

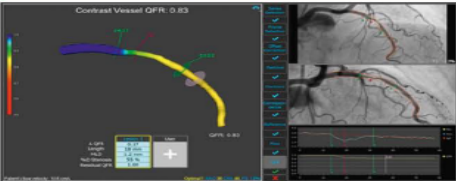
IMAGING & PHYSIOLOGY

FFRangio: dalle evidenze alla trasformazione della pratica clinica

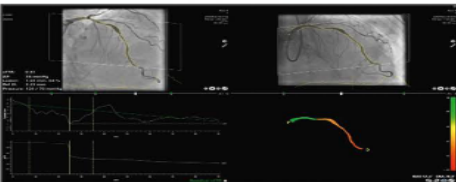
***Fabrizio Tomai, MD, FACC, FESC
European Hospital
Aurelia Hospital
Rome
fabriziotomai@gmail.com***

Current commercially available functional indices based on invasive coronary angiography

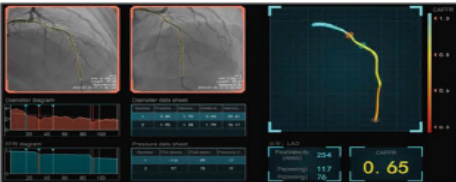
Quantitative Flow Ratio (QFR)_2016

User display	Projections needed	Pressure sensor	Microcirculation	Side branches	Available data
	2	No	Yes	No	FAVOR III CHINA FAVOR III EUR FLAVOUR II

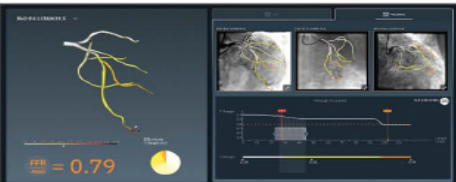
Vessel fractional Flow reserve (CAAS vFFR)_2019

	2	No	No	No	FAST II FAST III
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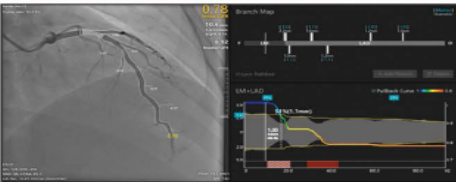
Computational pressure-flow dynamics derived FFR (caFFR)_2019

	2	Yes	Yes	No	Flash-FFR
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Coronary angiography-derived FFR (FFR angio)_2016

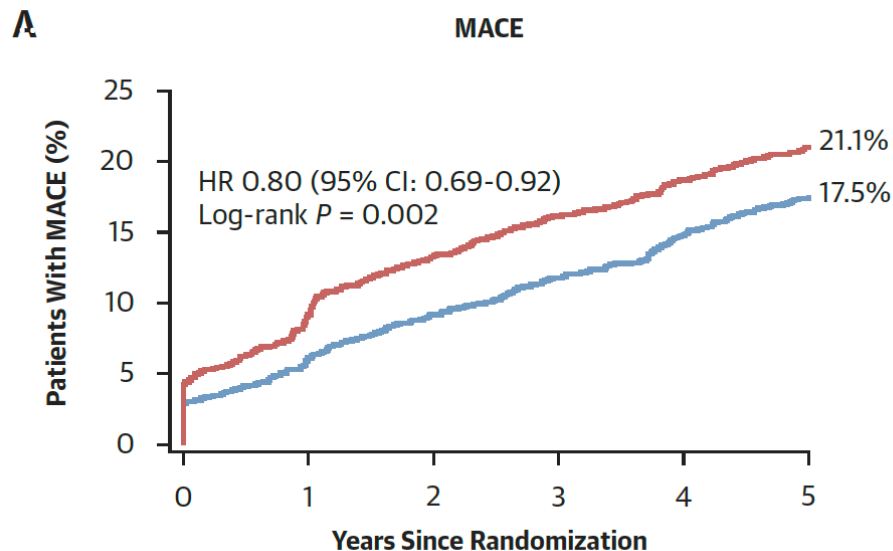
	3	Yes	No	Yes	FAST-FFR ALL-RISE
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Murry law-based FFR (μ QFR)_2021

	1	No	Yes	Yes	FLAVOUR II
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Angiographic Quantitative Flow Ratio-Guided Coronary Intervention

