

Physiologie non-invasive: Mythe ou réalité?

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Cardiovascular Center Aalst

Belgium

DÉCLARATION DE LIENS D'INTÉRÊT AVEC LA PRÉSENTATION

Nom de l'orateur : Jeroen SONCK, Aalst

Je déclare les liens d'intérêt potentiel suivants :

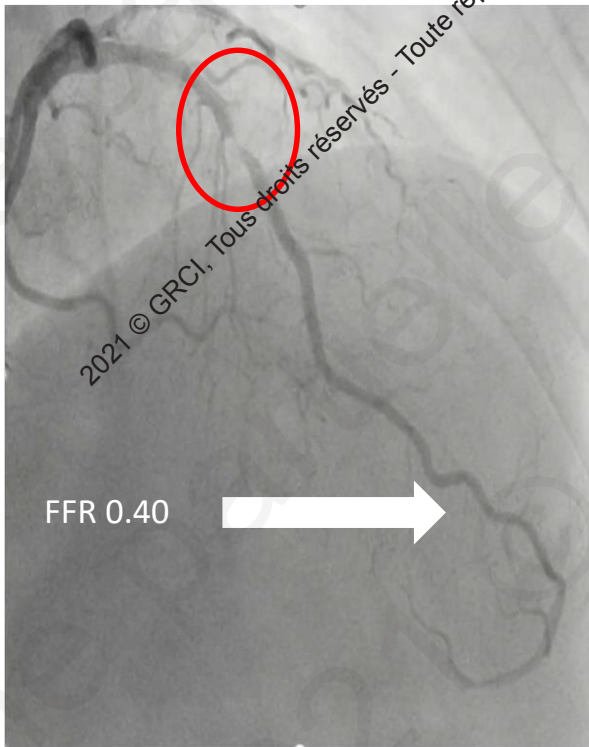
Bourse de Recherche : CardioPath PhD program

Droits de propriété intellectuelle : PCT/EP2021/062152

Fondateur : CoreAalst BV

The present: Is non-invasive coronary physiology accurate and does it predict outcomes?

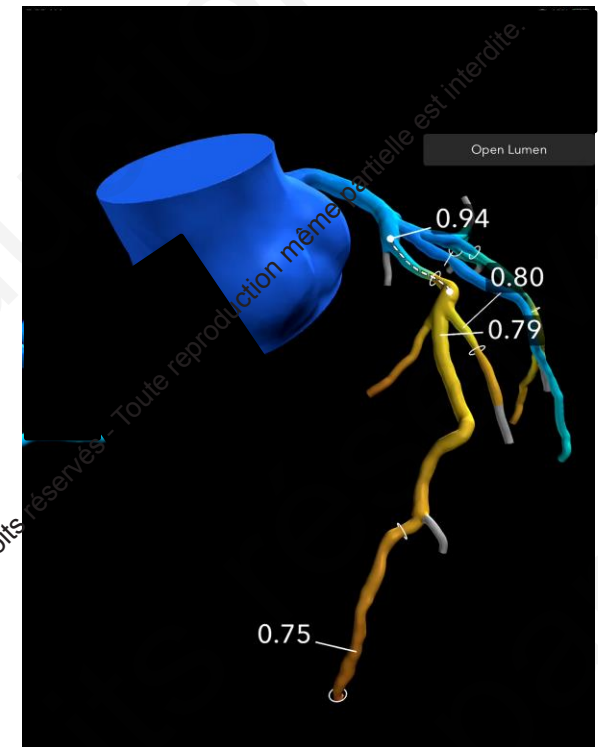
Invasive distal FFR



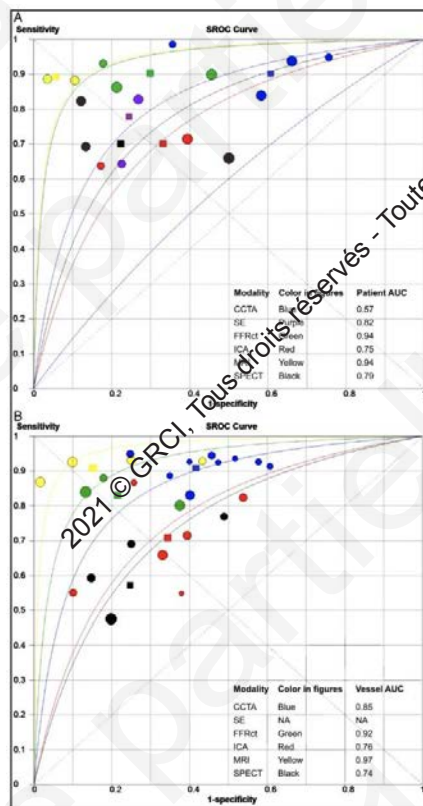
Angio-derived FFR



CT-derived FFR



FFR_{CT} vs. NICI and FFR?



Danad et al. EHJ 2017

CENTRAL ILLUSTRATION: Discriminative Ability of Imaging Modalities for the Detection of Per-Vessel Fractional Flow Reserve-Defined Ischemia

Angiography + Fractional Flow Reserve
AUC 0.94

Positron Emission Tomography
AUC 0.87

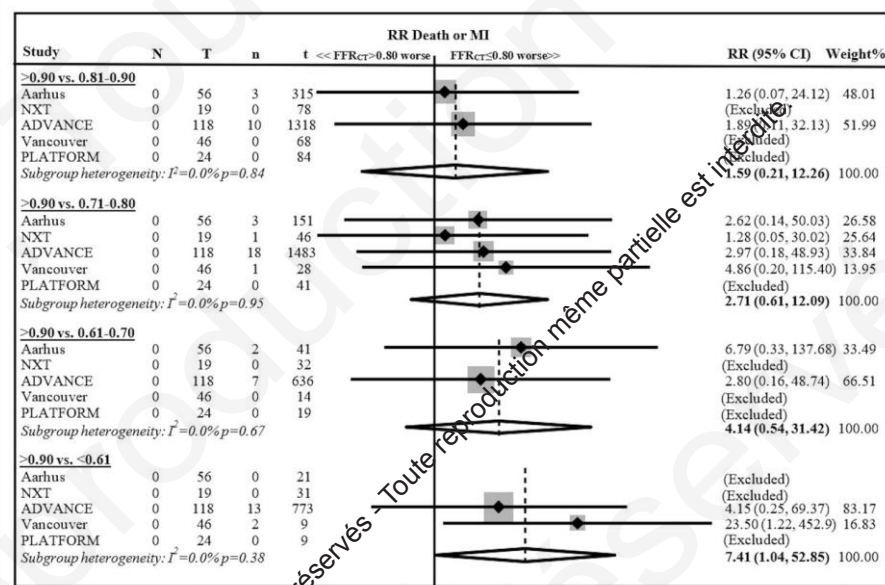
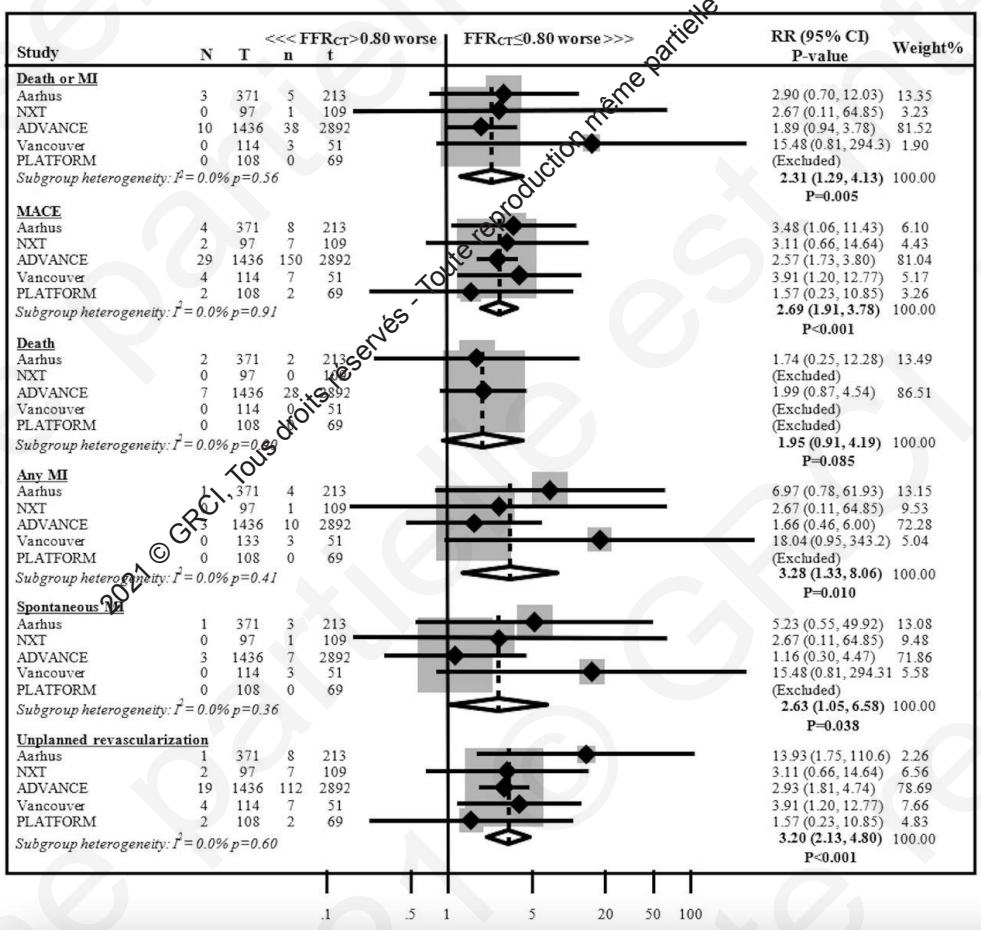
Coronary Computed Tomography Angiography
AUC 0.83

Single-photon Emission Computed Tomography
AUC 0.70

Sensitivity (per vessel) vs. 100-Specificity (per vessel)

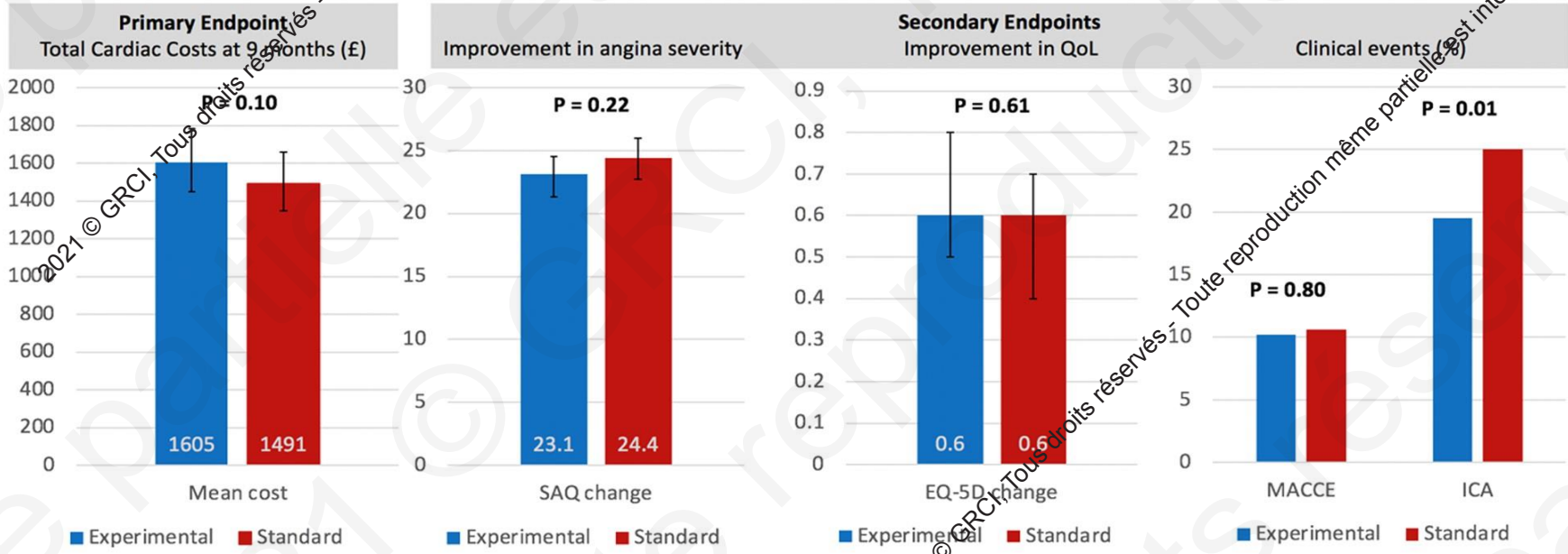
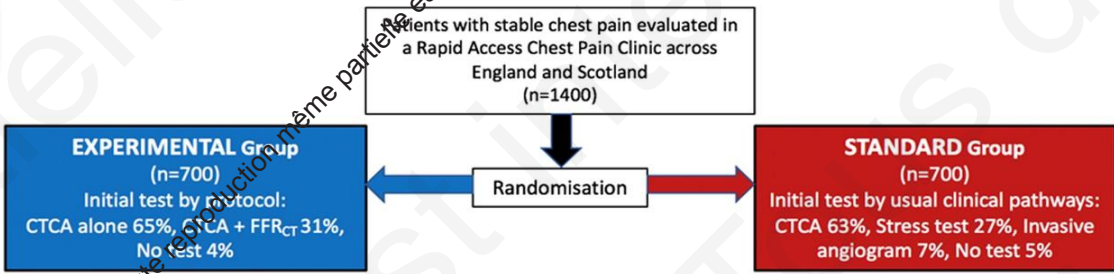
Driessen, R.S. et al. J Am Coll Cardiol. 2019;73(2):161-73.

