



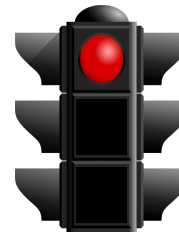
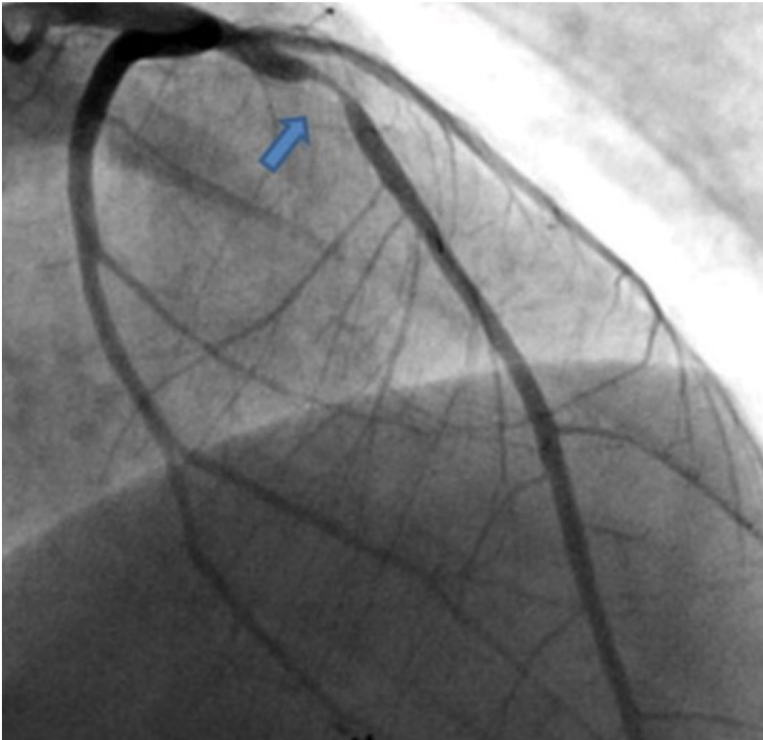
La planification de l'angioplastie

Eric Van Belle,

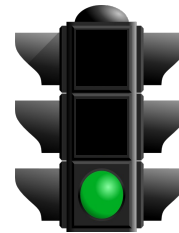
**Lille University Hospital
Heart & Lung Institute**



A simple case!

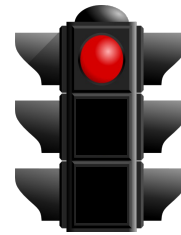
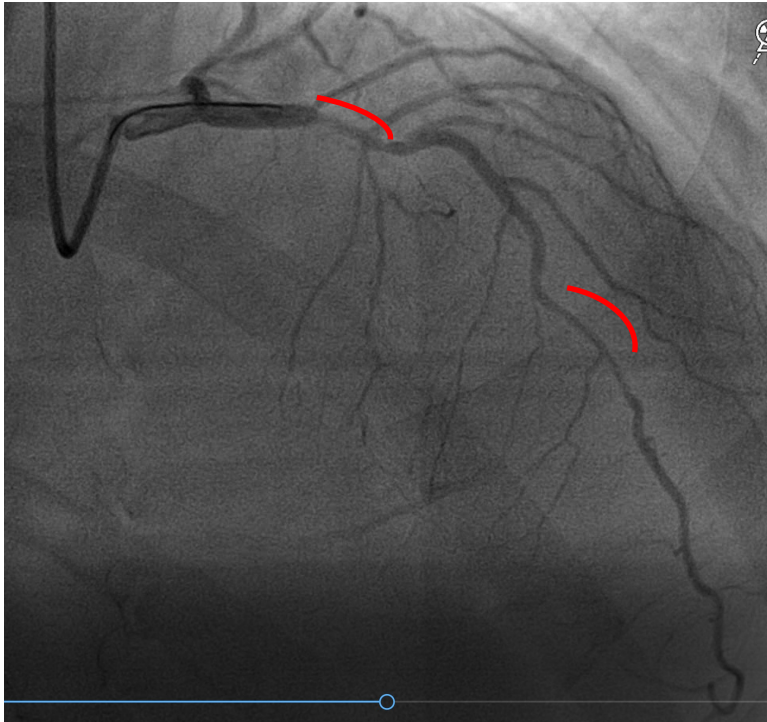


Traitement médical
FFR > 0.81
iFR > 0.89

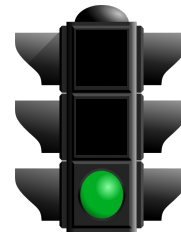


Angioplastie
FFR ≤ 0.80
iFR ≤ 0.89

Amore complexe case!



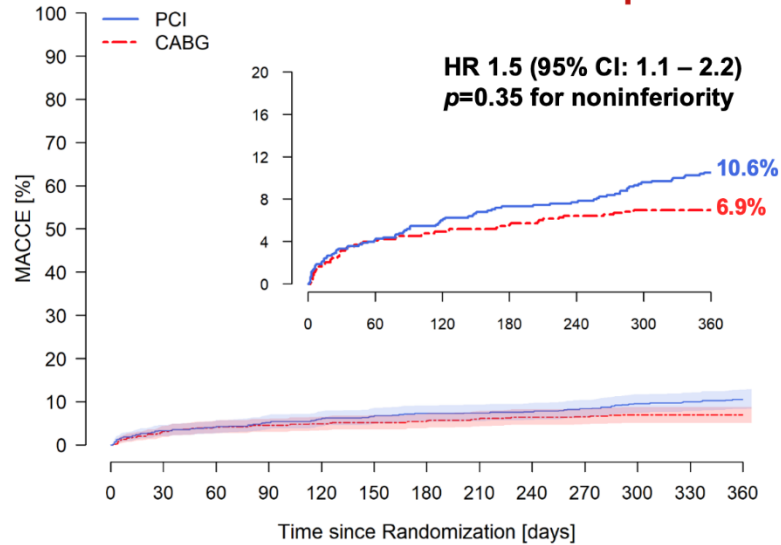
Traitement médical
FFR > 0.81
iFR > 0.89



Angioplastie
FFR ≤ 0.80
iFR ≤ 0.89

Primary Endpoint

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



	No. at Risk												
PCI	757	728	721	713	707	702	697	696	693	687	678	674	670
CABG	743	709	701	698	695	693	691	686	683	682	679	679	679

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%

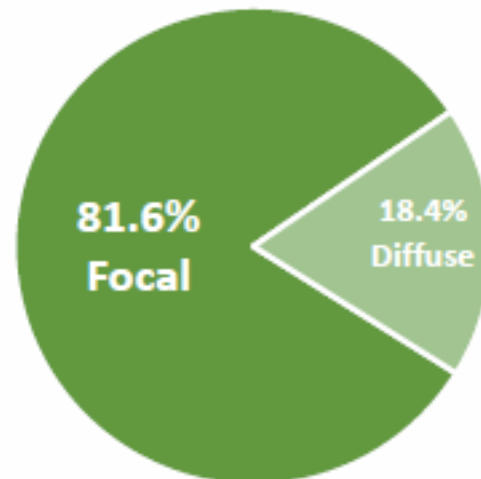
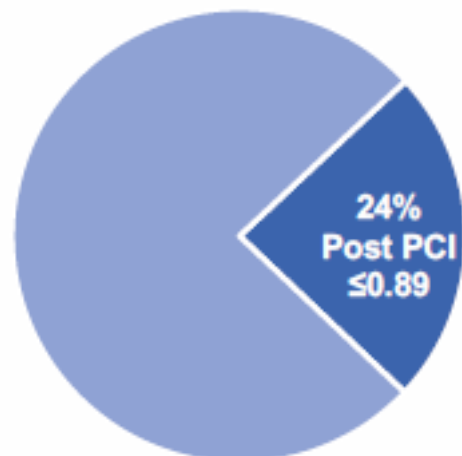
Variable	CABG (n=743)
FFR measured prior to CABG	10%
# of distal anastomoses	3.4±1.0
Multiple arterial grafts	25%
LIMA	97%
Off-Pump surgery	24%



Primary Study Endpoint

480 Patients with
Angiographically Successful PCI
and qualified iFR pullbacks

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

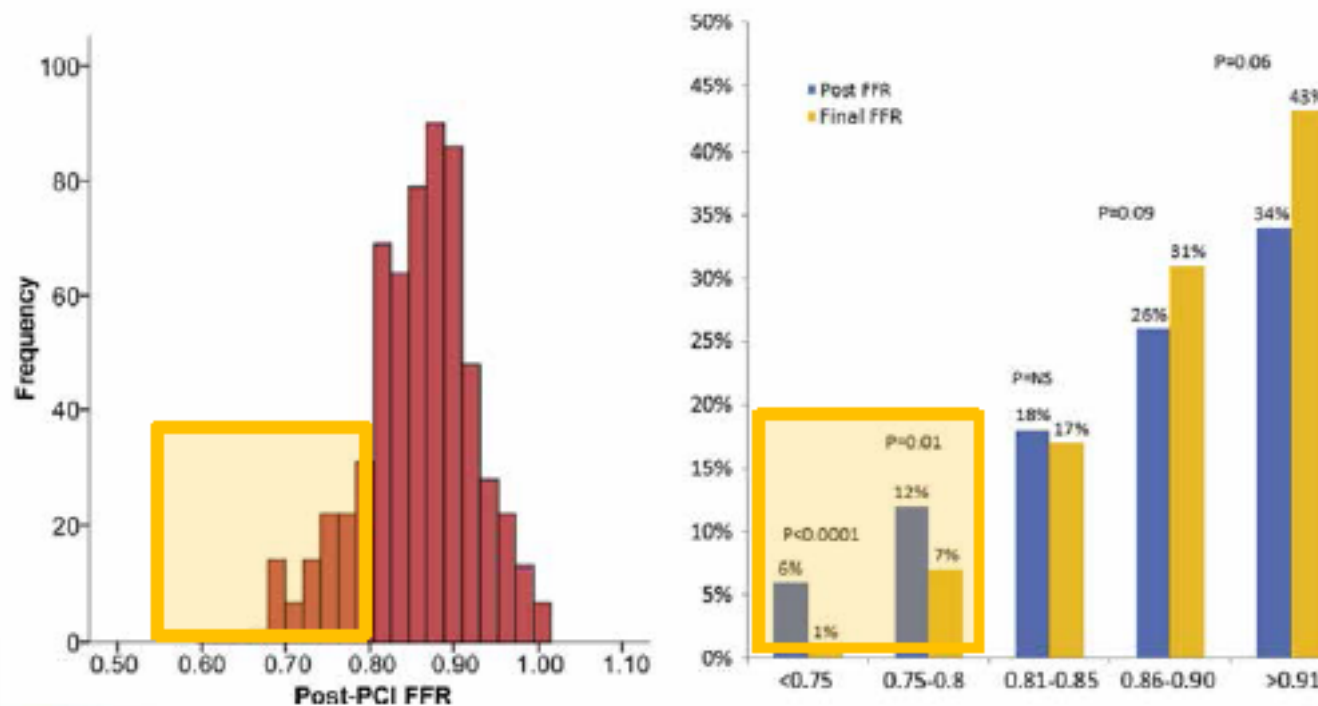


■ Post iFR \leq 0.89 ■ Post iFR $>$ 0.89

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



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

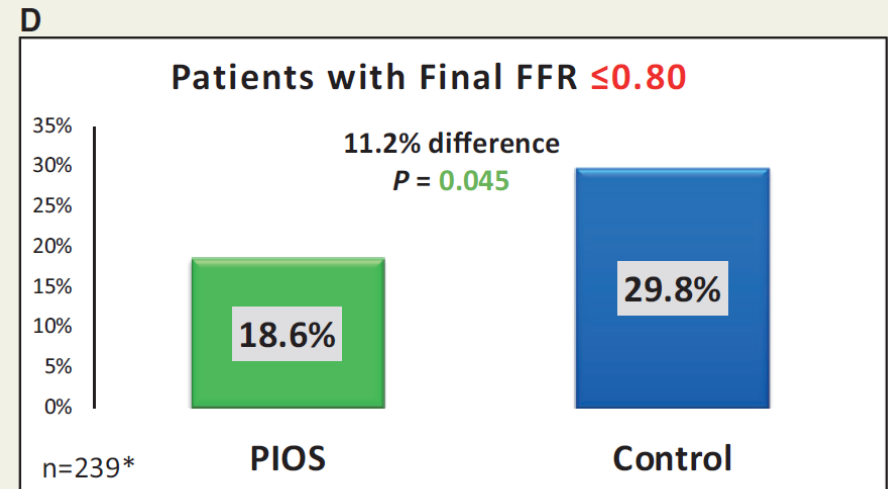
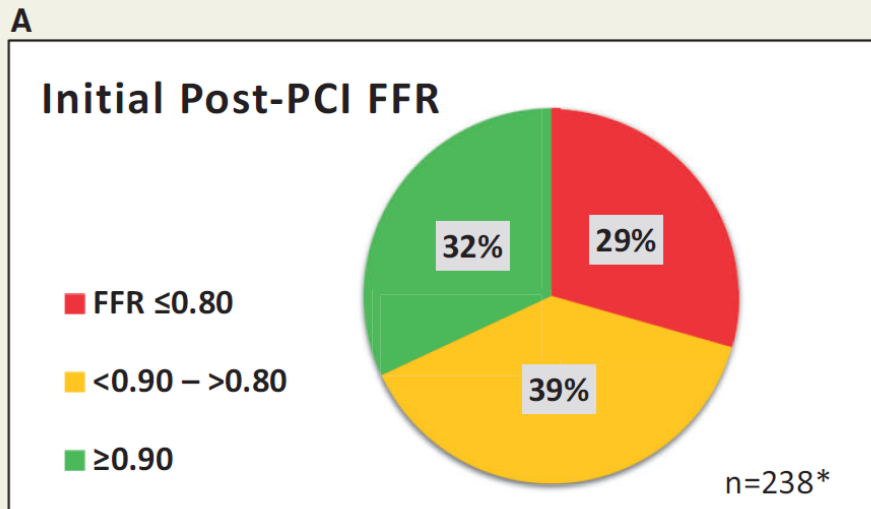


Lee JM, et al. *J Am Coll Cardiol Interv.* 2018;11:2099-109.

Agarwal SK, et al. *J Am Coll Cardiol* 2016;9:1022-31.

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

Damien Collison ^{1,2*}, Matthaios Didangelos ¹,



De quoi a t'on besoin?

- ✓ D'un outil qui nous permette de mesurer facilement la FFR/iFR des 3 artères (ce que l'on ne fait jamais)
- ✓ D'un outil qui nous permette de mesurer la FFR/iFR après que le patient a quitter la salle de coronarographie (lésions non coupables, dossiers difficiles,)
- ✓ D'un outil qui nous permette de mesurer facilement la FFR/iFR à la fin de notre procédure
- ✓ Mieux: D'un outil qui nous permette de prédire quelle sera la valeur de la FFR/iFr à la fin de la procedure pour adapter notre procedure

Homme, 78 ans

Bon état général

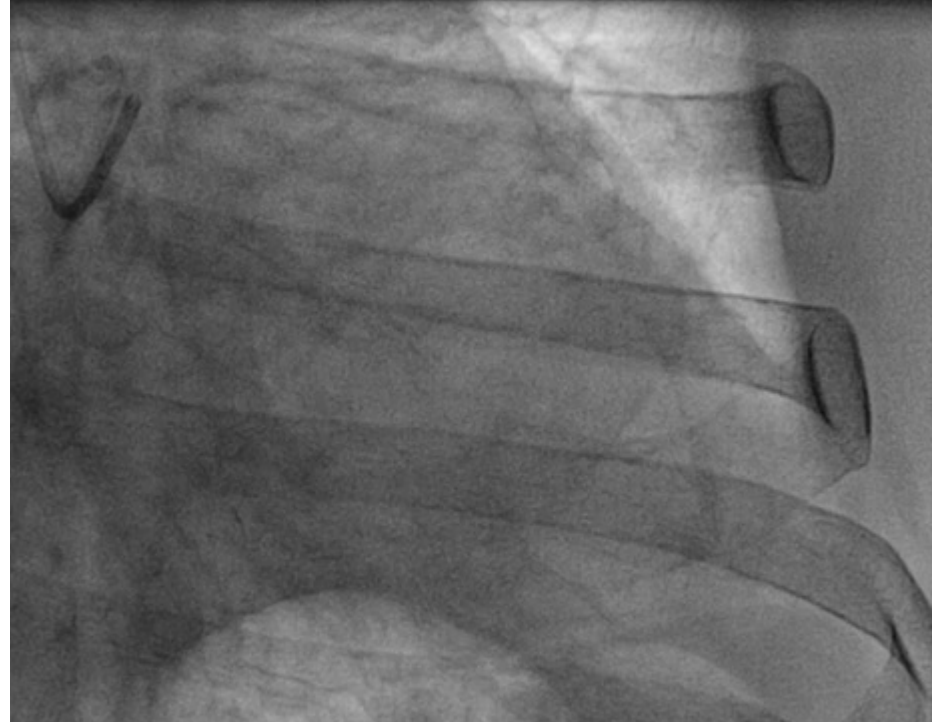
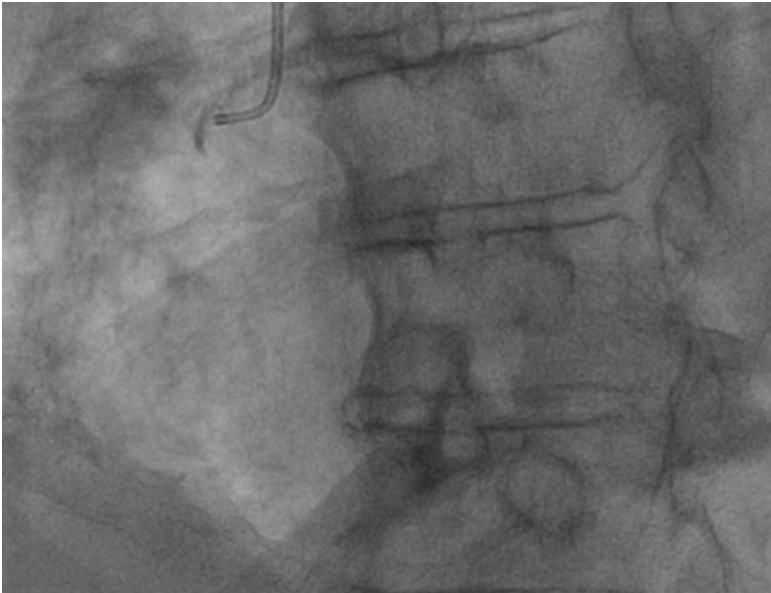
ATCD IDM inférieur (10 ans) – CD occluse connue non revascularisée

Hospitalisé pour NSTEMI avec décompensation cardiaque.

ETT : FEVG conservée avec séquelle inférieure.

Anticoagulation efficace pour une fibrillation atriale.

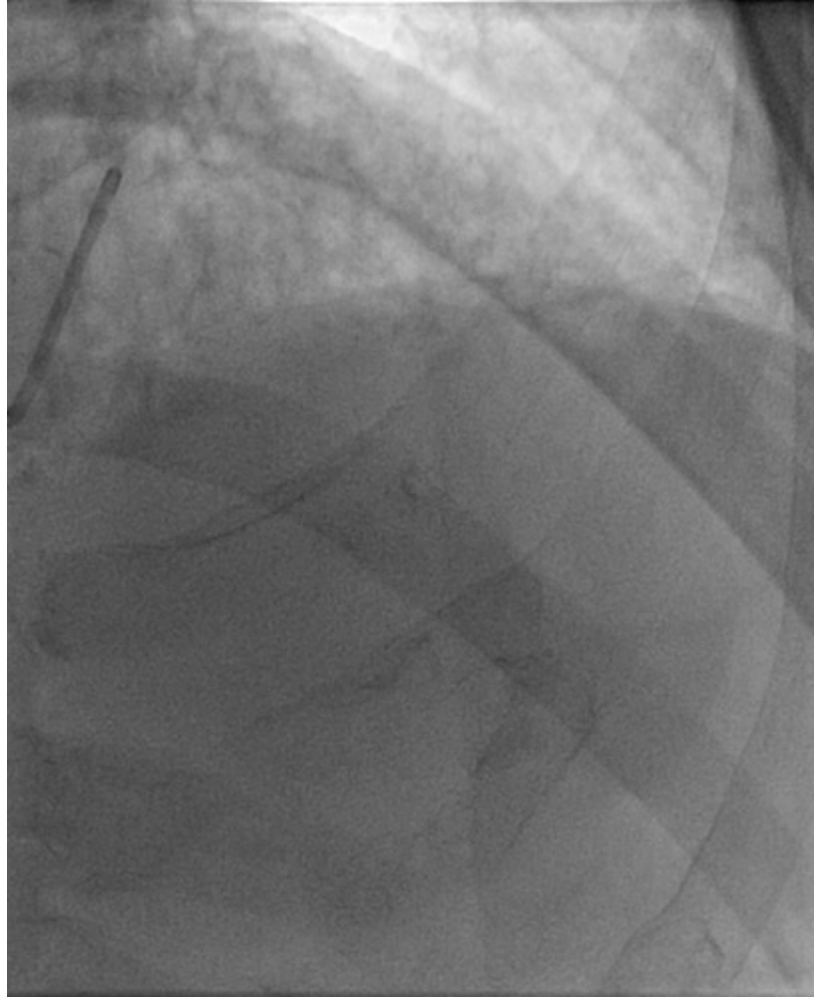
Fonction rénale normale. Pas de diabète.



Pr Eric VAN BELLE MD, PhD

Institut Coeur et Poumon - CHU Lille, France

University of Lille - School Of Medicine Henri Warembourg



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



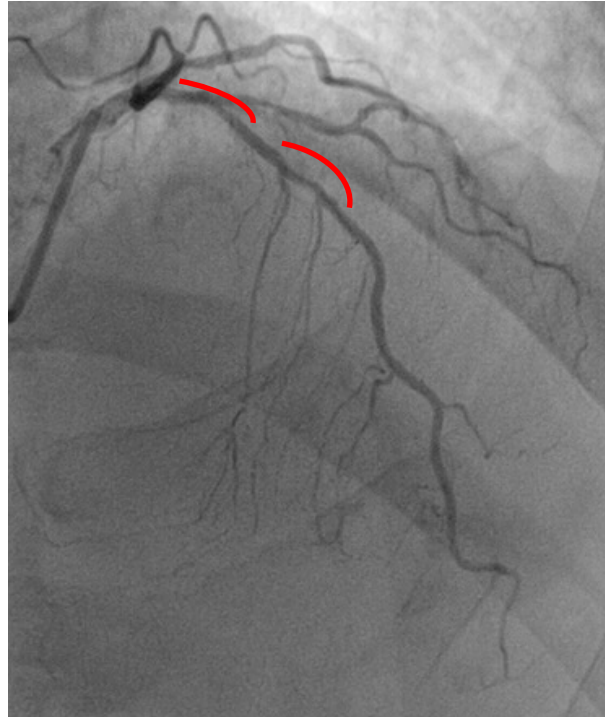
Evaluation physiologique sur l'IVA

FFR à 0,74

iFR à 0,69

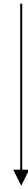
Vaisseau physiologiquement très
ischémique

*Zone de mesure avec
le guide de pression*

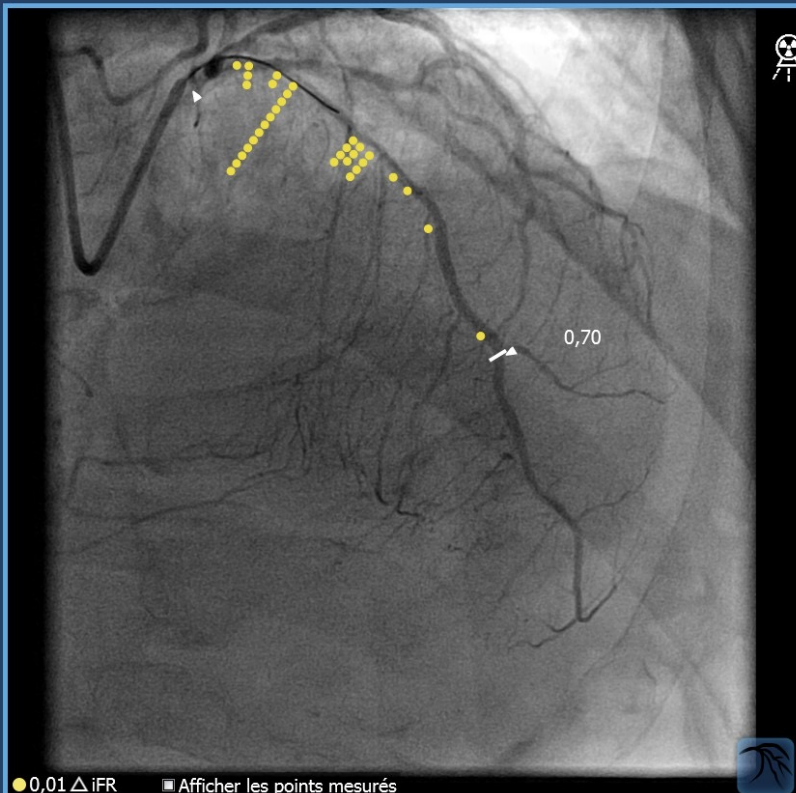


Angiographiquement :

Lésions relativement
diffuses avec 2 zones
distinctes



Quelle stratégie de
revascularisation ?



iFR distal: 0,69
 iFR au curseur: 0,70



● 0,01 Δ iFR Afficher les points mesurés

Navigation controls: back, forward, and 'Séq. 1/2' indicator.

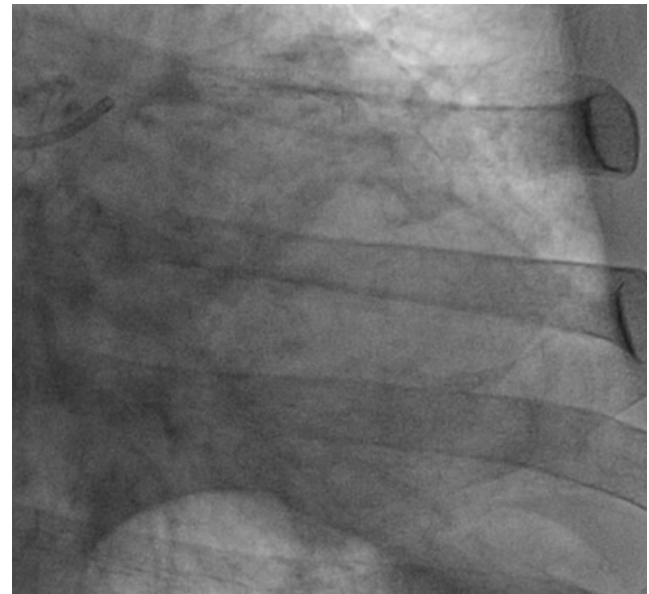
iFR pull back

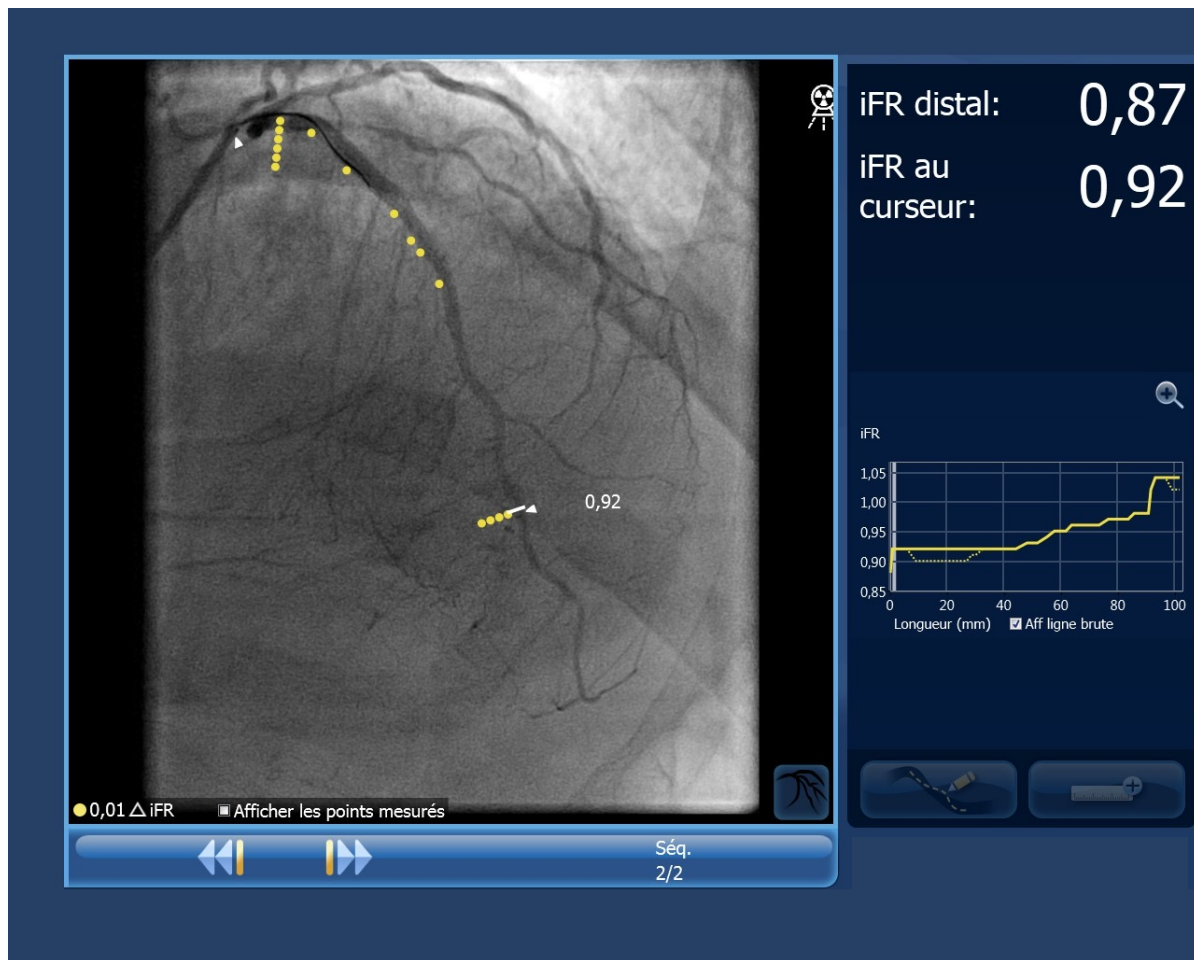
Perte de charge bien répartie entre les 2 lésions

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



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

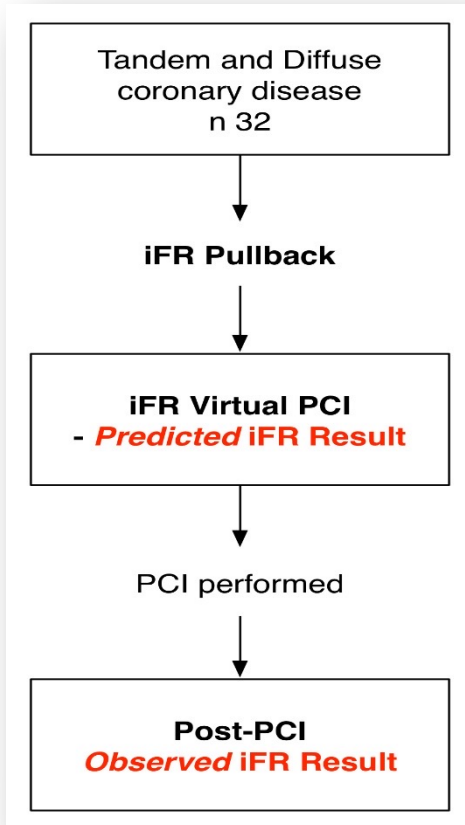




Excellent résultat
hémodynamique avec iFR
final au même point à 0,92.

