

FFR_{CT} et planification de procédure interventionnelle

Le cath-lab du futur frappe à votre porte

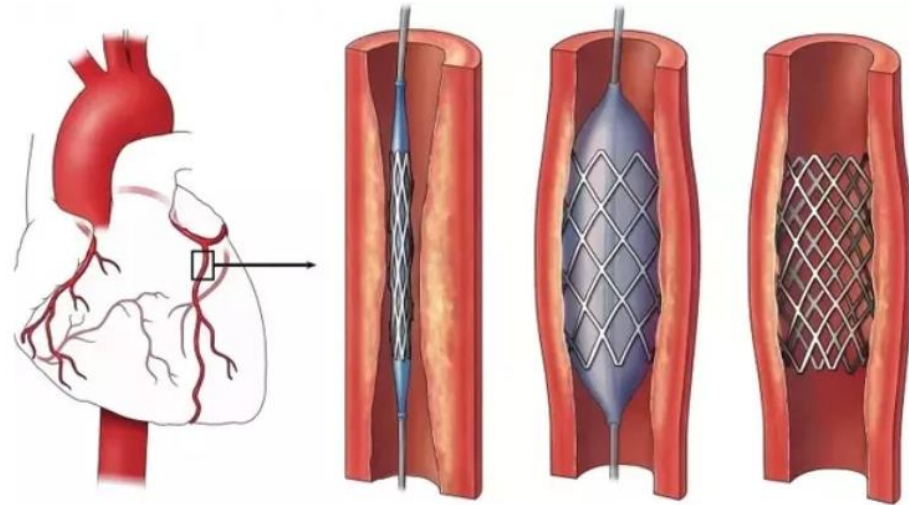
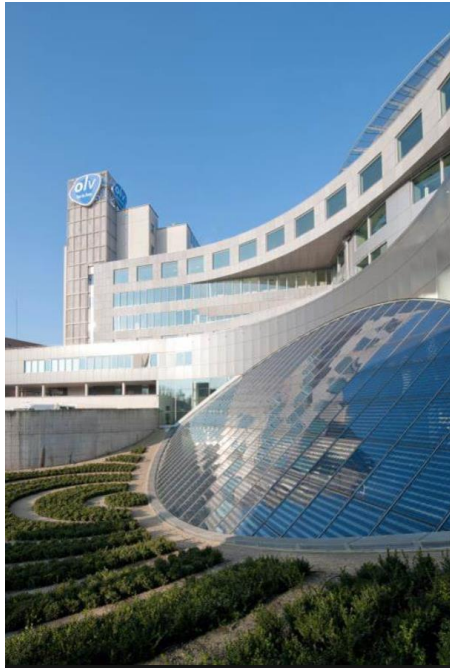
Jeroen Sonck, MD

Cardiovascular Center, OLV Clinic Aalst
Belgium

DÉCLARATION DE LIENS D'INTÉRÊT AVEC LA PRÉSENTATION

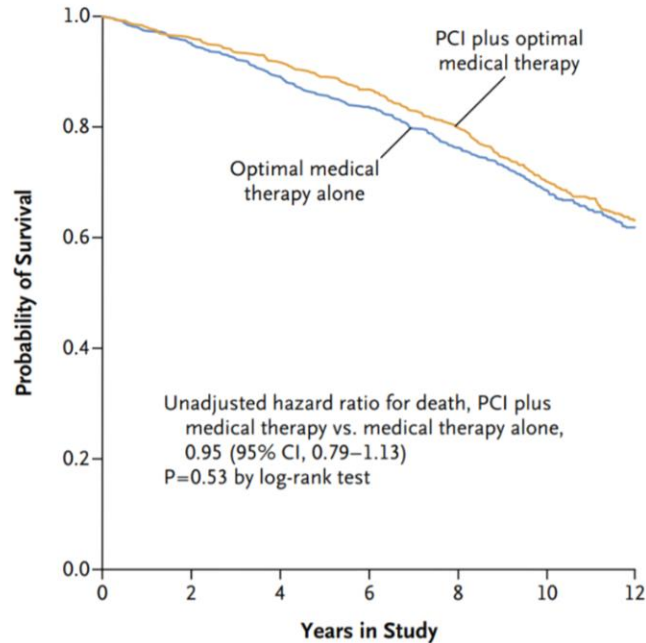
Intervenant : Jeroen SONCK, Aalst

Je n'ai pas de lien d'intérêt à déclarer



Cardiovascular
Center
Aalst

B Extended Follow-up Study Cohort

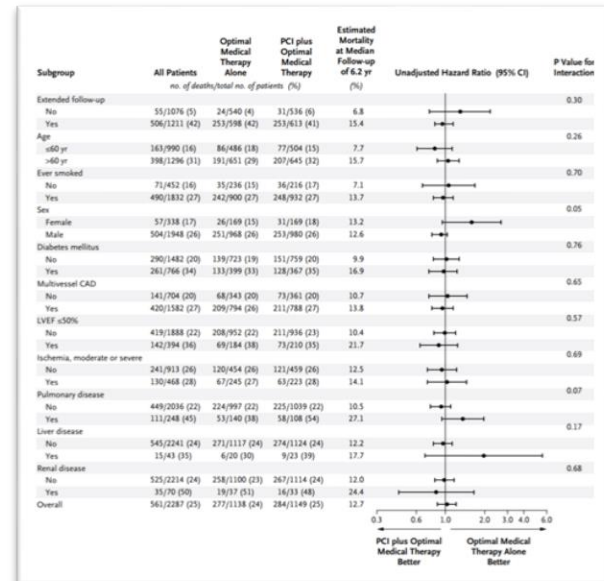


No. at Risk	0	2	4	6	8	10	12
Optimal medical therapy	598	569	533	500	455	403	280
PCI plus optimal medical therapy	613	589	561	529	486	416	302

ORIGINAL ARTICLE

Effect of PCI on Long-Term Survival in Patients with Stable Ischemic Heart Disease

Steven P. Sedlis, M.D., Pamela M. Hartigan, Ph.D., Koon K. Teo, M.B., B.Ch., Ph.D., David J. Maron, M.D., John A. Spertus, M.D., M.P.H., G.B. John Mancini, M.D., William Kostuk, M.D., Bernard R. Chaitman, M.D., Daniel Berman, M.D., Jeffrey D. Lorin, M.D., Marcin Dada, M.D., William S. Weintraub, M.D., and William E. Boden, M.D., for the COURAGE Trial Investigators*



FAME

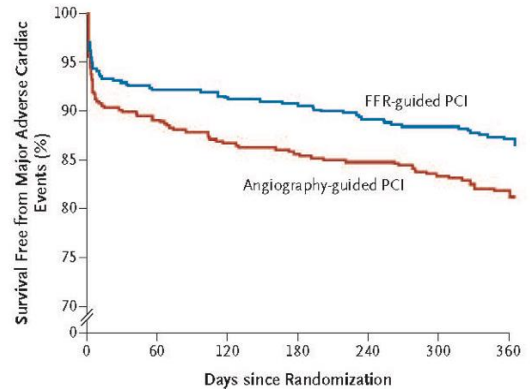
Defer PCI for lesions with FFR > 0.8

The NEW ENGLAND JOURNAL of MEDICINE
ESTABLISHED IN 1812 JANUARY 15, 2009 VOL. 360 NO. 3

Fractional Flow Reserve versus Angiography for Guiding Percutaneous Coronary Intervention

CONCLUSIONS
Routine measurement of FFR in patients with multivessel coronary artery disease who are undergoing PCI with drug-eluting stents significantly reduces the rate of the composite end point of death, nonfatal myocardial infarction, and repeat revascularization at 1 year. (ClinicalTrials.gov number, NCT00267774.)

Tonino et al. NEJM 2009, 360: 213



The NEW ENGLAND JOURNAL of MEDICINE

FAME-2

Perform PCI for lesions with FFR ≤ 0.8

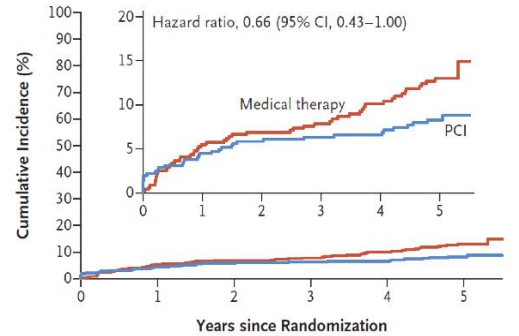
ORIGINAL ARTICLE

Five-Year Outcomes with PCI Guided by Fractional Flow Reserve

CONCLUSIONS
In patients with stable coronary artery disease, an initial FFR-guided PCI strategy was associated with a significantly lower rate of the primary composite end point of death, myocardial infarction, or urgent revascularization at 5 years than medical therapy alone. Patients without hemodynamically significant stenoses had a favorable long-term outcome with medical therapy alone. (Funded by St. Jude Medical and others; FAME 2 ClinicalTrials.gov number, NCT01132495.)

Xaplanteris et al. NEJM 2018

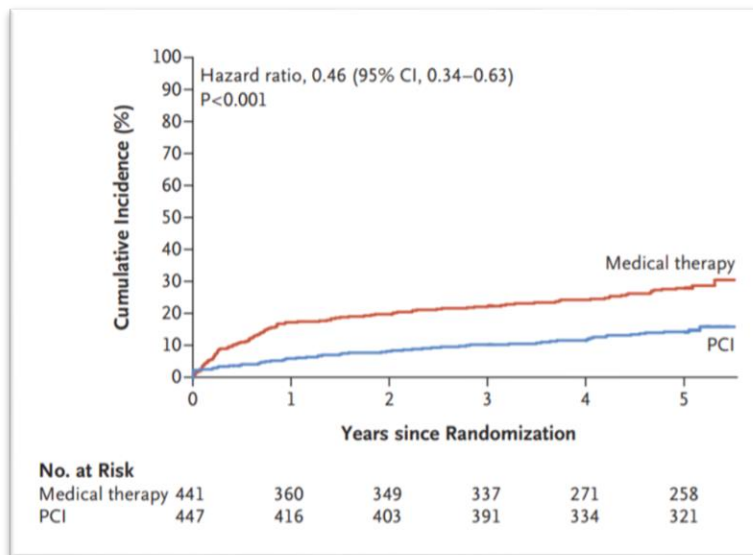
B Myocardial Infarction



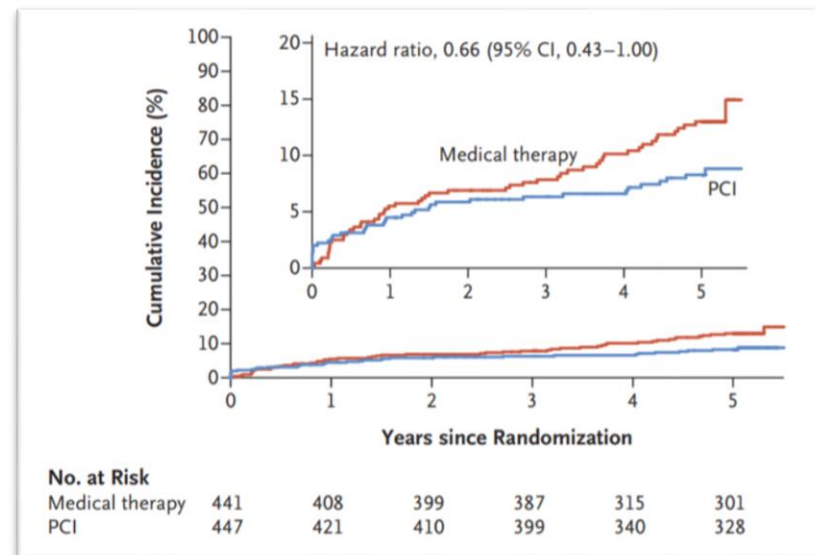
No. at Risk	441	408	399	387	315	301
Medical therapy	441	408	399	387	315	301
PCI	447	421	410	399	340	328

Patient selection using *physiology* at the *vessel level* is associated with improved clinical outcomes.

