GACI

DIU cardiologie interventionnelle

L'angiographie coronaire fonctionnelle: Le nouveau gold standard de l'évaluation coronaire?

Eric Van Belle,

Lille University Hospital

Heart & Lung Institute

FACULTE DE MEDECINE

Instituts thématiques Inserm

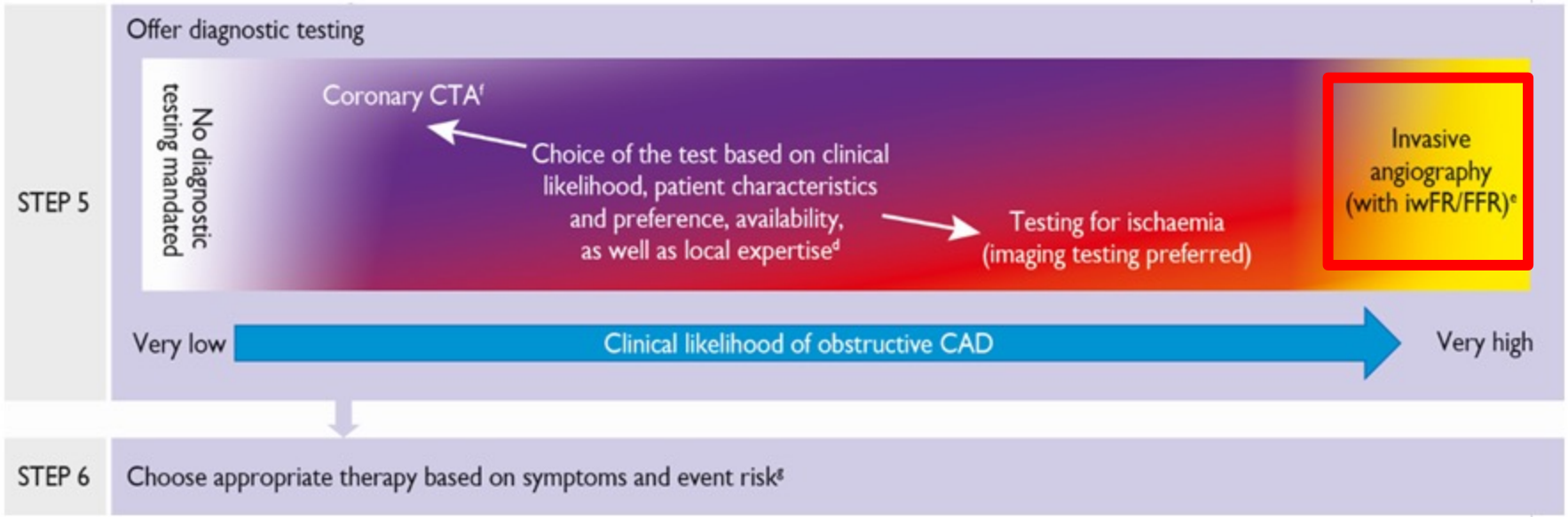
Institut national de la santé et de la recherche médicale

Functional testing and intravascular imaging for lesion assessment

Recommendations	Class	Level
When evidence of ischaemia is not available, FFR or iwFR are recommended to assess the haemodynamic relevance of intermediate-grade stenosis.	I	A

Patients with angina and/or dyspnoea and suspected coronary artery disease

Diagnostic approach (2)



[d] Ability to exercise, individual test-related risks, and likelihood of obtaining diagnostic test result. [e] High clinical likelihood and symptoms inadequately responding to medical treatment, high event risk based on clinical evaluation (such as ST-segment depression, combined with symptoms at a low workload or systolic dysfunction indicating CAD), or uncertain diagnosis on non-invasive testing. [f] Functional imaging for myocardial ischaemia if coronary CTA has shown CAD of uncertain grade or is non-diagnostic. [g] Consider also angina without obstructive disease in the epicardial coronary arteries (see section 6 of full text).

©ESC

ESC Guidelines on the diagnosis and management of chronic coronary syndromes (European Heart Journal 2019; 10.1093/eurheartj/ehz425)

JACC
JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY

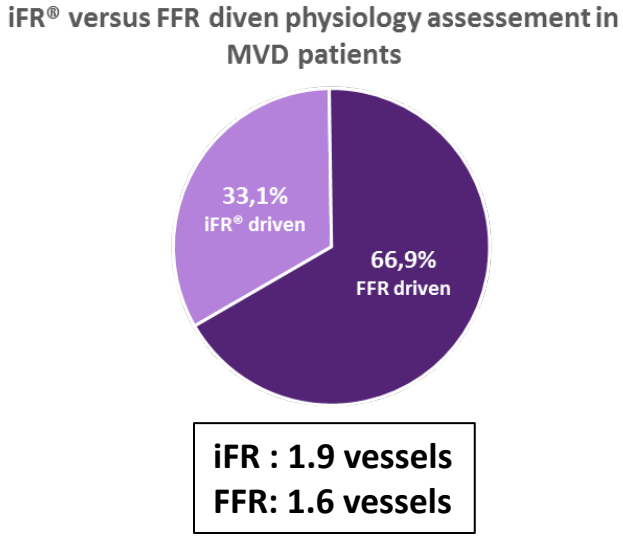
Impact of Routine Invasive Physiology at Time of Angiography in Patients With Multivessel Coronary Artery Disease on Reclassification of Revascularization Strategy

Results From the DEFINE REAL Study

Eric Van Belle, MD, PhD,[a] Robert Gil, MD, PhD,[b] Volker Klauss, MD,[c] Mohammed Balghith, MD,[d] Martijn Meuwissen, MD, PhD,[e] Jérôme Clerc, MD,[f] Bernhard Witzenbichler, MD,[g] Miha Cercek, MD,[h] Marios Vlachojannis, MD,[i] Irene Lang, MD,[j] Philippe Commeau, MD,[k] Flavien Vincent, MD,[a] Luca Testa, MD, PhD,[l] Wojciech Wasek, MD, PhD,[m] Nicolas Debry, MD,[a] Stephan Kische, MD, PhD,[n] Gabriele Gabrielli, MD,[o] Gennaro Sardella, MD, PhD[p]

JACC: CARDIOVASCULAR INTERVENTIONS VOL. 11, NO. 4, 2
FEBRUARY 26, 2018:354–65

Reclassification according to the number of vessel investigated

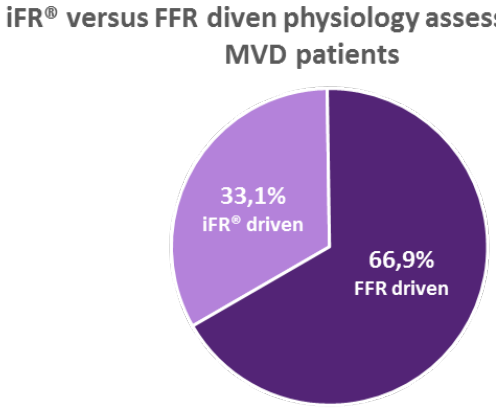


iFR : 1.9 vessels
FFR: 1.6 vessels

Van Belle *et al.*

Routine Invasive Physiology in MVD

Reclassification according to the number of vessel investigated

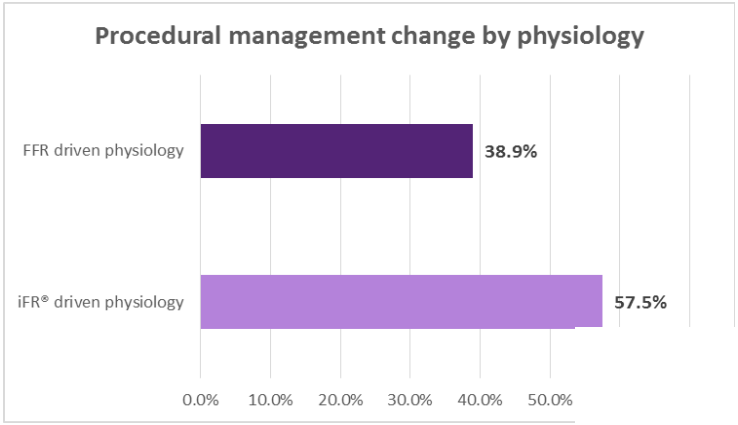


iFR : 1.9 vessels
FFR: 1.6 vessels

P=0.0001

FFR: 1.6 vessels

iFR : 1.9 vessels



Van Belle *et al.*
Routine Invasive Physiology in MVD

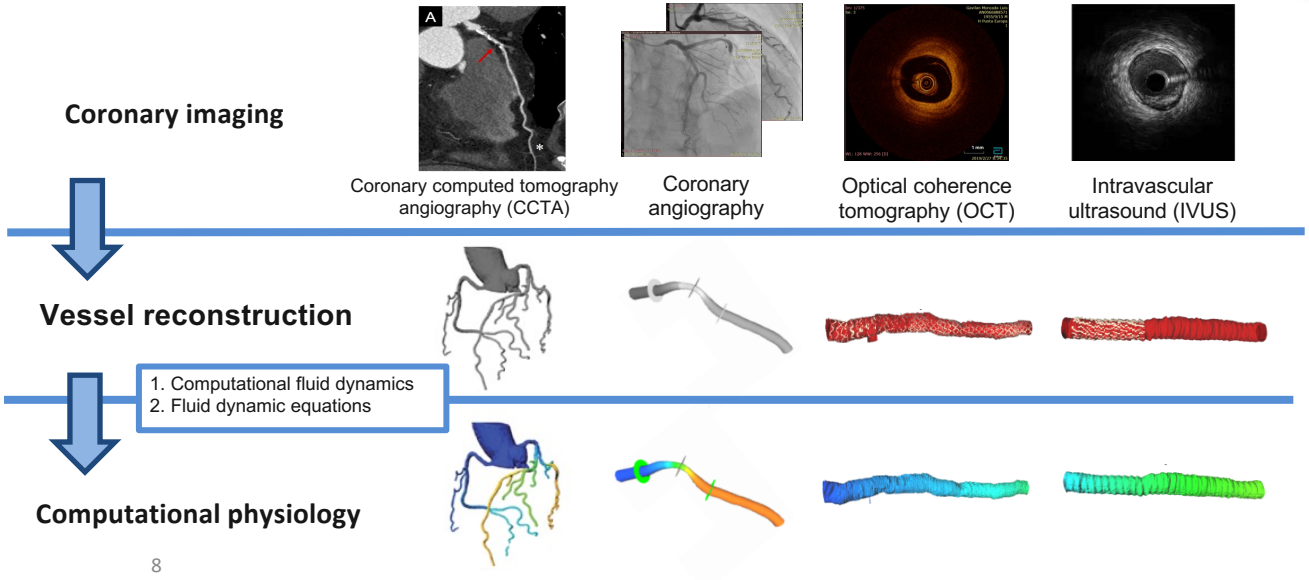
Gold Standard : FFR invasive

Limitations* :	
• Dérive	Prend du temps
• Adénosine	Temps de préparation et effets secondaires
• Manipulation invasive des guides	Risque et temps supplémentaires
• Évaluation des lésions tandem	Insérer des fils plusieurs fois (invasif, risque)
• Refranchissement t des stents pour obtenir le FFR à la fin de la procédure	Insérer/pousser un guide à travers un stent (invasif, risque)
• Cher	Coûts récurrents par procédure

Utilisation mondiale : 7 – 10%

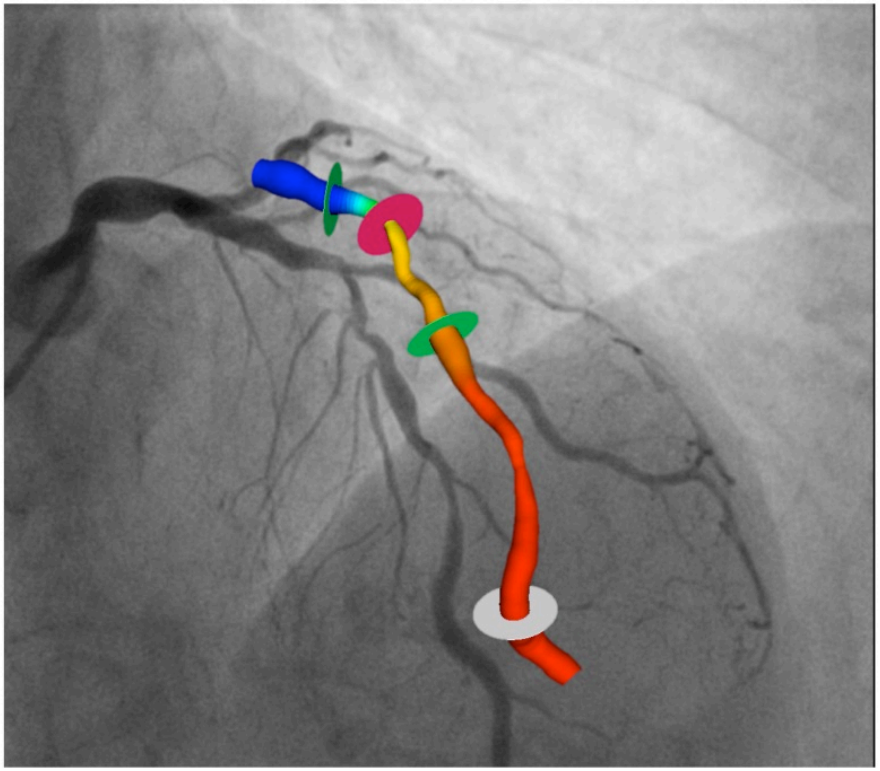
* From Dr Morton Kern: "Ten Things I Don't Like About FFR", Cathlab Digest, Volume 28 - Issue 3 - March 2020

Imaging-based physiology



Tu S, et al. Eur Heart J 2020; 41, 3271–3279.

≤0.8

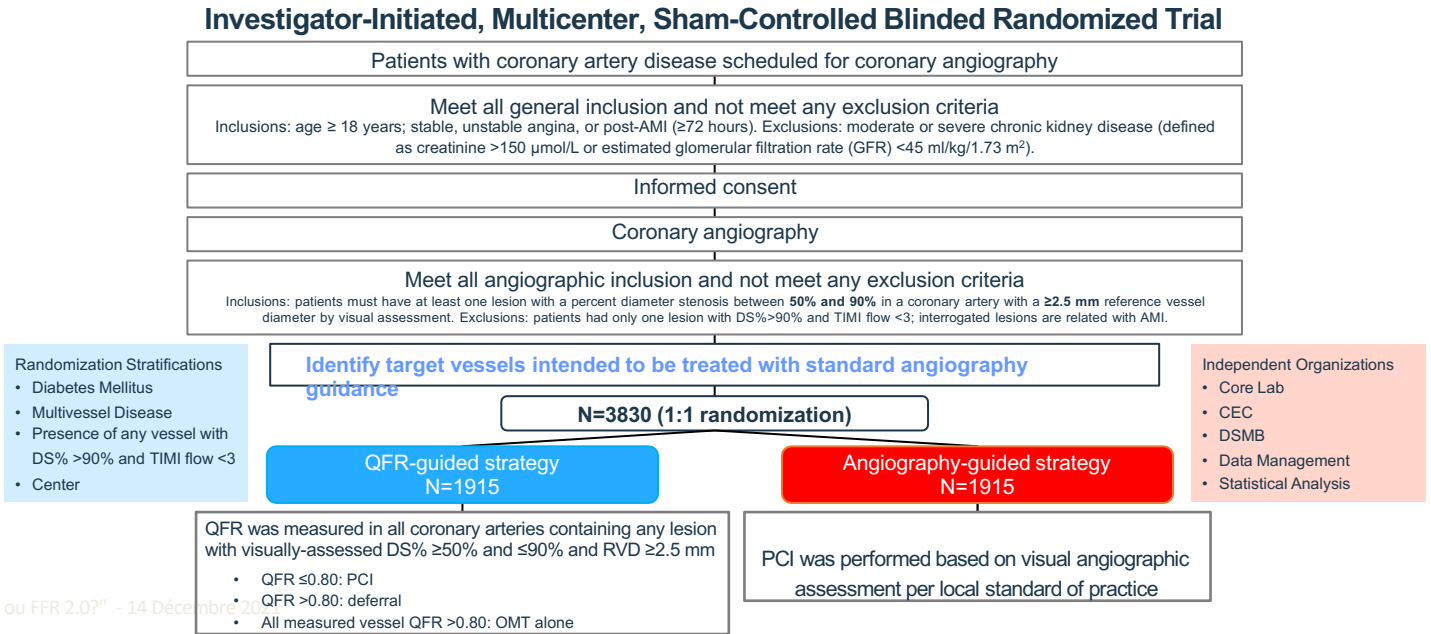


© WEBINAR "La QFR ou FFR 2.0?" - 14 Décembre 2021

Study Design

Angiographic quantitative flow ratio-guided coronary intervention (FAVOR III China): a multicentre, randomised, sham-controlled trial

Bo Xu, Shengxian Tu*, Lei Song*, Zening Jin, Bo Yu, Guosheng Fu, Yujie Zhou, Jian'an Wang, Yundai Chen, Jun Pu, Lianglong Chen, Xinkai Qu, Junqing Yang, Xuebo Liu, Lijun Guo, Chengxing Shen, Yaojun Zhang, Qi Zhang, Hongwei Pan, Xiaogang Fu, Jian Liu, Yanyan Zhao, Javier Escaned, Yang Wang, William F Fearon, Kefei Dou, Ajay J Kirtane, Yongjian Wu, Patrick W Serruys, Weixian Yang, William Wijns, Changdong Guan, Martin B Leon†, Shubin Qiao*†, Gregg W Stone†; FAVOR III China study group‡*



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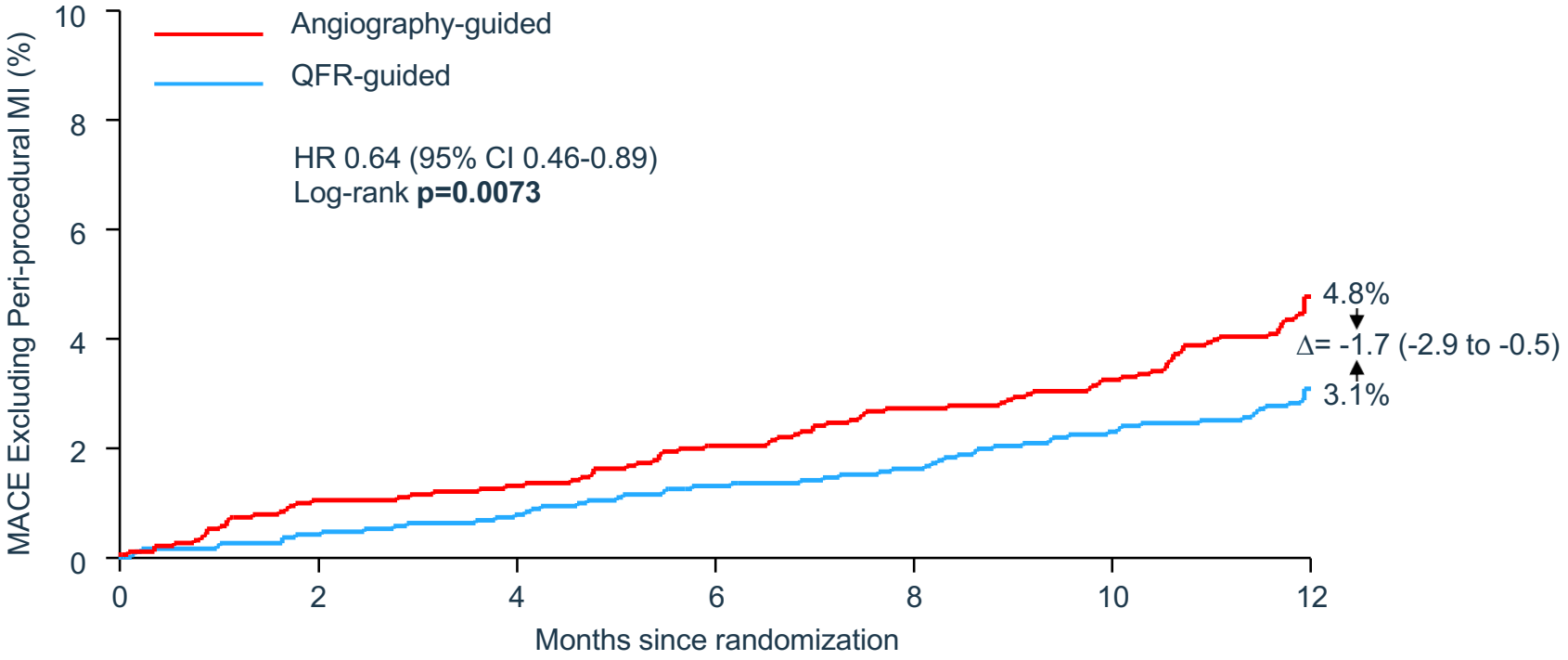
Major Secondary Endpoint (ITT)



No. at risk

QFR-guided	1913	1900	1894	1881	1874	1862	1846
Angiography-guided	1912	1883	1877	1862	1847	1839	1808

Approche vFFR: D'une pierre 2 coups:

- **Approche FFR invasive:**

- évaluation physiologique (par exemple avec FFR): nécessaire pour prouver l'ischémie

- évaluation anatomique (par exemple visuelle ou QCA): nécessaire pour planifier la revascularisation

- **Approche vFFR:**

  – Fournit les 2 informations: physiologiques et anatomiques en une seule analyse non-invasive!

Fonctional Coronary Angiography: Vessel FFR (vFFR)

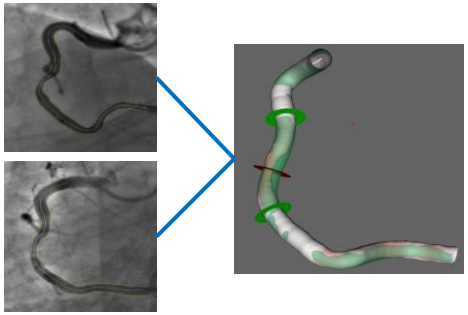
Standard Angiogram

Data Transmission System

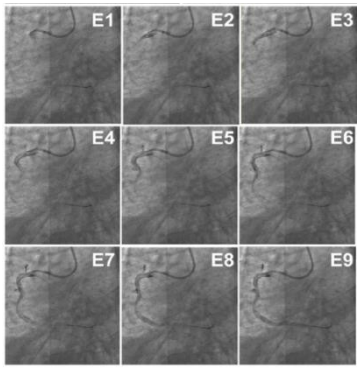
Two image runs with angle difference ≥25°

AngioPlus System

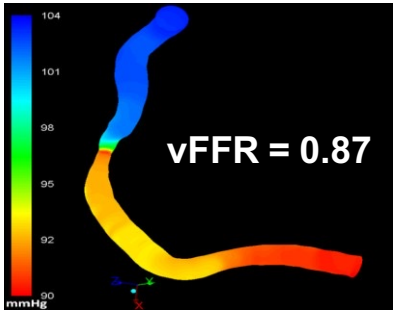
3D Reconstruction



Modified Frame Count



vFFR

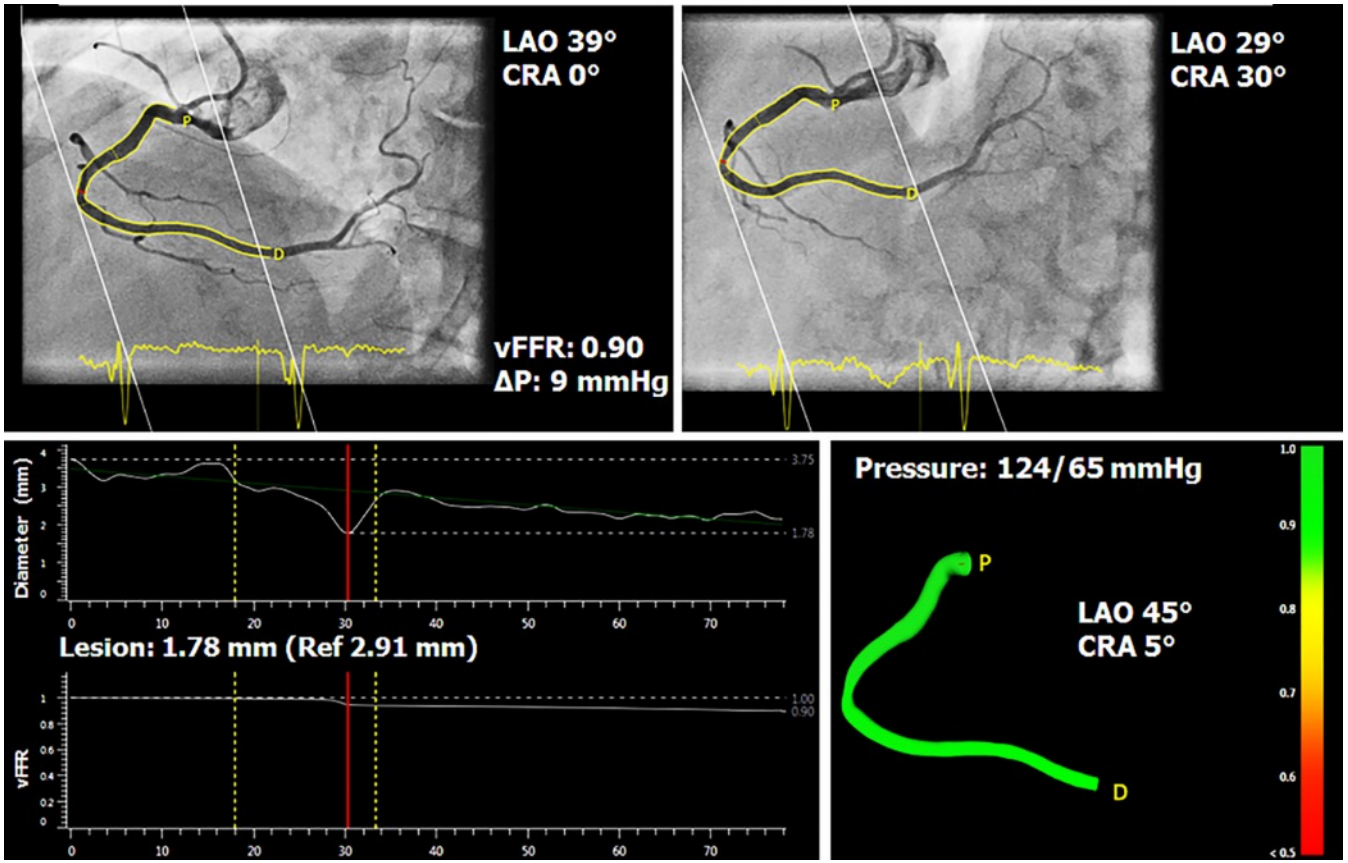


Without Inducing Hyperemia

vFFR based on Agngiography

Required:

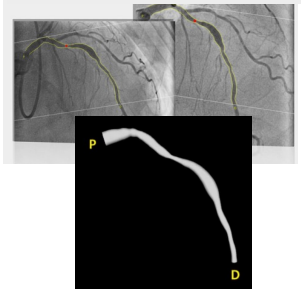
- **2 contrast filled angiograms**
- **Orthogonal views: ≥30 degrees**
- **Invasive aortic pressure**



vessel fractional flow reserve (vFFR)

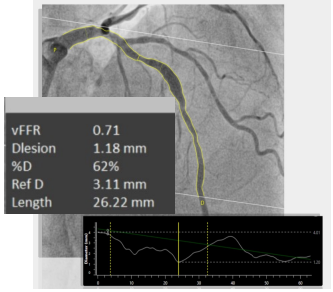
(CAAS, Pie Medical Imaging, Maastricht, the Netherlands)

