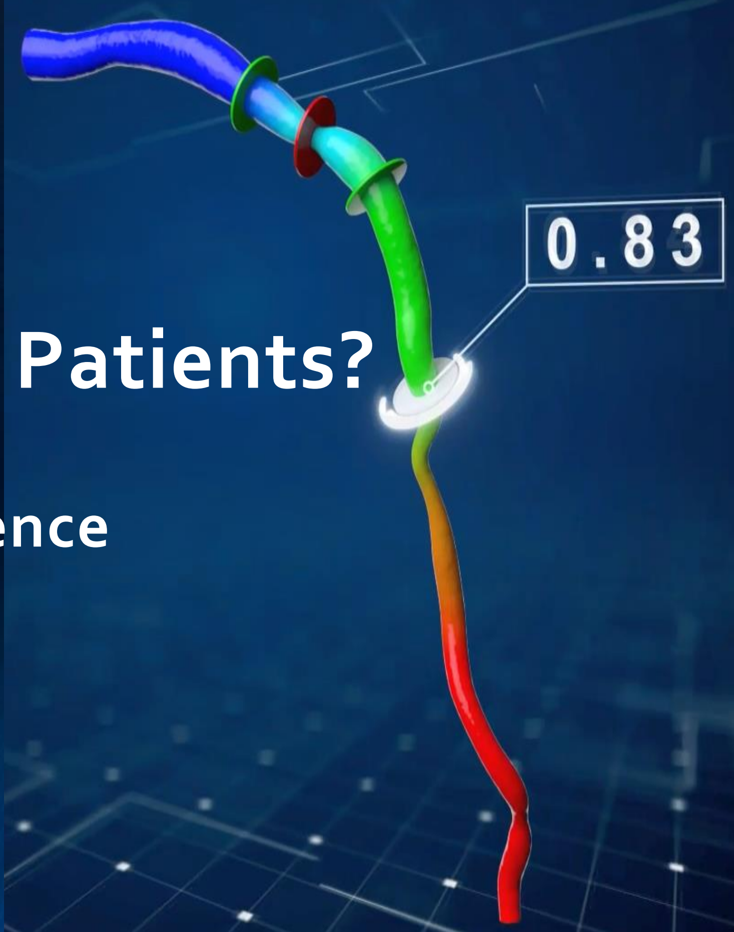
29th TCTAP 2024



QFR for All Lesions and Patients?

Current Level of Evidence

Niels Ramsing Holm

AARHUS UNIVERSITY

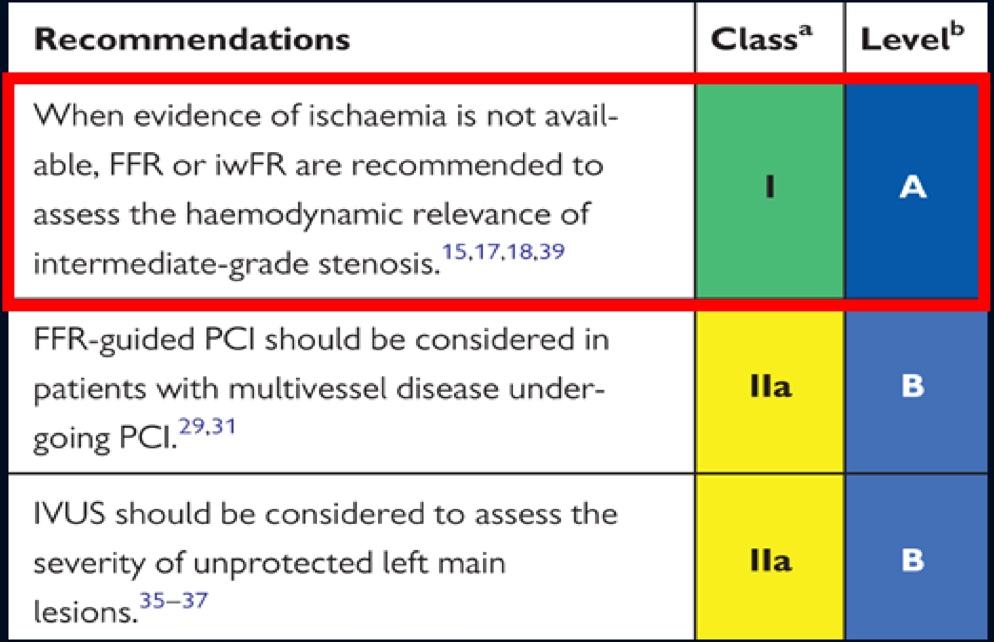
Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

Affiliation/Financial Relationship	Company
Grant/Research Support	Medis medical imaging bv.
	Abbott
	Biotronik
	Boston Scientific
	REVA Medical
Consulting Fees/Honoraria	Abbott
	Terumo
	Cardirad

Functional stenosis evaluation

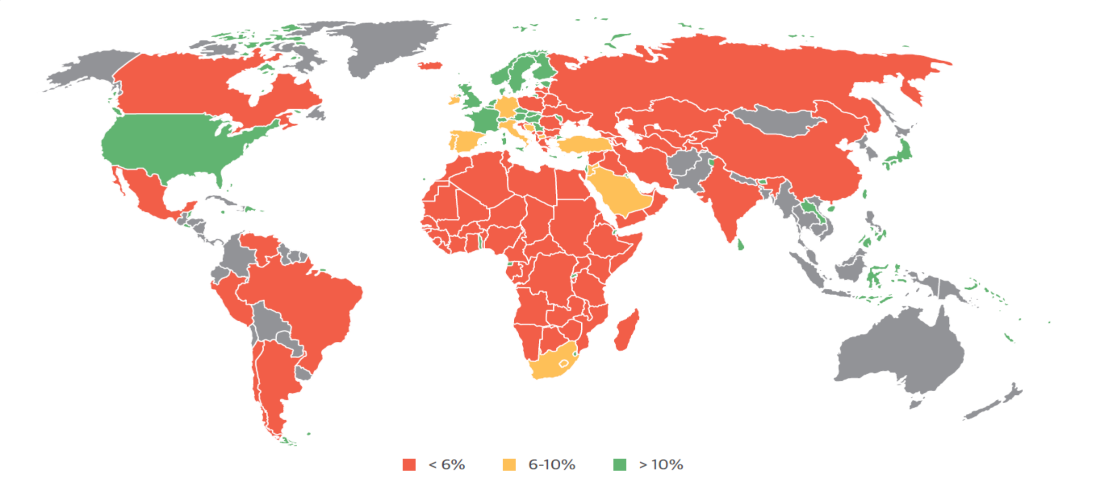
2018 ESC/EACTS Guidelines on myocardial revascularization