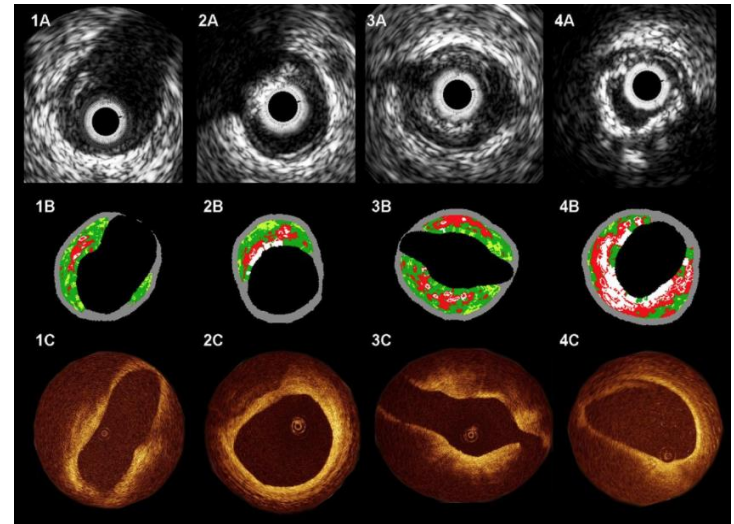
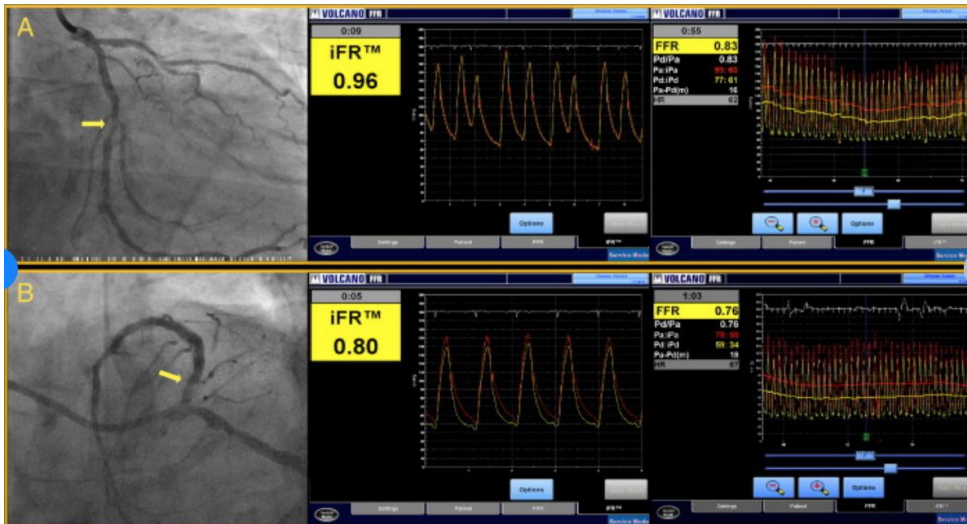
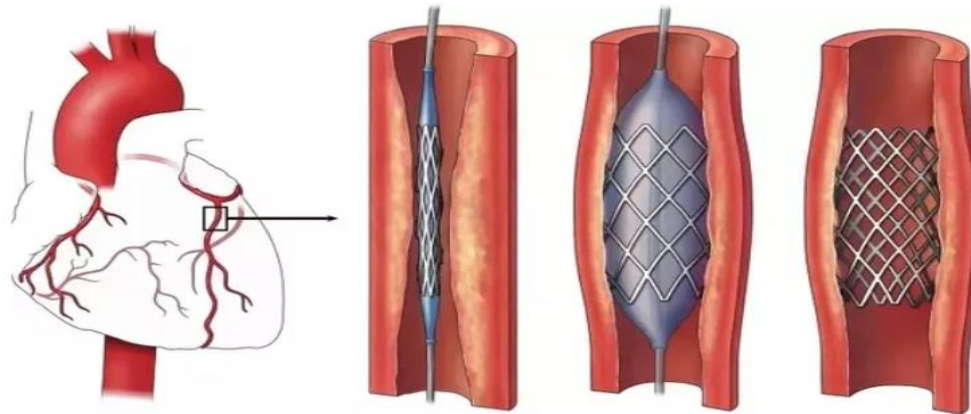
MACE



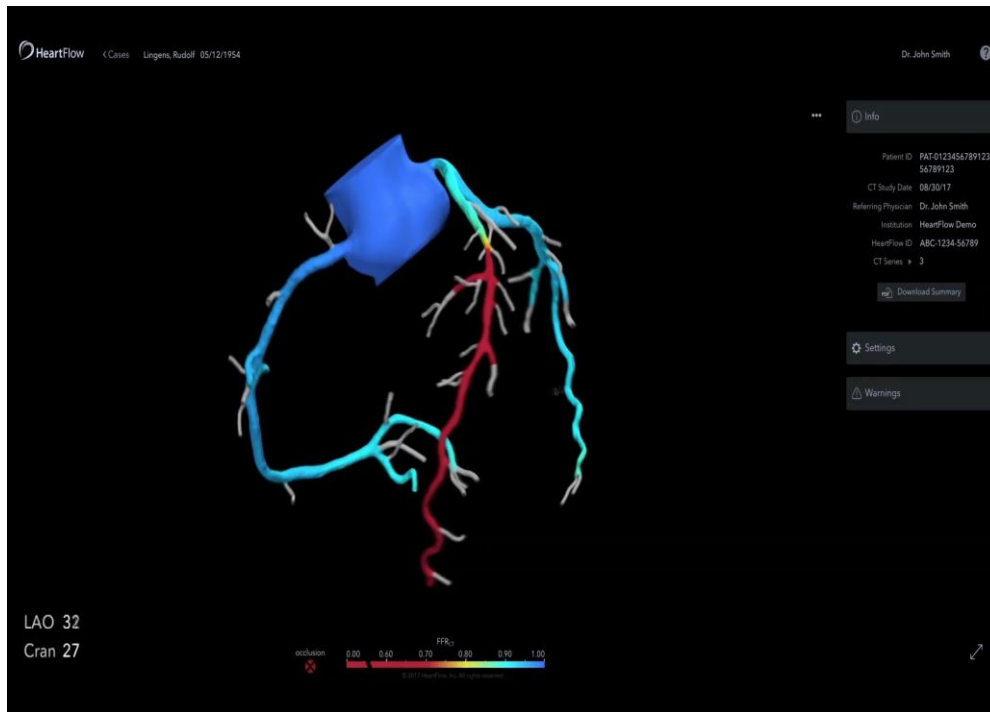
Myocardial infarction



Xaplanteris P et al. NEJM 2018

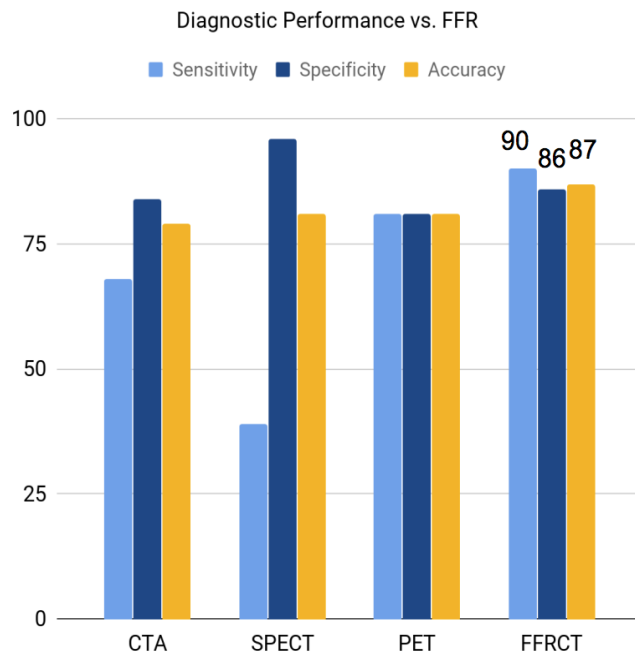


The incremental value of CT-derived FFR on top of CCTA

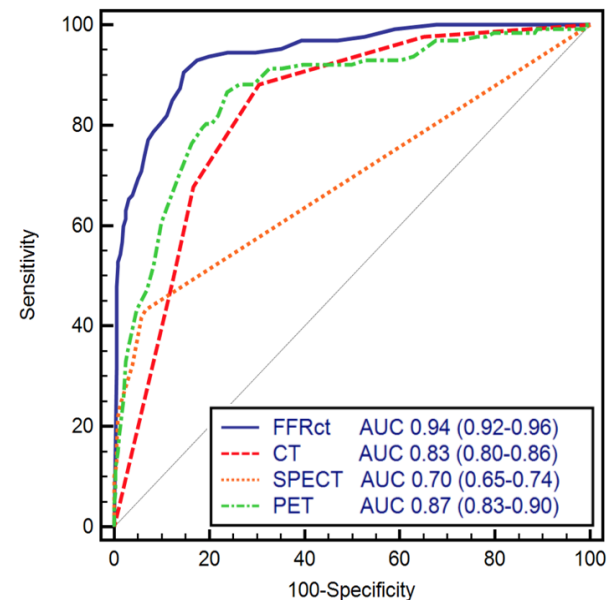


- 1/ Optimize patient selection for the lab
 - Vessel and lesion-specific physiology
 - Pre-lab MVD classification
- 2/ Plaque assessment \propto IVUS/OCT
- 3/ Plan the percutaneous approach

Diagnostic performance of FFR_{CT}: PACIFIC trial



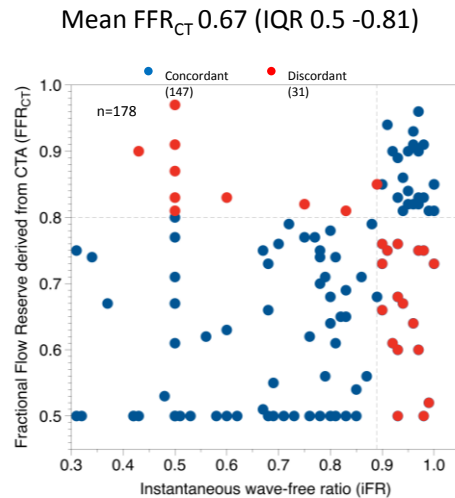
Presented Euro PCR 2018, Driessen RS et al.



Highest discrimination of ischaemia causing lesions for FFR_{CT} compared to:

- CT stenosis: Δ AUC 0.11, $p < 0.001$
- SPECT: Δ AUC 0.24, $p < 0.001$
- PET: Δ AUC 0.07, $p < 0.001$

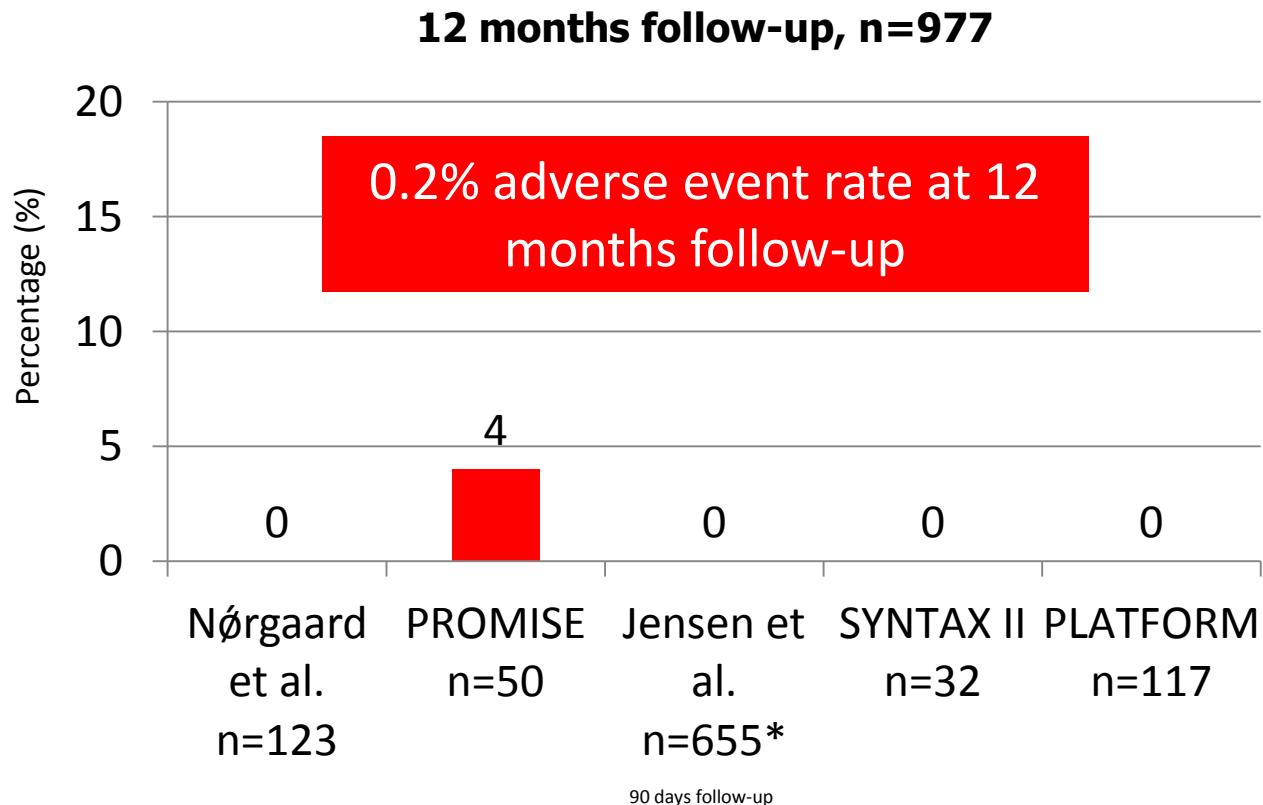
SYNTAX II sub-study: Performance of FFR_{CT} in patients with multivessel disease



Sensitivity 95% (95% CI: 89% to 98%); **specificity 61%** (95% CI: 48% to 73%);
positive predictive value 81% (95% CI: 76% to 86%) and **negative predictive value 87%** (95% CI: 74% to 94%).