Step 1. reconstruct 3D coronary geometry



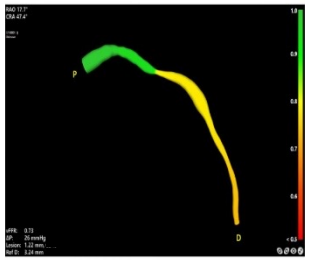
2 projections with ≥30° angle difference

Step 2. stenosis assessment



%DS, reference diameter, MLD, MLA, lesion length

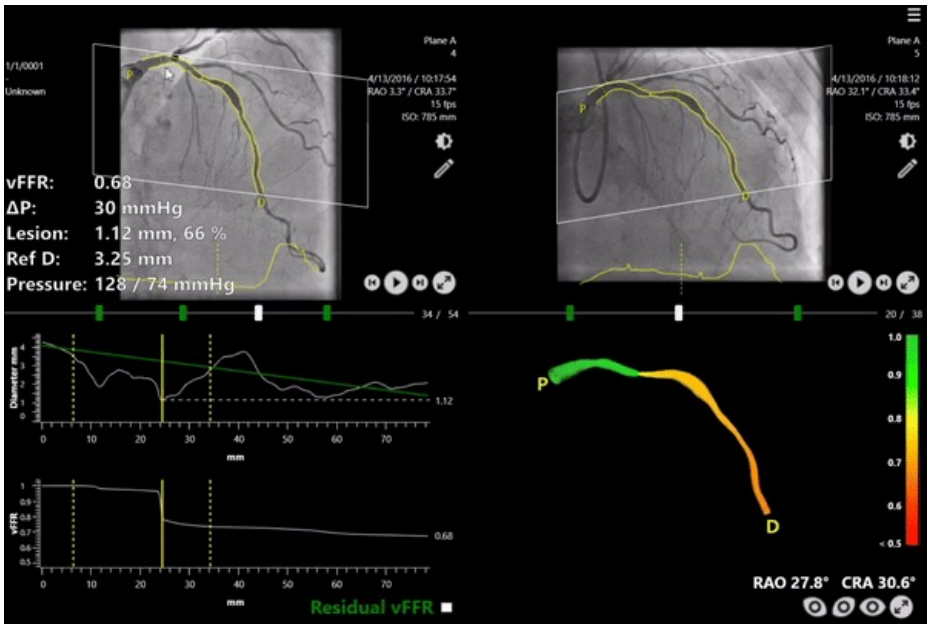
Step 3. Pressure drop calculation



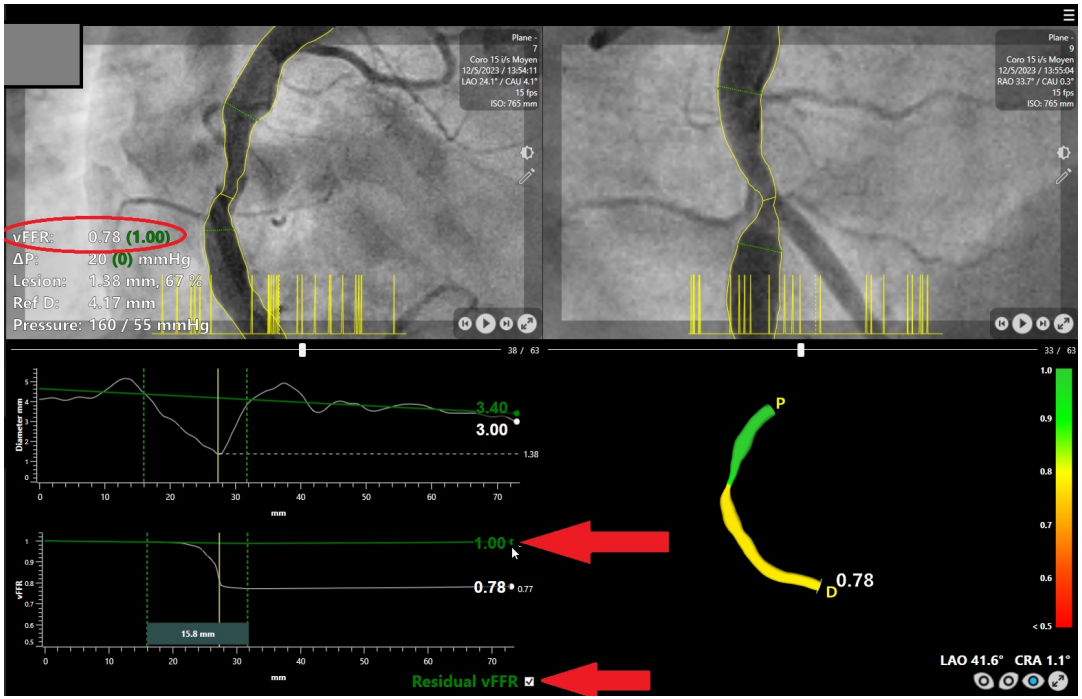
Patient-specific aortic pressure
Empirical hyperemic blood flow

Masdjedi K et al. EuroIntervention 2020,16:591-9

Pullback virtuel de vFFR:



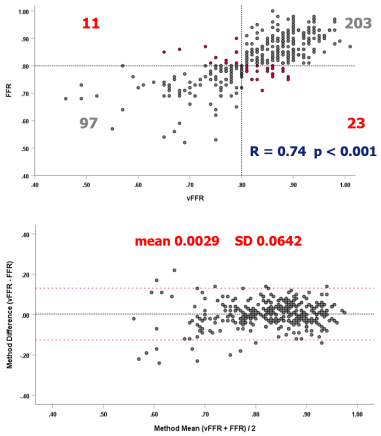
Angioplastie virtuelle par vFFR



FAST II study

(Prospective, observational, multicenter trial)

- **Aim**: To validate CAAS vessel fractional flow reserve (vFFR) using FFR as reference
- 330 vessels from 330 patients



Cardialysis Core Lab Analysis

PPV: 97/108

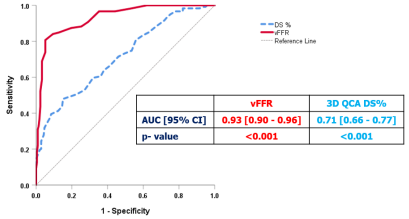
= 90%

NPV: 203/226

= 90%

Accuracy: 300/334 = 90%

Sensitivity: 97/120 = 81%

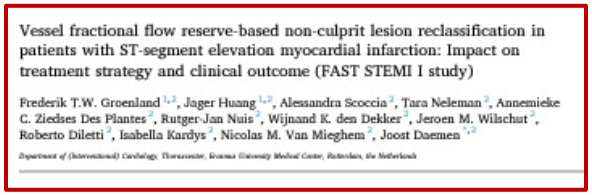


	vFFR	3D QCA DS%
AUC [95% CI]	0.93 [0.90 - 0.96]	0.71 [0.66 - 0.77]
p- value	<0.001	<0.001

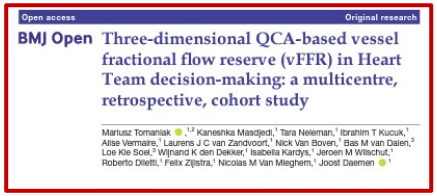
Masdjedi K et al. EuroIntervention 2022

Un nouveau champs des possibles

- Anticipation et optimisation des résultats avec la vFFR résiduelle
- Evaluation physiologique collégiale par la HeartTeam
- Évaluation des lésions non-coupables intermédiaires
- Évaluation ad-hoc d'un patient précédent
- Et bien d'autres encore…


Vessel fractional flow reserve-based non-culprit lesion reclassification in patients with ST-segment elevation myocardial infarction: Impact on treatment strategy and clinical outcome (FAST STEMI I study)

Frederik T.W. Groenland [1,2], Jager Huang [1,2], Alessandra Scoccia [2], Tara Neleman [2], Annemieke C. Ziedses Des Plantes [2], Rutger-Jan Nuis [2], Wijnand K. den Dekker [2], Jeroen M. Wilschut [2], Roberto Diletti [2], Isabella Kardys [2], Nicolas M. Van Mieghem [2], Joost Daemen [1,2]


Open access Original research

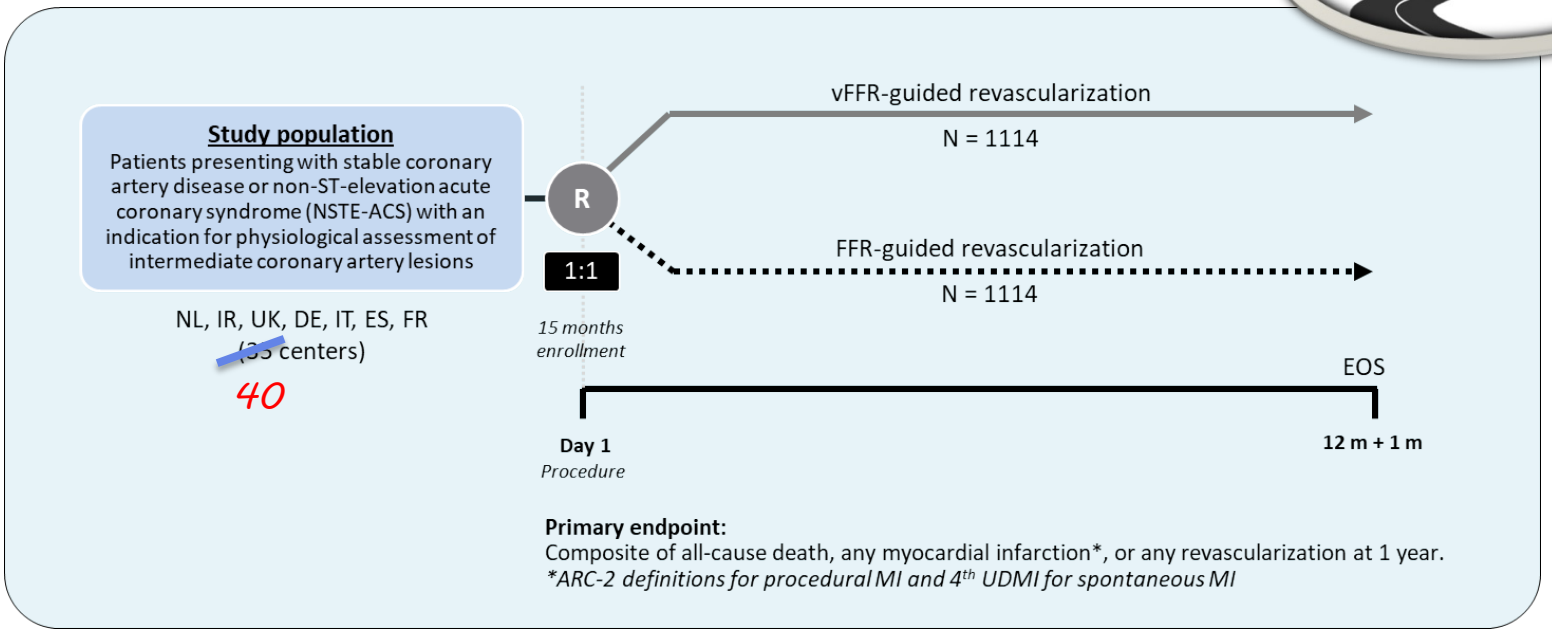
BMJ Open Three-dimensional QCA-based vessel fractional flow reserve (vFFR) in Heart Team decision-making: a multicentre, retrospective, cohort study

Mariusz Tomaniak [1,2], Kaneshka Masdjedi,[1] Tara Neleman,[1] Ibrahim T Kucuk,[1] Alise Vermaire,[1] Laurens J C van Zandvoort,[1] Nick Van Boven,[1] Bas M van Dalen,[3] Loe Kie Soel,[3] Wijnand K den Dekker,[1] Isabella Kardys,[1] Jeroen M Wilschut,[1] Roberto Diletti,[1] Felix Zijlstra,[1] Nicolas M Van Mieghem,[1] Joost Daemen [1]

The prognostic value of angiography-based vessel fractional flow reserve after percutaneous coronary intervention: The FAST Outcome study

Tara Neleman [a], Alessandra Scoccia [a], Kaneshka Masdjedi [a], Mariusz Tomaniak [a,b], Jurgen M.R. Ligthart [a], Karen T. Witberg [a], Alise Vermaire [a], Quinten Wolff [a], Leon Visser [a], Paul Cummins [a], Isabella Kardys [a], Jeroen Wilschut [a], Roberto Diletti [a], Wijnand K. Den Dekker [a], Felix Zijlstra [a], Nicolas M. Van Mieghem [a], Joost Daemen [a,*]

Study Design



ECRI European Cardiovascular Research Institute

FAST III is a randomized controlled, international, non-inferiority trial

Fractional Flow Reserve or 3D-Quantitative-Coronary-Angiography Based Vessel-FFR guided revascularization

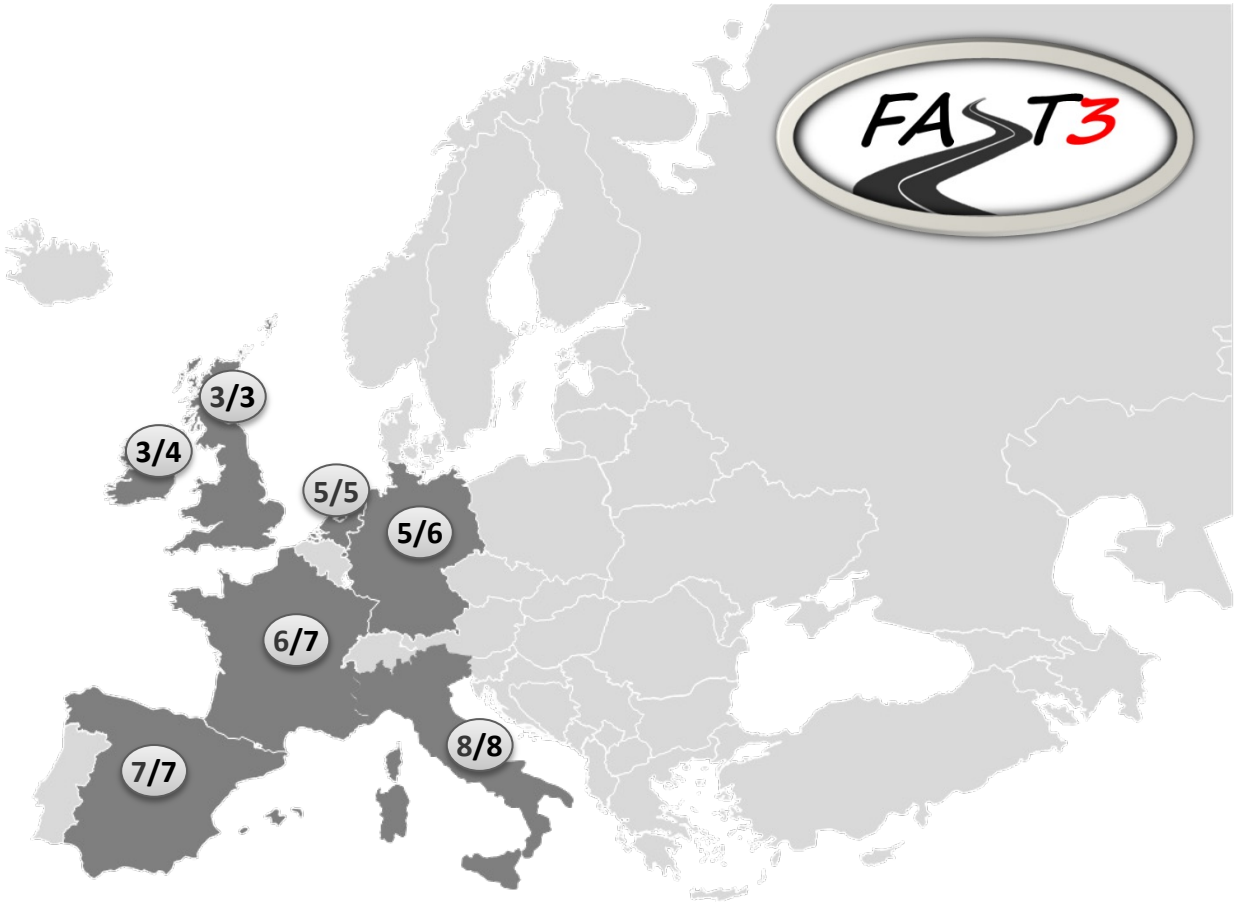
The FAST III Trial

STUDY UPDATE

ECRI European Cardiovascular Research Institute

Active Sites – *3/04/2024*

37/40 sites (93%)

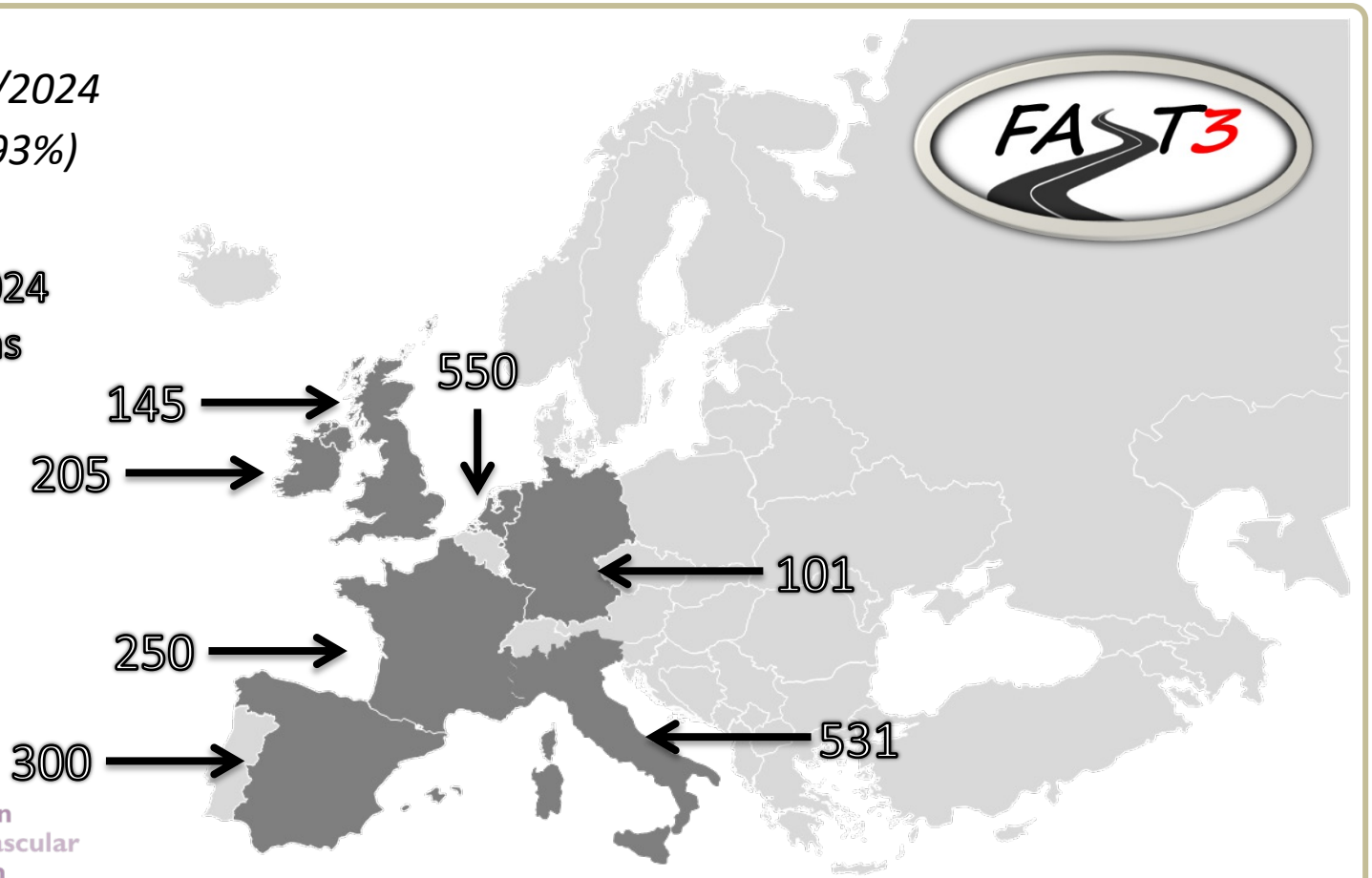


ECRI European Cardiovascular Research Institute

Enrolment – *3/04/2024*

2082/2228 patients (93%)

FPI in 11/2021
LPI planned on 05/2024
Enrolment: 31 months
~2 pts/site/month



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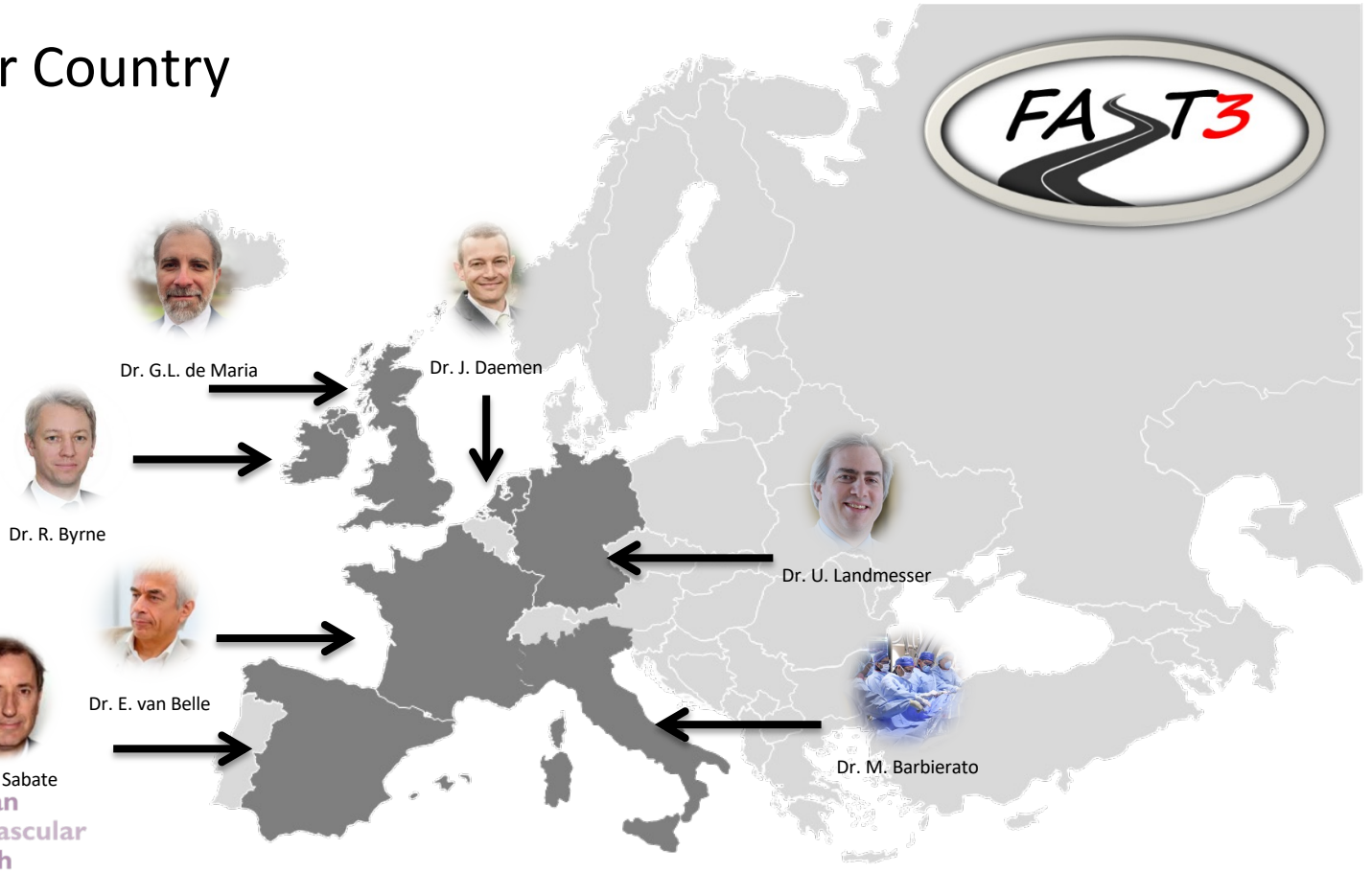
Top Enrollers Per Country



ECRI European Cardiovascular Research Institute

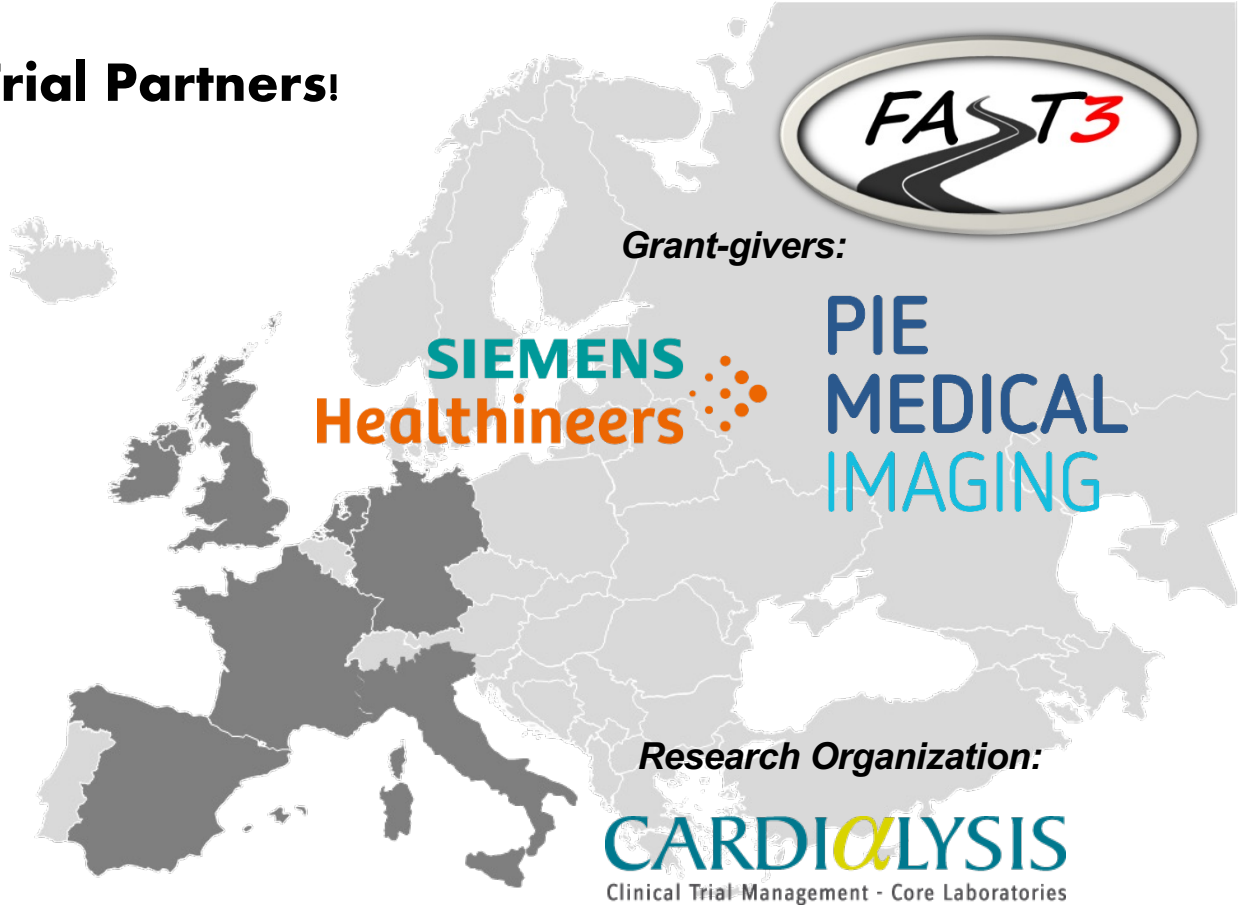
Conclusion

- ✓ Chez le patient stable la documentation de l'ischémie et son attribution à un vaisseau donné sont indispensables à la bonne prise de décision

- ✓ Dans le cadre d'une revascularisation par angioplastie il est indispensable de s'assurer de la correction de l'ischémie dans le territoire traité

- ✓ La mesure "virtuelle" de la FFR par "l'angiographie coronaire fonctionelle" est une technique **validée** (QFR: FAVOR III China) ou en cours de validation (vFFR:FAST III) qui permet de combler de nombreuses limites de la FFR/iFR:
  - ✓ Evaluation rapide des 3 axes coronaires.
  - ✓ Evaluation pendant MAIS AUSSI APRES la coronarographie (IDM, Heart team, oubli, …)
  - ✓ Permet d'obtenir une cartographie de la perte de charge (pull-back virtuel)
  - ✓ Permet d'adapter le "stenting" (longueur, localisation) pour obtenir

Big Thanks to all Trial Partners!