Gain de 0,23 par la
revascularisation

iFR PULLBACK STUDY

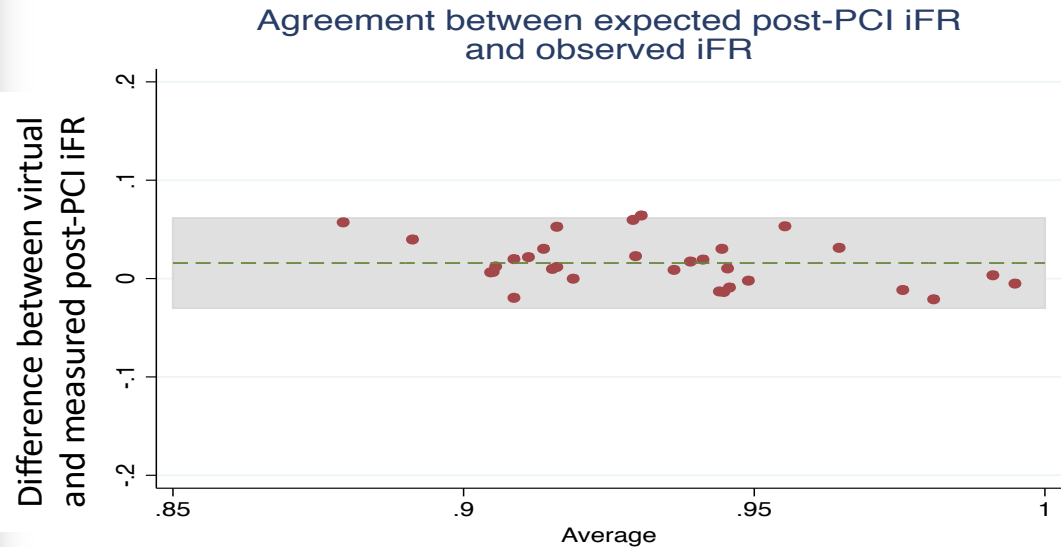


Pre-PCI iFR: 0.78 ± 0.03

Predicted iFR: 0.94 ± 0.01

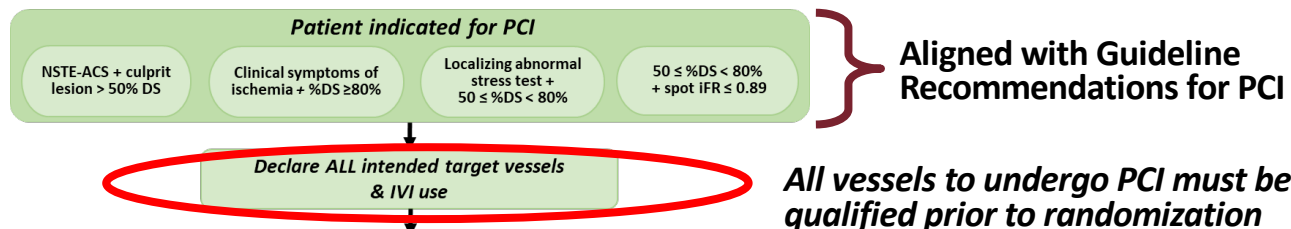
Observed iFR: 0.93 ± 0.03

} **p=0.48**



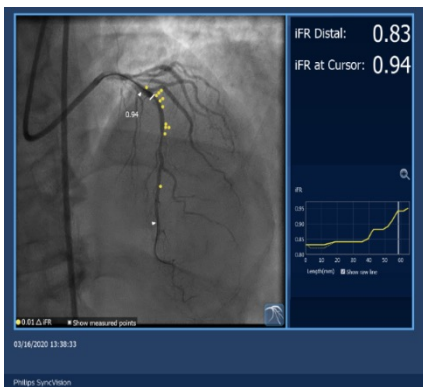
Nijjer SS, Davies J et al *JACC: Cardiovascular Interventions*. 2014;7:1386–1396

DEFINE GPS Flow

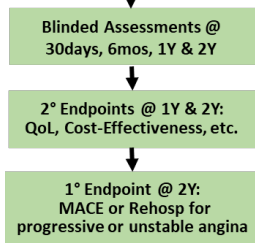
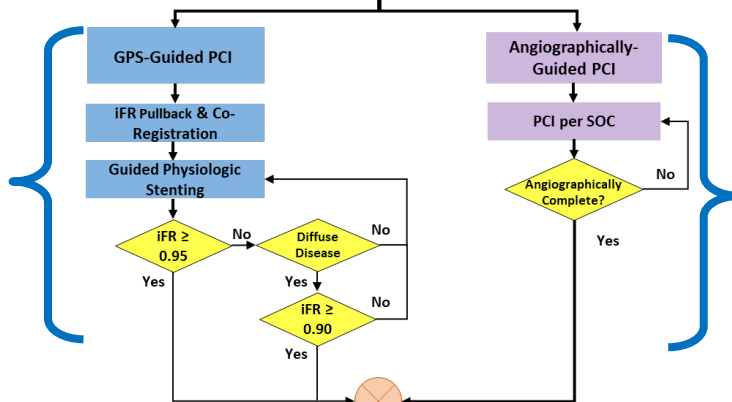
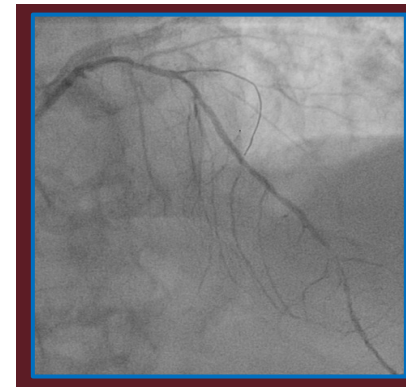


Randomize

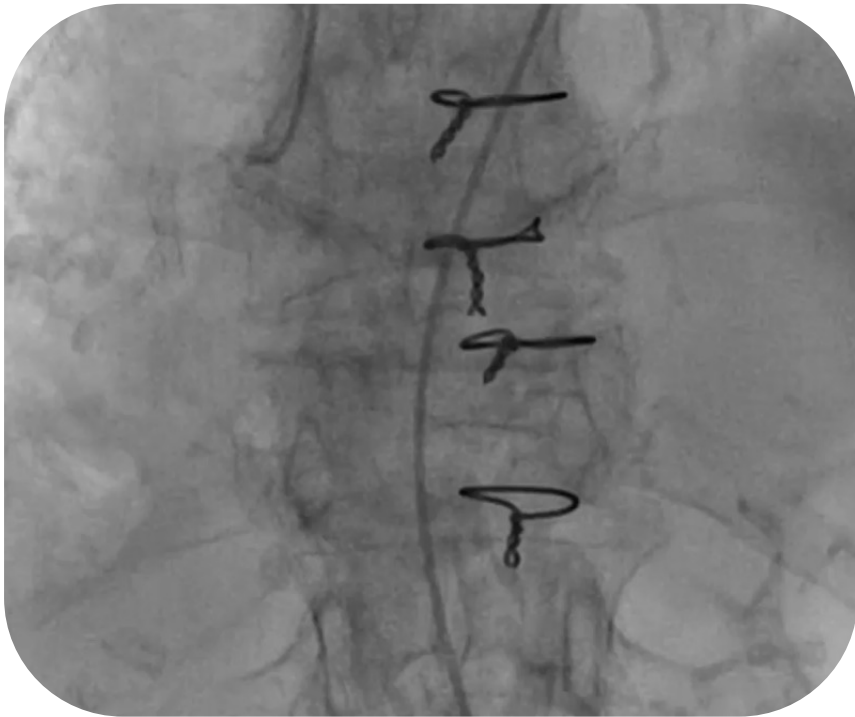
Physiology-Guided PCI



Standard of Care PCI



Coronarographie le 23 juin 2022



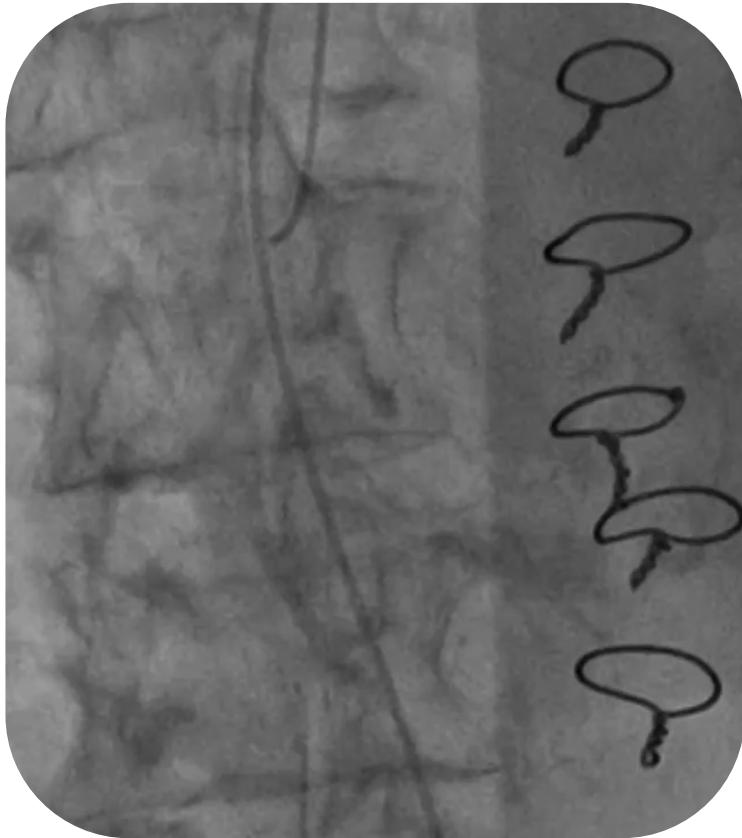
Voie fémorale gauche 6F

Ponction écho, guidée entre les
stent ilio fémoraux

JR 4 diagnostique 6F



Absence de resténose intra stent CD proximale

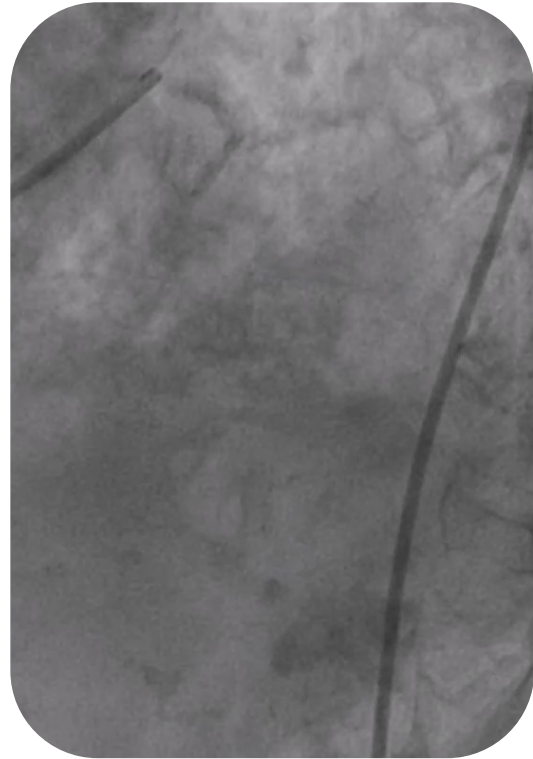
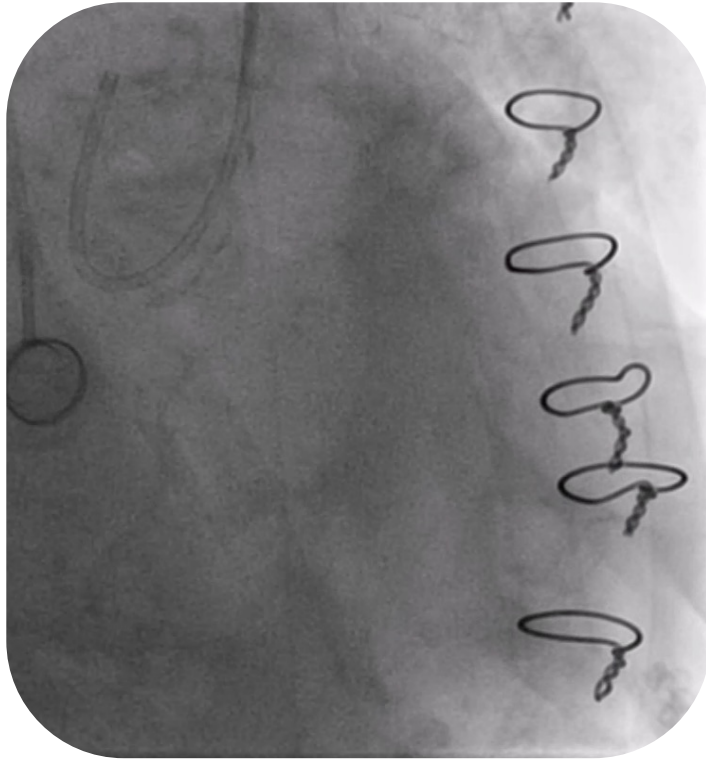


Sténose intermédiaire du genu inferior

Sténose intermédiaire de CD distale

Réseau coronaire droit tortueux et calcifié

XB 3.5 6F





Sténose serrée calcifiée d'IVA proximale et moyenne

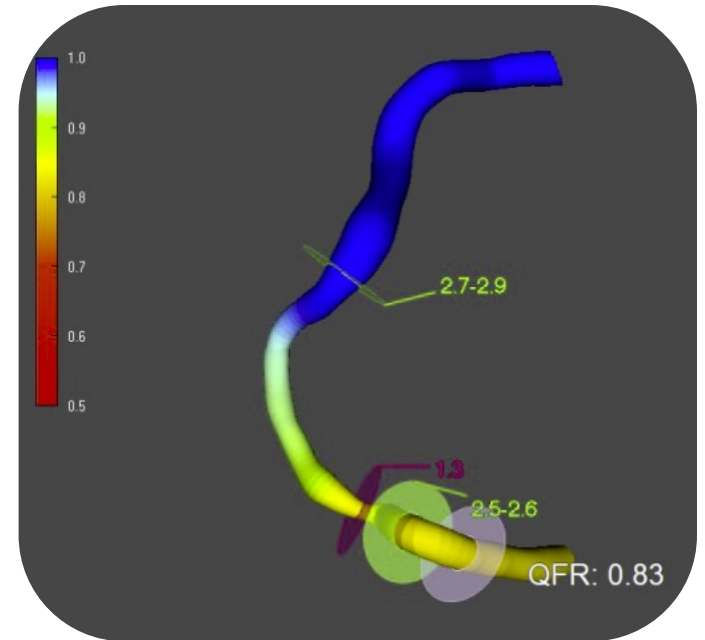
Sténose à 60% de Cx proximale



Prise en charge ?

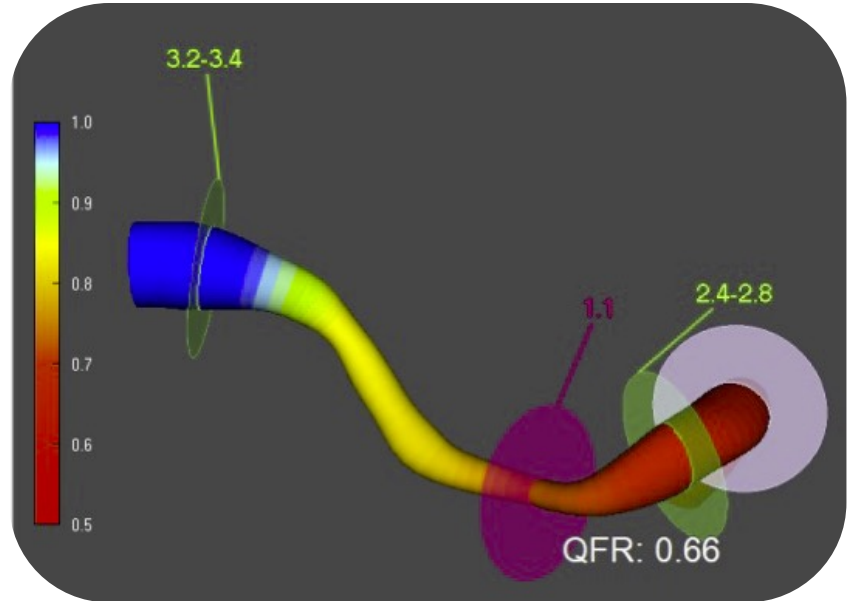
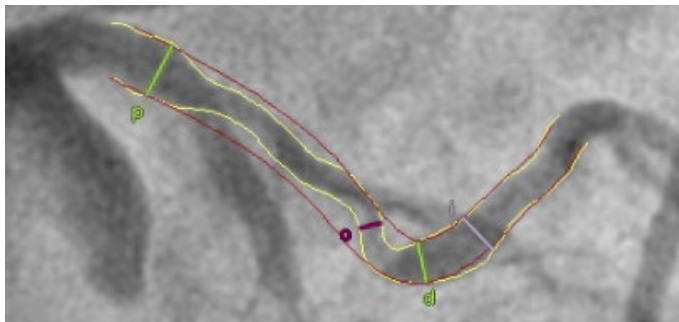
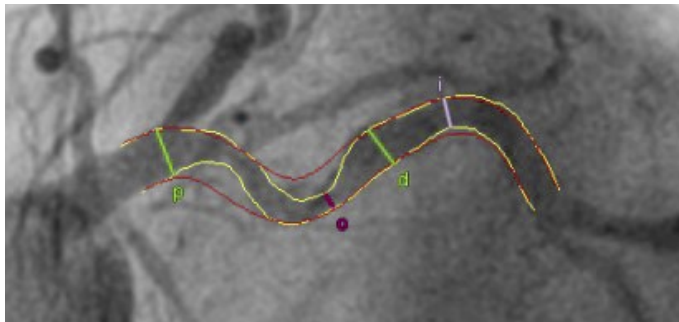
- Traitement médical
- Angioplastie
- Pontage

Analyse QFR de CD



	Vaisseau	Lésion 1	
Contraste Δ QFR		0.17	
Contraste QFR	0.83	0.83	
Longueur	83.3	34.6	mm
Diamètre proximal		2.7 - 2.9	mm
Diamètre distal		2.5 - 2.6	mm
Diamètre de référence		2.6	mm
MLD		1.3	mm
QFR vaisseau résiduel		1.00	

Analyse QFR de Cx

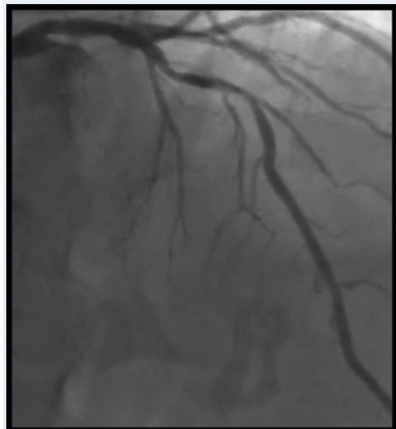


	Vaisseau	Lésion 1	
Contraste Δ QFR		0.33	
Contraste QFR	0.66	0.67	
Longueur	38.1	20.6	mm
Diamètre proximal		3.2 - 3.4	mm
Diamètre distal		2.4 - 2.8	mm
Diamètre de référence		2.7	mm
MLD		1.1	mm
QFR vaisseau résiduel		0.99	



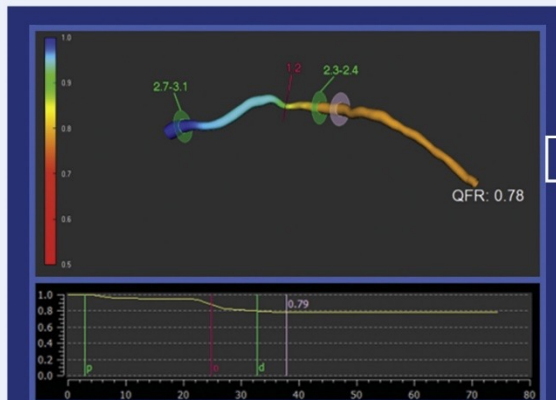
CENTRAL ILLUSTRATION: Study Flow and Main Results of the AQVA Trial

Angiography → Randomization → Procedure



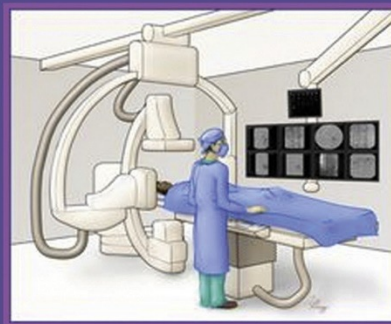
2 angiographic projections
>25° apart

R



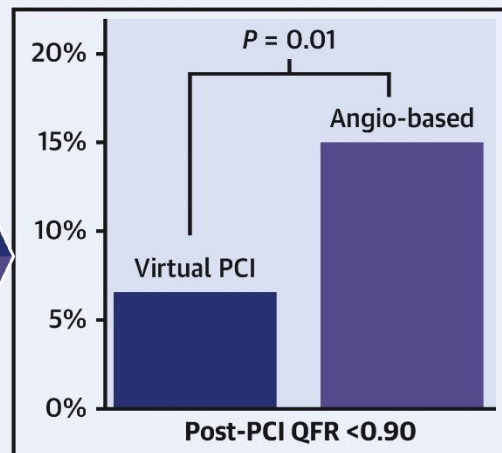
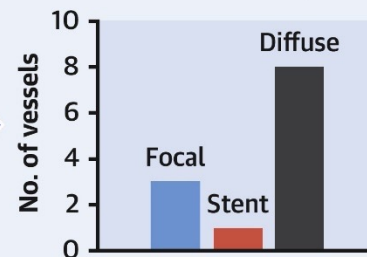
QFR-Based Virtual PCI

Angiography-Based PCI

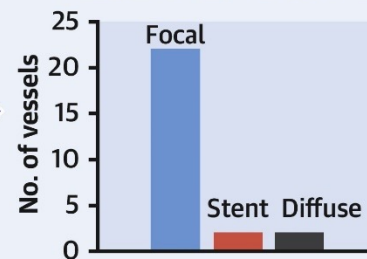


Primary Endpoint

Pattern in Post-PCI QFR <0.90

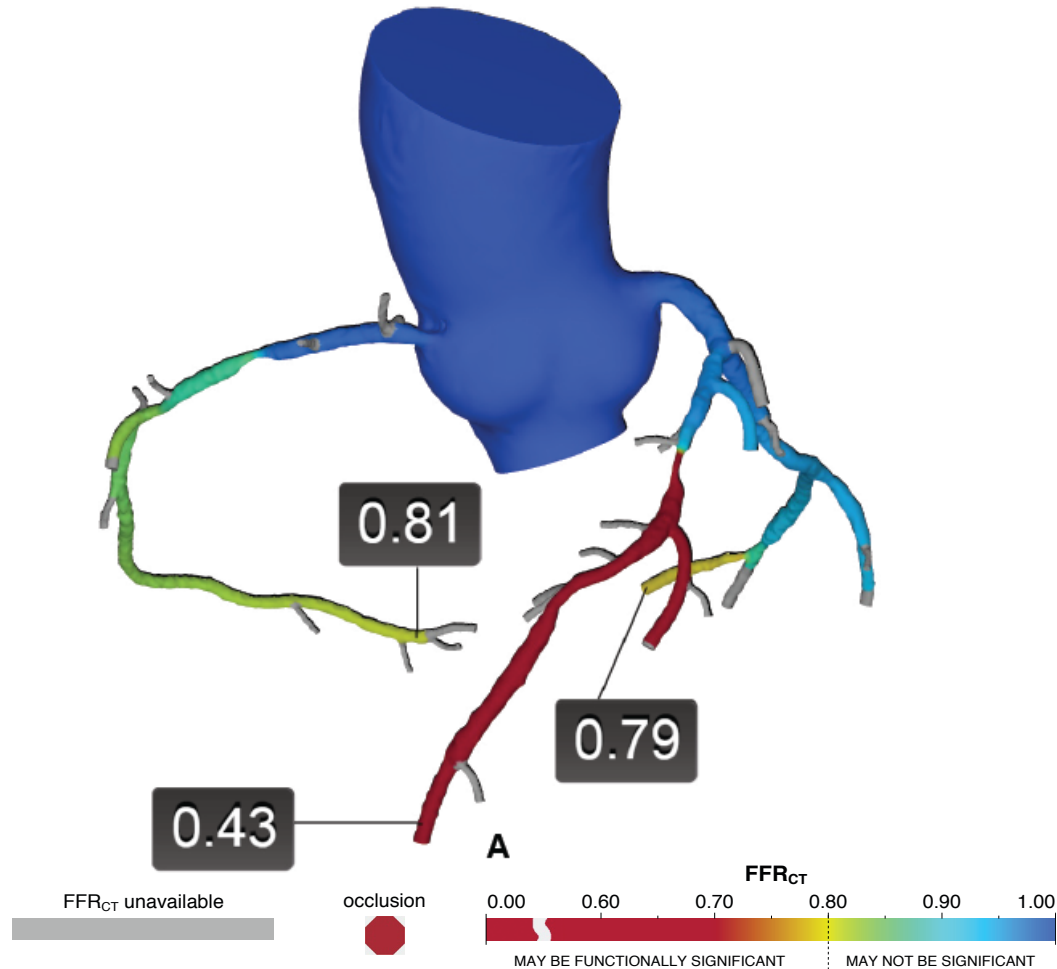


Pattern in Post-PCI QFR <0.90



Using CT to provide FFR

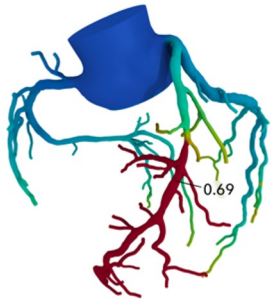
- Multi-vessel narrowings, but functional ischemia in only a single vessel
- Clinician determined that only a single stent was required



FFR_{CT} Planner Core Components

1

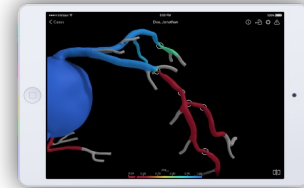
Starts with the HeartFlow Analysis



Interactive Mobile Platform

2

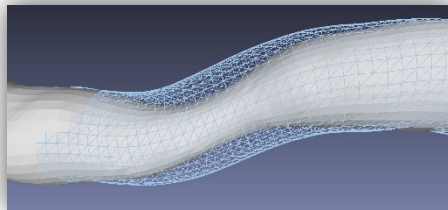
- iOS, interactive viewer



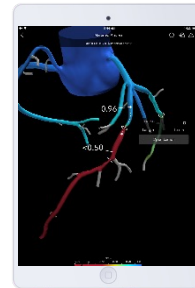
3

Ideal Geometry

- Contains a second anatomic model representing the “ideal” vessel



HeartFlow Planner



Real-time FFR_{CT} calculation

4

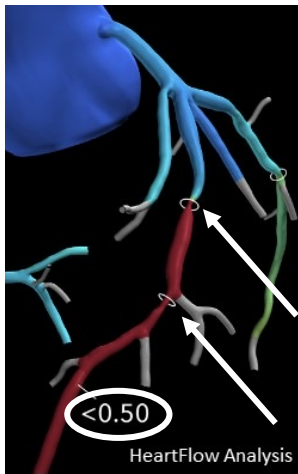
- Modified vessel combined with updated physiology



*Not yet commercially available, pending Regulatory Review

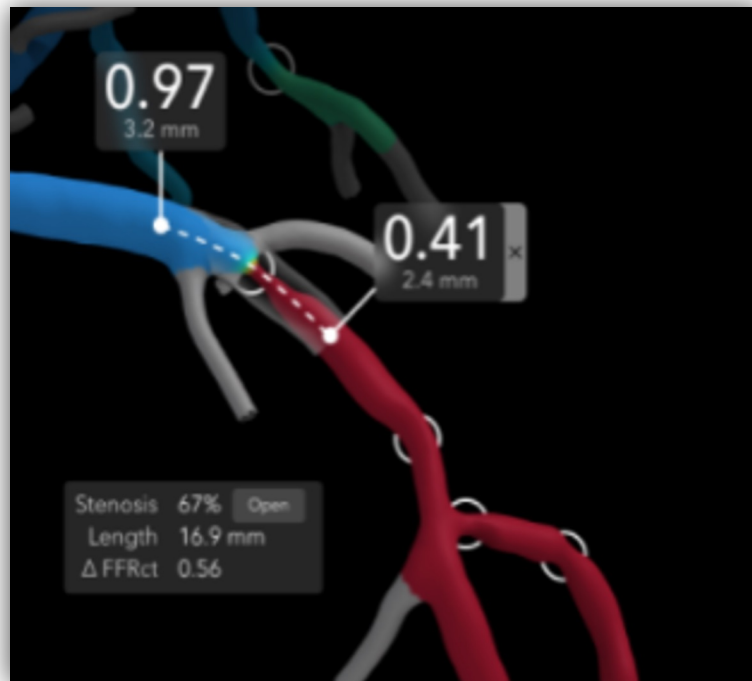
What is FFR_{CT} Planner* ?