5-Year Follow-Up From the FAVOR III China Randomized Trial



Number at risk

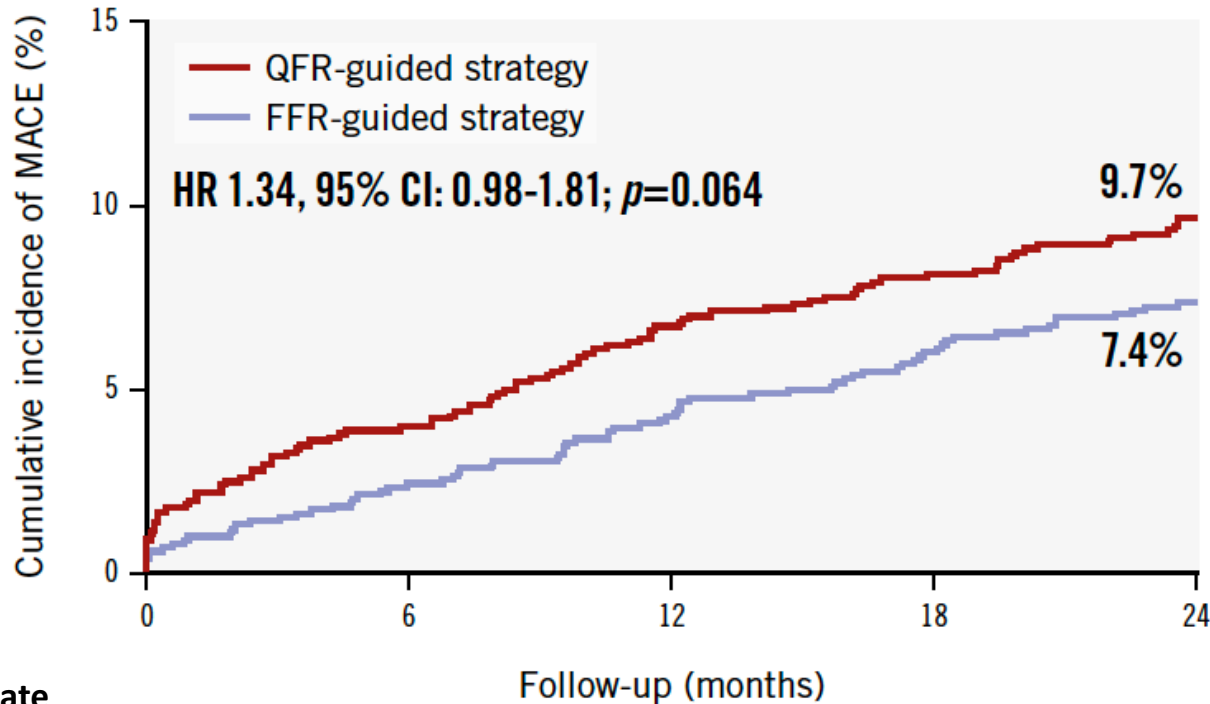
— 1,913 1,801 1,722 1,670 1,532 1,481

— 1,912 1,740 1,645 1,586 1,444 1,400

— QFR-Guided — Angiography-Guided

Zhang H et al. JACC 2026

Quantitative flow ratio versus fractional flow reserve: 2-year follow-up of the FAVOR III Europe trial



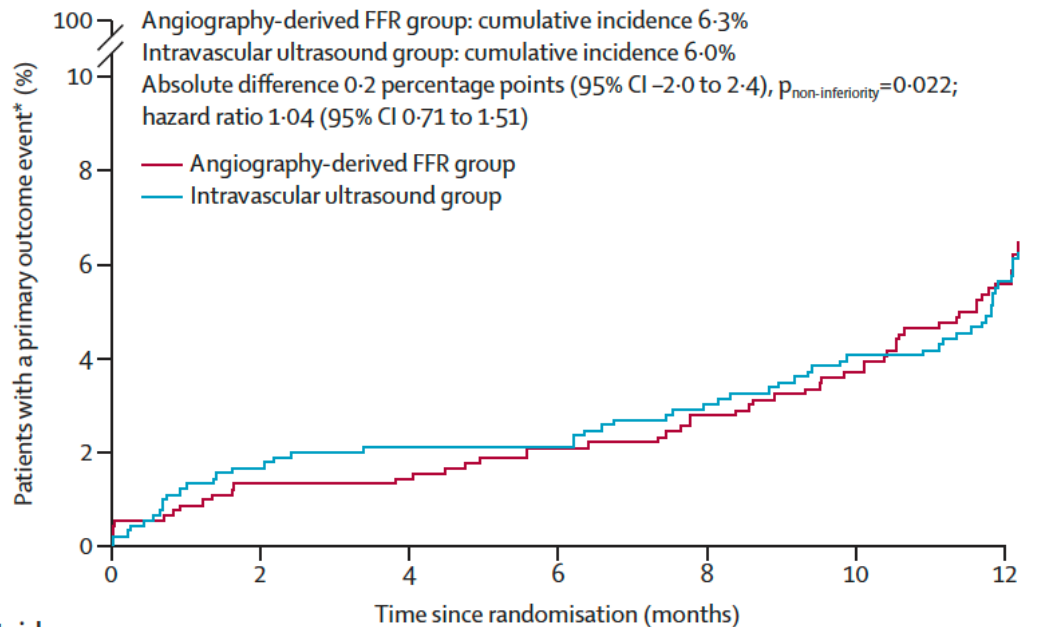
N= 2.000 pts
with intermediate
coronary stenoses

Angiography-derived fractional flow reserve versus intravascular ultrasound to guide percutaneous coronary intervention in patients with coronary artery disease (FLAVOUR II): a multicentre, randomised, non-inferiority trial

Angiography-FFR techniques:

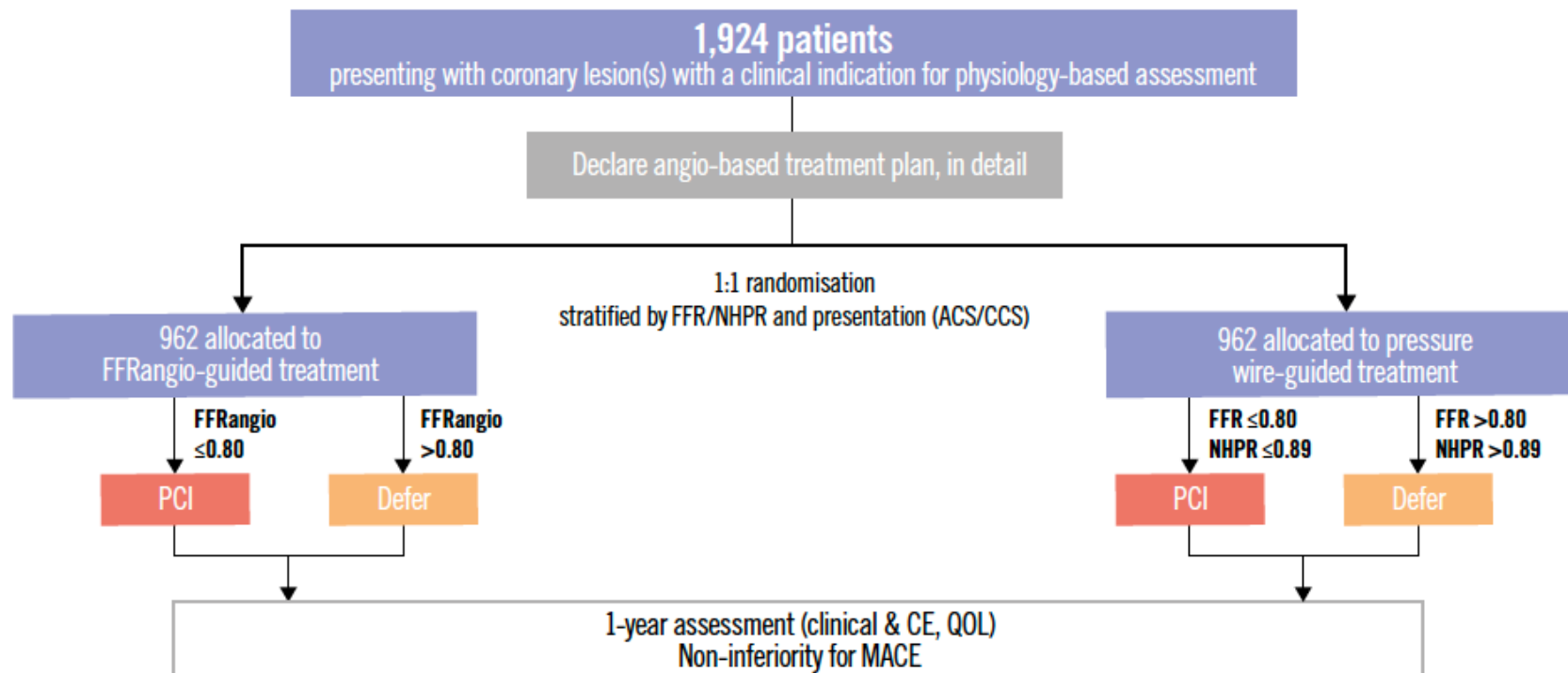
- QFR
- μ QFR

Hu X et al. Lancet 2025



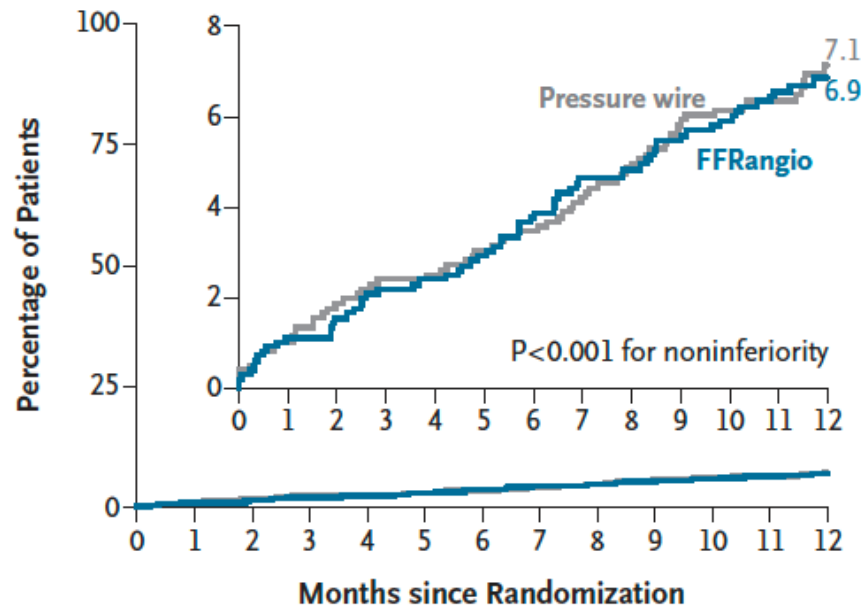
	Number at risk (number censored)						
Angiography-derived FFR group	923 (0)	904 (7)	901 (9)	894 (10)	886 (12)	865 (25)	813 (63)
Intravascular ultrasound group	916 (0)	895 (6)	888 (9)	887 (10)	878 (11)	864 (16)	809 (61)

FFRangio-guided versus pressure wire-guided PCI: design and rationale of the multicentre, randomised ALL-RISE trial



Angiography-Derived Fractional Flow Reserve to Guide PCI

A Primary End Point: Death from Any Cause, Myocardial Infarction, or Unplanned Clinically Indicated Coronary Revascularization