FFR_{CT} and outcomes



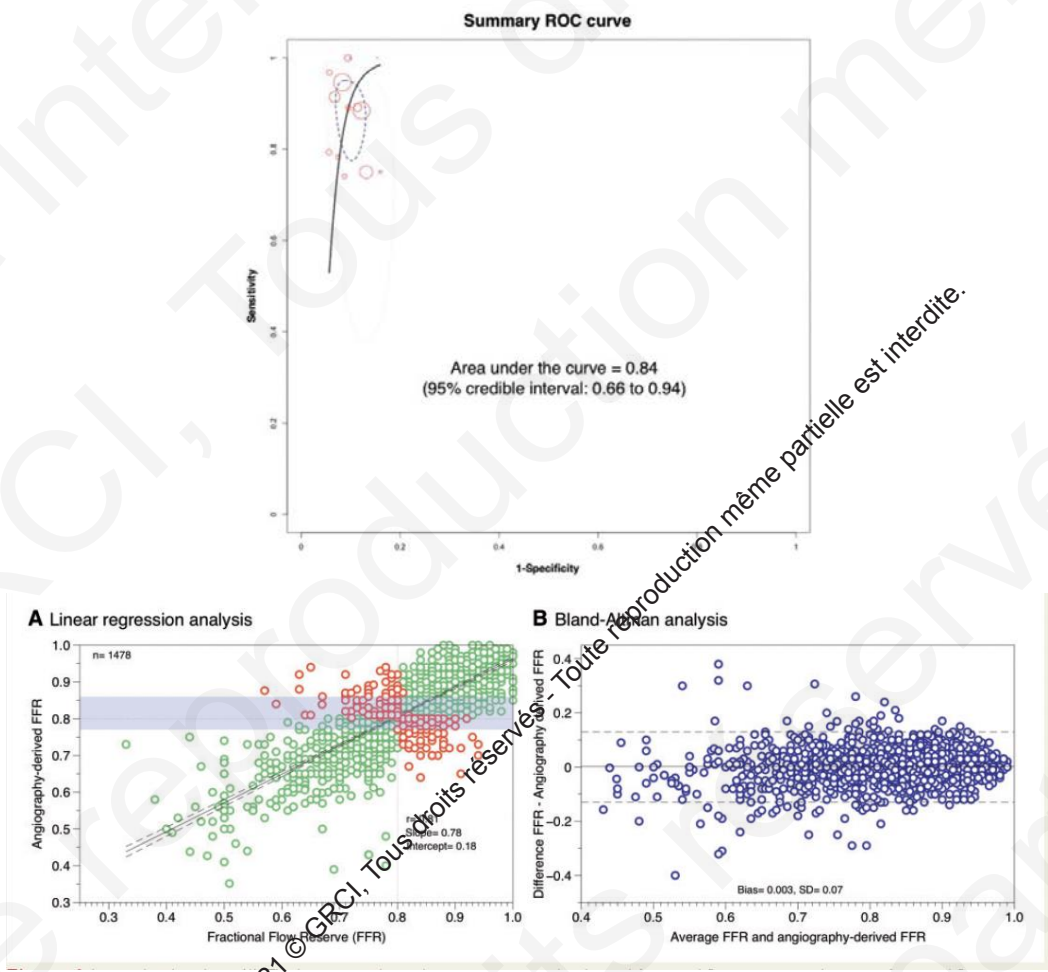
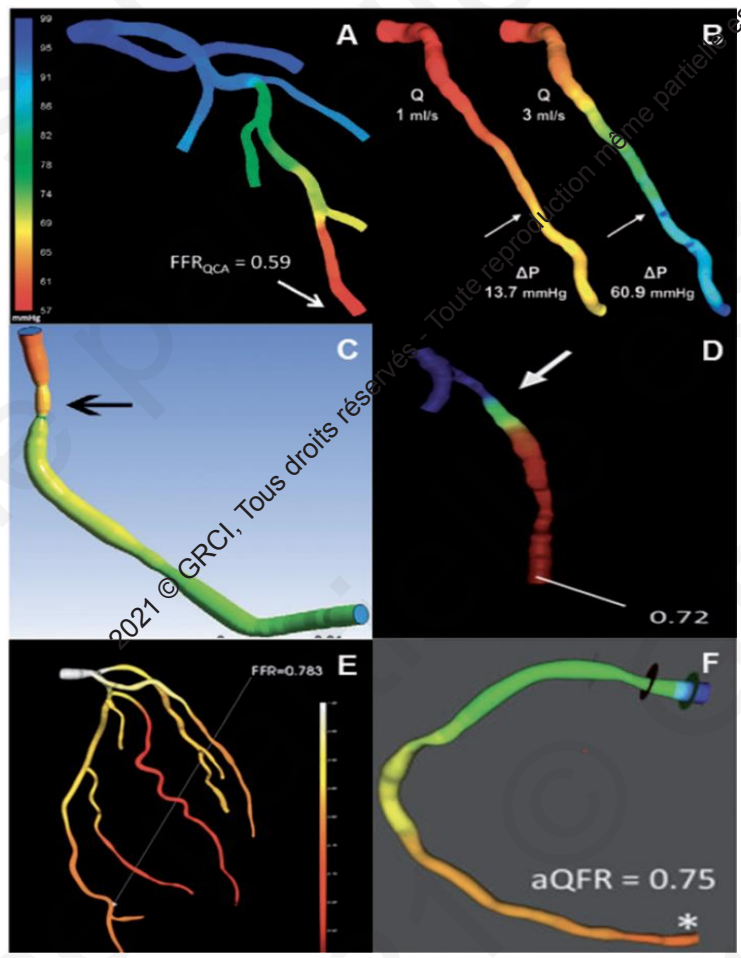
Norgaard B et al. Heart 2021

FFR_{CT} randomized trial data?



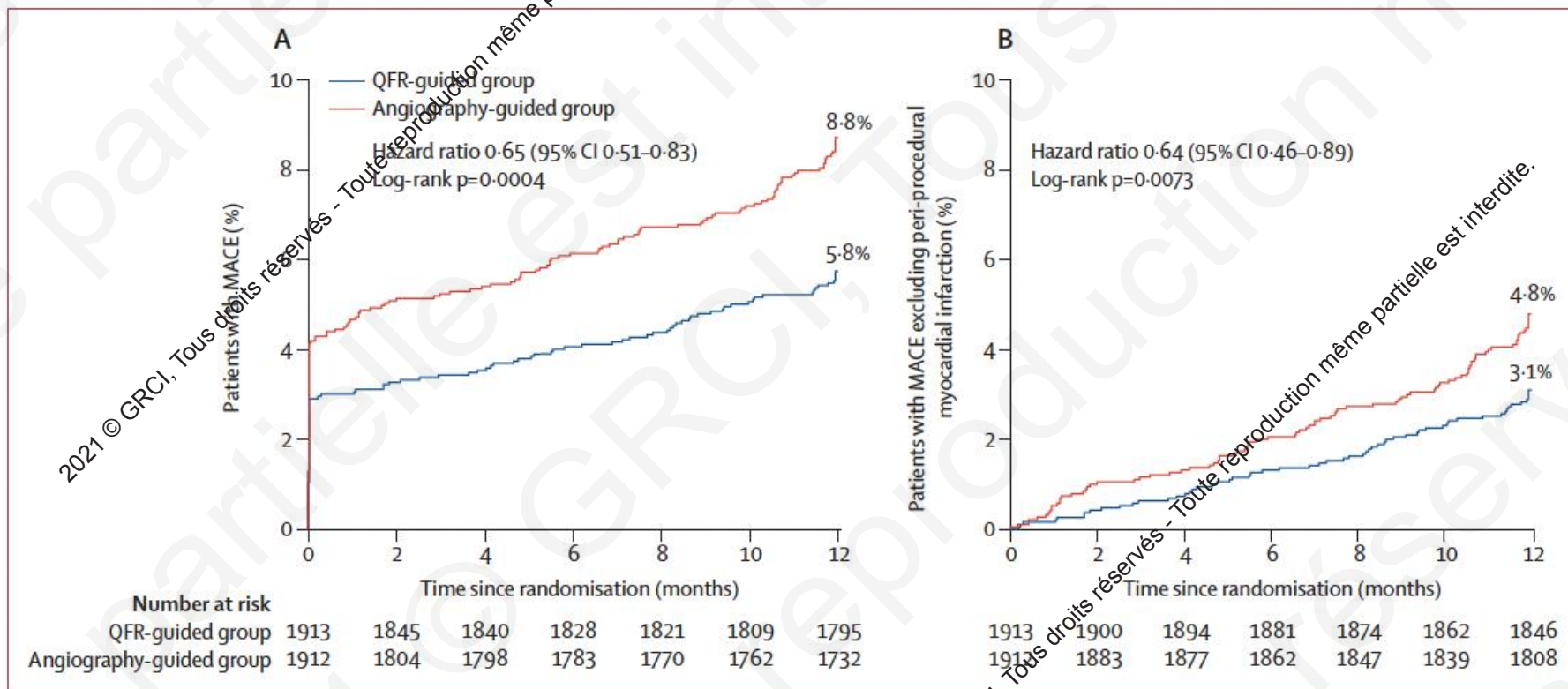
Curzen et al. EHJ 2021

Angiography-derived FFR vs. FFR?



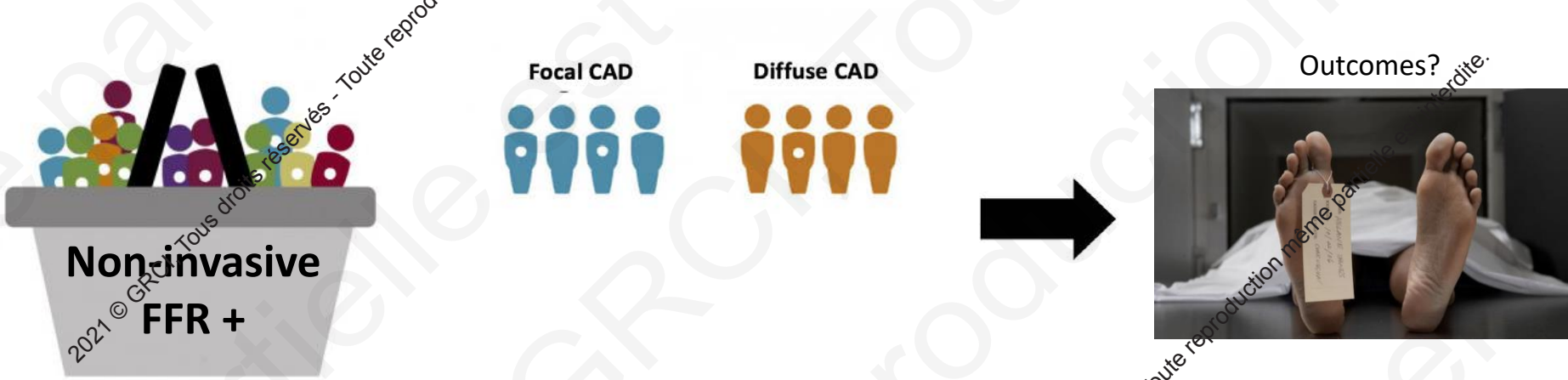
Collet C et al. EHJ 2018

QFR and outcomes: FAVOR III China



Xu et al. Lancet 2021

The Future: Appropriateness of PCI?



The current approach is **limited** in differentiating CAD endotypes

Focal Functional CAD

Pre-PCI angiography

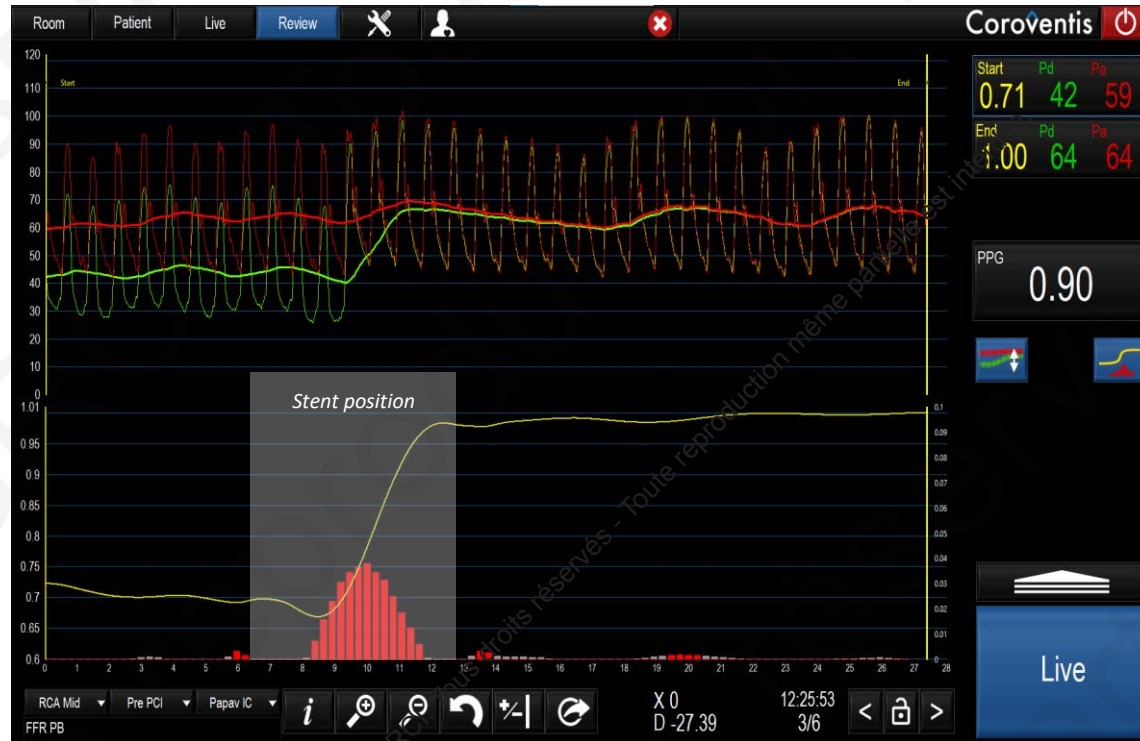
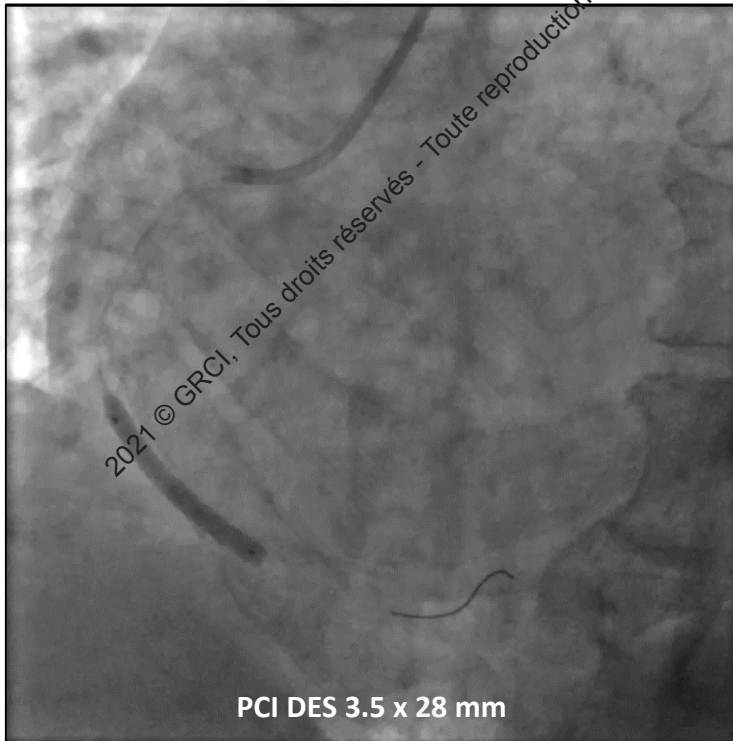


