Functional Coronary Angiography for the Assessment of Epicardial Vessels and Microcirculation.

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Functional Coronary Angiography for the Assessment of Epicardial Vessels and Microcirculation.

I have no conflict of interests related to this presentation

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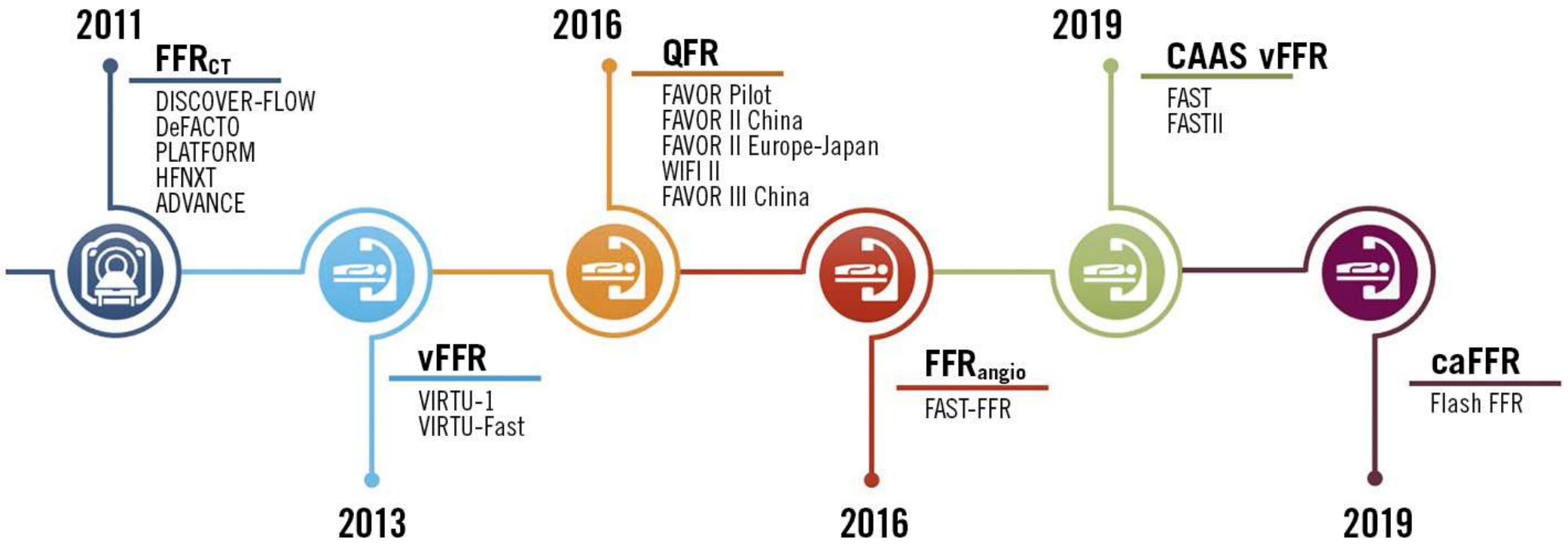
*Invasive functional coronary angiography (FCA) is an **angiography-derived** physiological index of the **functional significance** of coronary obstruction.*

*Physiological assessment tool for coronary obstruction that **does not require** the utilization of a pressure wire.*

*The concept of FCA calculation stems from the estimation of the pressure los across the stenosis using **computational flow dynamics** (CFD) according to **angiographic anatomical information***

Functional coronary angiography for the assessment of the epicardial vessels and the microcirculation



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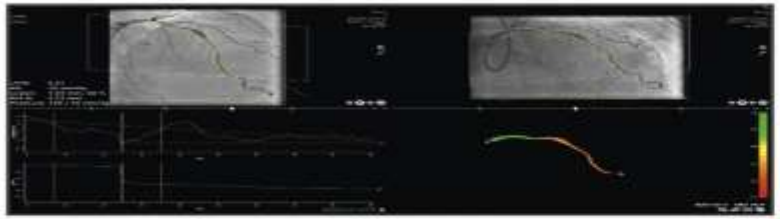
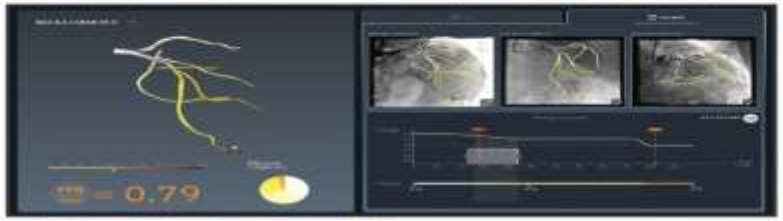
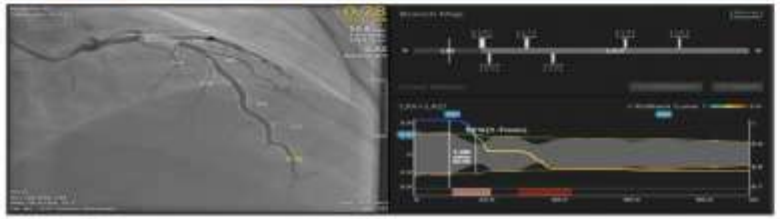
	User display	Proyections needed	Pressure sensor	Micro circulation	Side branches	Available data
QFR		2	No	Yes	No	
CAAS vFFR		2	No	No	No	
Ca FFR		2	Yes	Yes	No	
FFR Angio		3	Yes	No	Yes	
µQFR		1	No	Yes	Yes	

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QFR

JACC: CARDIOVASCULAR INTERVENTIONS
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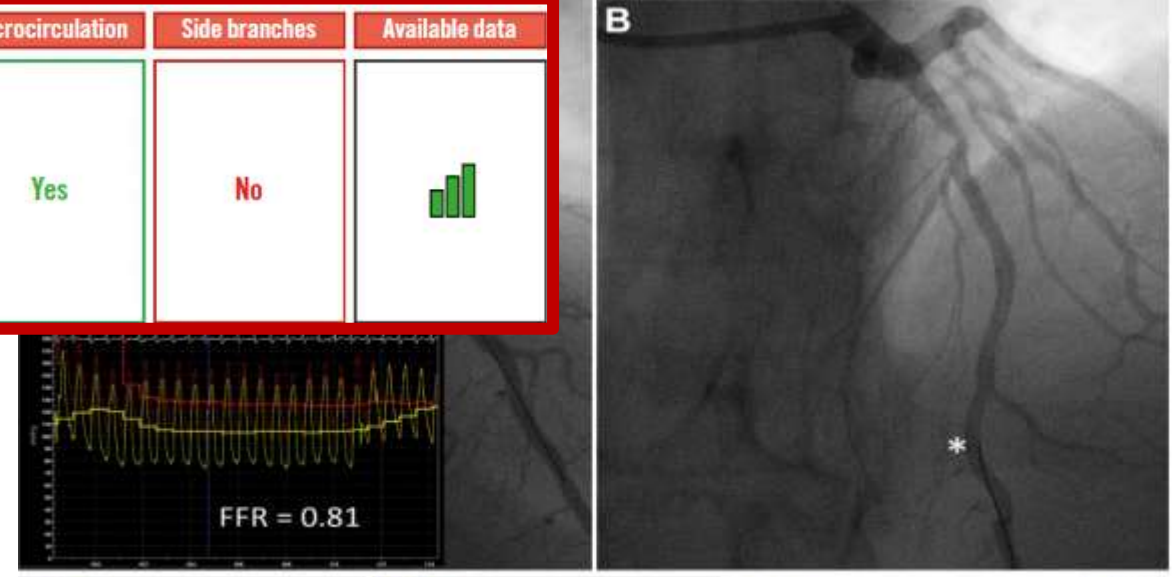
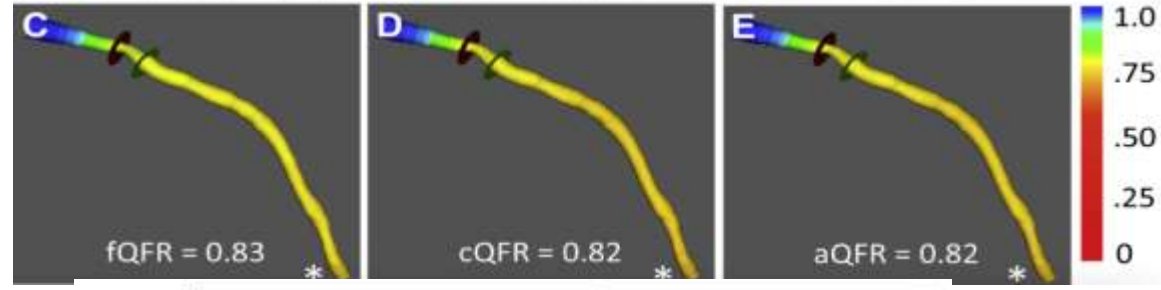
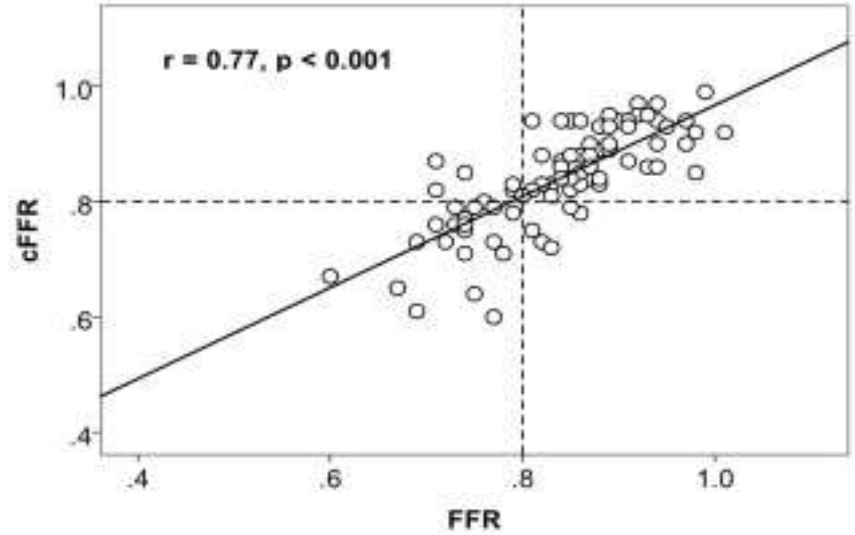
Diagnostic Accuracy of Fast Computational Approaches to Derive Fractional Flow Reserve From Diagnostic Coronary Angiography

The International Multicenter FAVOR Pilot Study

Shengxian Tu, PhD,[a] Jelmer Westra, MS,[b] Junqing Yang, MD,[c] Clemens von Birgelen, MD, PhD,[d] Angela Ferrara, MD,[e] Mariano Pellicano, MD,[e,f] Holger Nef, MD,[g] Matteo Tebaldi, MD,[h] Yoshinobu Murasato, MD, PhD,[i] Alexandra Lansky, MD, PhD,[j] Emanuele Barbato, MD, PhD,[e,f] Liefke C. van der Heijden, MD,[d] Johan H.C. Reiber, PhD,[k] Niels R. Holm, MD,[b] William Wijns, MD, PhD,[e,l]
on behalf of the FAVOR Pilot Trial Study Group







JACC Cardiovasc Interv. 2016 Oct 10;9(19):2024-2035.

Diagnostic performance of quantitative flow ratio in prospectively enrolled patients: An individual patient-data meta-analysis.

