Current Technology and Technique for Percutaneous Coronary Intervention

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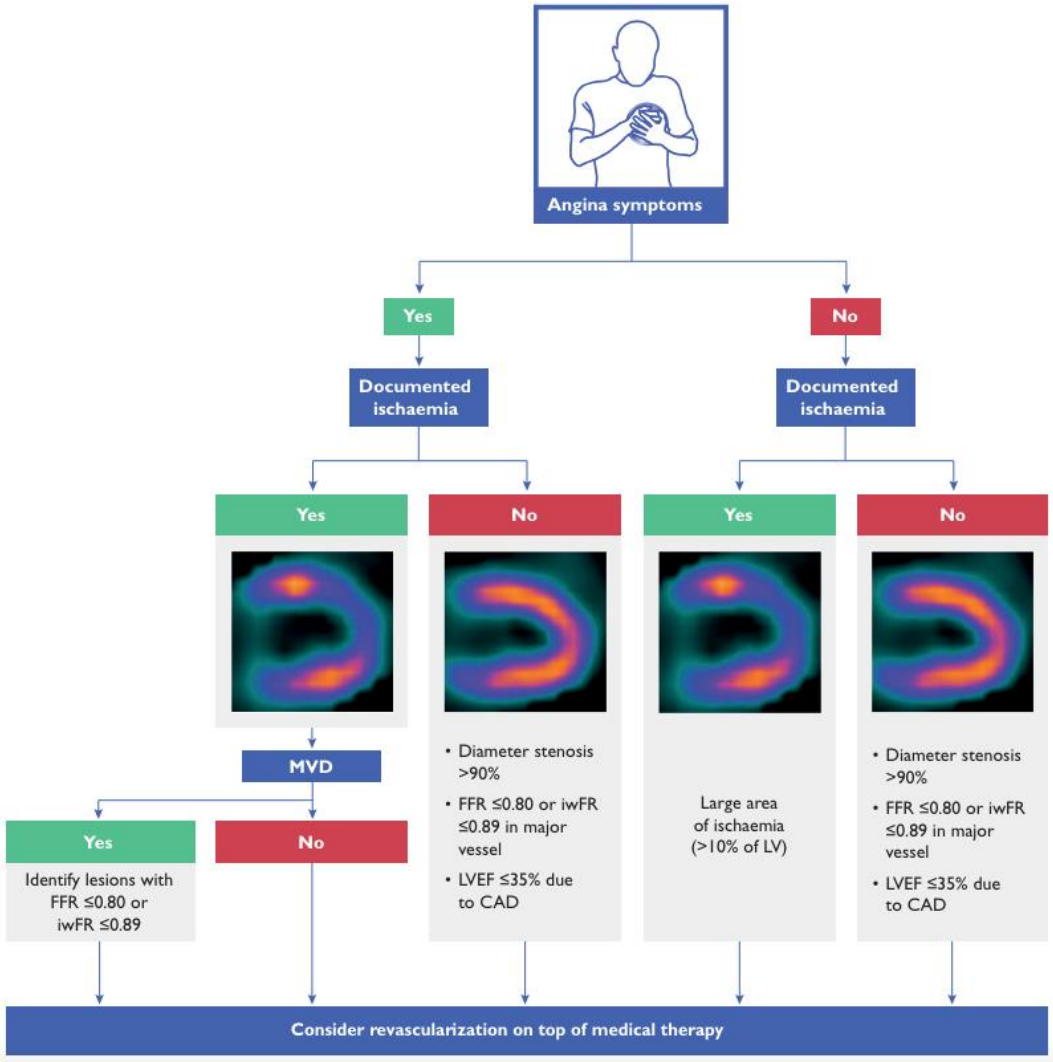
Disclosures

I, Doyeon Hwang, have no financial relationship with any commercial interest related to the contents of this activity.

When revascularization for CCS patients?

2019 European CCS guideline



2023 American guideline

Recommendations for Revascularization
Referenced studies that support the recommendations are summarized in the Online Data Supplement.

COR	LOE	Recommendations
Goals of Revascularization		
1	A	1. In patients with CCD and lifestyle-limiting angina despite GDMT and with significant coronary artery stenoses amenable to revascularization, revascularization is recommended to improve symptoms.[*1–7]
1	B-R	2. In patients with CCD who have significant left main disease or multivessel disease with severe LV dysfunction (LVEF ≤ 35%), CABG in addition to medical therapy is recommended over medical therapy alone to improve survival.[*8–11]
Decision-Making for Revascularization		
1	A	6. In patients with CCD who have angina or an anginal equivalent, no previous evaluation for ischemia, and angiographically intermediate stenoses, the use of FFR or other proven nonhyperemic pressure ratios (eg, iFR) is recommended before proceeding with PCI.[*2,22,23]

Eur Heart J. 2020 Jan 14;41(3):407-477.
J Am Coll Cardiol. 2023 Aug 29;82(9):833-955.

We are in the era of post ISCHEMIA Trial

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 APRIL 9, 2020 VOL. 382 NO. 15

Initial Invasive or Conservative Strategy for Stable Coronary Disease

D.J. Maron, J.S. Hochman, H.R. Reynolds, S. Bangalore, S.M. O'Brien, W.E. Boden, B.R. Chaitman, R. Senior, J. López-Sendón, K.P. Alexander, R.D. Lopes, L.J. Shaw, J.S. Berger, J.D. Newman, M.S. Sidhu, S.G. Goodman, W. Ruzyllo, G. Gosselin, A.P. Maggioni, H.D. White, B. Bhargava, J.K. Min, G.B.J. Mancini, D.S. Berman, M.H. Picard, R.Y. Kwong, Z.A. Ali, D.B. Mark, J.A. Spertus, M.N. Krishnan, A. Elghamaz, N. Moorthy, W.A. Hueb, M. Demkow, K. Mavromatis, O. Bockeria, J. Peteiro, T.D. Miller, H. Szwed, R. Doerr, M. Keltai, J.B. Selvanayagam, P.G. Steg, C. Held, S. Kohsaka, S. Mavromichalis, R. Kirby, N.O. Jeffries, F.E. Harrell, Jr., F.W. Rockhold, S. Broderick, T.B. Ferguson, Jr., D.O. Williams, R.A. Harrington, G.W. Stone, and Y. Rosenberg, for the ISCHEMIA Research Group*

ABSTRACT

BACKGROUND

Among patients with stable coronary disease and moderate or severe ischemia, whether clinical outcomes are better in those who receive an invasive intervention plus medical therapy than in those who receive medical therapy alone is uncertain.

METHODS

We randomly assigned 5179 patients with moderate or severe ischemia to an initial invasive strategy (angiography and revascularization when feasible) and medical therapy or to an initial conservative strategy of medical therapy alone and angiography if medical therapy failed. The primary outcome was a composite of death from cardiovascular causes, myocardial infarction, or hospitalization for unstable angina, heart failure, or resuscitated cardiac arrest. A key secondary outcome was death from cardiovascular causes or myocardial infarction.