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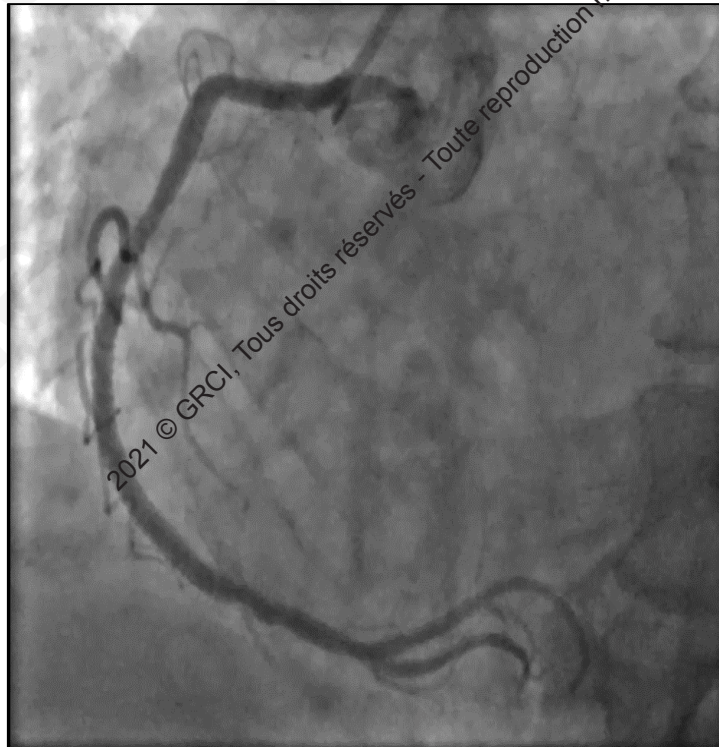
Focal Functional CAD

Pre-PCI FFR Pullback Curve

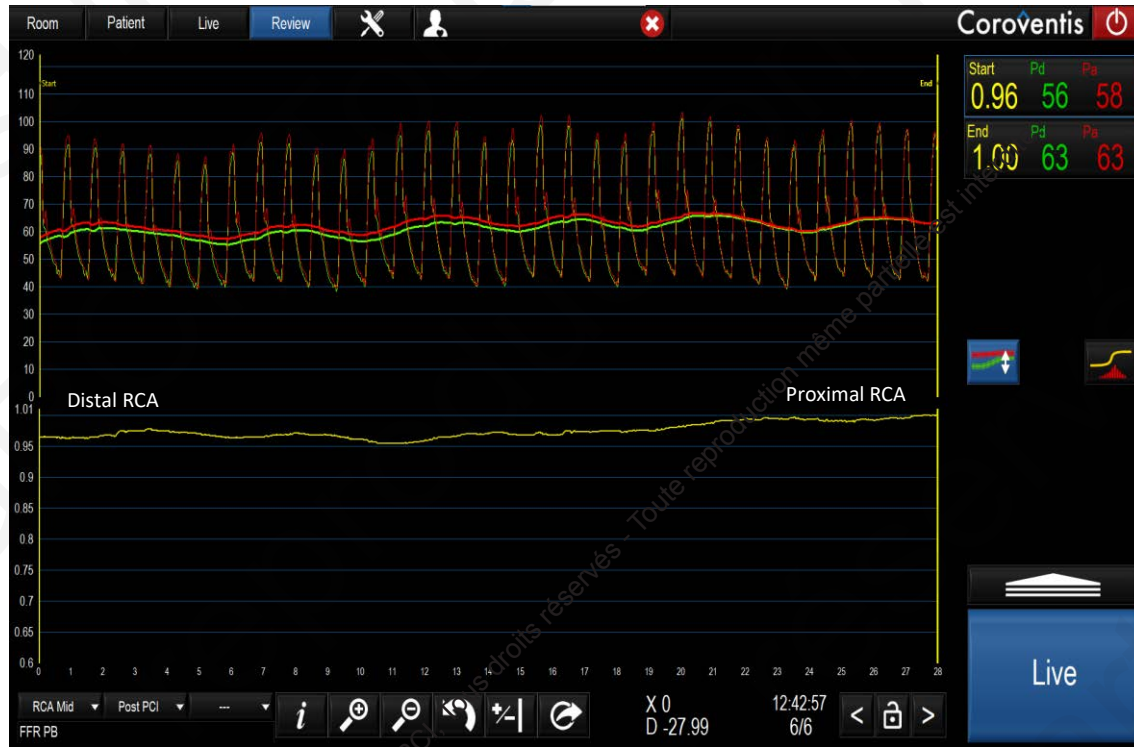


Focal Functional CAD Post-PCI

Post-PCI angiography

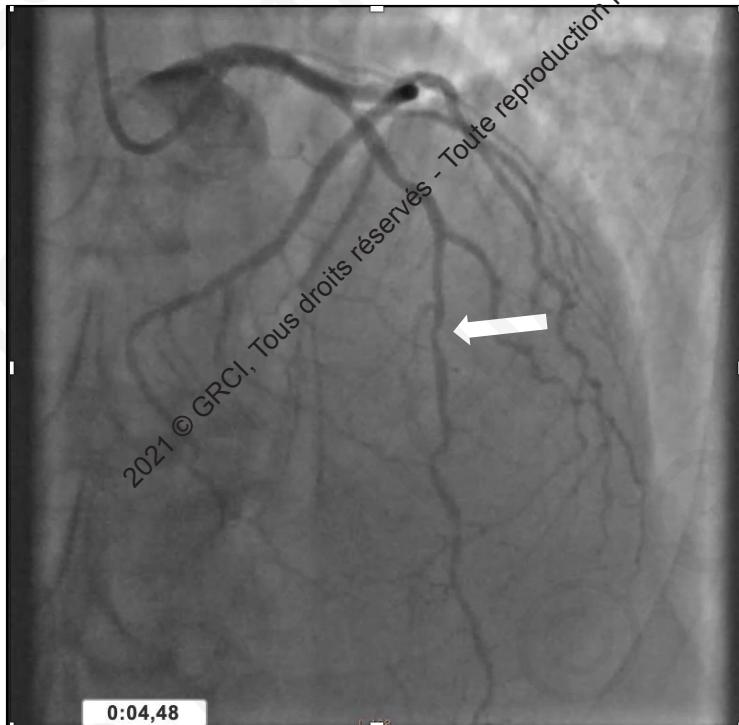


FFR Pullback Curve

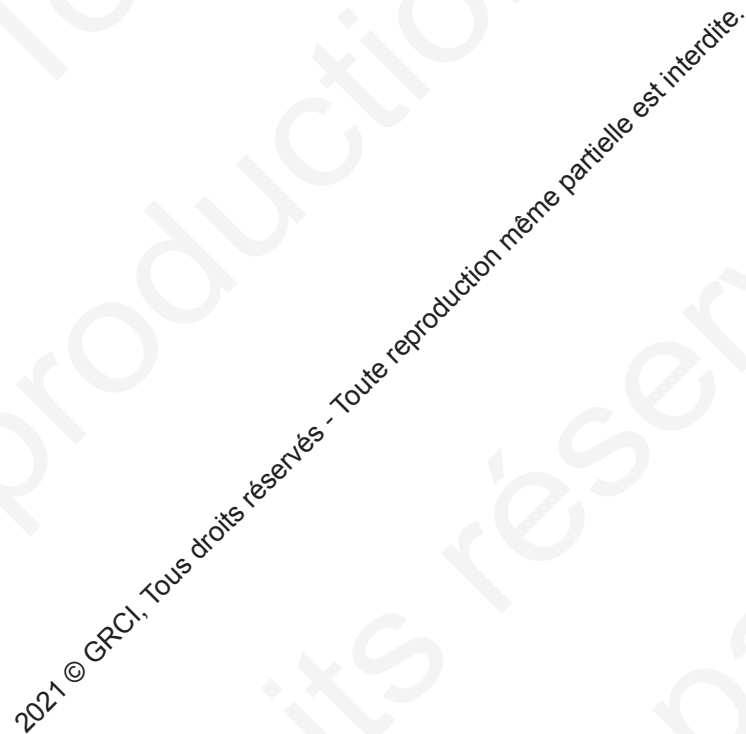


Diffuse Functional CAD

Pre-PCI angiography

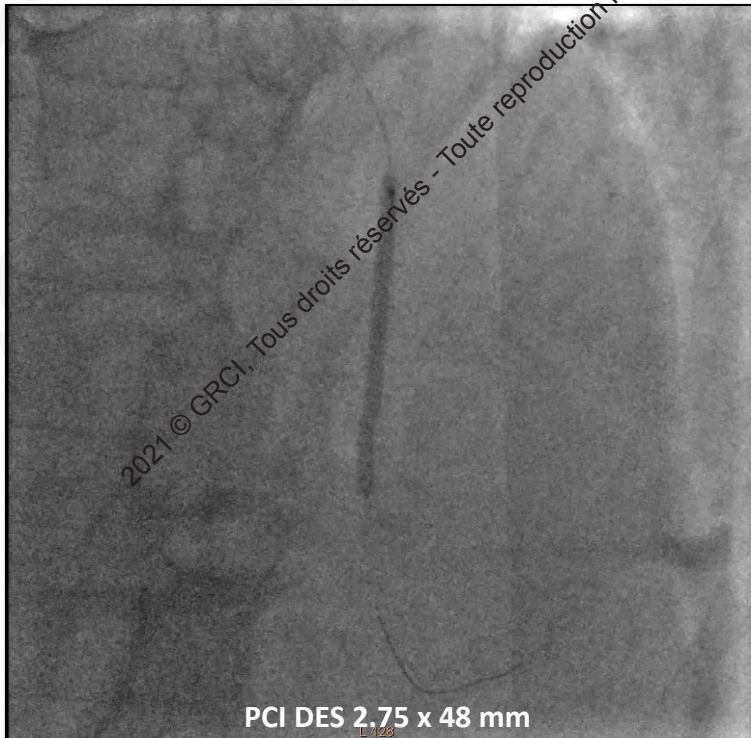


Pre-PCI FFR Pullback Curve



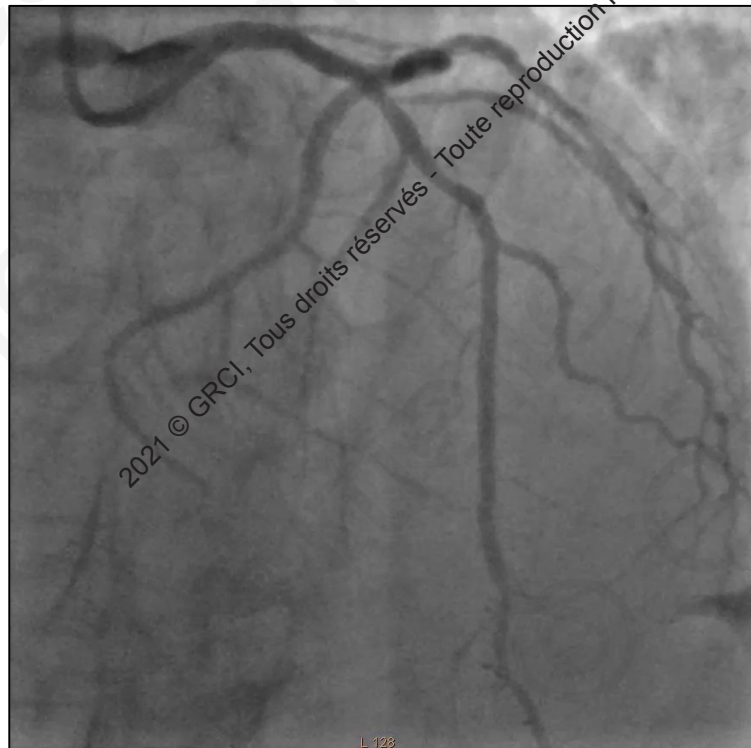
Diffuse Functional CAD

Pre-PCI FFR Pullback Curve



Diffuse Functional CAD Post-PCI

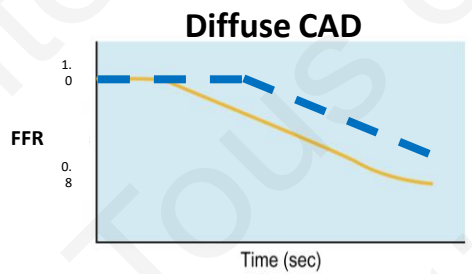
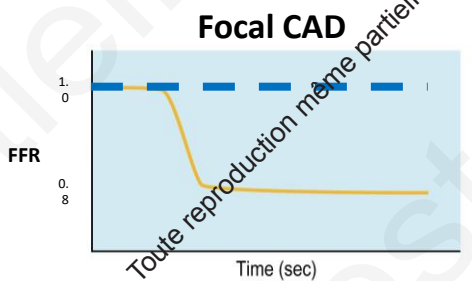
Post-PCI angiography



FFR Pullback Curve



CAD endotypes and PCI



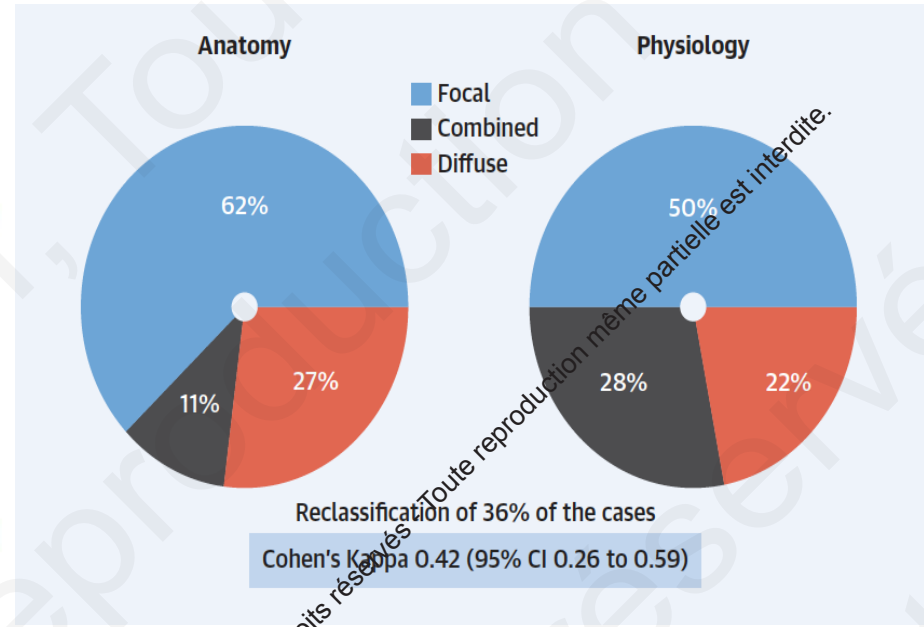
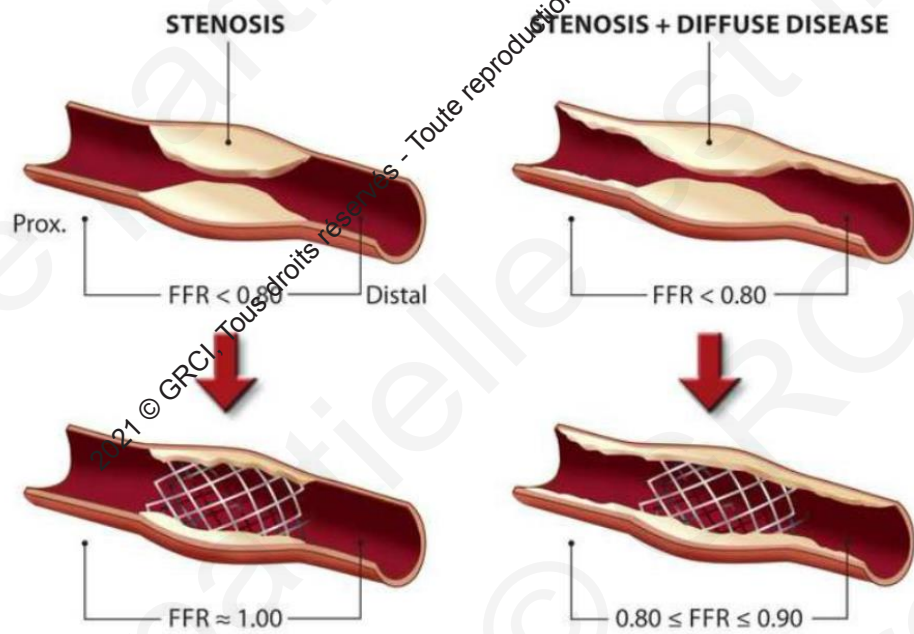
— Pre-PCI
- - Post-PCI