QFR

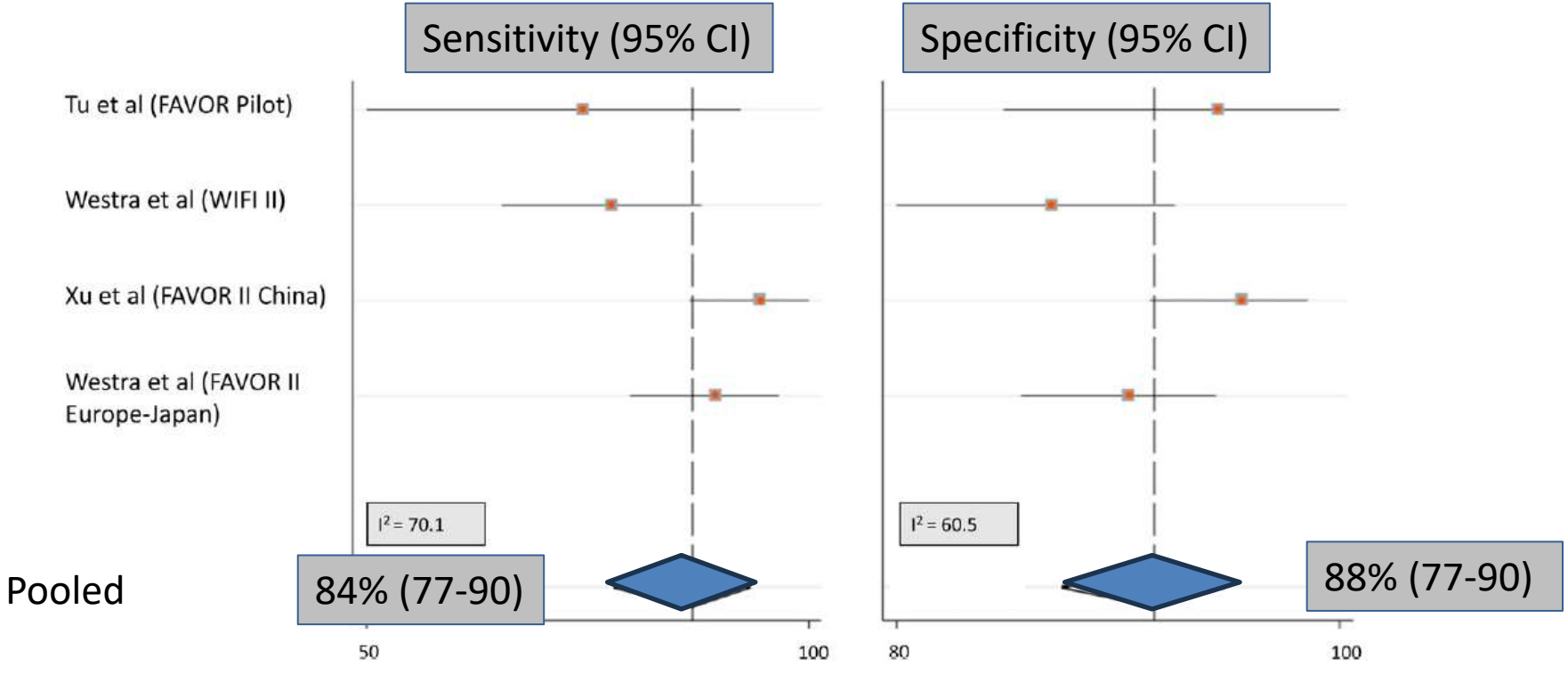


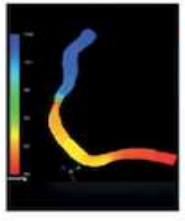
FIGURE 3 Diagnostic accuracy. Sensitivity and specificity of QFR with FFR as reference standard [Color figure can be viewed at wileyonlinelibrary.com]

Westra J, et al Catheter Cardiovasc Interv. 2019 Nov 1;94(5):693-701.

Two – year outcomes from FAVOR III China Trial

QFR

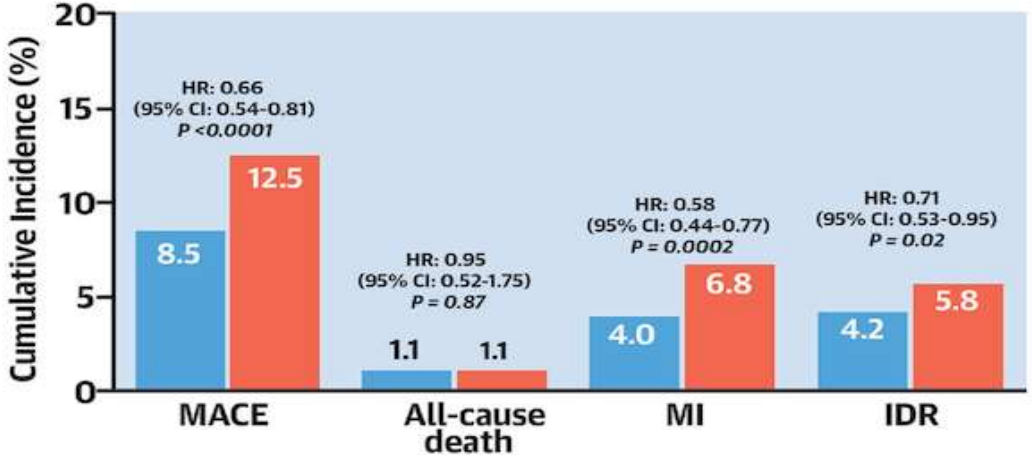
3,825 patients with at least 1 lesion with DS% of 50%-90% in a coronary artery with at least a 2.5 mm RVD by visual assessment



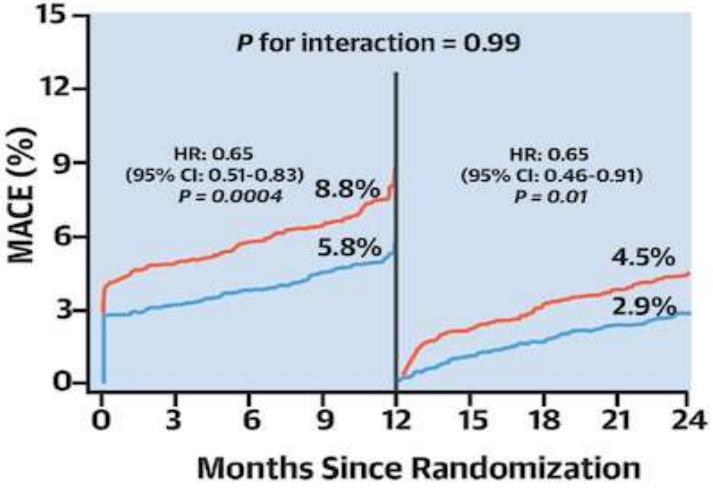
Quantitative Flow Ratio-Guided Group N = 1,913

Angiography-Guided Group N = 1,912

2-Year Clinical Outcomes

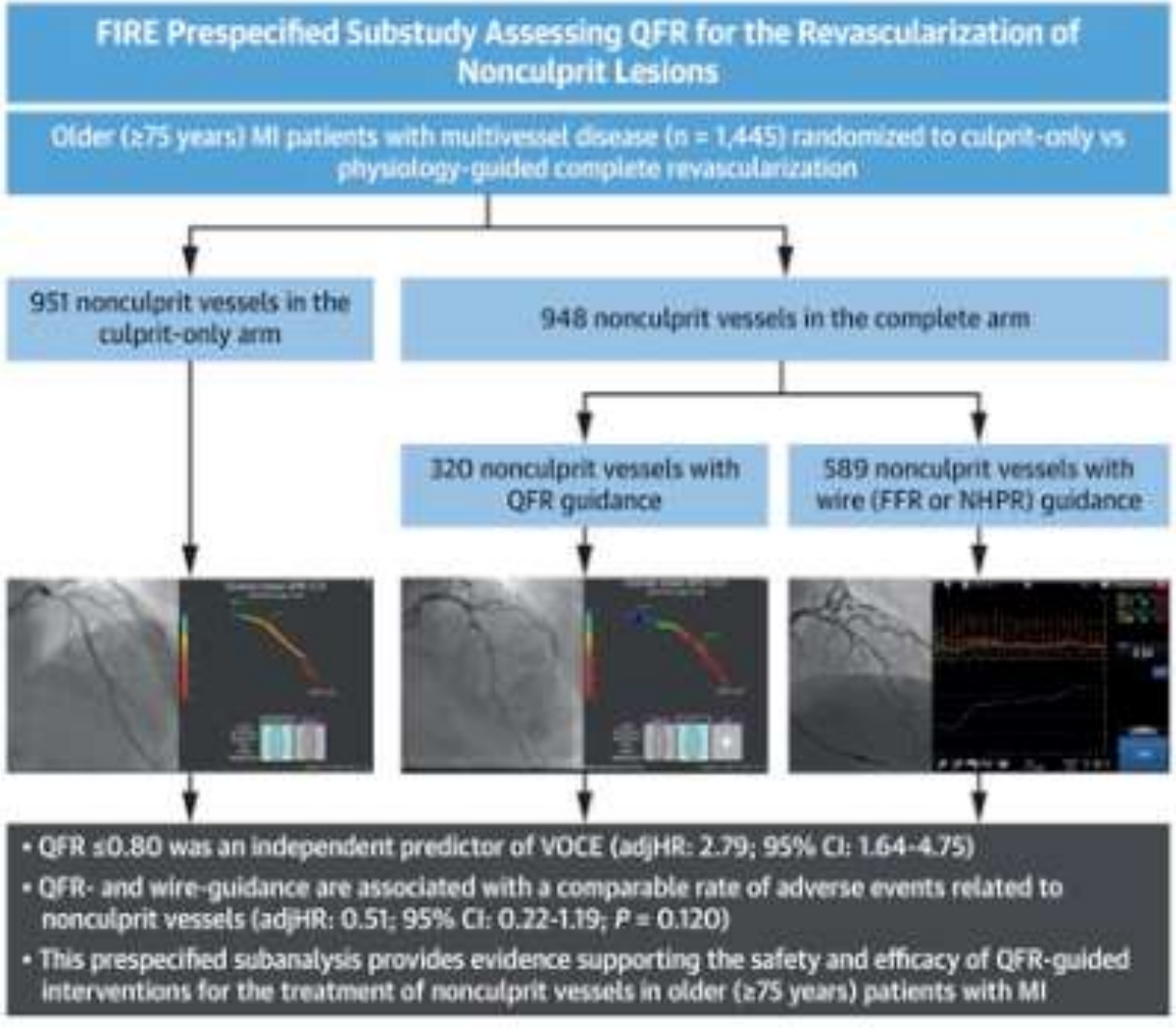


Landmark Analysis



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

QFR for the Revascularization of Nonculprit Vessels in MI Patients: Insights From the FIRE Trial.



Erriquez A, et al. *J Am Coll Cardiol Intv*. 2024 Jun, 17 (12) 1425–1436.