Initiator:

Erasmus MC
University Medical Center Rotterdam

40 European Interventional Cardiology Centers

Grant-givers:

FAST3

SIEMENS Healthineers

PIE MEDICAL IMAGING

Research Organization:

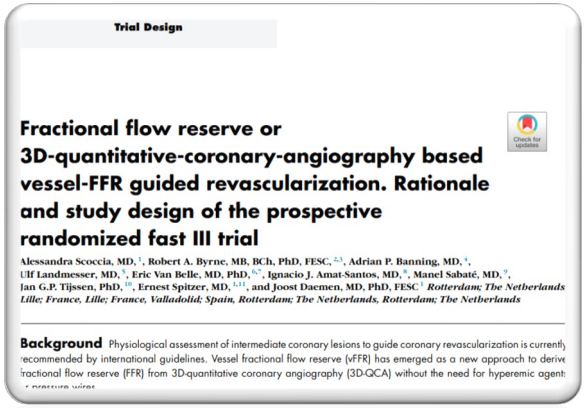
CARDIALYSIS
Clinical Trial Management - Core Laboratories

Sponsor:

ECRI European Cardiovascular Research Institute

Study Objective

- To determine the safety and effectiveness of a vFFR guided strategy versus an invasive FFR guided strategy to guide coronary revascularization in patients with intermediate coronary artery stenosis.



Trial Design

Fractional flow reserve or 3D-quantitative-coronary-angiography based vessel-FFR guided revascularization. Rationale and study design of the prospective randomized fast III trial

Alessandra Scoccia, MD,[1], Robert A. Byrne, MB, BCh, PhD, FESC,[2,3], Adrian P. Banning, MD,[4], Ulf Landmesser, MD,[5], Eric Van Belle, MD, PhD,[6,7], Ignacio J. Amat-Santos, MD,[8], Manel Sabaté, MD,[9], Jan G.P. Tijssen, PhD,[10], Ernest Spitzer, MD,[1,11], and Joost Daemen, MD, PhD, FESC[1] *Rotterdam; The Netherlands Lille; France, Lille; France, Valladolid; Spain, Rotterdam; The Netherlands, Rotterdam; The Netherlands*

Background Physiological assessment of intermediate coronary lesions to guide coronary revascularization is currently recommended by international guidelines. Vessel fractional flow reserve (vFFR) has emerged as a new approach to derive fractional flow reserve (FFR) from 3D-quantitative coronary angiography (3D-QCA) without the need for hyperemic agent:

Rapidité et simplicité

2 angiographies

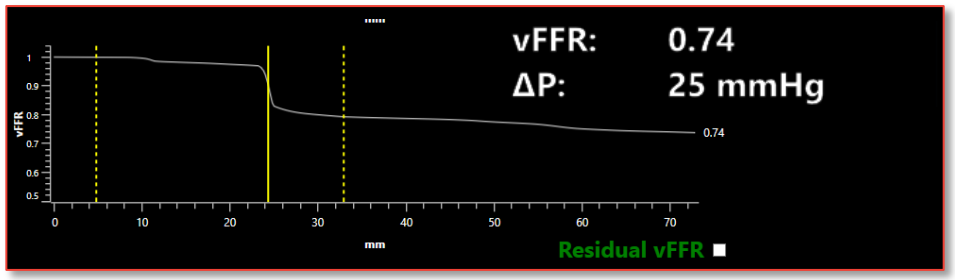
Pression ES et ED

120
80

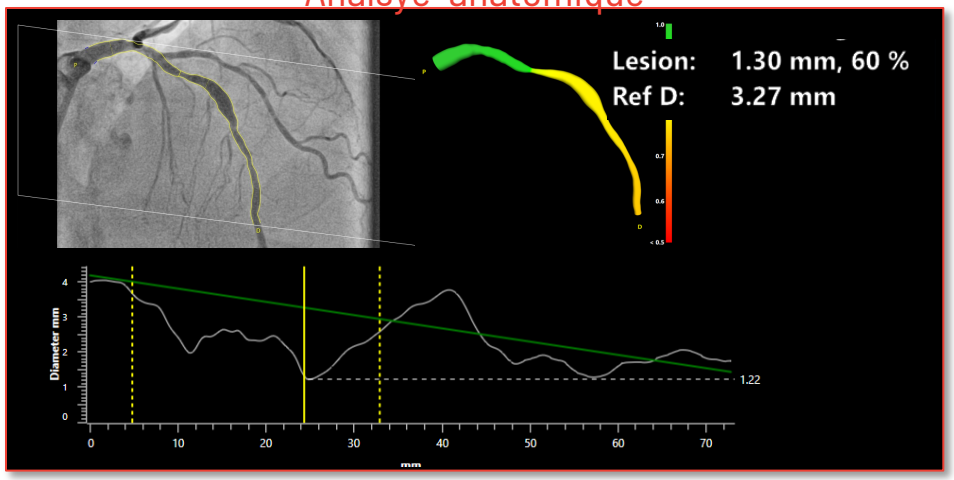
Calcul vFFR <5sec

Analyse complète : <1 minute

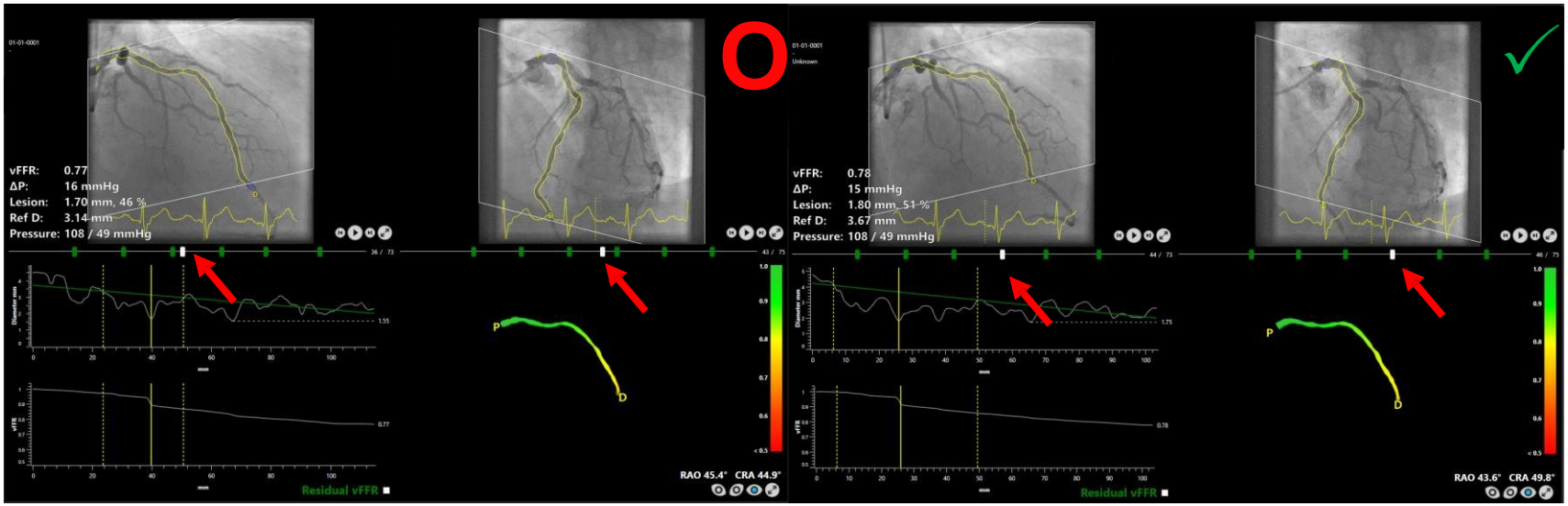
Analyse physiologique



Analsye anatomique



TIPS & TRICKS for vFFR analysis

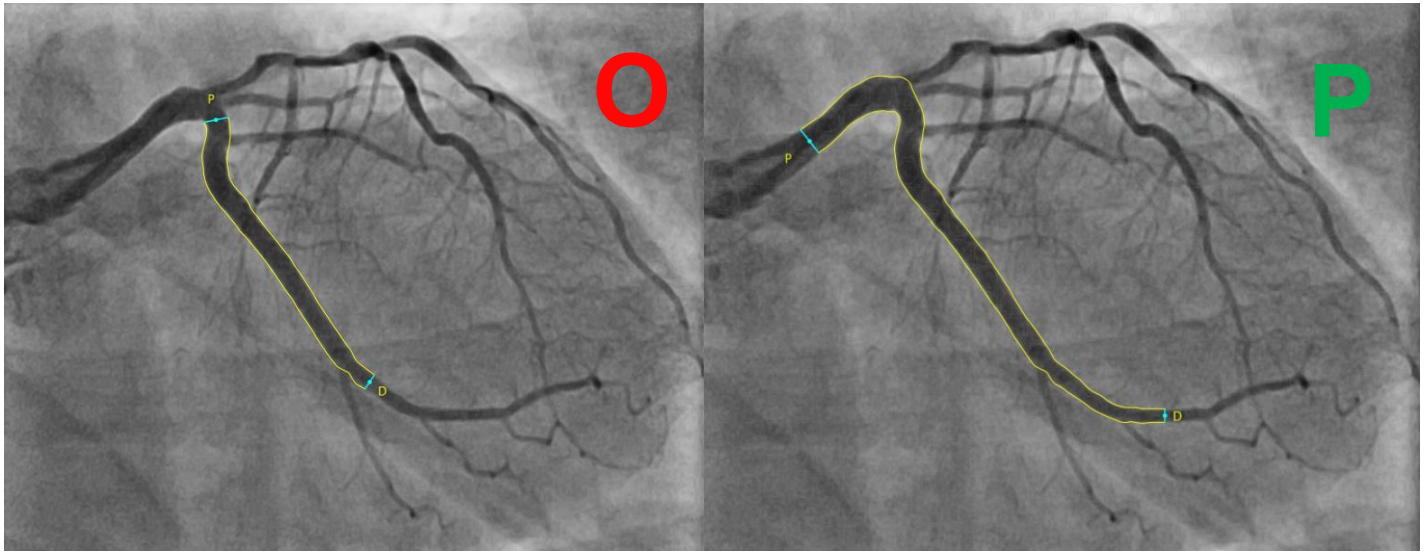


Use optimal end diastolic frame (if possible)

OR

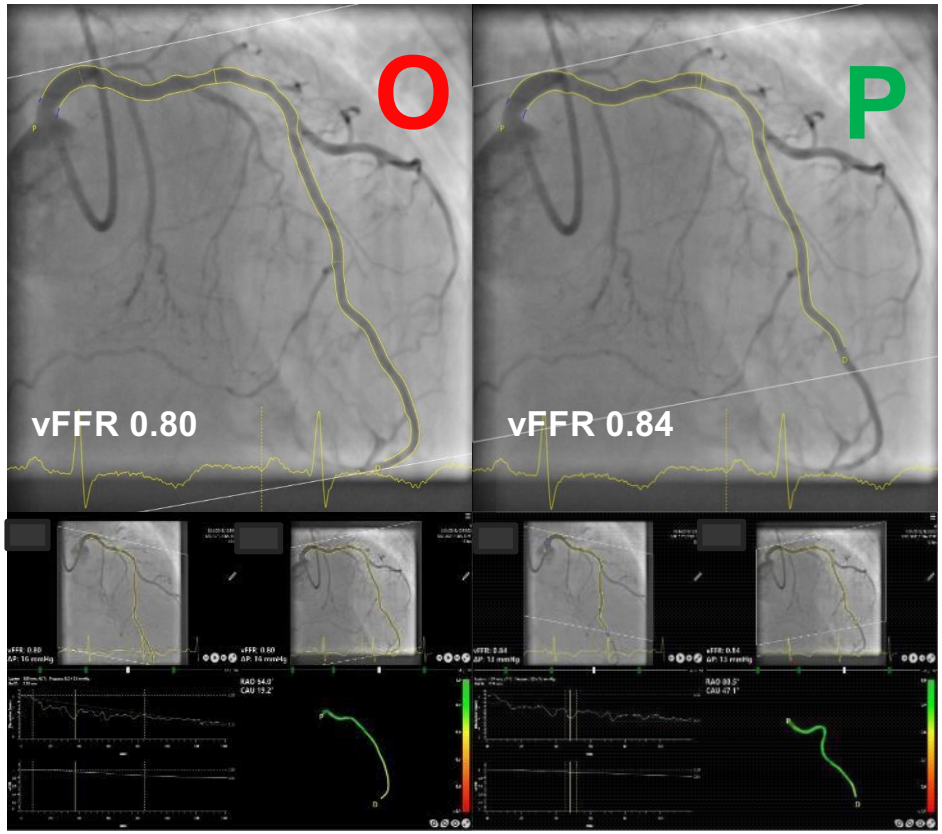
Use similar phase in both projections

TIPS & TRICKS for vFFR analysis



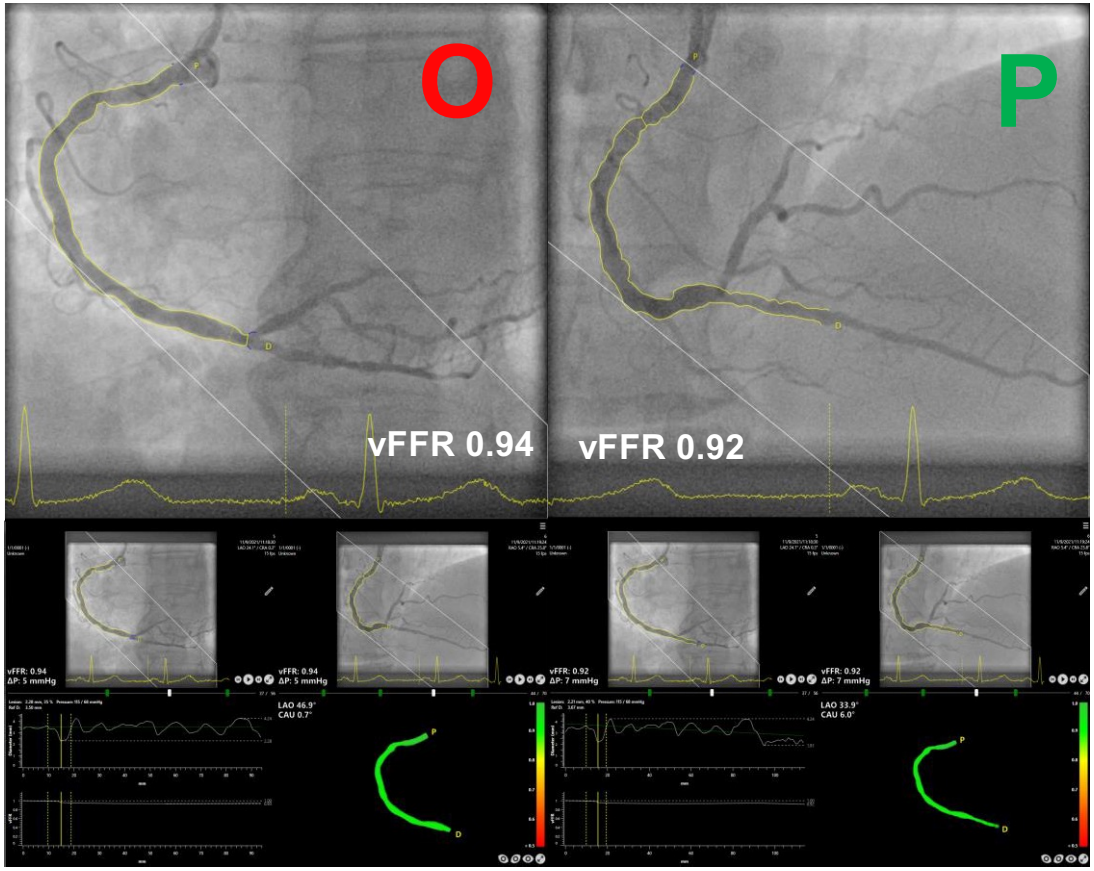
P **Start the analysis as proximal as possible**

TIPS & TRICKS for vFFR analysis



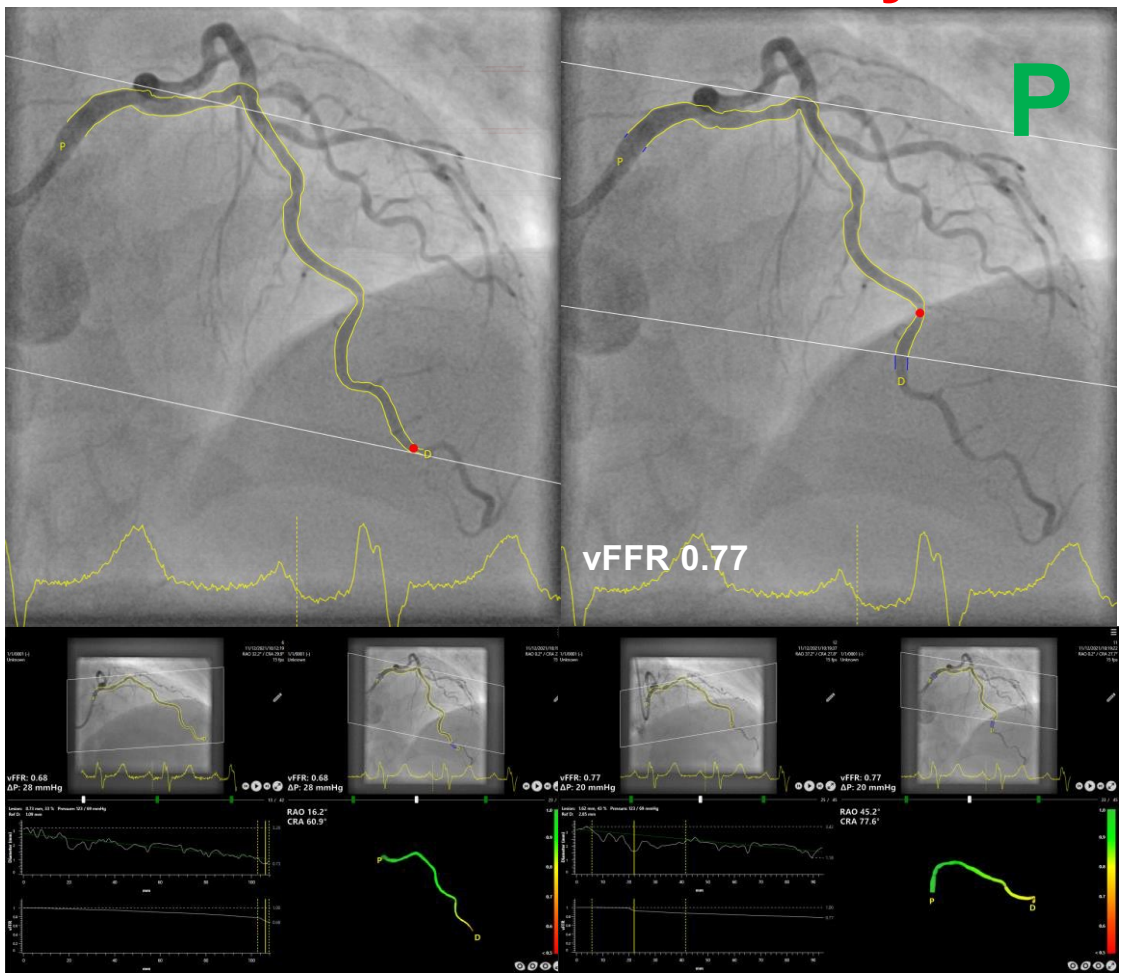
✓ **Contour detection should not be performed in distal segments where the reference vessel diameter < 2.0 mm**

TIPS & TRICKS for vFFR analysis:



✓ **Do not end the analysis in a bifurcation**

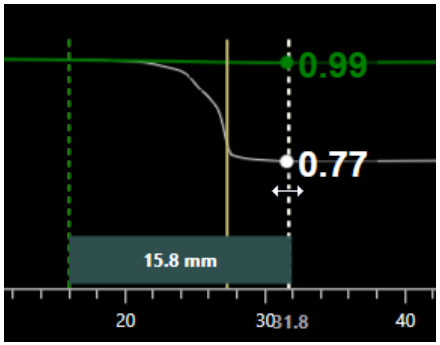
TIPS & TRICKS for vFFR analysis

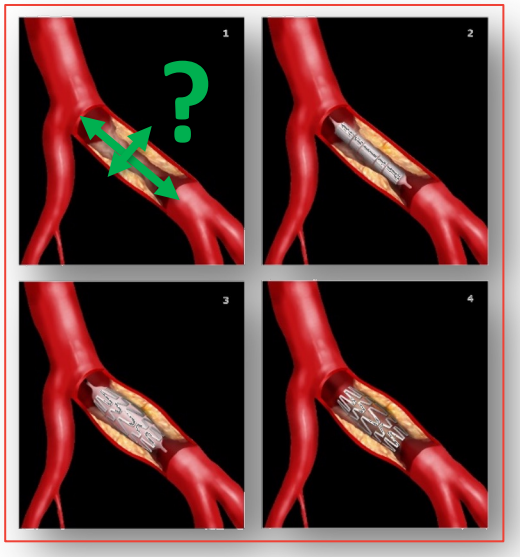


✓ **Do not end the analysis in a diseased segment**

Angioplastie virtuelle par vFFR

- Comment poser le stent : sélection de la stratégie de pose de stent
- Où poser le stent : évaluation des dimensions du stent (longueur et taille)





Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

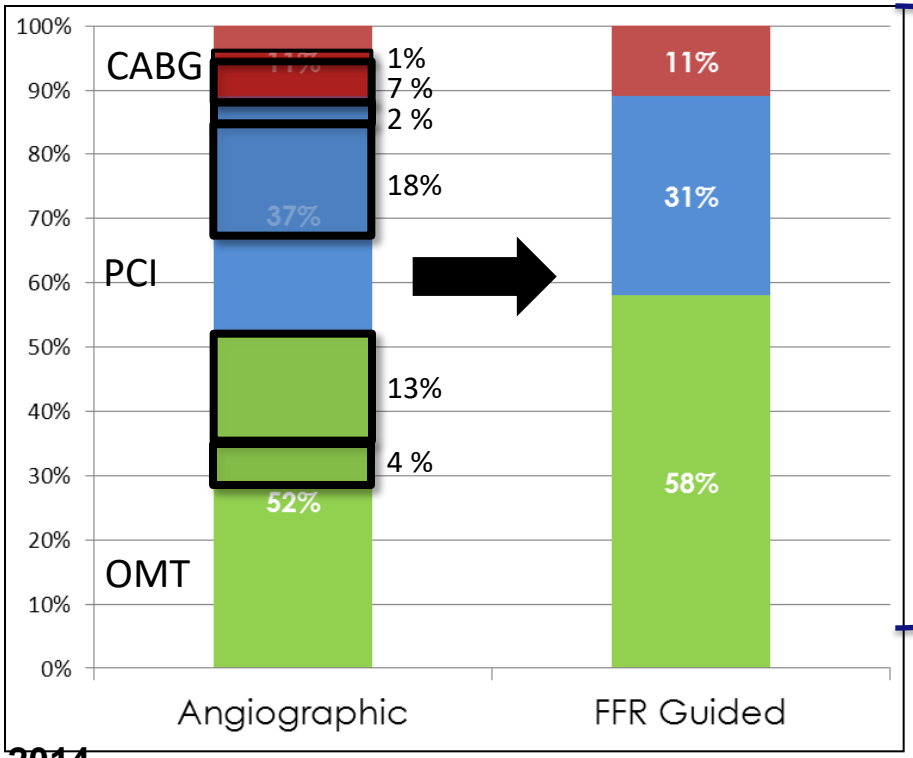
R3F

American Heart Association

Outcome Impact of Coronary Revascularization Strategy Reclassification With Fractional Flow Reserve at Time of Diagnostic Angiography

Insights From a Large French Multicenter Fractional Flow Reserve Registry

Eric Van Belle, MD, PhD; Gilles Rioufol, MD, PhD; Christophe Pouillot, MD;



43% of patients changed therapy with FFR guidance

Van Belle et al. Circulation 2014

QCM 1

- Dans le cadre de la prise en charge d'un infarctus transmural par angioplastie primaire chez un patient multitronculaire, vous faites la FFR des vaisseaux non-coupables:
- A) Oui, dans la même procédure
- B) Oui, dans la même procédure (mais pas la nuit)
- C) Oui, je remet le patient sur la table pour une nouvelle coronarographie (et un FFR) quelques jours plus tard.
- D) jamais

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

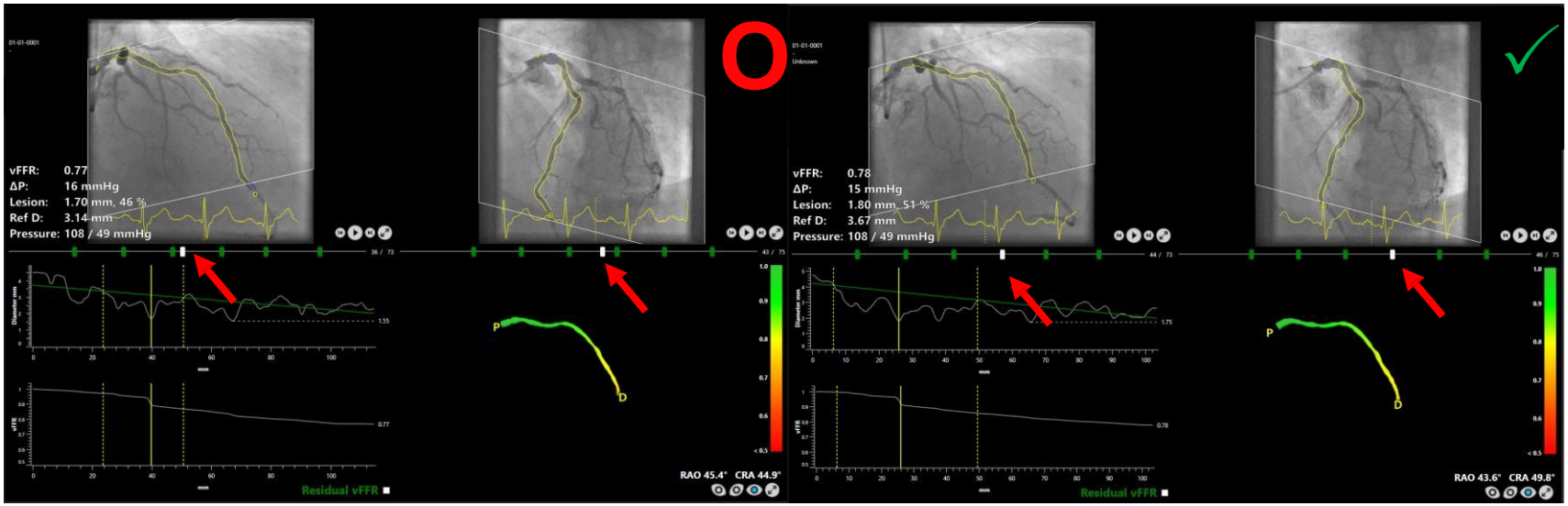
Multivessel PCI Guided by FFR or Angiography for Myocardial Infarction