Pre-procedure evaluation of alternate treatment strategies to optimize coronary flow

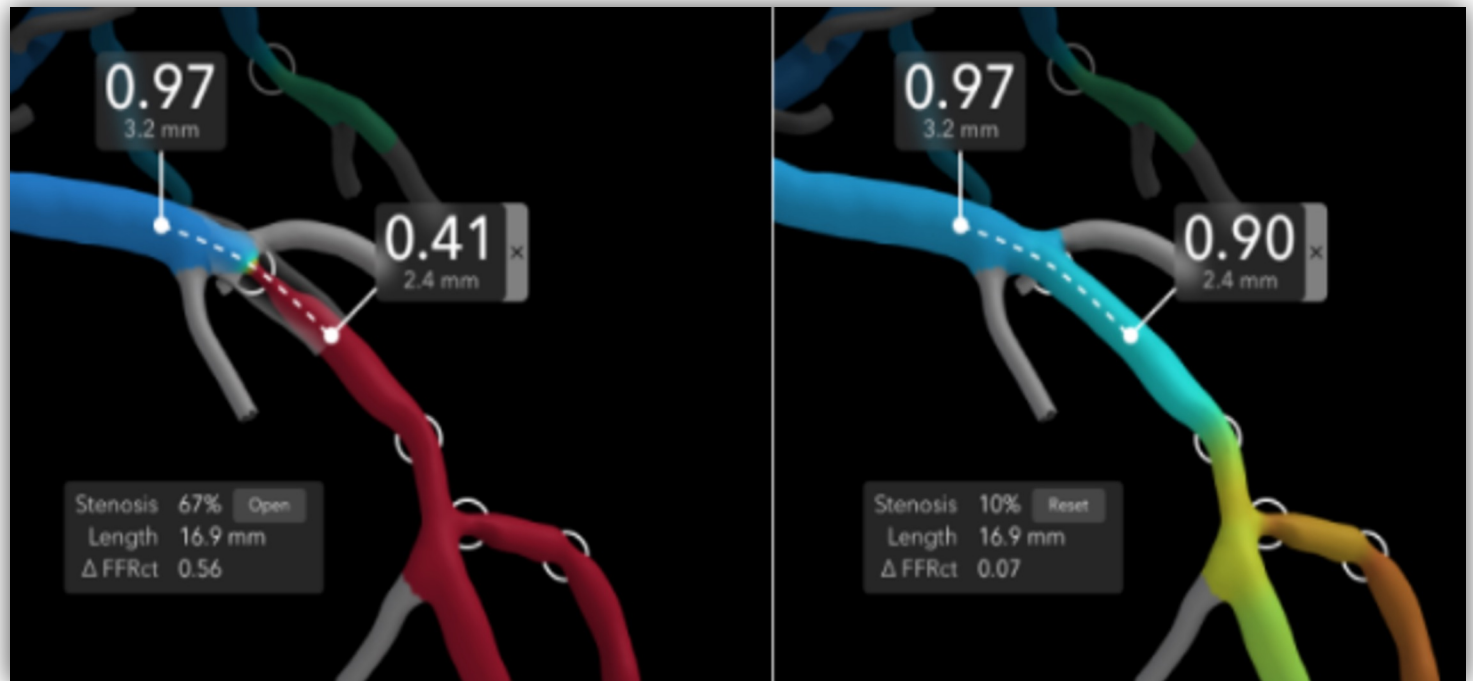


- Real-time non-invasive interactive tool
- Explore different clinical scenarios by virtually removing stenoses
- Assess resulting FFR_{CT} value(s) from any scenario

Real-time FFR_{CT} Recalculation

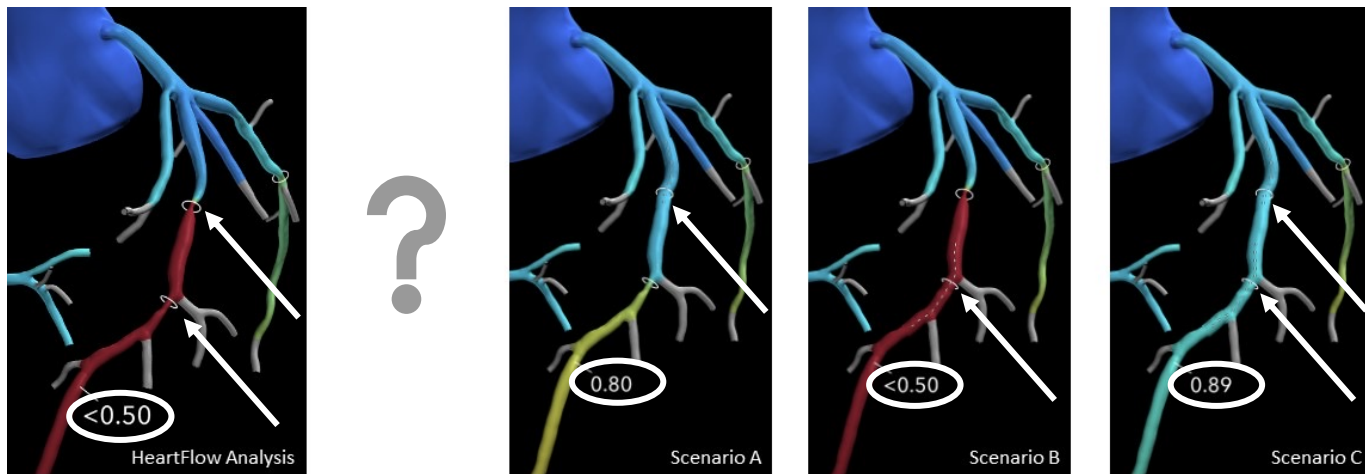


Real-time FFR_{CT} Recalculation



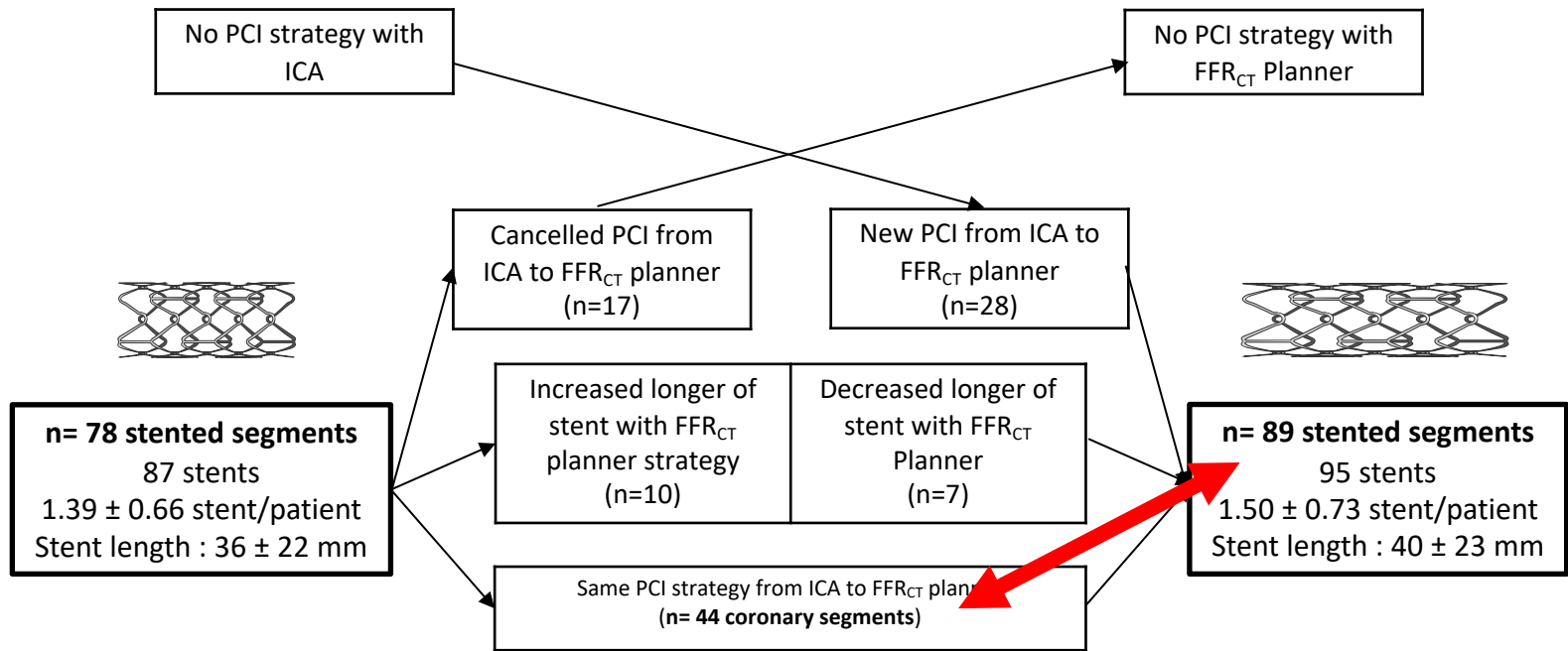
What is FFR_{CT} Planner* ?

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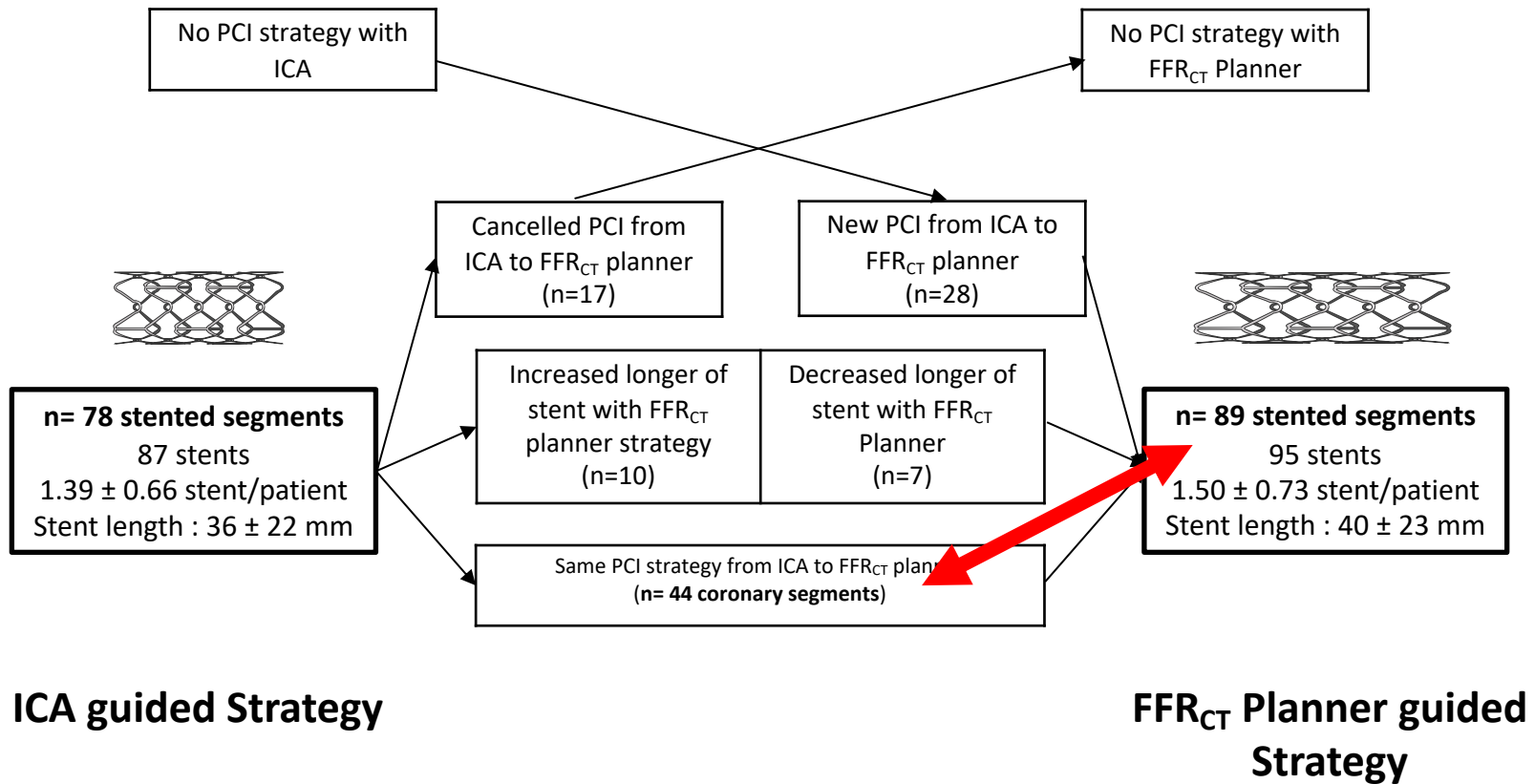
- Real-time non-invasive interactive tool
- Explore different clinical scenarios by virtually removing stenoses
- Assess resulting FFR_{CT} value(s) from any scenario

*Not yet commercially available, pending Regulatory Review



ICA guided Strategy

FFR_{CT} Planner guided Strategy



Change of strategy in 51% of cases

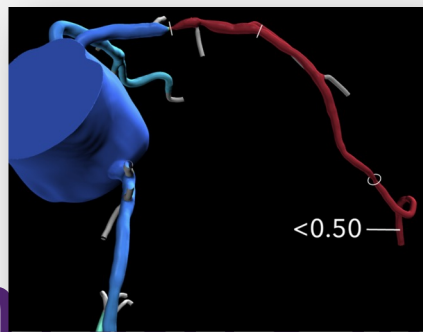
Pre-PCI

ICA



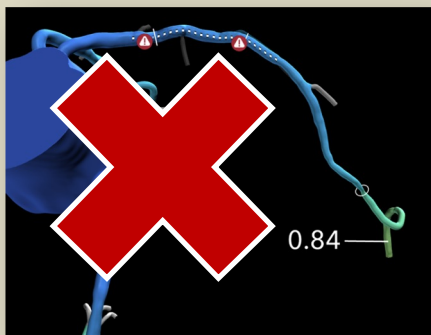
ICA-based plan
38mm stent

FFR_{CT} Planner

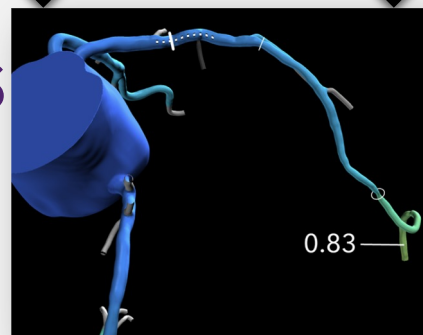


Baseline FFR_{CT}

Post-PCI



ICA-based plan reproduced on FFR_{CT} Planner
38mm stent



FFR_{CT} Plan
15mm stent

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

Conclusion

- ✓ Distal “spot” pre-procedural FFR/iFR has reach his limits to assist multivessel PCI (FAME 3)
- ✓ Recent studies hases shown that 15-30% vessels remain ischemic after an apparently appropriately conducted PCI (30-60% of patients with residual ischemia in case of multivessel PCI)
 - ✓ Post-PCI identification of “ischemic” FFR/iFR
 - ✓ Pre-procedural pullback-derived pressure coronary mapping
 - ✓ “virtual PCI”
are key to improve the clinical outcome of our coronary patients, in particular those with MVD.

Juin 2022, Mme G. se presente aux soins intensifs pour douleur thoracique

Femme de 72 ans

Pneumopathie à SARS-Cov2 + EP en mai 2022

Cardiopathie ischémique depuis 2019

Sub OAP + Douleur thoracique depuis 2h

- Angioplastie de CD proximale
- FEVG 60%

Onde T négatives antérieures

AOMI sévère

Tropo 114ng/L puis 147ng/L

- Angioplastie de l'iliaque droite en 2013
- Angioplastie ilio fémorale gauche en 2013

NTproBNP 44 461ng/L

MTEV à répétition

FEVG 30%

Akinésie apicale et des segments adjacents

Myélome multiple à chaines légères kappa


- 3^{ème} Ligne de Chimiothérapie en 2022

Insuffisance rénale chronique (DFG 34ml/min/SC), BPCO

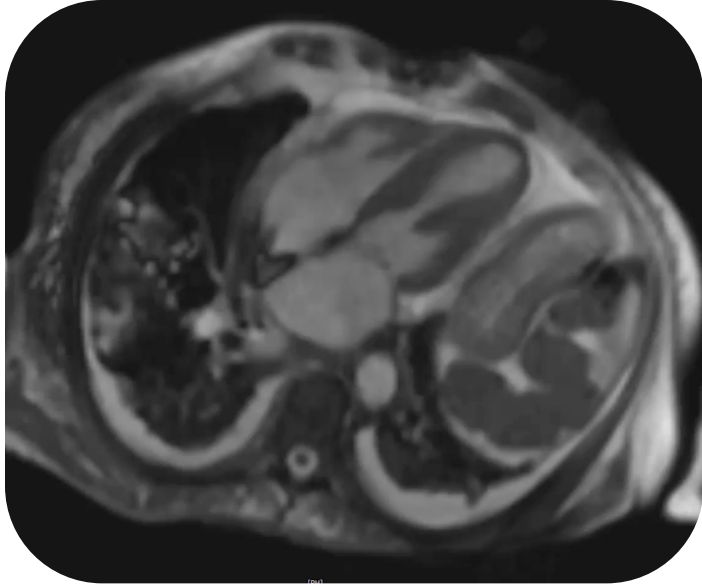
Thymectomie en 2014



Prise en charge ?

- Coronarographie
- Coro scanner
- IRM 

IRM myocardique le 14 juin 2022



FEVG 31%, pas de dilatation VG

Ballonisation apicale avec hypokinésie

FEVG 36%, pas de dilatation VD, hypokinésie diffuse

Élévation du T2 à l'apex avec rehaussement précoce

Absence de prise de contraste pathologique

Pas de séquelle d'infarctus

Evolution favorable

ETT à la sortie:

- FEVG 45%
- Akinésie apicale et septale
- Hypokinésie antérieure

Onde T négatives en antérieur

Retour à domicile à J3

Coronarographie



Avis des hématologues, pas de contre indication à l'injection de PdC

Refaire le point sur la coronaropathie d'une patiente à très haut risque CV

Explorer les anomalies

- de la cinétique
- de la repolarisation

 OUI

TTT medical

Symptômes ?
Ischémie ?

CABG

SYNTAX score 32

SYNTAX score II

PCI 4y mortality 85%

CABG 4y mortality 59%



PCI

71 ans

Redux

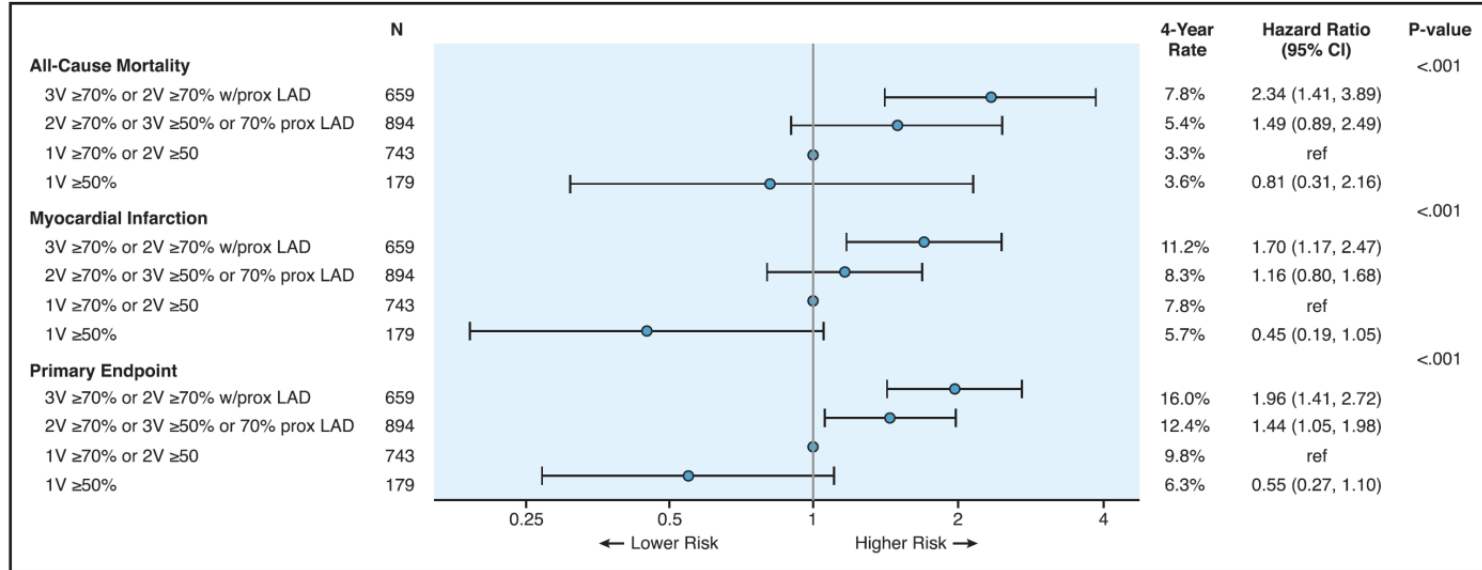
BPCO, IRC, FEVG 40%

Myélome actif

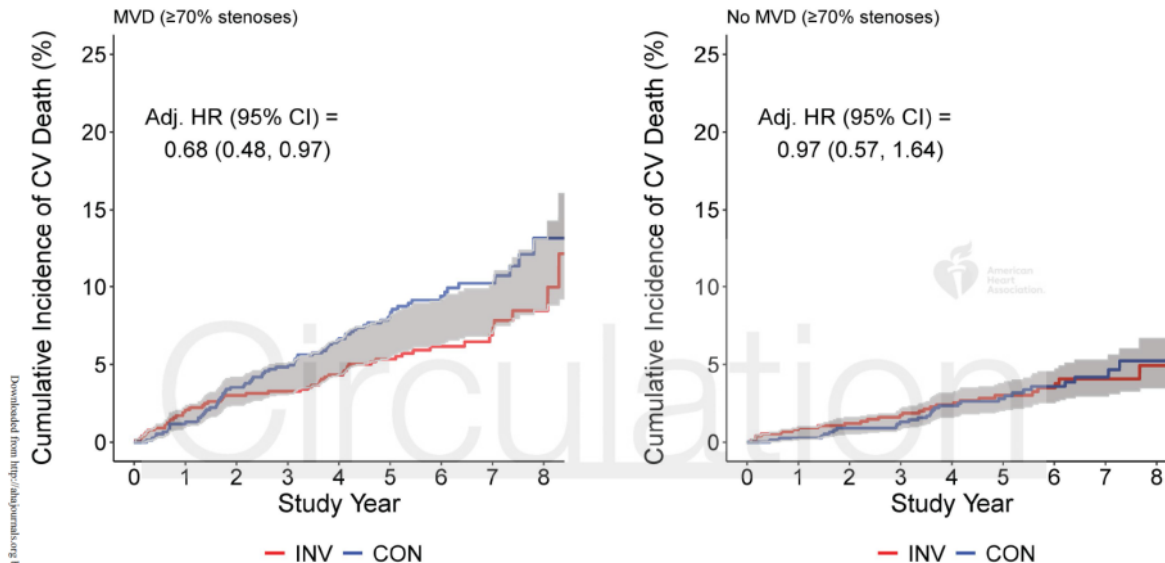
Chimiothérapie

Avis de la patiente

Outcome According to CAD severity in ISCHEMIA trial



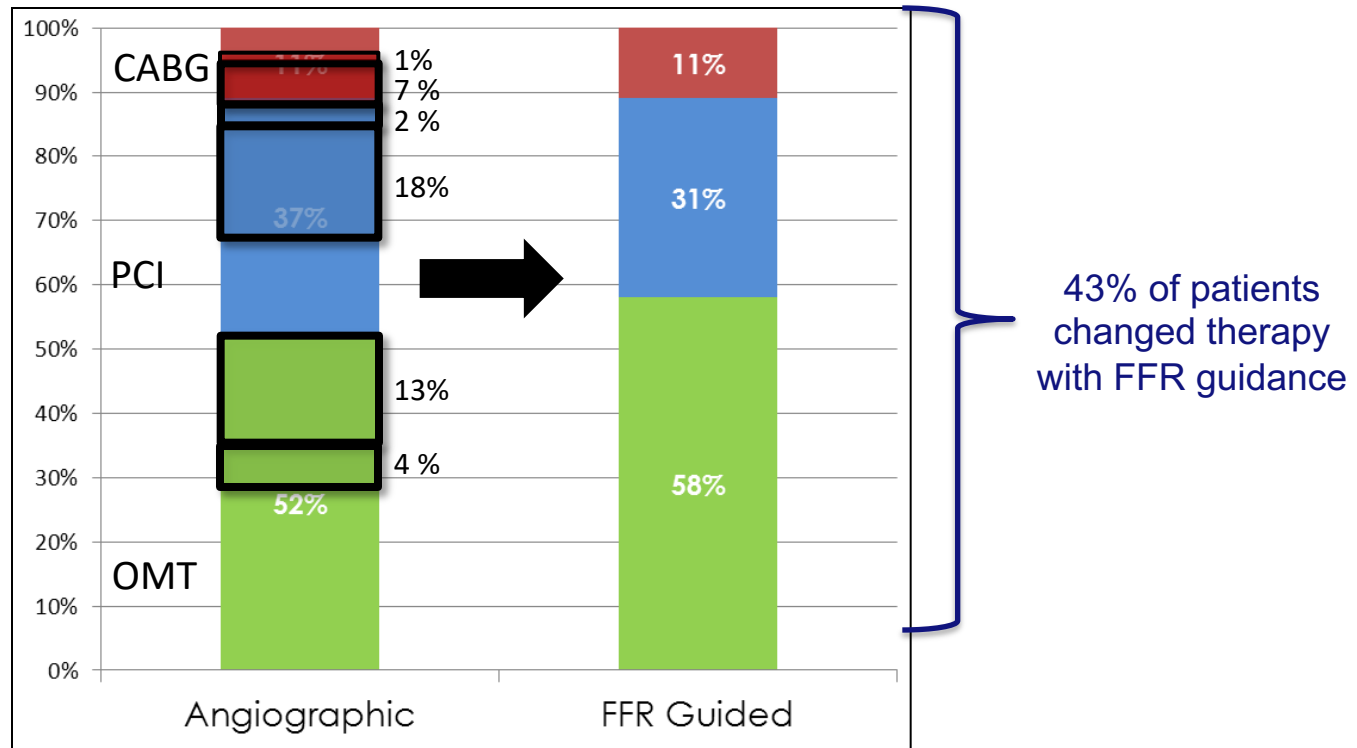
Revascularization and Cardiovascular Mortality at 7 years in ischemia-Extend



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;



La position de l'ESC

Recommendations on functional testing and intravascular imaging for lesion assessment

Recommendations	Class ^a	Level ^b
When evidence of ischaemia is not available, FFR or iwFR are recommended to assess the haemodynamic relevance of intermediate-grade stenosis. ^{15,17,18,39}	I	A
FFR-guided PCI should be considered in patients with multivessel disease undergoing PCI. ^{29,31}	IIa	B
IVUS should be considered to assess the severity of unprotected left main lesions. ^{35–37}	IIa	B

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FFR = fractional flow reserve; iwFR = instantaneous wave-free ratio; IVUS = intravascular ultrasound; PCI = percutaneous coronary intervention.

^aClass of recommendation.

^bLevel of evidence.

Indications for revascularization in patients with stable angina or silent ischaemia

Extent of CAD (anatomical and/or functional)		Class ^a	Level ^b
For prognosis	Left main disease with stenosis >50%. ^{c 68–71}	I	A
	Proximal LAD stenosis >50%. ^{c 62,68,70,72}	I	A
	Two- or three-vessel disease with stenosis >50% with impaired LV function (LVEF ≤35%). ^{c 61,62,68,70,73–83}	I	A
	Large area of ischaemia detected by functional testing (>10% LV) or abnormal invasive FFR. ^{d 24,59,84–90}	I	B
	Single remaining patent coronary artery with stenosis >50%. ^c	I	C
For symptoms	Haemodynamically significant coronary stenosis ^e in the presence of limiting angina or angina equivalent, with insufficient response to optimized medical therapy. ^{e 24,63,91–97}	I	A

© ESC 2018

CAD = coronary artery disease; FFR = fractional flow reserve; iwFR = instantaneous wave-free ratio; LAD = left anterior descending coronary artery; LV = left ventricular; LVEF = left ventricular ejection fraction.

^aClass of recommendation.

^bLevel of evidence.

^cWith documented ischaemia or a haemodynamically relevant lesion defined by FFR ≤0.80 or iwFR ≤0.85 (see section 3.2.1.1), or >90% stenosis in a major coronary vessel.

^dBased on FFR <0.75 indicating a prognostically relevant lesion (see section 3.2.1.1).

^eIn consideration of patient compliance and wishes in relation to the intensity of anti-anginal therapy.