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Endotype targets are in the eye of the beholder



Collet et Sonck et al. JACC 2019

Motorized FFR Pullback

Received: 23 October 2019 | Revised: 12 December 2019 | Accepted: 6 January 2020
DOI: 10.1002/ccd.20733



ORIGINAL STUDIES

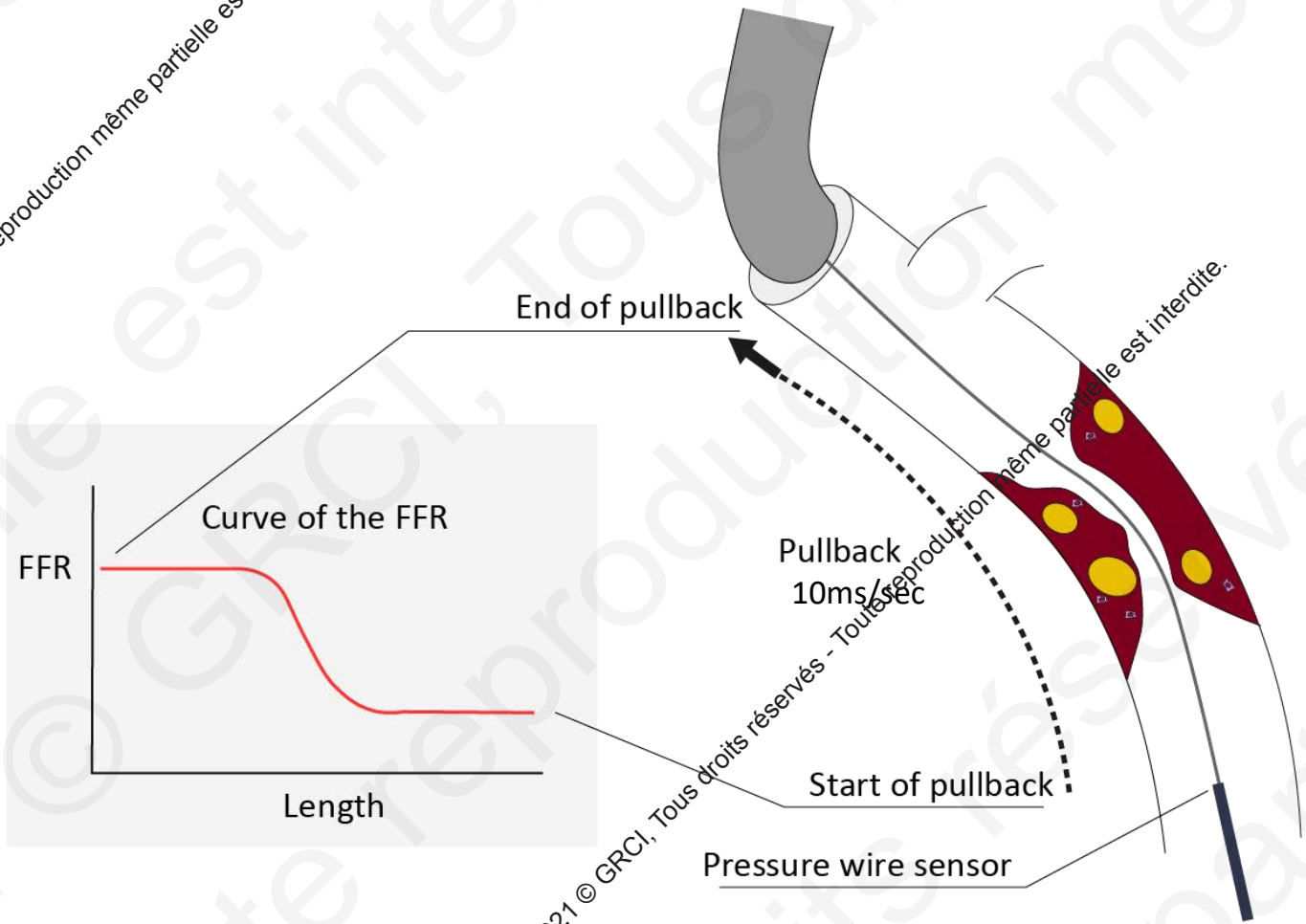
WILEY

Motorized fractional flow reserve pullback: Accuracy and reproducibility

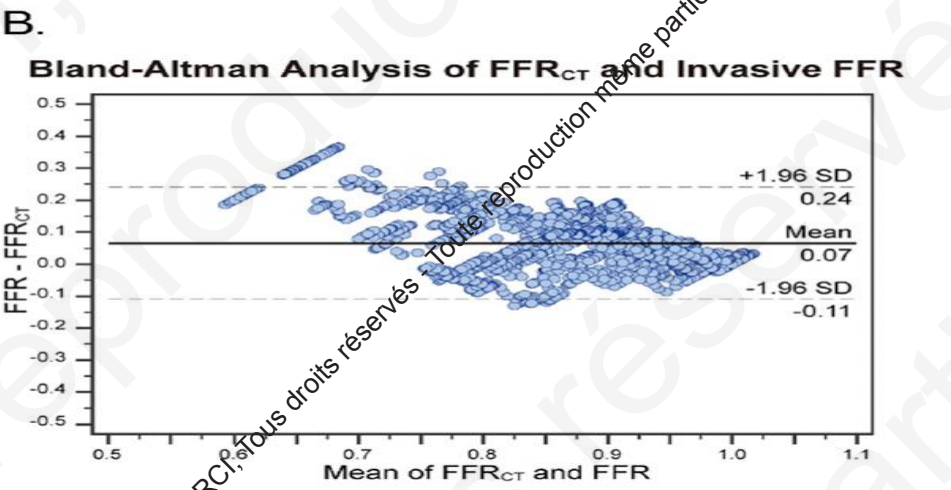
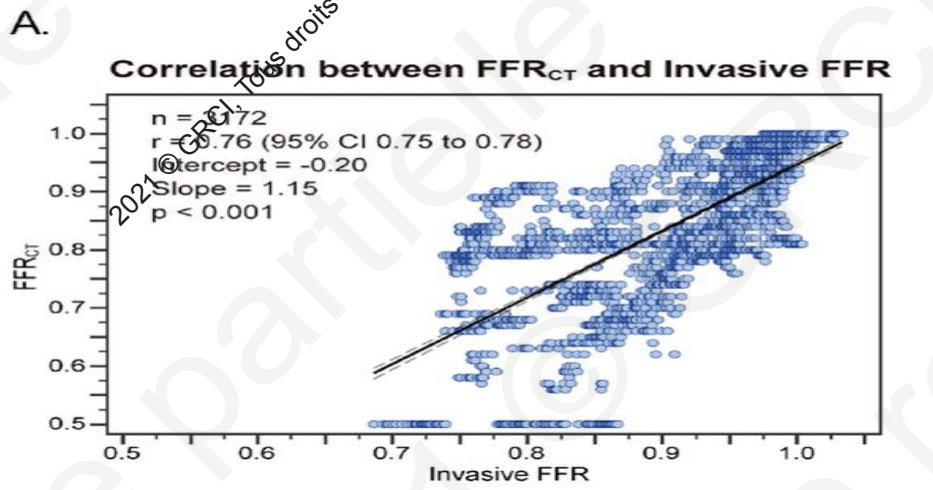
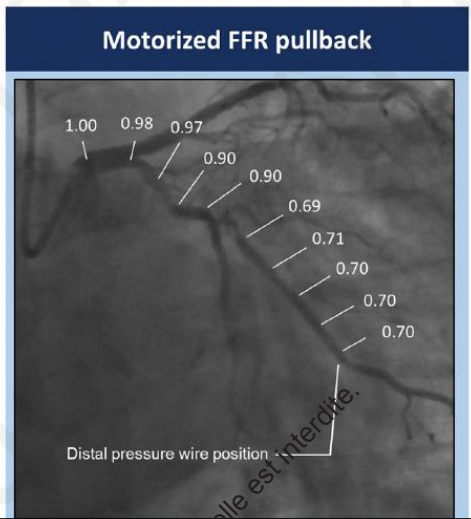
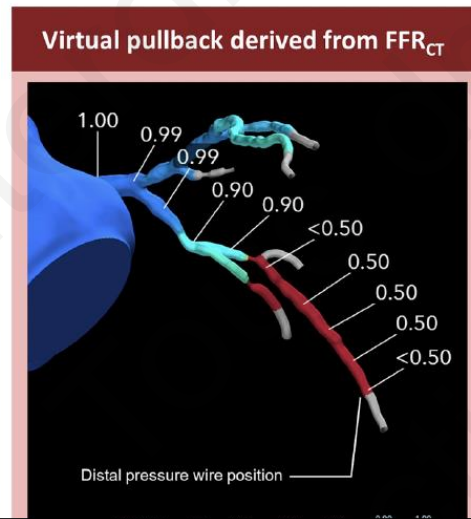
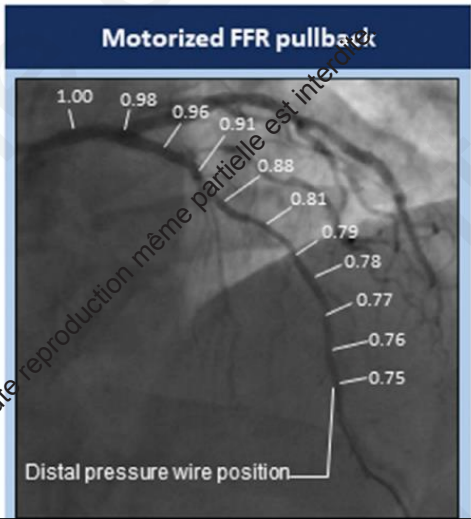
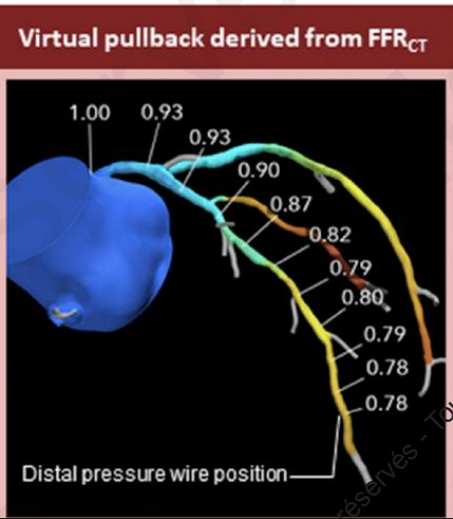
Jeroen Sonck MD^{1,2} | Carlos Collet MD, PhD^{1,3,4} | Takuya Mizukami MD, PhD^{1,3,4} | Bert Vandelooy MD⁵ | Jean F. Argacha MD, PhD⁶ | Emanuele Barbato MD, PhD^{1,2} | Daniele Andreini MD, PhD^{5,6} | Antonio Bartorelli MD, PhD^{5,7} | Bernard Cosyns MD, PhD⁸ | Bernard De Bruyne MD, PhD¹

Abstract
Objectives: The present study aimed at determining the accuracy and reproducibility of motorized FFR pullbacks in patients with stable coronary artery disease.
Background: Fractional flow reserve (FFR) is recommended for decision making regarding myocardial revascularization. The measurement of epicardial resistance along coronary vessels can be assessed using FFR pullbacks.
Methods: Duplicated FFR pullbacks were acquired using a motorized device at a speed of 1 mm/s in intermediate coronary stenosis. In addition, a single FFR value was measured at an anatomical landmark. The agreement between FFR measurements was assessed using the Bland-Altman method, Pearson's correlation coefficient and area under the receiver operating characteristic curve (AUROC).
Results: In 20 patients, 27,226 FFR values were obtained. The mean FFR from the pullbacks was 0.85 ± 0.08 whereas the mean FFR at the distal location was 0.85 ± 0.09. The mean difference between pullbacks was -0.002 (LOA -0.008 to 0.004). The difference in AUROC between the two FFR pullbacks was 2.1 ± 1.6%. At preselected anatomical locations, the mean difference between the FFR derived from pullback data and the measured FFR was 0 (LOA -0.040 to 0.039). The repeatability of the distal FFR measurement was high (Bland-Altman: LOA -0.046 to 0.041).
Conclusion: A motorized FFR pullback was accurate to assess the distribution of epicardial resistance in patients with intermediate coronary artery disease. The reproducibility of the FFR pullback was high. Further studies are required to determine the potential usefulness of a hyperemic FFR pullback strategy for decision making and treatment planning.