Etienne Puymirat, M.D., Ph.D., Guillaume Cayla, M.D., Ph.D., Tabassome Simon, M.D., Ph.D., Philippe G. Steg, M.D., Gilles Montalescot, M.D., Ph.D., Isabelle Durand-Zaleski, M.D., Ph.D., Alicia le Bras, M.D., Romain Gallet, M.D., Ph.D., Khalife Khalife, M.D., Jean-François Morelle, M.D., Pascal Motreff, M.D., Ph.D., Gilles Lemesle, M.D., Ph.D., Jean-Guillaume Dillinger, M.D., Ph.D., Thibault Lhermusier, M.D., Ph.D., Johanne Silvain, M.D., Ph.D., Vincent Roule, M.D., Ph.D., Jean-Noel Labèque, M.D., Grégoire Rangé, M.D., Grégory Ducrocq, M.D., Ph.D., Yves Cottin, M.D., Didier Blanchard, M.D., Anaïs Charles Nelson, N.D., Bernard De Bruyne, M.D., Ph.D., Gilles Chatellier, M.D., and Nicolas Danchin, M.D., for the FLOWER-MI Study Investigators*

Initial plan:
To perform FFR of non-culprit at the time of the initial PCI in all patients

Actaal plan
<5% of patients had FFR of additional non culprit during the index angiography

TIPS & TRICKS for vFFR analysis

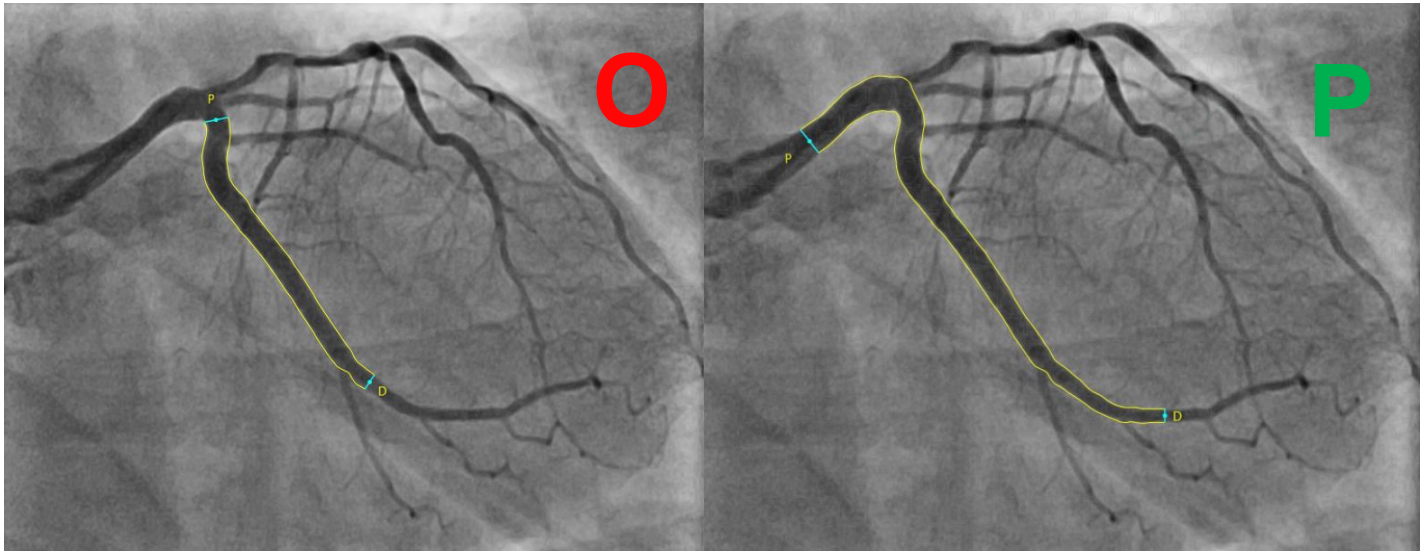


Use optimal end diastolic frame (if possible)

OR

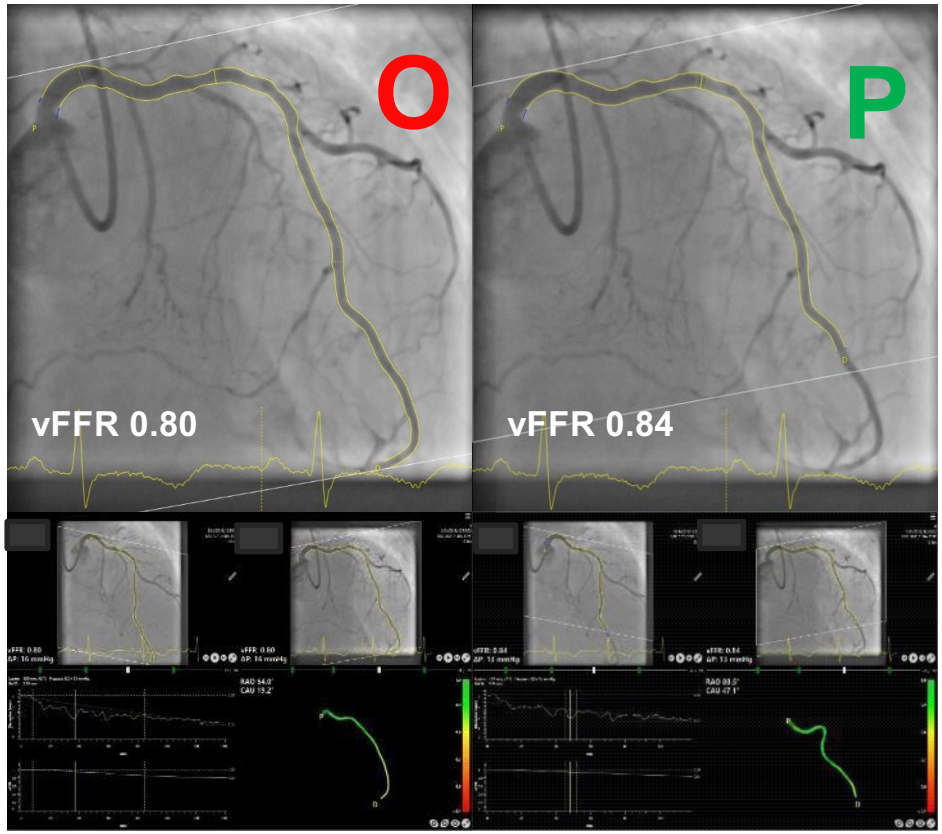
Use similar phase in both projections

TIPS & TRICKS for vFFR analysis



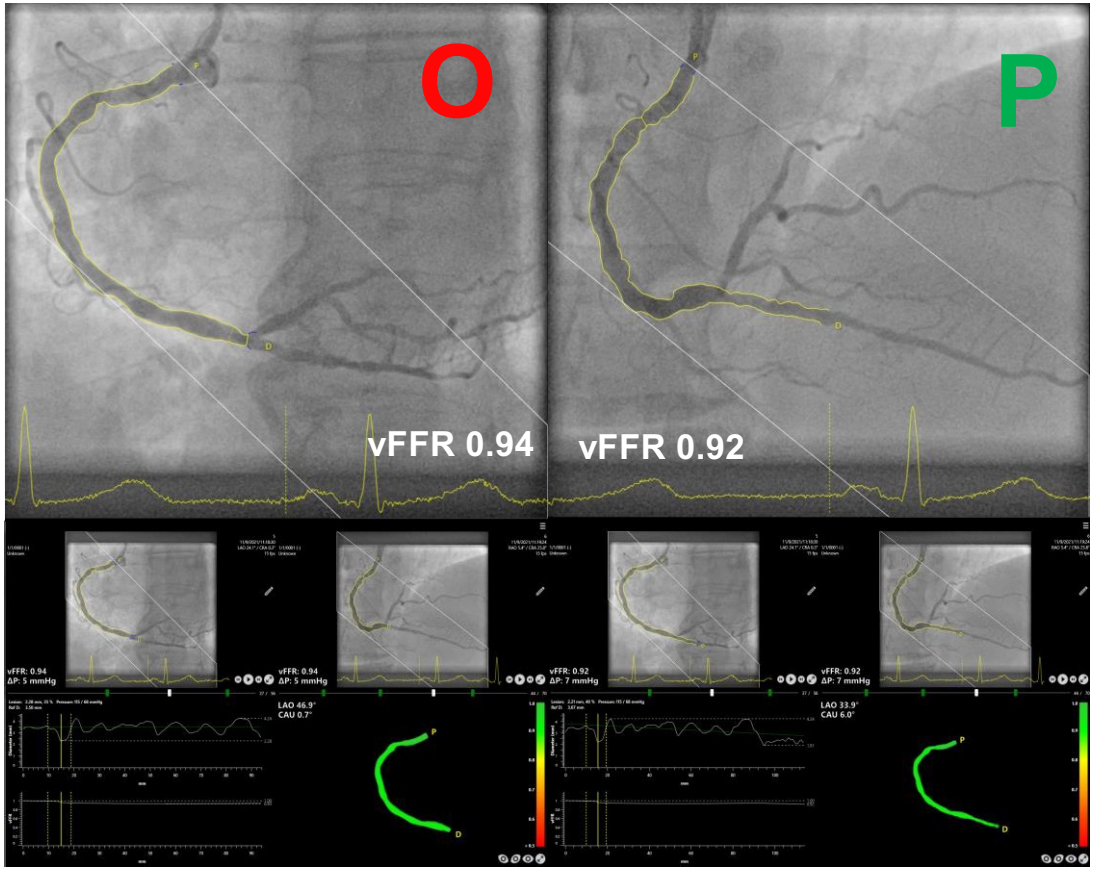
P **Start the analysis as proximal as possible**

TIPS & TRICKS for vFFR analysis



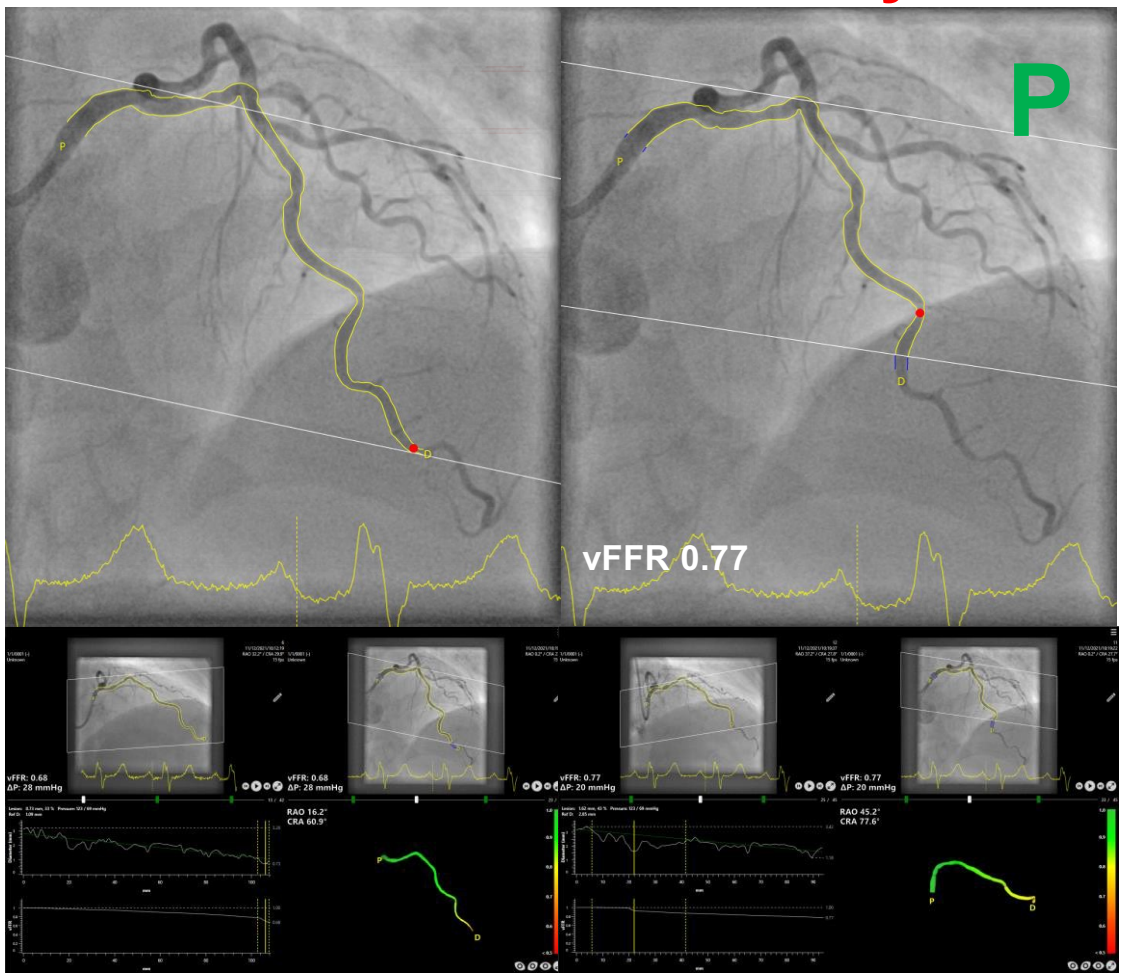
✓ **Contour detection should not be performed in distal segments where the reference vessel diameter < 2.0 mm**

TIPS & TRICKS for vFFR analysis:



✓ **Do not end the analysis in a bifurcation**

TIPS & TRICKS for vFFR analysis



✓ **Do not end the analysis in a diseased segment**

Angioplastie virtuelle par vFFR

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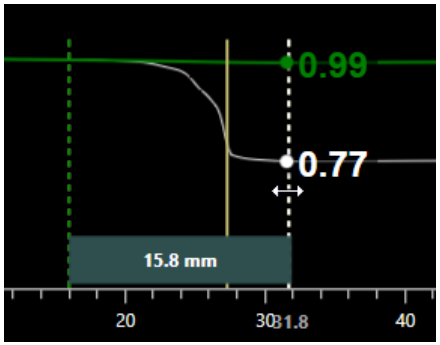
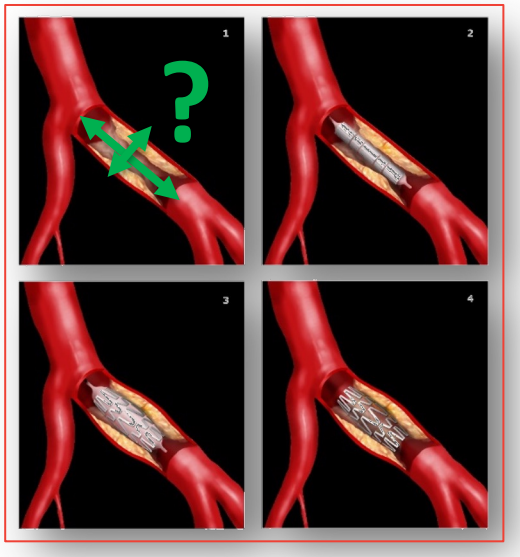
- Où poser le stent : évaluation des dimensions du stent (longueur et taille)

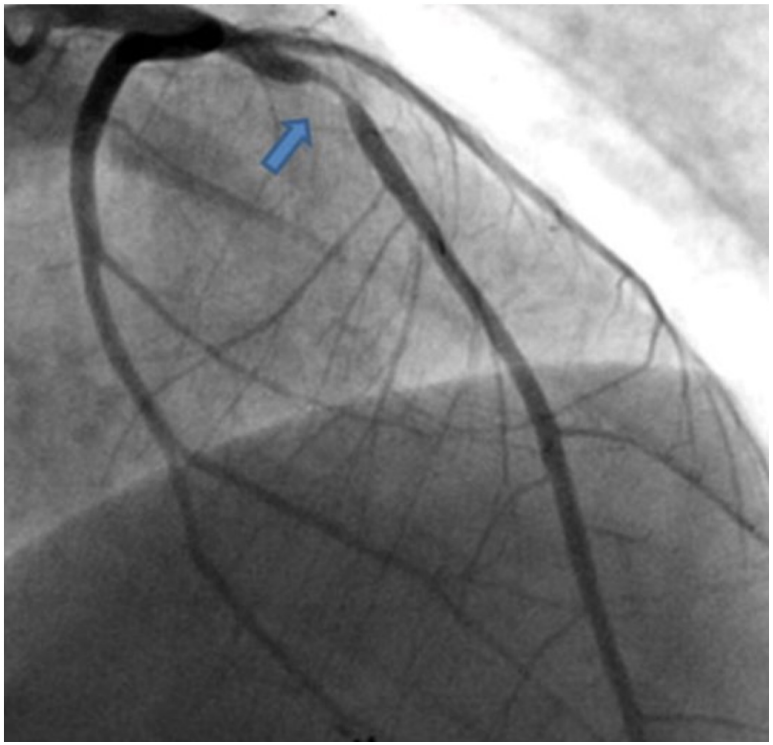


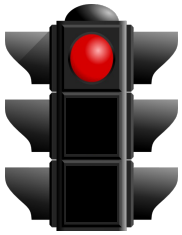


Performing pressure wire measurments in patients with MVD is very rare

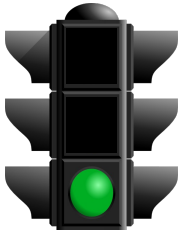
Further virtualization to « estimate » the pressure drop

A simple case!



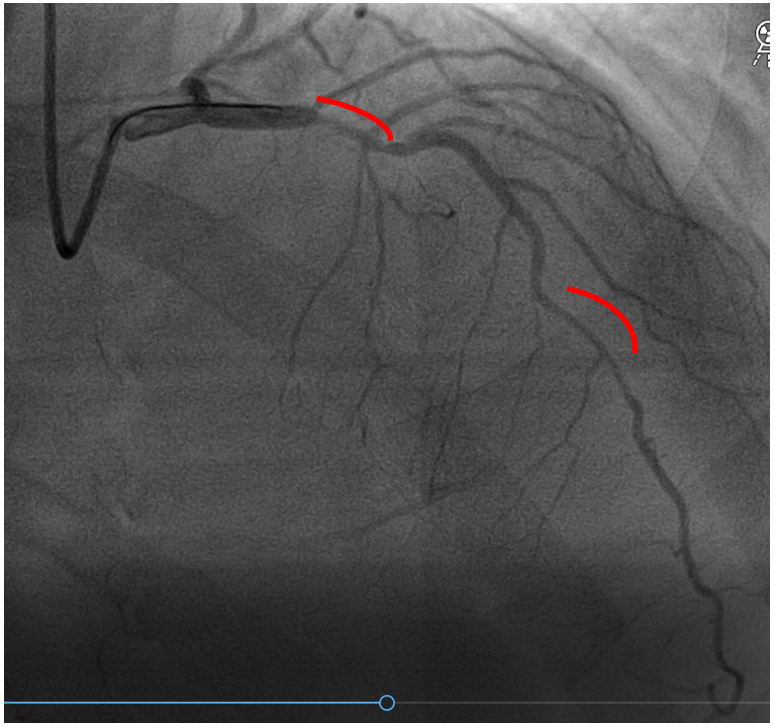


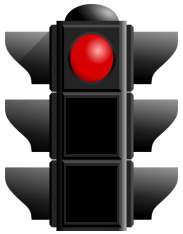
Traitement medical
FFR > 0.81
iFR > 0.89



Angioplastie
FFR ≤ 0.80
iFR ≤ 0.89

Amore complexe case!





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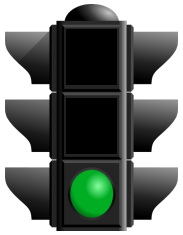


Angioplastie
FFR ≤ 0.80
iFR ≤ 0.89

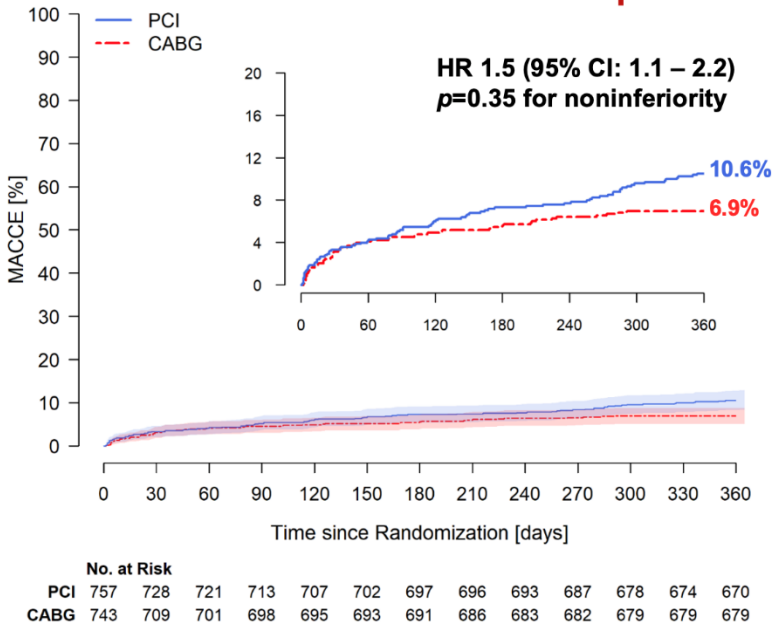
QCM 1

- Dans le cadre d'une angioplastie d'un vaisseau avec lesions diffuses/complexes, je verifie la FFR à la fin de la procedure pour m'assurer qu'elle est > 0.80:
- A) Toujours
- B) Jamais, cela prend trop de temps
- C) Jamais, la valeur de FFR post-angioplastie n'est pas fiable

FAME 3

Primary Endpoint

MACCE (Death, MI, stroke or repeat revascularization) at 1 Year

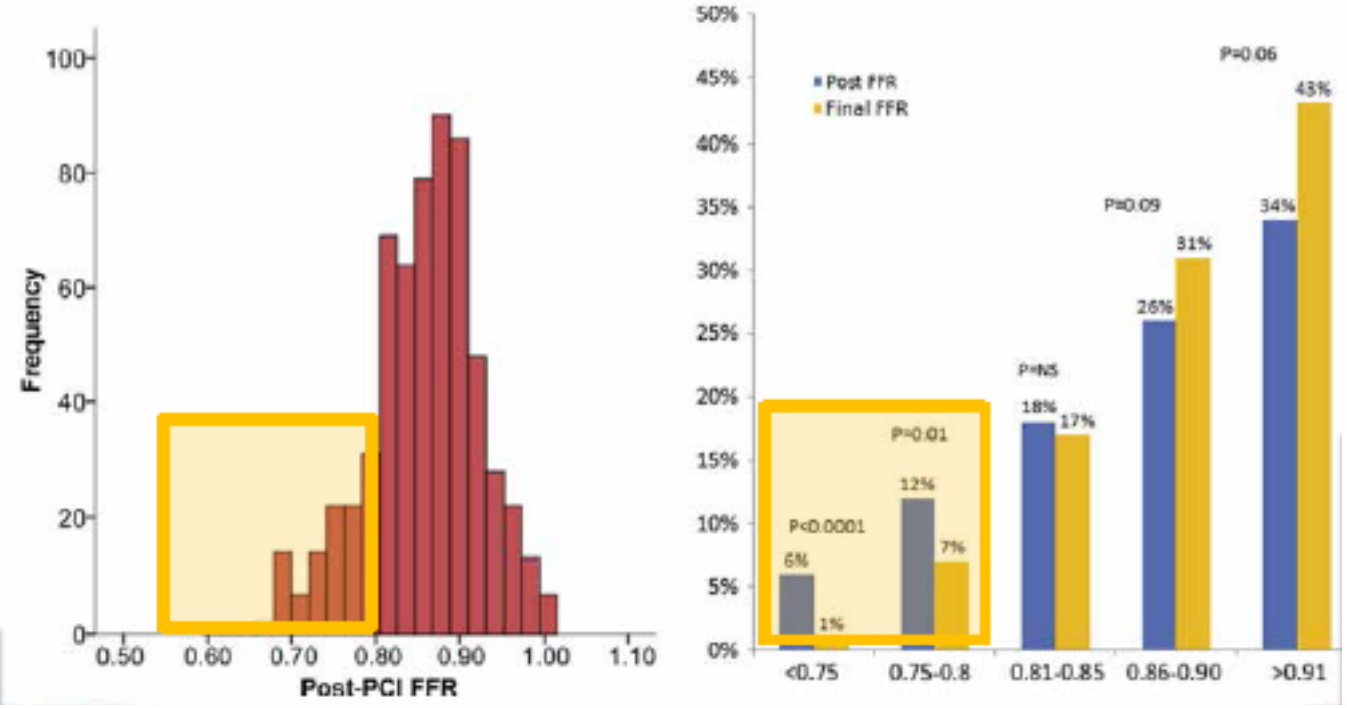


Procedural Characteristics

Variable	PCI (n=757)
% Lesions FFR measured	82%
FFR>0.80	24%
Staged procedure	22%
Number of stents	3.7±1.9
Total stent length	80 mm
Intravascular imaging	12%
FFR measured after PCI	60%

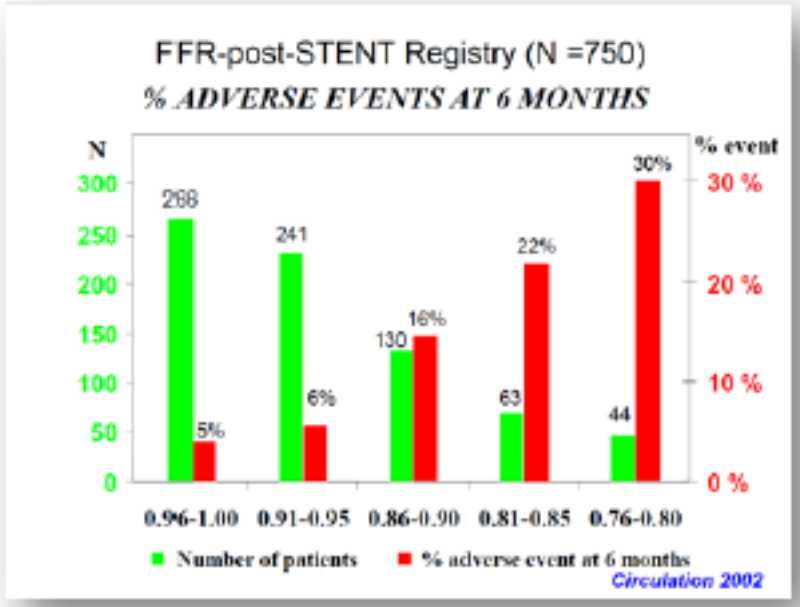
Variable	CABG (n=743)
FFR measured prior to CABG	10%
# of distal anastomoses	3.4±1.0
Multiple arterial grafts	25%
LIMA	97%
Off-Pump surgery	24%

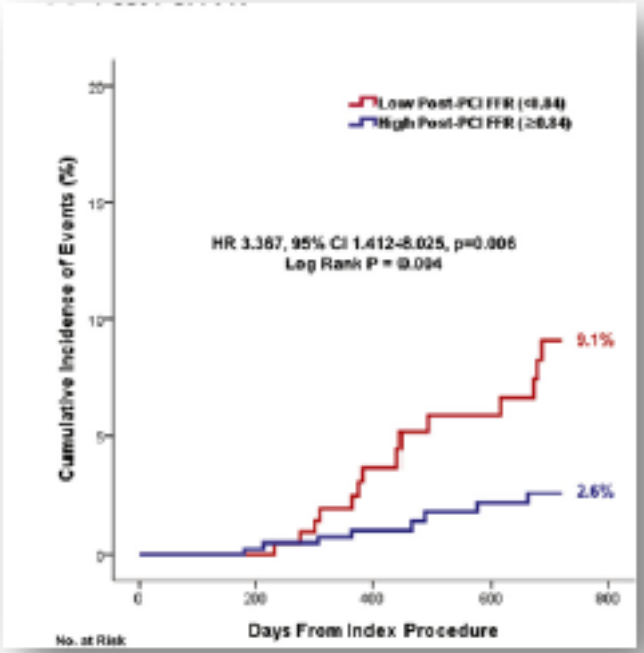
Post PCI ischemia based on FFR ≤0.80 occurs in 10-20% of cases



Lee JM., et al. *J Am Coll Cardiol Intv.* 2018;11:2099–109.
Agarwal SK, et al. J Am Coll Cardiol 2016;9:1022-31.