No. at Risk

Pressure wire 965 940

906

859

FFRangio 965 947

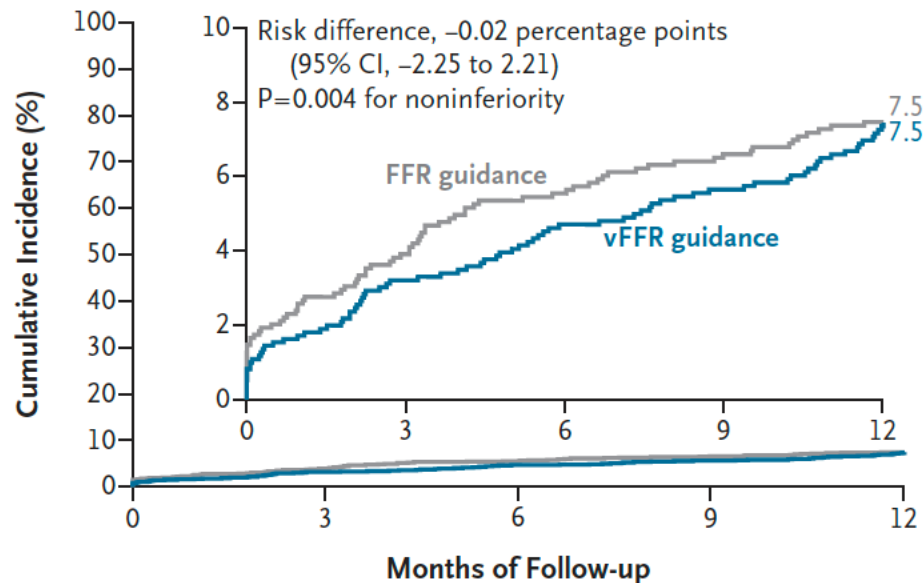
907

864

Fearon WF et al. (ALL-RISE Trial) NEJM 2026

Angiography-Based Physiology to Guide Coronary Revascularization

A Death, Myocardial Infarction, or Revascularization



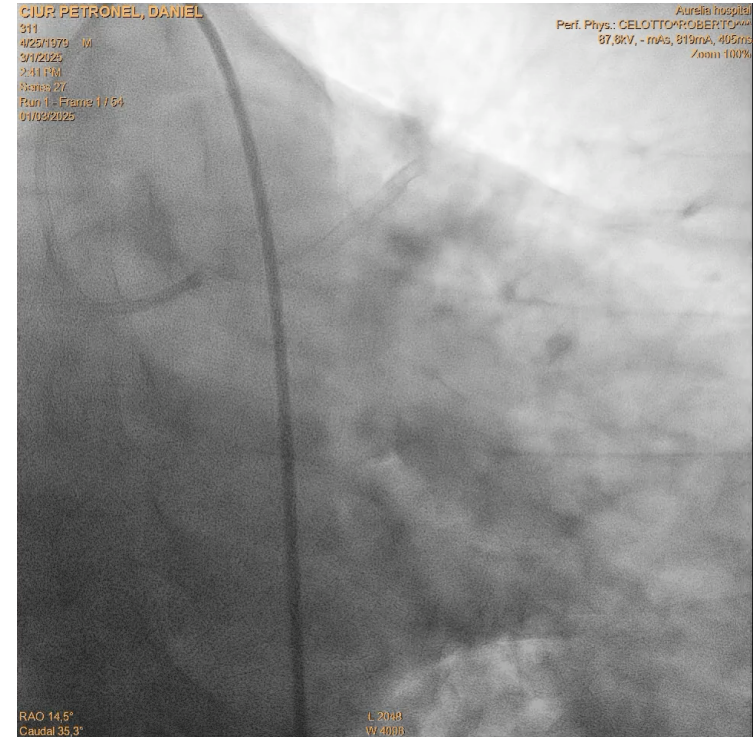
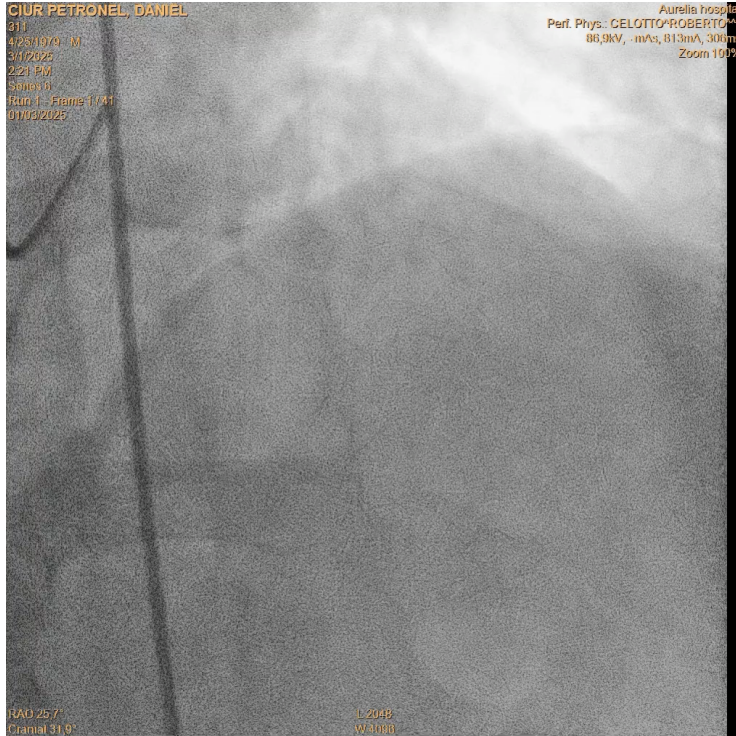
No. at Risk

FFR guidance	1095	999	981	969	953
vFFR guidance	1116	1033	1012	999	972

Clinical scenarios for functional coronary angiography

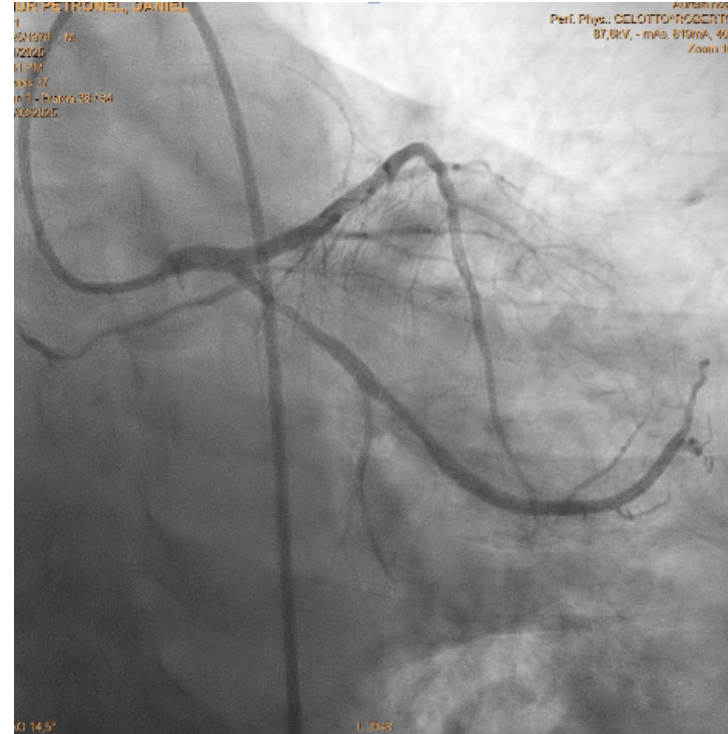
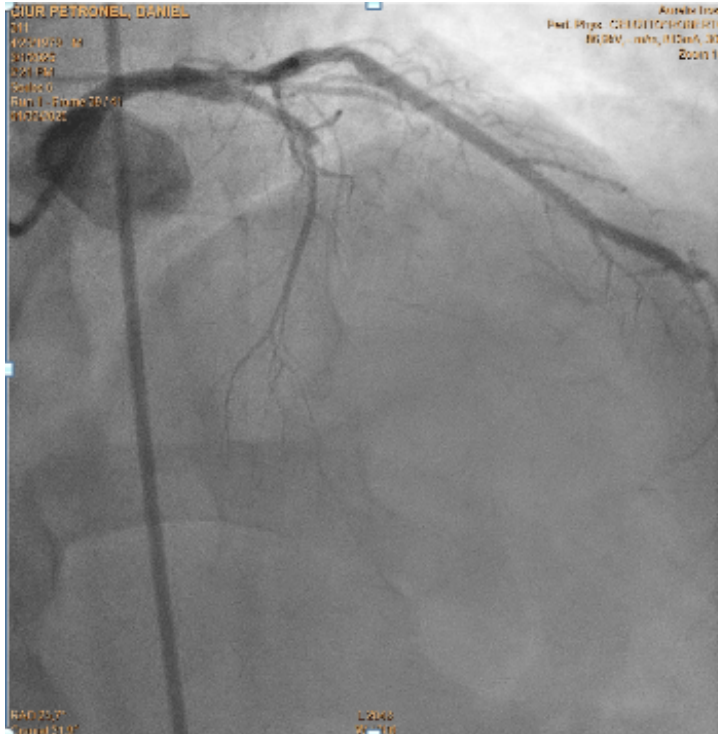
- Non culprit vessel evaluation in acute coronary syndromes
- Functional evaluation in pts with multivessel disease
- Post-PCI assessment (restrictions to additional contrast administration)
- Hybrid approach in clinical decision-making (FFR only when angio-FFR in the 'grey zone')
- Side branch evaluation after provisional bifurcation stenting
- Offline evaluation for heart team decisions