RESULTS

Over a median of 3.2 years, 318 primary outcome events occurred in the invasive-strategy group and 352 occurred in the conservative-strategy group. At 6 months, the cumulative event rate was 5.3% in the invasive-strategy group and 3.4% in the conservative-strategy group (difference, 1.9 percentage points; 95% confidence interval [CI], 0.8 to 3.0); at 5 years, the cumulative event rate was 16.4% and 18.2%, respectively (difference, –1.8 percentage points; 95% CI, –4.7 to 1.0). Results were similar with respect to the key secondary outcome. The incidence of the primary outcome was sensitive to the definition of myocardial infarction; a secondary analysis yielded more procedural myocardial infarctions of uncertain clinical importance. There were 145 deaths in the invasive-strategy group and 144 deaths in the conservative-strategy group (hazard ratio, 1.05; 95% CI, 0.83 to 1.32).

CONCLUSIONS

Among patients with stable coronary disease and moderate or severe ischemia, we did not find evidence that an initial invasive strategy, as compared with an initial conservative strategy, reduced the risk of ischemic cardiovascular events or death from any cause over a median of 3.2 years. The trial findings were sensitive to the definition of myocardial infarction that was used. (Funded by the National Heart, Lung, and Blood Institute and others; ISCHEMIA ClinicalTrials.gov number, NCT01471522.)

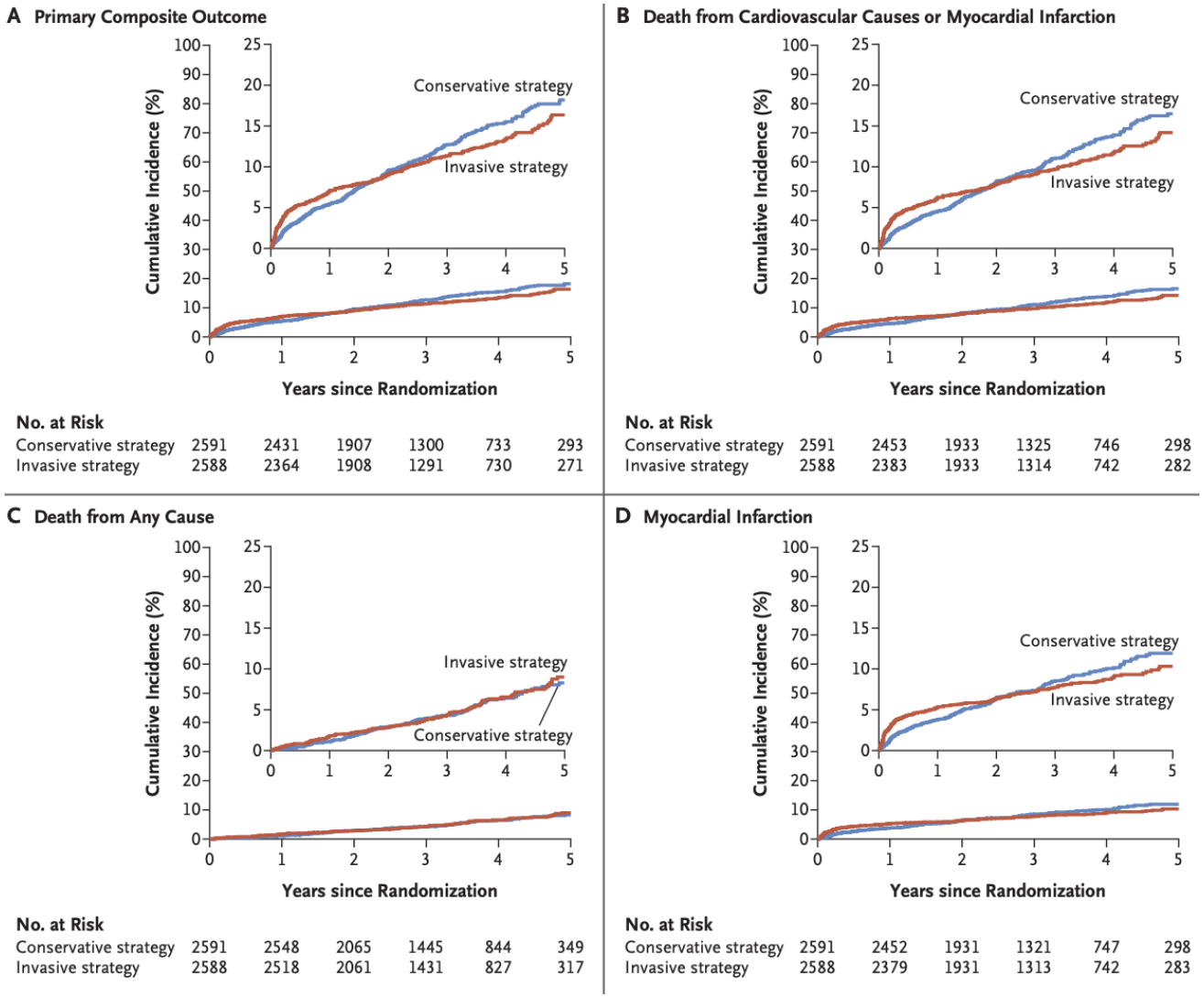
The authors' full names, academic degrees, and affiliations are listed in the Appendix. Address reprint requests to Dr. Maron at the Department of Medicine, Stanford University School of Medicine, 1265 Welch Rd., Medical School Office Bldg. x314, Stanford, CA 94305, or at david.maron@stanford.edu; or to Dr. Hochman at the New York University Grossman School of Medicine–New York University Langone Health, 530 First Ave., Skirball 9R, New York, NY 10016, or at judith.hochman@nyumc.org.

*A full list of ISCHEMIA Research Group members is provided in the Supplementary Appendix, available at NEJM.org.

Drs. Maron and Hochman contributed equally to this article.