Low post-PCI FFR is related to adverse events





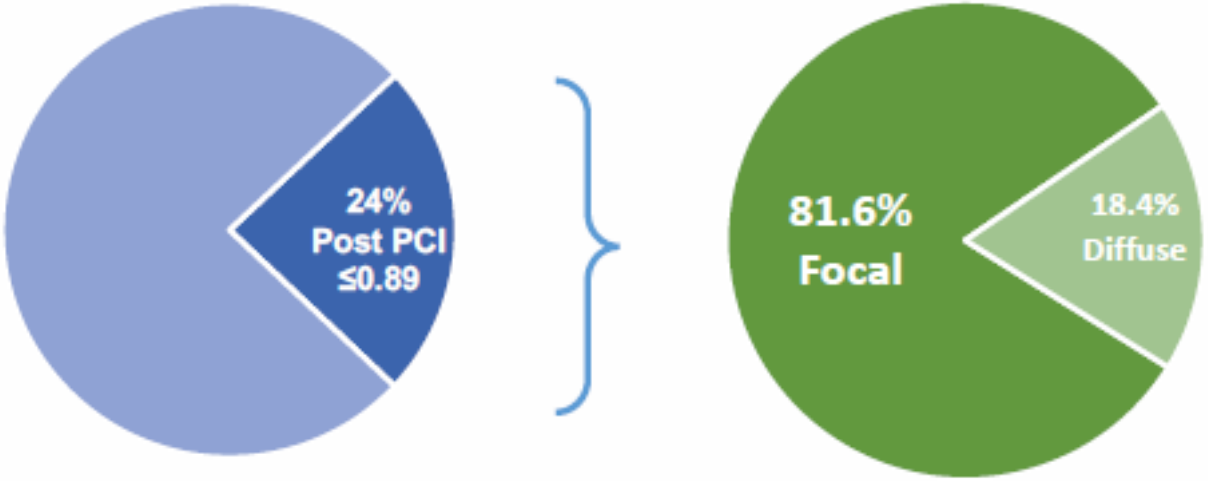
Pijls N., et al. *Circulation*. 2002;105:2950-54.
Lee JM., et al. *J Am Coll Cardiol Intv*. 2018;11:2099–109.

DEFINE PCI

Primary Study Endpoint

480 Patients with Angiographically Successful PCI and qualified iFR pullbacks

24% Residual Ischemia (112 patients with Post PCI iFR≤0.89)

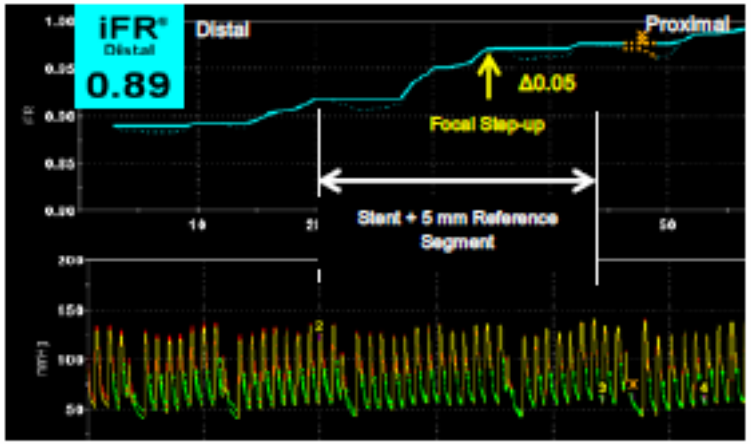


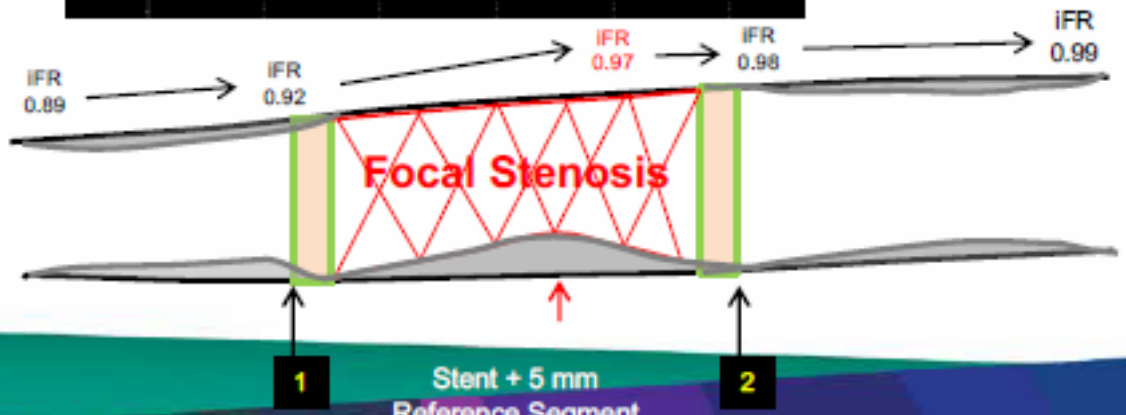
Focal defined as step-up of ≥0.03 units in < 15 mm segment
Diffuse defined as > 15 mm segment

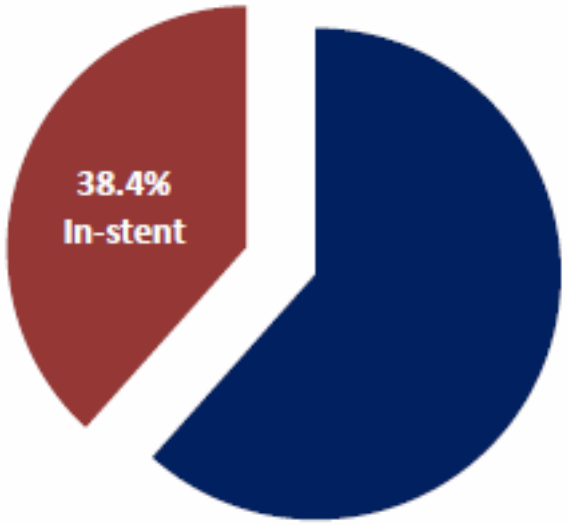
DEFINE PCI

Focal Residual Pressure Gradient in-stent

Among the 93 vessels with focal disease, there were 146 segments (stent, proximal or distal) that had significant residual pressure gradients



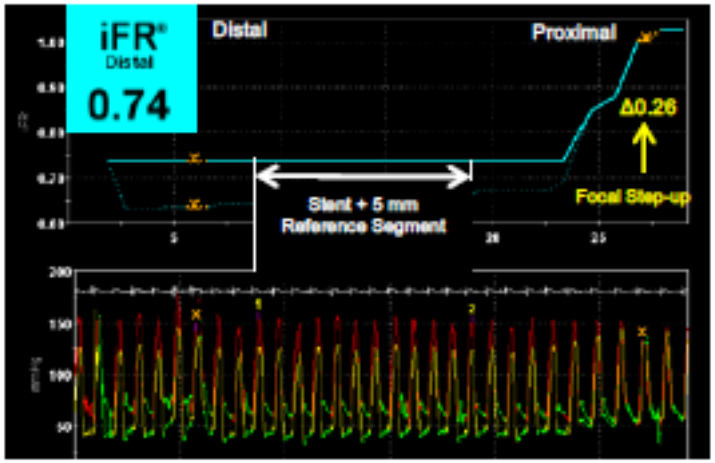


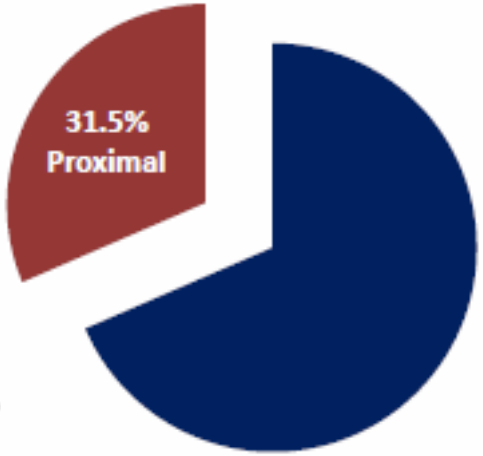


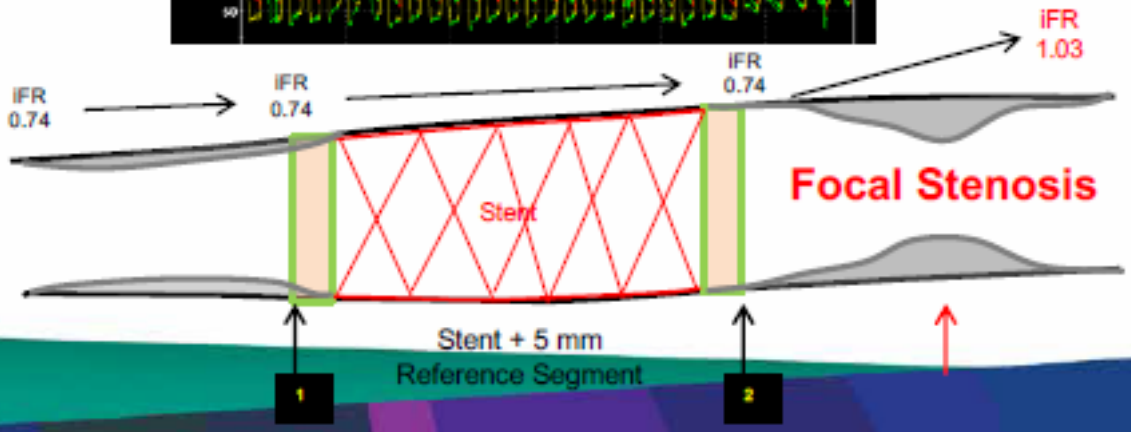
DEFINE PCI

Focal Residual Pressure Gradient Prox to stent

'Physiologic miss' occurred in 31.5% of focal lesions proximally





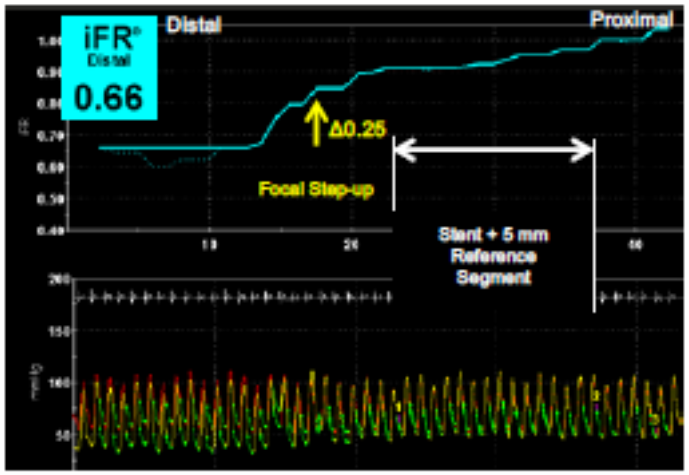


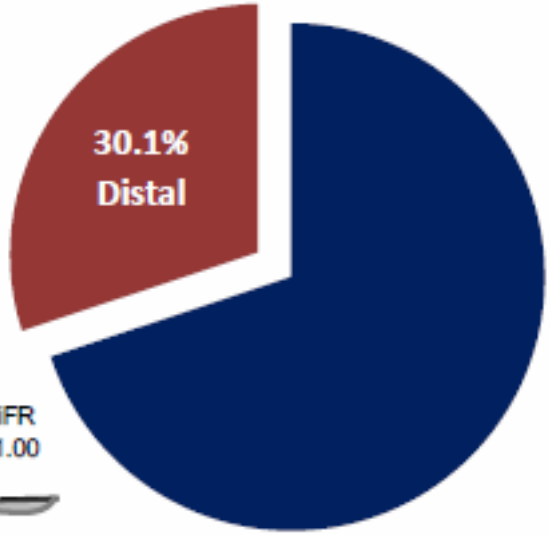
ACC.19

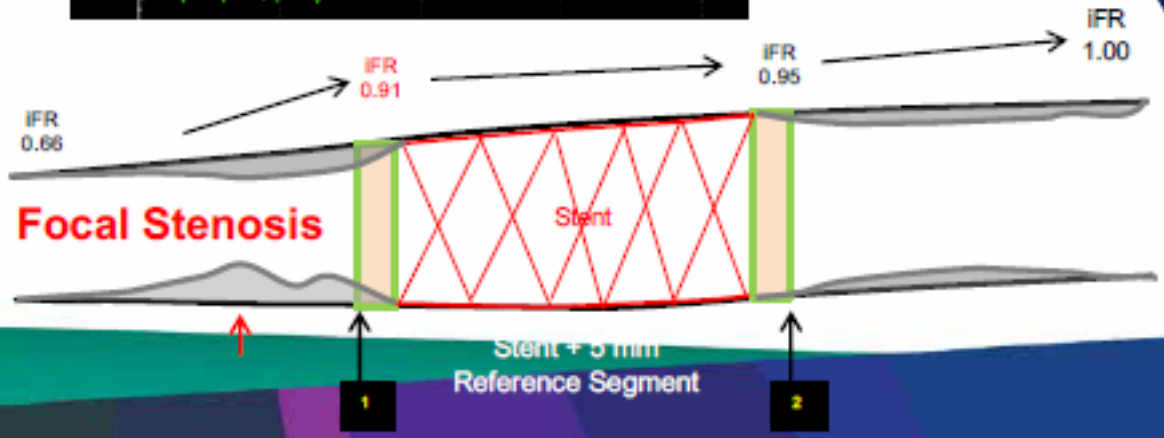
DEFINE PCI

Focal Residual Pressure Gradient Distal to stent

'Physiologic miss' occurred in 30.1% of focal lesions distally





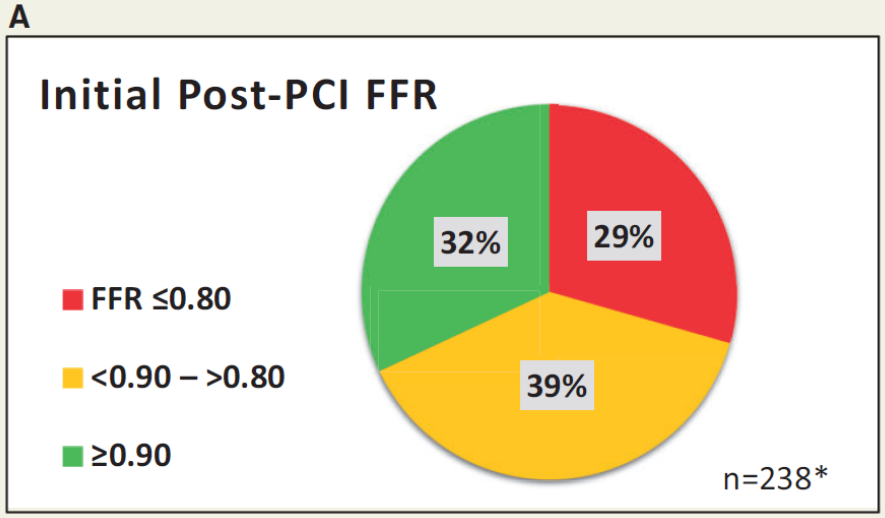


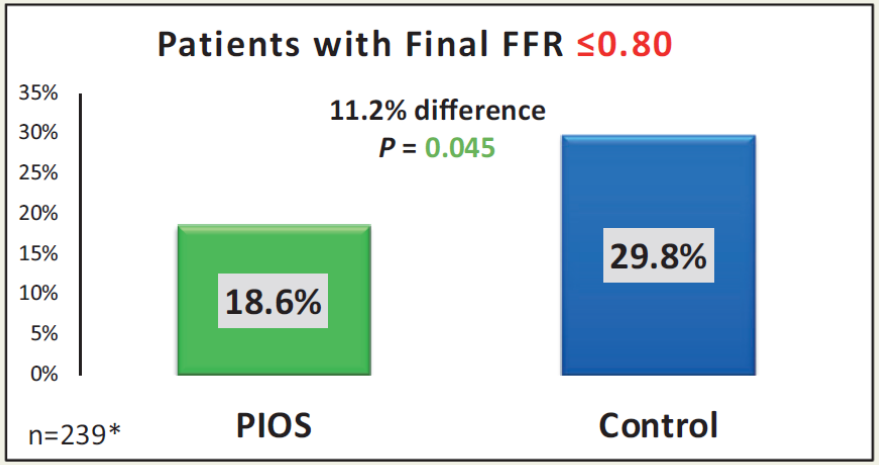
ESC European Society of Cardiology

European Heart Journal (2021) **42**, 4656–4668
doi:10.1093/eurheartj/ehab449

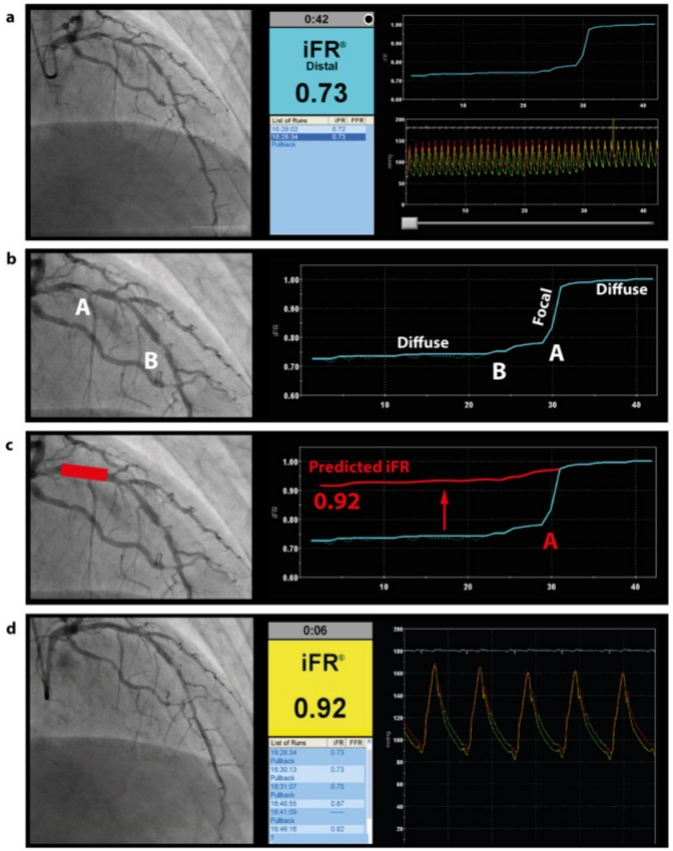
Post-stenting fractional flow reserve vs coronary angiography for optimization of percutaneous coronary intervention (TARGET-FFR)

Damien Collison [1,2]*, **Matthaios Didagelos** [1],





iFR et lésions en série



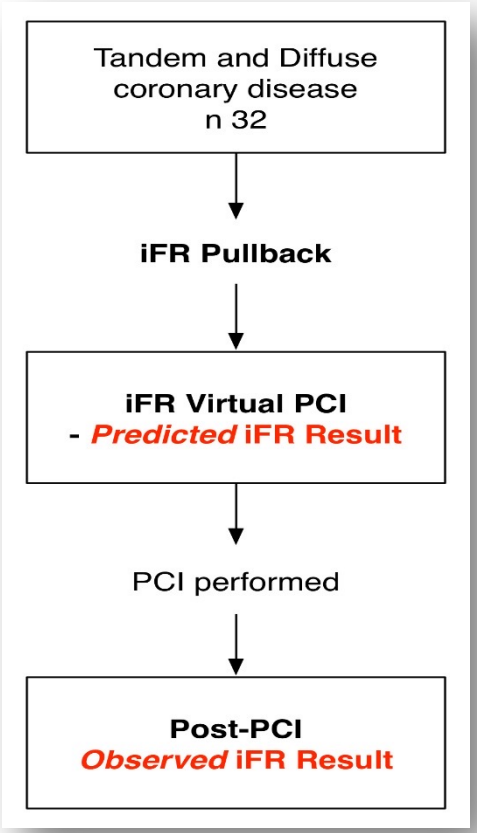
- Nombre et extension des sténoses n'impactent pas significativement le flux basal

- La perte de charge hémodynamique due à une lésion est spécifique à cette lésion uniquement
  - ✓ « Absence » de cross-talk entre les lésions en série

- Le changement du profil hémodynamique après angioplastie devient donc prévisible