JACC
JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY



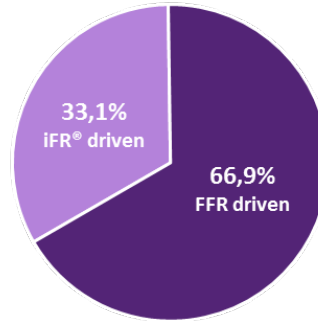
Impact of Routine Invasive Physiology at Time of Angiography in Patients With Multivessel Coronary Artery Disease on Reclassification of Revascularization Strategy

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

Reclassification according to the number of vessel investigated

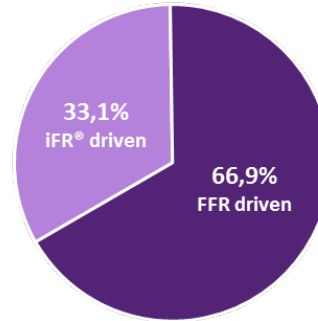
iFR[®] versus FFR driven physiology assesement in MVD patients



iFR : 1.9 vessels
FFR: 1.6 vessels

Reclassification according to the number of vessel investigated

iFR[®] versus FFR driven physiology assesement in MVD patients

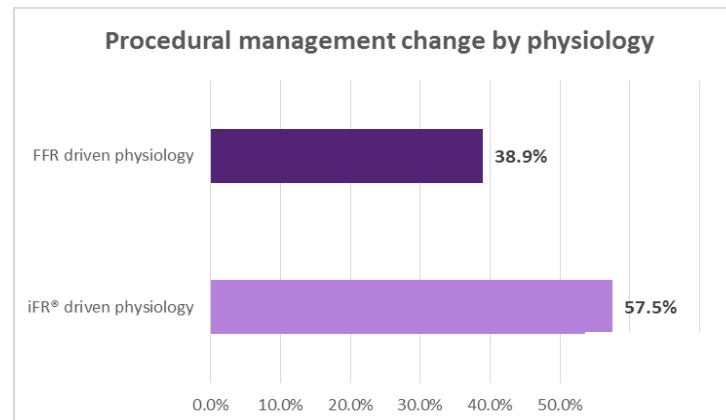


iFR : 1.9 vessels
FFR: 1.6 vessels

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 car Flower-MI a montré qu'il n'y avait aucun bénéfice

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.,
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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*

Original plan:

**To perform FFR of non-culprit at the time of the initial
PCI in all patients**

ORIGINAL ARTICLE

Multivessel PCI Guided by FFR or Angiography for Myocardial Infarction

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Original plan:

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

Actual management

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

ORIGINAL ARTICLE

Multivessel PCI Guided by FFR or Angiography for Myocardial Infarction

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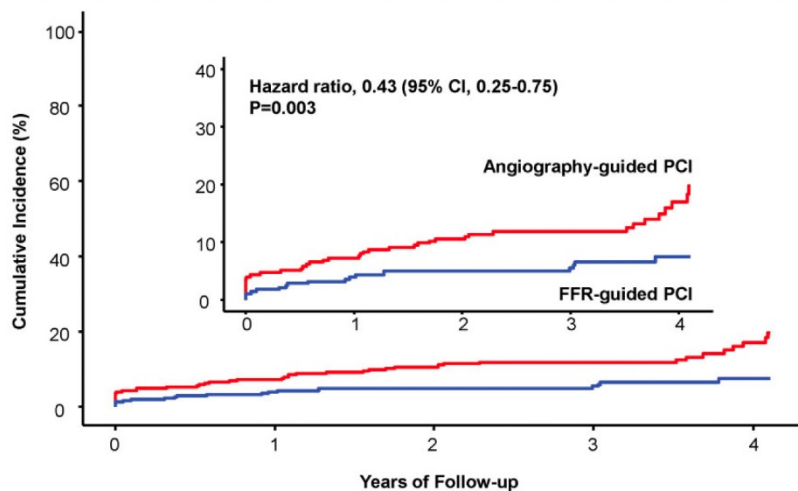
Original plan:

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

Actual management

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

A new angiography was performed 3 days later to
allow FFR investigation



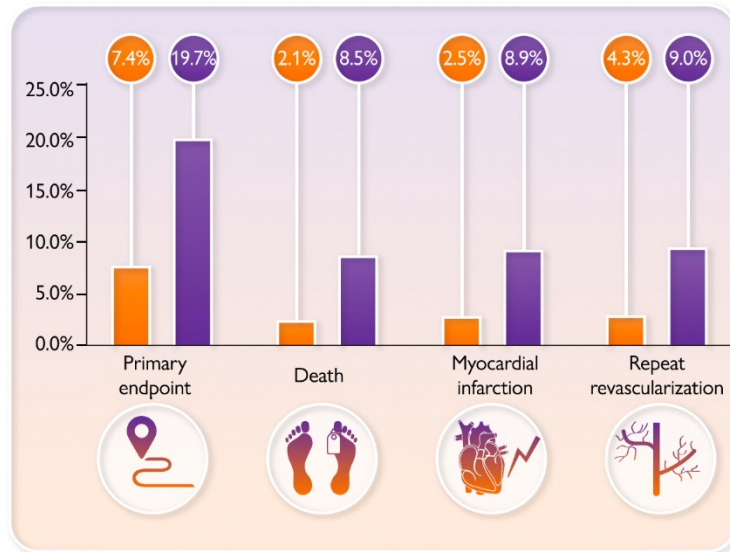
No. at Risk

	0	1	2	3	4
Angiography-guided PCI	278	257	223	173	74
FFR-guided PCI	284	271	237	186	79

European Heart Journal (2022) 00, 1–12

FRAME-AMI trial

Primary endpoint: death, myocardial infarction, or repeat revascularization
Hazard ratio, 0.43 (95% CI, 0.25-0.75), P=0.003

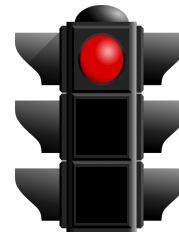
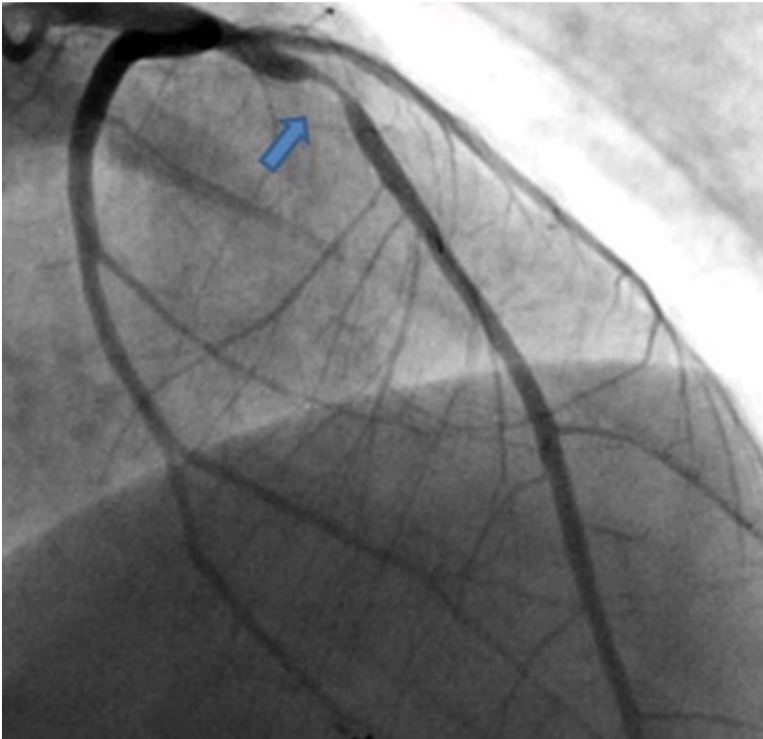


● FFR-guided PCI ● Angiography-guided PCI

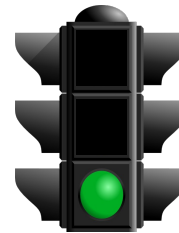
QCM 2

- Dans le cadre d'une angioplastie d'un vaisseau avec lésions diffuses/complexes, je vérifie la FFR à la fin de la procédure 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
- D) Rarement

A simple case!

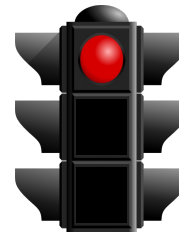
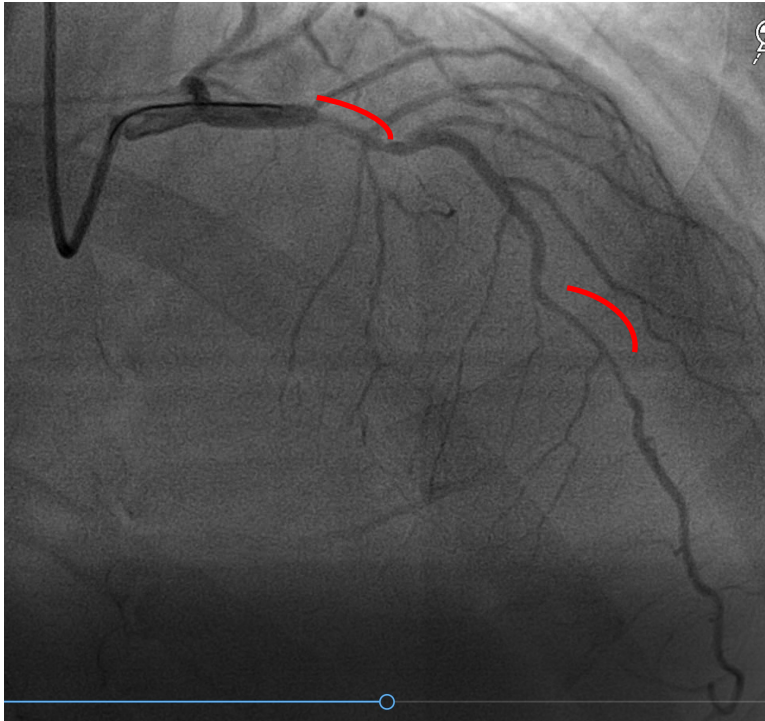


Traitement médical
FFR > 0.81
iFR > 0.89

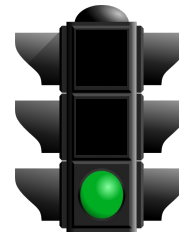


Angioplastie
FFR ≤ 0.80
iFR ≤ 0.89

Amore complexe case!



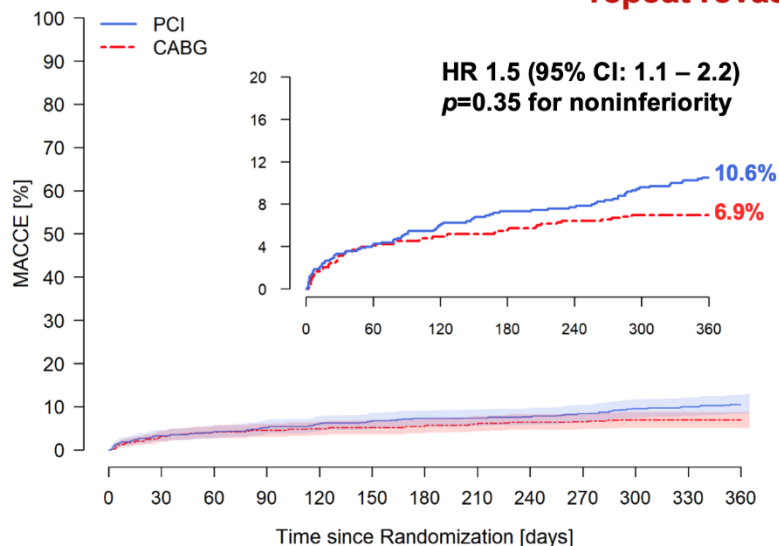
Traitement médical
FFR > 0.81
iFR > 0.89



Angioplastie
FFR ≤ 0.80
iFR ≤ 0.89

Primary Endpoint

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



	No. at Risk												
PCI	757	728	721	713	707	702	697	696	693	687	678	674	670
CABG	743	709	701	698	695	693	691	686	683	682	679	679	679

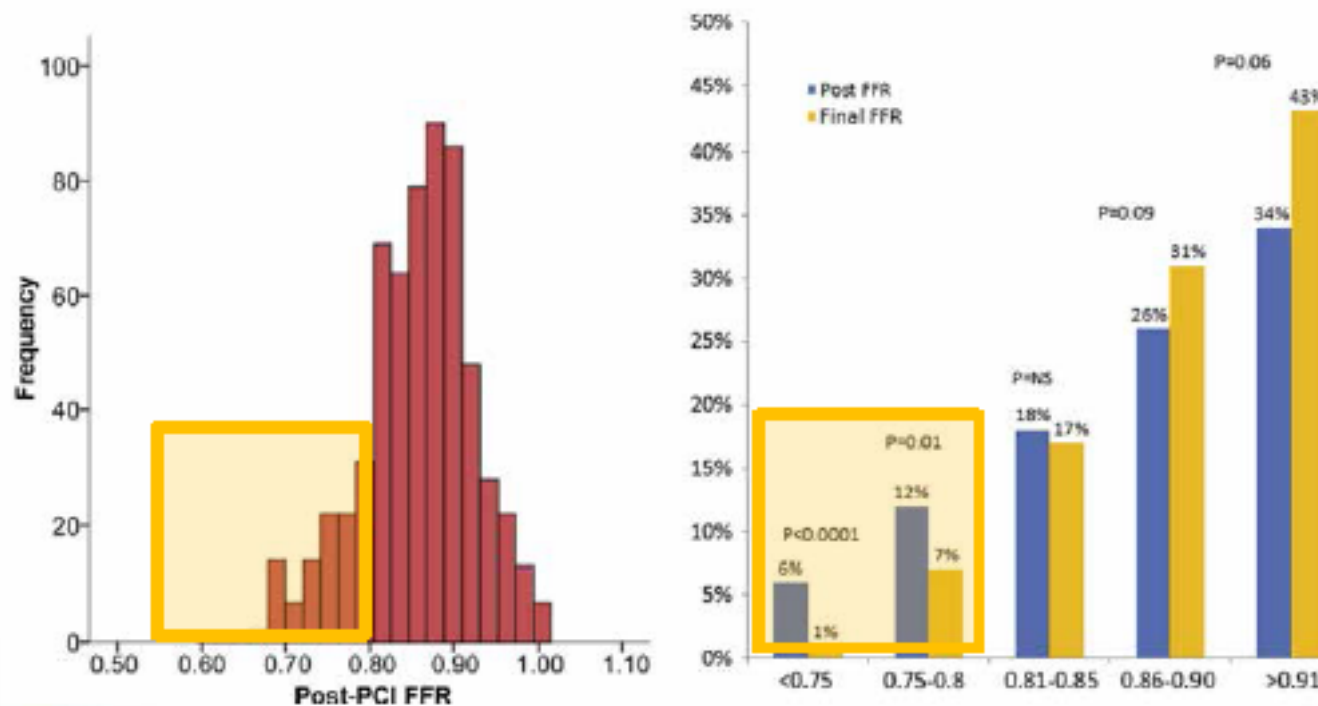
Procedural Characteristics

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%



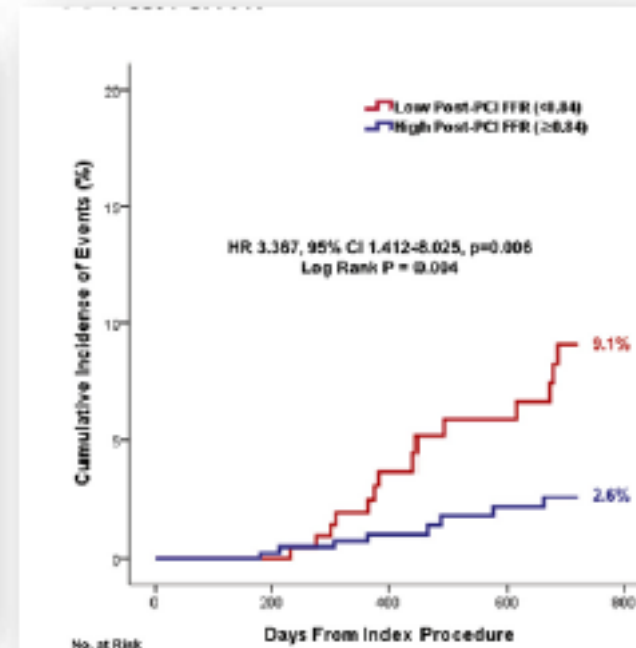
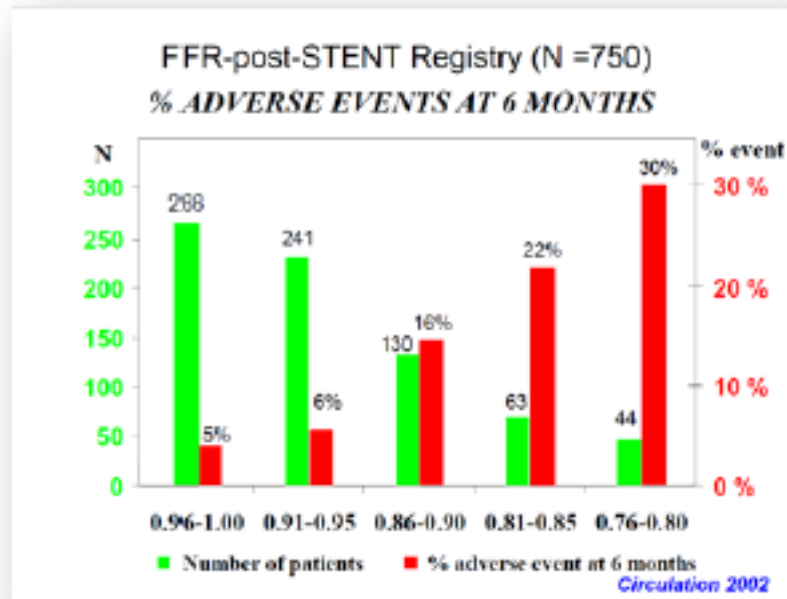
Post PCI ischemia based on FFR ≤ 0.80 occurs in 10-20% of cases



Lee JM, et al. *J Am Coll Cardiol Interv.* 2018;11:2099-109.

Agarwal SK, et al. *J Am Coll Cardiol* 2016;9:1022-31.

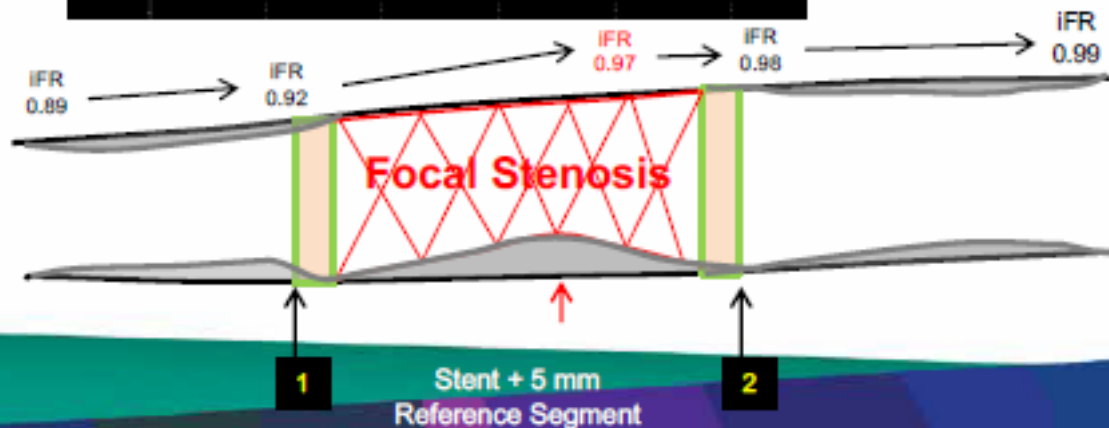
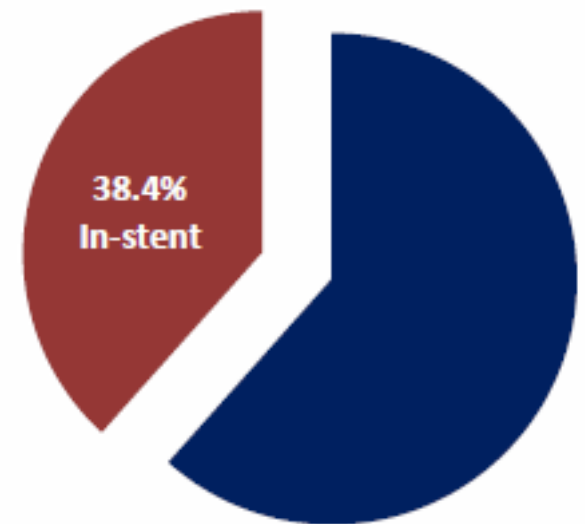
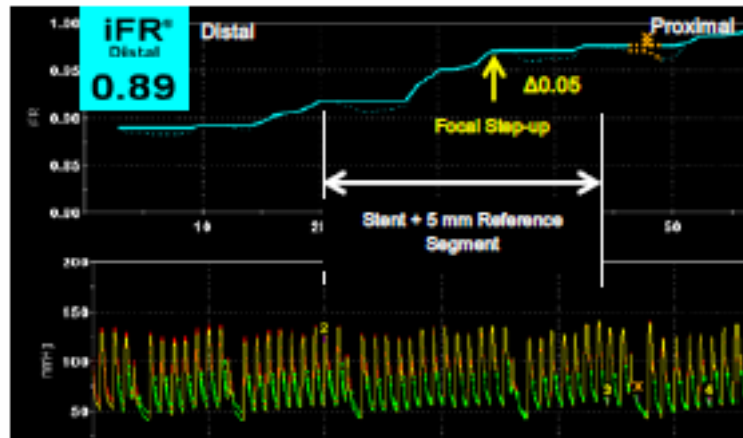
Low post-PCI FFR is related to adverse events



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

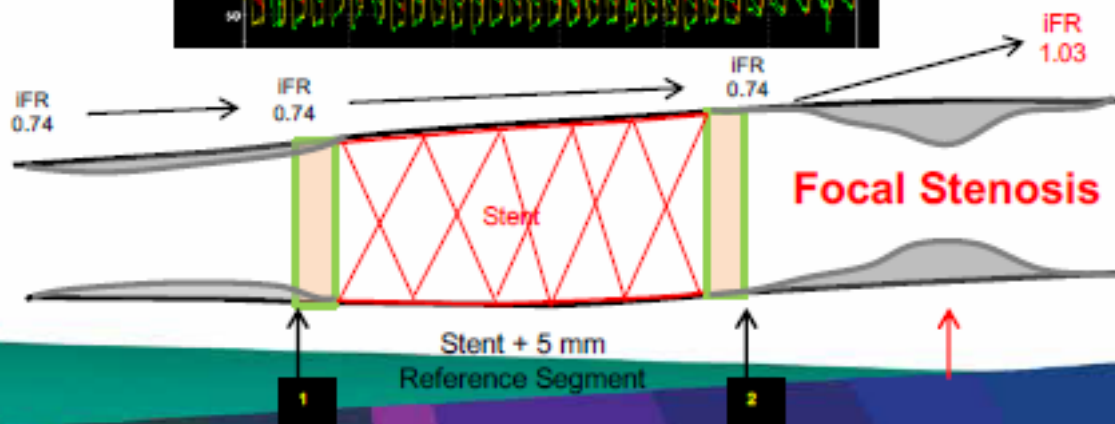
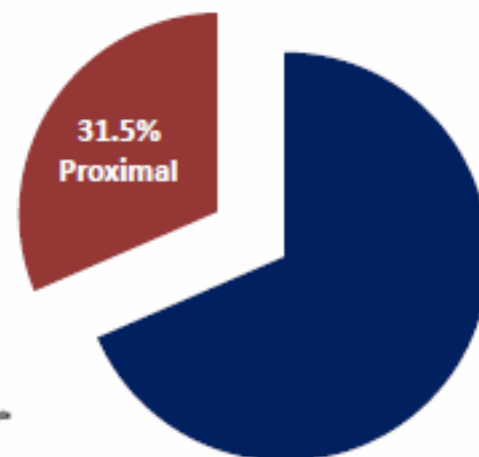
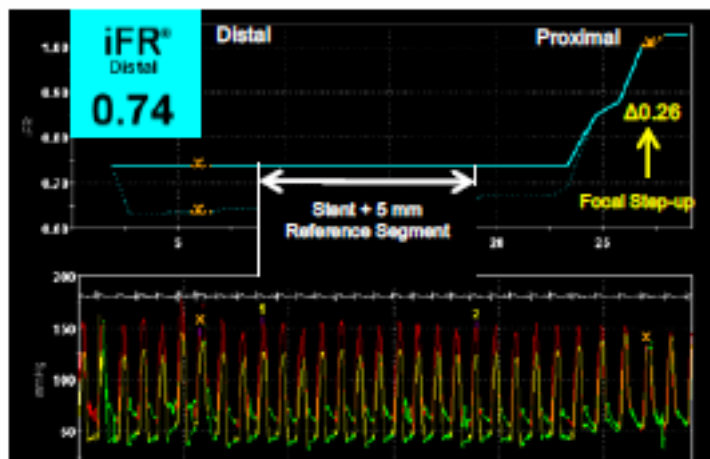
Focal Residual Pressure Gradient in-stent

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



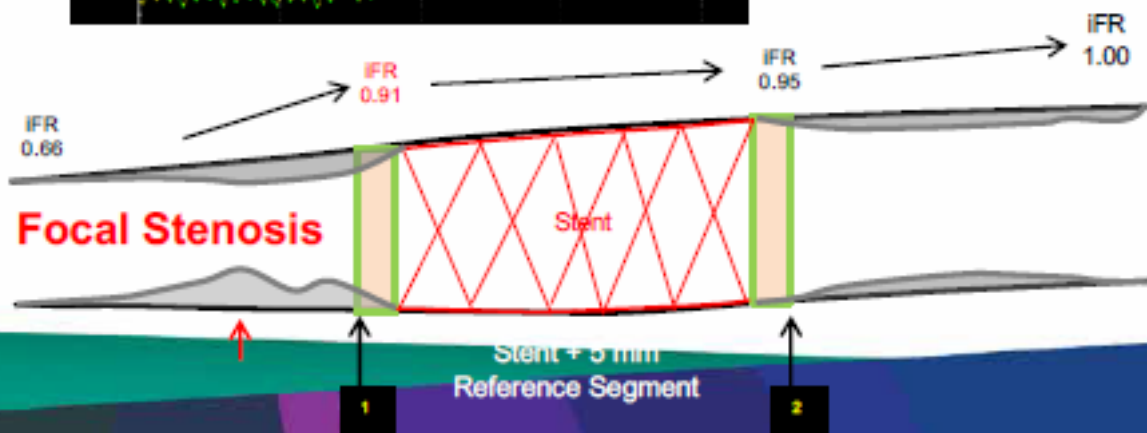
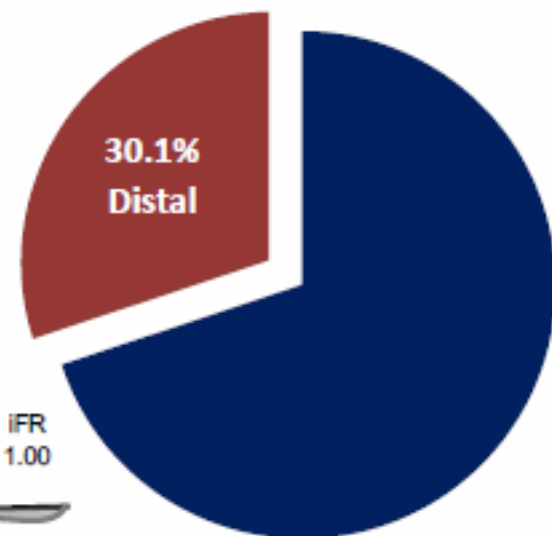
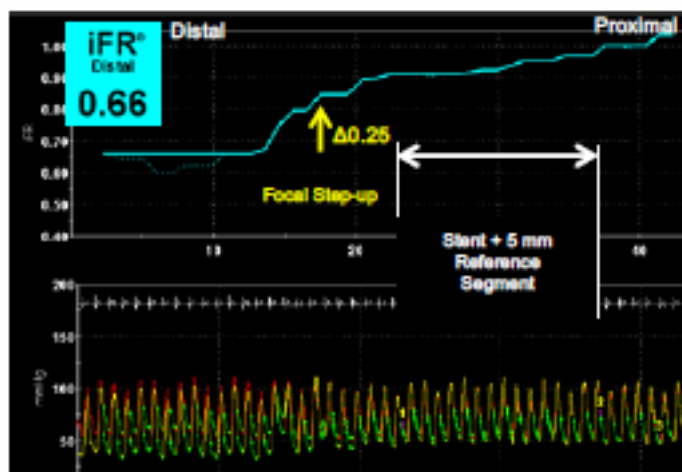
Focal Residual Pressure Gradient Prox to stent

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



Focal Residual Pressure Gradient Distal to stent

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

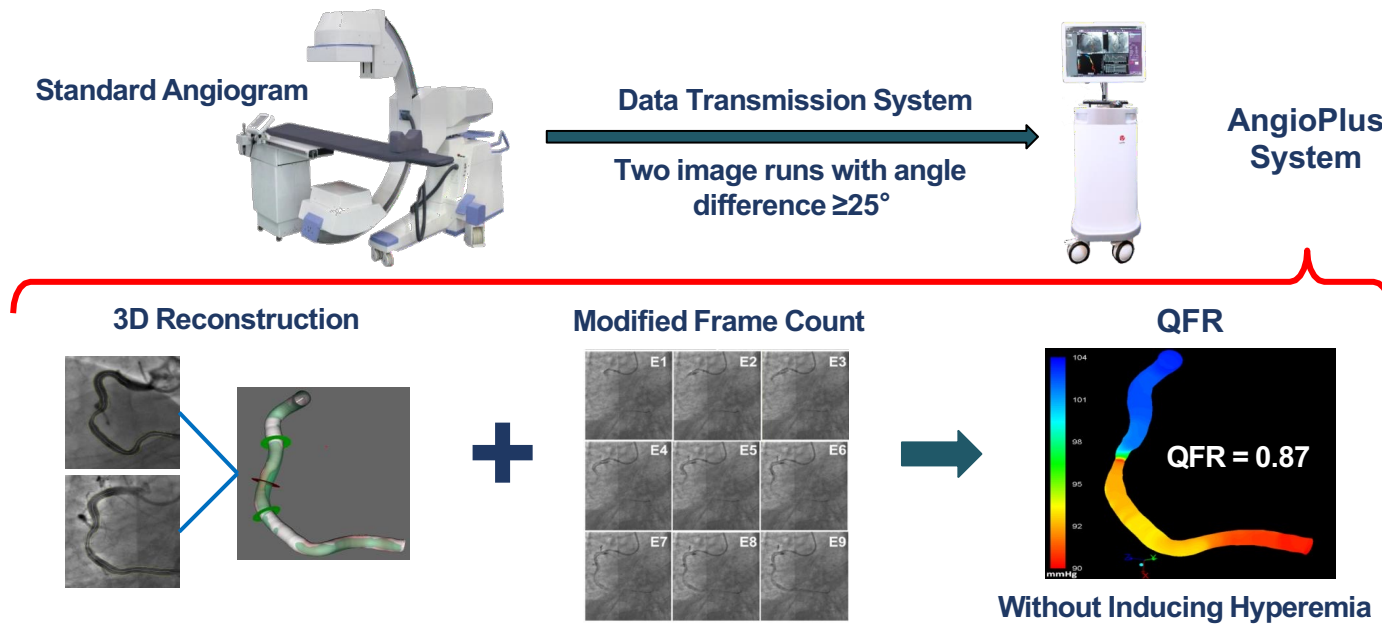


In 15-30% of cases a vessel remains ischemic after an appropriate PCI

In 2/3 of the cases this « ischemic » vessel post PCI is due to a « missed » focal lesion

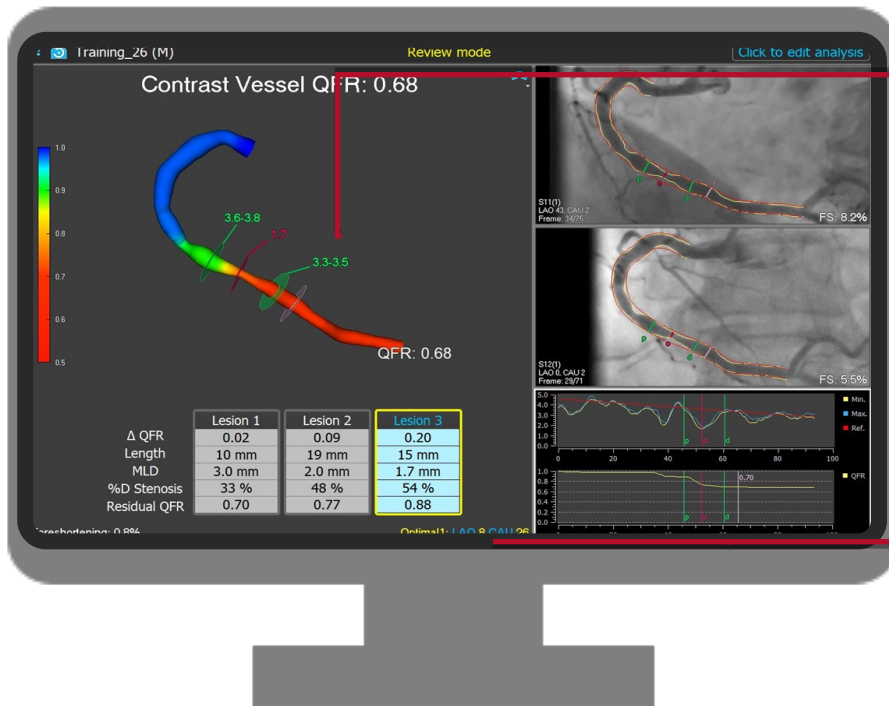
**Full virtualization to
« compensate » for the
limits of invasive pressure**

Quantitative Flow Ratio (QFR)



Tu S, et al. *JACC Cardiovasc Interv* 2016; Xu B, et al. *J Am Coll Cardiol* 2017.