Collet, Sonck and Serruys, JACC 2018

Major Adverse Cardiac Events in patients with deferred lesions based on FFR_{CT}



Jensen et al. EHJCI. 2017

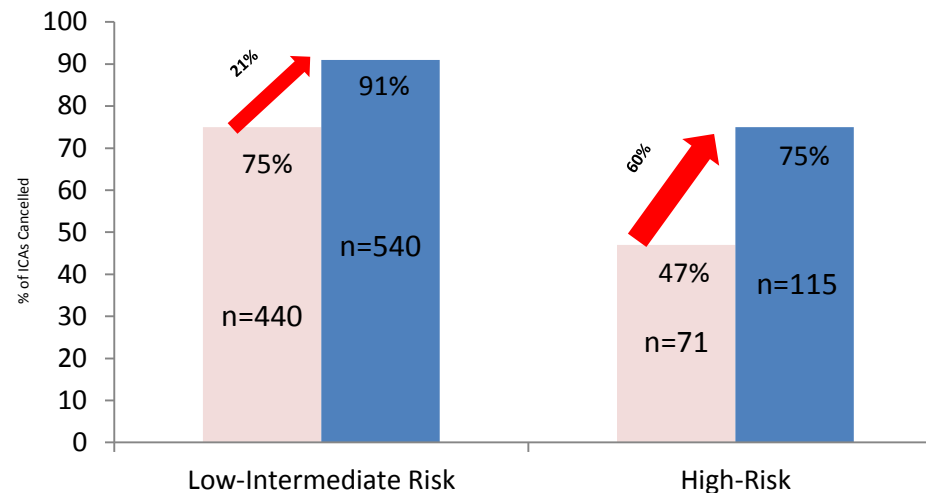
Lu, M. e.a. TCT 2015

PLATFORM. JACC 2016

Collet et al. JACC 2018

Norgaard et al. JACC Imag. 2017

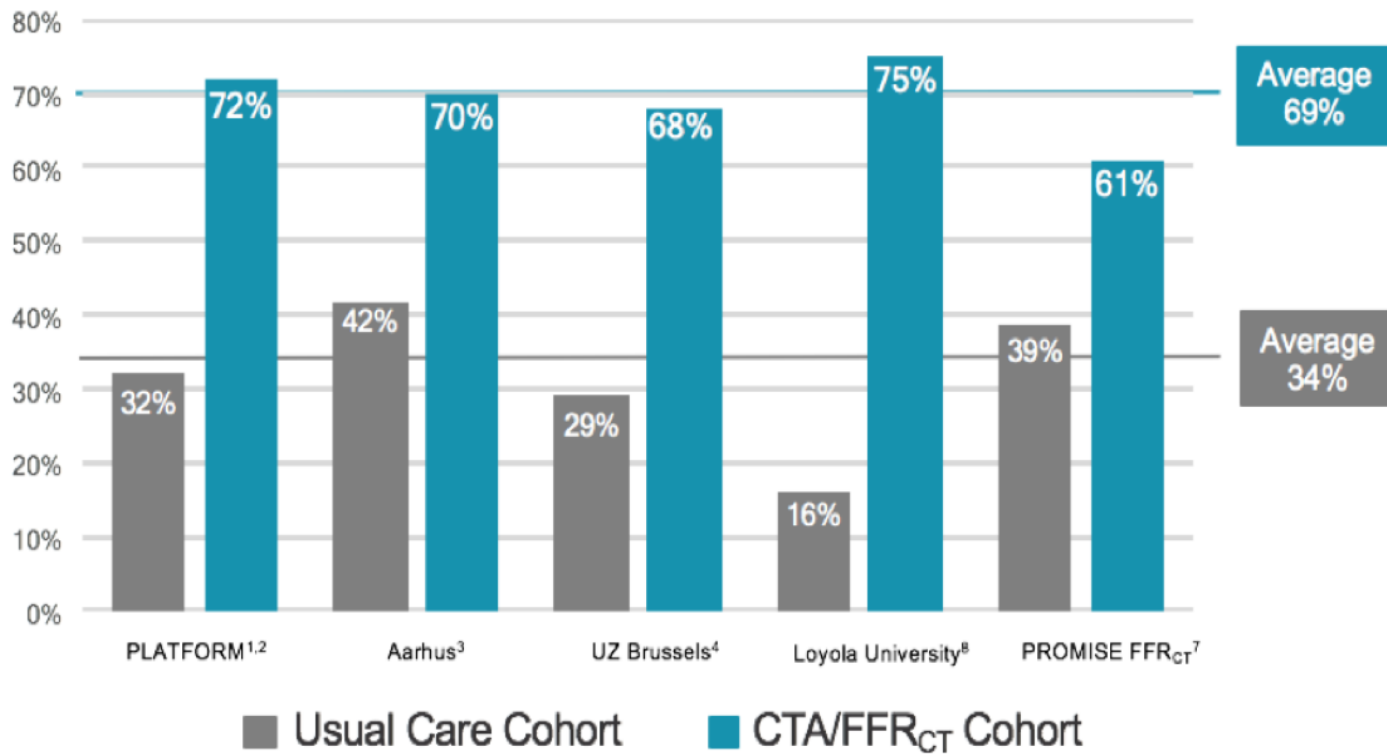
Combined cCTA and FFR_{CT}: ICA cancellations in high-risk patients



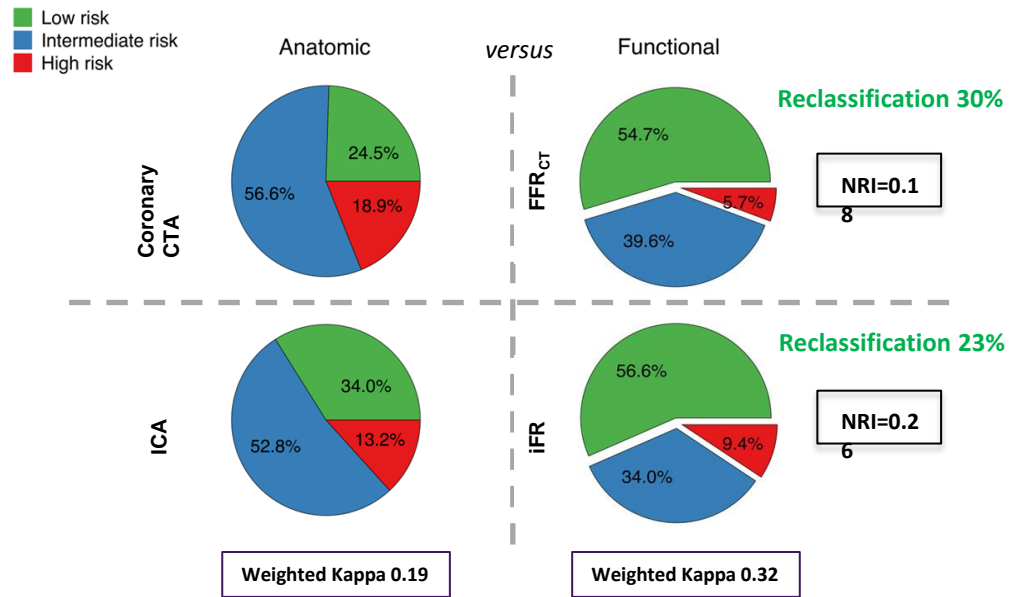
- A frontline cCTA and FFR_{CT} testing strategy cancelled 75% of ICAs in the high-risk group
- The incremental impact of FFR_{CT} was greater in high-risk as compared with the low-intermediate risk group
 - 60% in high-risk versus 21% in low-intermediate risk