iFR pull-back

iFR Pullback Study

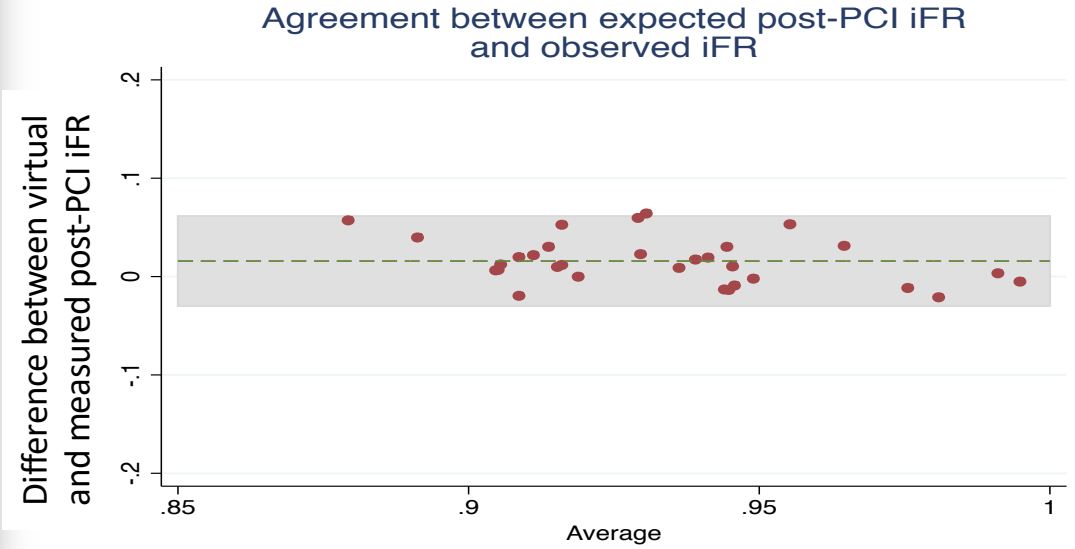


Pre-PCI iFR: 0.78 ± 0.03

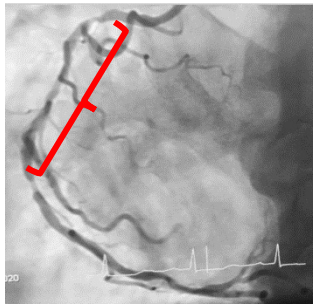
Predicted iFR: 0.94 ± 0.01

Observed iFR: 0.93 ± 0.03

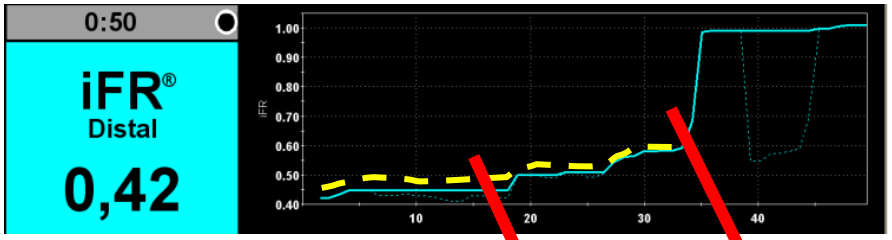
p=0.48

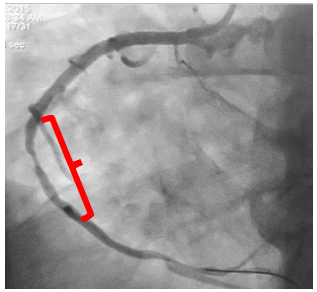


Nijjer SS, Davies J et al *JACC: Cardiovascular Interventions*. 2014;7:1386–1396

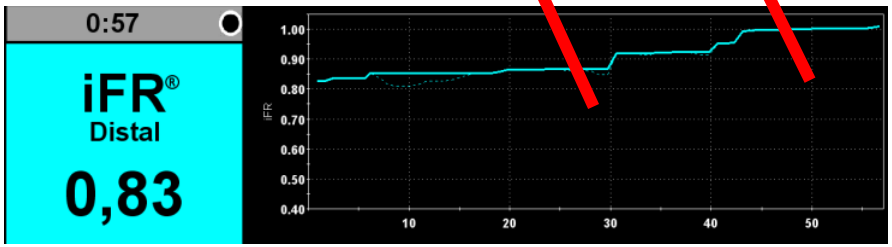


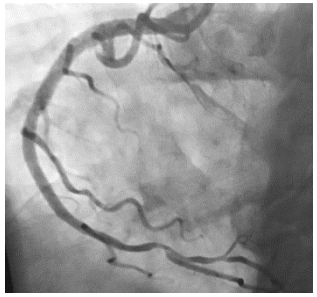
Profil de la perte de charge



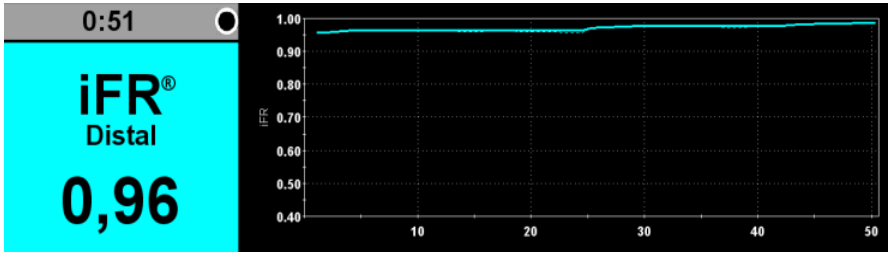


Perte de charge résiduelle
après 1er stenting

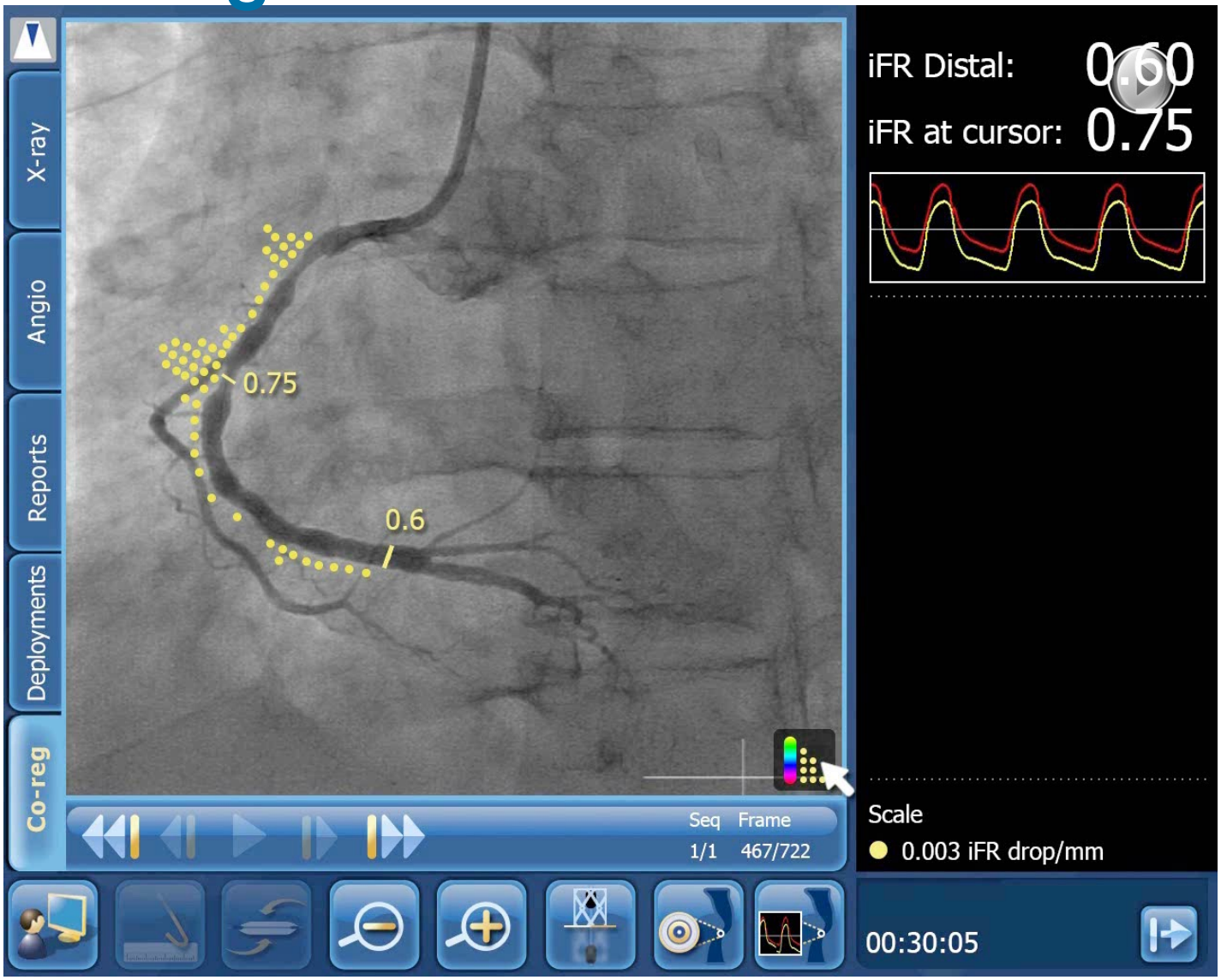




Profil hémodynamique
normal



iFR Co-registration et Virtual PCI



Homme, 78 *ans*

Bon état général

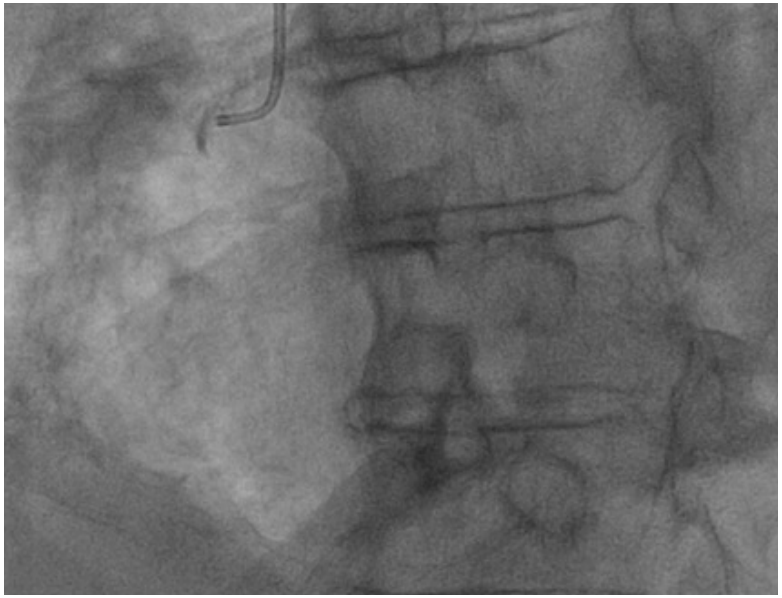
ATCD IDM inferieur (10 ans) – CD occluse connue non revascularisée

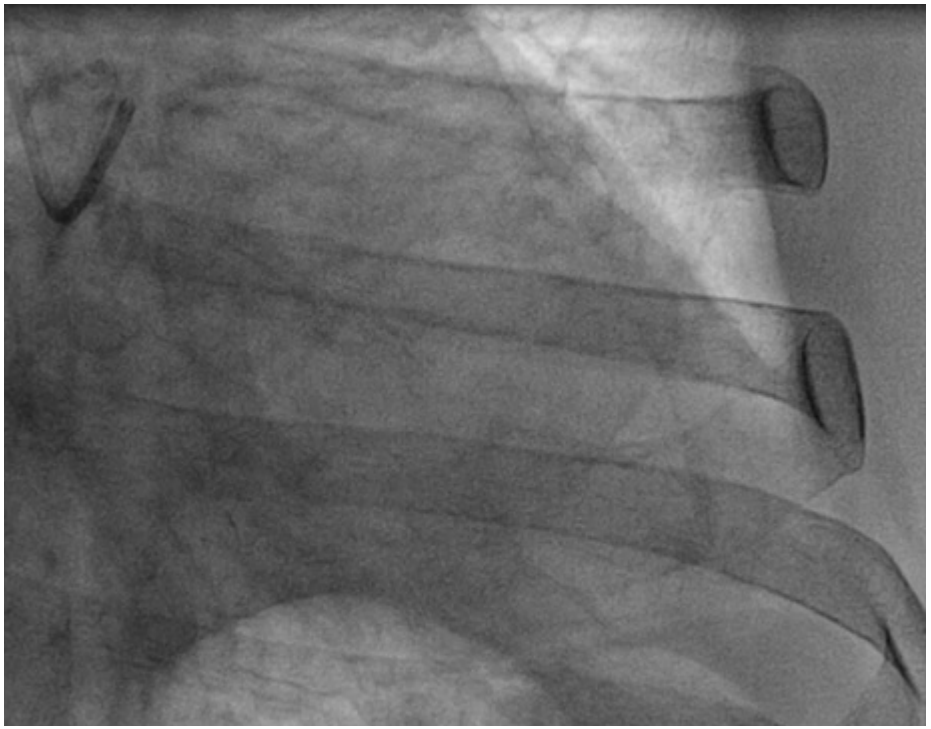
Hospitalisé pour NSTEMI avec décompensation cardiaque.

ETT : FEVG conservée avec séquelle inférieure.

Anticoagulation efficace pour une fibrillation atriale.

Fonction rénale normale. Pas de diabète.





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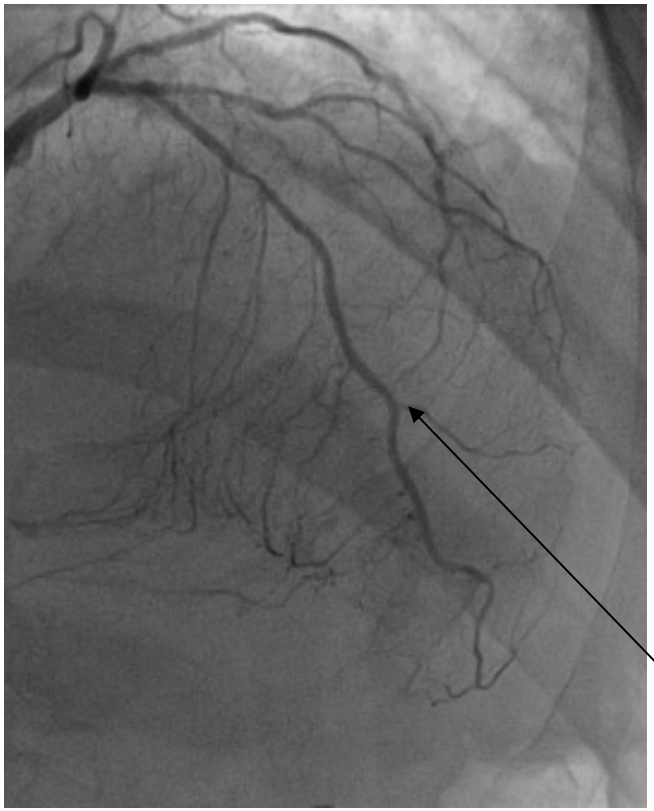

Zone de mesure avec le guide de pression

Evaluation physiologique sur l'IVA

FFR à 0,74
iFR à 0,69

Vaisseau physiologiquement très ischémique

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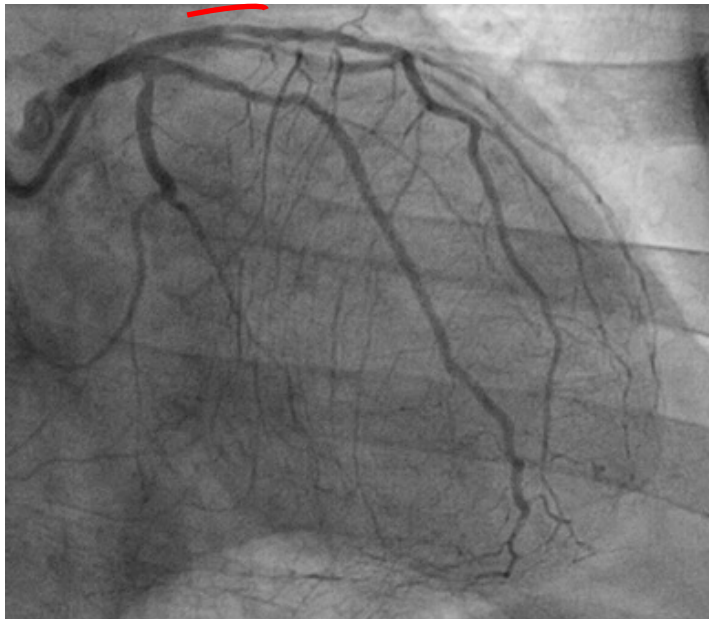

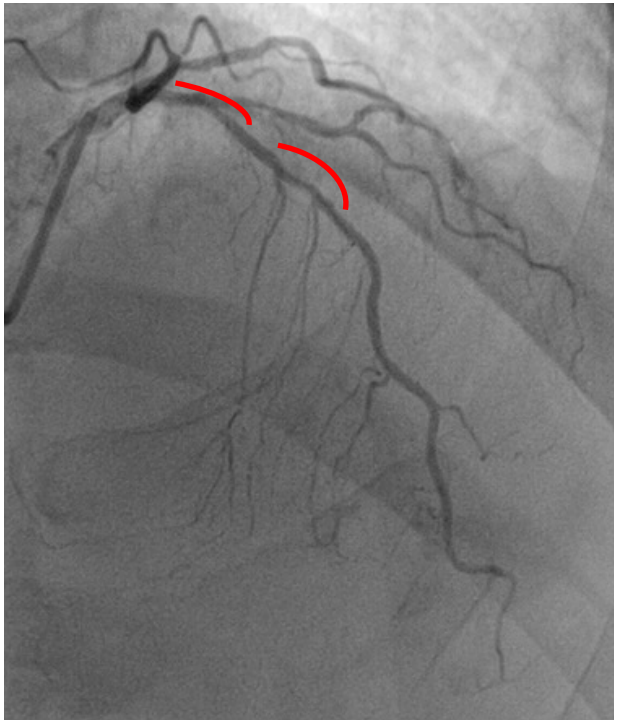

Angiographiquement :

Lésions relativement diffuses avec 2 zones distinctes

↓

Quelle stratégie de revascularisation ?

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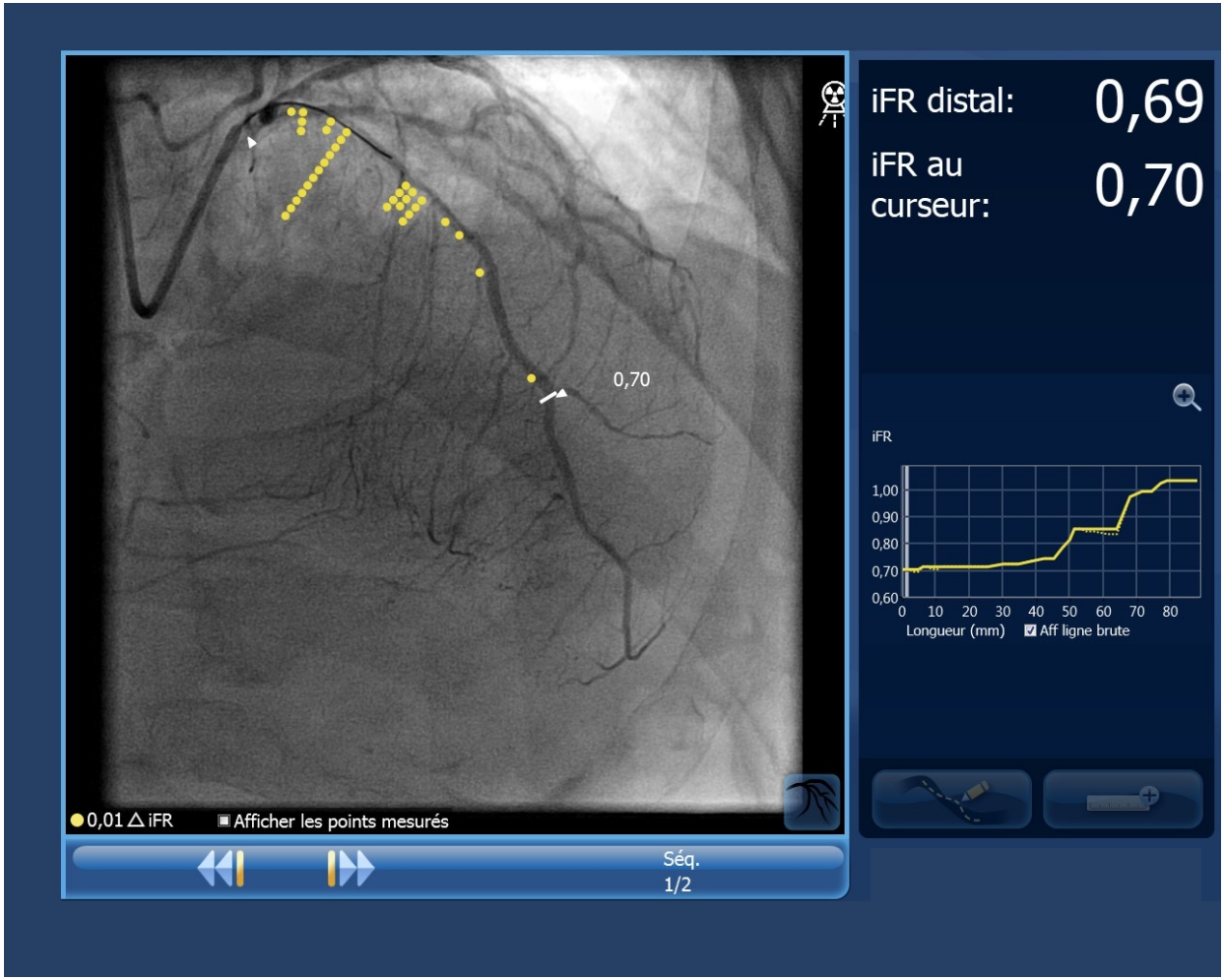
Institut Coeur et Poumon - CHU Lille, France
University of Lille - School Of Medicine Henri Warembourg



iFR pull back

Perte de charge bien repartie entre les 2 lésions

Pour amener iFR >.9 nécessité de traiter les 2 lésions

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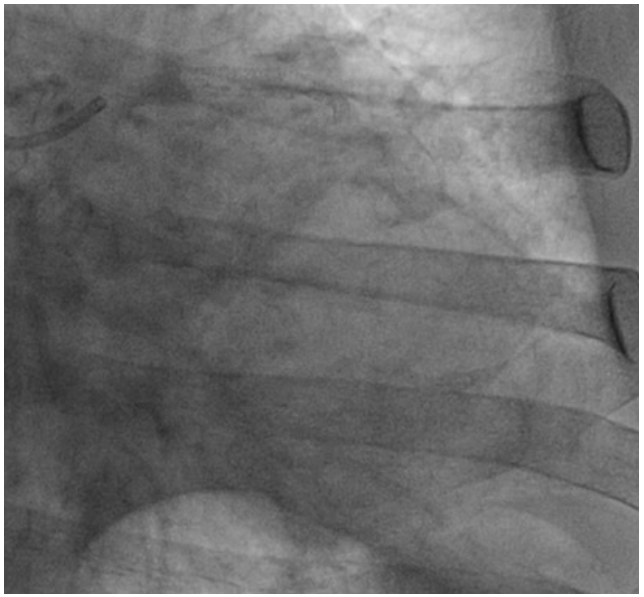
2 stents actifs 2,75*28mm et 3,5*28mm
POT à 3,75mm, Side vers la diagonale et POT final.



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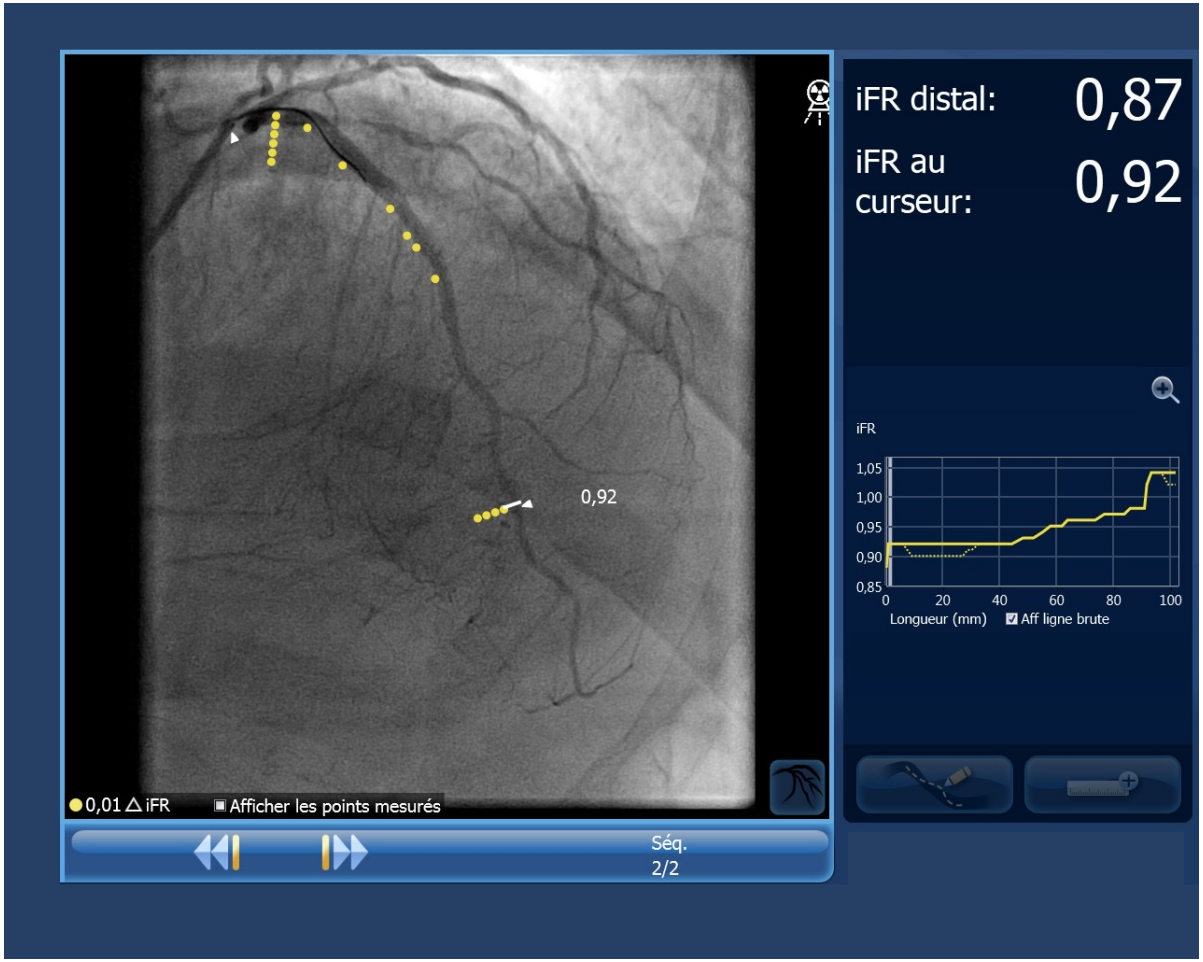

Excellent résultat hémodynamique avec iFR final au même point à 0,92.

Gain de 0,23 par la revasularisation

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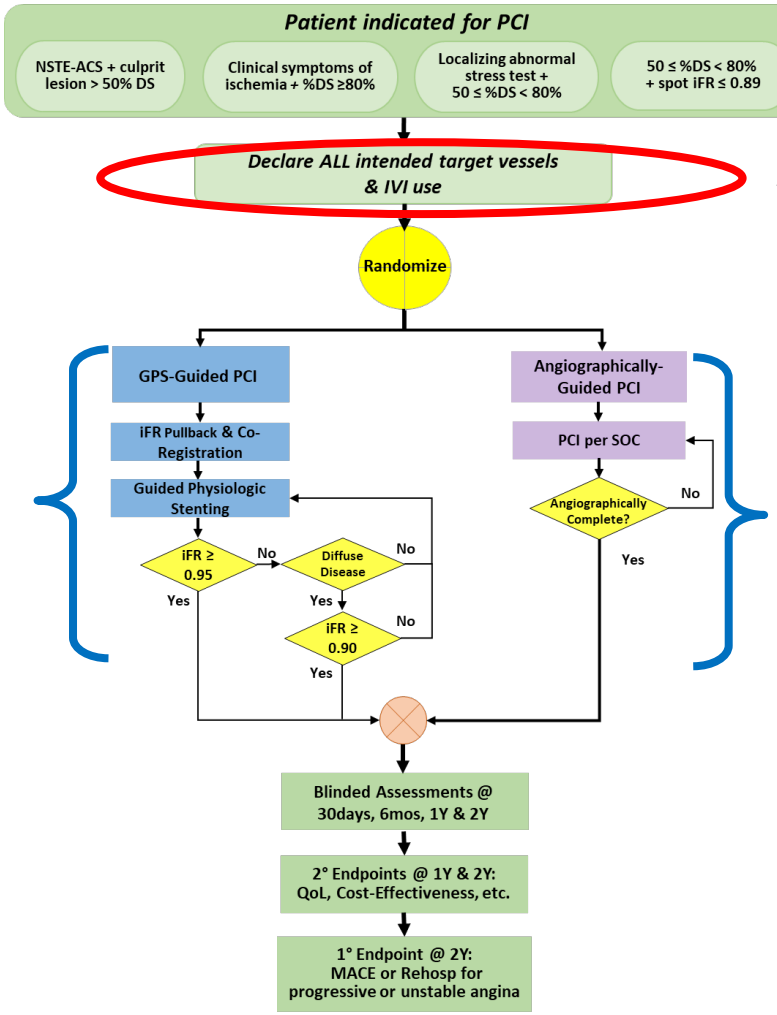
Institut Coeur et Poumon - CHU Lille, France
University of Lille - School Of Medicine Henri Warembourg

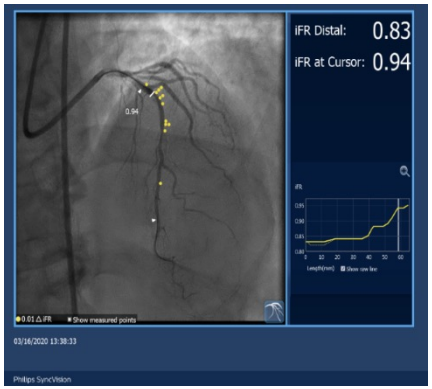
DEFINE GPS Flow



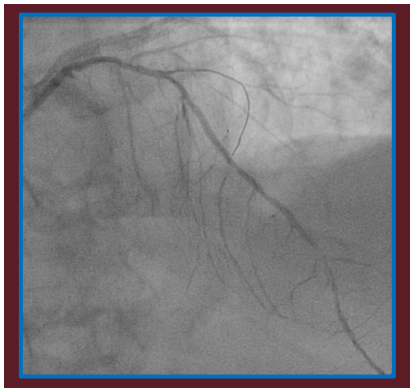
Aligned with Guideline Recommendations for PCI

All vessels to undergo PCI must be qualified prior to randomization

Physiology-Guided PCI



Standard of Care PCI



Proprietary and Confidential — Do not distribute

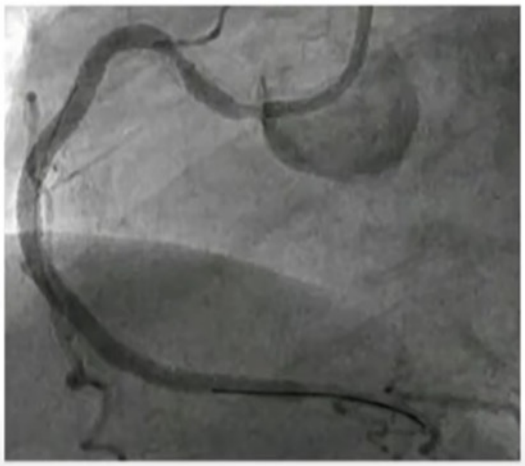
Summary

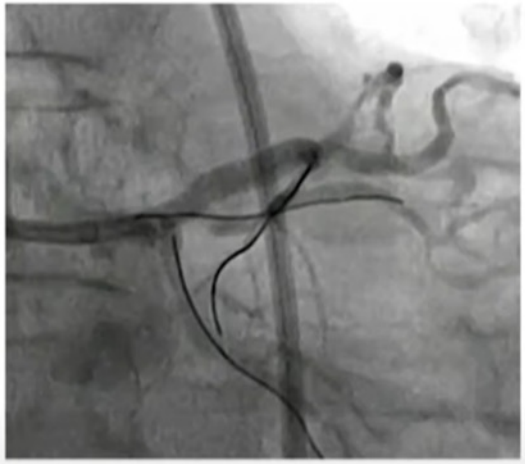
- ✓ Recent studies haves shown that 20-25% vessel territories remain ischemic after an apparently appropriately conducted PCI:
  - ✓ Once the procedure is "finished" it is possible but difficult to correct (TARGET FFR)
  - ✓ Pre-procedural pullback-derived pressure coronary mapping"
  - ✓ Combined to
  - ✓ virtual PCI" and c

    would be key to improve the clinical outcome of our coronary patients, in particular those with MVD.