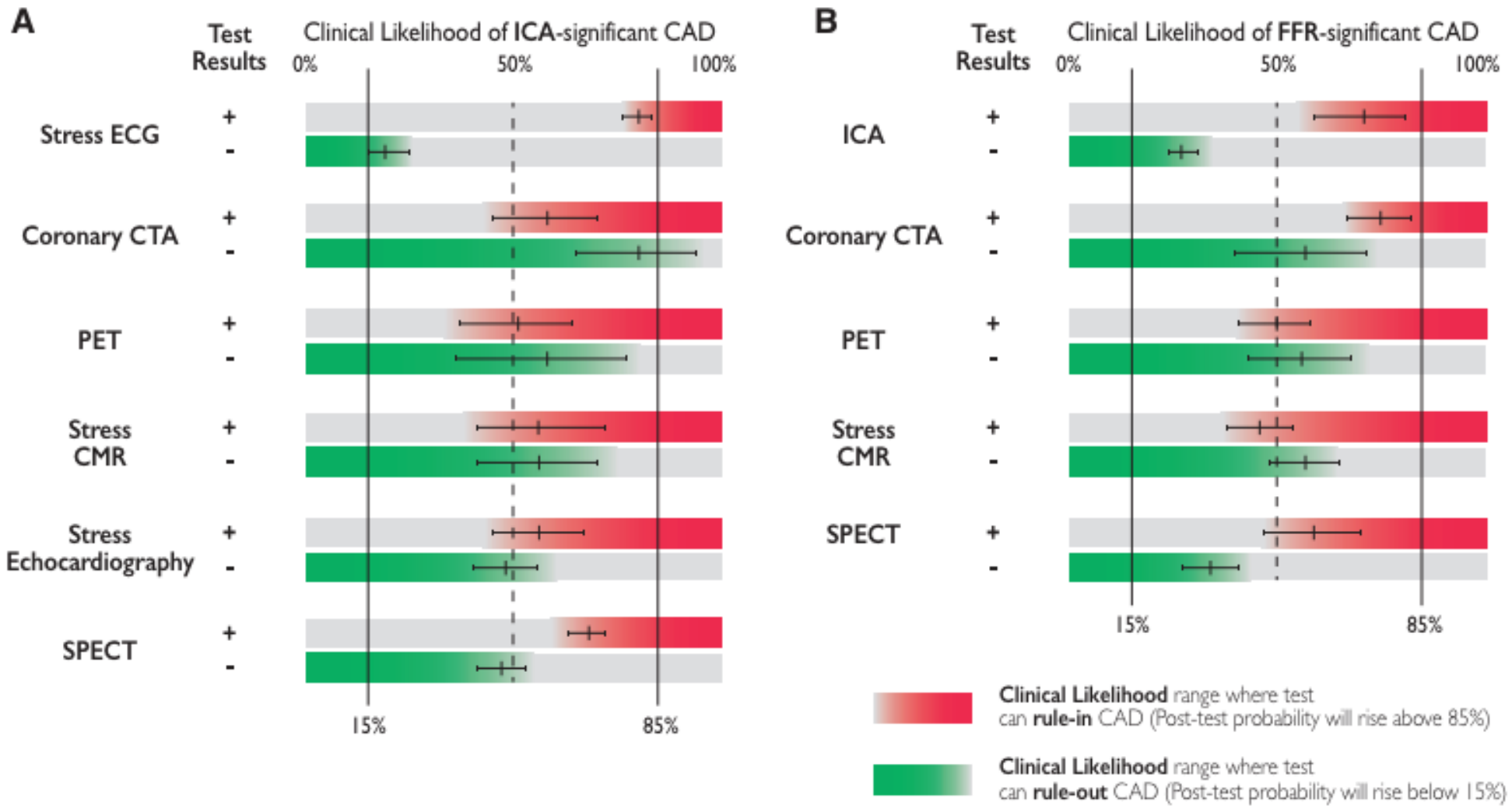
This article was published on March 30, 2020, at NEJM.org.

N Engl J Med 2020;382:1395-407.
DOI: 10.1056/NEJMoa1915922



N Engl J Med. 2020 Apr 9;382(15):1395-1407.

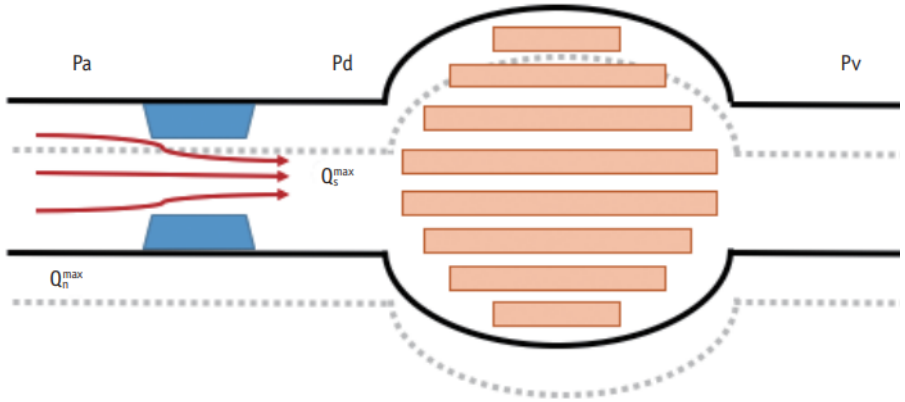
How to determine the presence of ischemia?



Eur Heart J. 2020 Jan 14;41(3):407-477.