Principes de la QFR®



Evaluation physiologique

- $QFR > 0,8$ → Patient reçoit un traitement médicamenteux
- $QFR < 0,8$ → A traiter

Note: Quand le QFR est dans l'intervalle $[0,78-0,84]$ (zone grise), on peut éventuellement s'aider un guide de pression et la mesure FFR.

Vue anatomique 3D pour le dimensionnement des stents

- Δ QFR (delta QFR): Cette valeur représente le pourcentage de chute de pression à travers la lésion. La valeur QFR de la lésion est calculée comme $1 - \Delta$ QFR.
- Longueur de la lésion
- Diamètre minimum de la lumière -(MLD)
- %DS (diamètre de sténose)
- Diamètre de référence de la lésion du segment du vaisseau

Planification du traitement

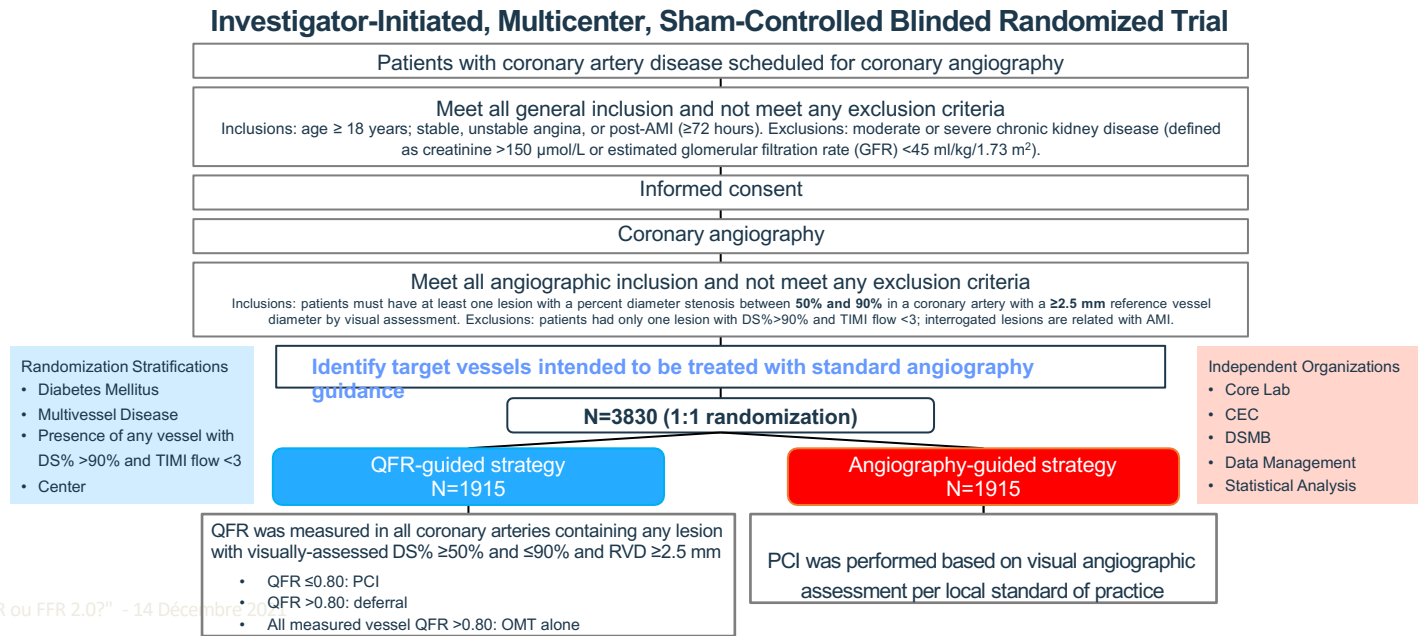
- **User Lesion (Lésion étudié)**: Les lésions peuvent être combinées ou sélectionnées en choisissant la lésion étudiée. Il est ainsi possible de définir et de planifier une prise en charge du patient optimisée.
- **Residual QFR (QFR résiduelle)**: donne une valeur prédictive de QFR après éventuelle traitement

Study Design



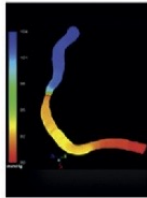
Angiographic quantitative flow ratio-guided coronary intervention (FAVOR III China): a multicentre, randomised, sham-controlled trial

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 Stoner†; FAVOR III China study group‡



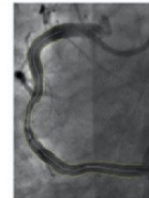
CENTRAL ILLUSTRATION: 2-Year Outcomes From the FAVOR III China Trial

3,825 patients with at least 1 lesion with DS% of 50%-90% in a coronary artery with at least a 2.5 mm RVD by visual assessment

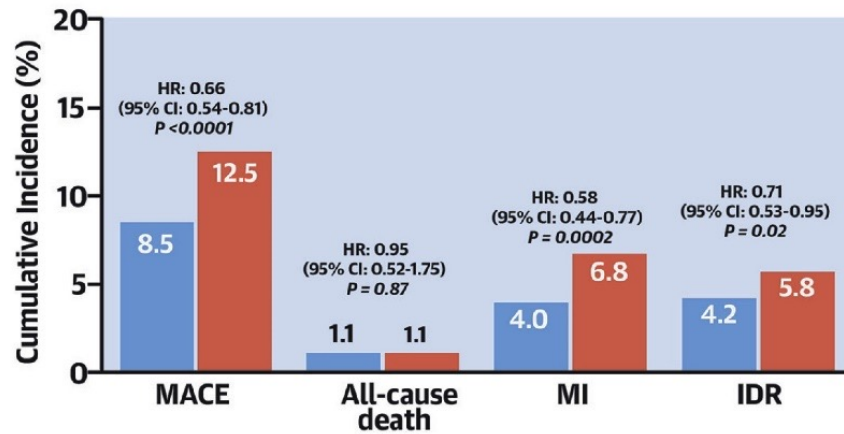


Quantitative Flow Ratio-Guided Group
N = 1,913

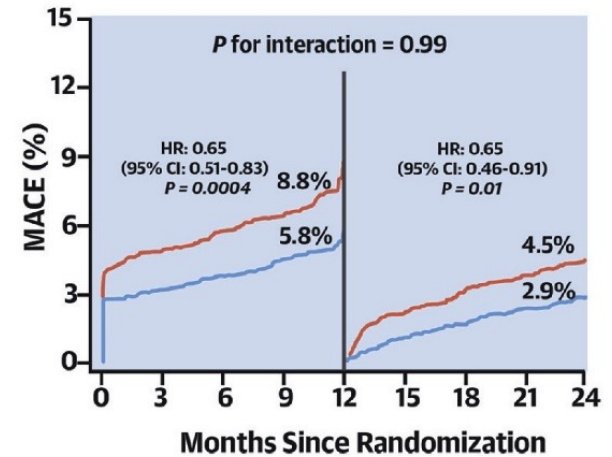
Angiography-Guided Group
N = 1,912



2-Year Clinical Outcomes

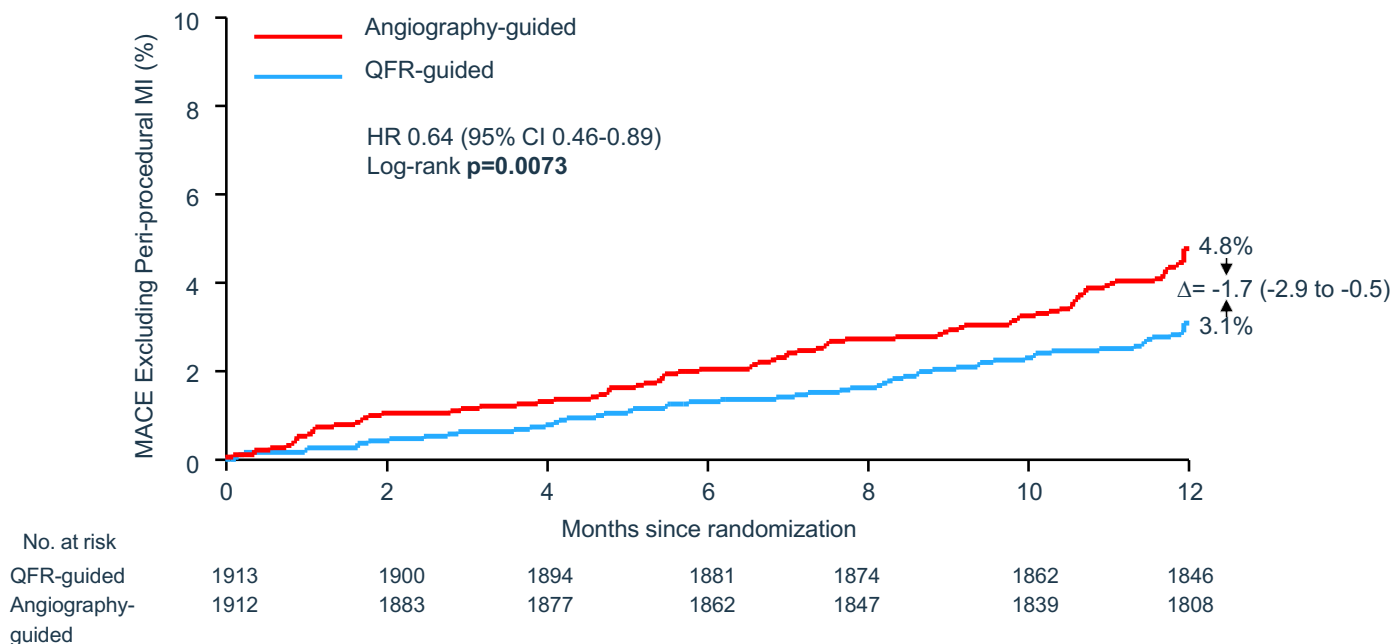


Landmark Analysis

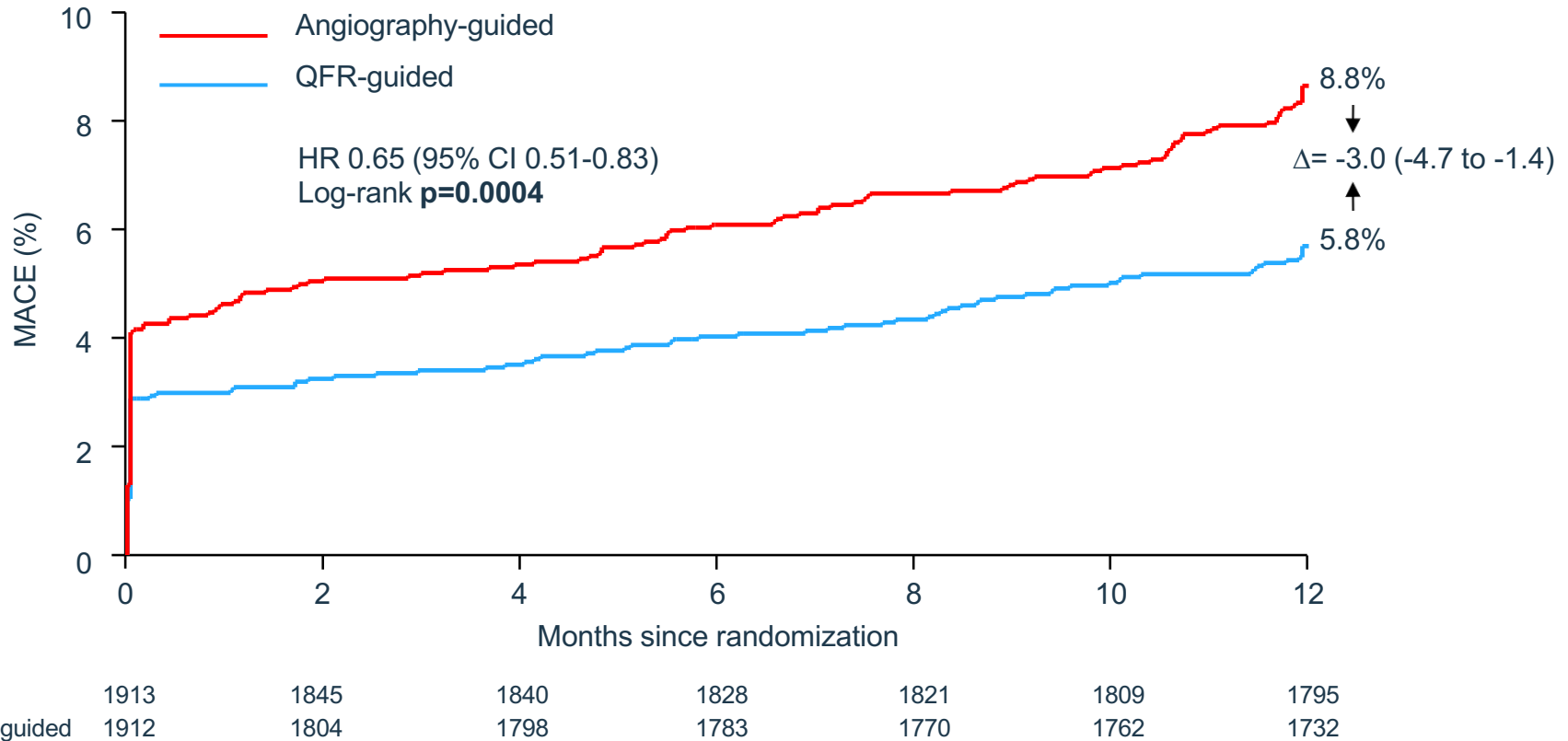


Song L, et al. J Am Coll Cardiol. 2022;80(22):2089-2101.

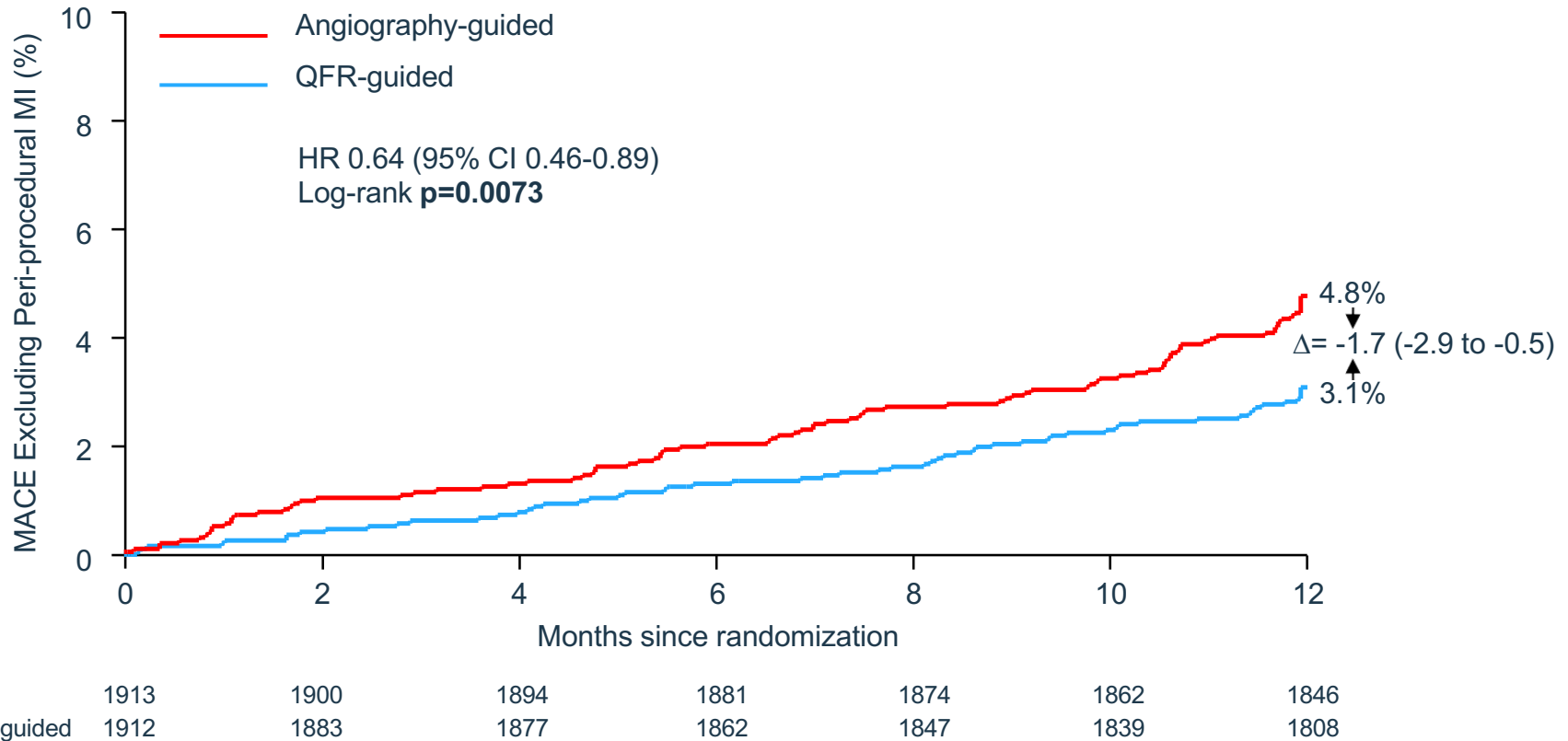
Major Secondary Endpoint (ITT)



Primary Endpoint (ITT)



Major Secondary Endpoint (ITT)



FAVOR III Europe Japan

- Stable angina pectoris or evaluation of secondary stenosis after MI
- Coronary stenosis of 40-90% by visual estimate

1:1 randomization of 2000 patients

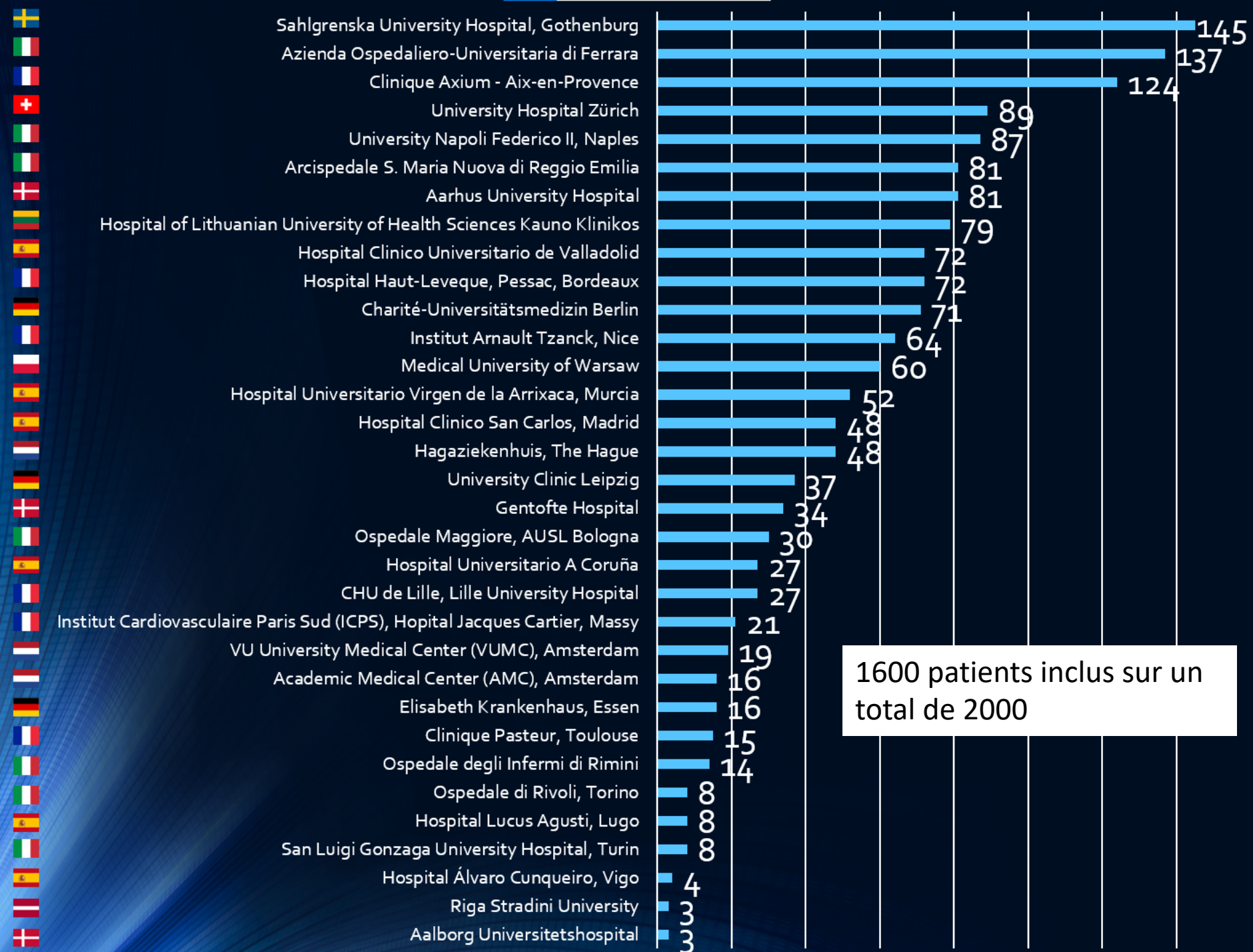
QFR guiding

FFR guiding

Primary endpoint: One year PoCE for non-inferiority

Two-year follow-up

Only clinical follow-up



Series Browser

New session

15

View	S#	Description
1	1	4
1	2	5
2	1	11
2	2	12



- Procedures
- Calibrations
 - Measurements
 - Annotations
 - Snapshots
 - Viewport layouts

Properties

All patient series will be loaded in the viewer.



Acquisition Aid for QFR

Target Vessel	1st View	2nd View
LM + LAD/LCX	RAO 20 , CAU 45	AP , CAU 10
LAD/Diag	AP , CRA 45	RAO 30 , CRA 20
LCX/OM	LAO 10 , CAU 25	RAO 25 , CAU 25
RCA	LAO 45 , CAU 10	LAO 20 , CRA 20

- **Administer nitroglycerin prior to the 1st acquisition**
- Acquire images:
 - at least 12.5 frames/s
 - angles more than 25° apart and perpendicular to the vessel segment
- Brisk contrast injection for 3 cardiac cycles
- Prevent vessel overlap and patient movement

CABG

Double pontave IVA-Marg
Monopontage IVA + stent CX



PCI

Stent IVA > 45 mm
Stent Cx = 20 mm

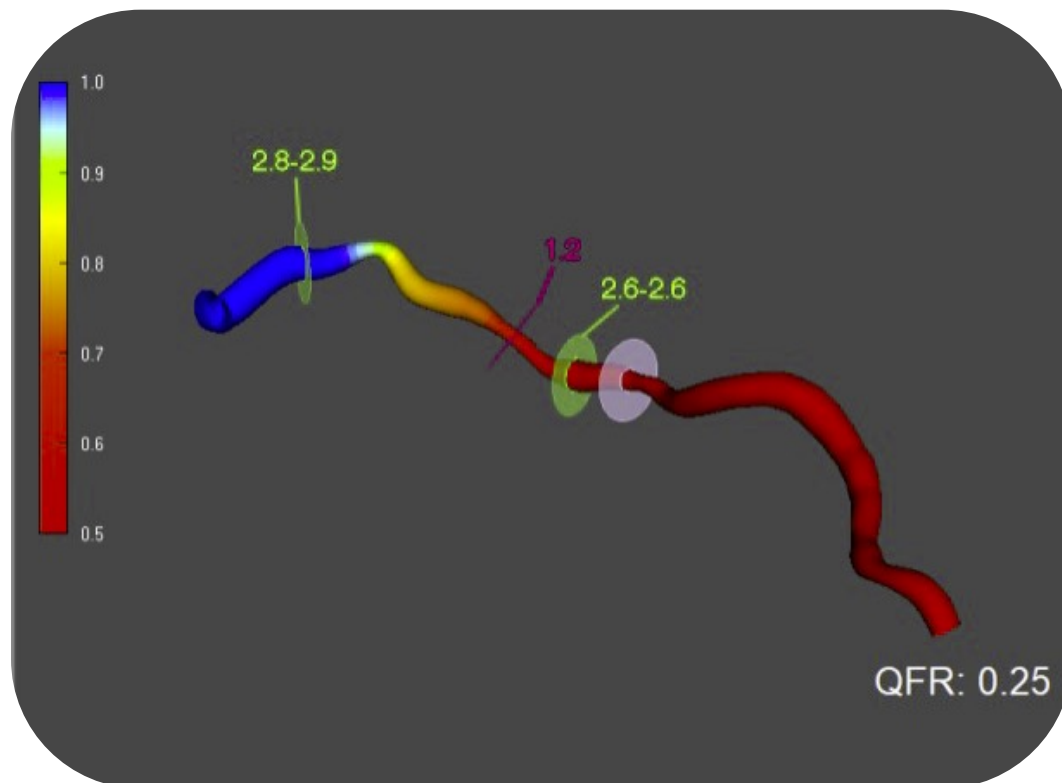
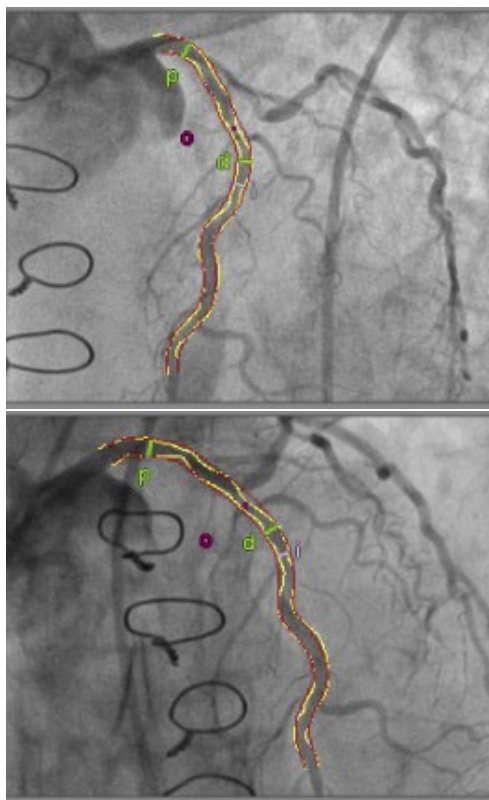
Avis de la patiente

Conclusion 1

- ✓ 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 la QFR est une technique **validé** (FAVOR III China) 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 une valeur de QFR predefinie ("virtual PCI")

La QFR il faut la faire !!!!!!!

Analyse QFR d'IVA



	Vaisseau	Lésion 1
Contraste Δ QFR		0.51
Contraste QFR	0.25	0.49
Longueur	82.5	27.3
Diamètre proximal		2.8 - 2.9
Diamètre distal		2.6 - 2.6
Diamètre de référence		2.7
MLD		1.2
QFR vaisseau résiduel		0.76

Conclusion 1

✓ La QFR il faut la FAIRE!!!!

More clinical benefits: QFR for optimal treatment planning

QFR helps to plan optimal treatment and to avoid unnecessary stenting. In FAVOR III China¹, QFR assessment in all vessels with one or more lesions led to changes in the treatment plan for 445 (23.3%) of 1913 patients.

	QFR-guided group	Angiography-guided group	p value
Vessels actually treated of those originally intended	84.4% (2112/2503)	95.7% (2449/2559)	<0.0001
Patients with intended vessel deferral or unintended vessel treatment	23.3% (445/1913)	6.2% (119/1912)	<0.0001
Deferral (non-treatment) of at least one vessel originally intended for PCI	19.6% (375/1913)	5.2% (100/1912)	<0.0001
Treatment of at least one vessel not originally intended for PCI	4.4% (85/1913)	1.5% (28/1912)	<0.0001

Table 1: Treatment Strategy in 2 groups

- QFR helped avoid unnecessary stenting
- QFR helped to identify vessels that could have been overlooked by visual interpretation

1. Xu, B., Tu, S., Song, L., Jin, Z., Yu, B., Fu, G., ... & FAVOR III China study group. (2021). Angiographic quantitative flow ratio-guided coronary intervention (FAVOR III China): a multicentre, randomised, sham-controlled trial. *The Lancet*.