➔ It has also the potential to test different PCI scenario and to predict the final "IFR/FFR" of these scenario: Virtual PCI

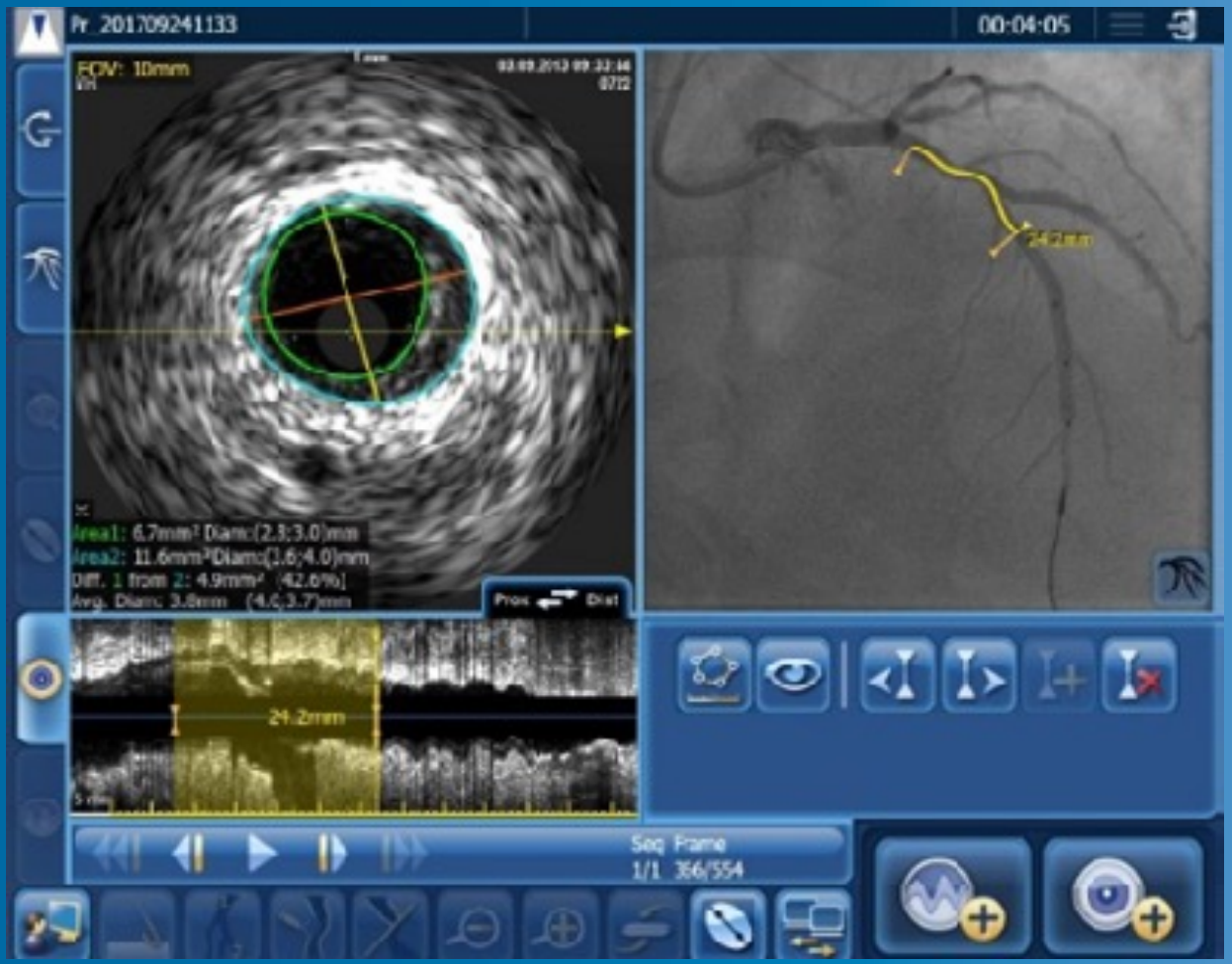
Procédure
Ultra low Co





- Total amount of contrast: 25 ml (CV/GFR 0.83)
- Uneventful in-hospital evolution.
- Patient discharged 2 days later. No modification of serum Cr levels.

Advanced IVUS imaging: **IVUS co-registration**



- Localization of IVUS withangiography to help avoid geographicmiss
- Easy length/area/diameter measurements with manual pullback to sizestent

Procédure
Ultra low Contrast

Steps to reduce contrast in PCI

Dr. Billal Patel

- Head of Interventional Cardiology, Lancashire Cardiac Centre, Blackpool, UK

Dilute contrast – 50% saline

Dynamic coronary roadmap

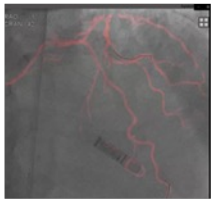
Device detection

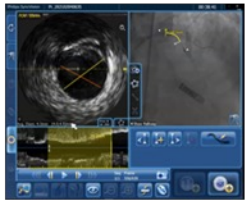
Multiple wires to highlight branches

iFR co-registration

IVUS co-registration and/or Tri-registration

Final angio to confirm successful PCI





Presented: 4th Asia Physiology Coronary Imaging (APACI) live webinar, PCI in Advanced CKD – When Less Contrast is More. 20th March 2021.

The opinions and clinical experiences herein are specific to the featured physicians and featured patients and are for information purposes only. The results from their experiences may not be predictive for all patients. Individual results may vary depending on a variety of patient-specific attributes and related factors. Nothing in this presentation is intended to provide specific medical advice or to take the place of written law or regulations.

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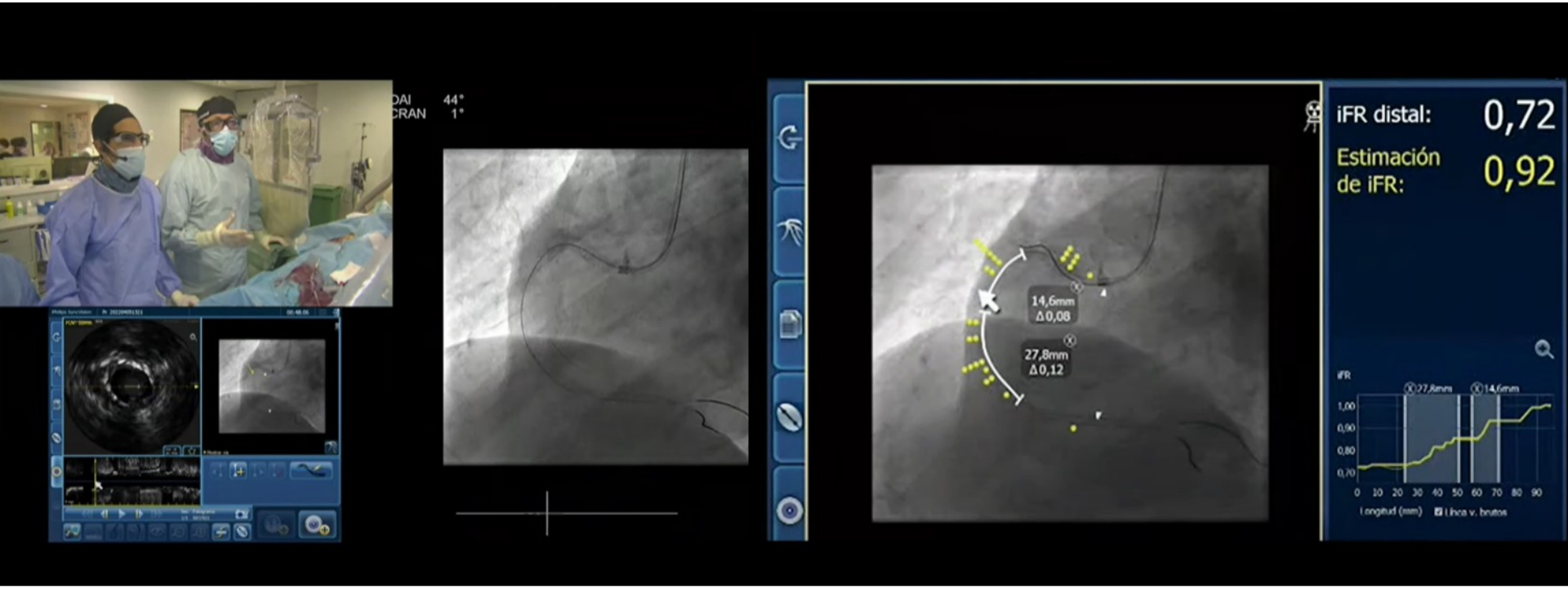
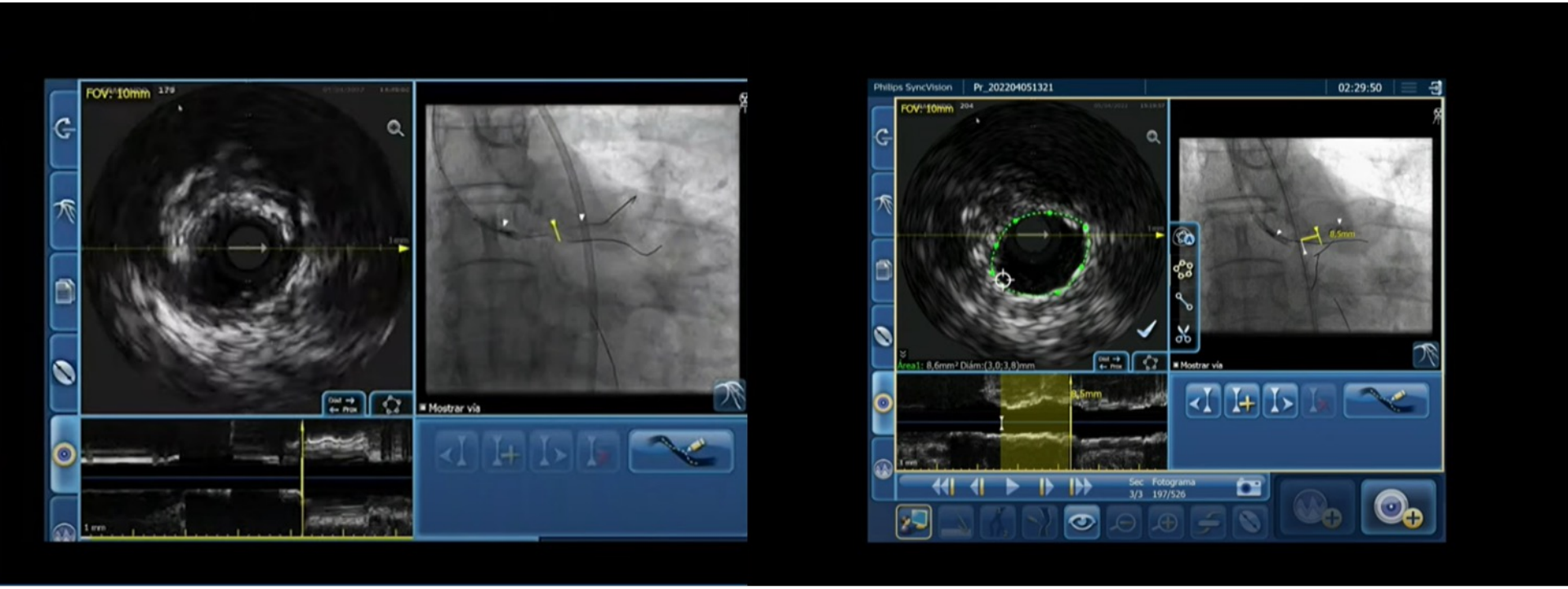
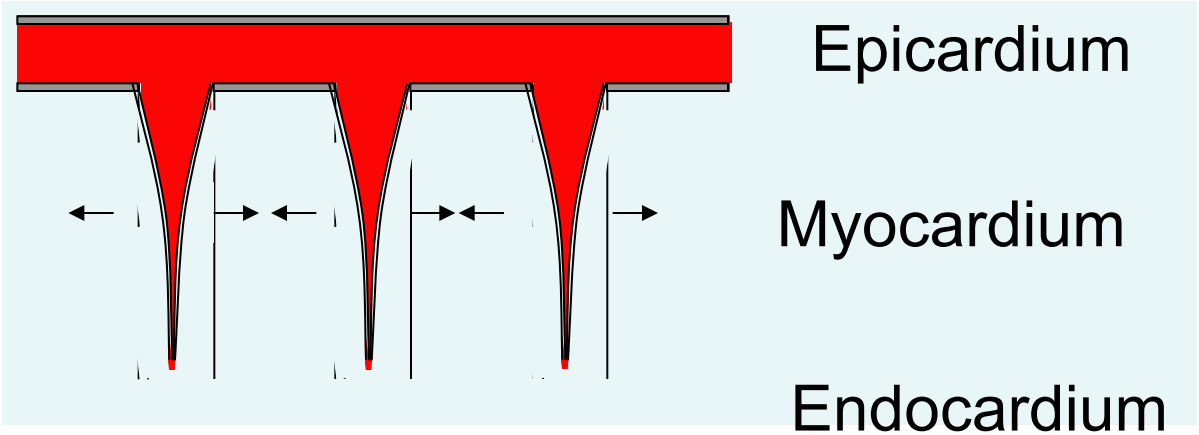
Procédure
Ultra low Contrast

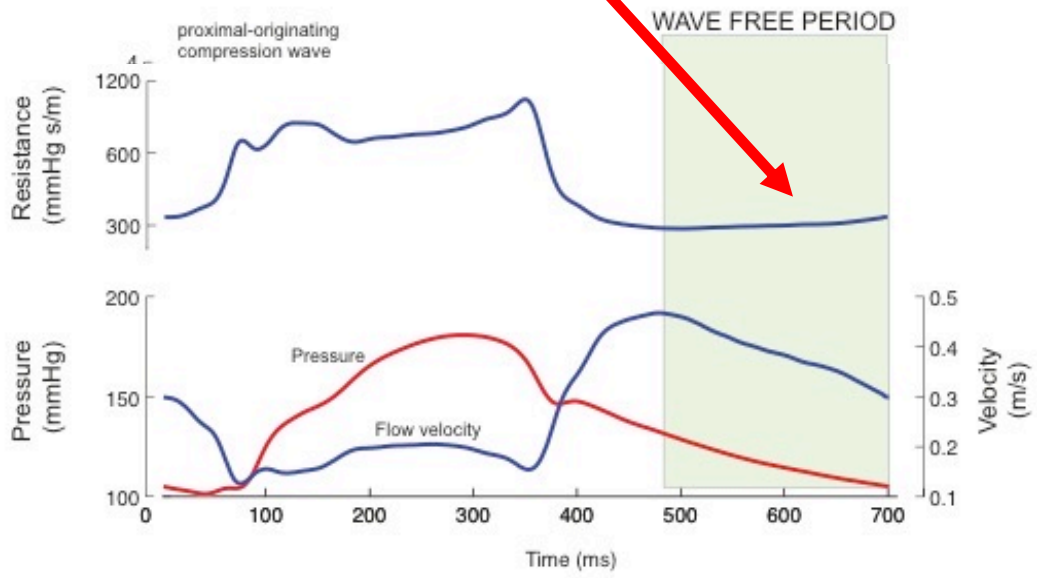


Procédure
Ultra low Contrast





Distal pressure falling



Summary 1

- ✓ Invasive pressure wire (FFR/iFR) is the "gold standard" for the detection of ischemic territory vessels.

- ✓ In patients with MVD, investigation of every vessel with lesion > 30% is critical to propose the best treatment option.

JACC
JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY

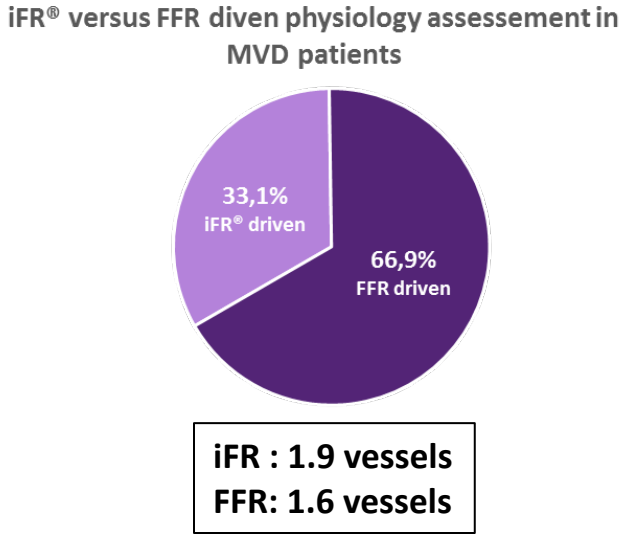
Impact of Routine Invasive Physiology at Time of Angiography in Patients With Multivessel Coronary Artery Disease on Reclassification of Revascularization Strategy

Results From the DEFINE REAL Study

Eric Van Belle, MD, PhD,[a] Robert Gil, MD, PhD,[b] Volker Klauss, MD,[c] Mohammed Balghith, MD,[d] Martijn Meuwissen, MD, PhD,[e] Jérôme Clerc, MD,[f] Bernhard Witzenbichler, MD,[g] Miha Cercek, MD,[h] Marios Vlachojannis, MD,[i] Irene Lang, MD,[j] Philippe Commeau, MD,[k] Flavien Vincent, MD,[a] Luca Testa, MD, PhD,[l] Wojciech Wasek, MD, PhD,[m] Nicolas Debry, MD,[a] Stephan Kische, MD, PhD,[n] Gabriele Gabrielli, MD,[o] Gennaro Sardella, MD, PhD[p]

JACC: CARDIOVASCULAR INTERVENTIONS VOL. 11, NO. 4, 2
FEBRUARY 26, 2018:354–65

Reclassification according to the number of vessel investigated

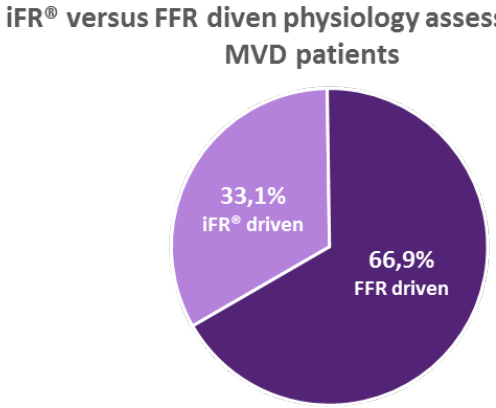


iFR : 1.9 vessels
FFR: 1.6 vessels

Van Belle *et al.*

Routine Invasive Physiology in MVD

Reclassification according to the number of vessel investigated

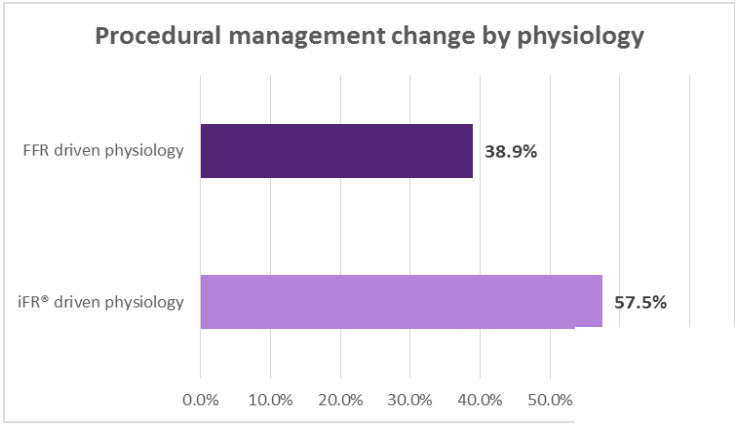


iFR : 1.9 vessels
FFR: 1.6 vessels

P=0.0001

FFR: 1.6 vessels

iFR : 1.9 vessels



Van Belle *et al.*
Routine Invasive Physiology in MVD

QCM 1

- Dans le cadre de la prise en charge d'un infarctus transmural par angioplastie primaire chez un patient multitronculaire, vous faites la FFR des vaisseaux non-coupables:
- A) Oui, dans la même procédure
- B) Oui, dans la même procédure (mais pas la nuit)
- C) Oui, je remet le patient sur la table pour une nouvelle coronarographie (et un FFR) quelques jours plus tard.
- D) jamais

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Multivessel PCI Guided by FFR or Angiography for Myocardial Infarction

Etienne Puymirat, M.D., Ph.D., Guillaume Cayla, M.D., Ph.D., Tabassome Simon, M.D., Ph.D., Philippe G. Steg, M.D., Gilles Montalescot, M.D., Ph.D., Isabelle Durand-Zaleski, M.D., Ph.D., Alicia le Bras, M.D., Romain Gallet, M.D., Ph.D., Khalife Khalife, M.D., Jean-François Morelle, M.D., Pascal Motreff, M.D., Ph.D., Gilles Lemesle, M.D., Ph.D., Jean-Guillaume Dillinger, M.D., Ph.D., Thibault Lhermusier, M.D., Ph.D., Johanne Silvain, M.D., Ph.D., Vincent Roule, M.D., Ph.D., Jean-Noel Labèque, M.D., Grégoire Rangé, M.D., Grégory Ducrocq, M.D., Ph.D., Yves Cottin, M.D., Didier Blanchard, M.D., Anaïs Charles Nelson, N.D., Bernard De Bruyne, M.D., Ph.D., Gilles Chatellier, M.D., and Nicolas Danchin, M.D., for the FLOWER-MI Study Investigators*

Initial plan:
To perform FFR of non-culprit at the time of the initial PCI in all patients

Actaal plan
<5% of patients had FFR of additional non culprit during the index angiography

Performing pressure wire measurments in patients with MVD is very rare

Further virtualization to « estimate » the pressure drop

Quantitative Flow Ratio (QFR)

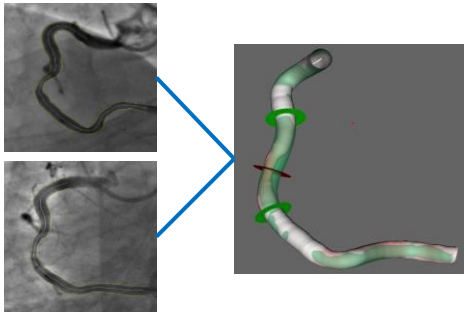
Standard Angiogram

Data Transmission System

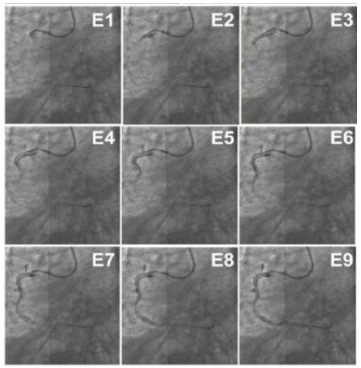
Two image runs with angle difference ≥25°

AngioPlus System

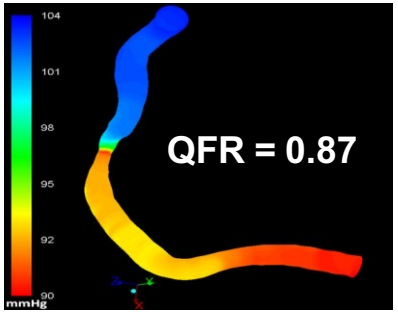
3D Reconstruction



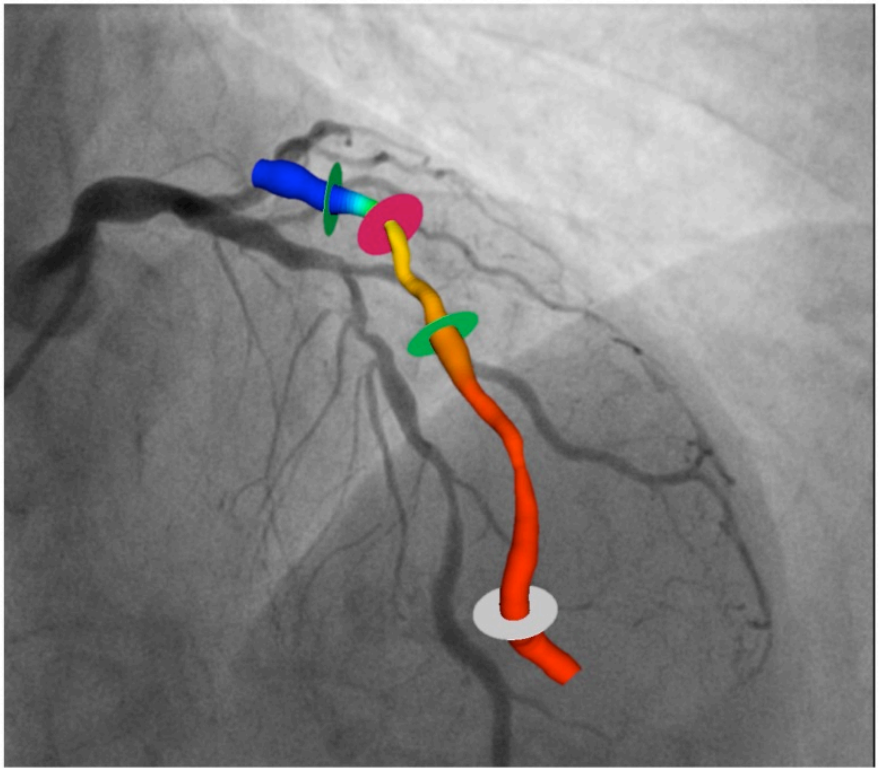
Modified Frame Count



QFR



Without Inducing Hyperemia

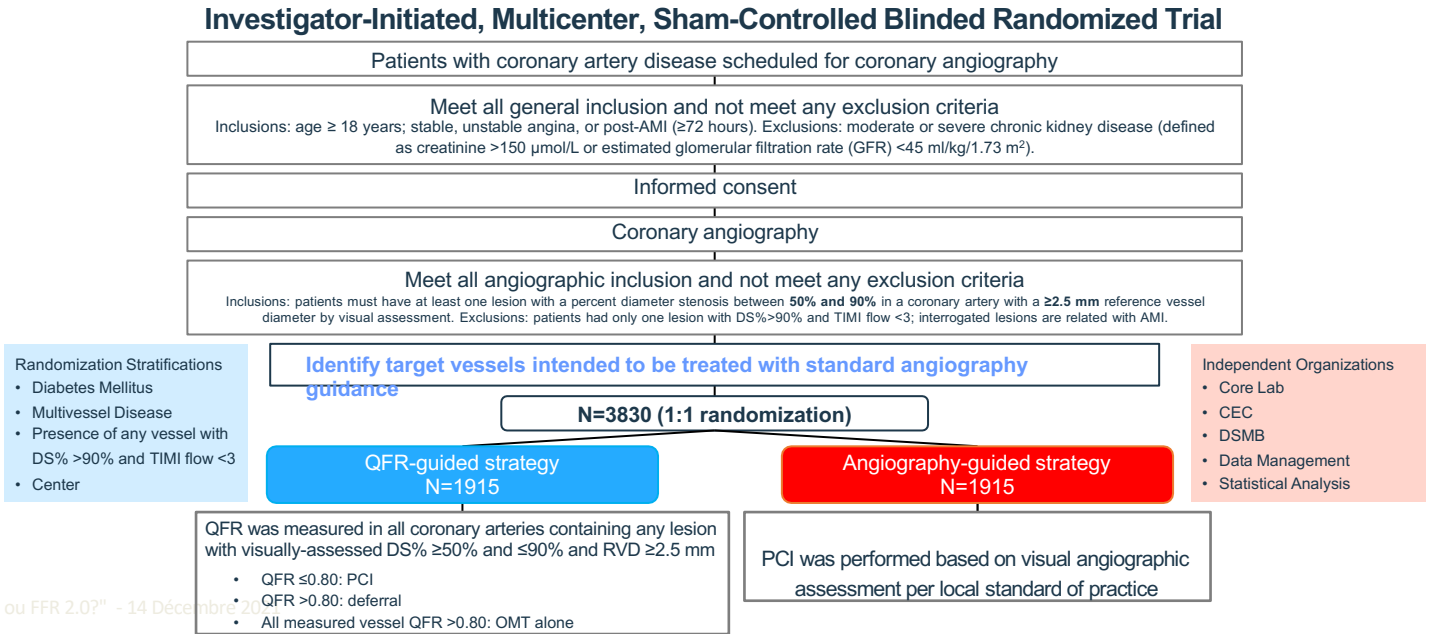


© WEBINAR "La QFR ou FFR 2.0?" - 14 Décembre 2021

Study Design

Angiographic quantitative flow ratio-guided coronary intervention (FAVOR III China): a multicentre, randomised, sham-controlled trial

Bo Xu, Shengxian Tu*, Lei Song*, Zening Jin, Bo Yu, Guosheng Fu, Yujie Zhou, Jian'an Wang, Yundai Chen, Jun Pu, Lianglong Chen, Xinkai Qu, Junqing Yang, Xuebo Liu, Lijun Guo, Chengxing Shen, Yaojun Zhang, Qi Zhang, Hongwei Pan, Xiaogang Fu, Jian Liu, Yanyan Zhao, Javier Escaned, Yang Wang, William F Fearon, Kefei Dou, Ajay J Kirtane, Yongjian Wu, Patrick W Serruys, Weixian Yang, William Wijns, Changdong Guan, Martin B Leon†, Shubin Qiao*†, Gregg W Stone†; FAVOR III China study group‡*



Summary 1

- ✓ Invasive pressure wire (FFR/iFR) is the "gold standard" for the detection of ischemic territory vessels.
- ✓ In patients with MVD, investigation of every vessel with lesion > 30% is critical to propose the best treatment option.
- ✓ Despite its benefit extensive one shot physiology investigation is difficult to achieve with invasive methods (in Flower MI only 5% of patients had complete FFR investigation at time of PCI).