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

European Heart Journal, September 2018

FFR usage world-wide

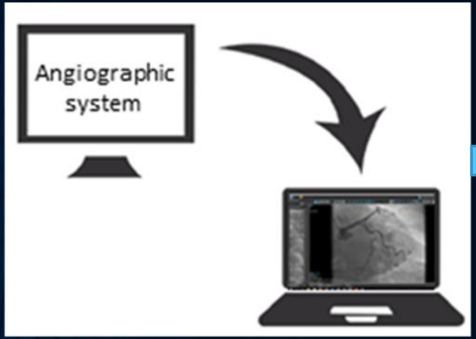


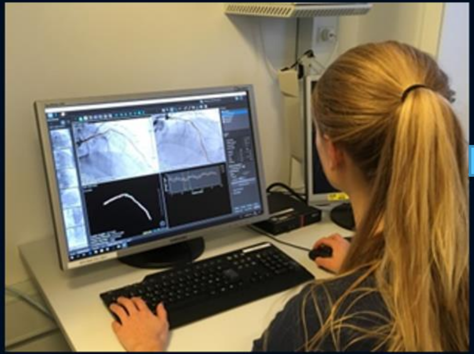
Götberg et al., JACC 2017

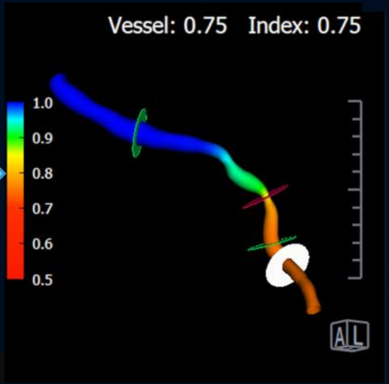
Poor utilization of pressure wire based functional stenosis evaluation in most areas

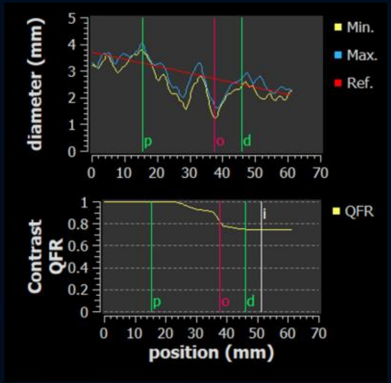
- Physician´s beliefs
- Expensive
- Economical incentiments
- Side effects
- Risk

Angio-based physiology


Angiographic system

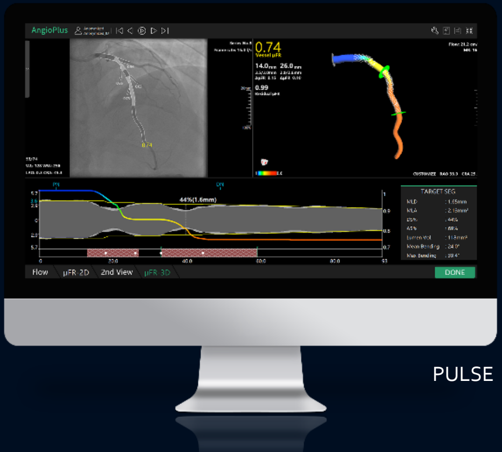



Vessel: 0.75
Index: 0.75
1.0
0.9
0.8
0.7
0.6
0.5
AL

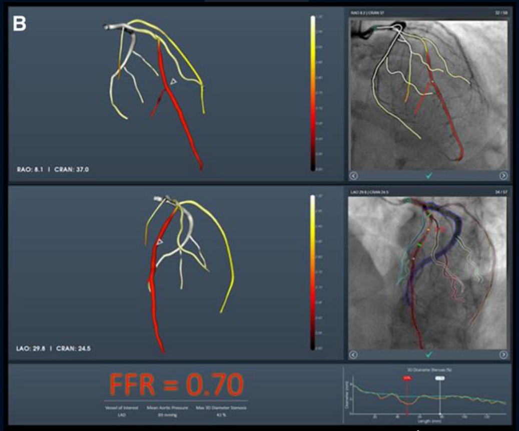


Angio-based physiology systems

QFR	Medis medical imaging	2 projections
µFR	PULSE medical	1-2 projections
vFFR	Pie Medical	2 projections
FFR$_{angio}$	CathWorks	≥2 projections
caFFR	RainMed	2 projections
angio-FFR	VIRTUheart	2 projections
accuFFRangio	ArteryFlowTechnology	2 projections
Angio-iFR	Philips	1 projection

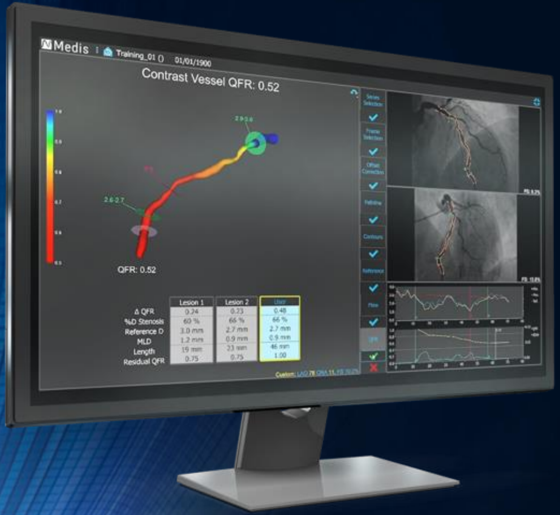

AngioPlus
0.74
Vessel µFR
0.99
44%(1.6mm)
TARGET SEG
Flow
µFR 2D
2nd View
µFR 3D
DONE

PULSE


B
RAO: 8.1 | CRAN: 37.0
LAO: 29.8 | CRAN: 24.5
FFR = 0.70

Fearon et a. Circulation 2018

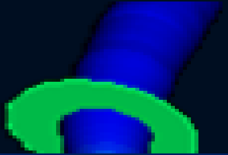
Prospective studies on QFR



Contrast Vessel QFR: 0.52

QFR: 0.52

	Lesion 1	Lesion 2	User
Δ QFR	0.24	0.23	0.48
%D Stenosis	60 %	66 %	66 %
Reference D	3.0 mm	2.7 mm	2.7 mm
MLD	1.2 mm	0.9 mm	0.9 mm
Length	19 mm	23 mm	46 mm
Residual QFR	0.75	0.75	1.00