Jensen et al, European Heart Journal – Cardiovascular Imaging 2017

Ratio of cath/PCI: Cath-lab efficiency

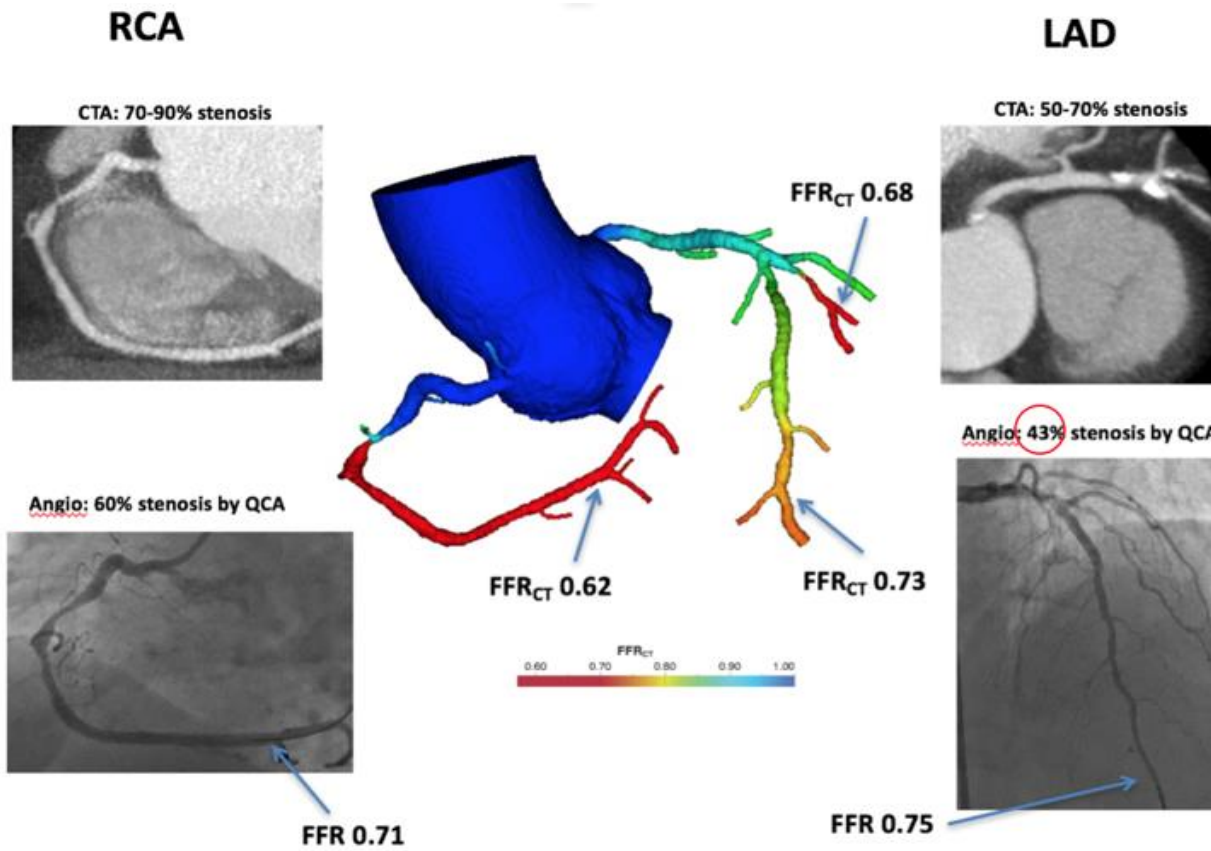


Reclassification of the SYNTAX-score tertiles



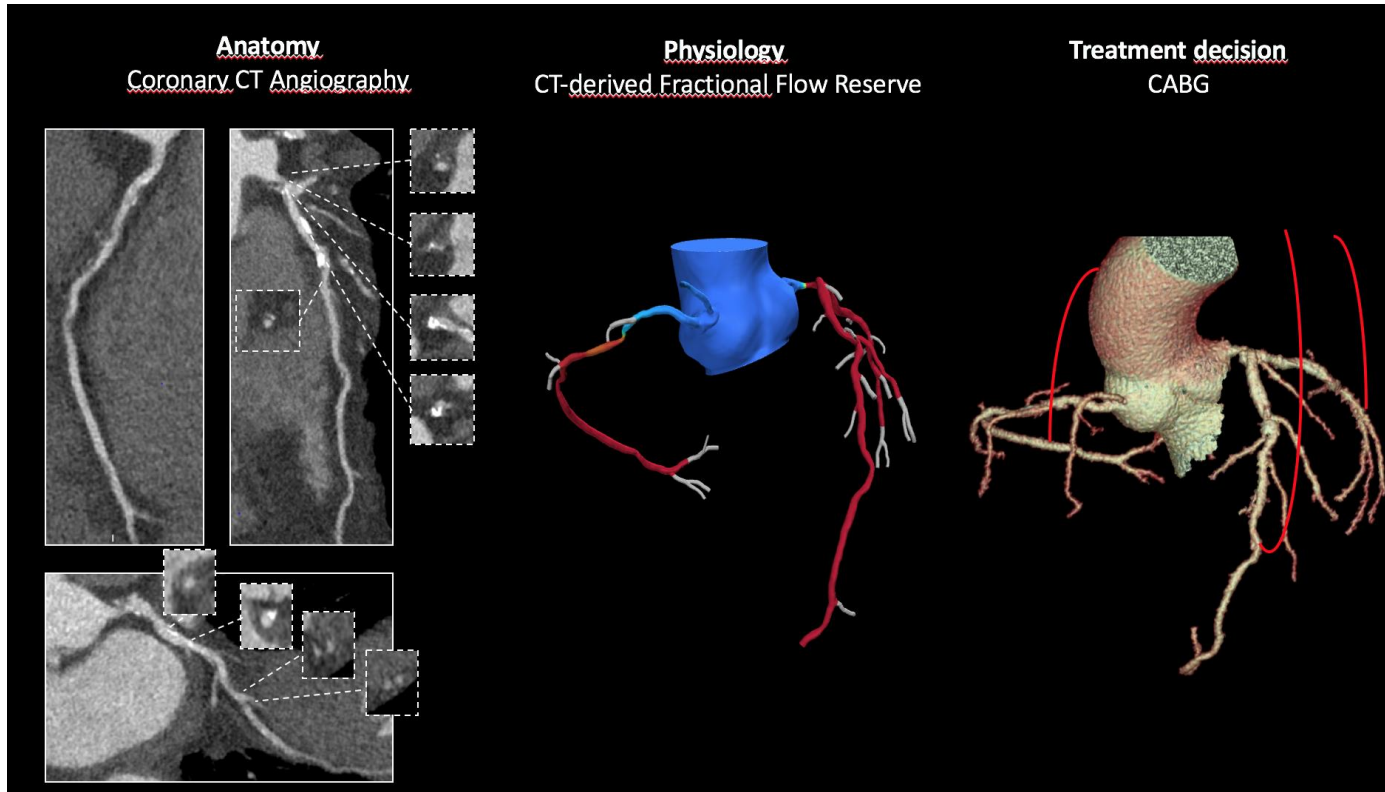
Collet, Sonck, Serruys et al. JACC 2018

MVD classification before we enter the lab



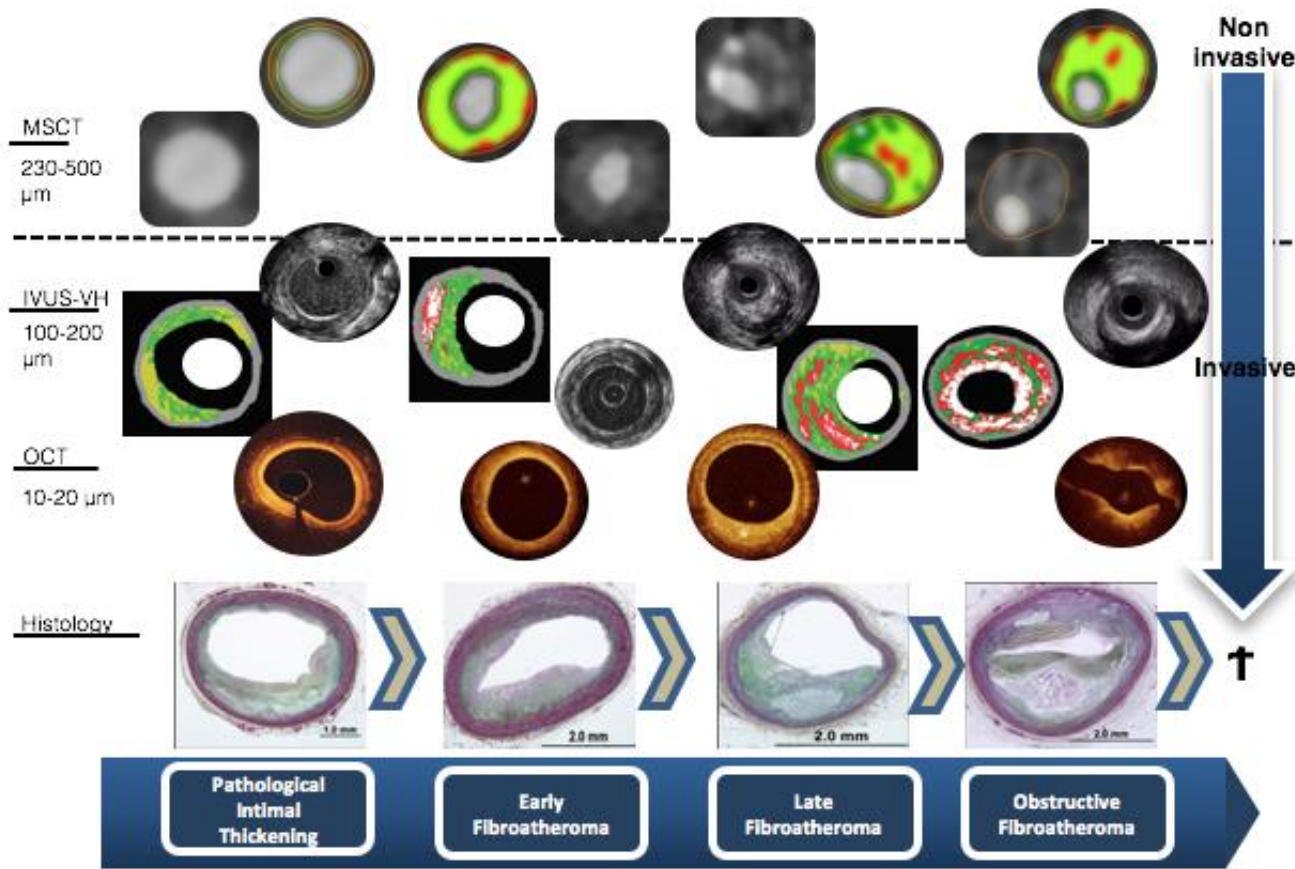
Ongoing trial: CABG Revolution

CABG without ICA



In patients with left main or three-vessel coronary artery disease, a heart team treatment decision-making based on coronary CTA showed an almost perfect agreement with the decision derived from conventional coronary angiography suggesting the potential feasibility of a treatment decision-making and planning based solely on this non-invasive imaging modality.

Coronary Imaging: from vessel to plaque



Otsuka et al. Atherosclerosis 2015

Cheng et al ATHEROREMO-IVUS EHJ 2014

Serruys et al. JACC 2015

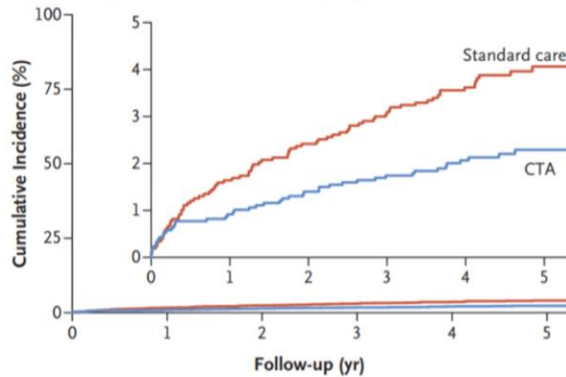
The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Coronary CT Angiography and 5-Year Risk of Myocardial Infarction

The SCOT-HEART Investigators*

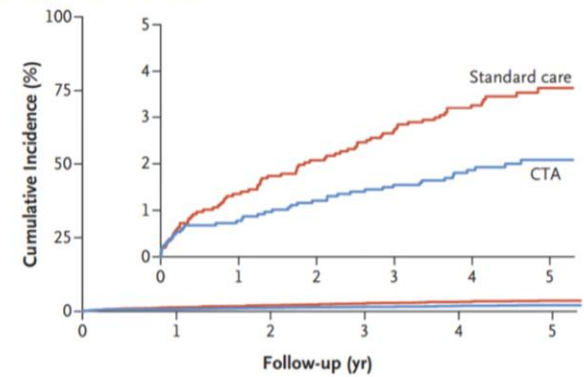
A Death from Coronary Heart Disease or Nonfatal Myocardial Infarction



No. at Risk

Standard care	2073	2033	2008	1994	1572	856
CTA	2073	2051	2029	2015	1588	872

B Nonfatal Myocardial Infarction



No. at Risk

Standard care	2073	2045	2030	2017	1597	881
CTA	2073	2057	2048	2041	1618	891

Newby et al. NEJM 2018

High Risk Plaques and Clinical Outcomes

Low attenuation plaque. Positive remodeling. Spotty calcification

Computed Tomographic Angiography Characteristics of Atherosclerotic Plaques Subsequently Resulting in Acute Coronary Syndrome

Yoshida M, et al. *Journal of the American College of Cardiology*. 2013;61:100-107.

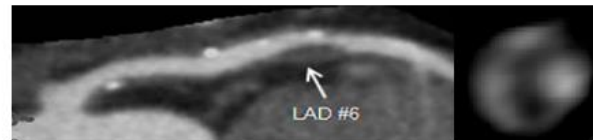
Objective: In a computed tomography (CT) angiography study, we identified the most severe atherosclerotic plaque characteristics of acute coronary syndrome (ACS) patients.

Background: The CT characteristics of atherosclerotic plaques in ACS patients were investigated in this study.

Methods: In 1,000 patients who underwent CT angiography, atherosclerotic plaques were identified. The most severe atherosclerotic plaques were identified in ACS patients.

Results: Of the 40 patients showing plaque with both low attenuation (LA) and napkin-ring (NR) signs, 28 (70%) patients were identified as ACS patients. In only 4 (10%) of the 400 patients with neither NR nor LA signs, ACS patients were identified.

Conclusion: The patients demonstrating atherosclerotic plaques with both LA and NR signs were at a higher risk of ACS developing over the next compared with a non-ACS patient.



Napkin-Ring Sign on Coronary CT Angiography for the Prediction of Acute Coronary Syndrome

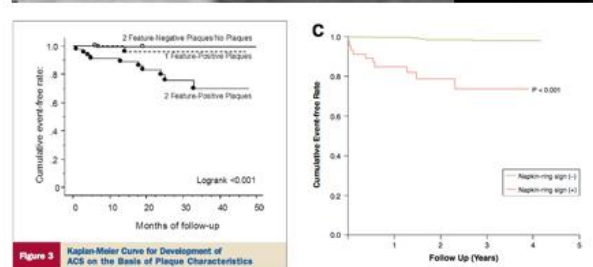
Kaneko O, et al. *Journal of the American College of Cardiology*. 2013;61:108-115.

Objective: The aim of this study was to determine the predictive value of napkin-ring sign on coronary computed tomography angiography (CTA) for future acute coronary syndrome (ACS).

Background: Recent studies have reported a close association between coronary CTA and risk of ACS.

Methods: The subjects of this prospective study were 895 consecutive coronary CTA examinations and were followed for >1 year.

Results: The subjects with napkin-ring sign were at a higher risk of ACS developing over the next compared with a non-ACS patient.



Plaque Characterization by Coronary Computed Tomography Angiography and the Likelihood of Acute Coronary Events in Mid-Term Follow-Up

Yoshida M, et al. *Journal of the American College of Cardiology*. 2013;61:116-123.

Objective: The aim of this study was to determine the predictive value of plaque characteristics on coronary CTA for future ACS.

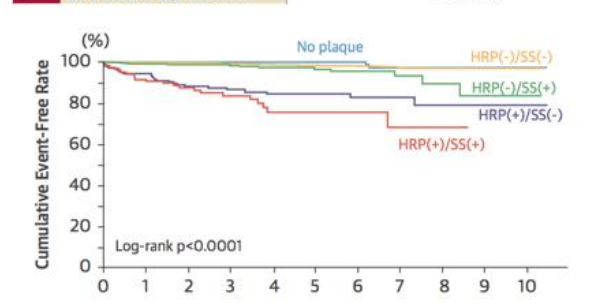
Background: Recent studies have reported a close association between coronary CTA and risk of ACS.

Methods: The subjects of this prospective study were 895 consecutive coronary CTA examinations and were followed for >1 year.

Results: The subjects with high-risk plaque characteristics were at a higher risk of ACS developing over the next compared with a non-ACS patient.

RESULTS: The 12,727 segments, 1,774 plaques were observed, including 130 segments (1.0%), LAD in 107 segments (0.8%) and napkin-ring signs in 37 (0.3%) of the 45 plaques with napkin-ring signs (80%) overlapped with or LAD. During the follow-up period (2.3 ± 0.8 years), 24 patients (2.8%) and 167 plaques developed in 41% with a napkin-ring sign. Segment-based C models analysis showed that PR ($p < 0.001$), LAD ($p = 0.007$), and the napkin-ring sign ($p = 0.007$) were independent predictors for future ACS events. Kaplan-Meier analysis showed that patients with napkin-ring signs showed a higher risk of ACS events compared with non-ACS patients.