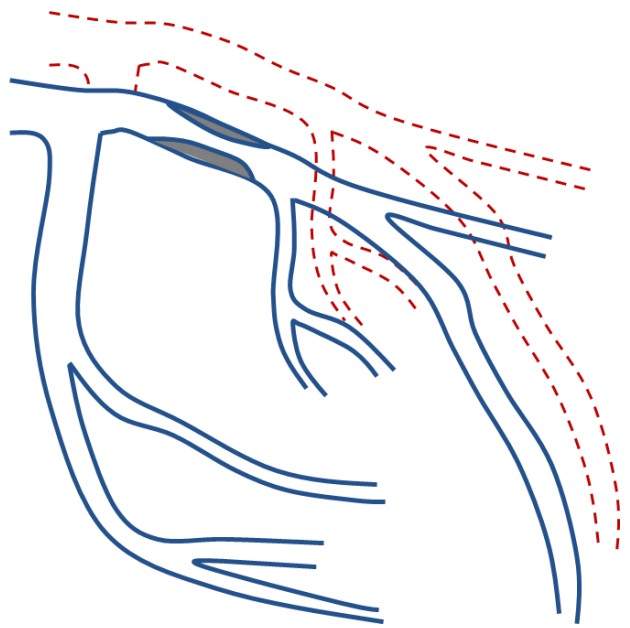
Invasive Physiologic Assessment

Fractional Flow Reserve



Q^N_{max}

Q^S_{max}

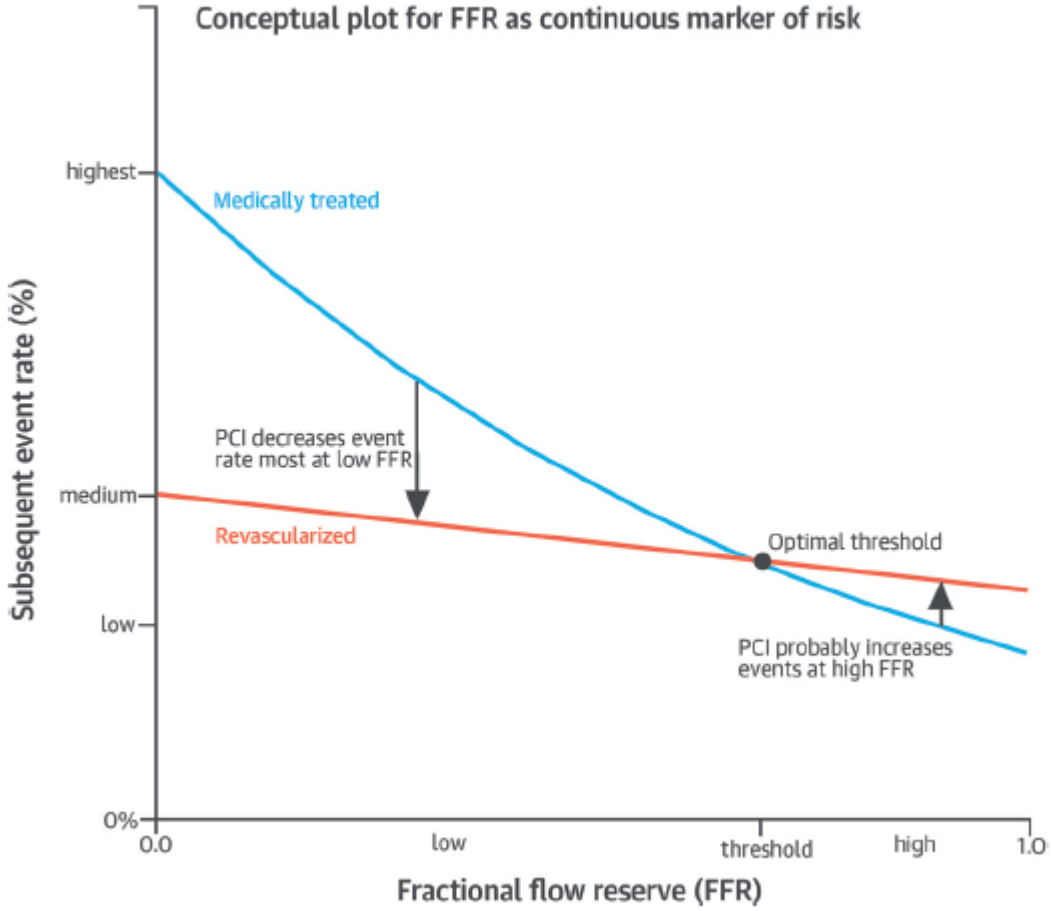


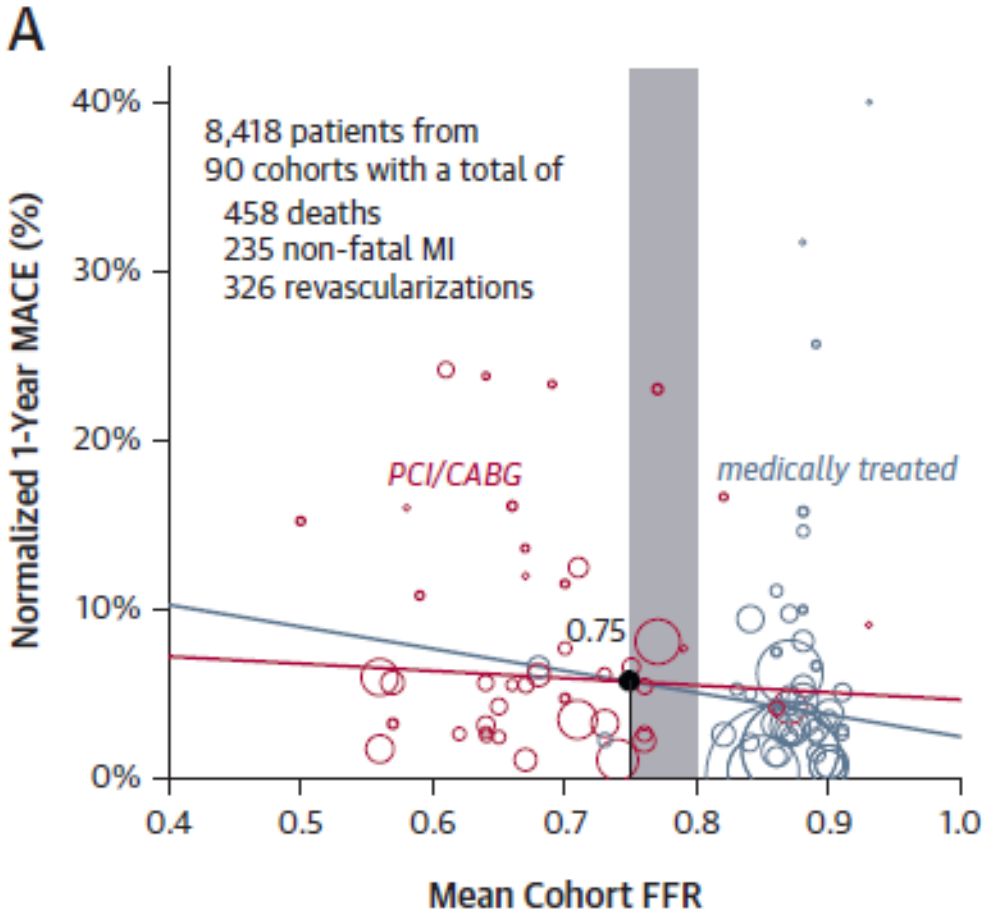
Q(flow)=Pressure/Resistance

$$FFR = \frac{\text{Maximum flow in presence of stenosis}}{\text{Normal maximum flow}} = \frac{Q^S_{max}}{Q^N_{max}} = \frac{(Pd-Pv)/R}{(Pa-Pv)/R} = \frac{\text{Distal Pr } (P_d)}{\text{Proximal Pr } (P_a)}$$

Korean J Radiol. 2016 May-Jun;17(3):307-20.

Conceptual Relationship Between FFR and Outcomes





J Am Coll Cardiol 2014;64:1641–54

Concrete Evidence for FFR-guided PCI

- Robust scientific evidence
  - Various Major clinical trials (DEFER, FAME 1, FAME 2, FAMOUS-NSTEMI)
  - Around 5,000 studies has been published.

2018 European guideline

Recommendations on functional testing and intravascular imaging for lesion assessment