Paired assessment of QFR and FFR

- FAVOR Pilot — Tu et al., JACC Intv., 2016
- WIFI II — Westra et al., Circulation Img, 2018
- FAVOR II China — Xu et al, JACC 2017
- FAVOR II Europe Japan — Westra et al., JAHA 2018

Total patients: 819 Vessels: 969 Non - VHD

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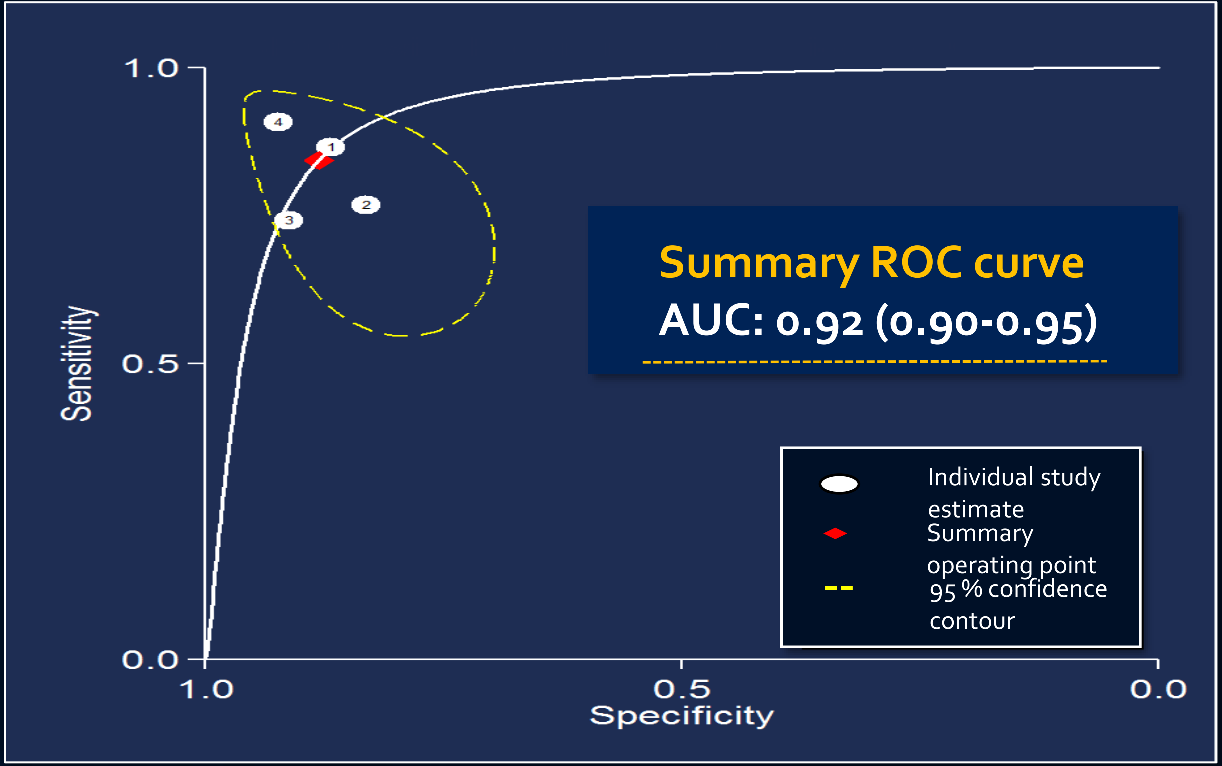
QFR Diagnostic performance

Medis
Training_01
01/01/1900
Contrast Vessel QFR: 0.52
QFR: 0.52
Lesion 1
Lesion 2

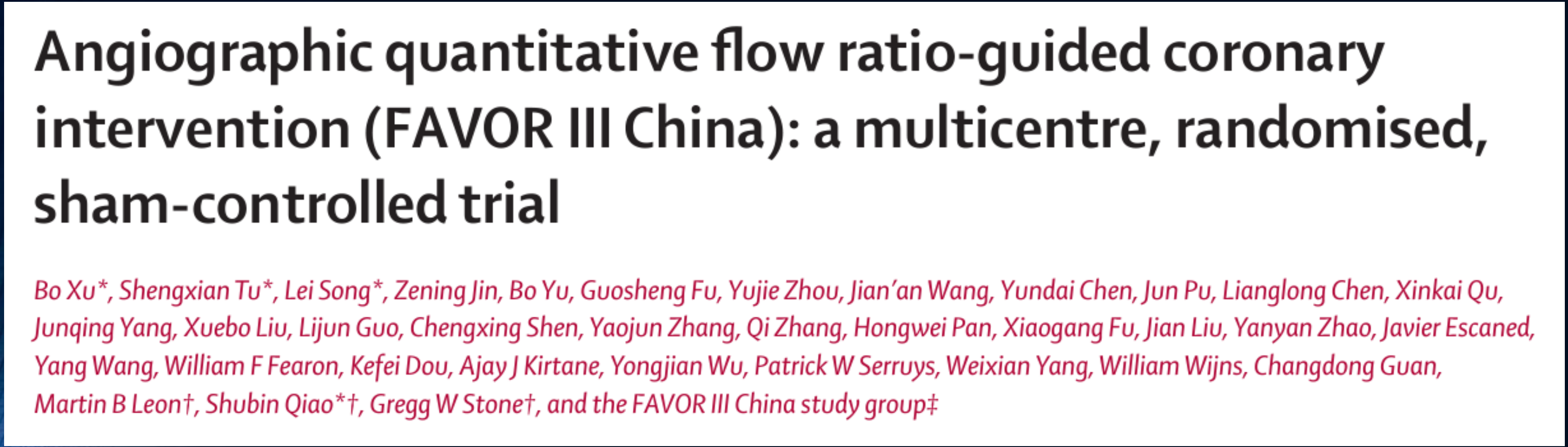


Summary ROC curve

AUC: 0.92 (0.90-0.95)