FFR angio

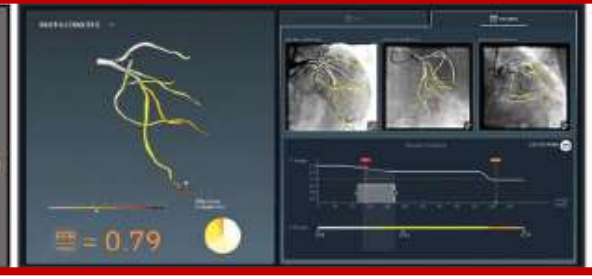
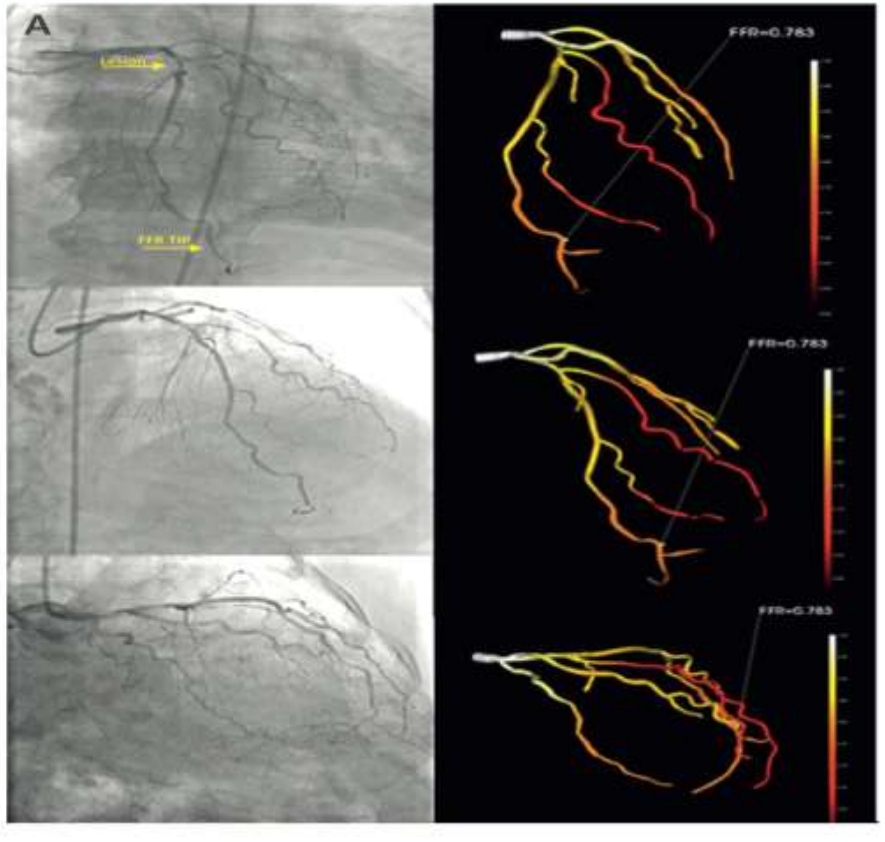
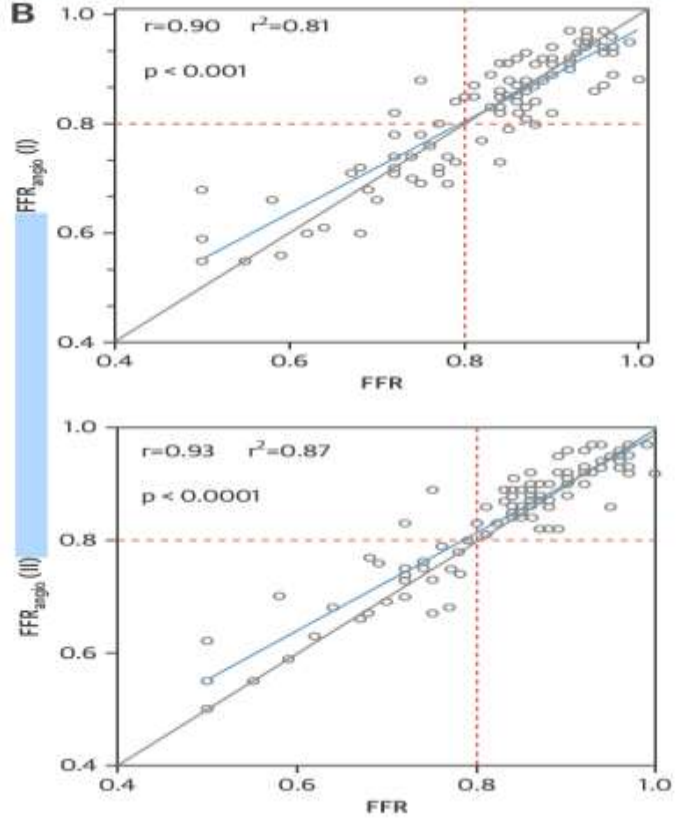
	User display	Projections needed	Pressure sensor	Microcirculation	Side branches	Available data
FFR angio		3	Yes	No	Yes	

FIGURE 1 Lesion in the Left Coronary Tree



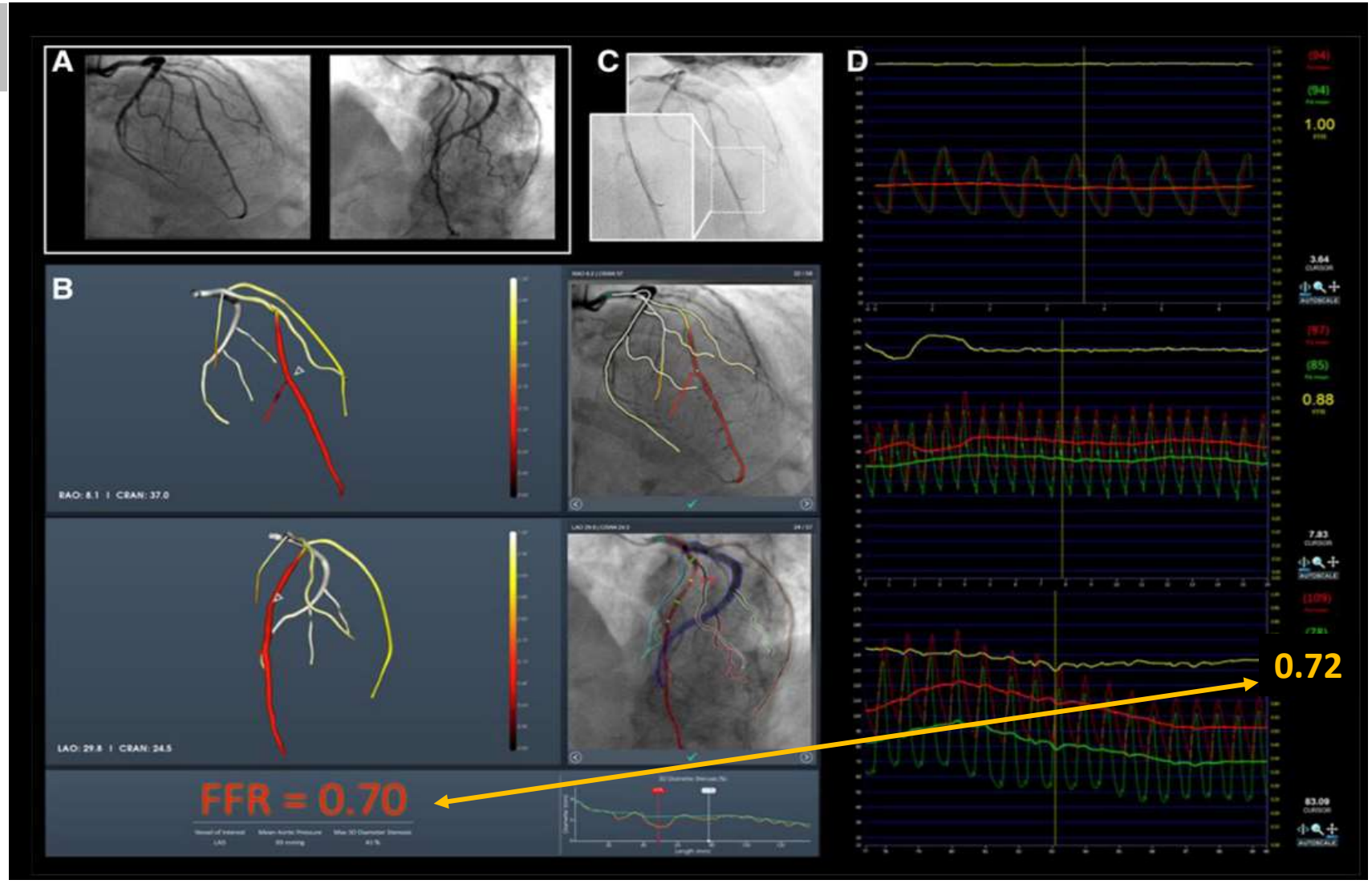


Kornowski R. Et al J Am Coll Cardiol. 2016 Nov 15;68(20):2235-2237.