Summary 2

- ✓ Recent studies haves shown that 20-25% vessel territories remain ischemic after an apparently appropriately conducted PCI:
  - ✓ Once the procedure is "finished" it is difficult to correct (TARGET FFR)
  - ✓ Pre-procedural pullback-derived pressure coronary mapping"
  - ✓ Combined to
  - ✓ virtual PCI"

    would be key to improve the clinical outcome of our coronary patients, in particular those with MVD.

➔ These approaches are difficult to achieve in most patients with current invasive technics

Perspective

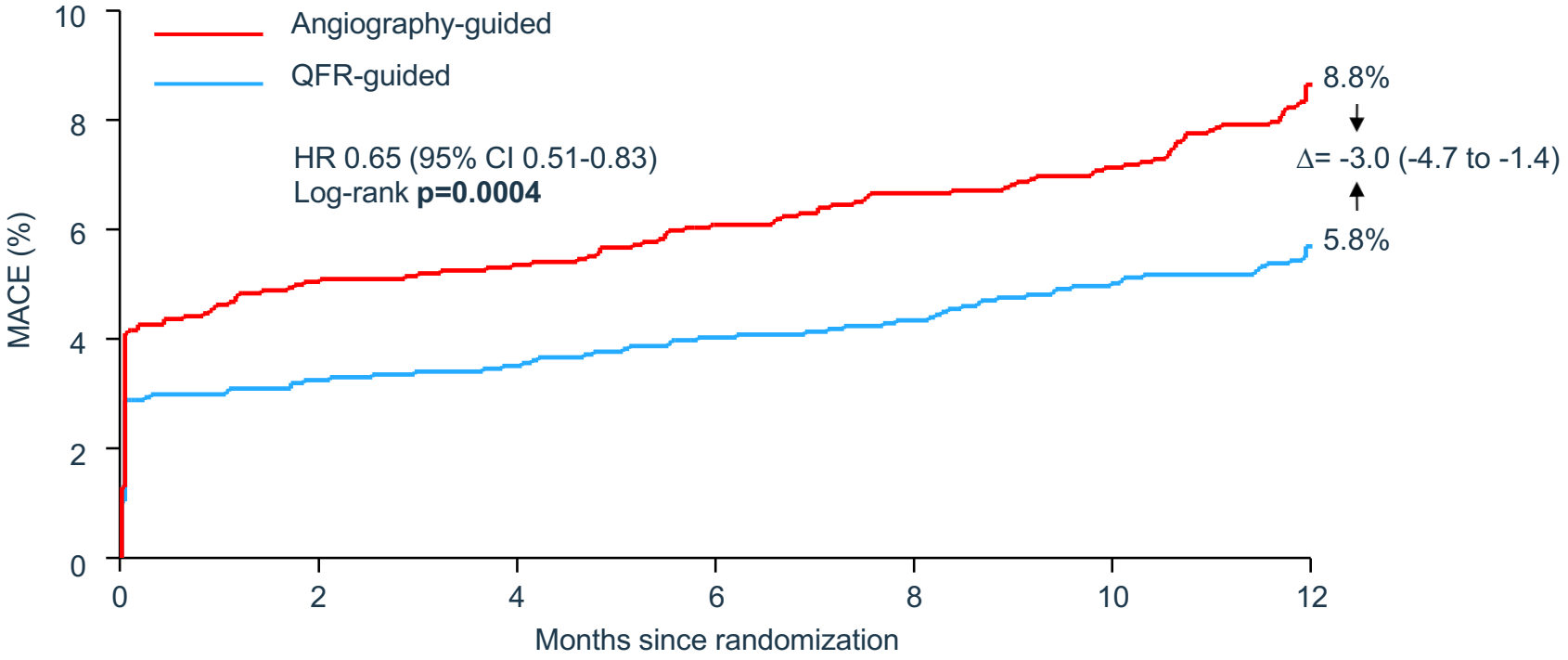
- ✓ Virtualization of coronary pressure drop using computational fluid dynamics derived from imaging (CT-scan or angiography) has a strong potential to provide a more complete picture of pressure drop in all coronary arteries in a single investigation.

- ✓ It has also the potential to test different PCI scenario and to predict the final "FFR" of these scenario: Virtual PCI

Thank you for your attention!

Pr Eric VANBELLE MD, PhD, FESC, FACC
Institut Coeur et Poumon - CHU Lille, France
University of Lille - School Of Medicine Henri Warembourg

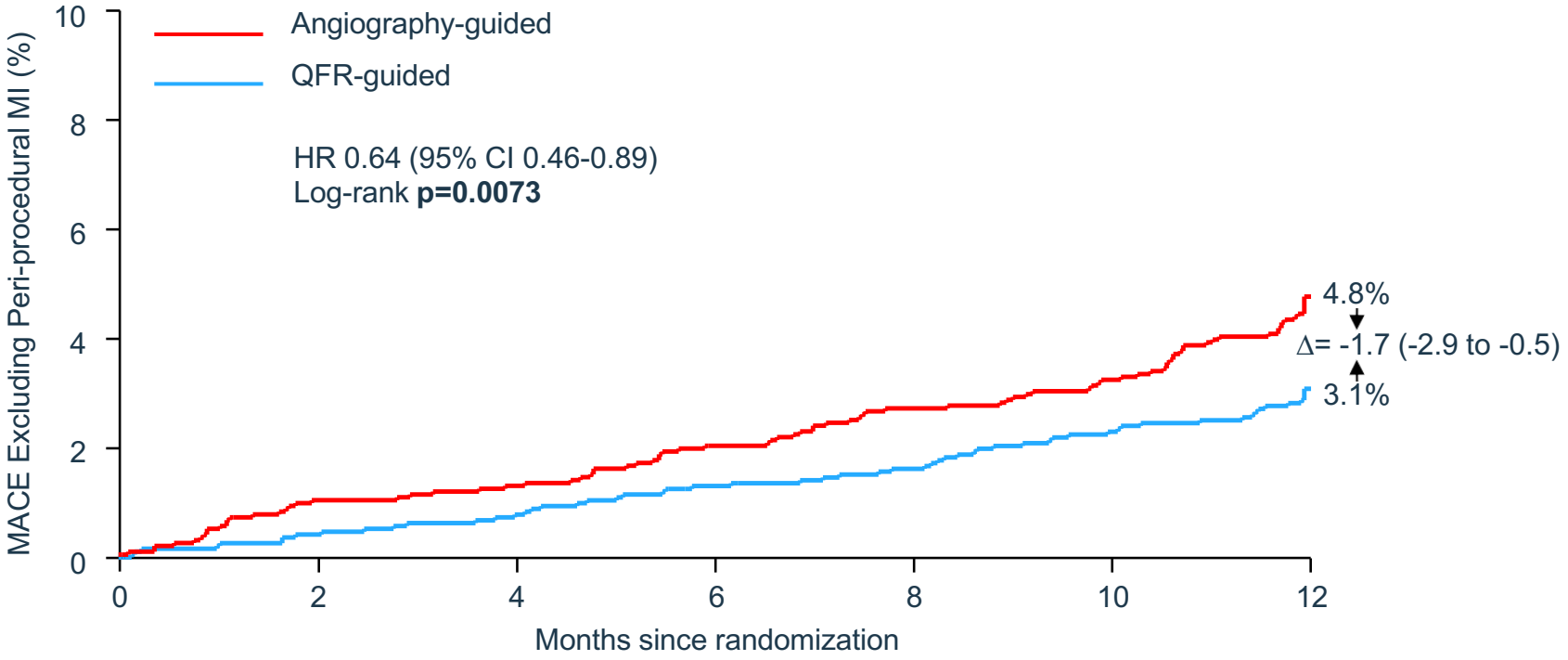
Primary Endpoint (ITT)



No. at risk

QFR-guided	1913	1845	1840	1828	1821	1809	1795
Angiography-guided	1912	1804	1798	1783	1770	1762	1732

Major Secondary Endpoint (ITT)



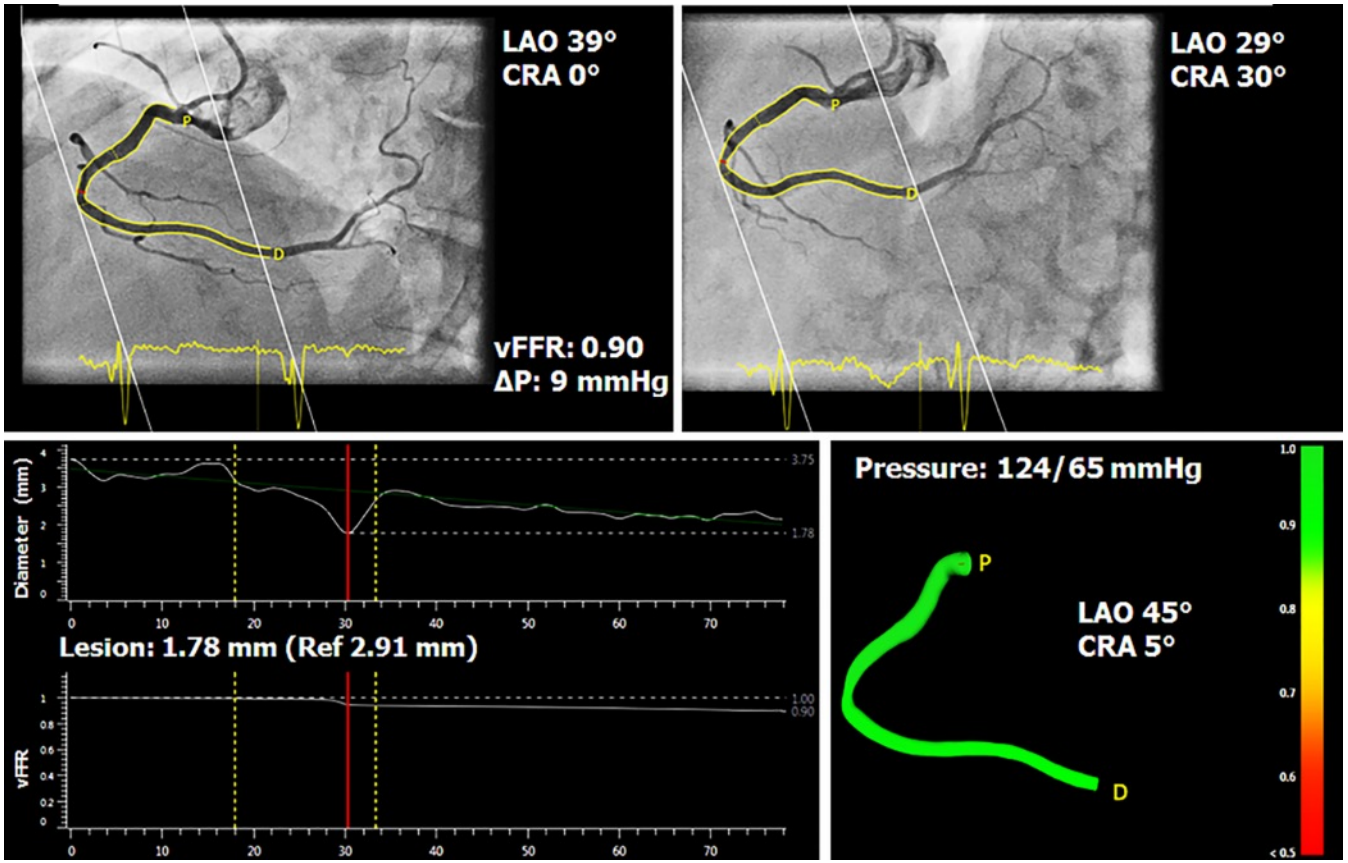
No. at risk

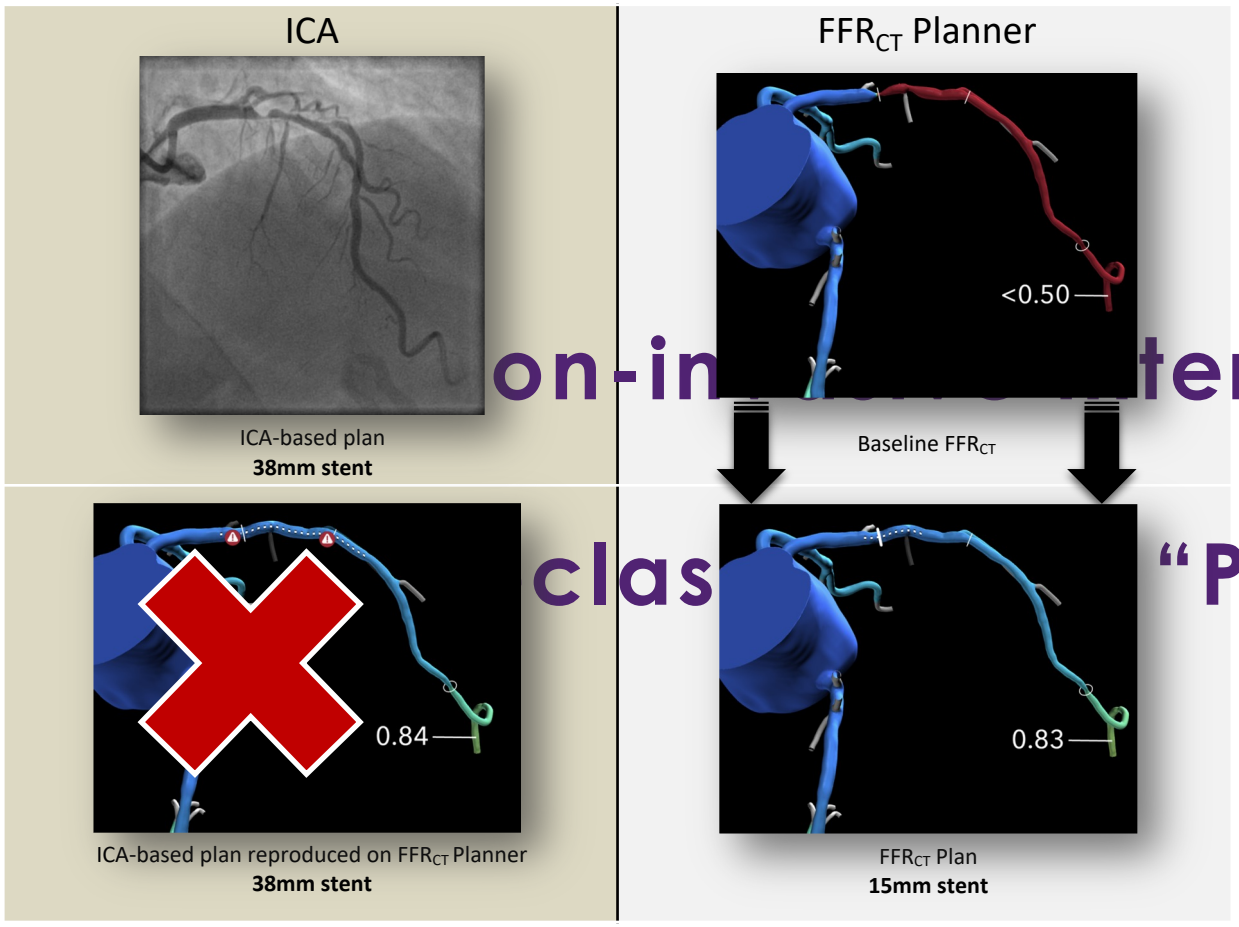
QFR-guided	1913	1900	1894	1881	1874	1862	1846
Angiography-guided	1912	1883	1877	1862	1847	1839	1808

Virtual FFR based on Agngiography

Required:

- **2 contrast filled angiograms**
- **Orthogonal views: ≥30 degrees**
- **Invasive aortic pressure**



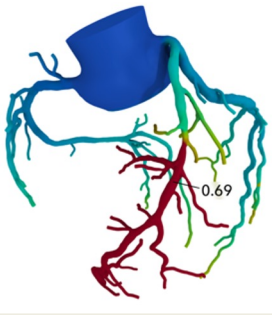


Reduced stent length using FFR$_{CT}$ Planner strategy yielded similar physiologic result as ICA-based plan

FFR_{CT} Planner· Core Components

1

Starts with the HeartFlow Analysis

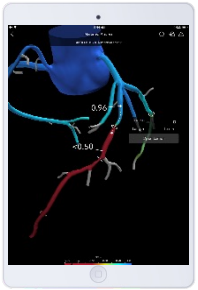


Interactive Mobile Platform

2

- iOS, interactive viewer

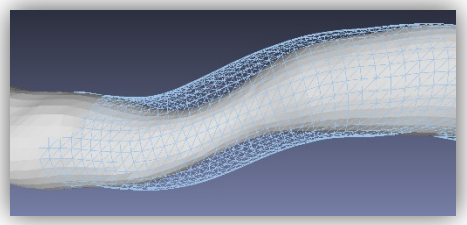
HeartFlow Planner



3

Ideal Geometry

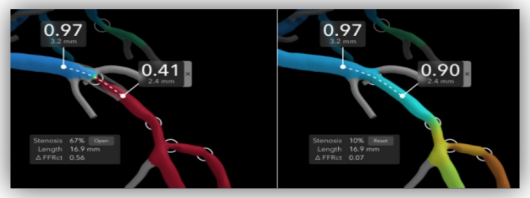
- Contains a second anatomic model representing the "ideal" vessel



Real-time FFR_{CT} calculation

4

- Modified vessel combined with updated physiology



*Not yet commercially available, pending Regulatory Review

2019 ESC Guidelines on the diagnosis and management of chronic coronary syndromes

ESC
European Society of Cardiology

What is new in the 2019 Guidelines?

New recommendations (1)

ESC European Society of Cardiology

Basic testing, diagnostics, and risk assessment

Non-invasive functional imaging or coronary CTA as the initial test for diagnosing CAD.	Invasive angiography to diagnose CAD in patients with - a high clinical likelihood and severe symptoms refractory to medical therapy - typical angina at low level of exercise and clinical evaluation that indicates high event risk. Invasive functional assessment must be available and used to evaluate stenoses before revascularization, unless very high grade (>90% diameter stenosis).	Invasive coronary angiography with availability of invasive functional evaluation for confirmation of CAD diagnosis in patients with uncertain diagnosis on non-invasive testing.
Initial non-invasive diagnostic test based on the clinical likelihood of CAD, patient characteristics, local expertise and availability.		Coronary CTA as an alternative to invasive angiography if another non-invasive test is equivocal or non-diagnostic.
Functional imaging for myocardial ischaemia if coronary CTA has shown CAD of uncertain functional significance or is not diagnostic.		Coronary CTA when any conditions make good image quality unlikely.

Class I Class IIa Class IIb Class III

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ESC Guidelines on the diagnosis and management of chronic coronary syndromes (European Heart Journal 2019; 10.1093/eurheartj/ehz425)

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Patients with angina and/or dyspnoea and suspected coronary artery disease

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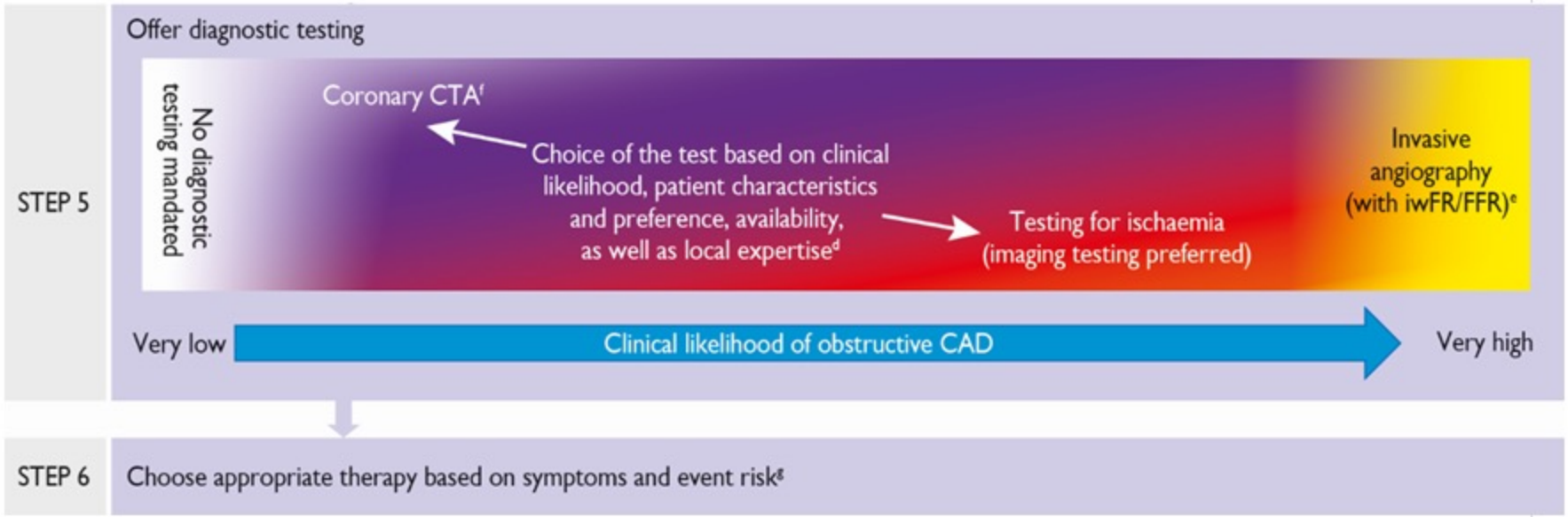
Diagnostic approach (2)



[d] Ability to exercise, individual test-related risks, and likelihood of obtaining diagnostic test result. [e] High clinical likelihood and symptoms inadequately responding to medical treatment, high event risk based on clinical evaluation (such as ST-segment depression, combined with symptoms at a low workload or systolic dysfunction indicating CAD), or uncertain diagnosis on non-invasive testing. [f] Functional imaging for myocardial ischaemia if coronary CTA has shown CAD of uncertain grade or is non-diagnostic. [g] Consider also angina without obstructive disease in the epicardial coronary arteries (see section 6 of full text).

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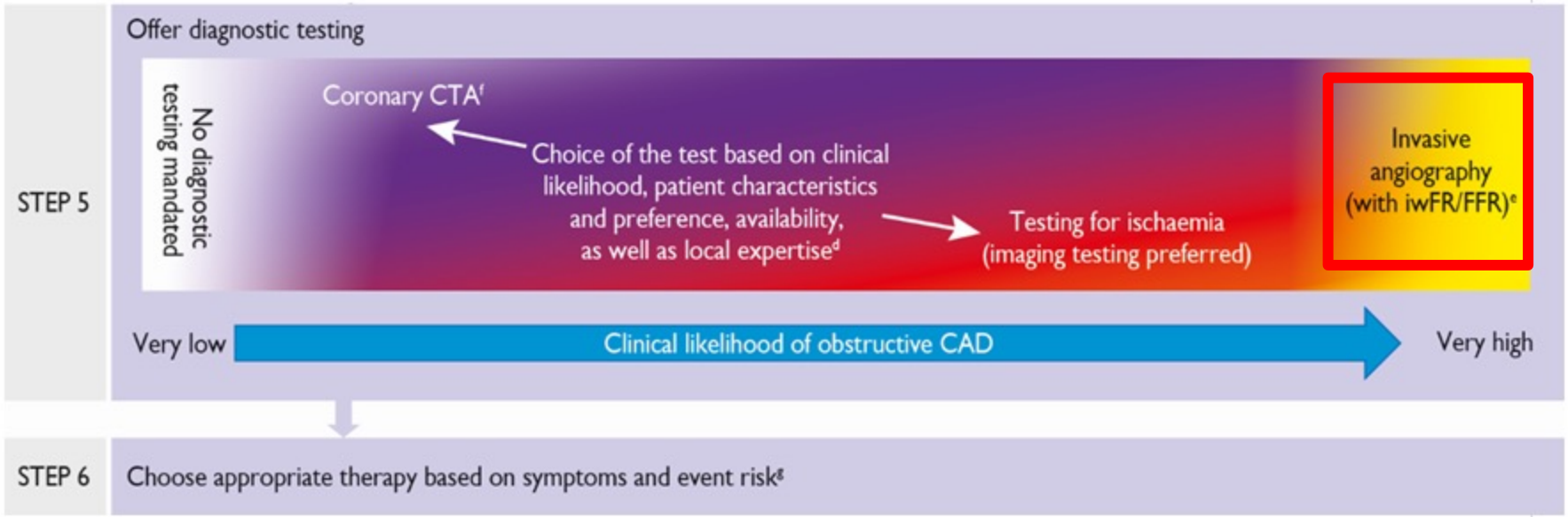

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