Non culprit vessel evaluation in acute coronary syndromes (Case #1)



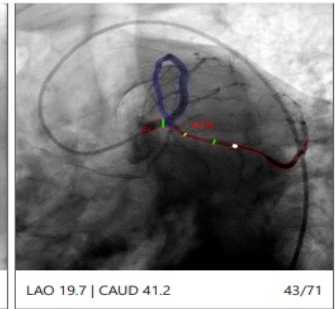
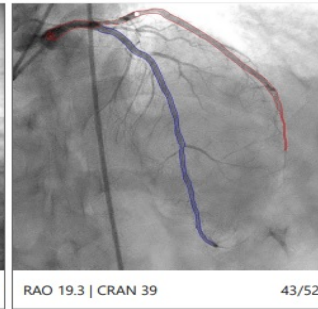
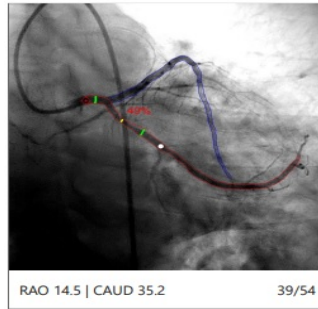
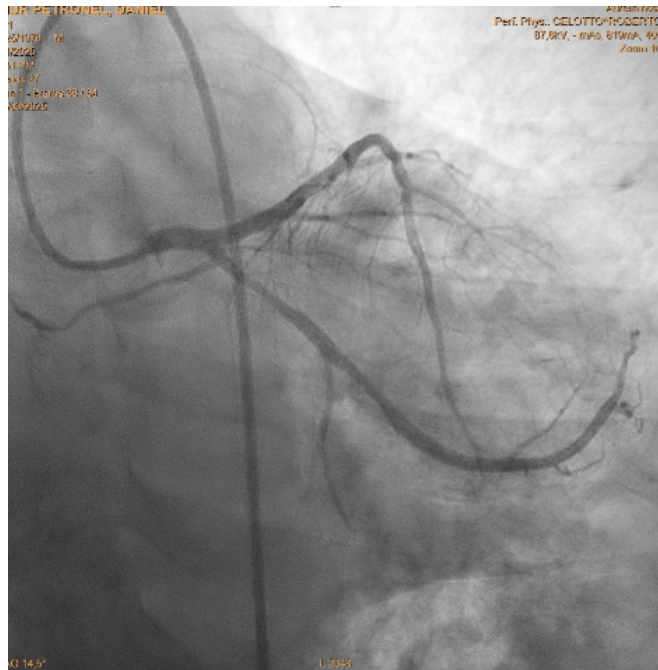
- STEMI patient with LAD occlusion and an intermediate stenosis on LCx
- PPCI of LAD and offline non invasive functional evaluation of LCX stenosis

Non culprit vessel evaluation in acute coronary syndromes (Case #1)



- STEMI patient with LAD occlusion and an intermediate stenosis on LCx
- PPCI of LAD and offline non invasive functional evaluation of LCX stenosis

Non culprit vessel evaluation in acute coronary syndromes (Case #1)

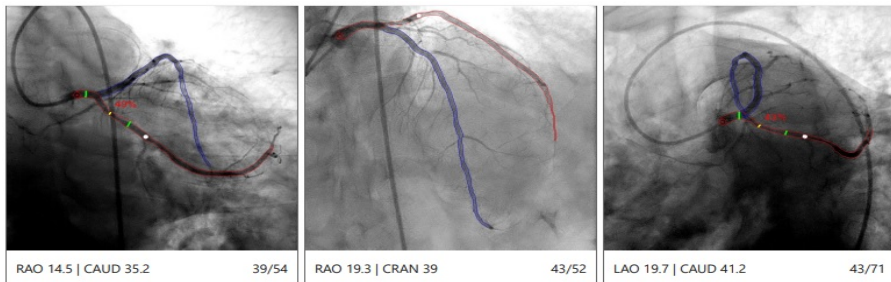


FFRango Results

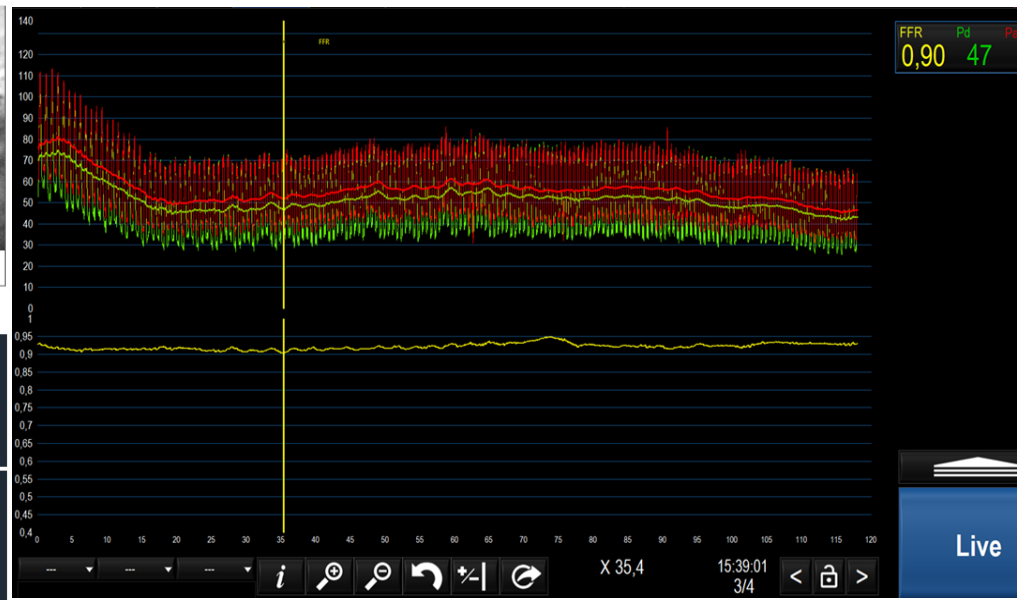


Off-line non-invasive functional evaluation of LCx with *FFR Angio*

Diagnostic performance of FFR Angio vs. Pw-FFR (Case #1)