Accuracy of Fractional Flow Reserve Derived From Coronary Angiography

FAST-FFR Study

FFR angio

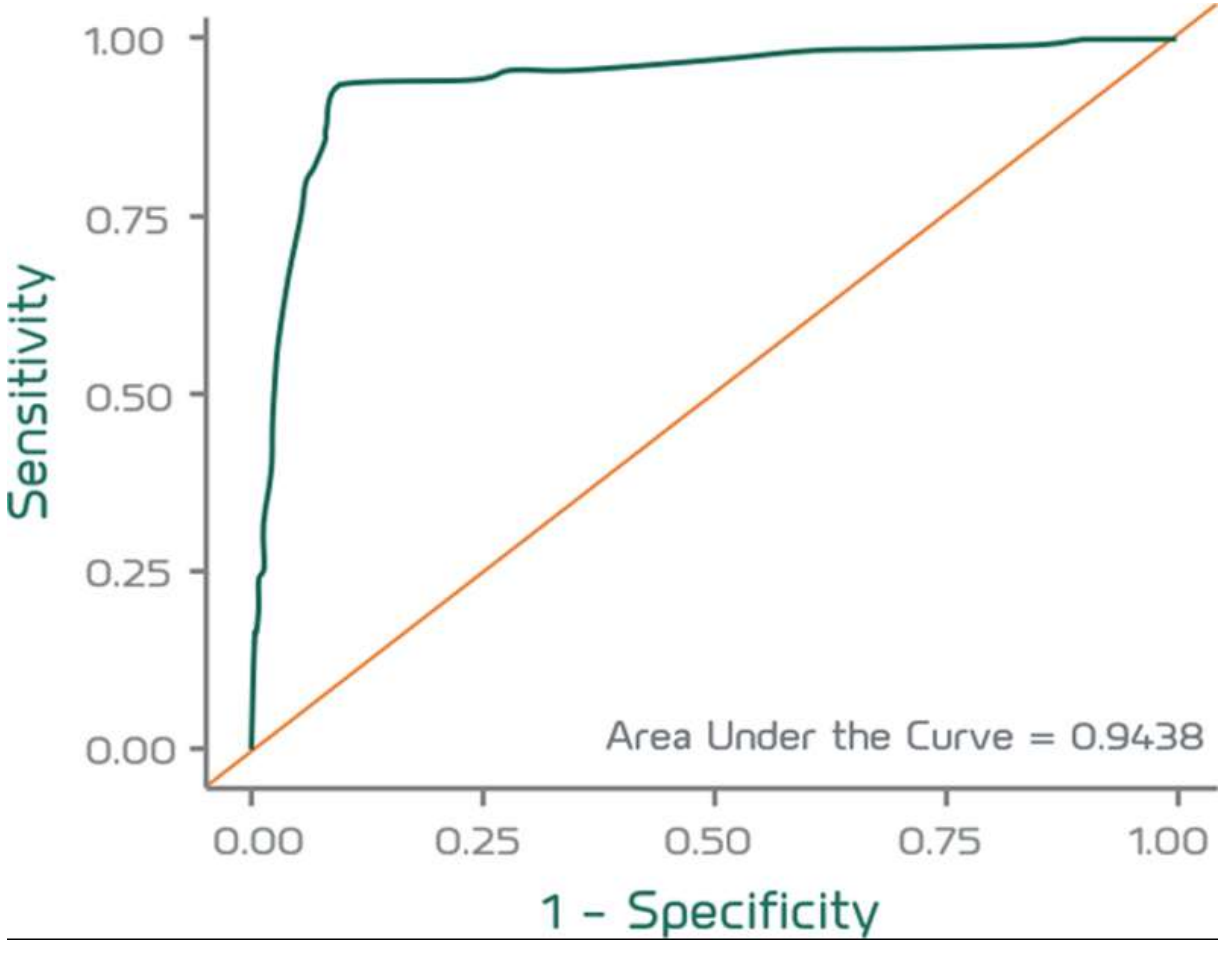


Fearon WF, et al. Circulation. 2019 Jan 22;139(4):477-484

Accuracy of Fractional Flow Reserve Derived From Coronary Angiography

FAST-FFR Study

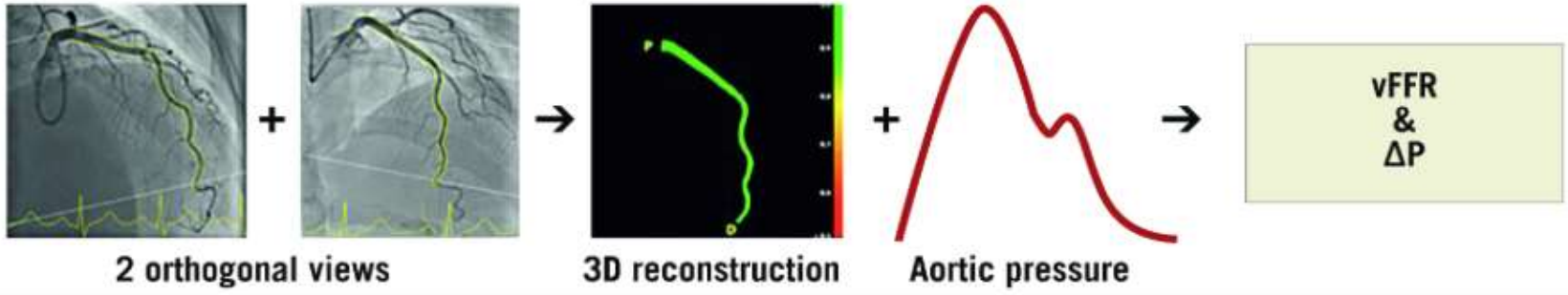
FFR angio

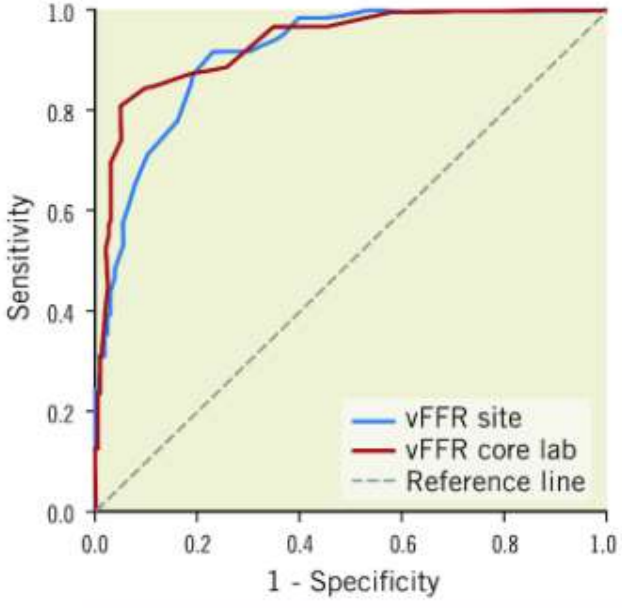


Fearon WF, et al. Circulation. 2019 Jan 22;139(4):477-484

Vessel fractional flow reserve (vFFR) for the assessment of stenosis severity: the FAST II study.

vFFR





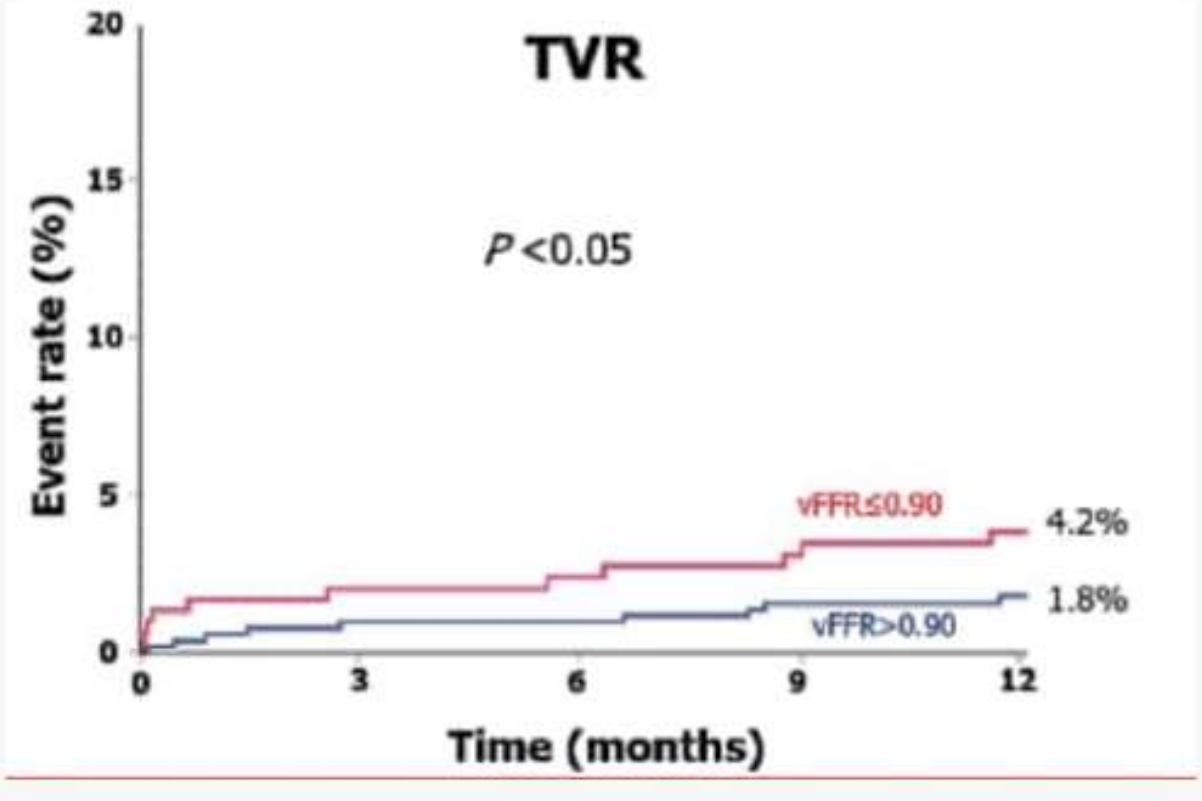
	vFFR core lab	vFFR site
AUC [95% CI]; *p*-value	0.93 [0.90-0.96] *p*<0.001	0.91 [0.88-0.94] *p*<0.001
PPV	90%	79%
NPV	90%	85%
Accuracy	90%	83%
Sensitivity	81%	71%
Specificity	95%	89%

Caas vFFR Pie Medical Imaging

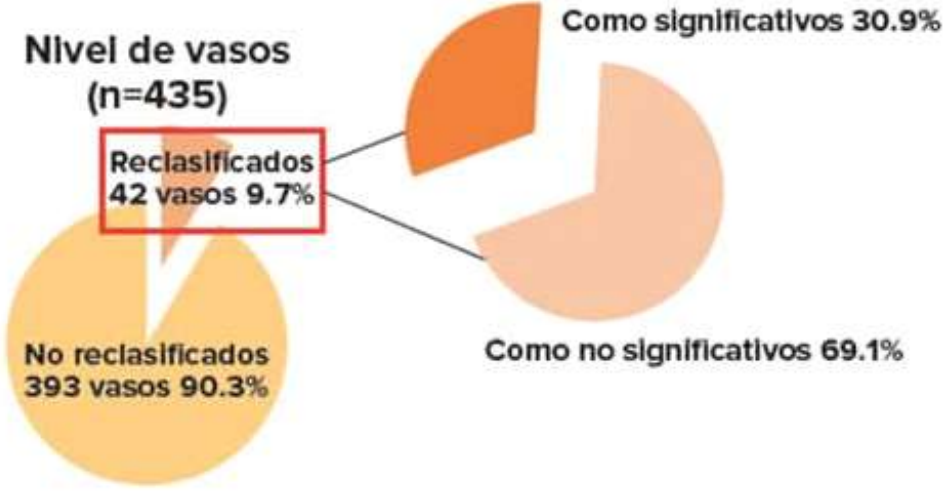
Masdjedi K, et al EuroIntervention. 2022;17(18):1498–505.

Vessel fractional flow reserve (vFFR) for the assessment of stenosis severity: the FAST II study.