1 | INTRODUCTION
Functional assessment of coronary stenosis is recommended to decide the need for myocardial revascularization.¹ Fractional flow reserve (FFR) is advocated prior to revascularization in absence of a non-invasive functional test.¹ In patients with coronary artery disease, use of FFR significantly reduced the rate of death and myocardial infarction compared to

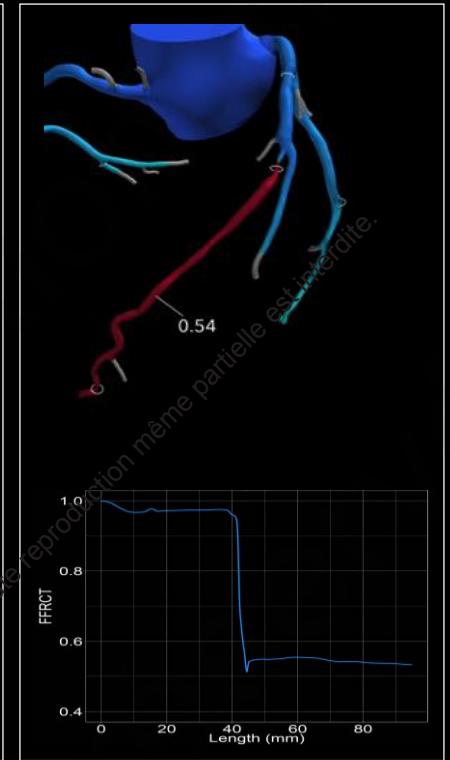
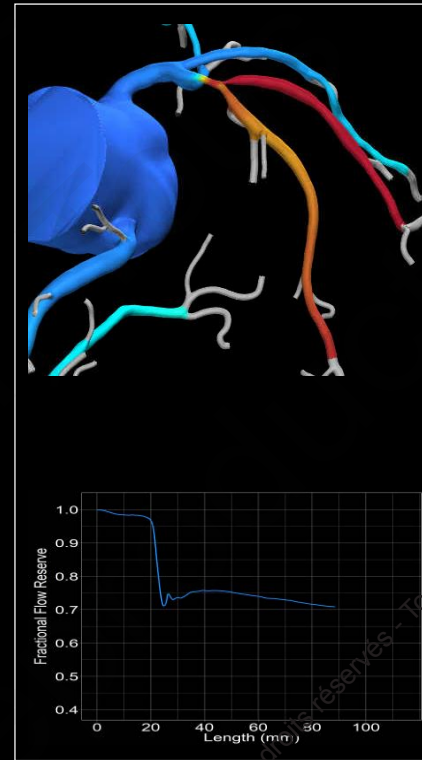
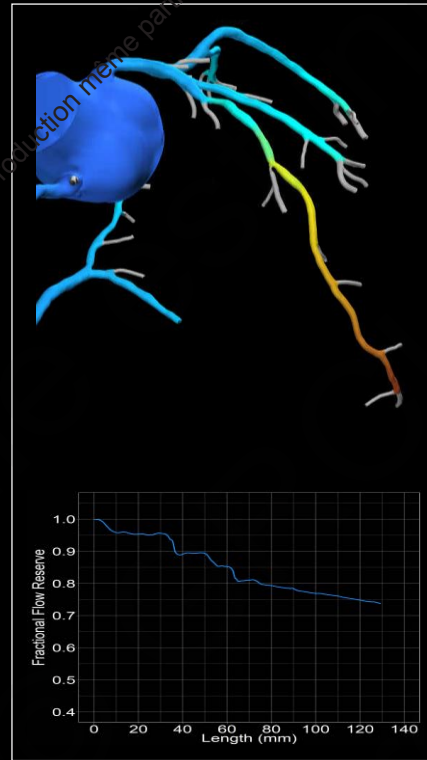
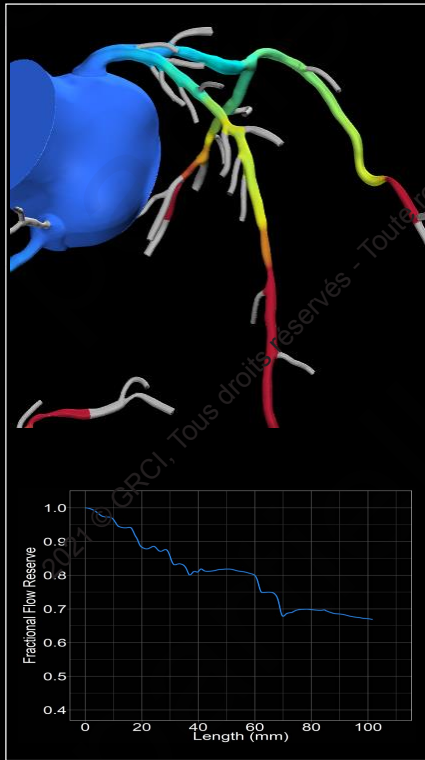


Sonck J et al CCI 2019



Mizukami T et al. JCT 2020

FFR_{CT} Functional CAD Endotypes



Diffuse CAD

Focal CAD

0



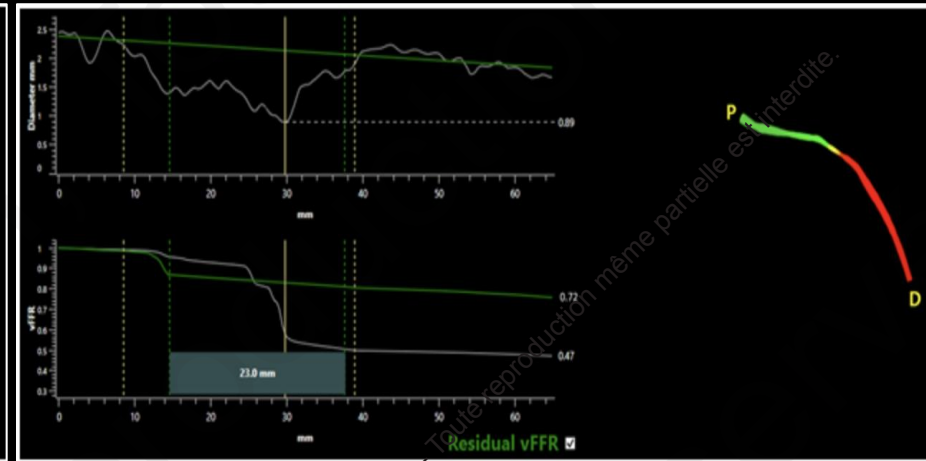
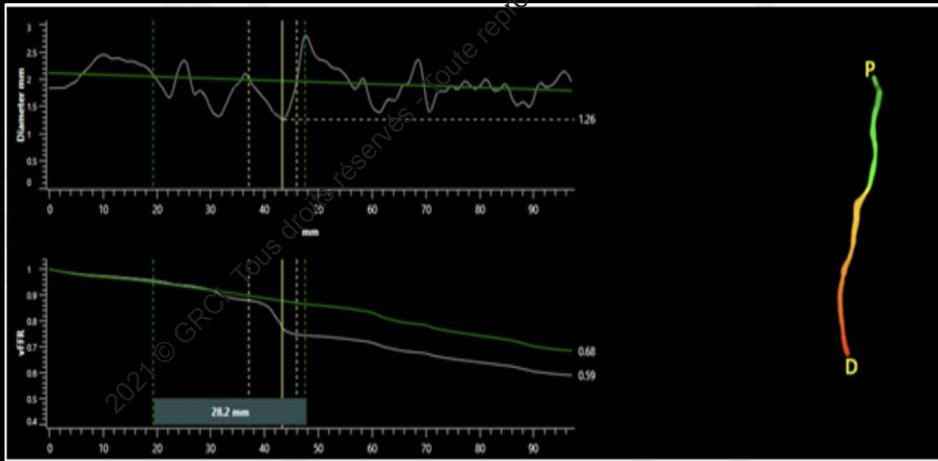
PPG



1.0

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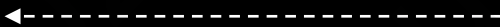
Angio-FFR Functional CAD Endotypes



Diffuse CAD

Focal CAD

0



PPG



1.0

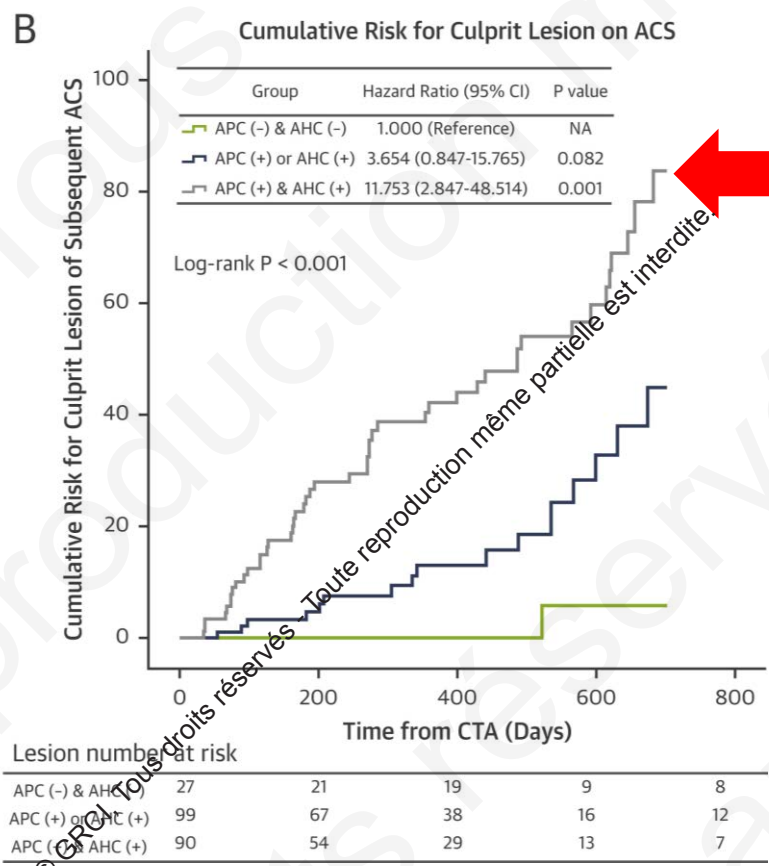
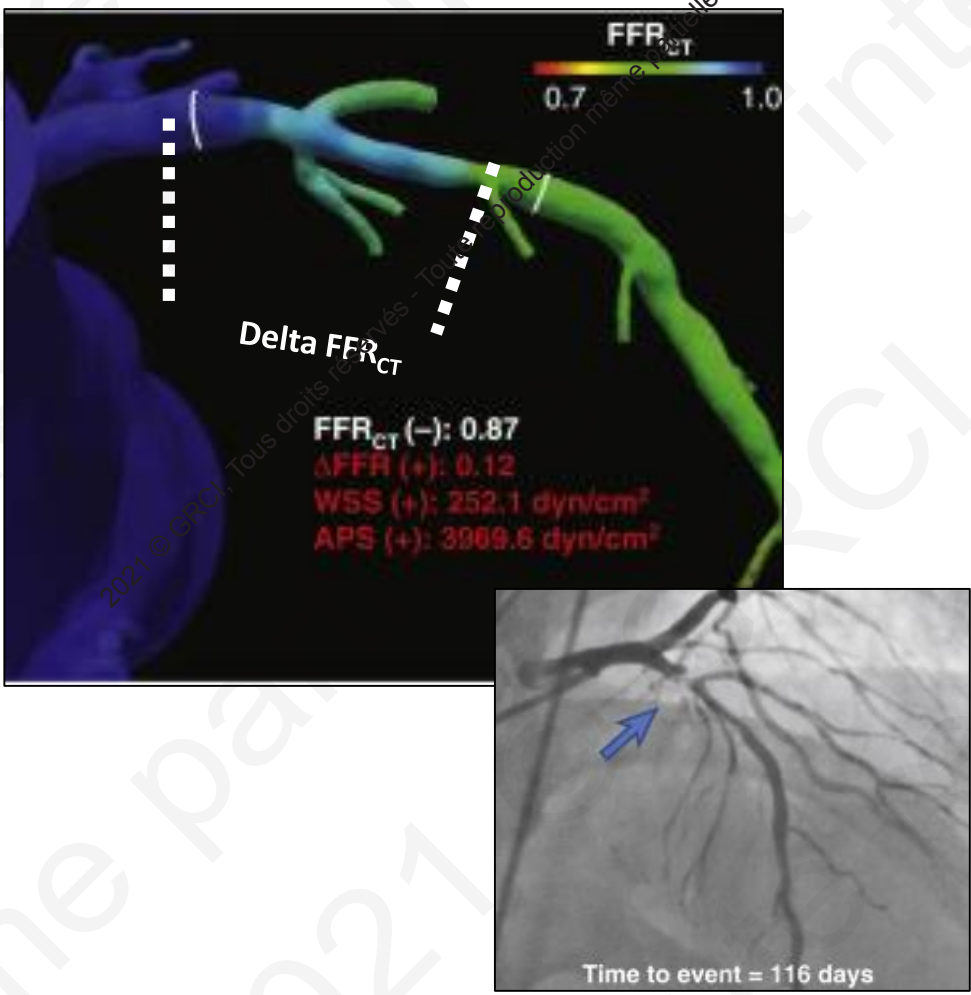
CAD endotypes and outcomes



Plaque Progression and Rupture

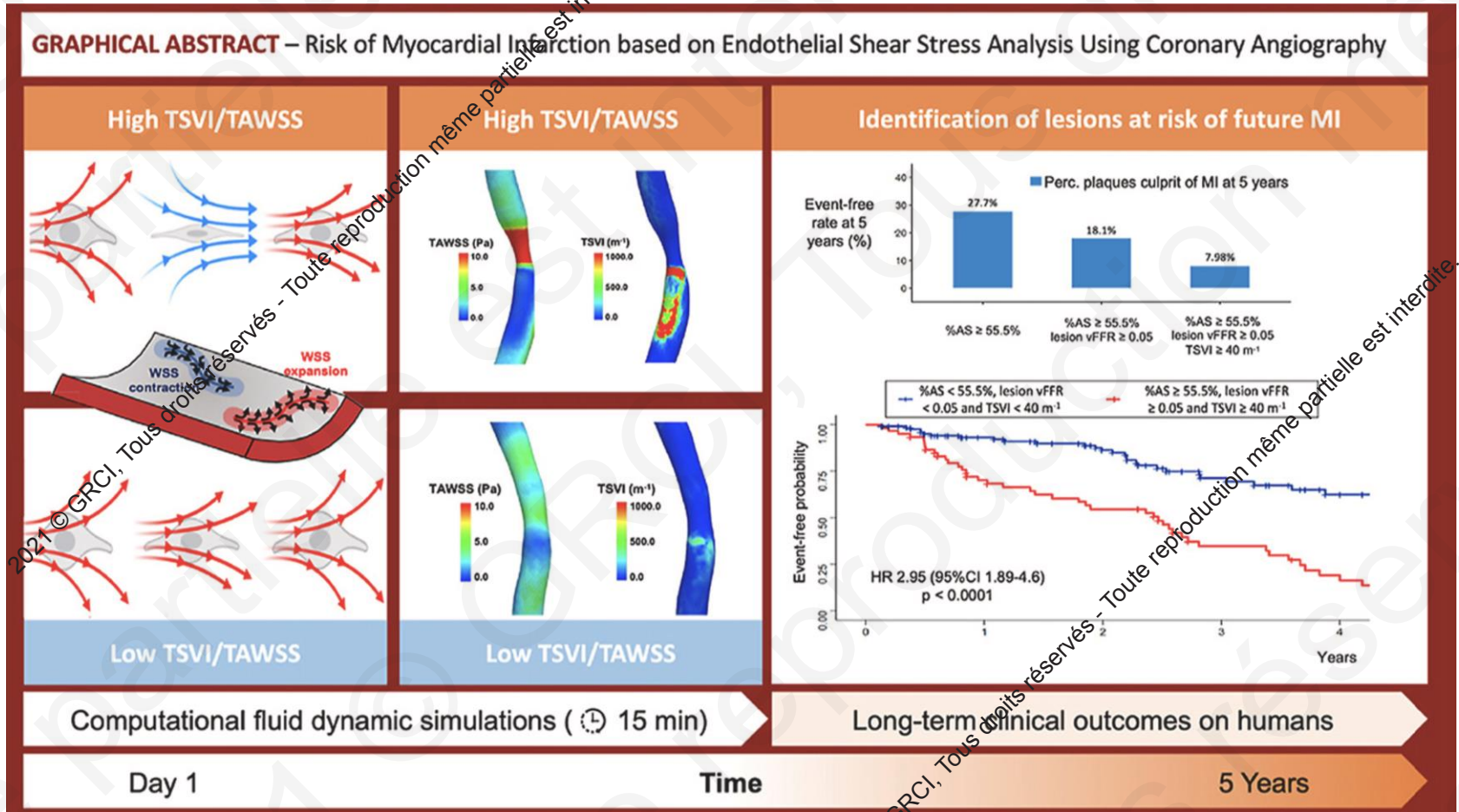
Physical forces >> *Material strength*
(hemodynamics) *(histopathology)*