CONCLUSIONS: The present study demonstrated on coronary CTA that high-risk plaque characteristics were associated with a higher risk of future ACS events in patients at high risk of future ACS events.



2009

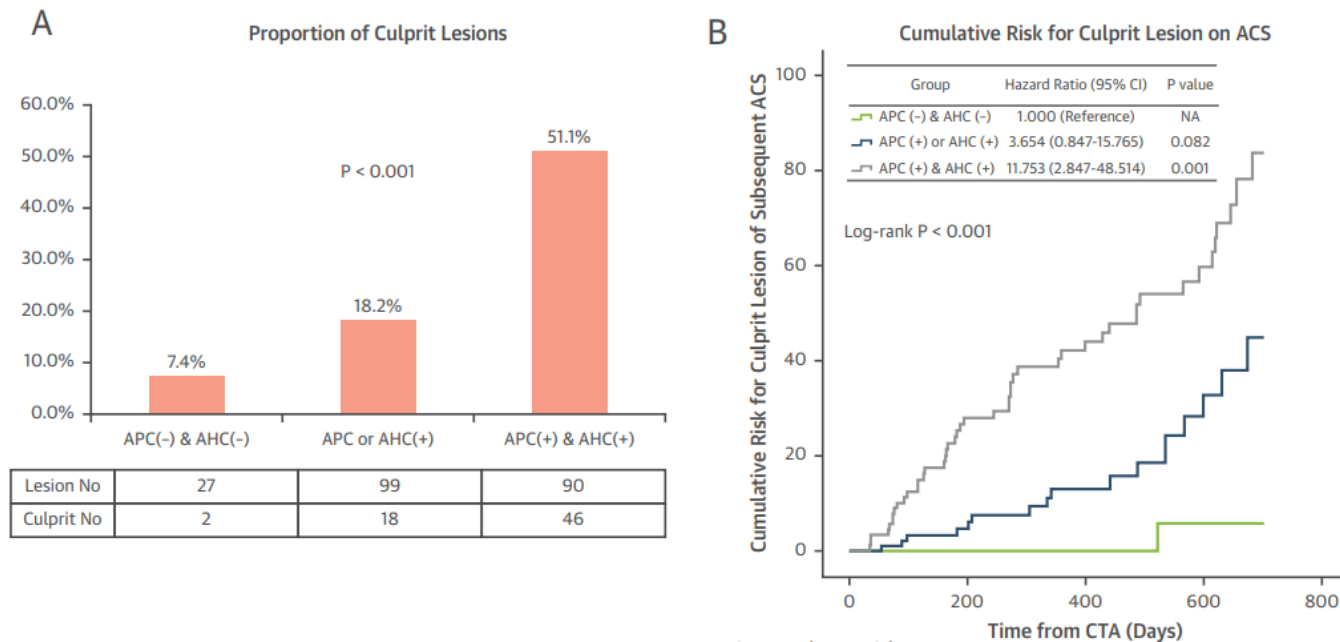
For the first time with future ACS even in high risk patients. *Coronary CT Angiography*. 2009;41:100-107.



2013

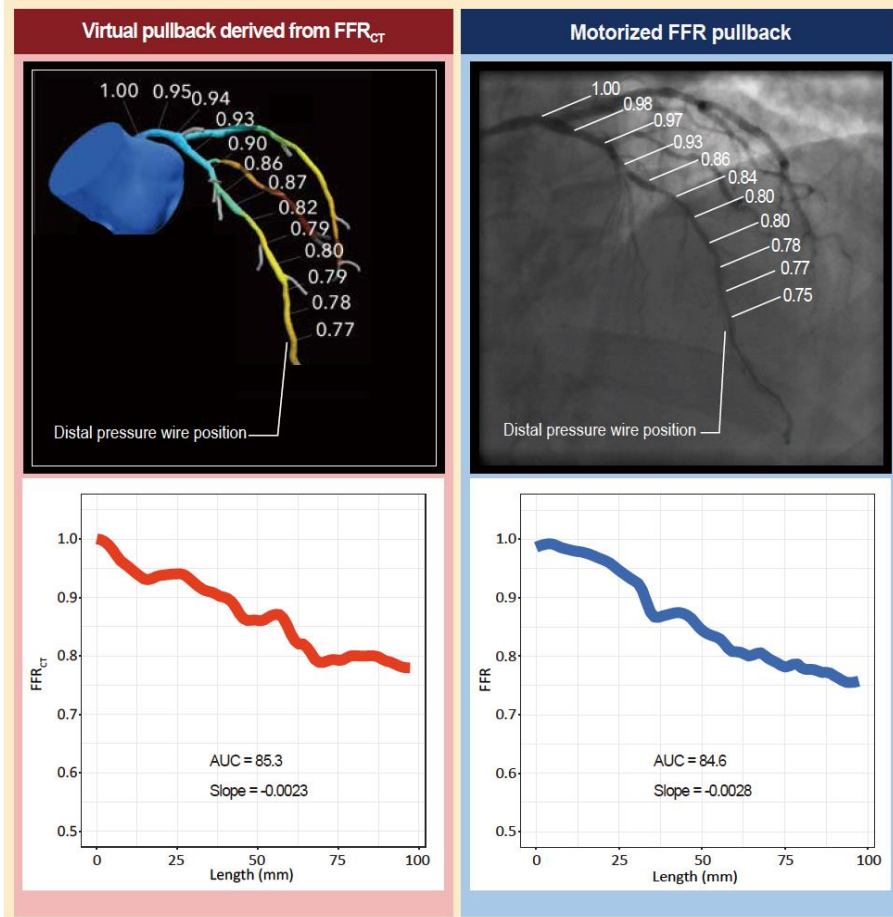
2015

Identification of High Risk Plaques



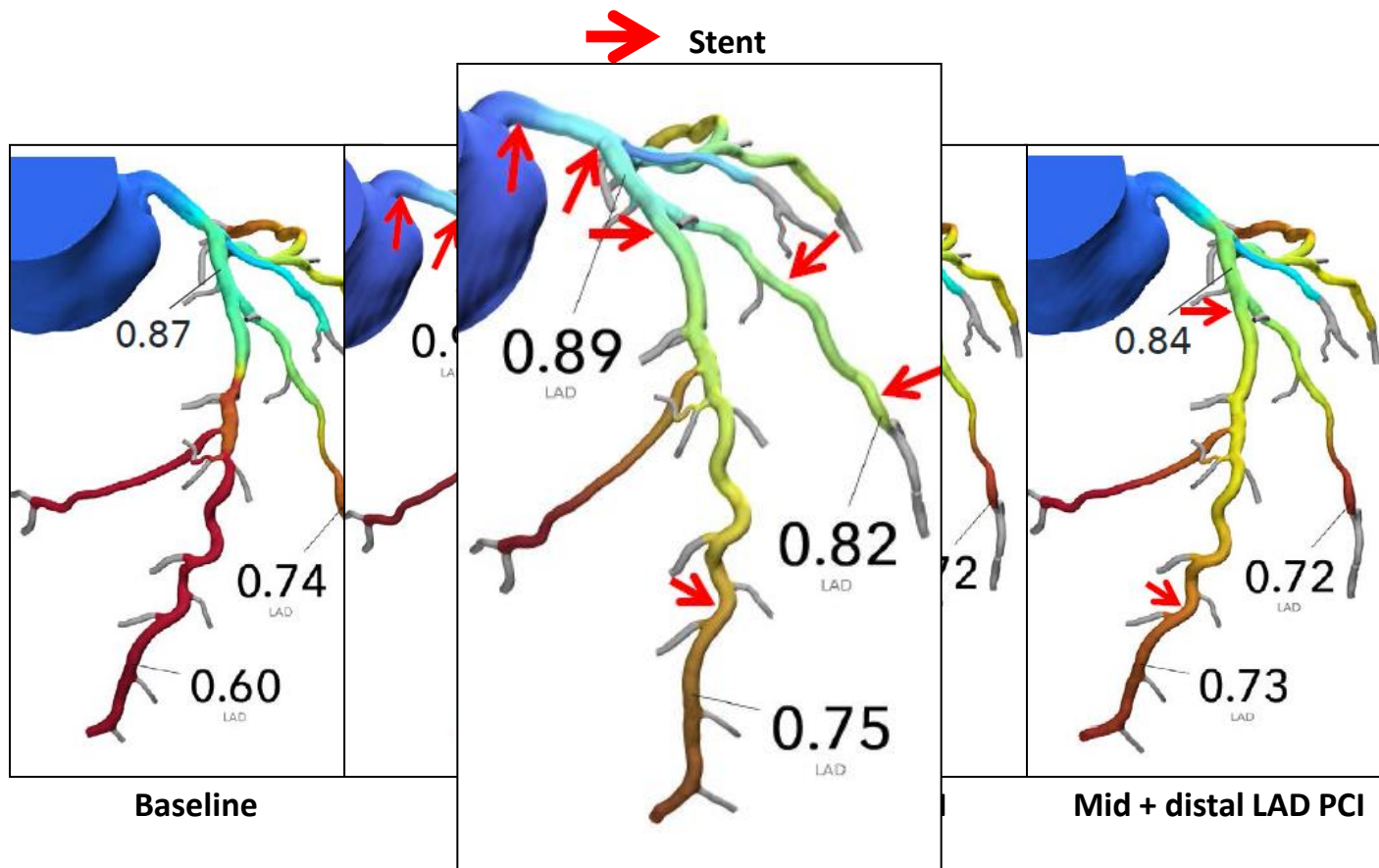
Adverse Hemodynamic characteristics (AHC) defined as lesions that have **low FFR_{CT}** (<0.80), **high ΔFFR_{CT}** (>0.06), **high WSS** (≥ 154.7 dyn/cm²), or **high axial plaque stress** ($\geq 1,606.6$ dyn/cm²).

Treatment planning based on FFR_{CT}



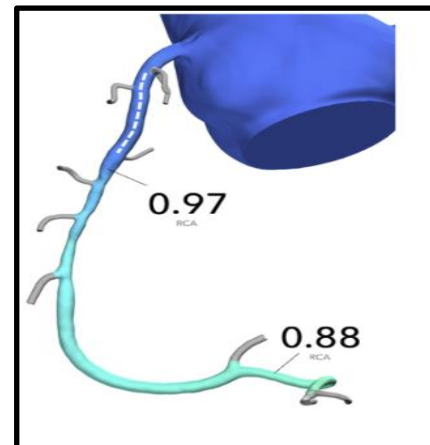
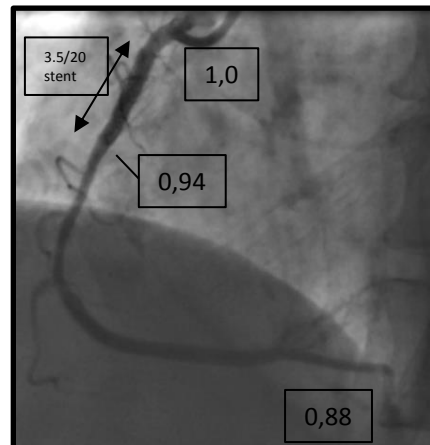
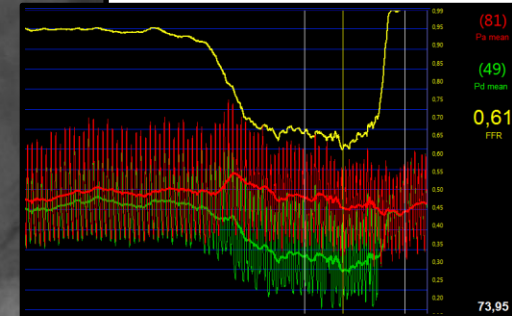
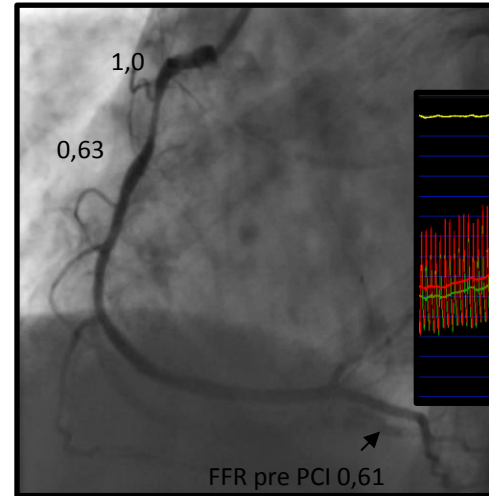
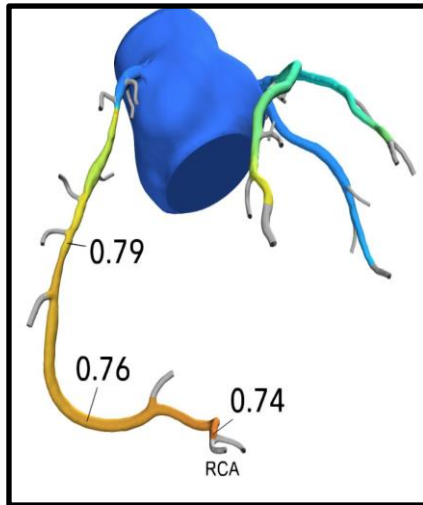
Collet et al. Circulation 2018. Sonck et al. Circ Interv submitted.