More clinical benefits : Less PCI, Less Stents, Less Contrast, Better Syntax Score

In FAVOR II China result¹, the final data have revealed more aspects of procedural benefits of QFR. The below table gives an immediate illustration of several benefits.

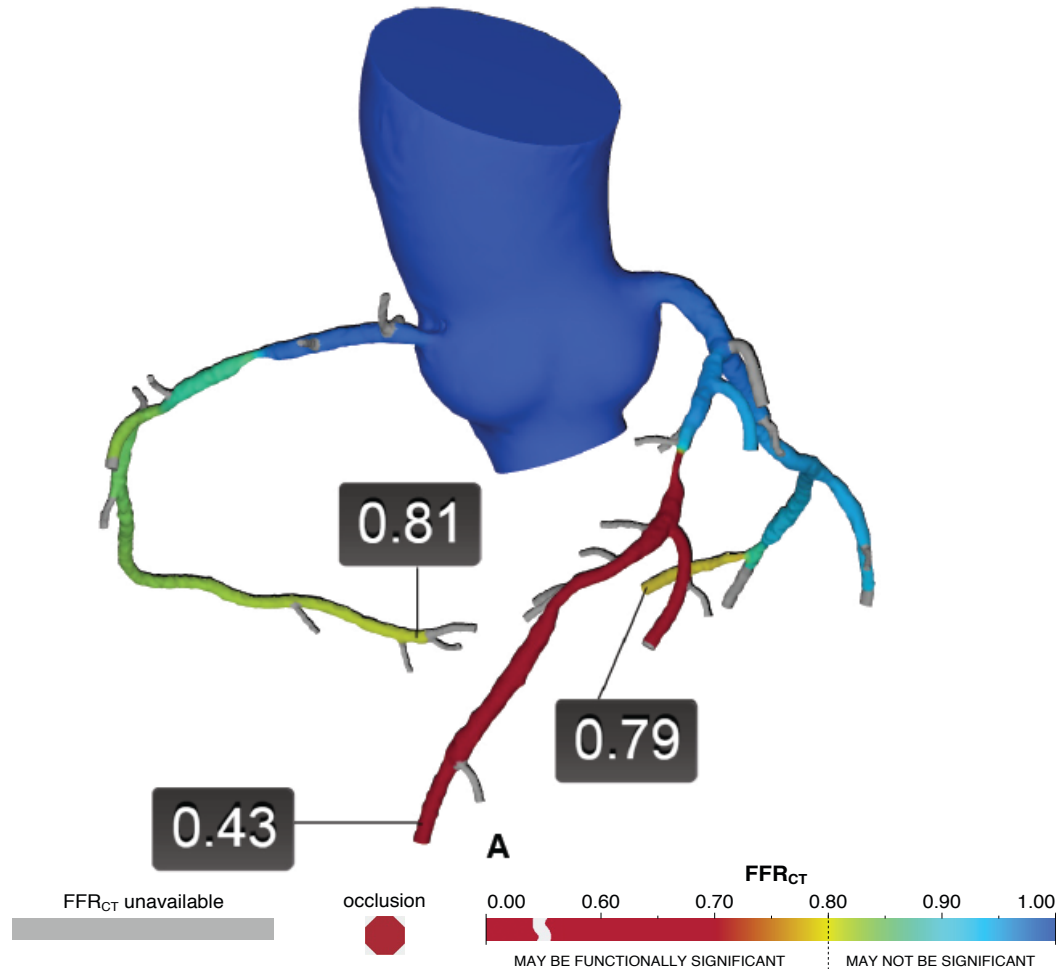
	QFR-guided group (N=1913)	Angiography-guided group (N=1912)	p value	
PCI performed	90.5%	99.1%	<0.0001	
Number of stents placed per patient	1.45 ± 1.02	1.58 ± 0.97	<0.0001	➤ Less stents
Use of intravascular imaging	6.2%	6.3%	0.89	
Contrast medium used per patient, ml	163.0 ± 75.6	169.7 ± 74.2	0.0060	
Fluoroscopy time, min	14.1 ± 8.0	14.9 ± 7.4	0.0013	
Procedure time, min	53.7 ± 30.4	59.4 ± 30.4	<0.0001	➤ Less fluoroscopy time and
Adjusted procedure time, min	44.6 ± 28.8	49.5 ± 30.2	<0.0001	contrast used
PCI lesion success	99.0%	99.3%	0.38	
Residual anatomic SYNTAX score	2.4 ± 3.6	2.4 ± 4.0	0.49	
Residual functional SYNTAX score	0.7 ± 2.3	1.0 ± 2.8	<0.0001	➤ Better syntax score
Residual functional SYNTAX score=0	88.1%	82.2%	<0.0001	

Table 1: Procedural characteristics

1. Xu, B., Tu, S., Song, L., Jin, Z., Yu, B., Fu, G., ... & FAVOR III China study group. (2021). Angiographic quantitative flow ratio-guided coronary intervention (FAVOR III China): a multicentre, randomised, sham-controlled trial. *The Lancet*.

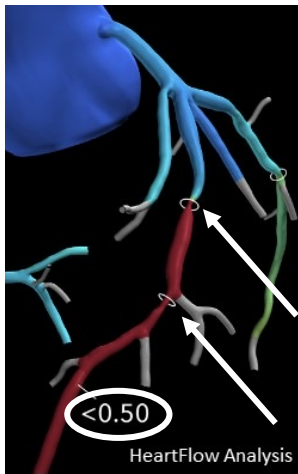
Using CT to provide FFR

Multi-vessel narrowings, but functional ischemia in only a single vessel
Clinician determined that only a single stent was required



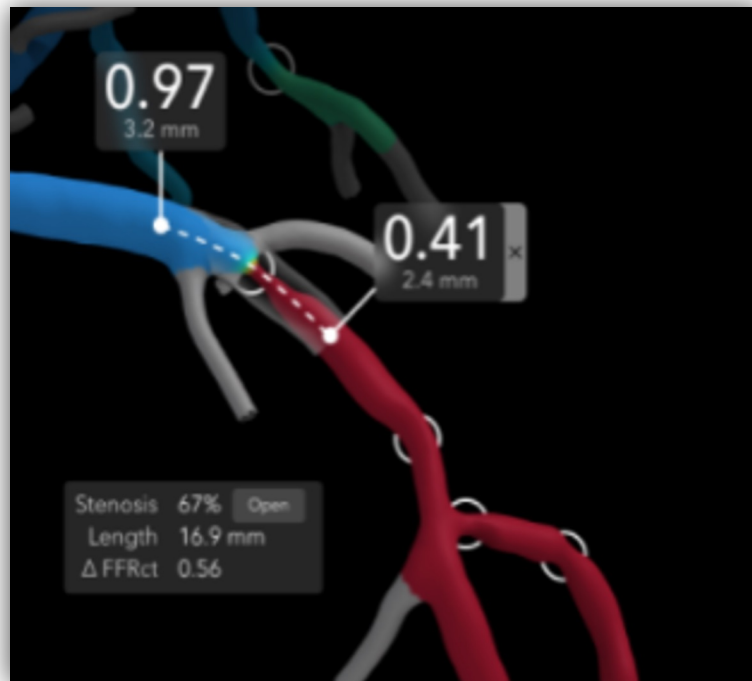
What is FFR_{CT} Planner?

Pre-procedure evaluation of alternate treatment strategies to optimize coronary flow

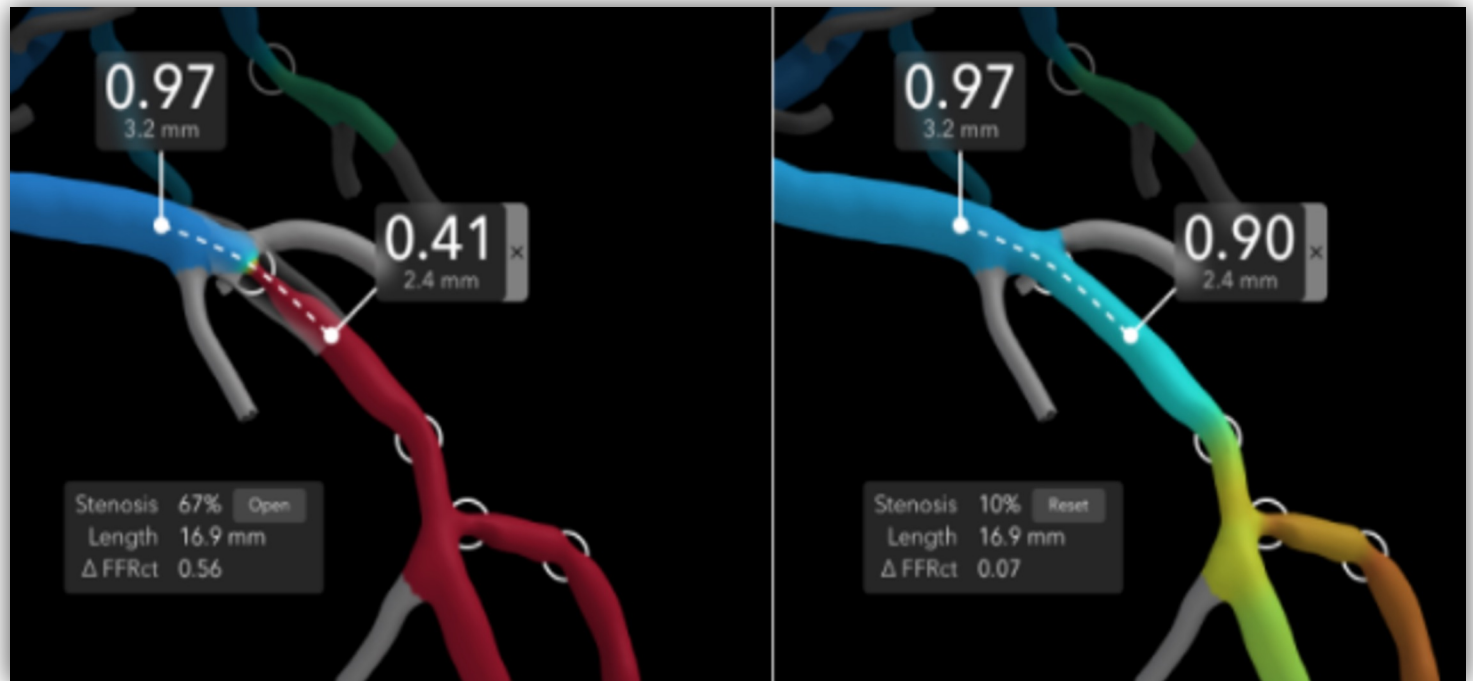


- Real-time non-invasive interactive tool
- Explore different clinical scenarios by virtually removing stenoses
- Assess resulting FFR_{CT} value(s) from any scenario

Real-time FFR_{CT} Recalculation

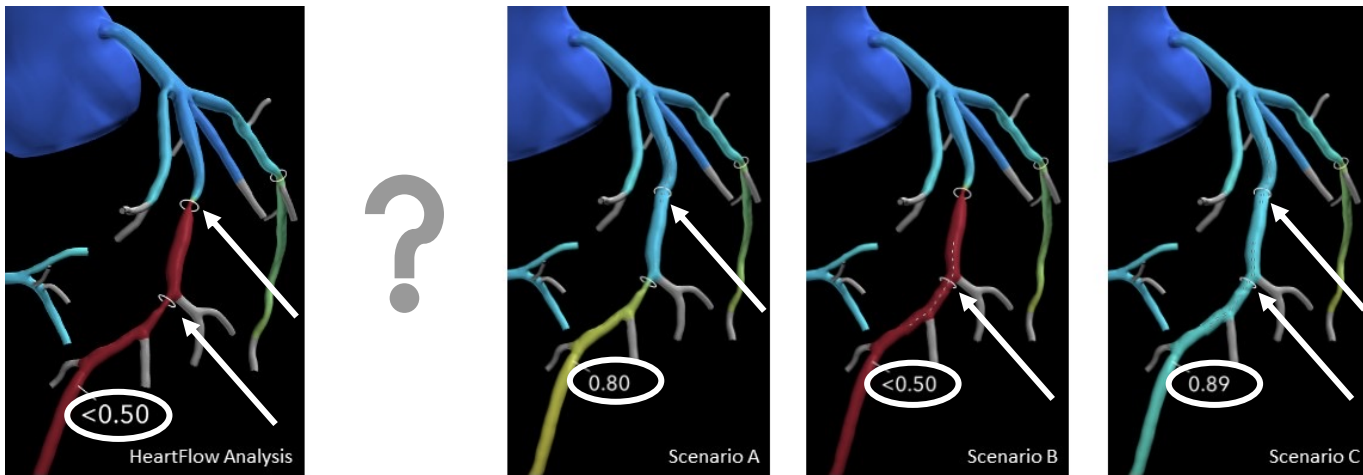


Real-time FFR_{CT} Recalculation



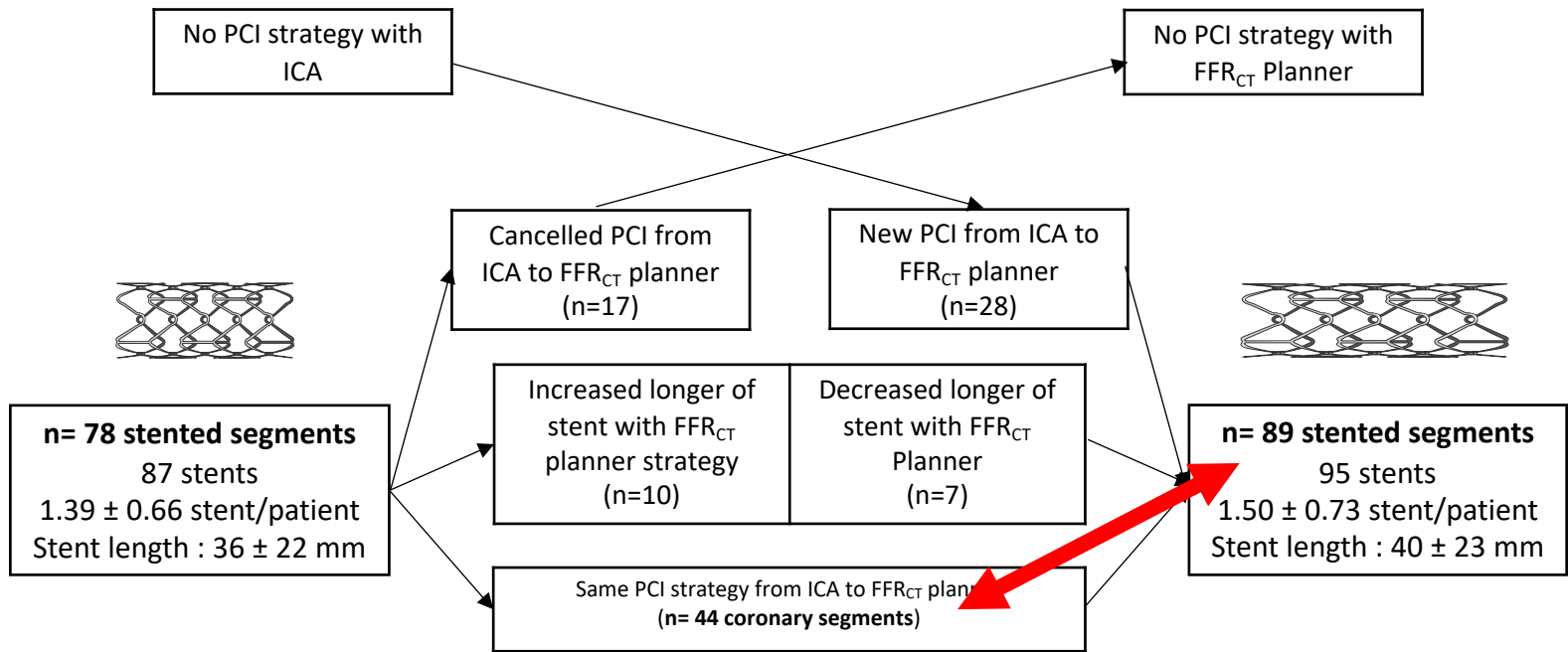
What is FFR_{CT} Planner* ?

Pre-procedure evaluation of alternate treatment strategies to optimize coronary flow



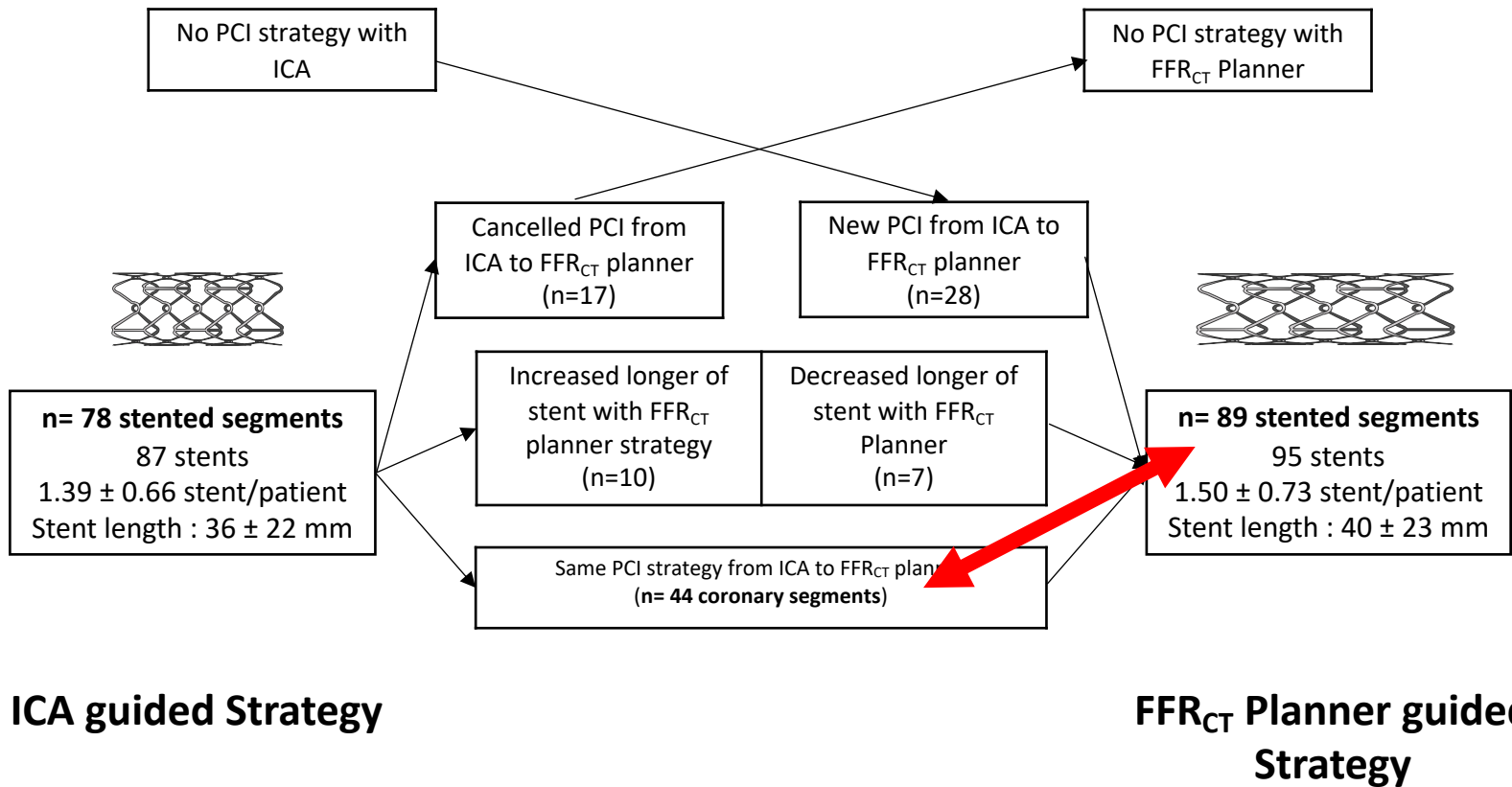
- Real-time non-invasive interactive tool
- Explore different clinical scenarios by virtually removing stenoses
- Assess resulting FFR_{CT} value(s) from any scenario

*Not yet commercially available, pending Regulatory Review



ICA guided Strategy

FFR_{CT} Planner guided Strategy



Change of strategy in 51% of cases

Conclusion 1

- ✓ Invasive pressure wire (FFR/iFR) is the “gold standard” for the detection of ischemic territory vessels
- ✓ Distal “spot” pre-procedural FFR/iFR has reach his limits to assist multivessel PCI (FAME 3)
- ✓ Recent studies have shown that 15-30% vessels remain ischemic after an apparently appropriately conducted PCI (30-60% of patients with residual ischemia in case of multivessel PCI)

- ✓ Post-PCI identification of “ischemic” FFR/iFR
- ✓ Pre-procedural pullback-derived pressure coronary mapping
- ✓ “virtual PCI”

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

TARGET-FFR is supporting this concept and DEFINE-GPS is further investigating it

Conclusion 2

- ✓ In patients with MVD, investigation of every vessel with lesion $> 30\%$ is critical to propose the best treatment option.
- ✓ Despite its benefit extensive pressure investigation is difficult to achieve with invasive methods (see Define-Real and Flower MI)
- ✓ Virtualization of pressure drop based on computational fluid dynamics derived from 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.
- ✓ FAVOR3 china is a breakthrough study which demonstrates the benefit of this approach in clinical practices
- ✓ Additional large outcome studies are undergoing to demonstrate the benefit of this approach:
 - ✓ “Angio-FFR” versus “invasive-FFR”: FAVOR 3 Europe, FAST 3

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





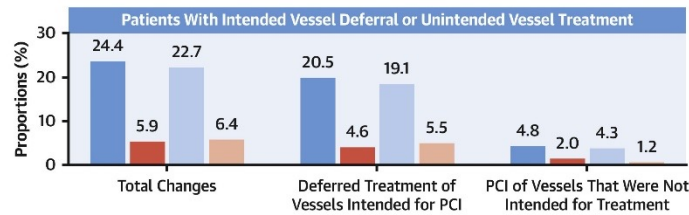
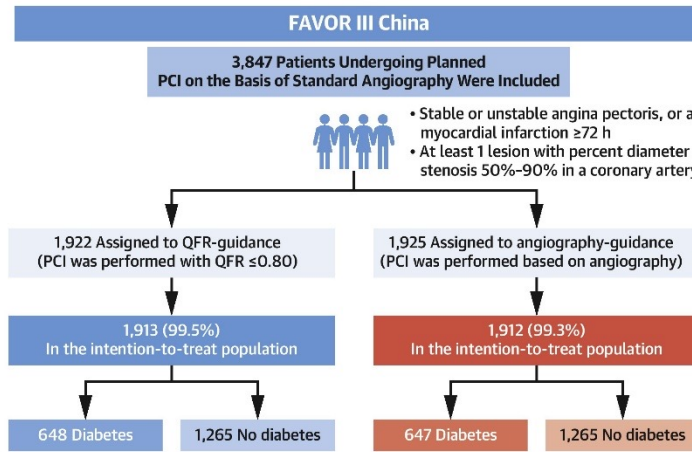
Actualités sur la qFR

Eric Van Belle,

**Lille University Hospital
Heart & Lung Institute**



CENTRAL ILLUSTRATION: Coronary Intervention Guided by Quantitative Flow Ratio vs Angiography in Patients With and Without Diabetes



Primary Outcome

1-Year Risk of Major Adverse Cardiac Events, a Composite of All-Cause Death, Myocardial Infarction, or Ischemia-Driven Revascularization

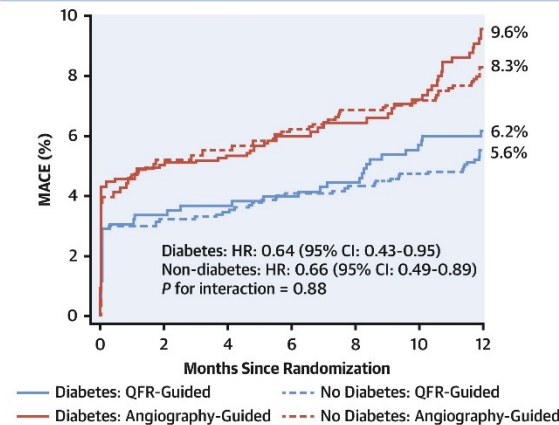
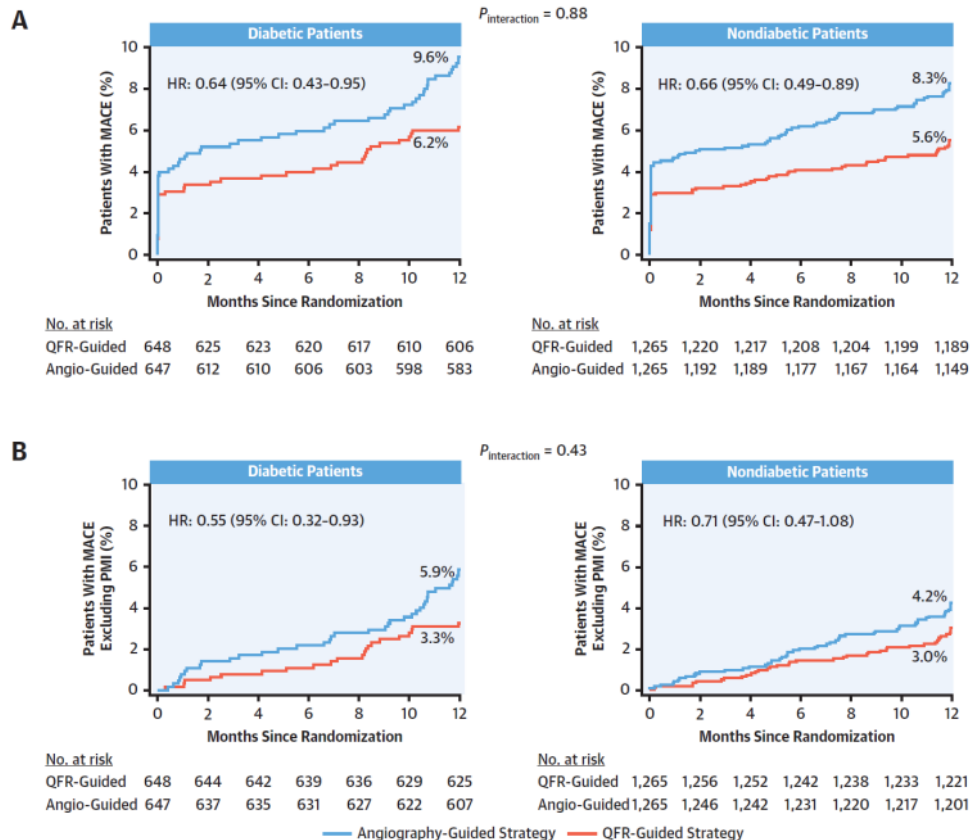
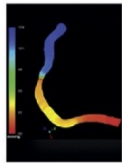


FIGURE 1 Kaplan-Meier Curves for the Primary and Major Secondary Trial Outcomes



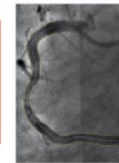
CENTRAL ILLUSTRATION: 2-Year Outcomes From the FAVOR III China Trial

3,825 patients with at least 1 lesion with DS% of 50%-90% in a coronary artery with at least a 2.5 mm RVD by visual assessment

