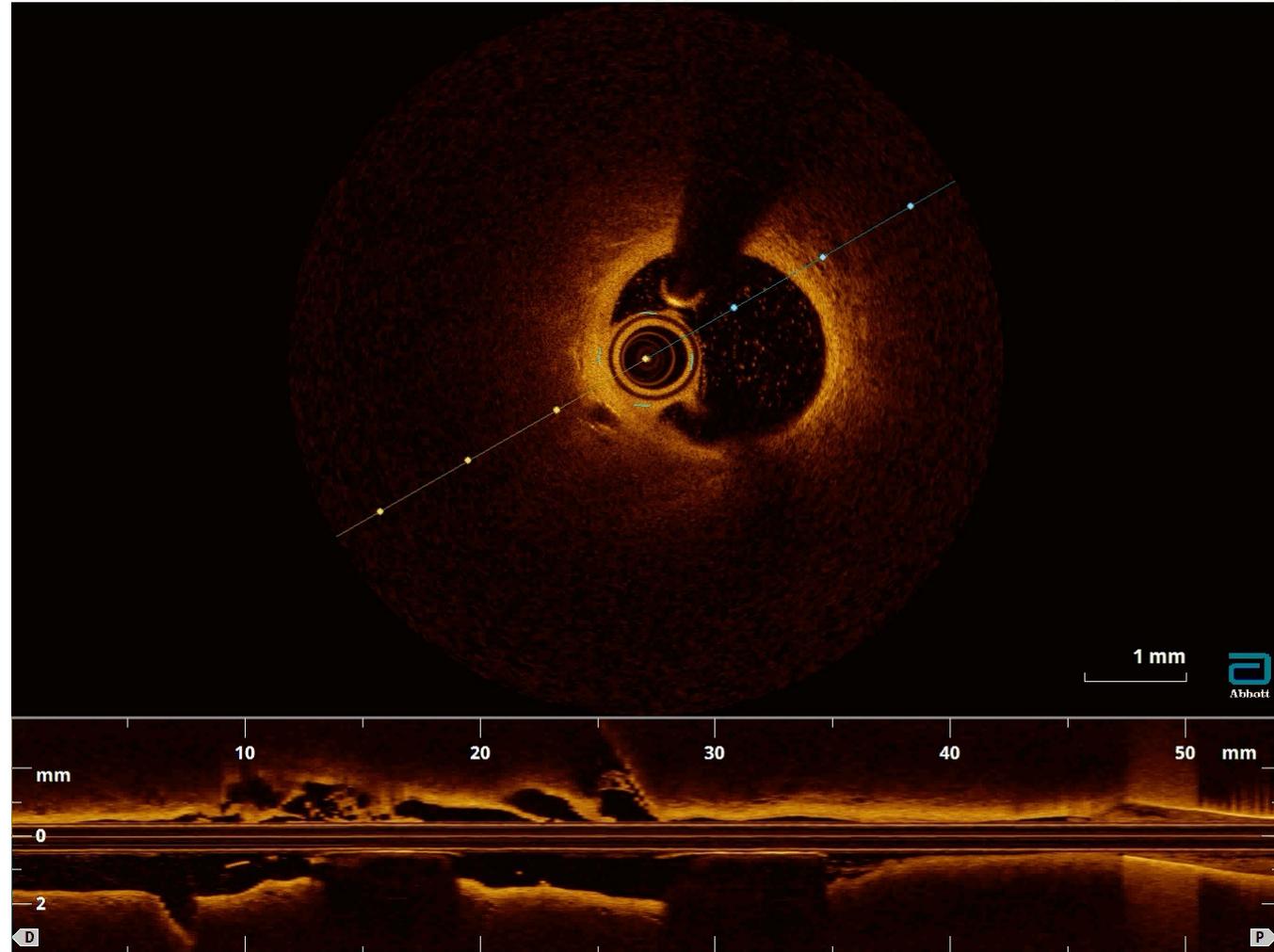
Bashir R. JACC 2023





Comment la rendre intéressante

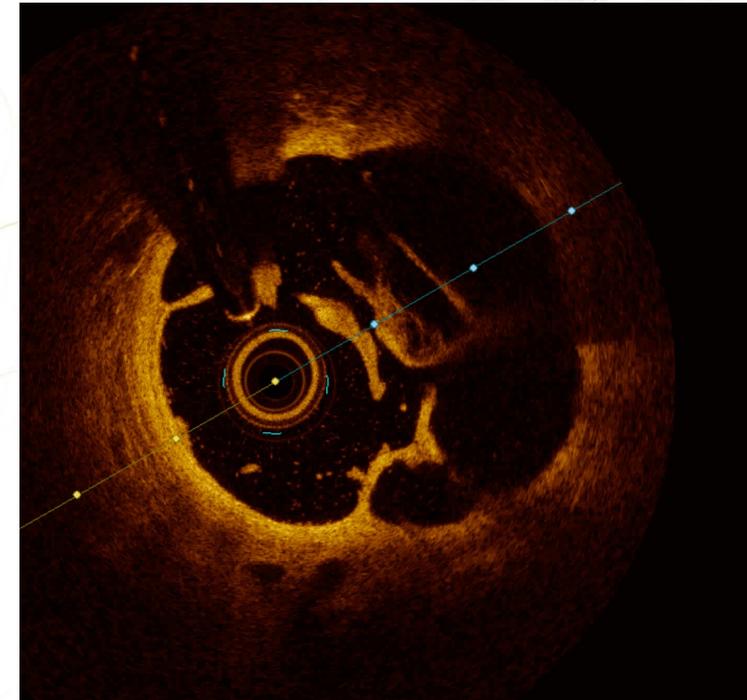
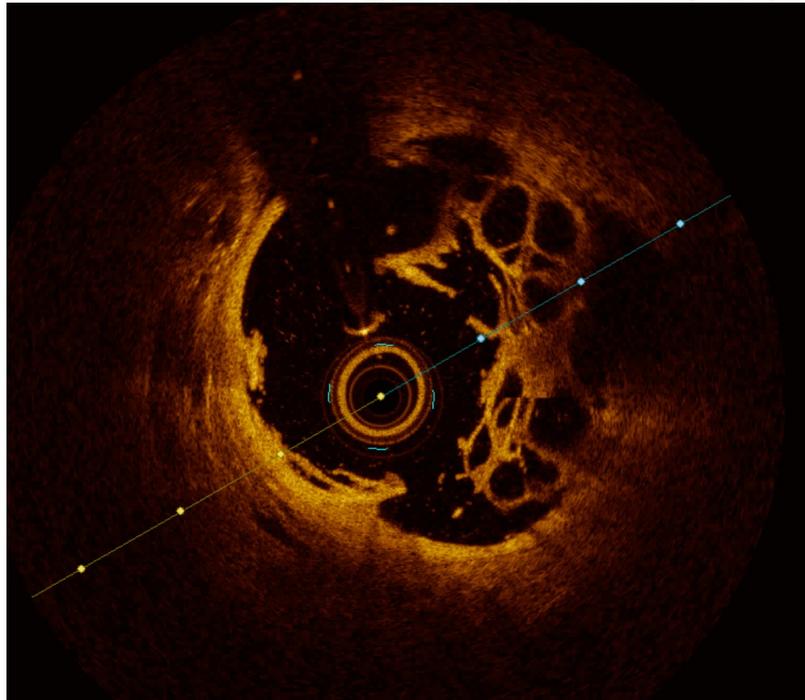
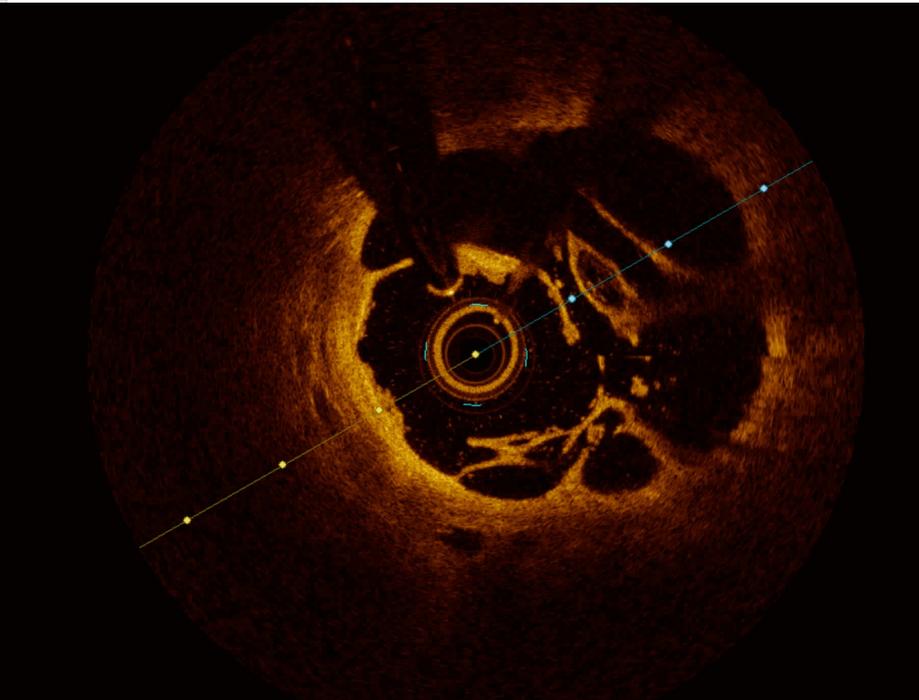
- Imagerie endovasculaire (OCT) : Avant angioplastie





Comment le rendre intéressant

- Imagerie endovasculaire (OCT) : Après angioplastie





JE VOUS REMERCIE POUR VOTRE ATTENTION