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

2021 American guideline

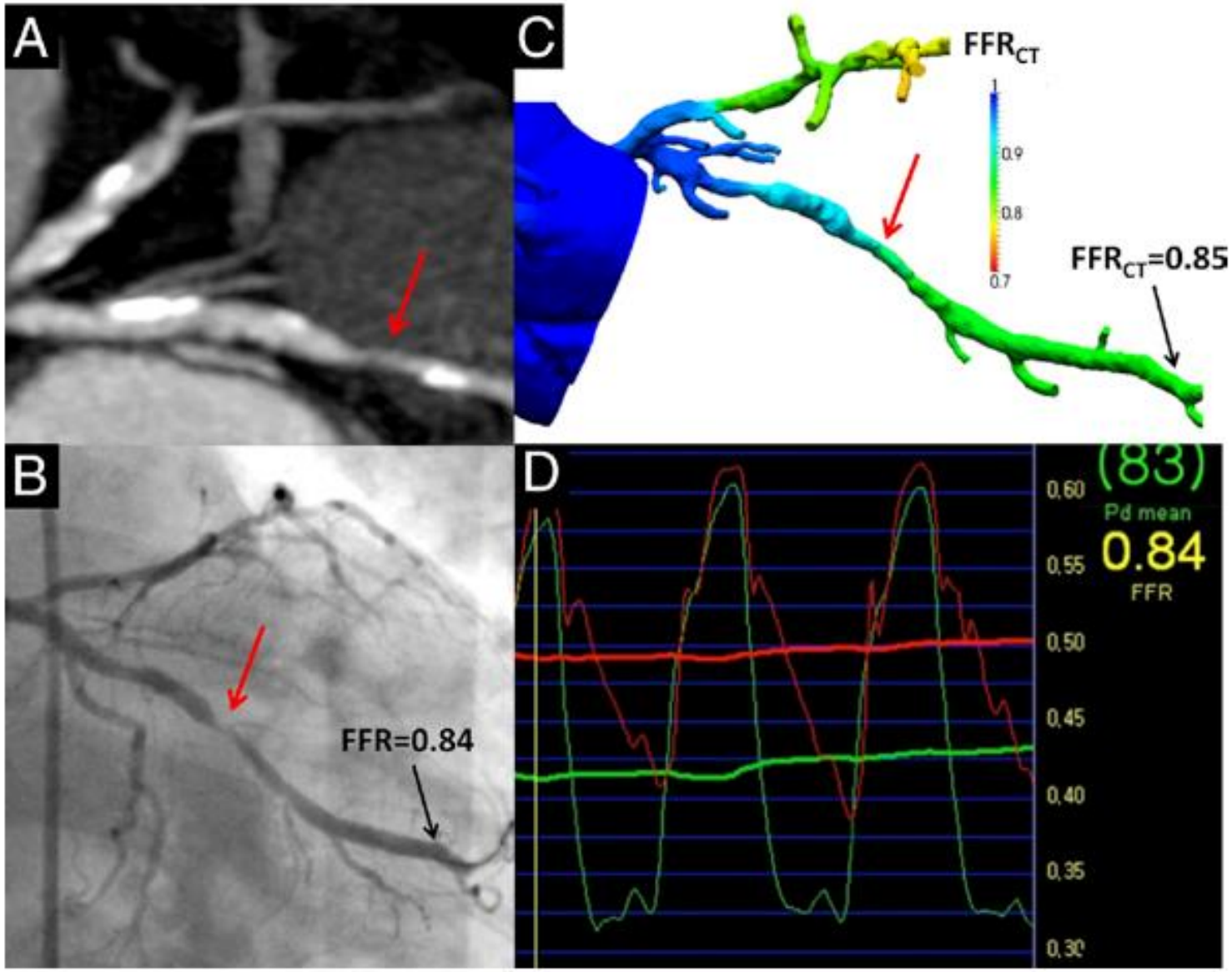
Recommendations for the Use of Coronary Physiology to Guide Revascularization With PCI
Referenced studies that support the recommendations are summarized in Online Data Supplement 5.

COR	LOE	Recommendations
1	A	1. In patients with angina or an anginal equivalent, undocumented ischemia, and angiographically intermediate stenoses, the use of fractional flow reserve (FFR) or instantaneous wave-free ratio (iFR) is recommended to guide the decision to proceed with PCI.[1-6]
3: No benefit	B-R	2. In stable patients with angiographically intermediate stenoses and FFR >0.80 or iFR >0.89, PCI should not be performed.[7-10]

The clinical studies on FFR have been focused on its prognostic value and treatment decision-making before PCI.

Eur Heart J. 2019 Jan 7;40(2):87-165.
Circulation. 2022 Jan 18;145(3):e4-e17.

Computational Fluid Dynamic and CT-FFR



J Am Coll Cardiol. 2011 Nov 1;58(19):1989-97.

Long-term Prognostic Implications of CT-FFR

10-year outcomes of the DISCOVER-FLOW study

Cardiac Imaging

Diagnosis of Ischemia-Causing Coronary Stenoses by Noninvasive Fractional Flow Reserve Computed From Coronary Computed Tomographic Angiograms

Results From the Prospective Multicenter DISCOVER-FLOW (Diagnosis of Ischemia-Causing Stenoses Obtained Via Noninvasive Fractional Flow Reserve) Study

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Seoul and Goyang, South Korea; Riga, Latvia; Palo Alto, San Francisco, and Los Angeles, California; New York, New York; New Haven, Connecticut; and Vancouver, British Columbia, Canada

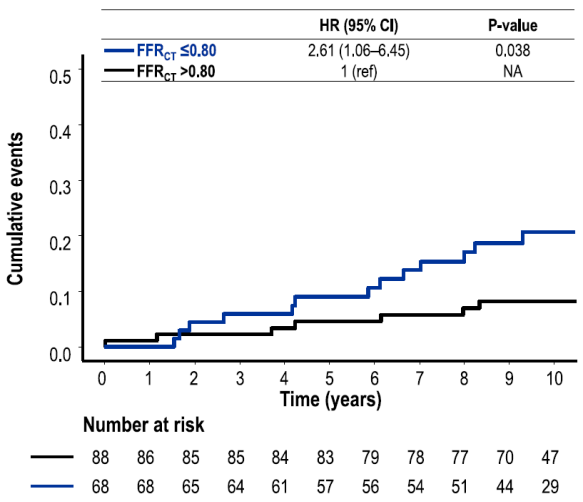
Objectives The aim of this study was to determine the diagnostic performance of a new method for quantifying fractional flow reserve (FFR) with computational fluid dynamics (CFD) applied to coronary computed tomography angiography (CCTA) data in patients with suspected or known coronary artery disease (CAD).

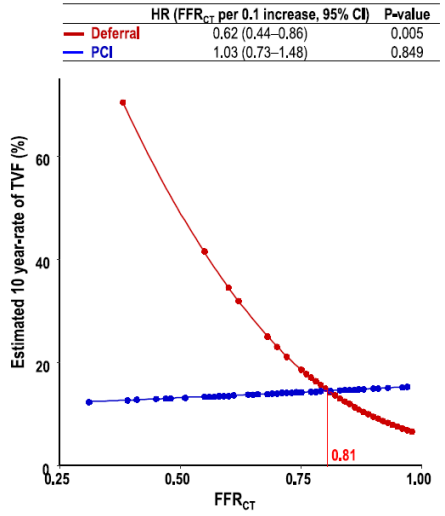
Background Measurement of FFR during invasive coronary angiography is the gold standard for identifying coronary artery lesions that cause ischemia and improves clinical decision-making for revascularization. Computation of FFR from CCTA data (FFR_{CT}) provides a noninvasive method for identifying ischemia-causing stenosis; however, the diagnostic performance of this new method is unknown.

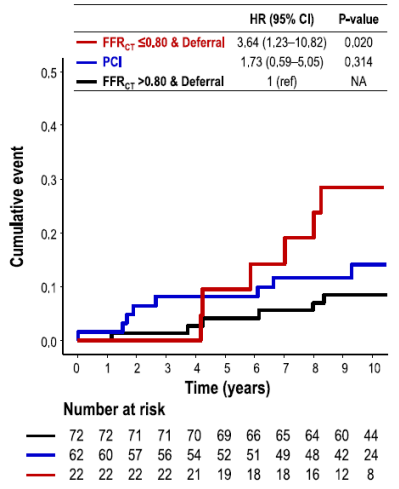
Methods Computation of FFR from CCTA data was performed on 159 vessels in 103 patients undergoing CCTA, invasive coronary angiography, and FFR. Independent core laboratories determined FFR_{CT} and CAD stenosis severity by CCTA. Ischemia was defined by an FFR_{CT} and FFR ≤0.80, and anatomically obstructive CAD was defined as a CCTA with stenosis ≥50%. Diagnostic performance of FFR_{CT} and CCTA stenosis was assessed with invasive FFR as the reference standard.