Westra et al. CCI 2019

FAVOR III China – A landmark trial

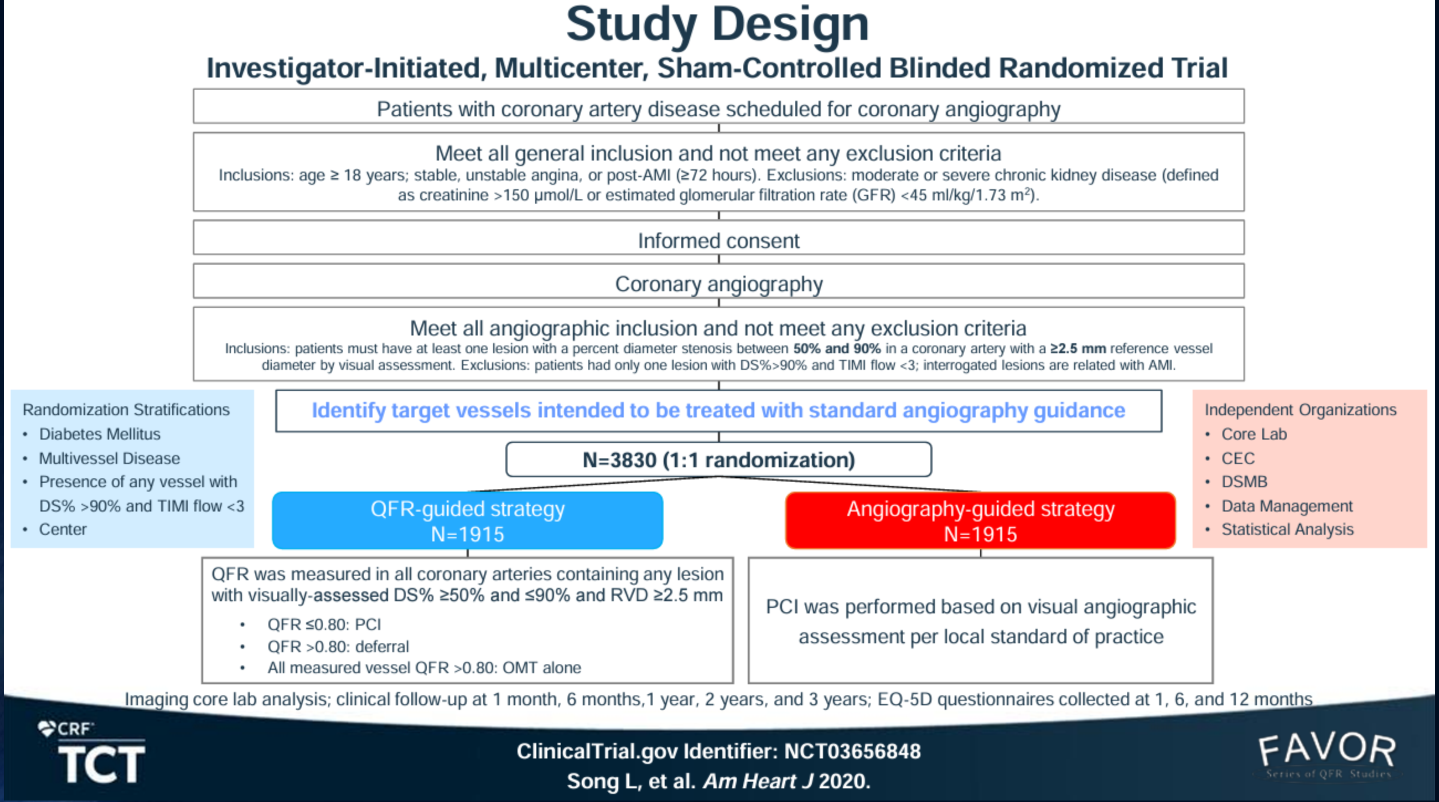


Angiographic quantitative flow ratio-guided coronary intervention (FAVOR III China): a multicentre, randomised, sham-controlled trial

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 Stone†, and the FAVOR III China study group‡*

LANCET 2021

FAVOR III China



Study Design

Investigator-Initiated, Multicenter, Sham-Controlled Blinded Randomized Trial

Patients with coronary artery disease scheduled for coronary angiography

Meet all general inclusion and not meet any exclusion criteria

Inclusions: age ≥ 18 years; stable, unstable angina, or post-AMI (≥72 hours). Exclusions: moderate or severe chronic kidney disease (defined as creatinine >150 μmol/L or estimated glomerular filtration rate (GFR) <45 ml/kg/1.73 m^2).

Informed consent

Coronary angiography

Meet all angiographic inclusion and not meet any exclusion criteria

Inclusions: patients must have at least one lesion with a percent diameter stenosis between **50% and 90%** in a coronary artery with a **≥2.5 mm** reference vessel diameter by visual assessment. Exclusions: patients had only one lesion with DS%>90% and TIMI flow <3; interrogated lesions are related with AMI.

Randomization Stratifications
- Diabetes Mellitus
- Multivessel Disease
- Presence of any vessel with DS% >90% and TIMI flow <3
- Center

Identify target vessels intended to be treated with standard angiography guidance

N=3830 (1:1 randomization)

QFR-guided strategy
N=1915

Angiography-guided strategy
N=1915

Independent Organizations
- Core Lab
- CEC
- DSMB
- Data Management
- Statistical Analysis

QFR was measured in all coronary arteries containing any lesion with visually-assessed DS% ≥50% and ≤90% and RVD ≥2.5 mm
- QFR ≤0.80: PCI
- QFR >0.80: deferral
- All measured vessel QFR >0.80: OMT alone

PCI was performed based on visual angiographic assessment per local standard of practice

Imaging core lab analysis; clinical follow-up at 1 month, 6 months,1 year, 2 years, and 3 years; EQ-5D questionnaires collected at 1, 6, and 12 months