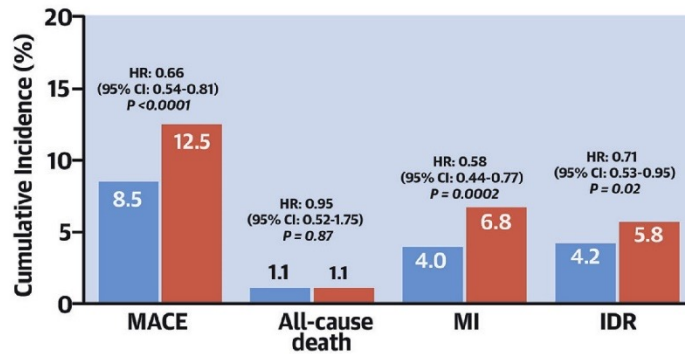


Quantitative Flow Ratio-Guided Group
N = 1,913

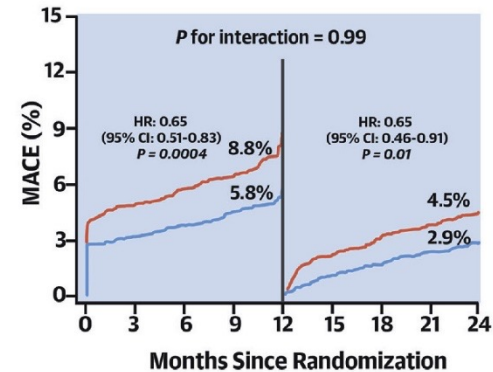
Angiography-Guided Group
N = 1,912



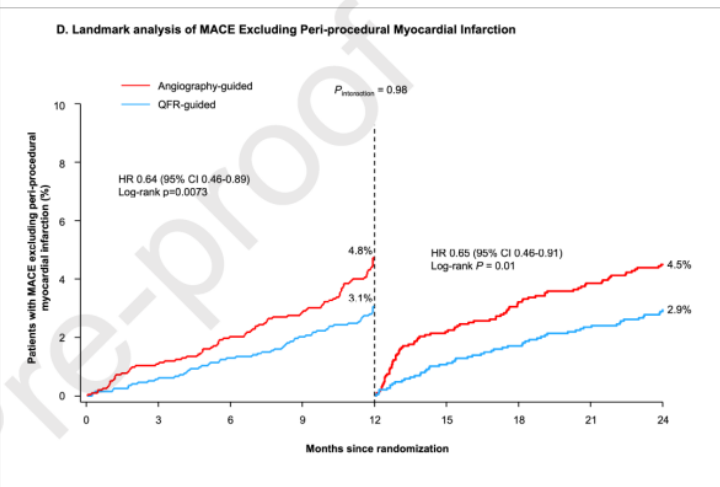
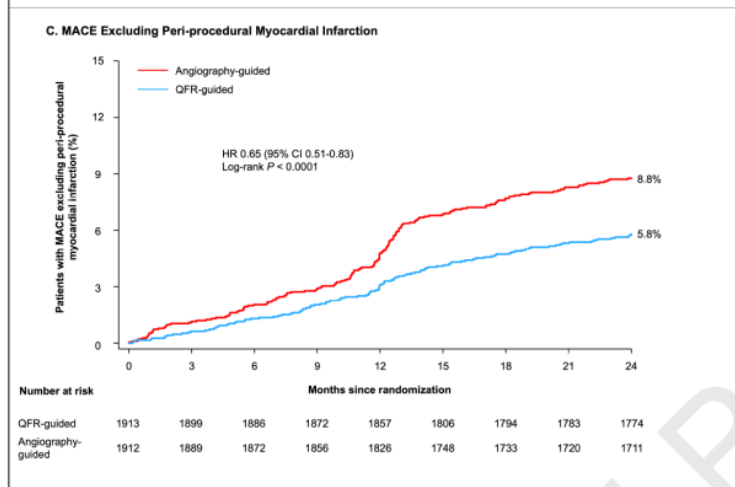
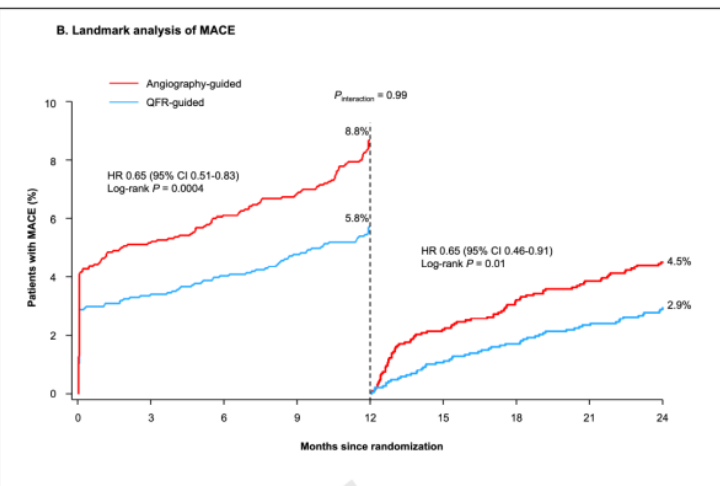
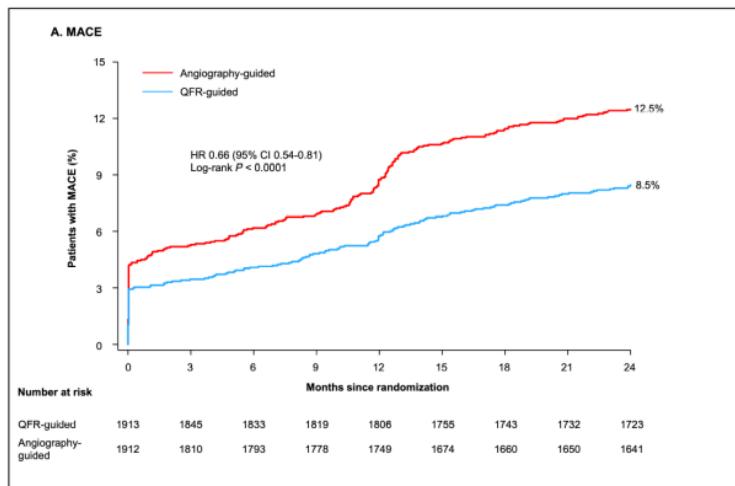
2-Year Clinical Outcomes



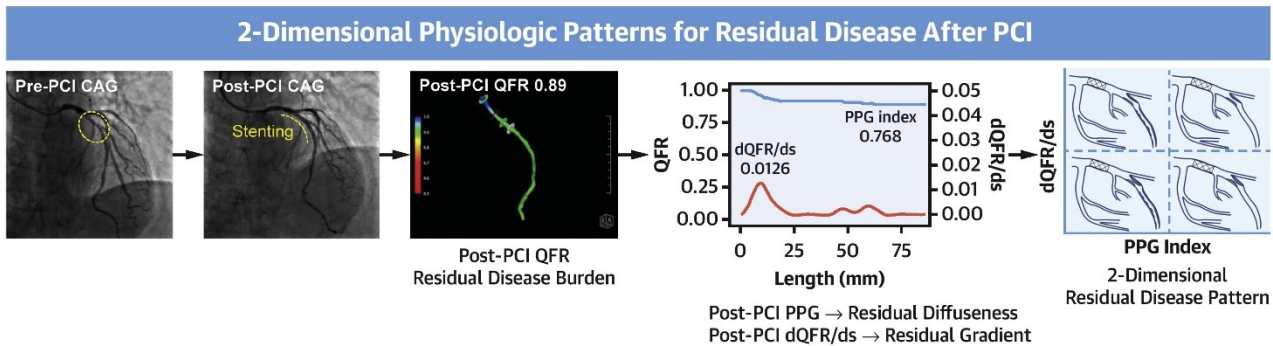
Landmark Analysis



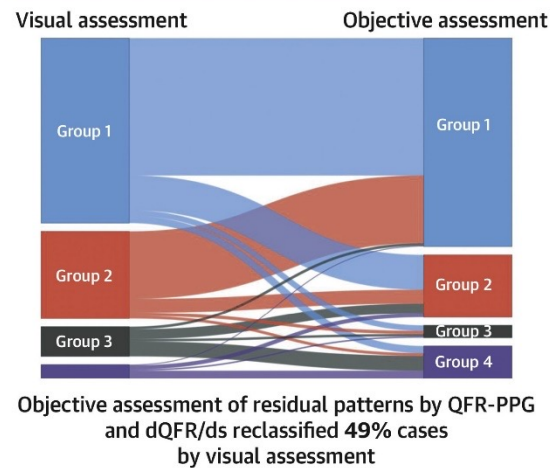
Song L, et al. J Am Coll Cardiol. 2022;80(22):2089-2101.



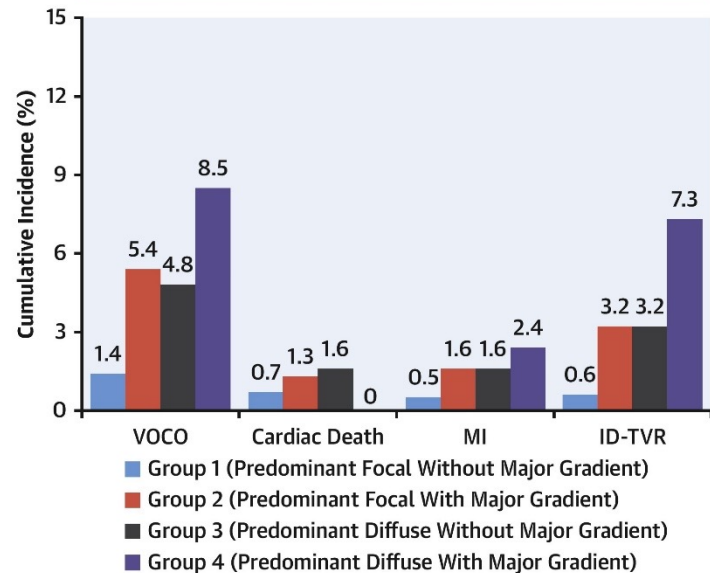
CENTRAL ILLUSTRATION: Clinical Impact of 2-Dimensional Residual Disease Patterns After PCI



Reclassification Between Objective and Visual Assessment



2-Year Clinical Outcomes According to 2-Dimensional Residual Disease Patterns



Dai N, et al. J Am Coll Cardiol Intv. 2022;15(16):1624-1634.

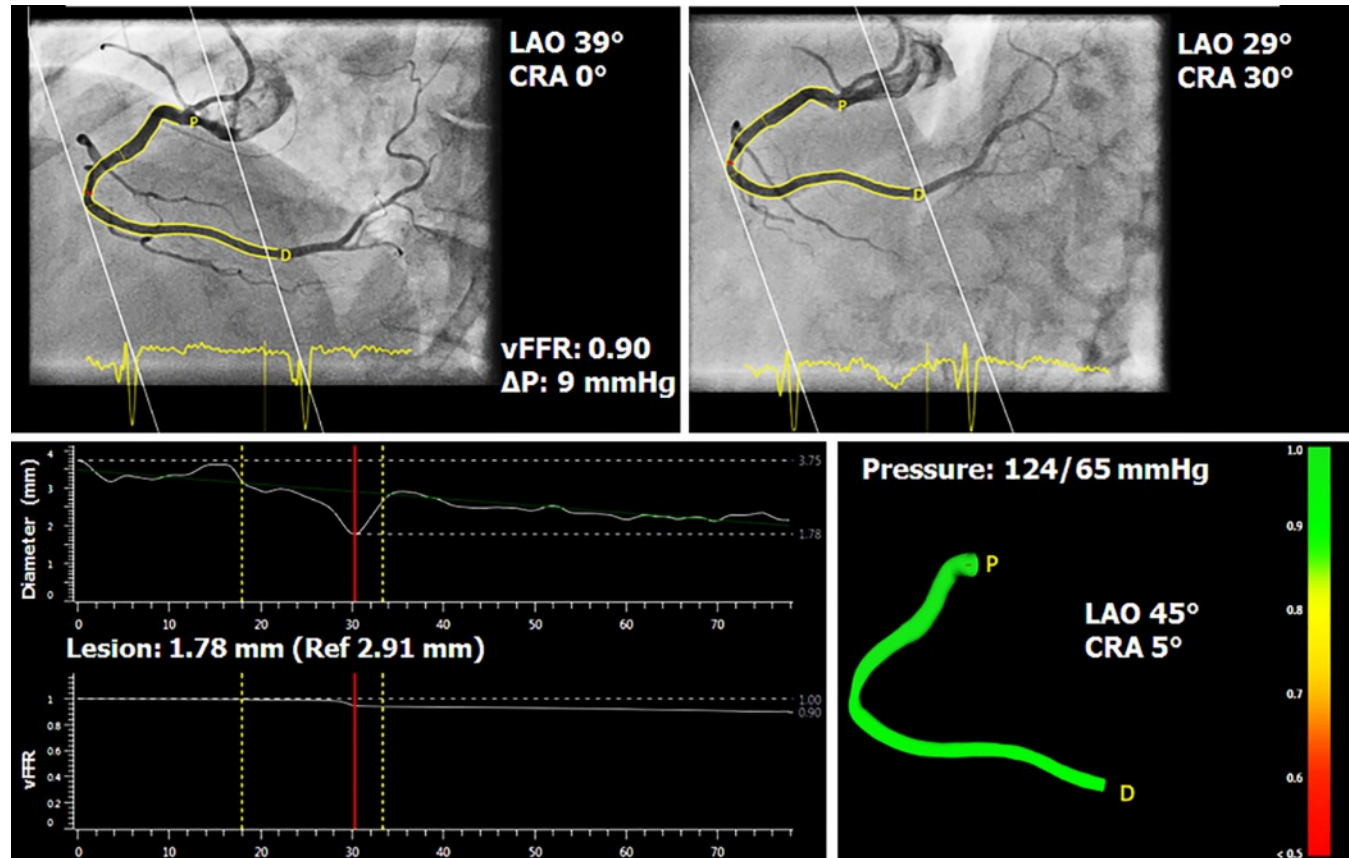
Conclusion

- ✓ In patients with microvascular dysfunction, illustrated by patients with DM, the clinical benefit of qFR is similar than in the general population
- ✓ At 2 years follow-up, the benefit of qFR in FAVOR3 is confirmed
- ✓ Recent studies suggest that qFR “vessel mapping” could be use to tailor the PCI procedure and verify that a target qFR value has been obtained post-PCI.

Virtual FFR based on Angiography

Required:

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



FAVOR III Europe Japan

- Stable angina pectoris or evaluation of secondary stenosis after MI
- Coronary stenosis of 40-90% by visual estimate

1:1 randomization of 2000 patients

QFR guiding

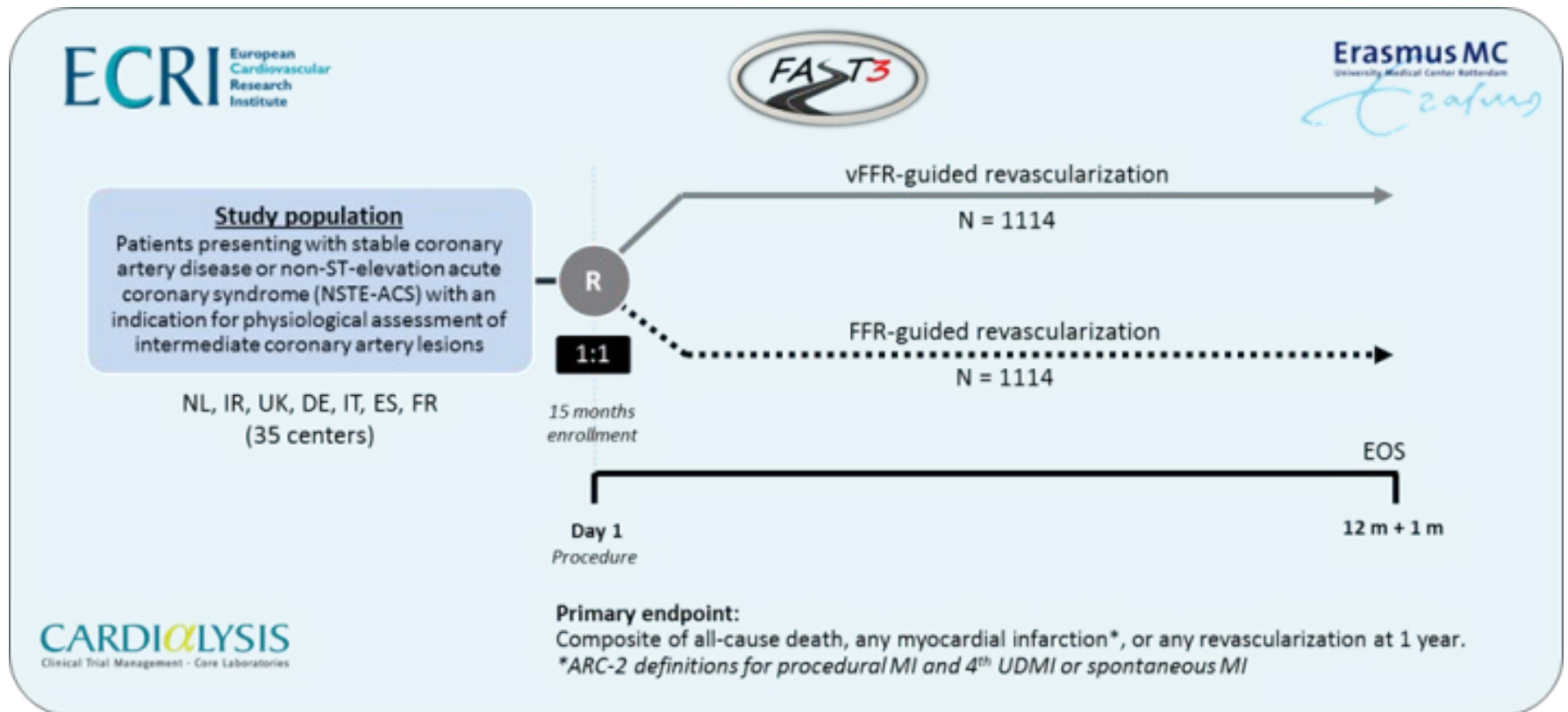
FFR guiding

Primary endpoint: One year PoCE for non-inferiority

Two-year follow-up

Only clinical follow-up

Study flow chart



Benefits of Obtaining information for planning With noninvasive FFR_{CT} prior to Invasive Evaluation- The BOWIE study

Eric Van Belle, MD PhD, Luis Raposo MD, Sergio Bravo Baptista MD PhD,
Flavien Vincent, MD PhD, Sina Porouchani MD, Alessandro Cosenza MD,
Campbell Rogers MD, Jonathon Leipsic MD

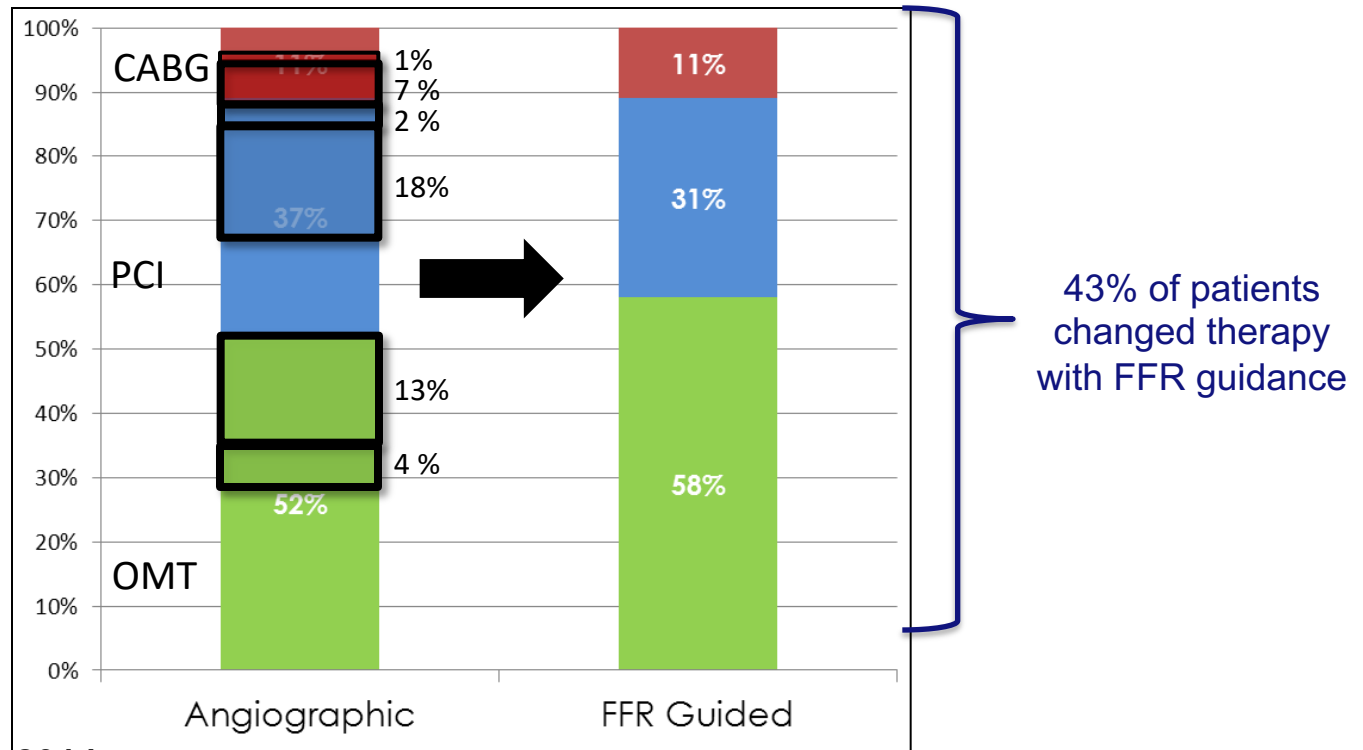
Functional testing and intravascular imaging for lesion assessment

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

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;





JACC
JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY



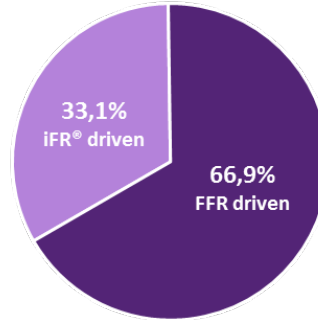
Impact of Routine Invasive Physiology at Time of Angiography in Patients With Multivessel Coronary Artery Disease on Reclassification of Revascularization Strategy

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

Reclassification according to the number of vessel investigated

iFR[®] versus FFR driven physiology assesement in MVD patients



iFR : 1.9 vessels
FFR: 1.6 vessels

**Performing pressure wire
measurements in patients with
MVD is very rare**

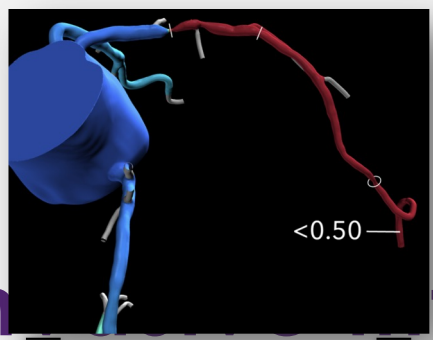
Pre-PCI

ICA



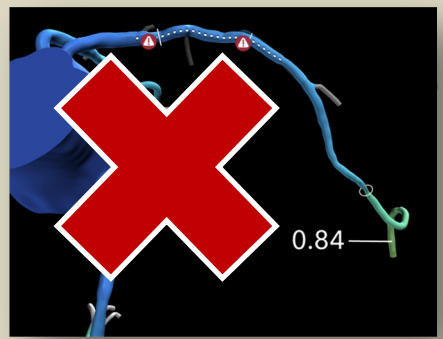
ICA-based plan
38mm stent

FFR_{CT} Planner

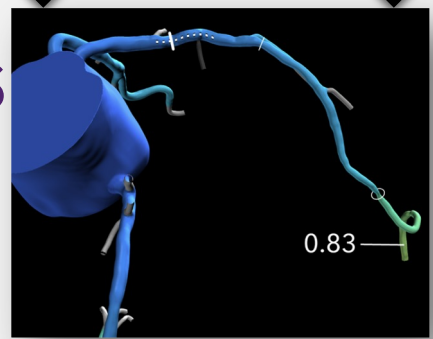


Baseline FFR_{CT}

Post-PCI



ICA-based plan reproduced on FFR_{CT} Planner
38mm stent



FFR_{CT} Plan
15mm stent

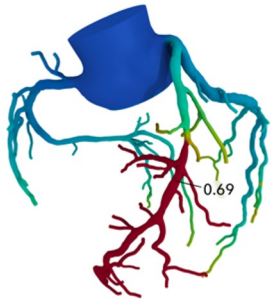
on-in...terc
clas
“PC

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

FFR_{CT} Planner Core Components

1

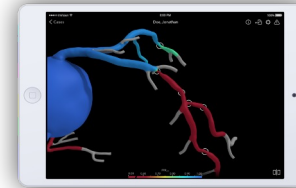
Starts with the HeartFlow Analysis



Interactive Mobile Platform

2

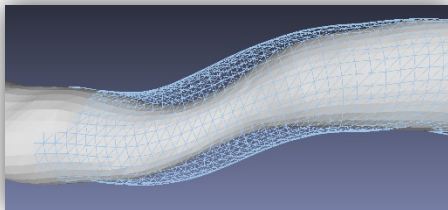
- iOS, interactive viewer



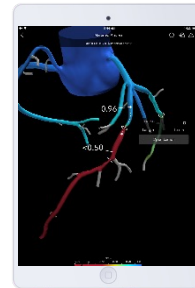
3

Ideal Geometry

- Contains a second anatomic model representing the “ideal” vessel



HeartFlow Planner



Real-time FFR_{CT} calculation

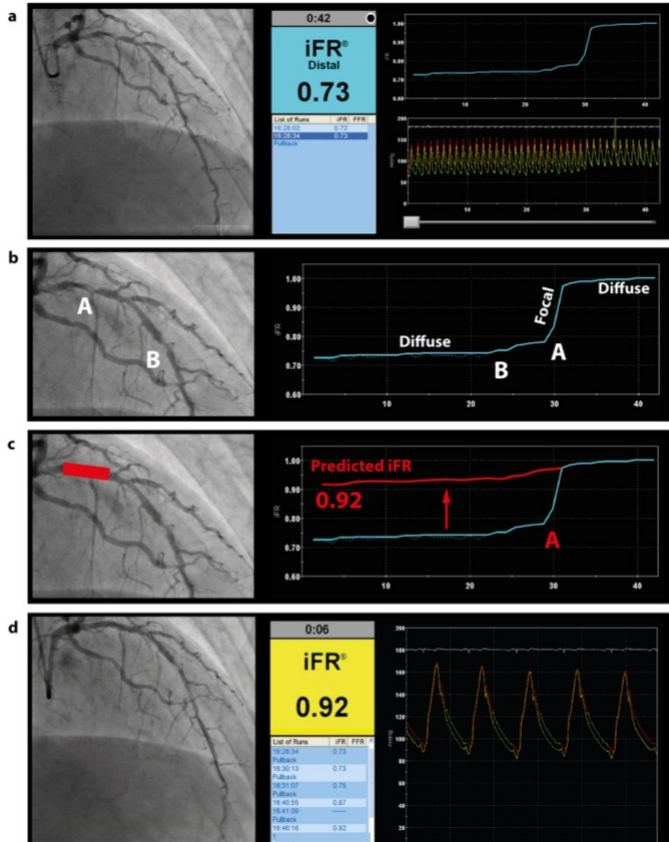
4

- Modified vessel combined with updated physiology



*Not yet commercially available, pending Regulatory Review

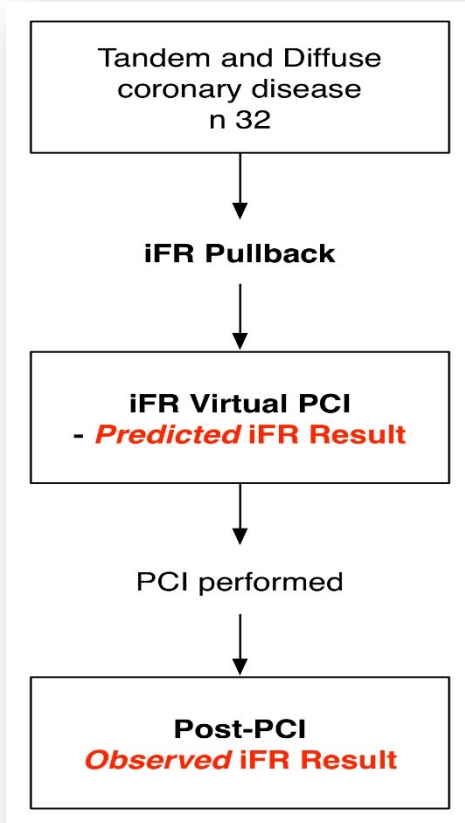
iFR et lésions en série



- 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



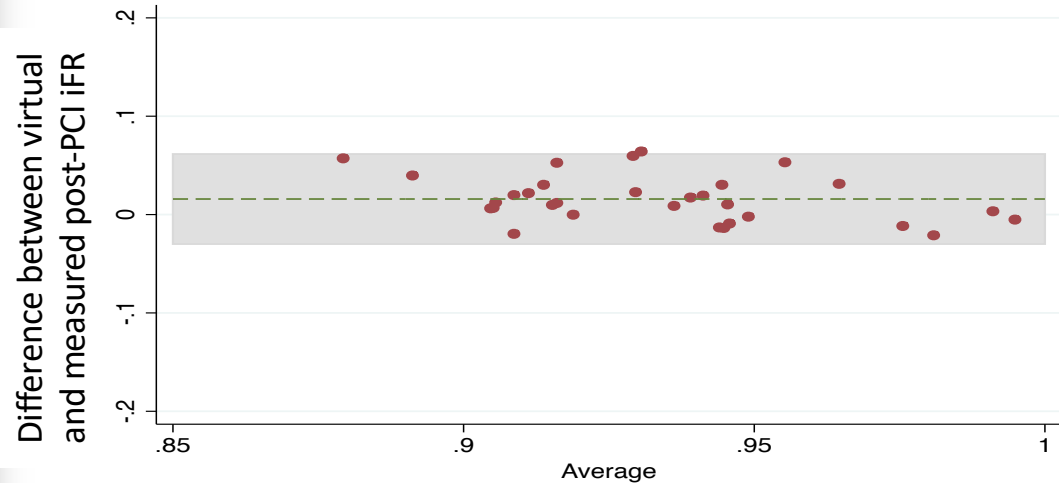
Pre-PCI iFR: 0.78 ± 0.03

Predicted iFR: 0.94 ± 0.01

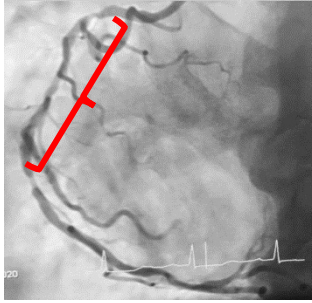
Observed iFR: 0.93 ± 0.03

} **p=0.48**

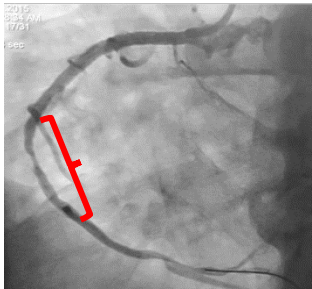
Agreement between expected post-PCI iFR and observed iFR



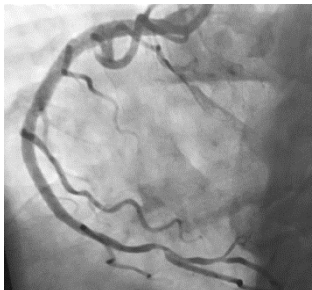
Nijjer SS, Davies J et al *JACC: Cardiovascular Interventions*. 2014;7:1386–1396



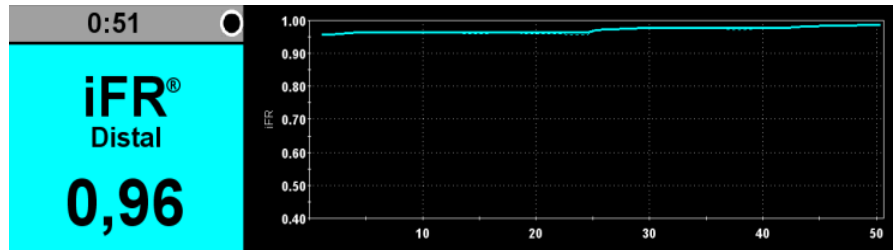
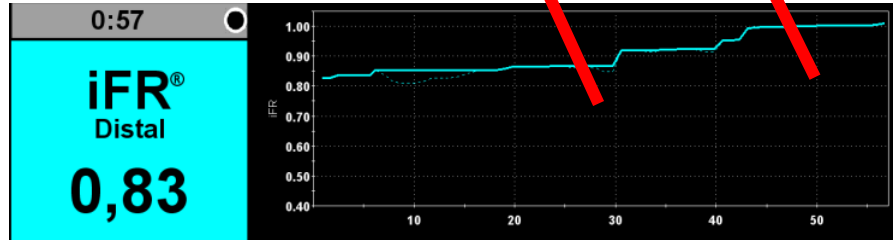
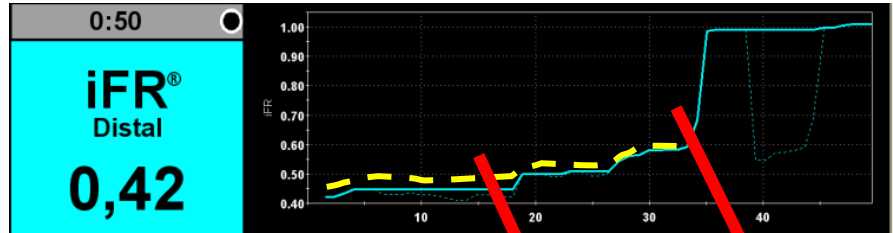
Profil de la perte de charge