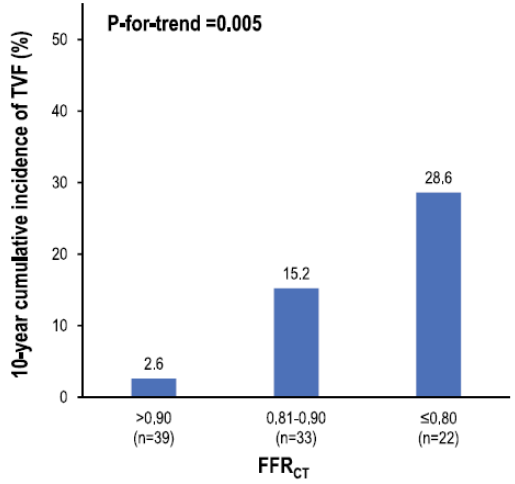
Results Fifty-six percent of patients had ≥1 vessel with FFR ≤0.80. On a per-vessel basis, the accuracy, sensitivity, specificity, positive predictive value, and negative predictive value were 84.3%, 87.9%, 82.2%, 73.9%, 92.2%, respectively, for FFR_{CT} and were 58.5%, 91.4%, 39.6%, 46.5%, 88.9%, respectively, for CCTA stenosis. The area under the receiver-operator characteristics curve was 0.90 for FFR_{CT} and 0.75 for CCTA ($p = 0.001$). The FFR_{CT} and FFR were well correlated ($r = 0.717$, $p < 0.001$) with a slight underestimation by FFR_{CT} (0.022 ± 0.116, $p = 0.016$).

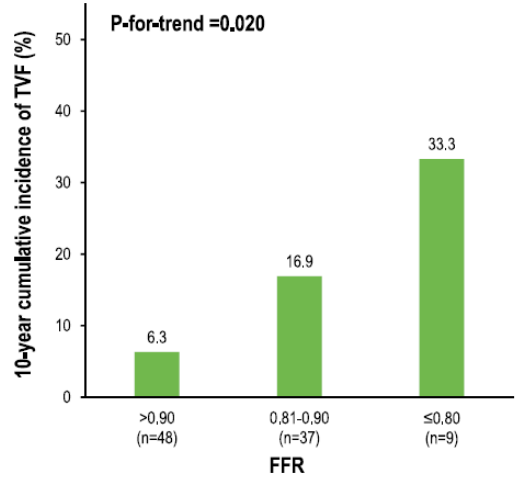
Conclusions Noninvasive FFR derived from CCTA is a novel method with high diagnostic performance for the detection and exclusion of coronary lesions that cause ischemia. (The Diagnosis of ISChemia-Causing Stenoses Obtained Via NoninvasivE FRactional FLOW Reserve; NCT01189331) (J Am Coll Cardiol 2011;58:1989–97) © 2011 by the American College of Cardiology Foundation











Koo et al. J Am Coll Cardiol. 2011 Nov 1;58(19):1989-97.
Yang, Chung, Koo, et al. J Cardiovasc Comput Tomogr. 2024 Feb 19:S1934-5925(24)00027-3.

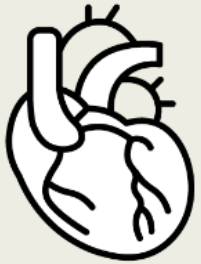
Initial Risk-Based Testing Strategy with CT-FFR

PRECISE trial

RCT: Comparison of an Initial Risk-Based Testing Strategy vs Usual Testing in Stable Symptomatic Patients With Suspected Coronary Artery Disease

POPULATION

1056 Men, 1047 Women



Symptomatic adults with suspected coronary artery disease (CAD)

Mean age, 58.4 y

SETTINGS / LOCATIONS

65 Sites in the US, Europe, and UK

INTERVENTION

2103 Participants randomized

1057 Precision Strategy (PS)
PROMISE minimal risk score used to select low-risk participants for deferred testing. All others received coronary computed tomographic (CT) angiography with CT-derived fractional flow reserve for 30%-90% stenoses

1046 Usual Testing (UT)
Initial testing modality chosen by site clinicians, including imaging or nonimaging stress tests or catheterization

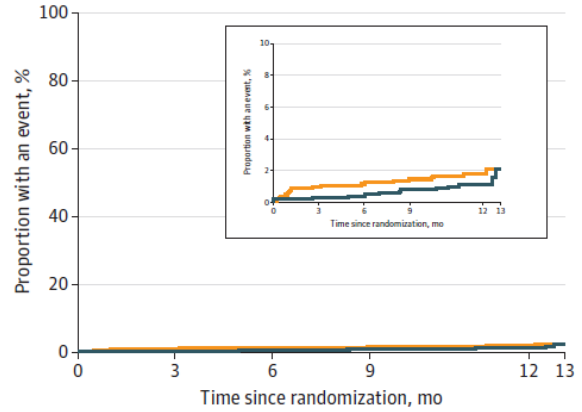
PRIMARY OUTCOME

Safety and clinical efficiency composite end point at 1y; safety events included were death or nonfatal myocardial infarction, and clinical efficiency was determined by catheterization without obstructive CAD

FINDINGS

The primary end point was significantly less frequent in PS compared with UT participants due to a lower rate of catheterization without obstructive CAD in PS

Death or nonfatal MI



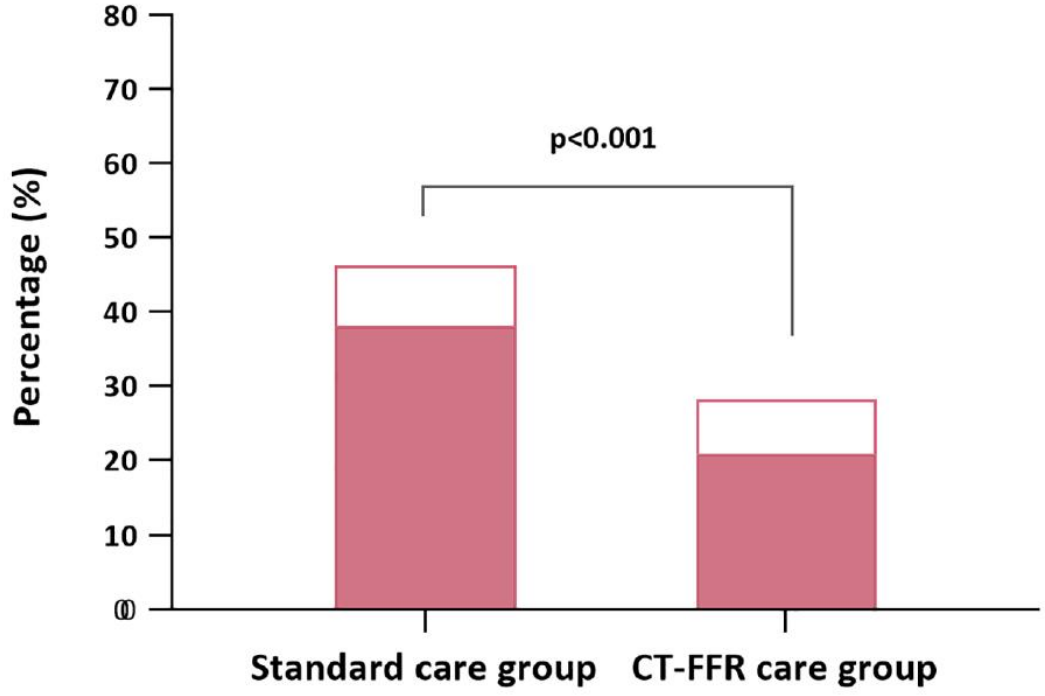
No. at risk

Precision strategy	1057	1014	993	970	446	89
Usual testing	1046	1009	996	970	468	107