Caas vFFR **Pie Medical Imaging**

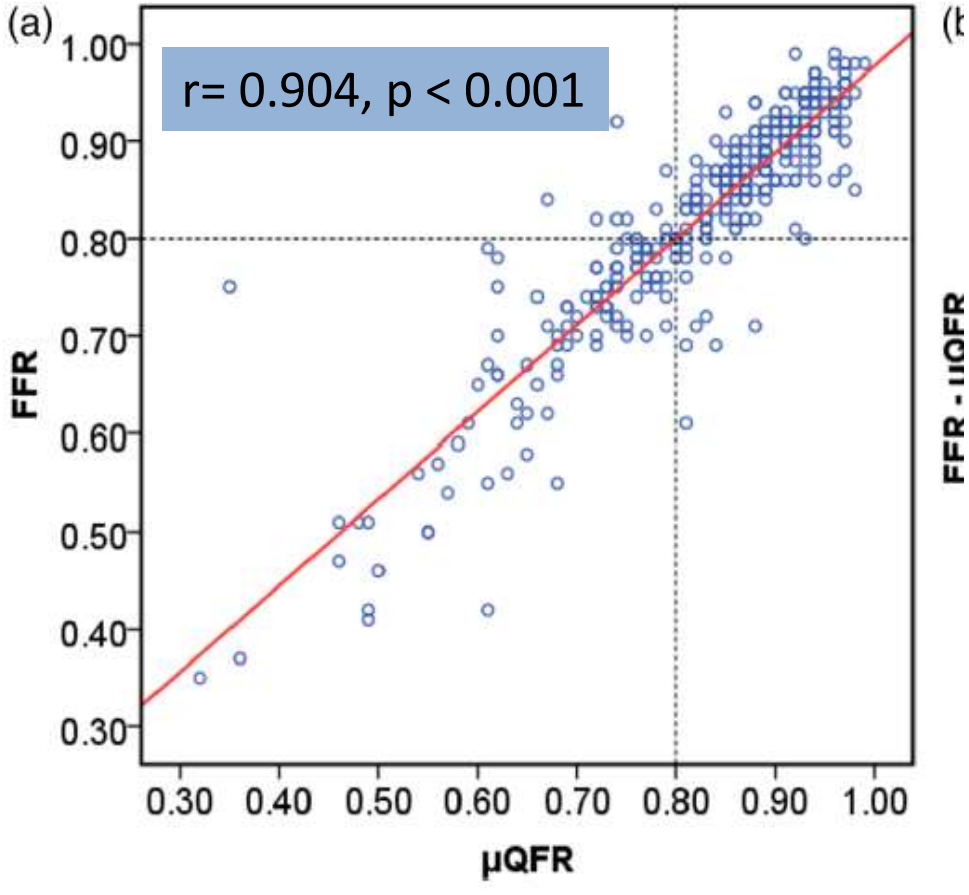


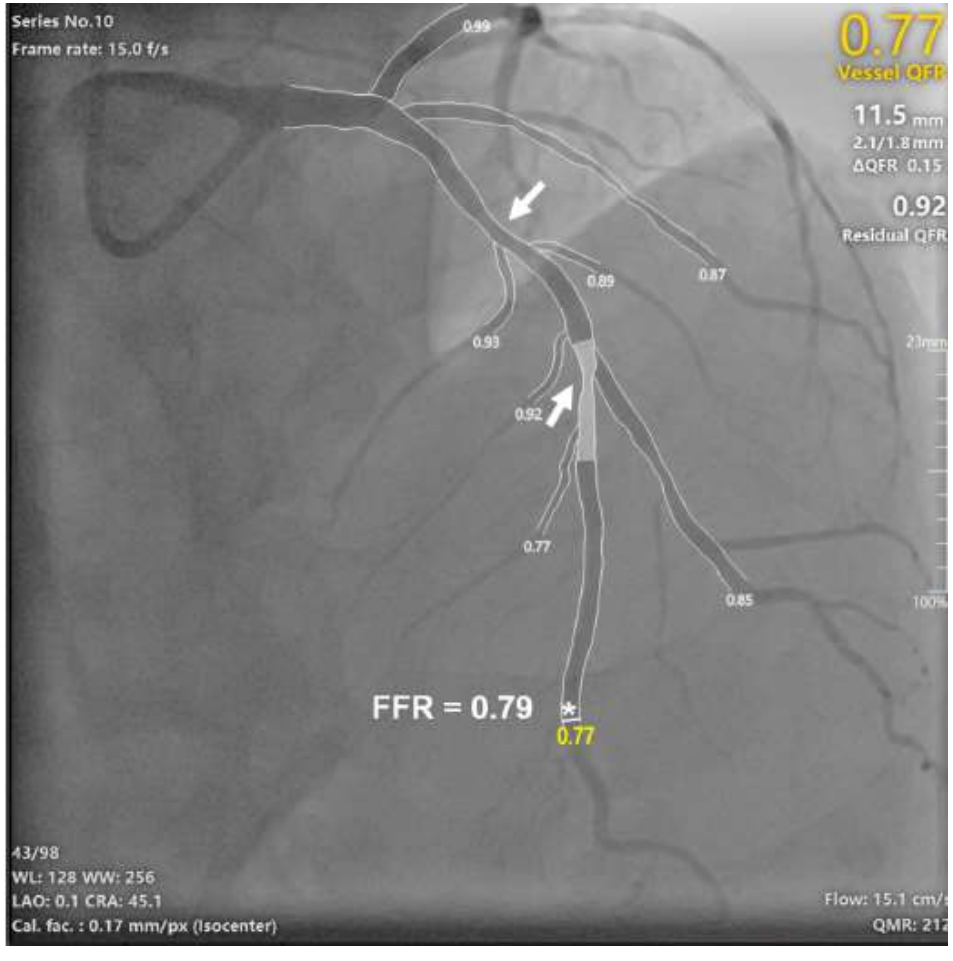
TCT 2019



TCT 2020

Diagnostic accuracy of quantitative flow ratio for assessment of coronary stenosis significance from **a single angiographic view**: a novel method based on bifurcation fractal law. ***(μQFR)***





Tu S, et al Catheter Cardiovasc Interv. 2021 May 1;97 Suppl 2:1040-1047.

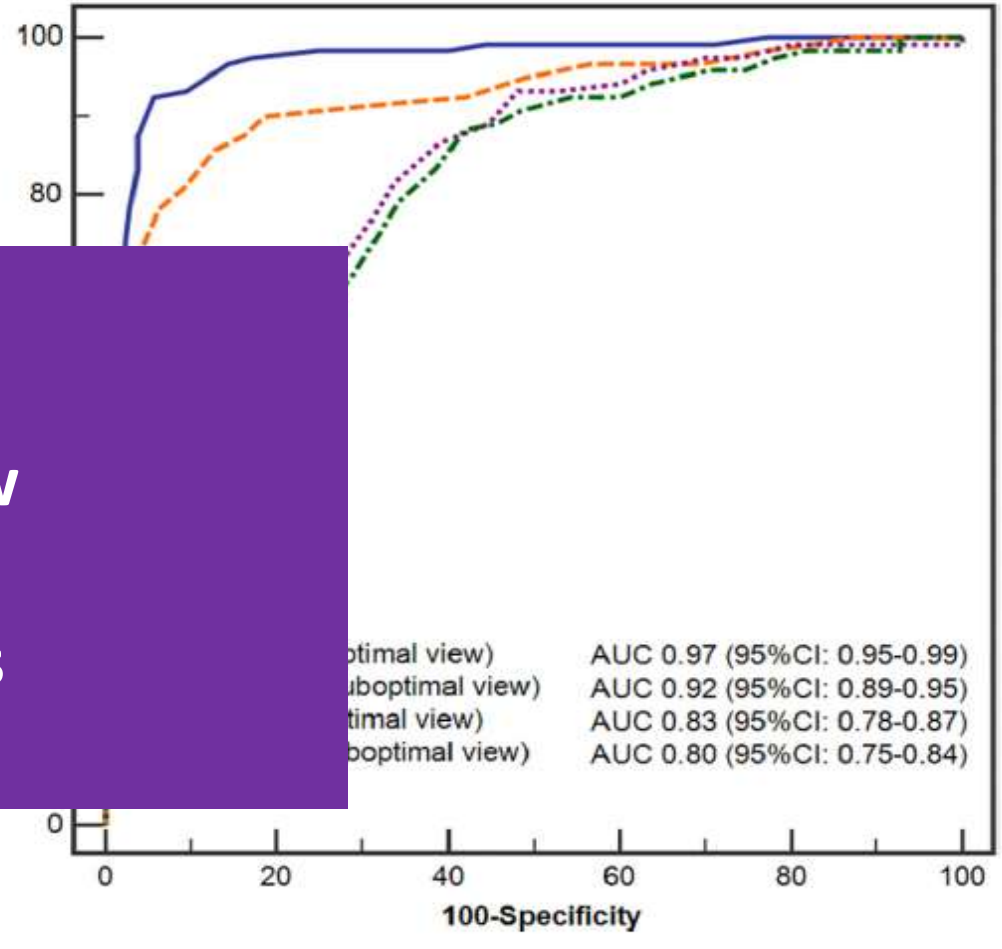
Diagnostic accuracy of QFR for assessment of coronary stenosis significance from **a single angiographic view**: a novel method based on bifurcation fractal law. ***(µQFR)***

Diagnostic performance of uQFR and QCA-derived %DS **in predicting FFR ≤0.80**

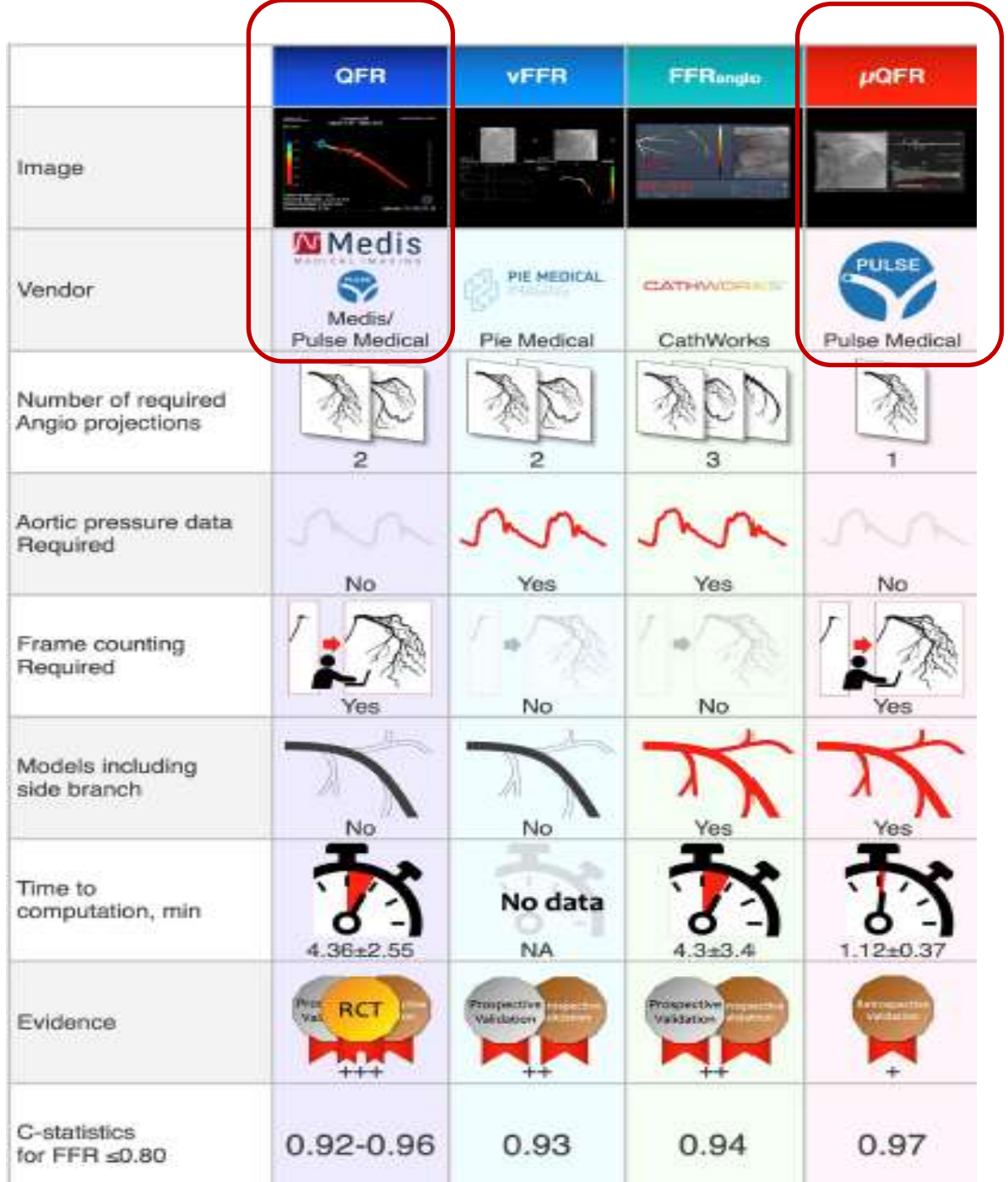
Accuracy, % (95% C	
Sensitivity, % (95%	
Specificity, % (95%	
PPV, % (95% CI)	
NPV, % (95% CI)	

Comparison µQFR vs QFR:

- **Needs only one single view**
- **Faster (1 vs 5 minutes)**
- **Allows bifurcation analysis**