CAD endotypes and outcomes



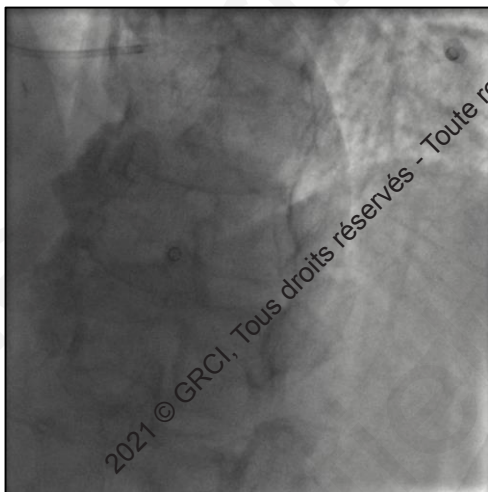
Lee JM et al. JACC Cardiovasc Imaging. 2019

vFFR and the prediction of events



Candrea et al. Atherosclerosis 2021

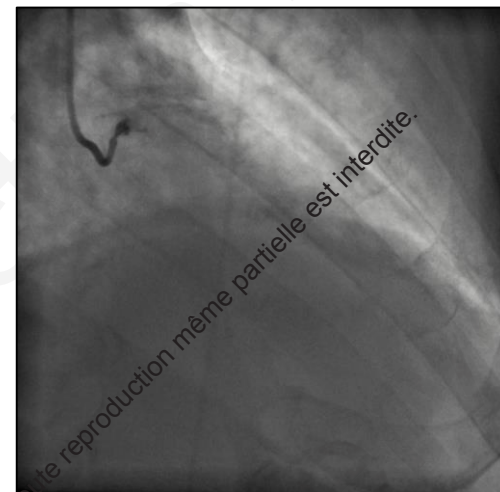
The Future: Complete functional revascularization?



Focal CAD

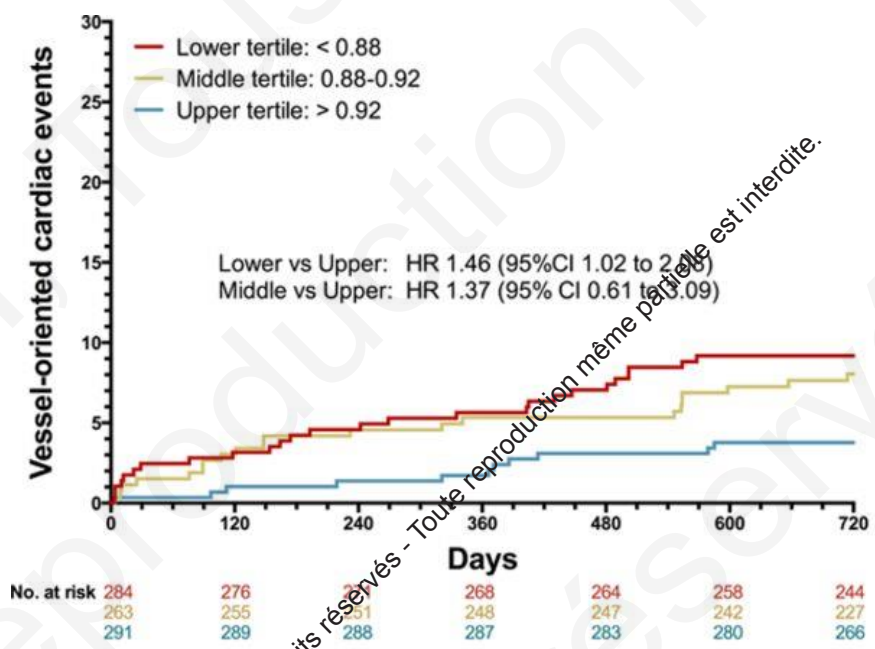
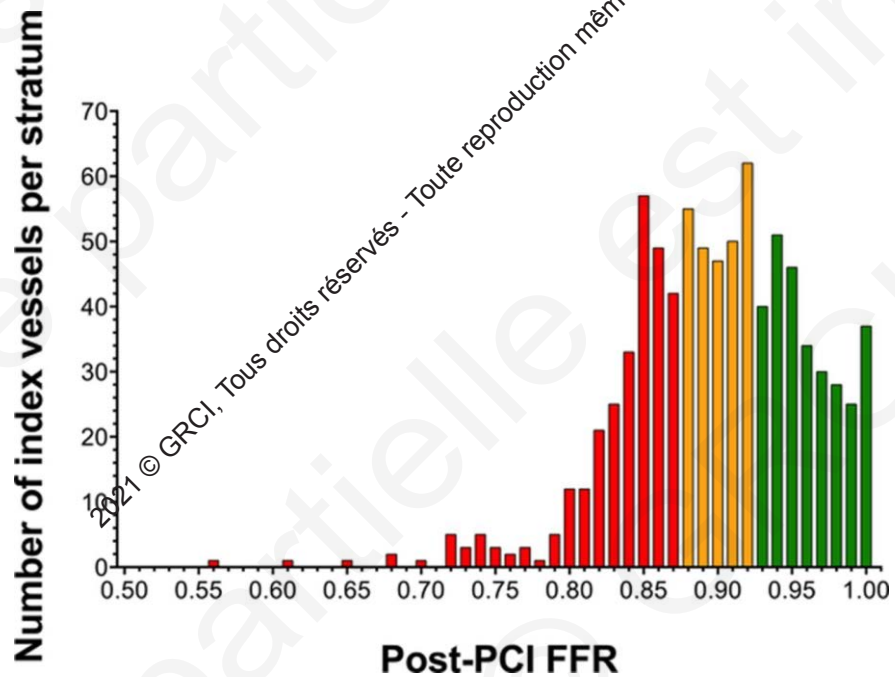


Diffuse CAD



Goal = **Complete** “functional” myocardial revascularization and improve outcome

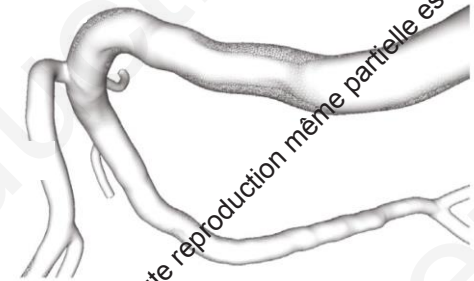
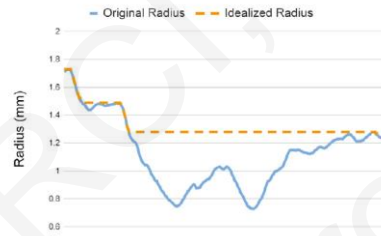
Post-PCI FFR and Clinical Outcomes



Proth et al. Circ Cardiovasc Interv. 2017

HeartFlow Planner

- Predicts FFR in response to changes to a patient-specific lumen geometry in real time.
- From a patient specific model a dilation of the original model from its local radius to the target ideal radius



- Lumen geometry influences the flowrate through the model.

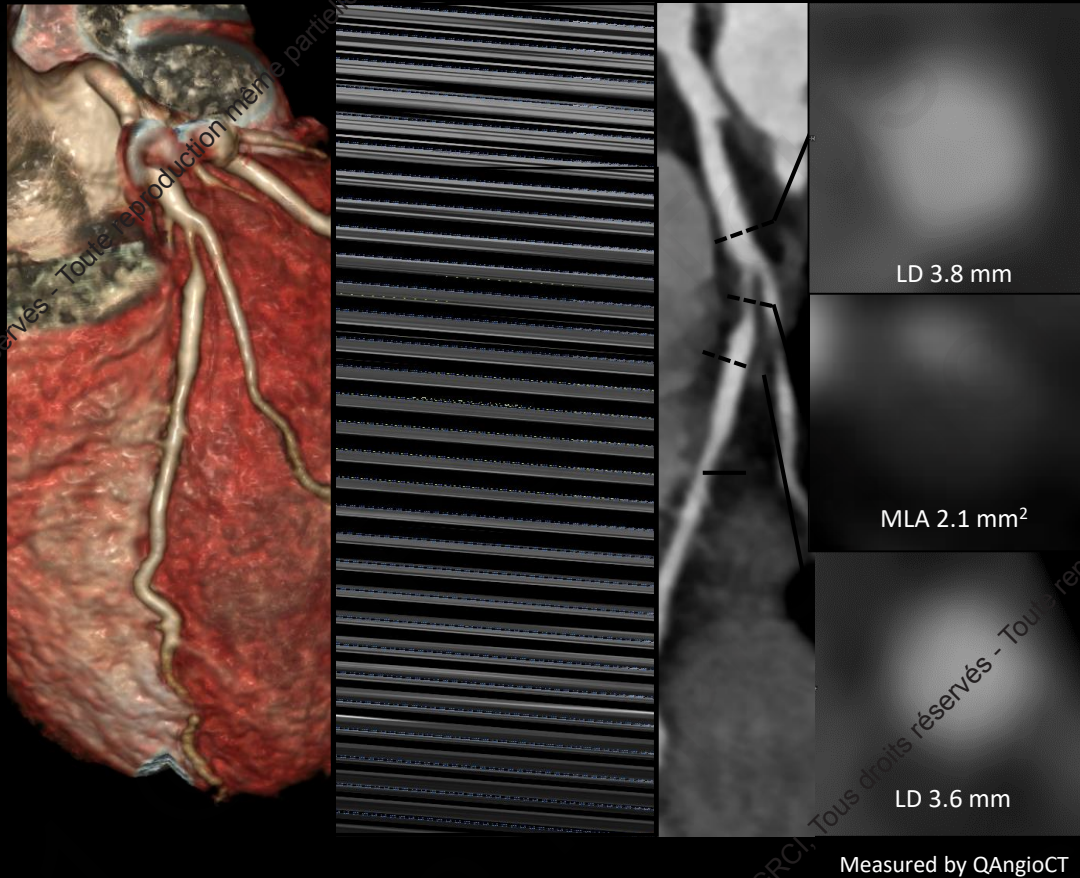
Sankaran et al. Comput. Methods Appl. Mech. Eng. 2020

Planning PCI in patients with Functional Focal CAD

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Planning PCI in Focal CAD

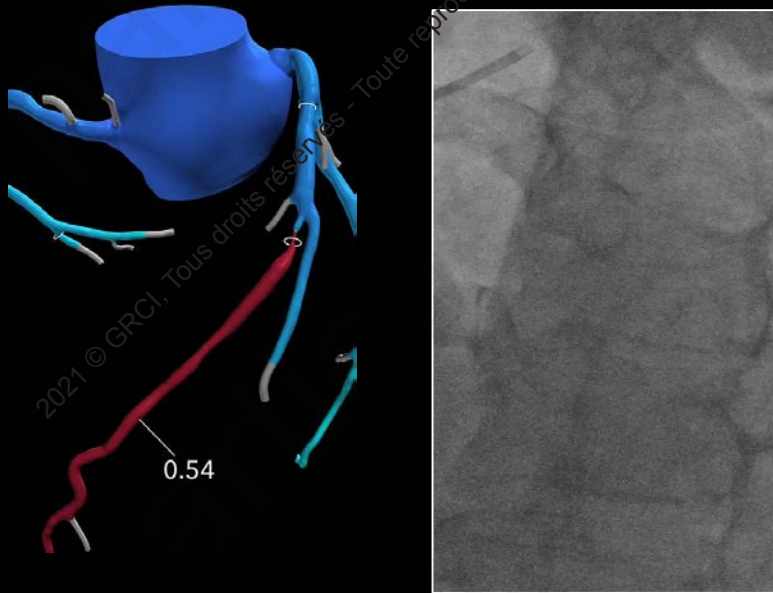


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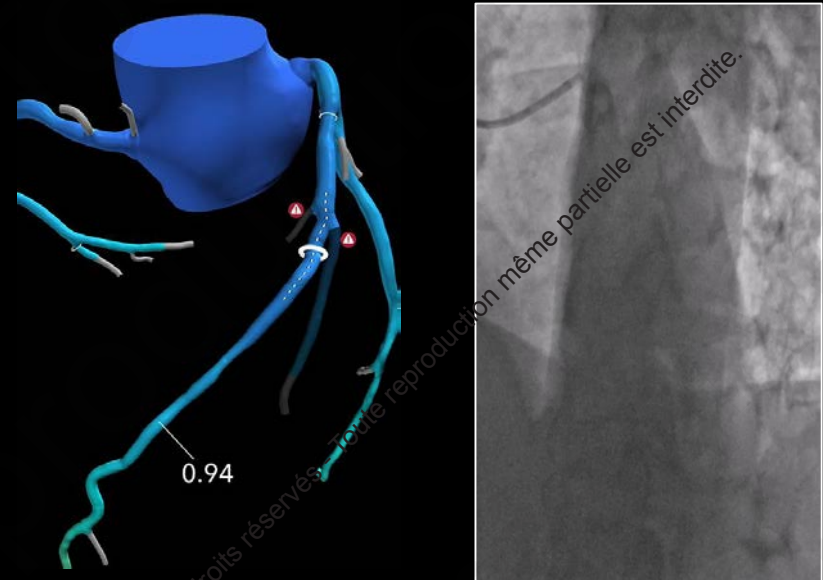
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Planning PCI in Focal CAD