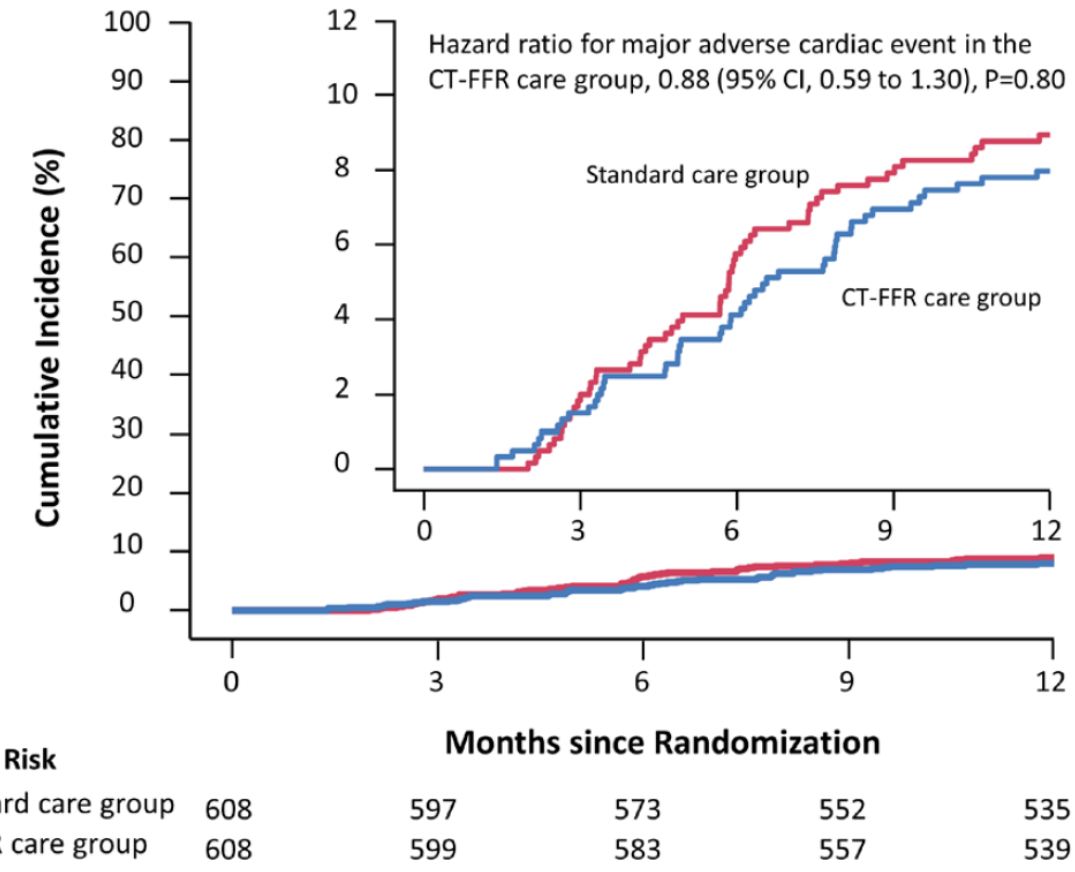
Douglas et al., JAMA Cardiol. 2023 Oct 1;8(10):904-914. doi: 10.1001/jamacardio.2023.2595.

CT-FFR in Treatment Strategy

TARGET trial



	Standard care group	CT-FFR care group
Primary endpoint	46.2% (223/483)	28.3% (119/421)
ICA without obstructive CAD within 90 days	38.1% (184/483)	20.9% (88/421)
ICA with obstructive CAD who did not undergo intervention within 90 days	8.1% (39/483)	7.4% (31/421)