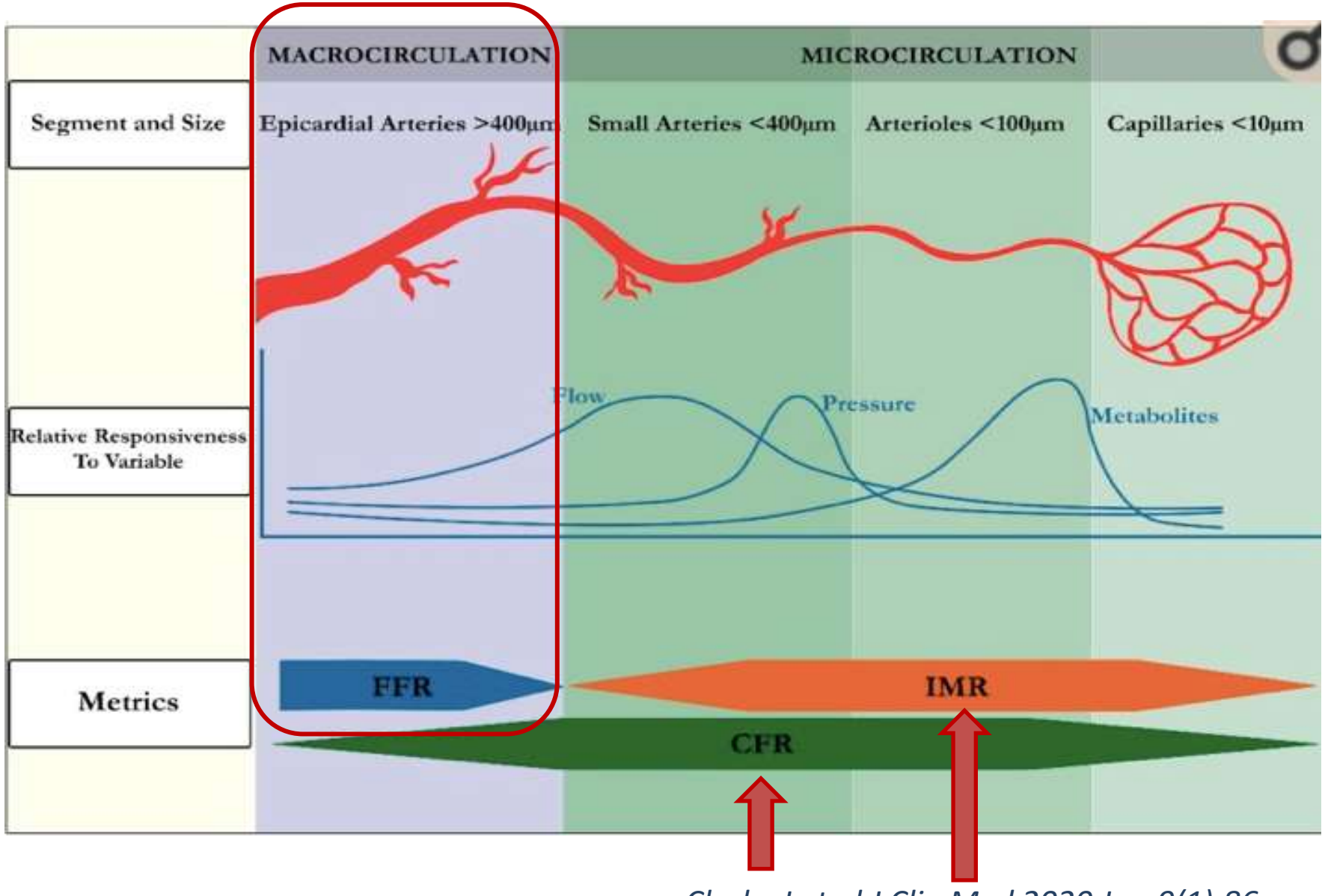
Tu S, et al Catheter Cardiovasc Interv. 2021 May 1;97 Suppl 2:1040-1047.



Consensus document on the clinical application of invasive functional coronary angiography from the Japanese Association of Cardiovascular Intervention and Therapeutics

Asano T, et al Cardiovasc Interv Ther. 2024 Apr;39(2):109-125.

Coronary mocrocirculation assessment using wire-free conventional coronary angiograms

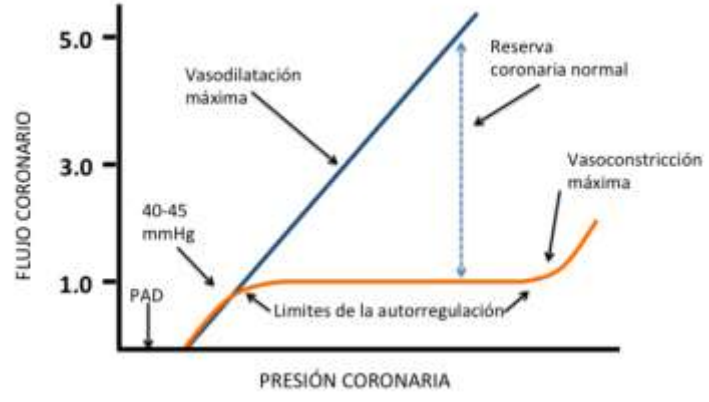


Clarke J et al J Clin Med 2020 Jan;9(1):86

Invasive

Coronary Flow Reserve

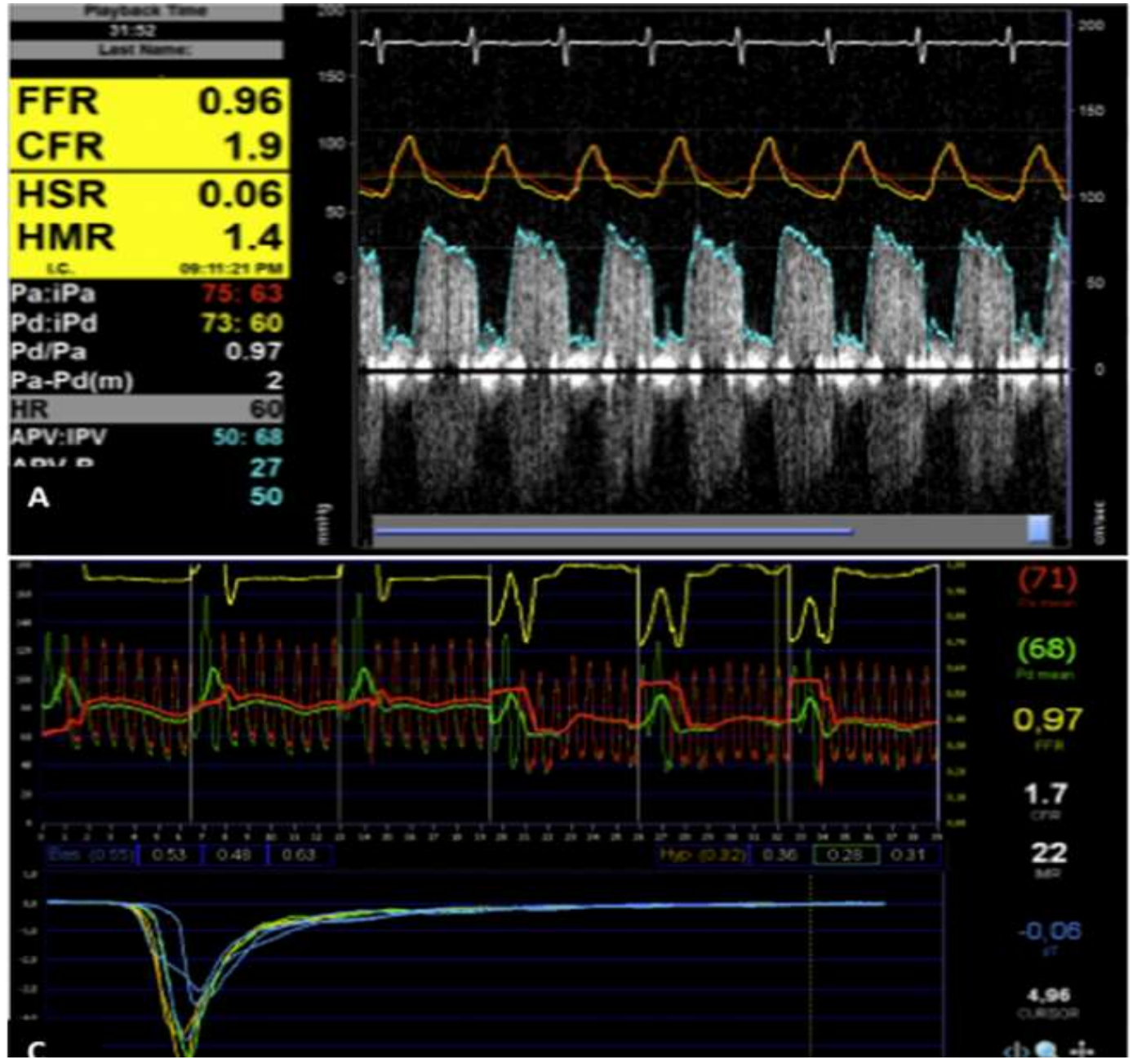
$$CFR = \frac{\text{Hyperemic Flow}}{\text{Resting Flow}}$$



CFR Doppler wire

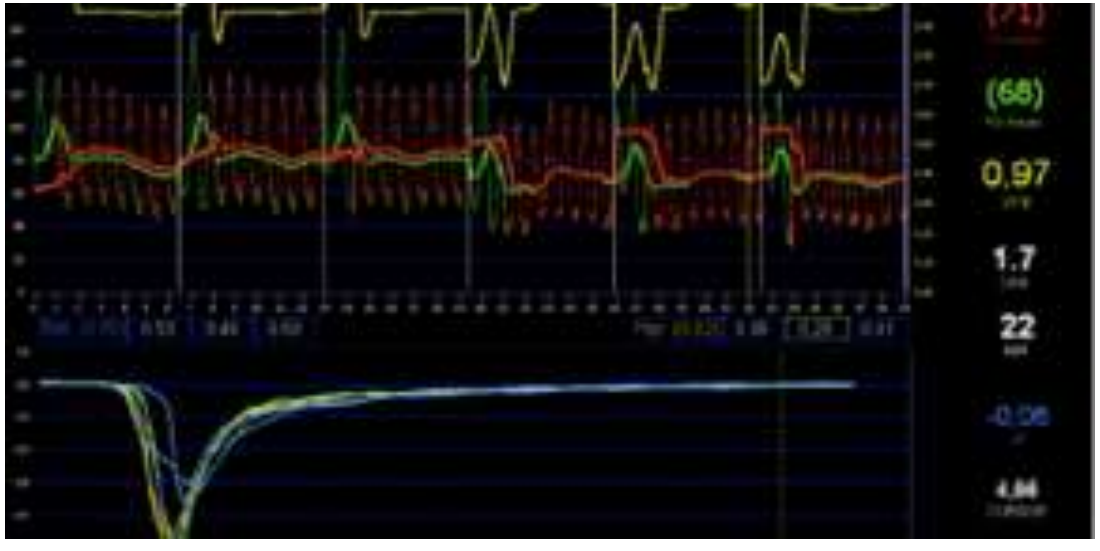
CFR thermodilution

CFR continuous thermodilution



Williams R et al Am J Cardiol 2018;121:1–8)

$$F = \frac{V}{T_{mn}}$$



F: Flujo

V: Volúmen (en general 3 ml de solución salina)