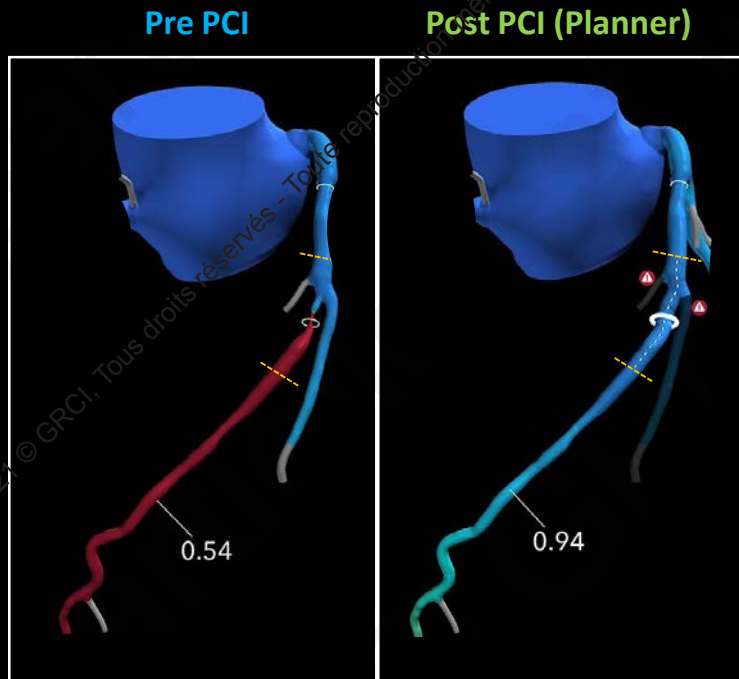
Pre PCI



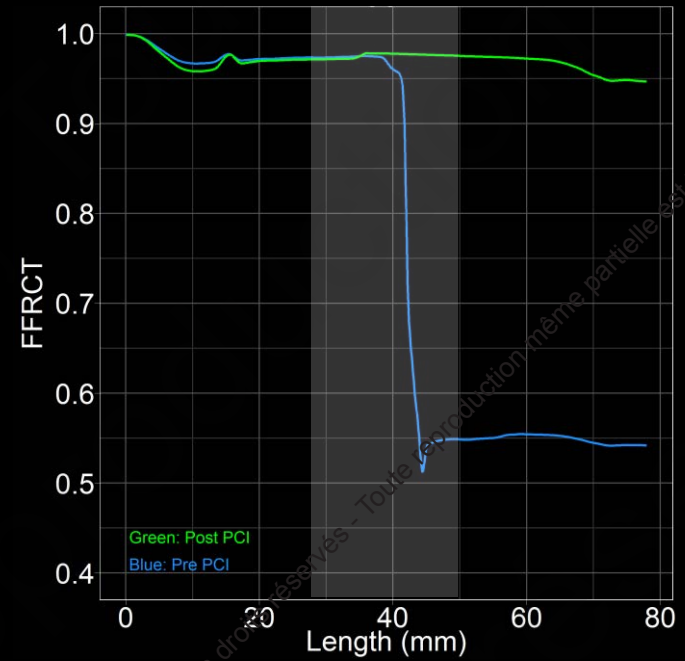
Post PCI



FFR_{CT} pullbacks pre and post PCI

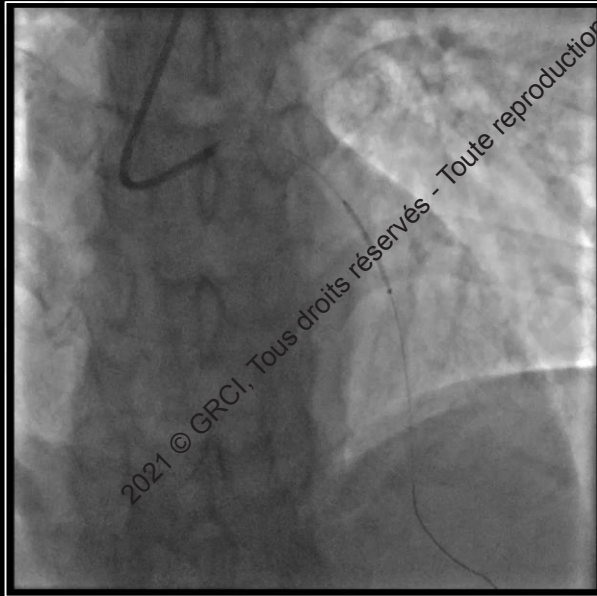


Dash line: edge of stent



Shaded area: stent position

PCI in focal CAD



Stent Position



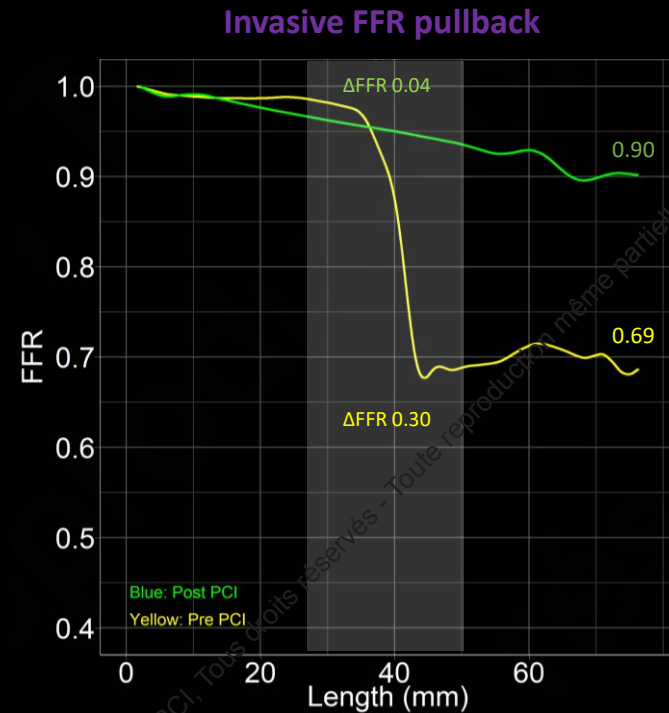
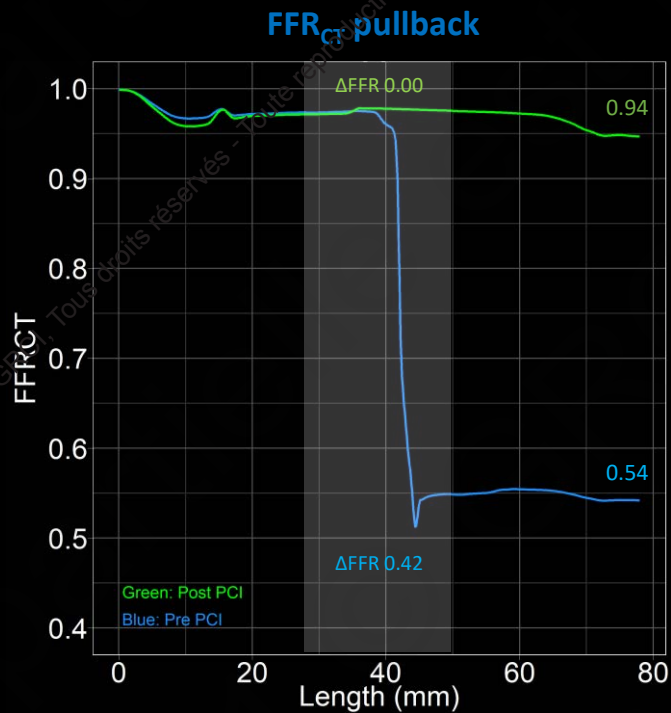
Xience 3.5 x 23mm

Post-dilatation 4.0 x 12 mm



Post PCI

Comparison between FFR_{CT} and invasive FFR pullback pre and post PCI



*Shaded area corresponds to the stented segment

Planning PCI in patients with Functional Diffuse CAD

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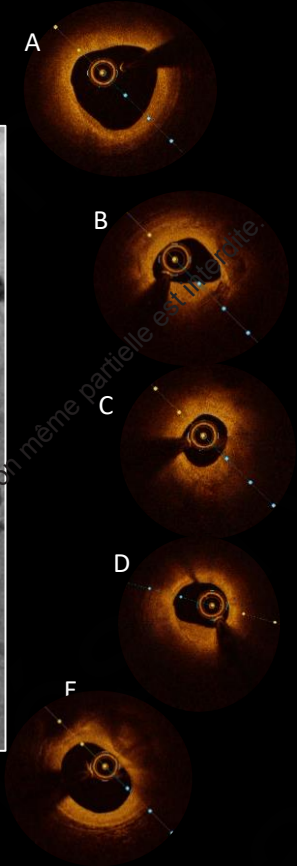
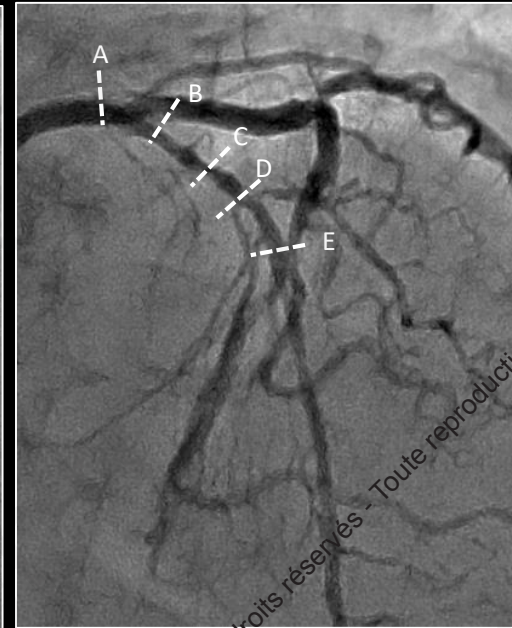
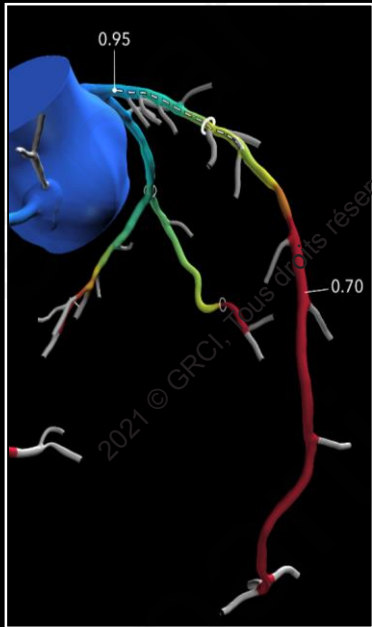
Planning PCI in diffuse CAD



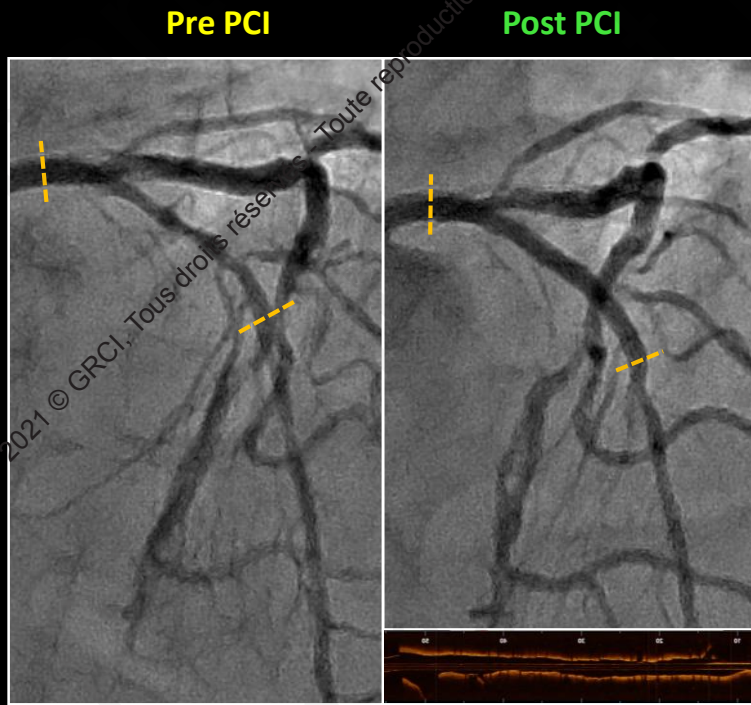
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Planning PCI in Diffuse CAD

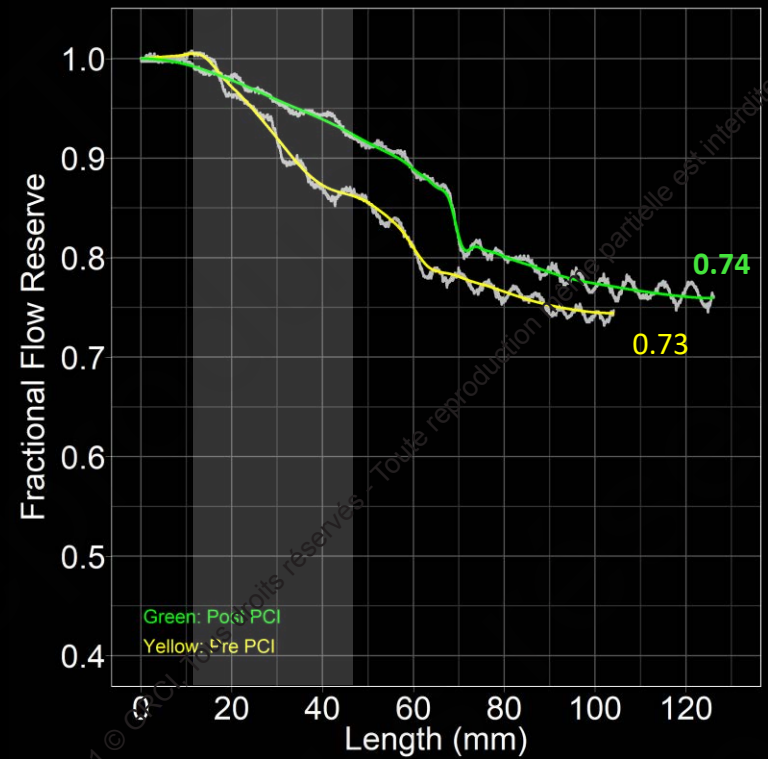
Pre PCI



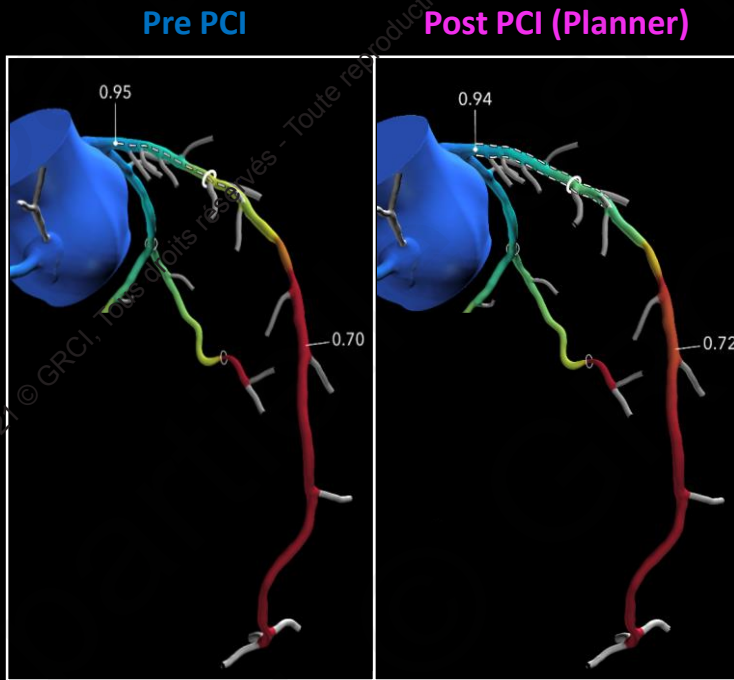
Comparison between invasive FFR pullback **pre** and **post** PCI