HeartFlow Interactive Revascularization Planner



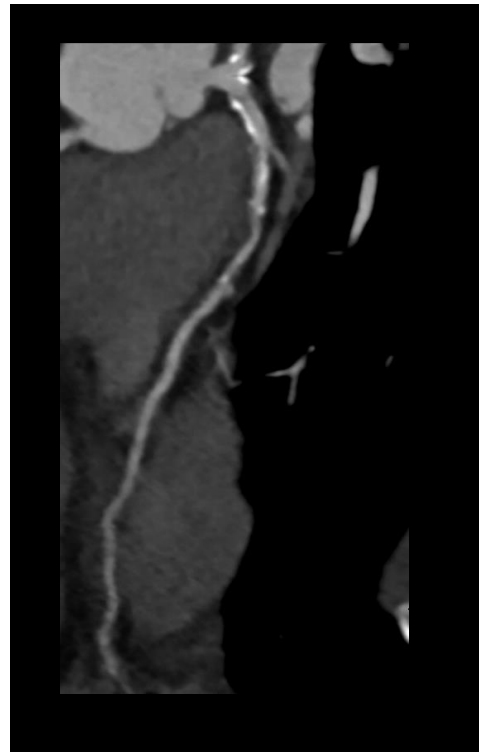
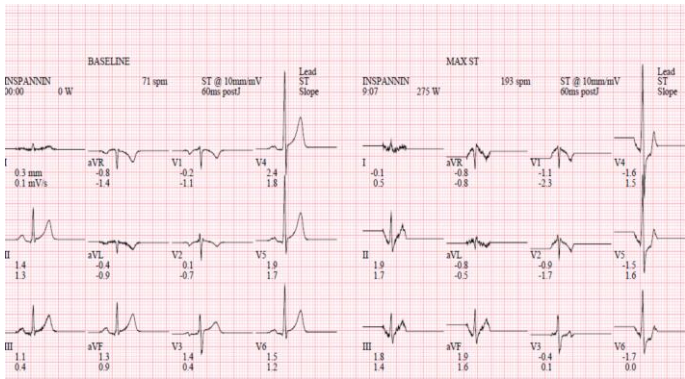
Collet et al. Nature Reviews 2018.

Case 1 Precise PCI Plan Study

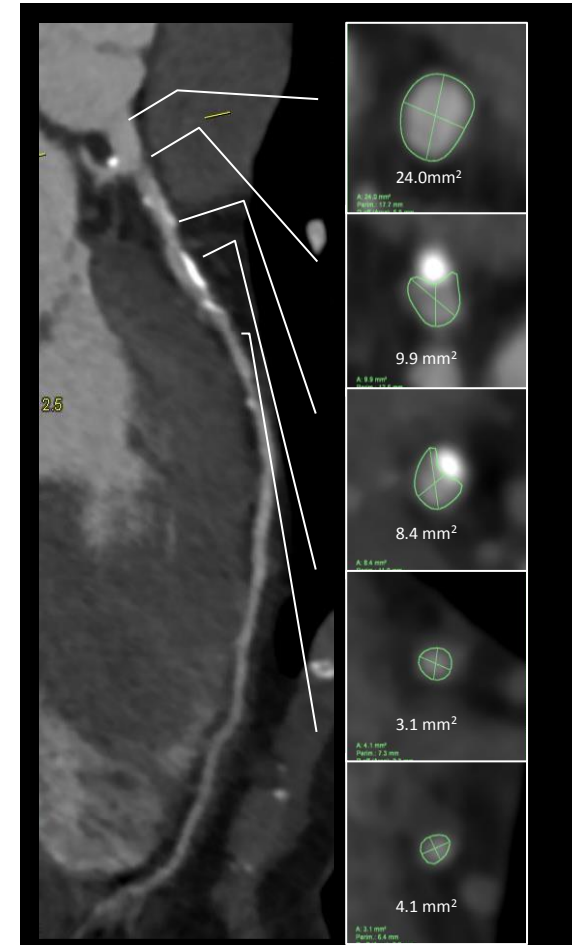


Case 2 Precise PCI Plan Study

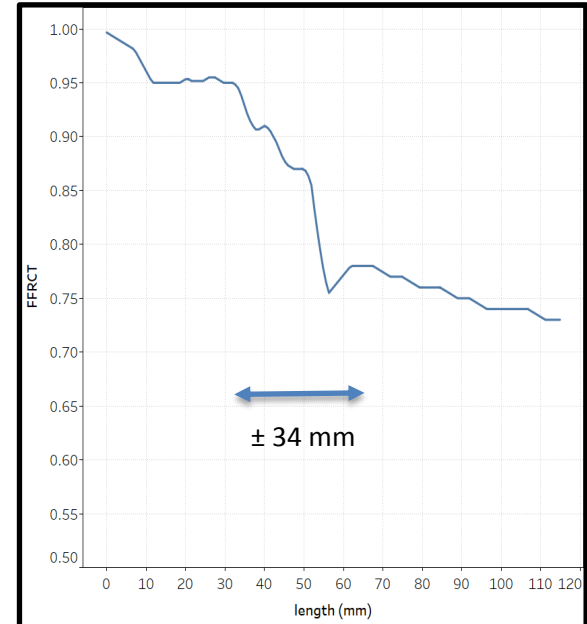
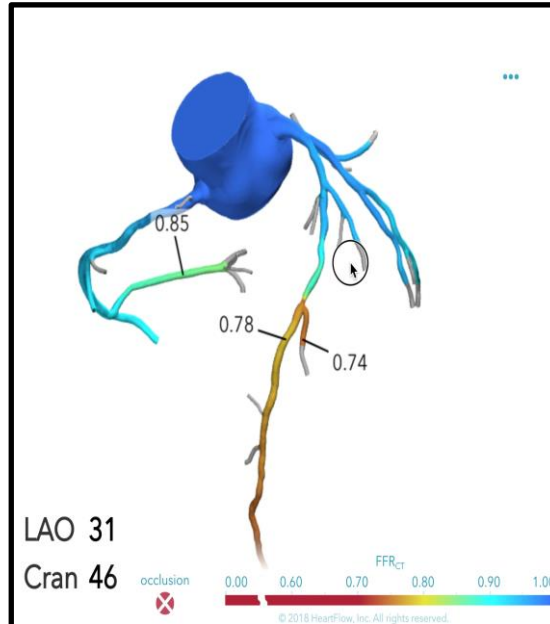
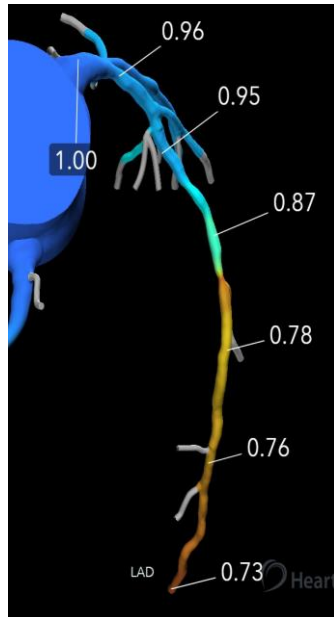
- 40 year old sportive male
- Asymptomatic



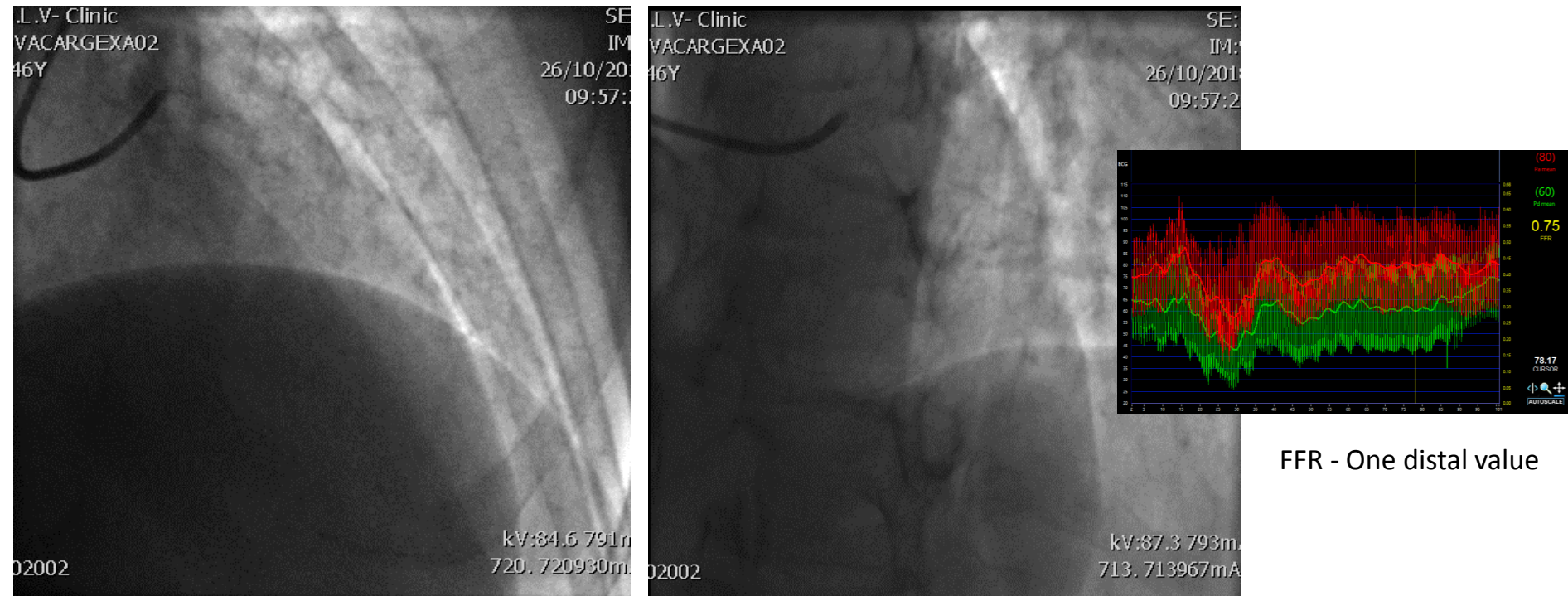
Multiplanar reconstruction (MPR)