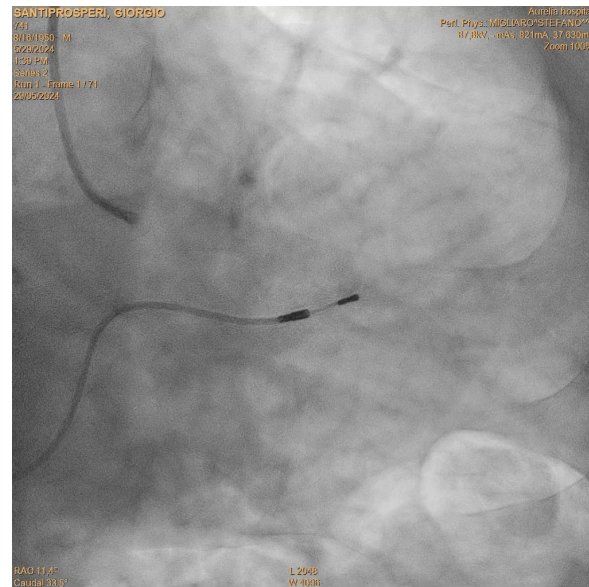
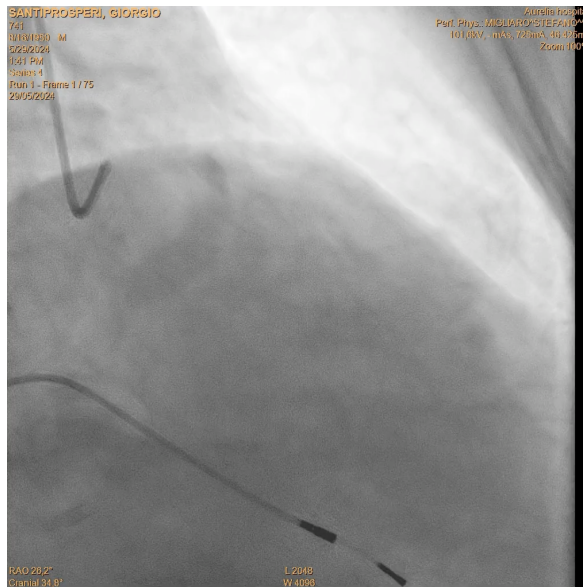
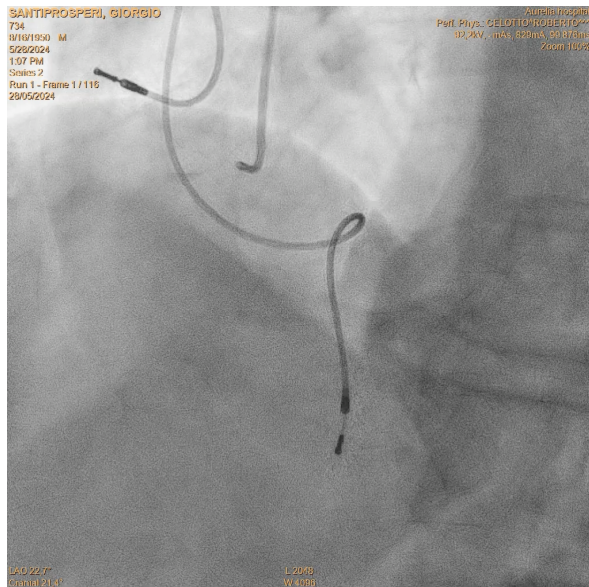
FFRangio Results



FFR Angio (LCx)

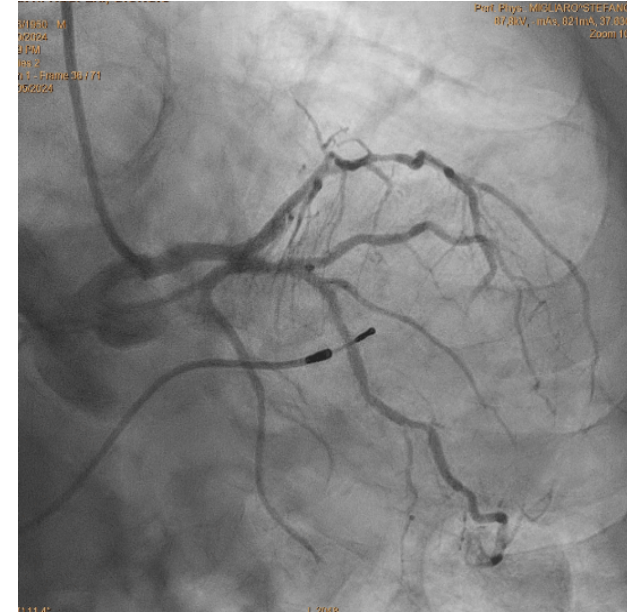
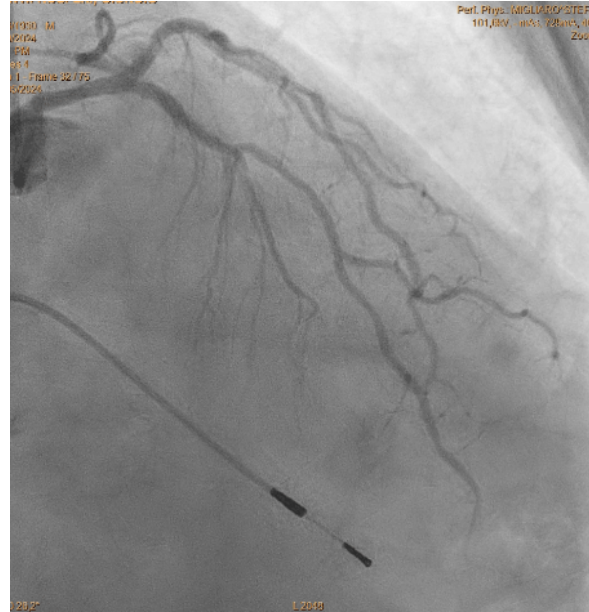
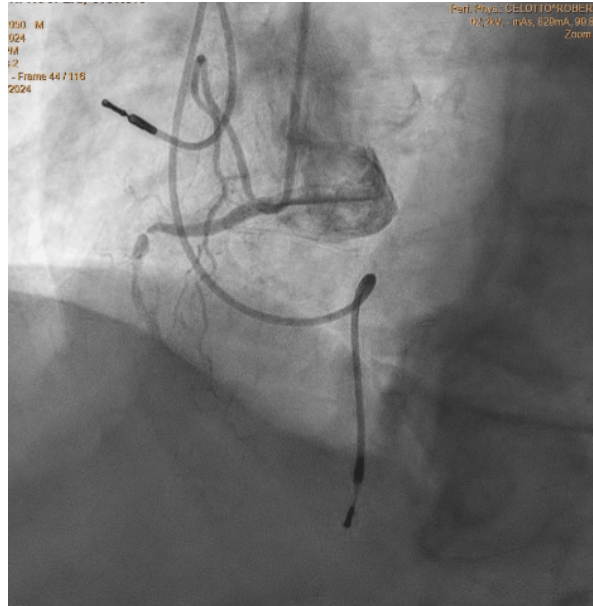
Pw-FFR (LCx)