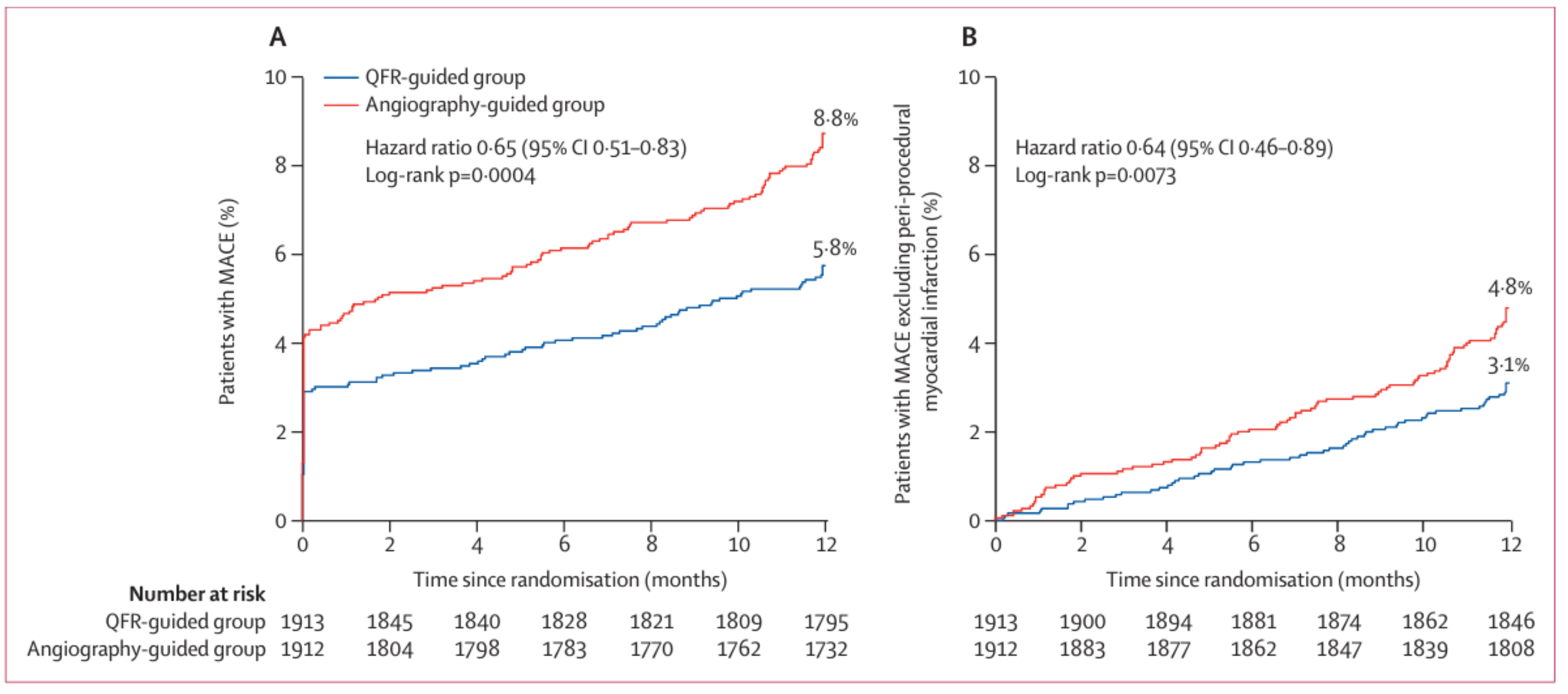
CRF TCT

ClinicalTrial.gov Identifier: NCT03656848

Song L, et al. *Am Heart J* 2020.

FAVOR Series of QFR Studies

FAVOR III China



Xu et al. LANCET 2021

FAVOR III China

QFR guiding resulted in

- Fewer patients stented
- Fewer stents implanted
- Shorter procedure time

Xu et al. LANCET 2021

Angio-based physiology vs. angio: RCTs

FAVOR III China	QFR vs angio	3830 pts ✓
PIONEER IV	QFR vs standard	2450 pts
FAVOR4-QVAS	QFR vs angio	792 pts

Angio-based physiology vs. FFR: RCTs

FAVOR III Europe	QFR vs FFR	2000 pts
FAST III	vFFR vs FFR	2228 pts
FLASH II	caFFR vs FFR	2450 pts
ALL-RISE	FFRangio vs FFR	1924 pts

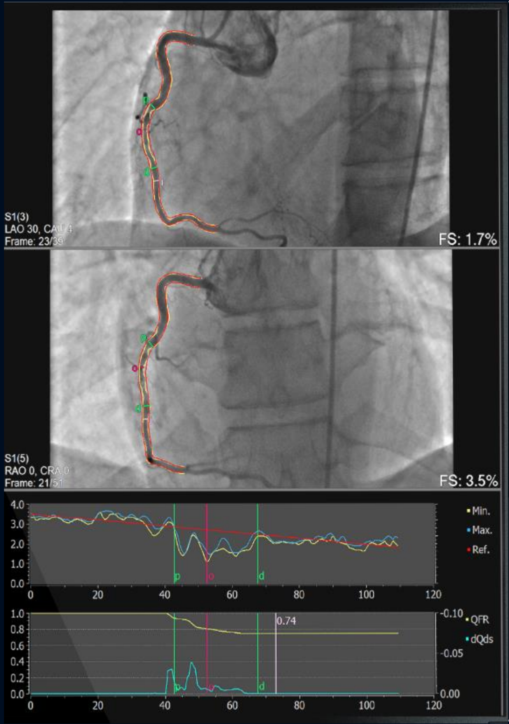
QFR for other lesion subsets

Bifurcation lesions

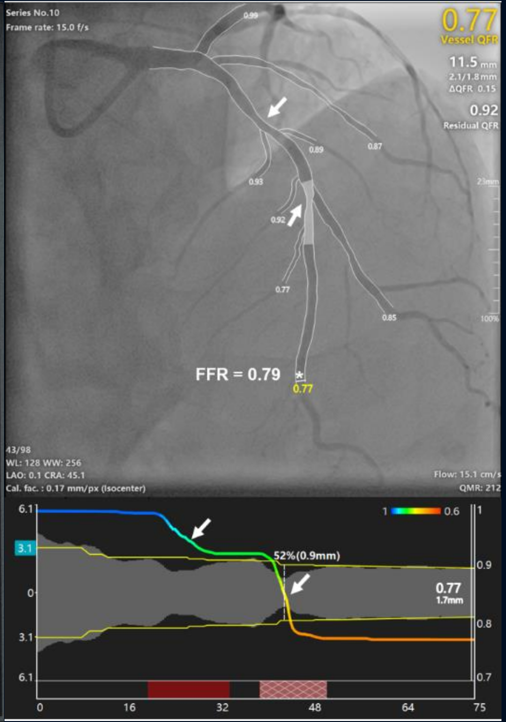
- QFR – pausity in data

- µFR – Murray-based single view
  - Good correlation with FFR

    Wu et al Circulation Card Img 2024


S1(3)
LAO 30, CAU 1
Frame: 23/39
FS: 1.7%
S1(5)
RAO 0, CRA 0
Frame: 21/51
FS: 3.5%
Min.
Max.
Ref.
0.74
QFR
dQds