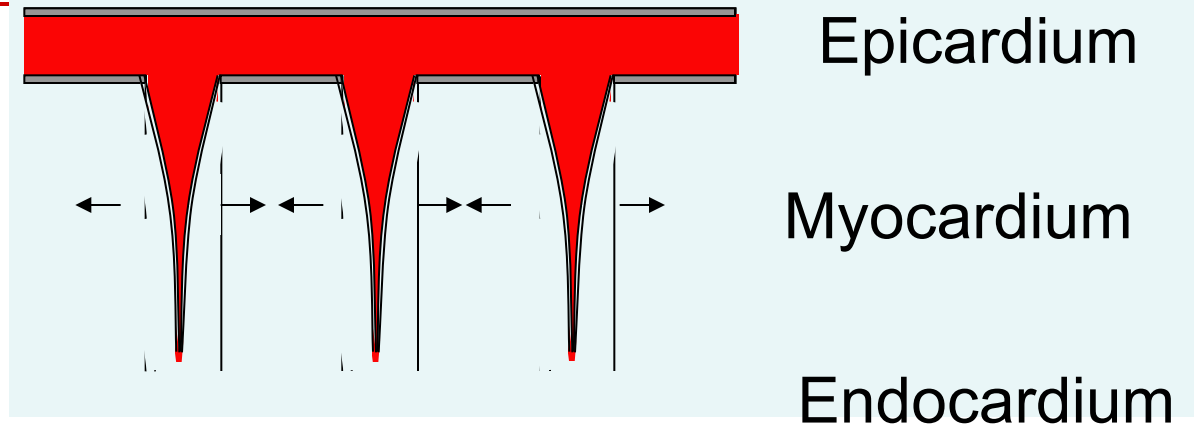


Perte de charge résiduelle après 1^{er} stenting

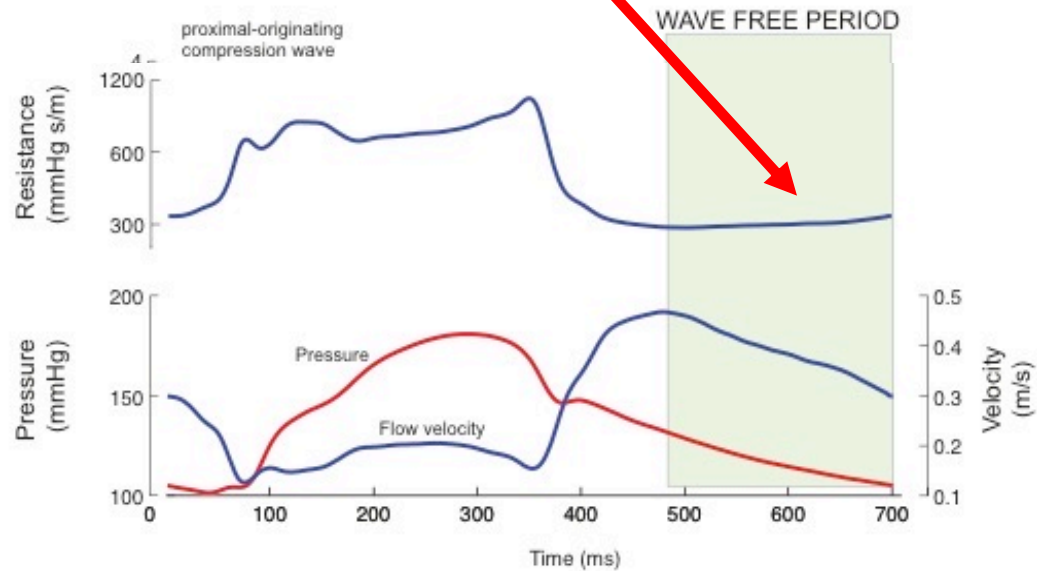


Profil hémodynamique normal





Distal pressure falling



Homme, 78 ans

Bon état général

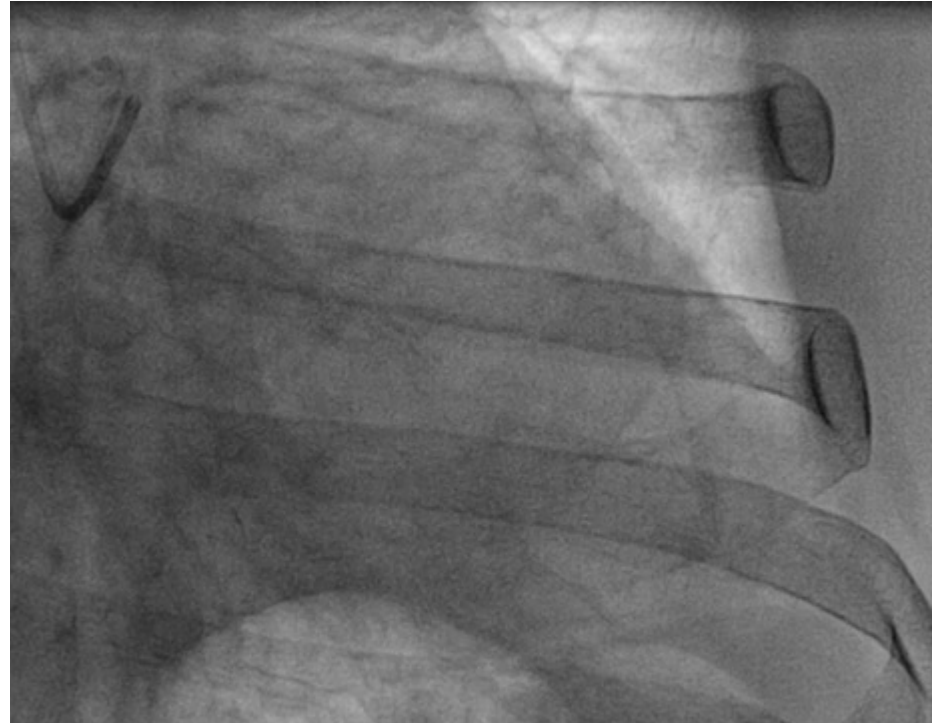
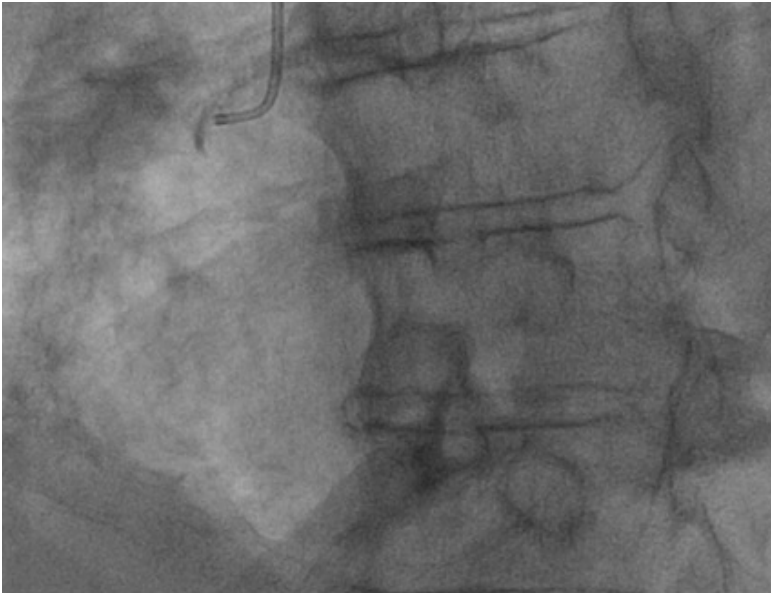
ATCD IDM inférieur (10 ans) – CD occluse connue non revascularisée

Hospitalisé pour NSTEMI avec décompensation cardiaque.

ETT : FEVG conservée avec séquelle inférieure.

Anticoagulation efficace pour une fibrillation atriale.

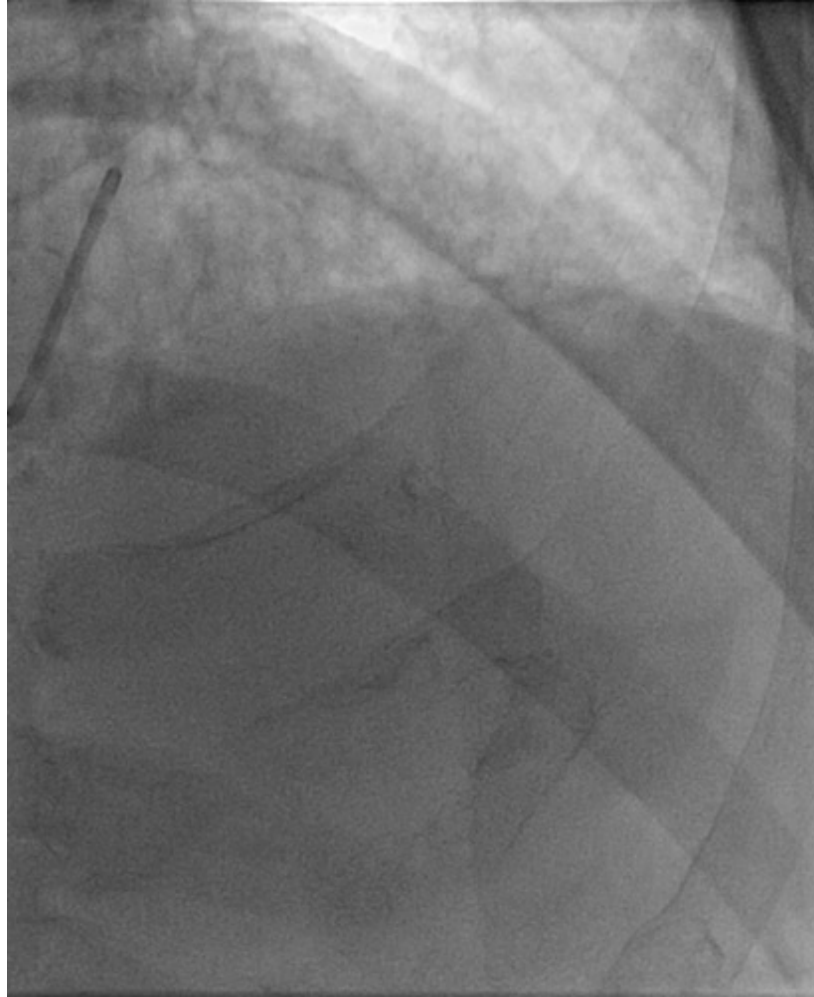
Fonction rénale normale. Pas de diabète.



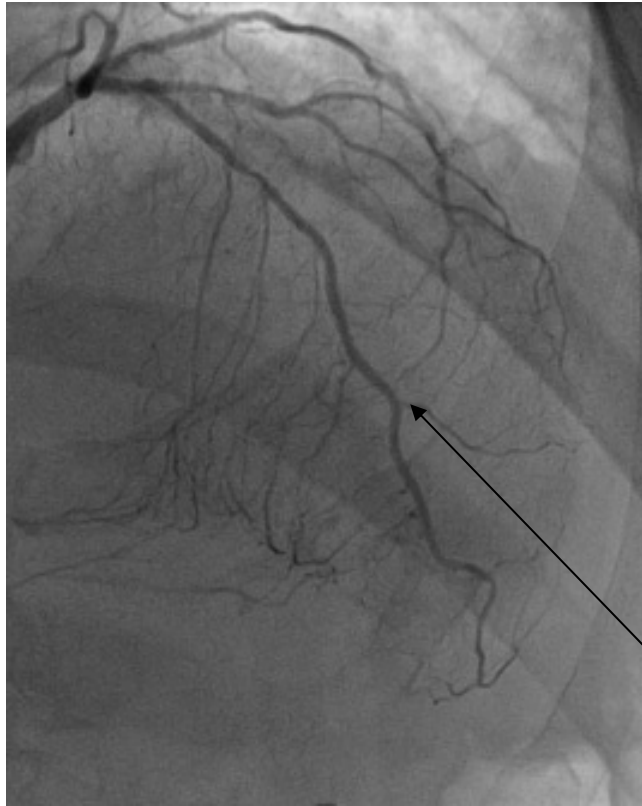
Pr Eric VAN BELLE MD, PhD

Institut Coeur et Poumon - CHU Lille, France

University of Lille - School Of Medicine Henri Warembourg



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



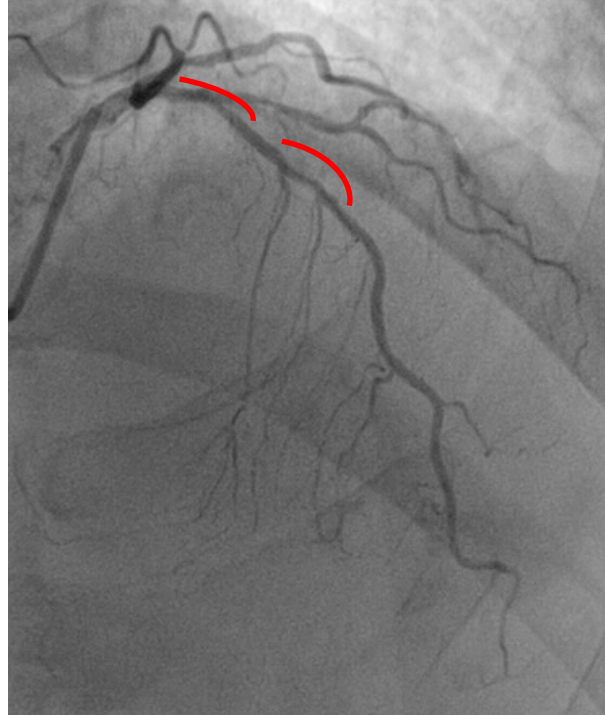
Evaluation physiologique sur l'IVA

FFR à 0,74

iFR à 0,69

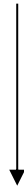
Vaisseau physiologiquement très
ischémique

*Zone de mesure avec
le guide de pression*

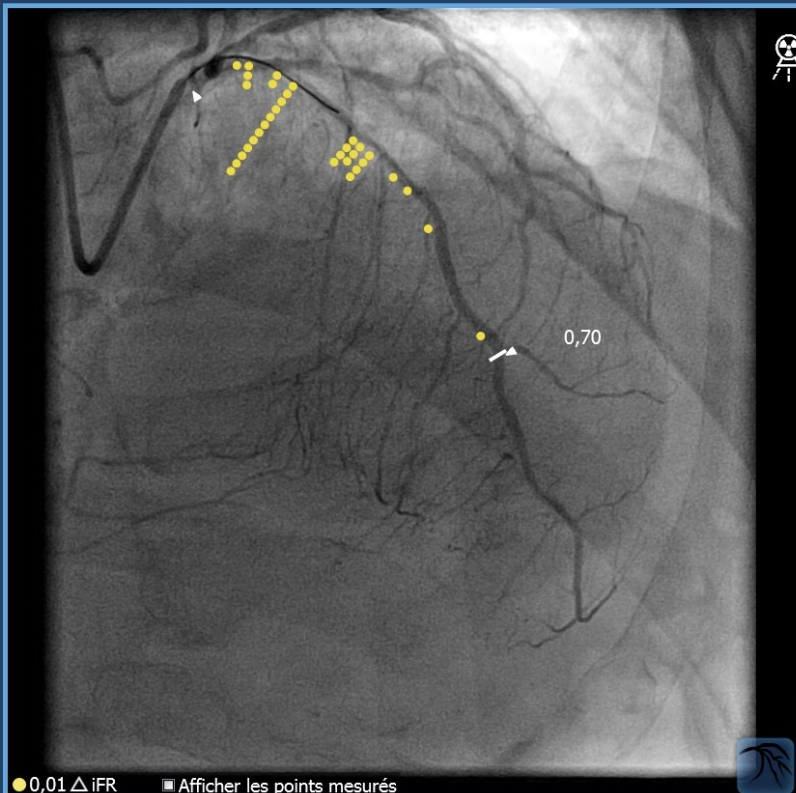


Angiographiquement :

Lésions relativement
diffuses avec 2 zones
distinctes

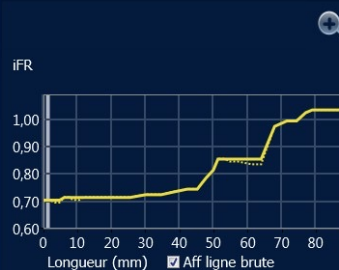


Quelle stratégie de
revascularisation ?



iFR distal: 0,69

iFR au curseur: 0,70



● 0,01 Δ iFR Afficher les points mesurés



Séq.
1/2

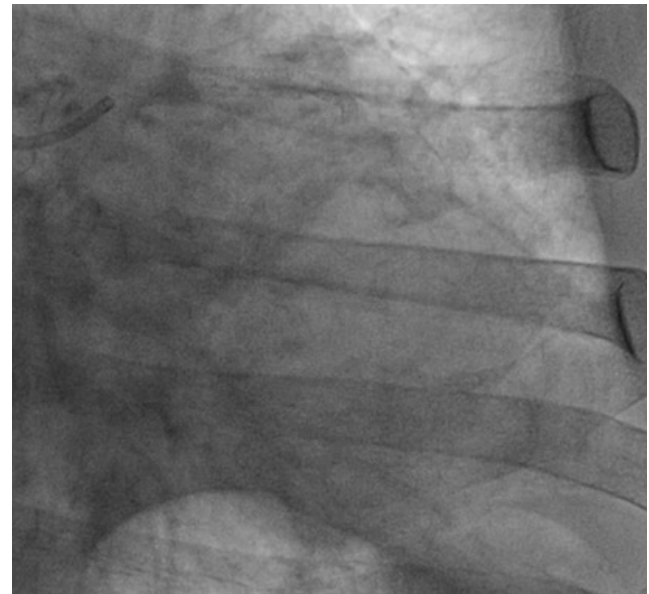
iFR pull back

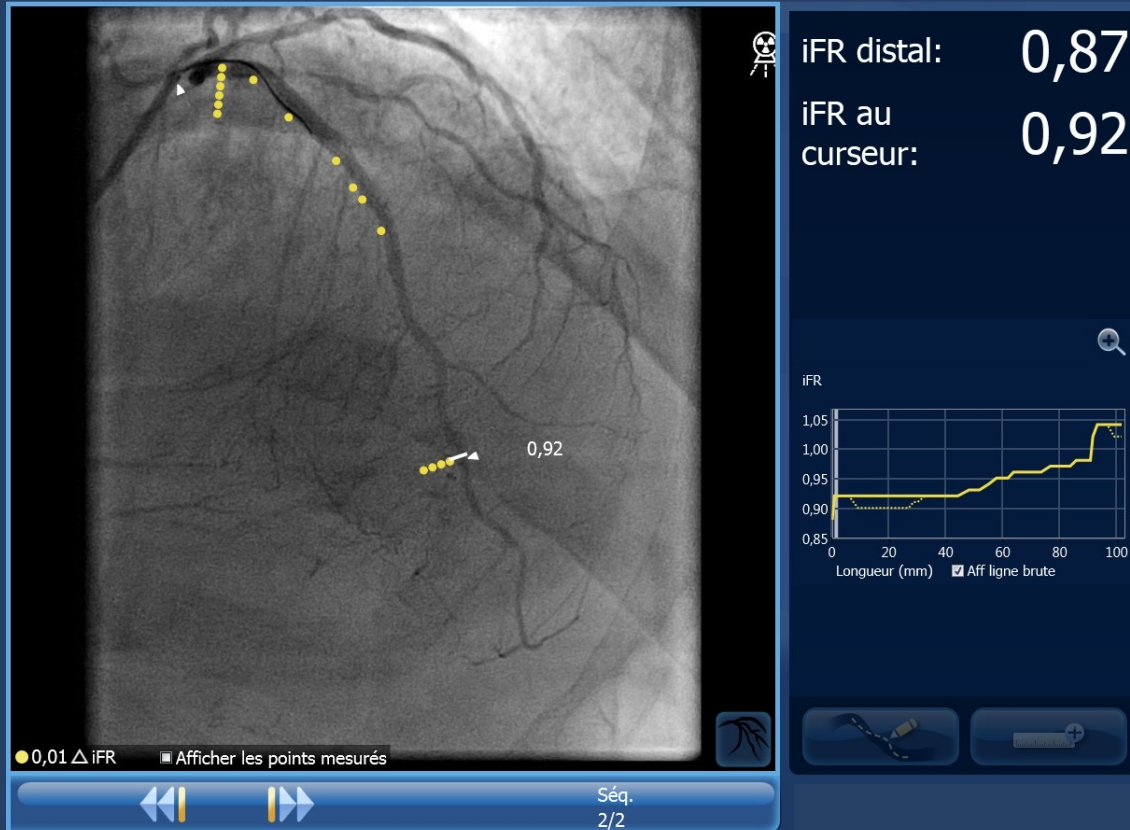
Perte de charge bien
repartie entre les 2
lésions

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



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

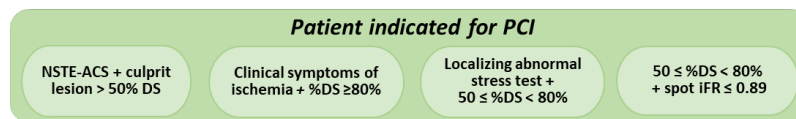




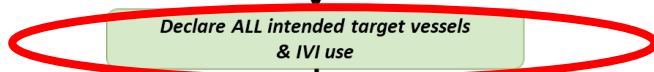
Excellent résultat
hémodynamique avec iFR
final au même point à 0,92.

Gain de 0,23 par la
revascularisation

DEFINE GPS Flow



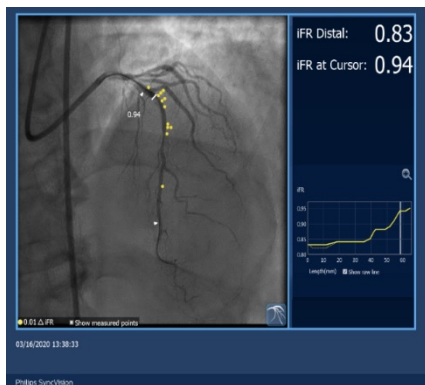
Aligned with Guideline Recommendations for PCI



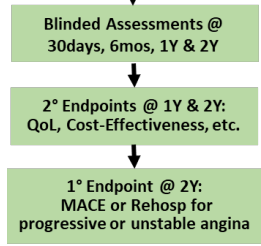
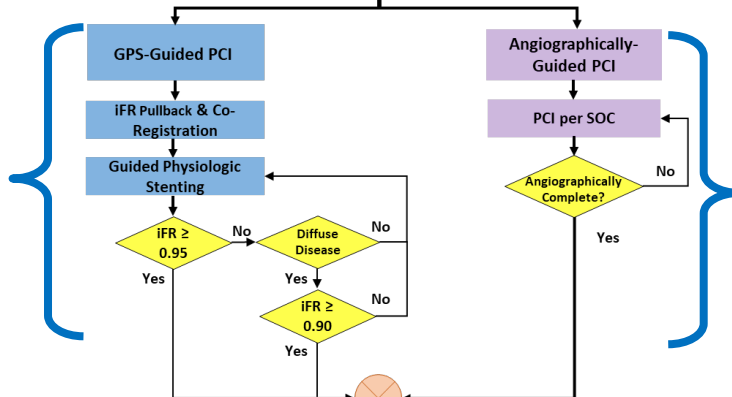
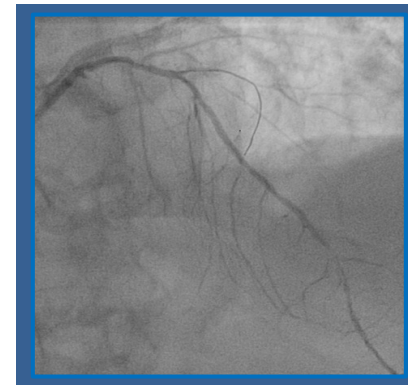
All vessels to undergo PCI must be qualified prior to randomization

Randomize

Physiology-Guided PCI



Standard of Care PCI



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

What is new in the 2019 Guidelines?

New recommendations (1)

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 <ul style="list-style-type: none">- 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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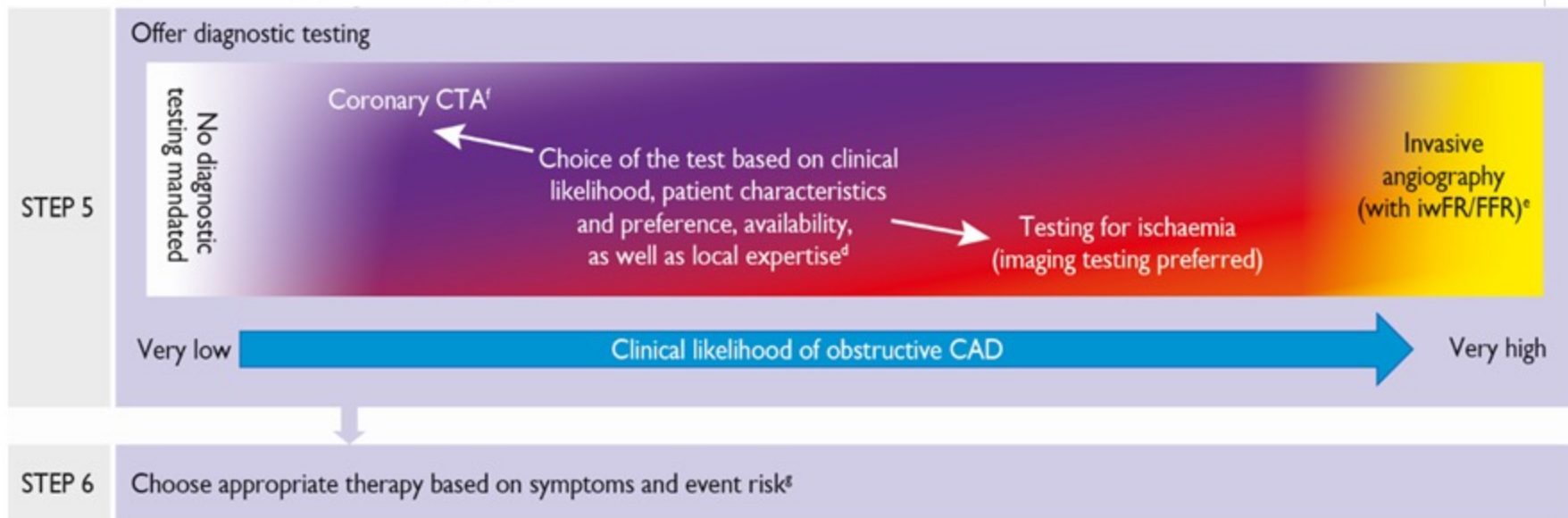
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■ Class I ■ Class IIa ■ Class IIb ■ Class III

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

Diagnostic approach (2)

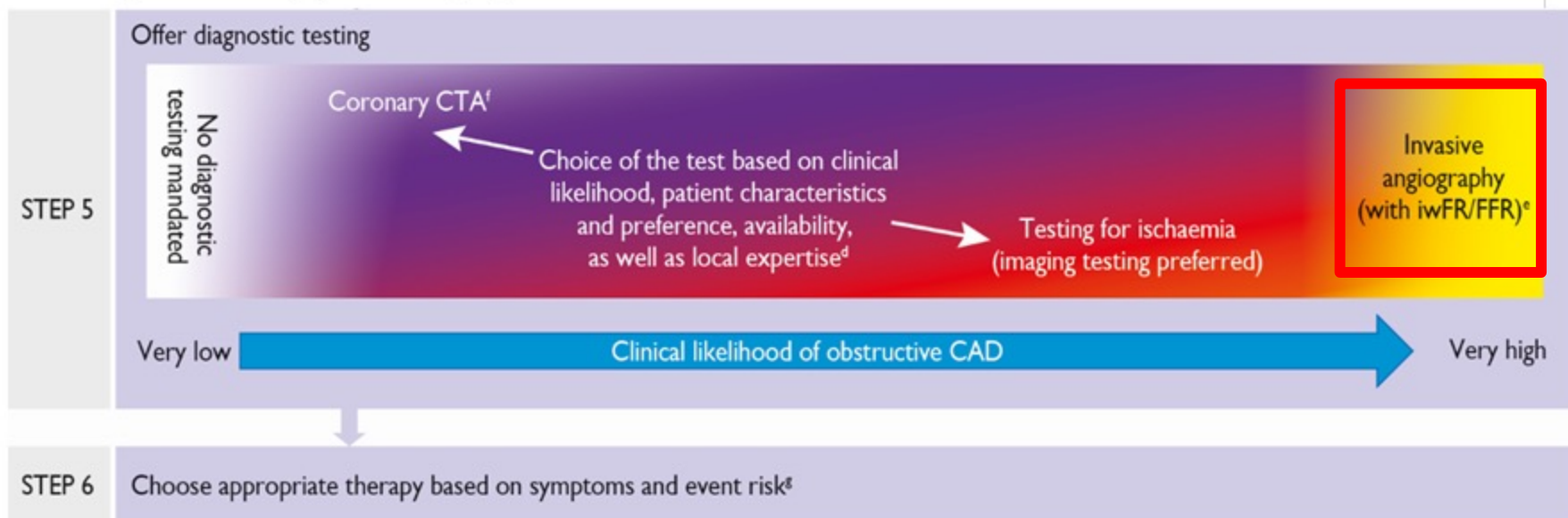


^d Ability to exercise, individual test-related risks, and likelihood of obtaining diagnostic test result. ^e High clinical likelihood and symptoms inadequately responding to medical treatment, high event risk based on clinical evaluation (such as ST-segment depression, combined with symptoms at a low 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).

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