T_{mn}: tiempo de tránsito entre la inyección y el sensor

Index of Microcirculatory Resistance (IMR)

$$\mathrm{IMR} = \frac{P_d}{\left(\frac{1}{T_{mn}}\right)},$$

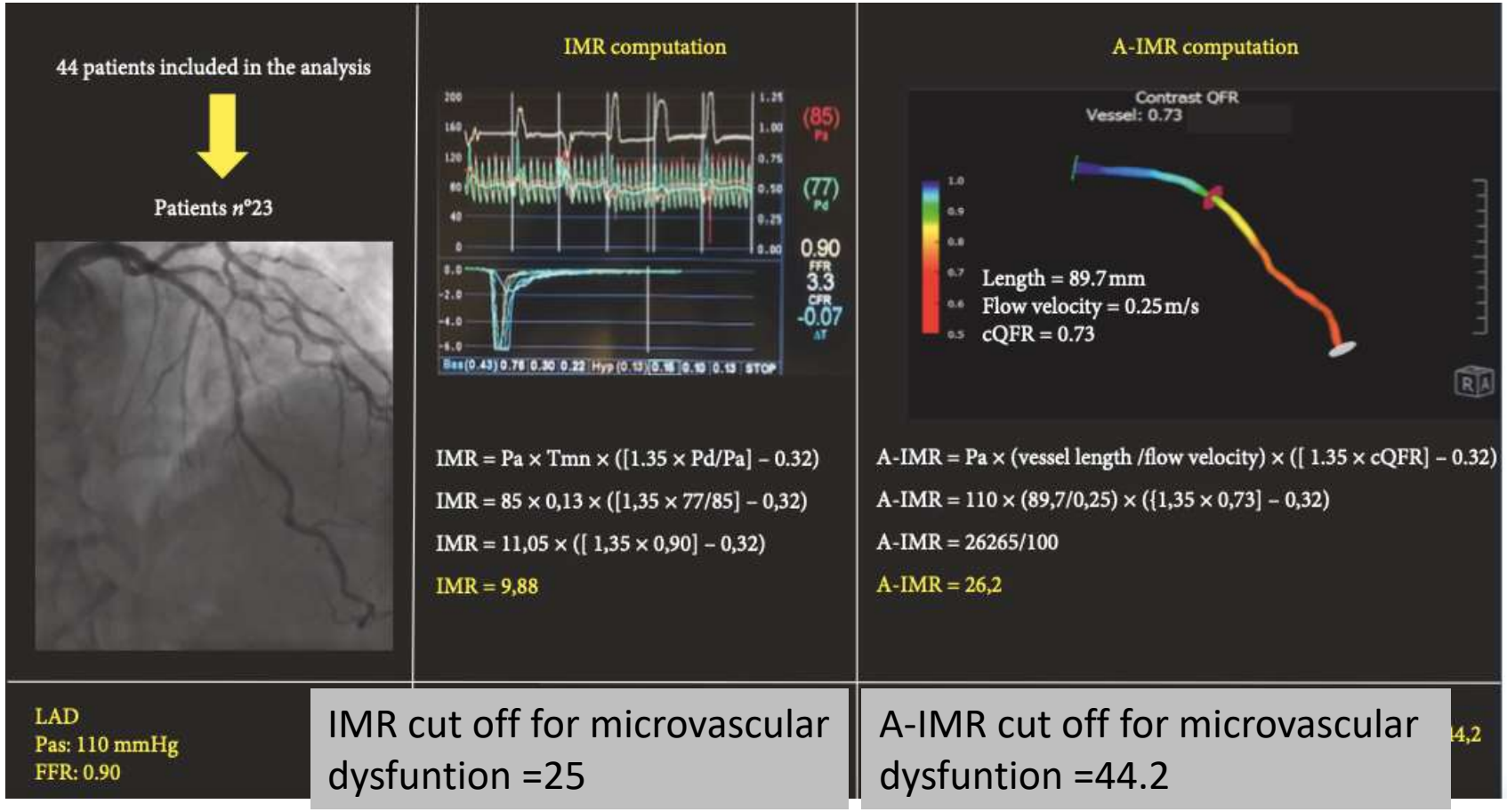
$$R = \frac{\Delta P}{Q},$$

$$\mathrm{IMR} = P_d \times T_{mn},$$

Coronary microcirculation assessment using Functional Angiography

Angio-Based Index of Microcirculatory Resistance for the Assessment of the Coronary Resistance: A Proof of Concept Study

$$A - IMR = \frac{Pa \times (\text{vessel length/flow velocity}) \times ([1.35 \times cQFR] - 0.32)}{100}.$$

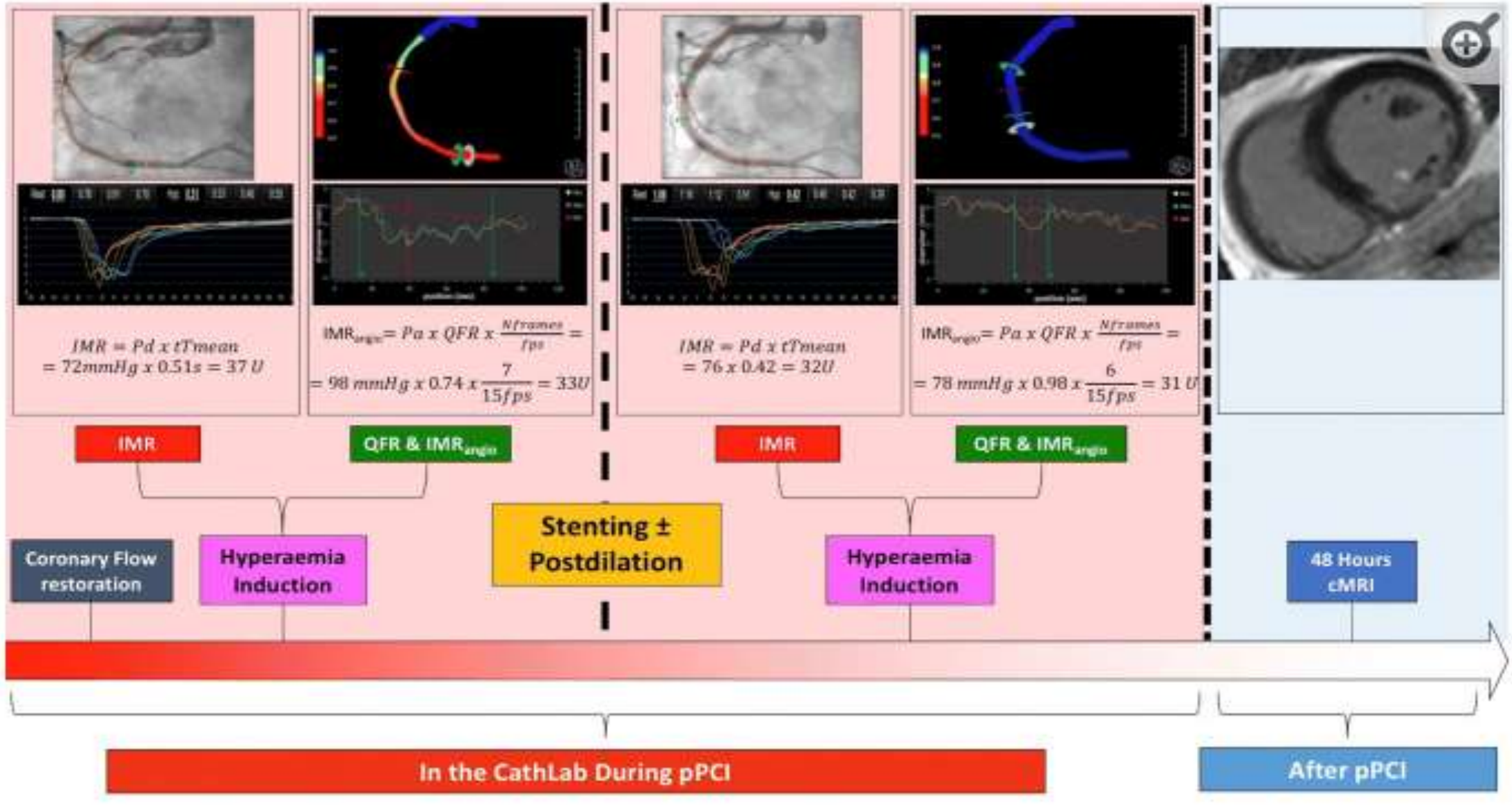


IMR cut off for microvascular dysfuntion =25

A-IMR cut off for microvascular dysfuntion =44.2

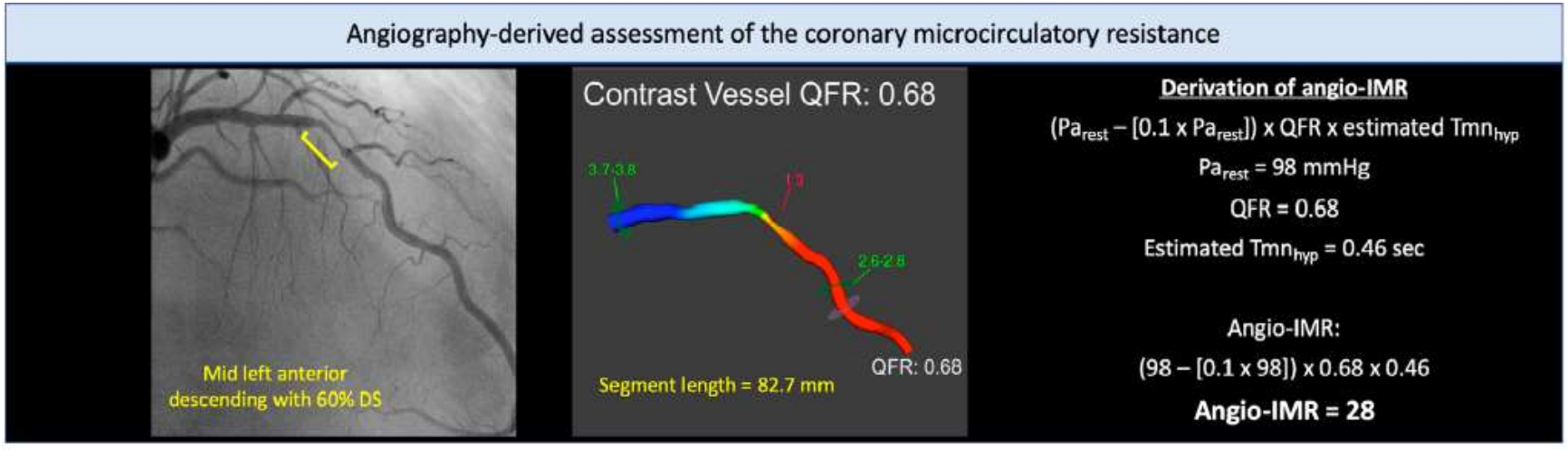
Tebaldi M, et al . J Interv Cardiol. 2020 Oct 25;2020:8887369.

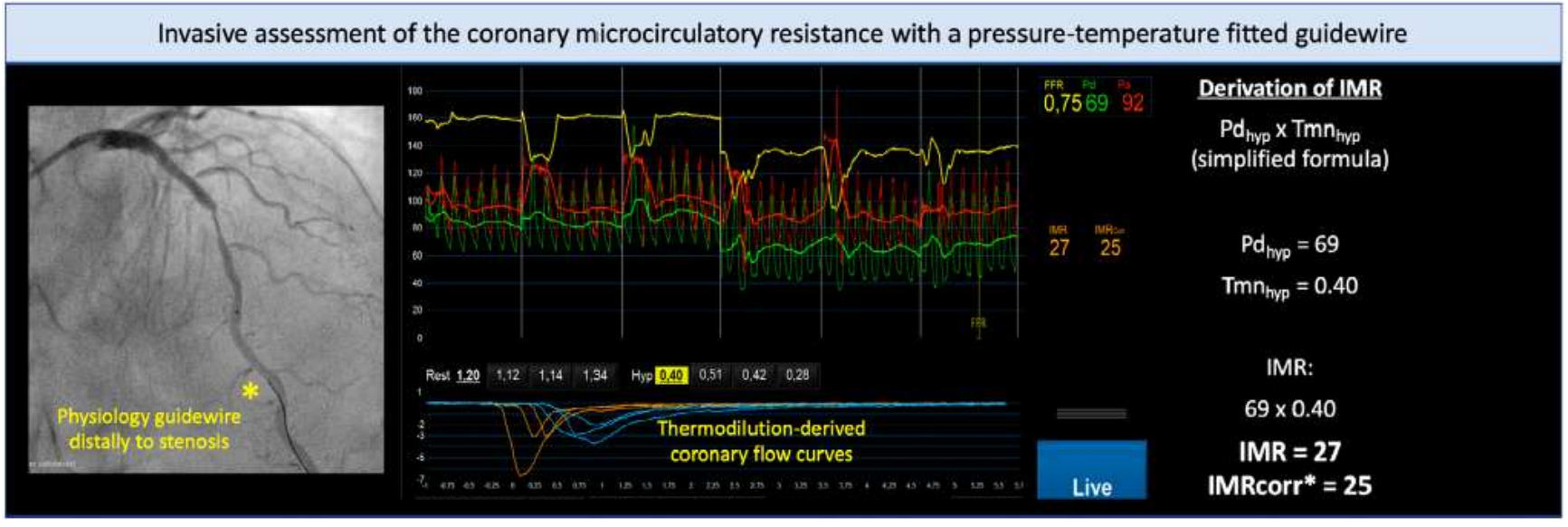
Angiography-derived index of microcirculatory resistance as a novel, pressure-wire-free tool to assess coronary microcirculation in ST elevation myocardial infarction



De Maria GL, et al Int J Cardiovasc Imaging. 2020 Aug;36(8):1395-1406.