Non invasive functional evaluation in pts with multivessel disease (Case #2)



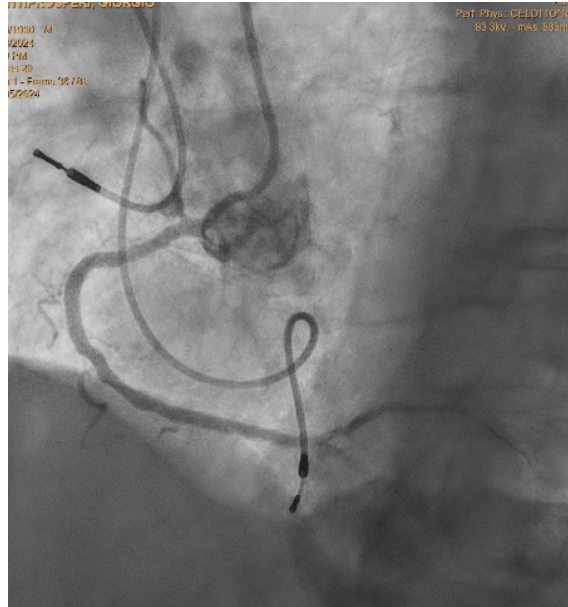
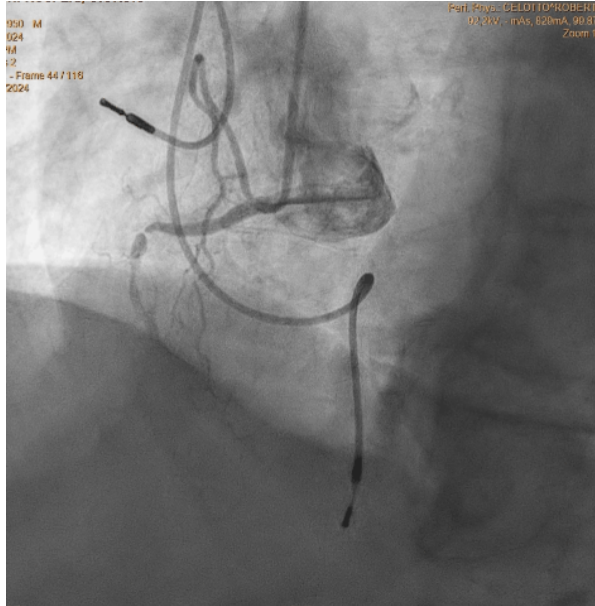
Subocclusive stenosis of RCA and intermediate lesions of LAD and LCX

Non invasive functional evaluation in pts with multivessel disease (Case #2)



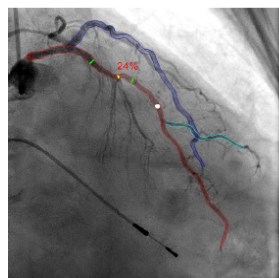
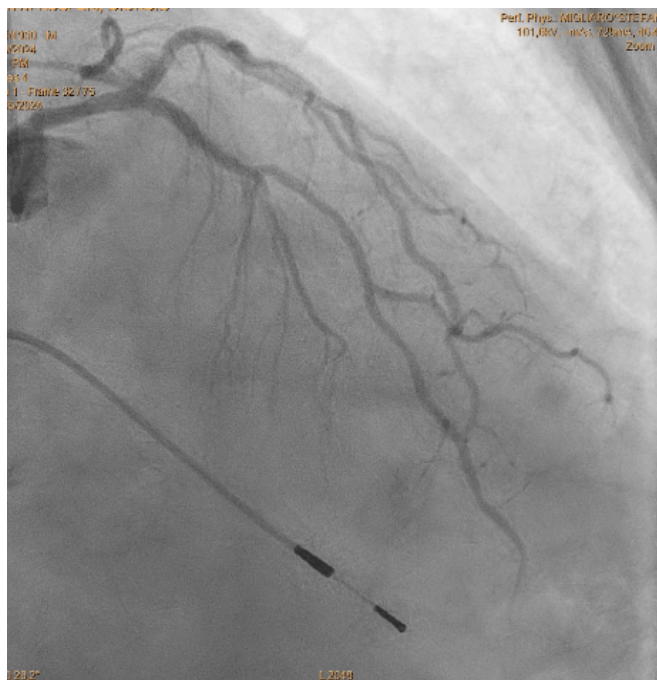
Subocclusive stenosis of RCA and intermediate lesions of LAD and LCX

Non invasive functional evaluation in pts with multivessel disease (Case #2)