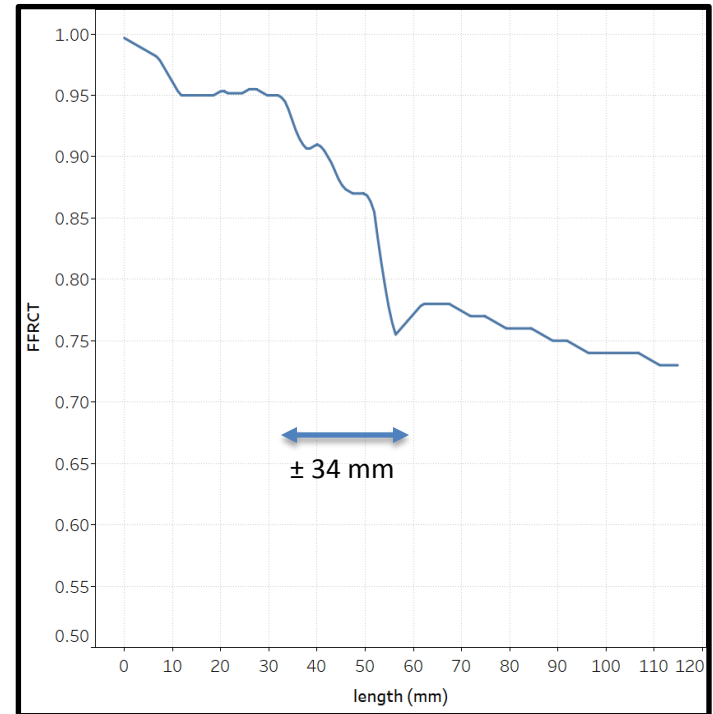
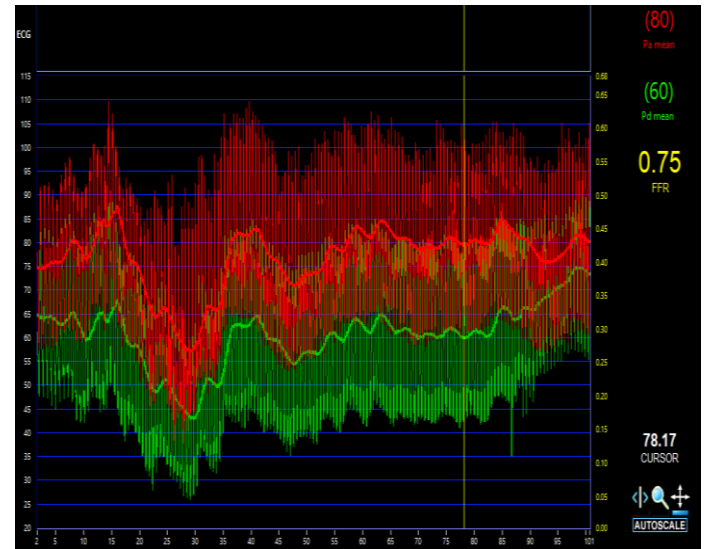
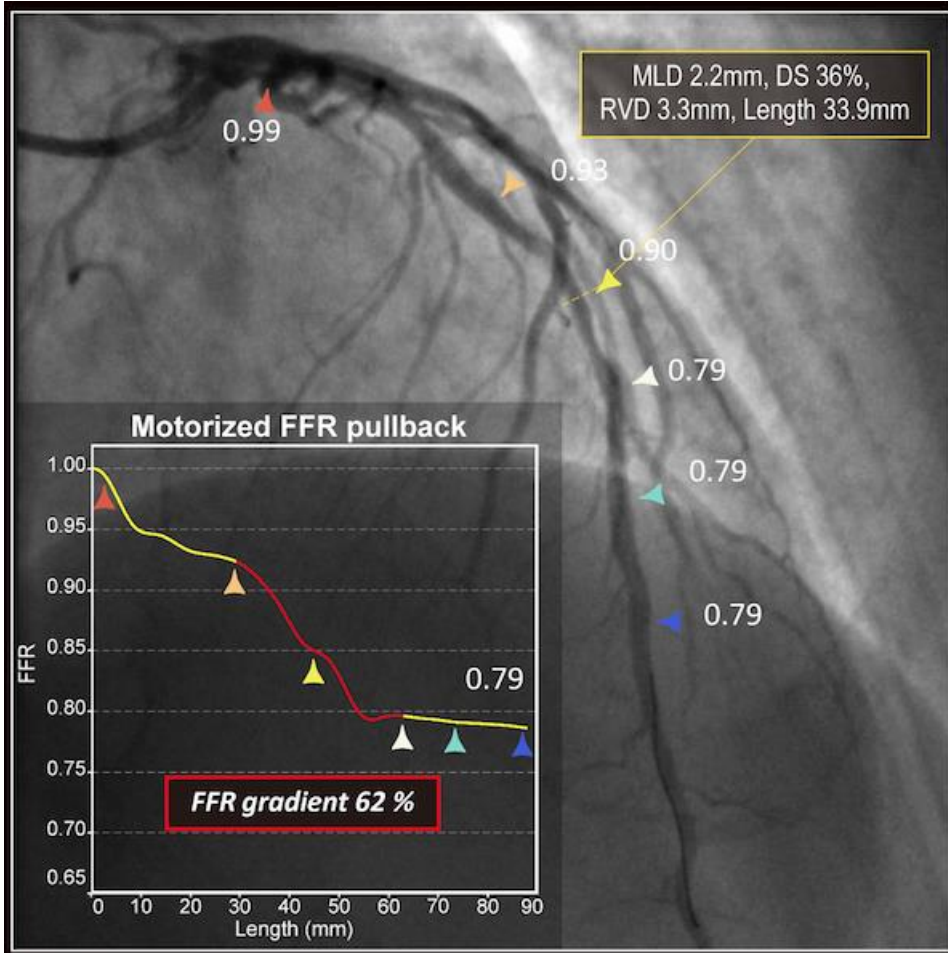
Case 2 Precise PCI Plan Study

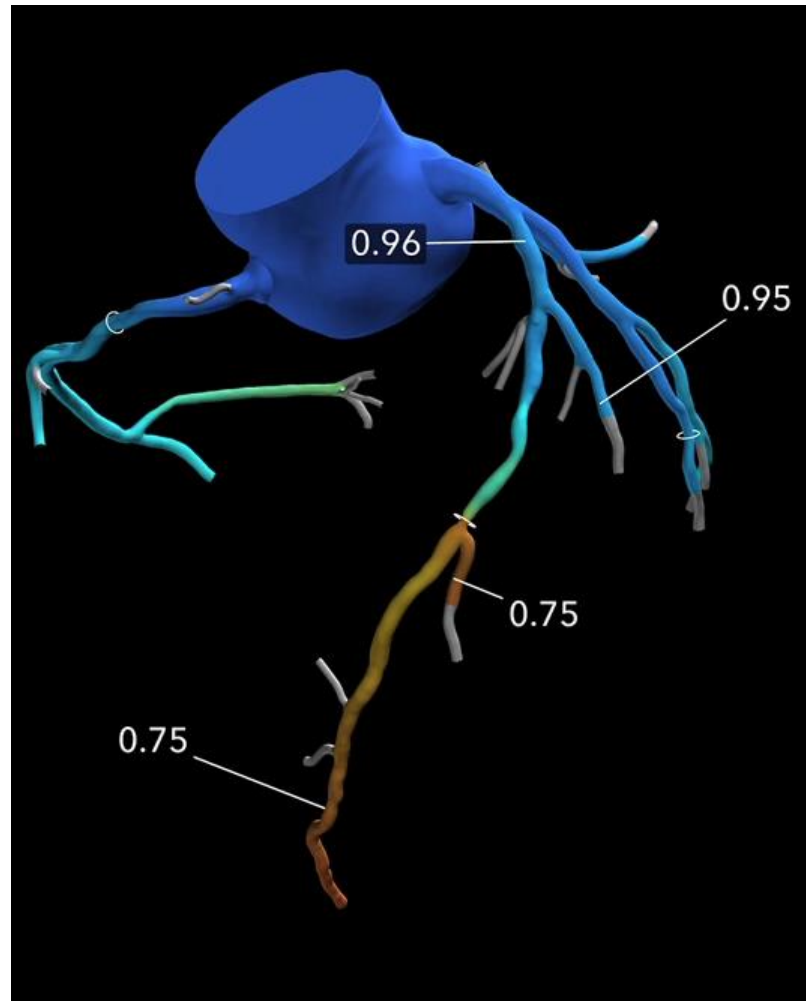


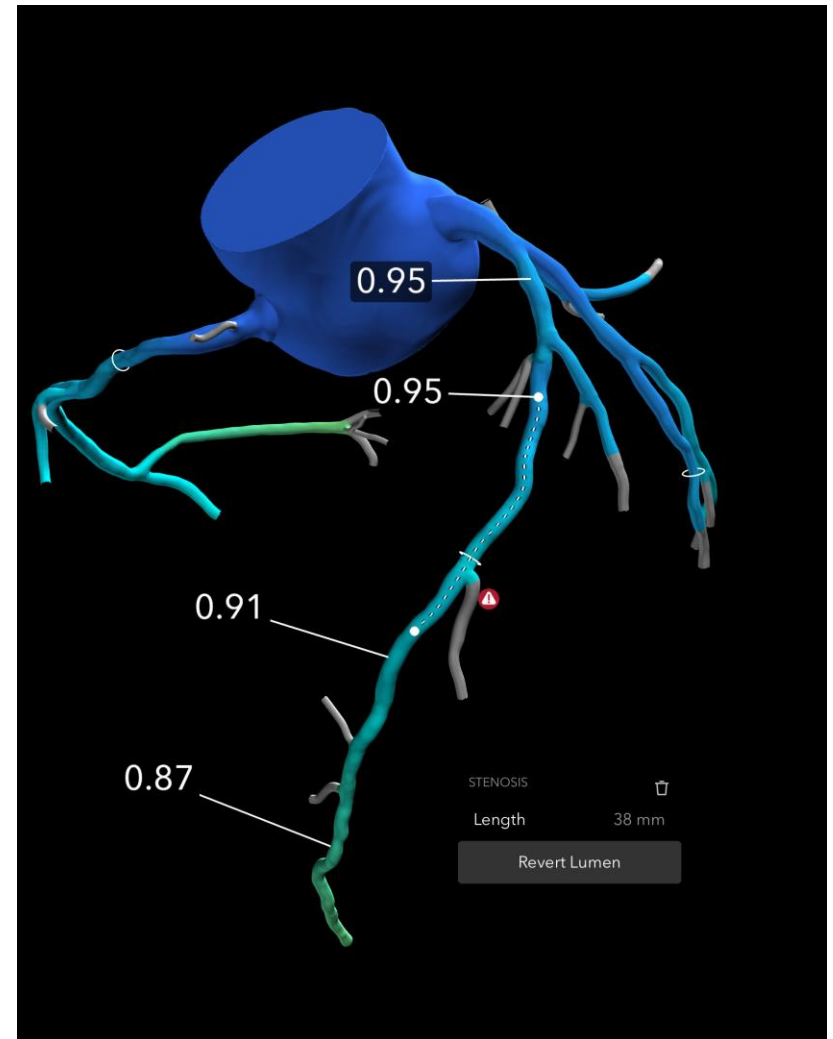
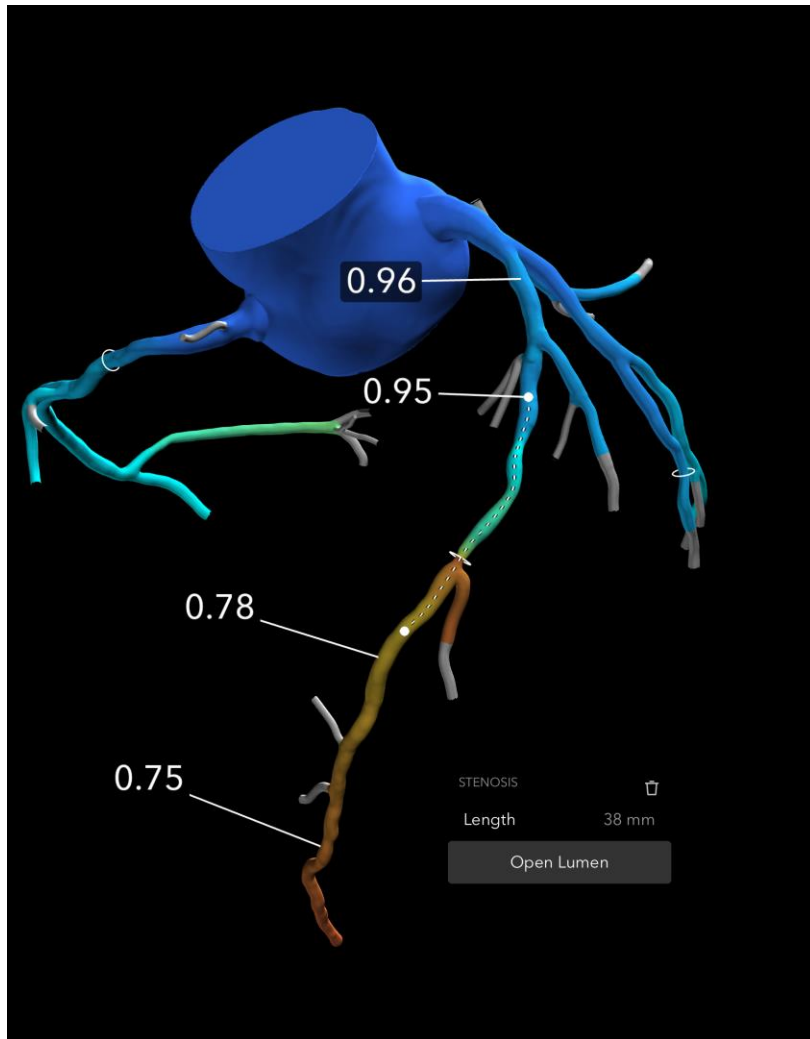
Case 2 Precise PCI Plan Study