Medis medical imaging


Series No.10
Frame rate: 15.0 f/s
0.77
Vessel QFR
11.5 mm
2.1/1.8mm
ΔQFR 0.15
0.92
Residual QFR
FFR = 0.79
0.77
43/98
WL: 128 WW: 256
LAO: 0.1 CRA: 45.1
Cal. fac.: 0.17 mm/px (Isocenter)
Flow: 15.1 cm/s
QMR: 212
52%(0.9mm)
0.77
1.7mm

Kotoku et al IJCI2024

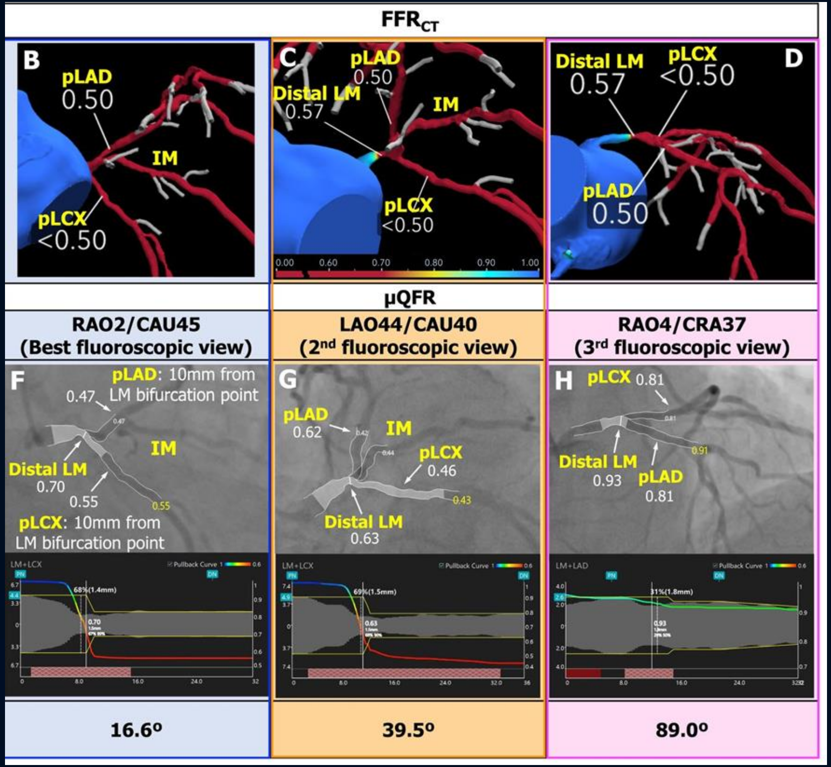
QFR for other lesion subsets

Left Main

- QFR: LM excluded from trials
- Modest accuracy Yuasa et al CCI2023

- Projections very important
  - µFR good accuracy with CT identified optimal projection Kotoku et al IJCI2024
  - Circumflex ostium not visible in 40% cases Tu et al IJC2012

More evidence needed

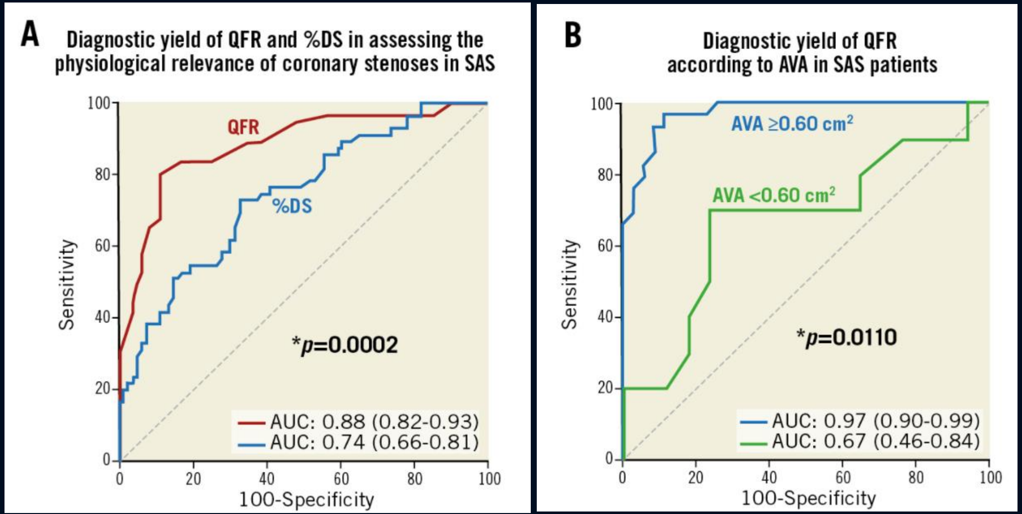

FFR$_{CT}$
B
pLAD 0.50
IM
pLCX <0.50
C
pLAD 0.50
Distal LM 0.57
IM
pLCX <0.50
0.00 0.60 0.70 0.80 0.90 1.00
Distal LM 0.57
pLCX <0.50
D
pLAD 0.50
µQFR
RAO2/CAU45 (Best fluoroscopic view)
LAO44/CAU40 (2nd fluoroscopic view)
RAO4/CRA37 (3rd fluoroscopic view)
F
pLAD: 10mm from LM bifurcation point
0.47
IM
Distal LM 0.70
0.55
pLCX: 10mm from LM bifurcation point
G
pLAD 0.62
IM
pLCX 0.46
Distal LM 0.63
H
pLCX 0.81
Distal LM 0.93
pLAD 0.81
LM+LCX
68%(1.4mm)
LM+LCX
69%(1.5mm)
LM+LAD
31%(1.8mm)
16.6°
39.5°
89.0°

Kotoku et al IJCI2024

QFR in pts with aortic stenosis

Paired QFR and FFR in 118 patients with either

- Valve area<1.0 cm^2
- Indexed valve area <0.6 cm^2/m^2 body surface area
- Flow-pressure parameters (mean gradient >40 mmHg
- Maximum jet velocity >4.0 m/s, and velocity ratio <0.25