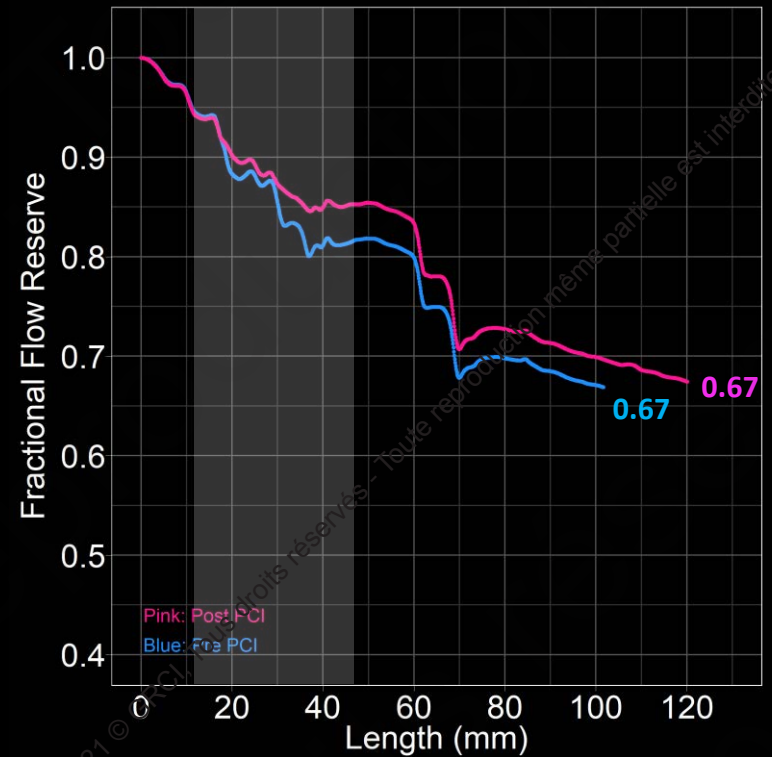
Dash line: edge of stent



Comparison between FFR_{CT} pullbacks pre and post PCI



Dash line: stented segment



*Shaded area: stent position in FFR_{CT} model

Trial design

Inclusion Criteria

Patients with one lesion $FFR \leq 0.80$
Clinical indication for PCI

Procedure

FFR- and OCT-guided PCI
FFR with motorized pullbacks

Primary endpoint

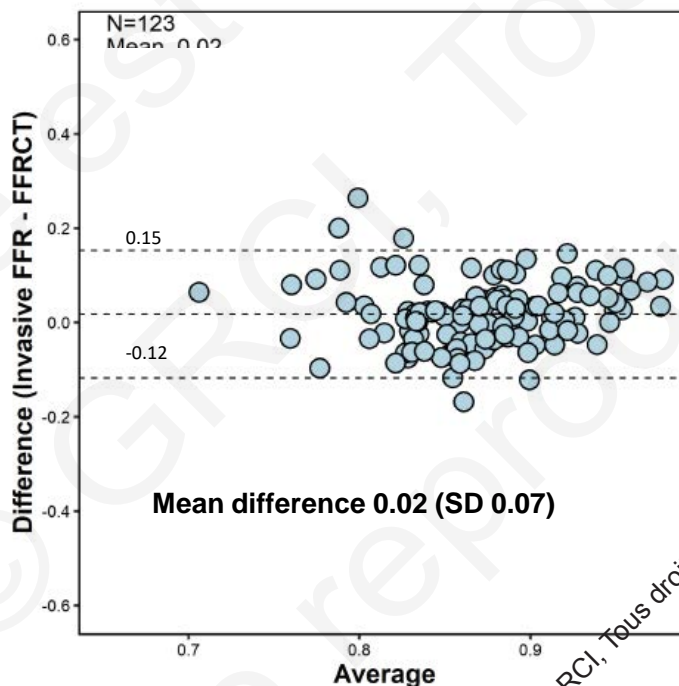
Agreement on post PCI FFR between the FFR_{CT} planner and invasive FFR

Organization

Investigator initiated study
CRO: Genae
Core Laboratory: CoreAalst, Belgium
 FFR_{CT} HeartFlow Inc

PI: Jeroen Sonck, MD
Chairman: Bernard De Bruyne MD, PhD
80% of the patients recruited

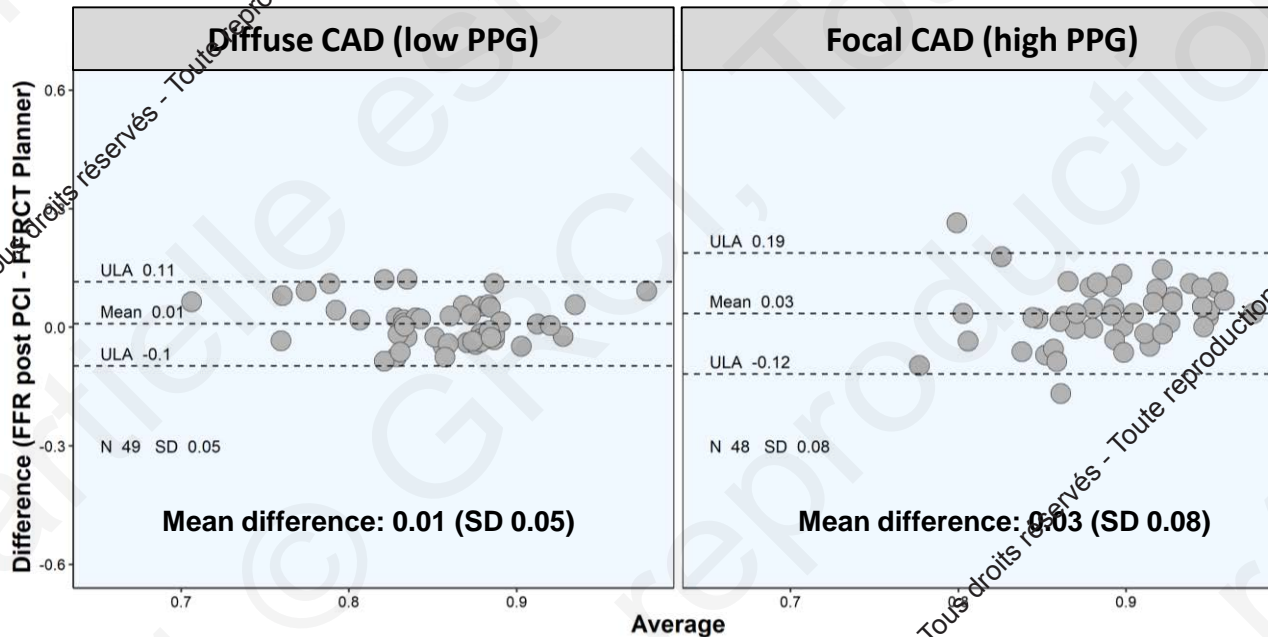
Agreement on post-PCI FFR between invasive FFR and FFR_{CT} Planner



| Variables | Invasive FFR | FFR _{CT} |
|--------------------------|--------------|-------------------|
| Post-PCI FFR (mean (SD)) | 0.88 (0.06) | 0.86 (0.06) |

Diffuse vs. Focal CAD (PPG cut-off 0.66)

P-value = 0.057



Mean difference on post PCI FFR between FFR_{CT} Planner and invasive FFR Post PCI

Application of the FFR_{CT} Planner

Patients with suspected and confirmed CAD



Consultation

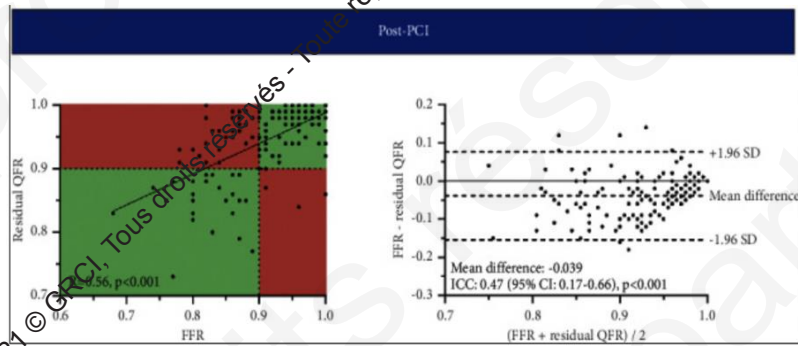
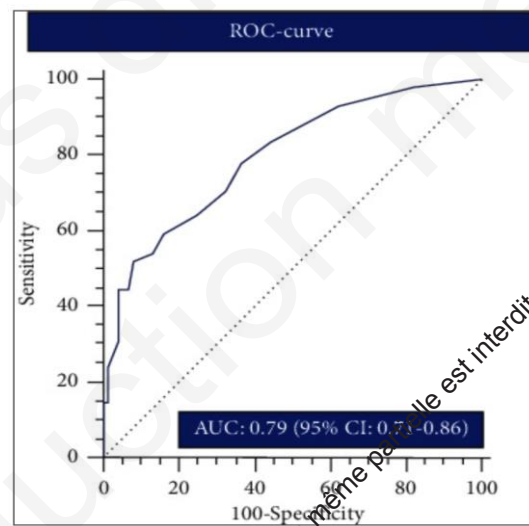
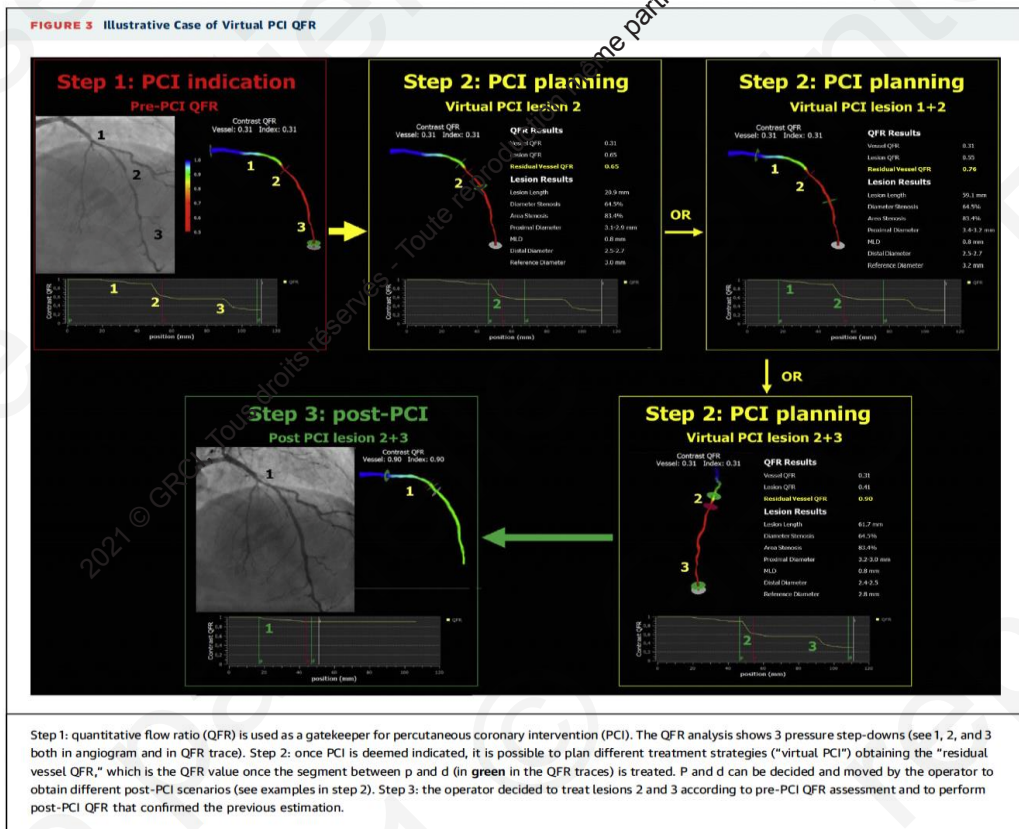
Cath-lab

Ascertain of lesion significance
Patient selection for PCI

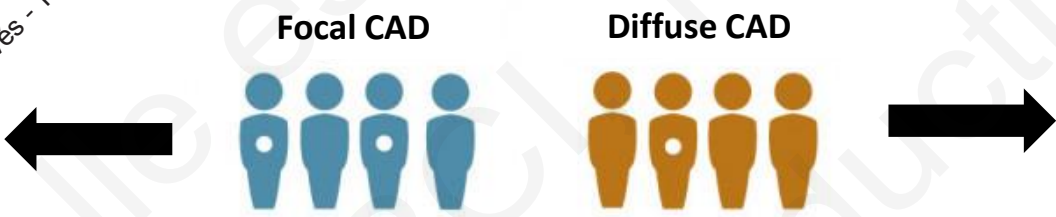
Cath lab logistics

PCI Guidance
Serial lesions
Functional normal to normal

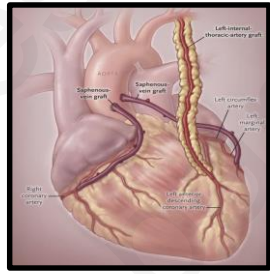
Virtual PCI QFR



Personalized epicardial approach based on FFR_{CT} or angio-derived FFR



Appropriate to perform PCI? FFR_{CT} or angio- $FFR < .8$
Ascertain the CAD endotype! Focal?
Predict functional outcome of PCI! FFR post PCI?
Predict clinical outcomes? WSS and $TSVI$



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Conclusions

- **FFR_{CT} and angiography-derived FFR** have evolved from a diagnostic test to a tool for patient selection, CAD endotype evaluation and decision on the appropriateness of PCI
- **FFR_{CT} Planner and Angiography-derived virtual PCI tools** are accurate, can aid in achieving complete functional revascularization and can guide your PCI
- **Non-invasive coronary physiology has the potential to improve clinical outcomes in patient with CAD**

The Future Is Now!

Merci de votre attention

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