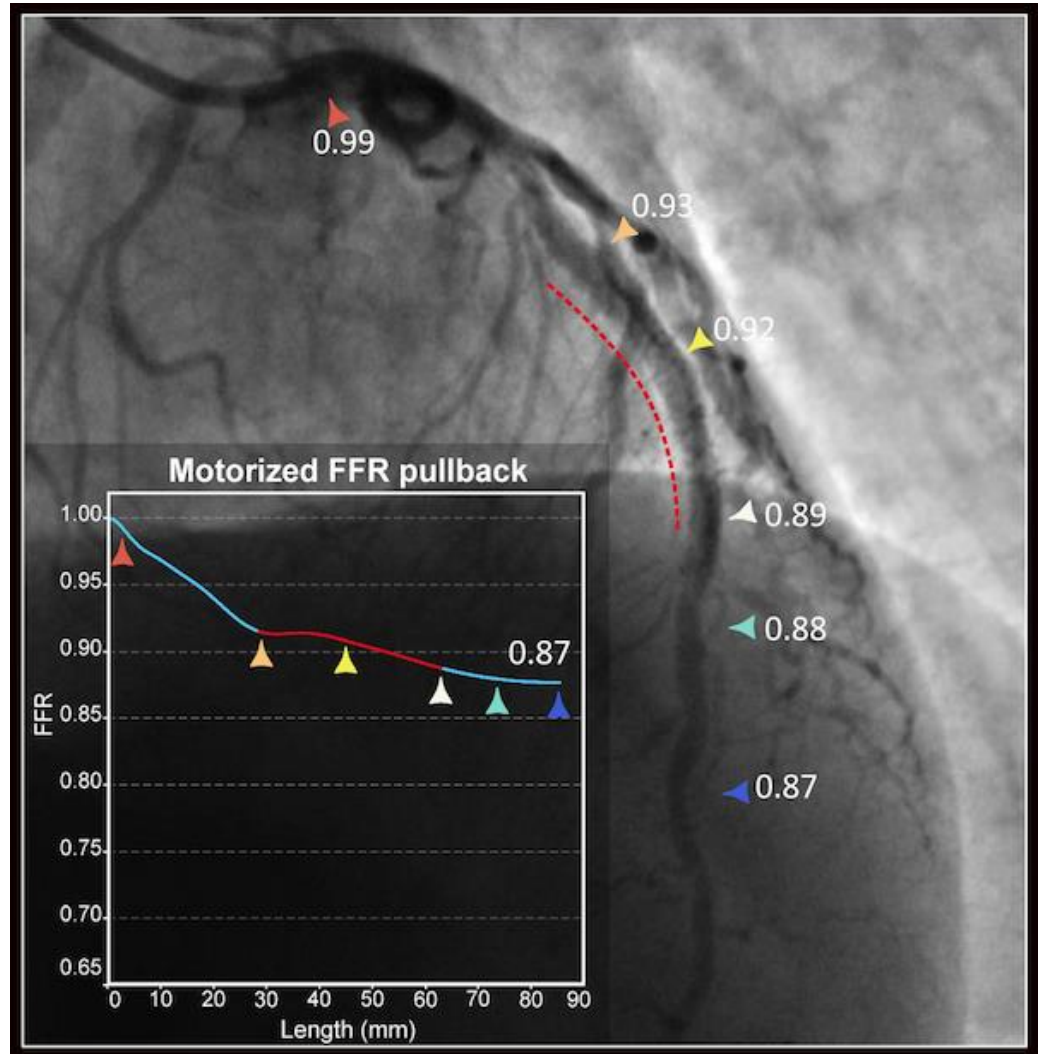
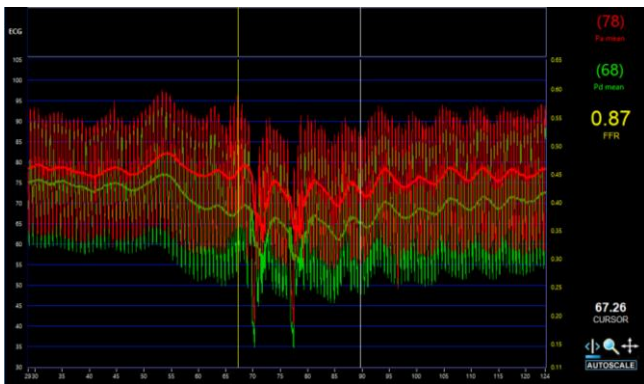
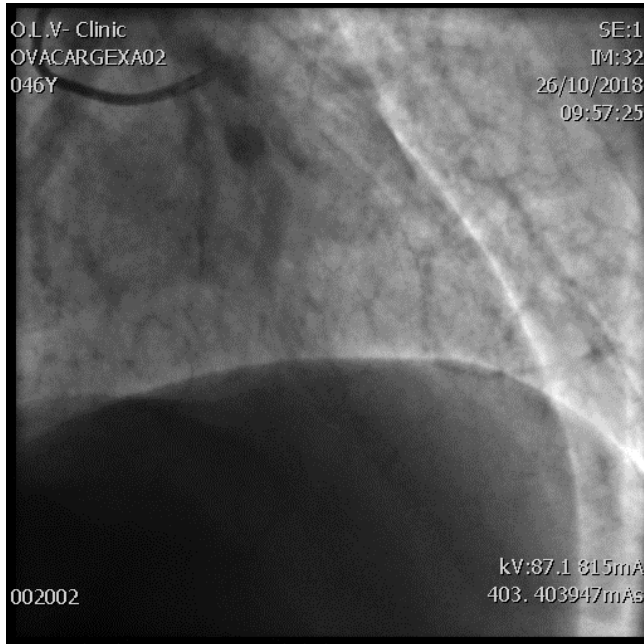


FFR - One distal value

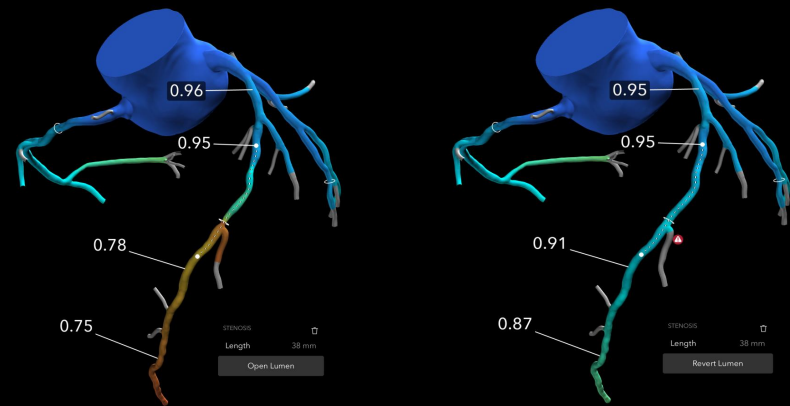
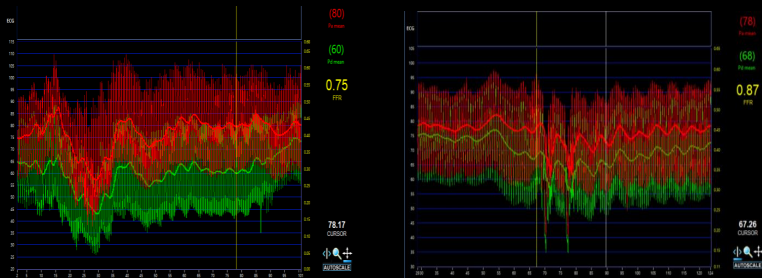
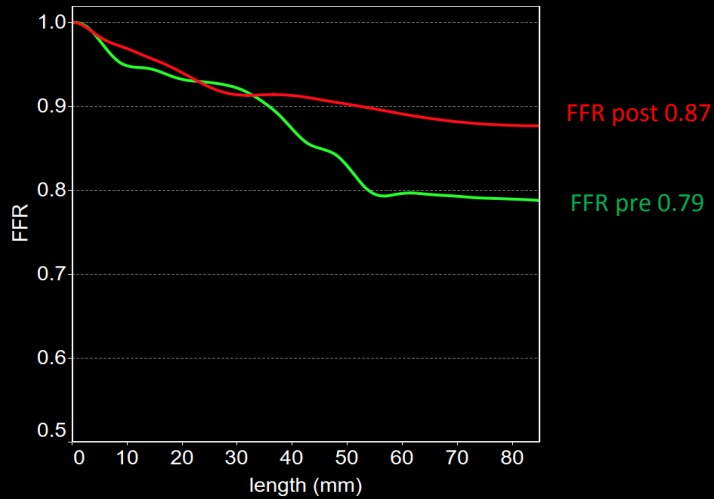




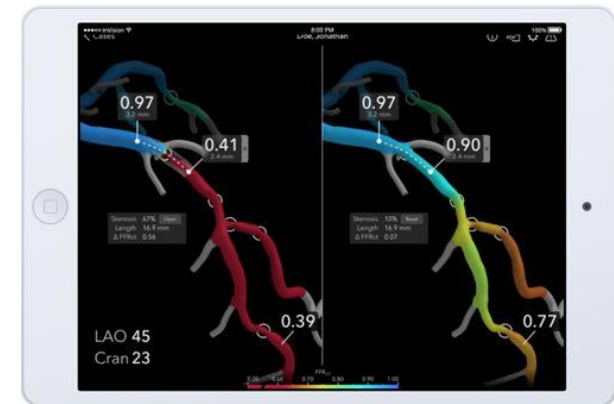


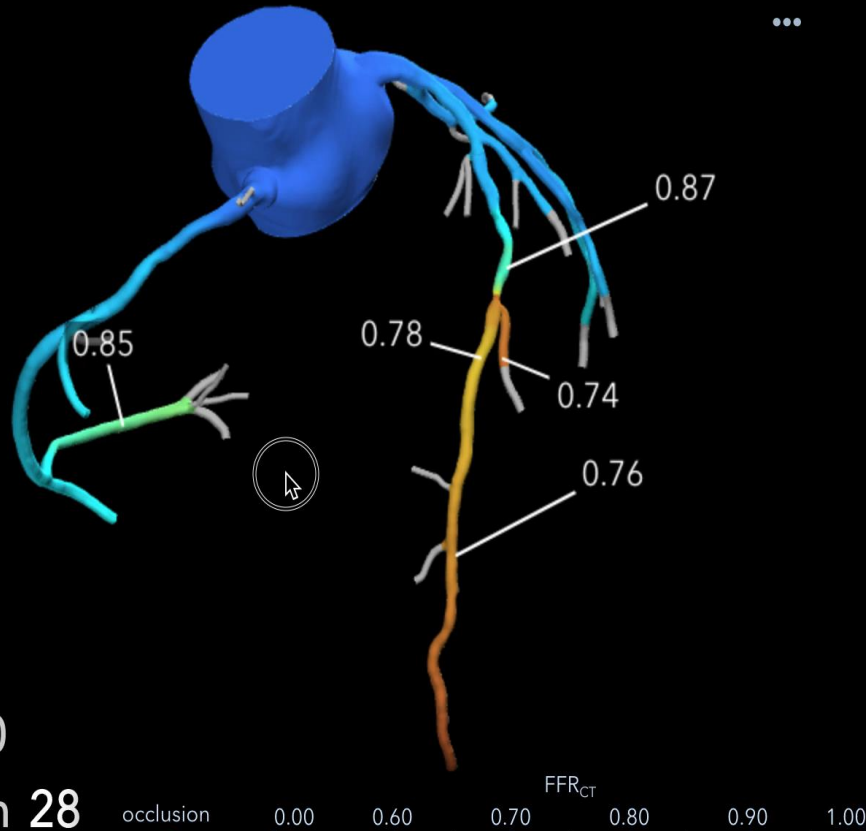


Invasive vs. non-invasive treatment planning



The future of FFR_{CT}: Mobile, On-Demand, Integrated & Interactive



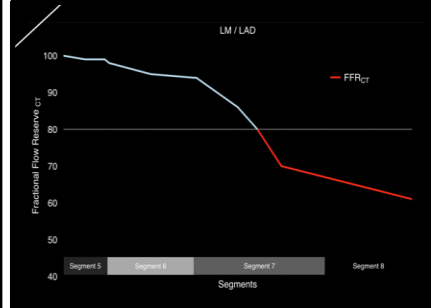
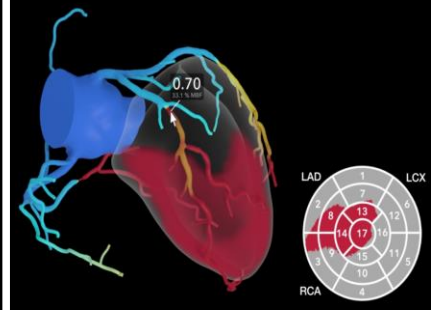
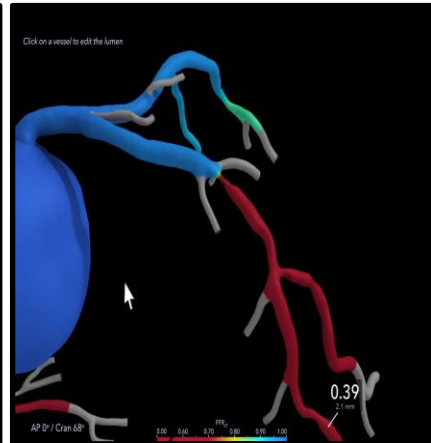


AP 0
Cran 28

occlusion



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Conclusion: FFR_{CT} in the lab of tomorrow

- FFR_{CT} enhances the non-invasive assessment of myocardial ischemia.
- Refine risk stratification with coronary physiology parameters on top of anatomy and known adverse plaque characteristics.
- May allow for decision-making between CABG and PCI and treatment planning in the non-invasive setting.
- Guide which lesions require an invasive assessment in the lab.
- Select the optimal revascularization strategy.
- Improve cathlab efficiency