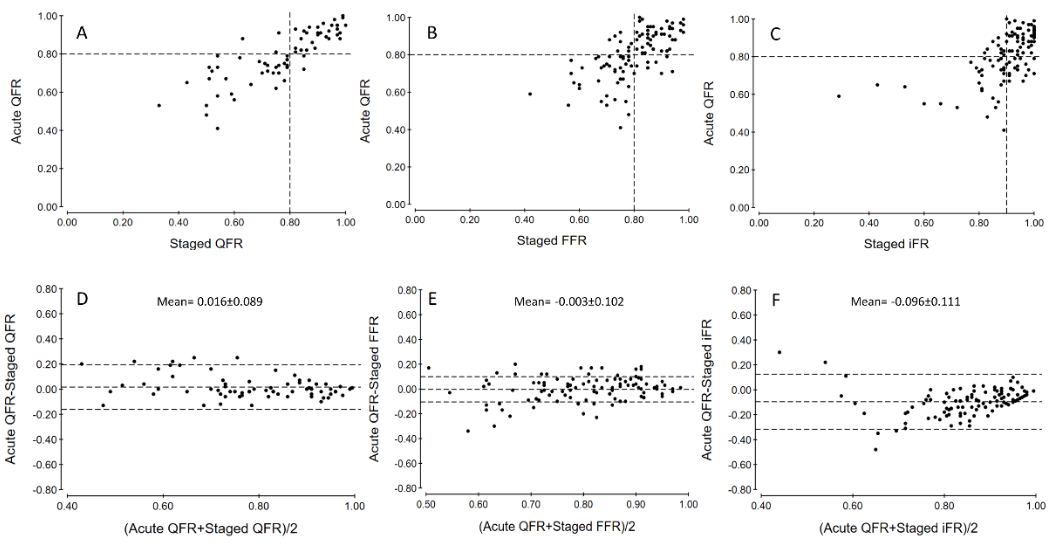
Hernán Mejía-Rentería. EuroInterventio

Pre-TAVI QFR – good correspondance with post TAVI FFR Sejr-Hansen et al. CCI 2021

QFR in ACS

Paired QFR during acute procedures - and FFR at staged procedures compare well

Sejr-Hansen et al. CCI 2021



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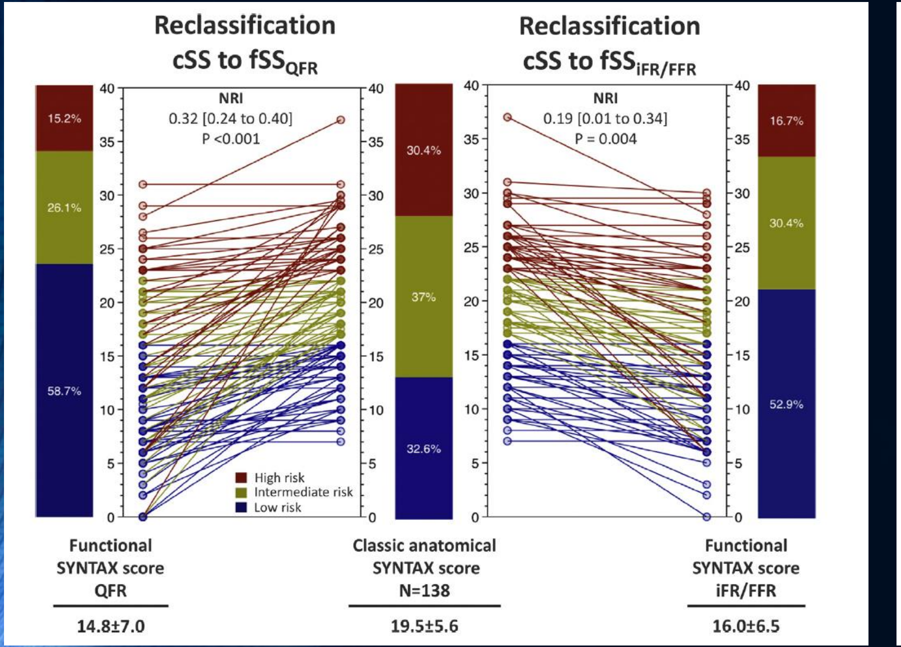
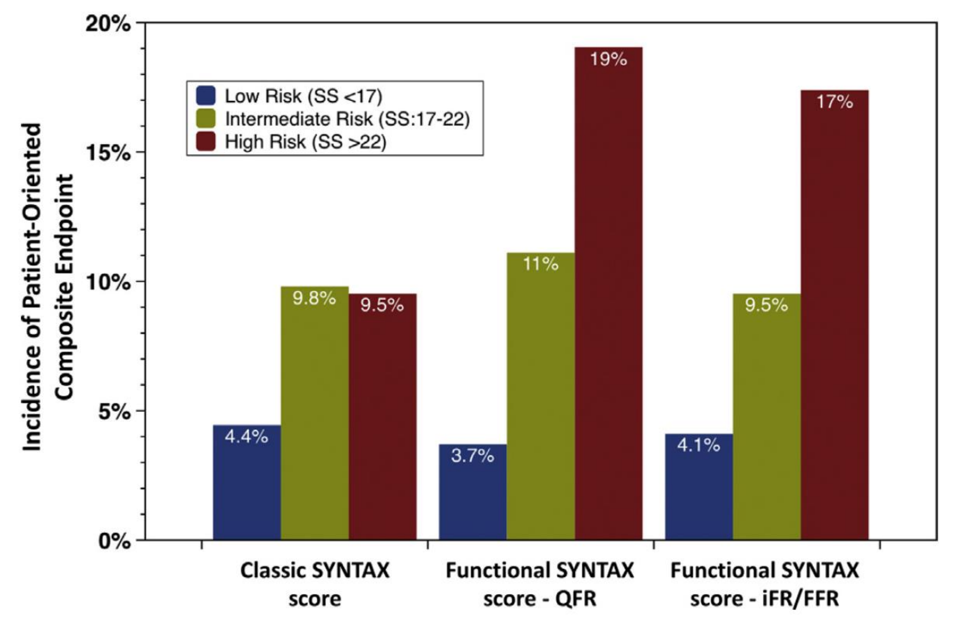
Computed functional SYNTAX score