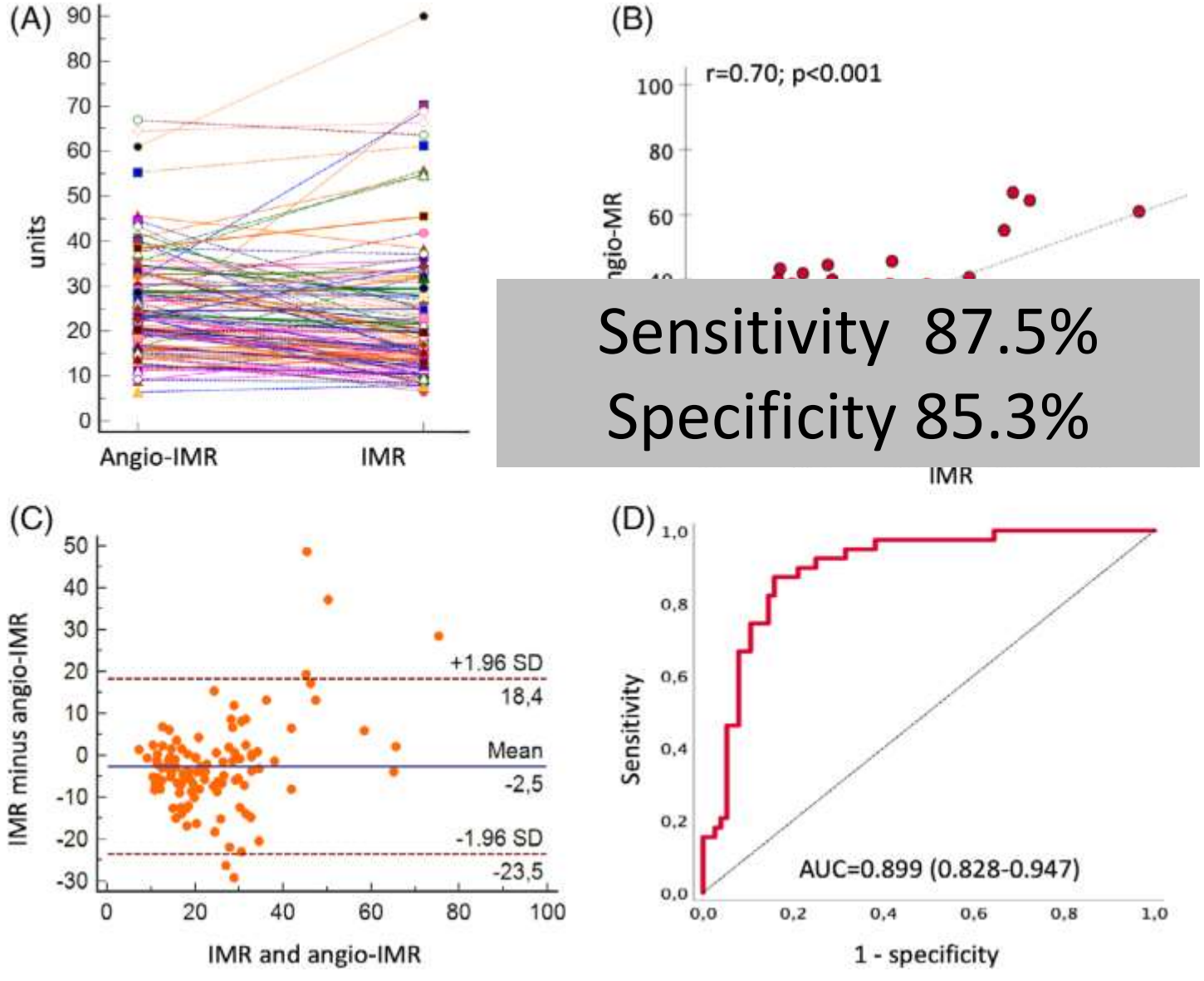
$$\text{Angio} - \text{IMR} = (\text{Pa}_{\text{rest}} - [0.1 * \text{Pa}_{\text{rest}}]) * \text{QFR} * (\text{vessel length} / \text{V}_{\text{hyp}})$$





Mejia-Renteria H, et al. *Catheter Cardiovasc Interv.* 2021;98:1027–37

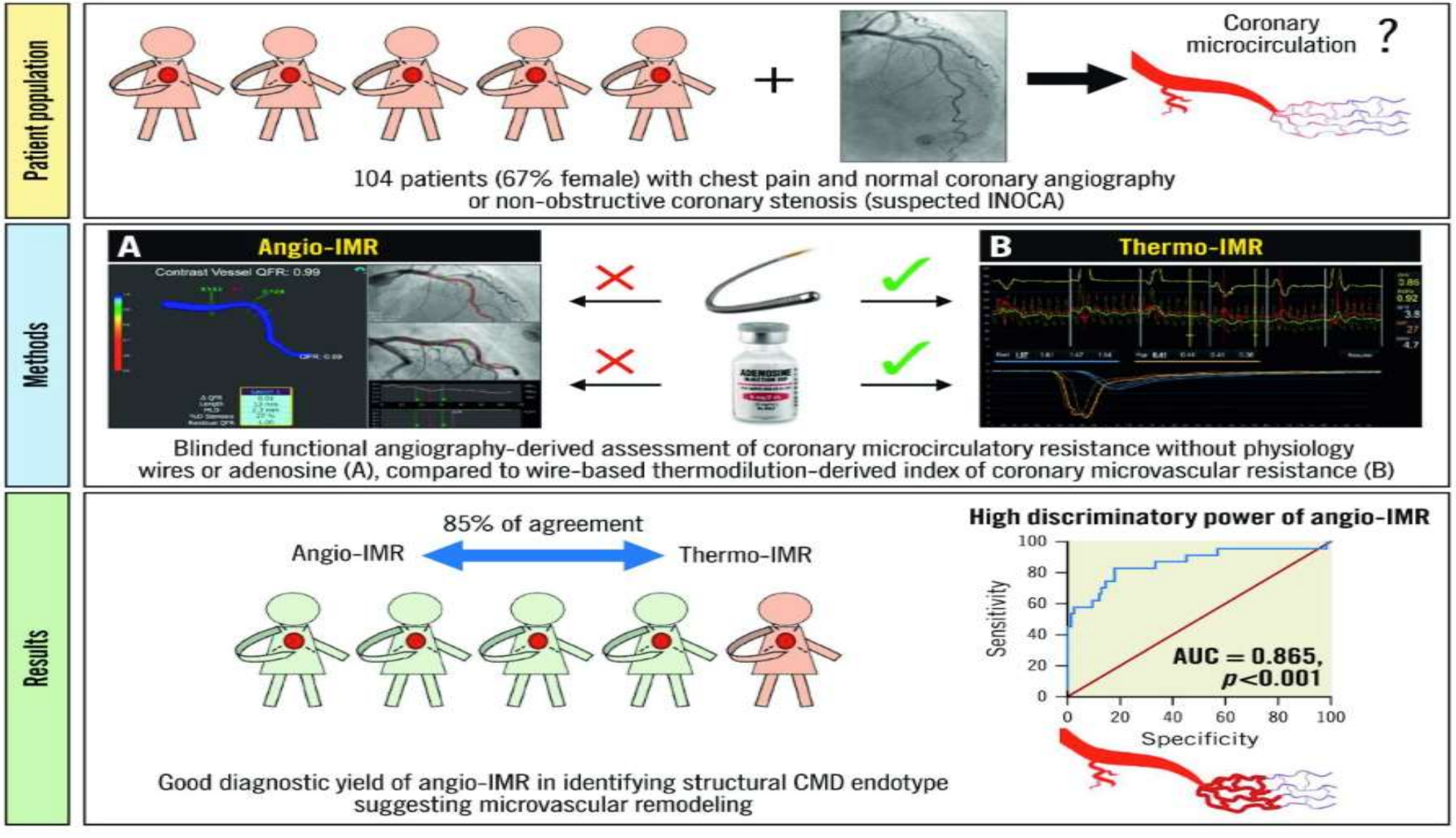
*Coronary **microcirculation** assessment using FCA*



Sensitivity 87.5%
Specificity 85.3%

Mejia-Renteria H, et al. Catheter Cardiovasc Interv. 2021;98:1027–37

Diagnostic yield of angiography-derived assessment of coronary microcirculatory resistance in patients with suspected myocardial ischaemia and non-obstructive coronary arteries (INOCA)



Mejía-Rentería H, Escaned J. Et al. EuroIntervention. 2023 Apr 3;18(16)

Take-home message

*In recent years, major technical developments in the field of coronary imaging (invasive angiography and CCTA) have made it possible to obtain **functional** information from a primary **anatomical** examination.*

*The evaluation of coronary microcirculatory resistance in patients with INOCA síndrome using cAngio-IMR from coronary angiography is **feasible** and **accurate.***

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jagalvarez@hbritanico.com.ar

Take-home message

*In recent years, major technical developments in the field of coronary imaging (invasive angiography and CCTA) have made it possible to obtain **functional** information from a primary **anatomical** examination.*

*The evaluation of coronary microcirculatory resistance in patients with INOCA síndrome using cAngio-IMR from coronary angiography is **feasible** and **accurate.***

PHILIPS

Friday 10:40 / 12:00 Buen Ayre A Contemporary Management of INOCA patients: Practical Guideliness

(15') - General discussion and key Learning points Alc&#65533;ntara, Marco Antonio - Chairman
(5') - Welcome and Session Objectives. &#65533;lvarez, Jos&#65533; Amadeo Guillermo - Chairman
(10') - INOCA Prevalence and Causes: Between Epicardial and Microvascular Factors. Paiva, Maria Sanali - Speaker
(10') - Invasive Physiological Assessment of Coronary Disease (FFR and iFR). Dauvergne Maya, Christian - Speaker
(10') - Functional Coronary Angiography for the Assessment of Epicardial Vessels and Microcirculation. &#65533;lvarez, Jos&#65533; Amadeo Guillermo - Speaker
(10') - Endotype-Based INOCA Management. Mehran, Roxana - Speaker
Rubilar, Bibiana - Panelist
Galon, Micheli - Panelist
Rivero, Mirza Vanessa - Panelist
Ponce, Juan Manuel - Panelist
Vigo, C&#65533;sar Federico - Panelist
Rifourcat, Ignacio - Panelist