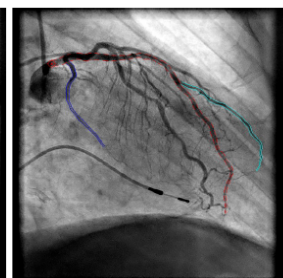


**PCI of RCA and offline non
invasive functional
evaluation of LAD and LCX
stenoses**

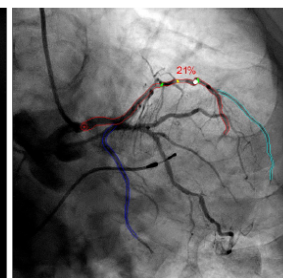
Non invasive functional evaluation in pts with multivessel disease (Case #2)



RAO 26.2 | CRAN 34.8 34/75

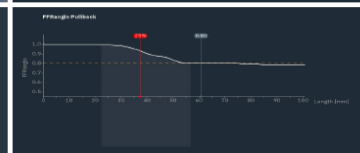
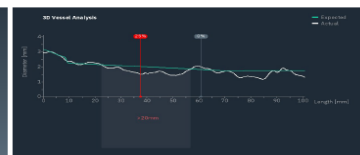
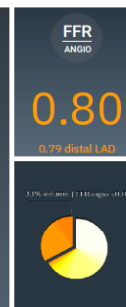


RAO 28.1 | CRAN 3.3 36/68



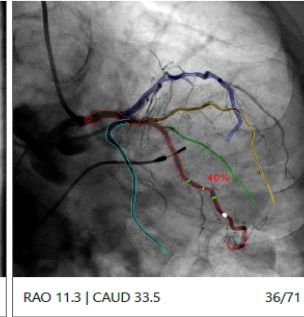
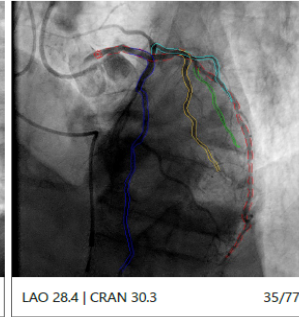
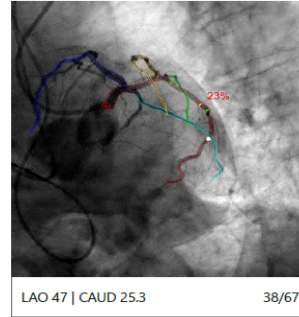
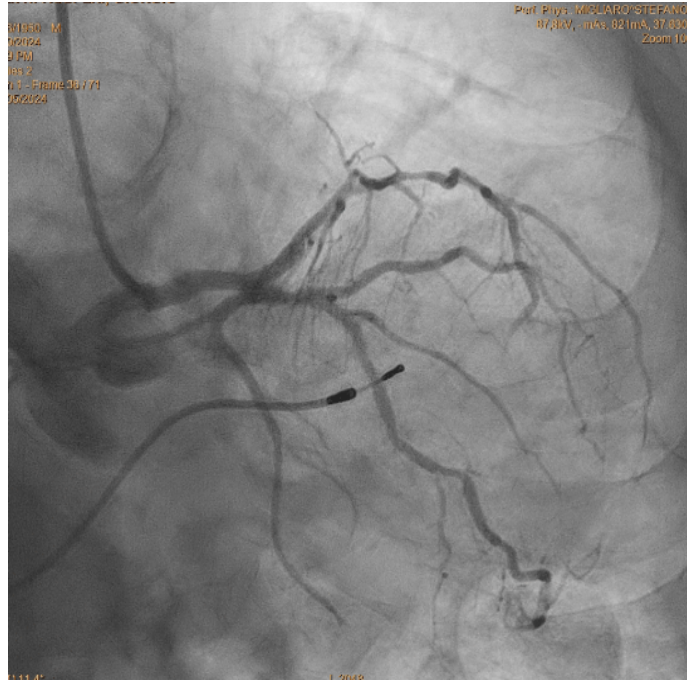
RAO 11.3 | CAUD 33.5 36/71

FFR Angio Results

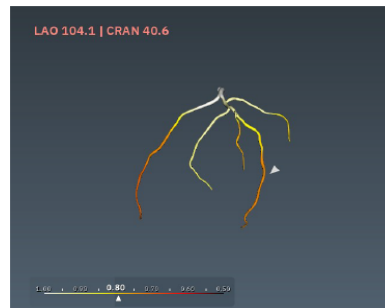


Off-line non-invasive functional evaluation of LAD with *FFR Angio*

Non invasive functional evaluation in pts with multivessel disease (Case #2)



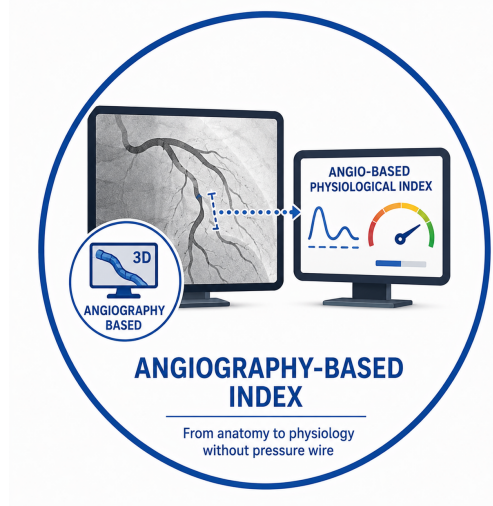
FFRangio Results



Off-line non-invasive functional evaluation of LCx with *FFR Angio*

Limitations of angiography-derived FFR

- **Technical issues**
 - Highly operator-dependency (during the learning curve)
 - Multiple steps required
 - Significant interobserver variation
 - **Accuracy strictly dependent on image quality**
- **Issues related to reported evidence**
 - Most studies retrospective with small sample size
 - Most of the validation studies performed in pts with chronic coronary syndromes
 - Studies not powered for clinical endpoints
 - **Exclusion of 15-20% of screened patients (with angiographically complex lesions)**
- **Confounding factors**
 - Microvascular dysfunction, vessel and plaque metrics



Conclusions



- Angiographic FFR may be appealing in some clinical settings and will hopefully continue to improve using artificial intelligence and deep learning algorithms, resulting in higher accuracy and shorter processing time
- Invasive FFR holds its ground as the preferred method for physiology-guided PCI
- Two recent trials (**FAST III**: vFFR vs FFR, and **ALL-RISE**: FFRangio vs FFR) confirmed the non-inferiority of angiographic-derived FFR compared to FFR in terms of clinical outcomes