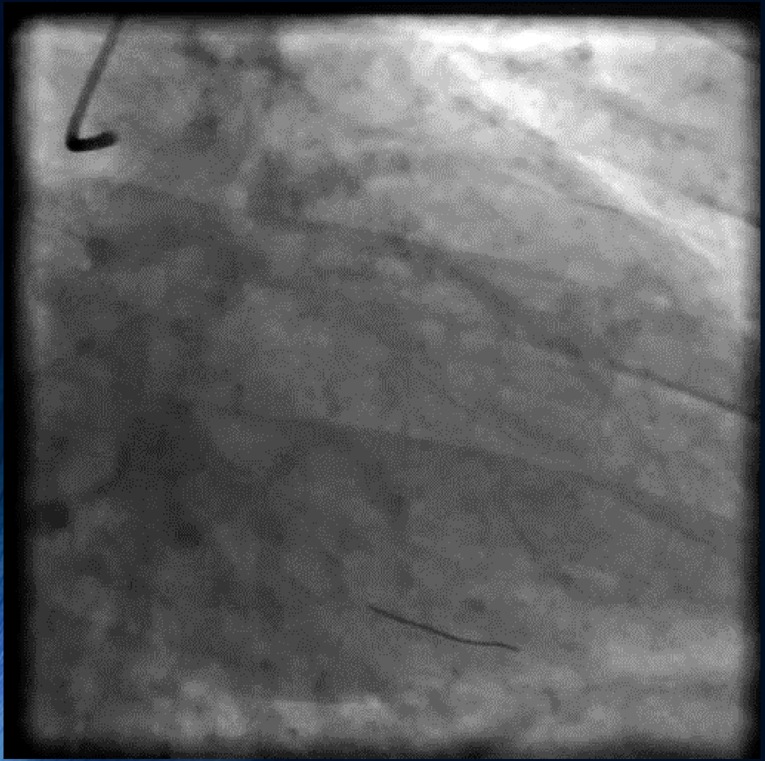
- 3-vessel level (functional SYNTAX score: $\mathrm{fSS}_{\mathrm{QFR}}$)

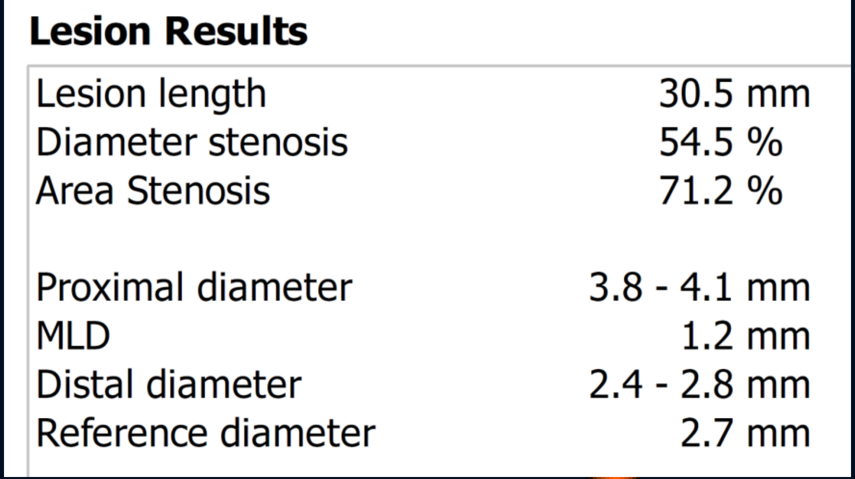




Asano et al. JACC Cardiovascular Interventions 2019

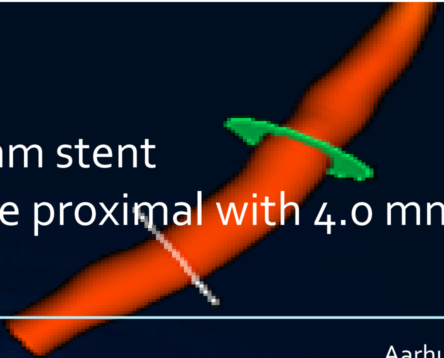
Stent sizing





Lesion Results

Lesion length	30.5 mm
Diameter stenosis	54.5 %
Area Stenosis	71.2 %
Proximal diameter	3.8 - 4.1 mm
MLD	1.2 mm
Distal diameter	2.4 - 2.8 mm
Reference diameter	2.7 mm



Plan:

3.0 x 33mm stent

Postdilate proximal with 4.0 mm NC balloon

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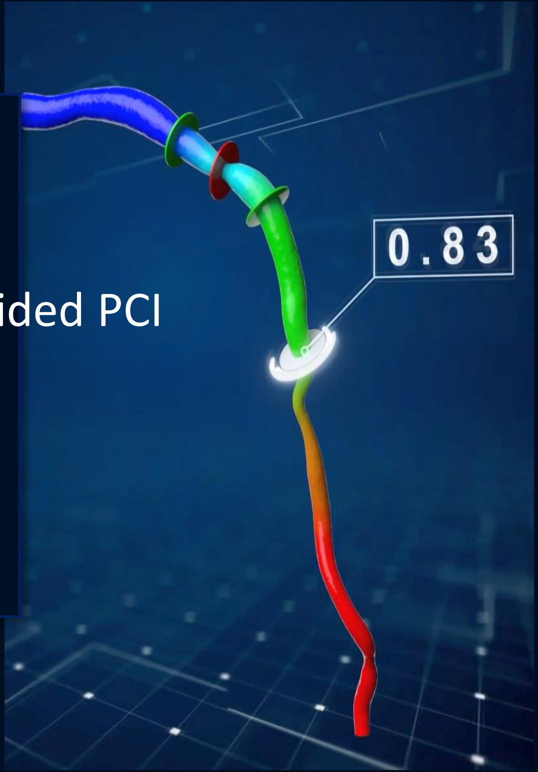
Assessment of microvascular resistance

- **Index of microvascular resistance** (angio-IMR, AIMR, aIMR)
  - Several methods presented (at least 4 formula)
    - Tebaldi et al *Journal of Interventional Cardiology 2021*
    - Mejia-Renteria et al *EuroInvervention 2021*
    - Milzi et al *Frontiers in Cardiovascular Medicine 2022*
  - Limited validation (cut-off, verification, reproducitibility)

?

Conclusions



- Multiple systems approved for use in various regions
- Major differences in body of supporting evidence
- FAVOR III China showed clear advantages of QFR over angio guided PCI
- Multiple ongoing RCTs
- Differences between systems may be important
- Further validation required for multiple aspects of use

Thank you