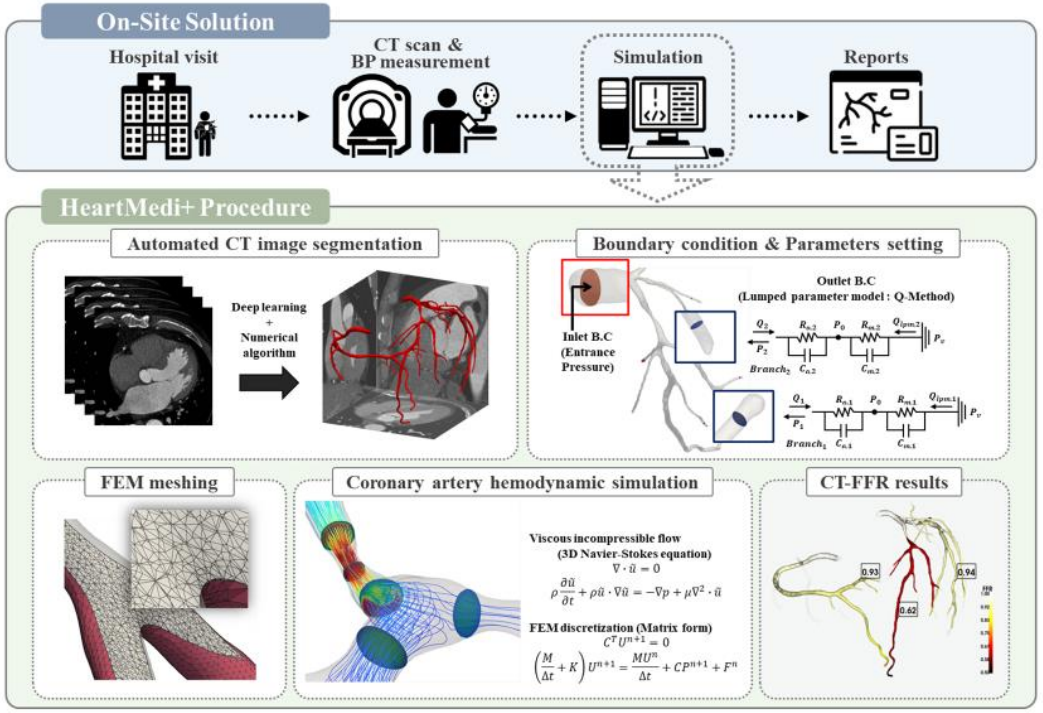


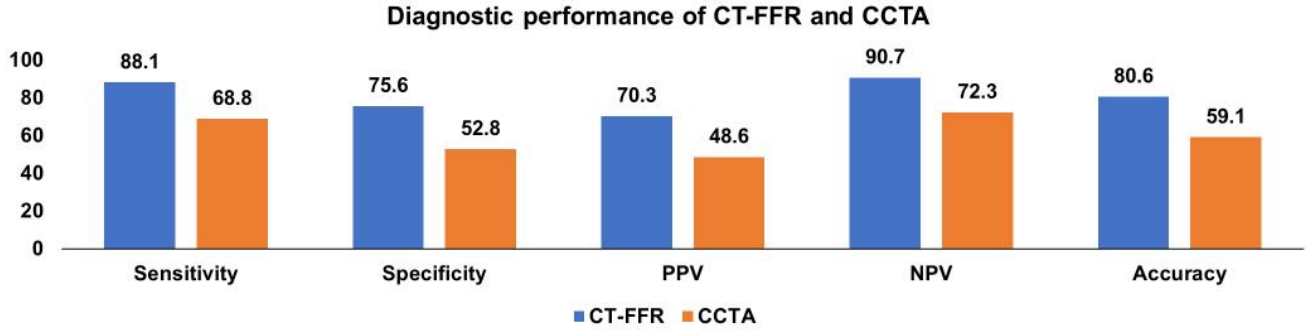
The primary end point was the proportion of patients undergoing invasive coronary angiography without obstructive coronary artery disease or with obstructive disease who did not undergo intervention within 90 days.

Yang et al., Circulation. 2023 May 2;147(18):1369-1381.

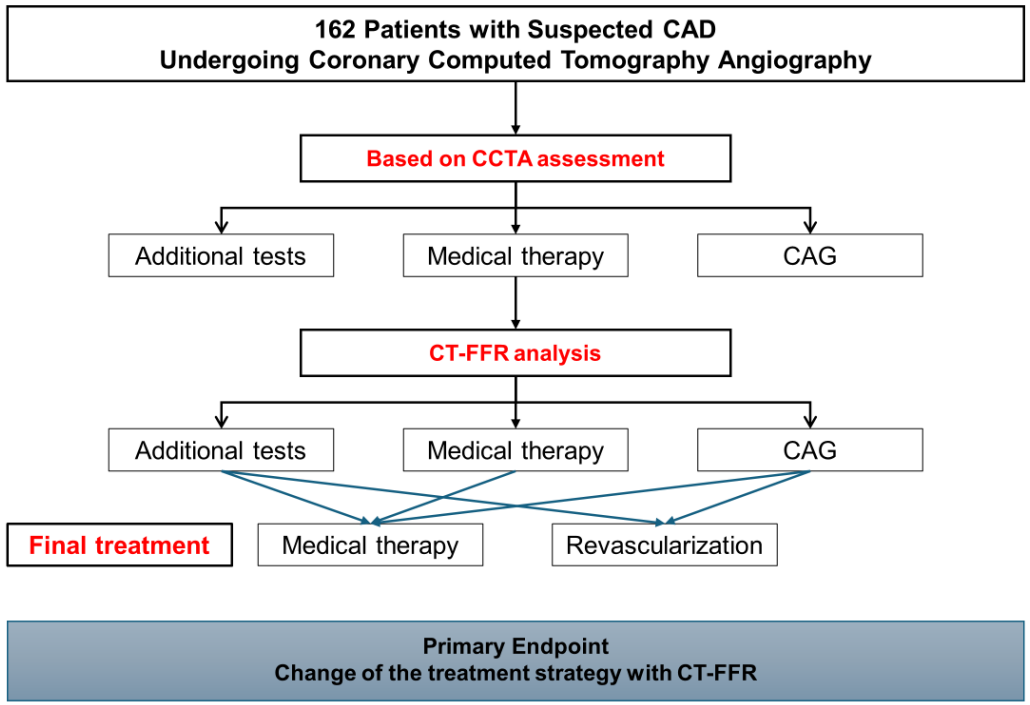
Korean Version of CT-FFR

On-site automatic CT-FFR from CCTA





CHANGE-FLOW on preparation



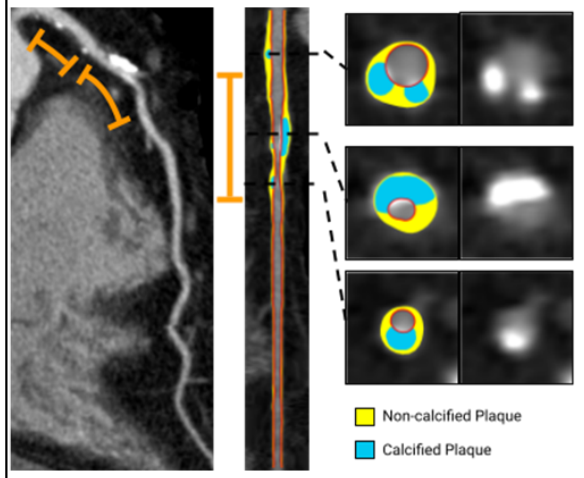
Hwang, Nam, Doh, Kim, Kim and Koo et al. Korean Circ J in press

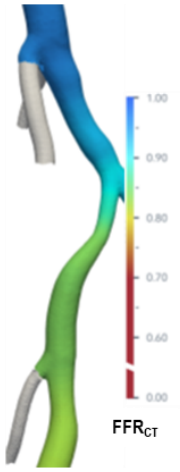
AI-based CCTA evaluation

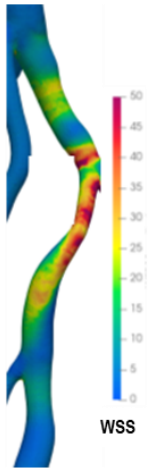
EMERALD II study
ACS patients who underwent CCTA from 1 month to 3 years prior to ACS event → Culprit vs. non-culprit lesions in CCTA

Derivation cohort (n=1,495 lesions)

Artificial Intelligence-enabled Quantitative Coronary Plaque and Hemodynamic Analysis (AI-QCPHA)

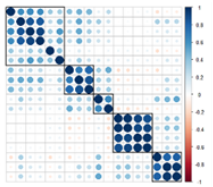




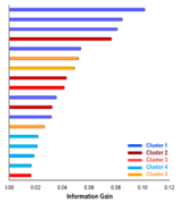


Features from AI-QCPHA

Plaque		Hemodynamics	
TPV, mm^3	57	WSS (Avg), dyne/cm^2	284
NCPV, mm^3	34	WSS (Peak), dyne/cm^2	743
LAPV, mm^3	3.9	APS (Avg), dyne/cm^2	588
% TPV	71	APS (Peak), dyne/cm^2	28099
% NCPV	43	ΔFFR_{CT}	0.10
% LAPV	5	Peak FFR$_{CT}$ gradient	0.02
Plaque burden, %	78	% Total MBF (Avg)	17
Lesion length, mm	13	% Total MBF (Peak)	30
		% LV MBF (Avg)	20
		% LV MBF (Peak)	36



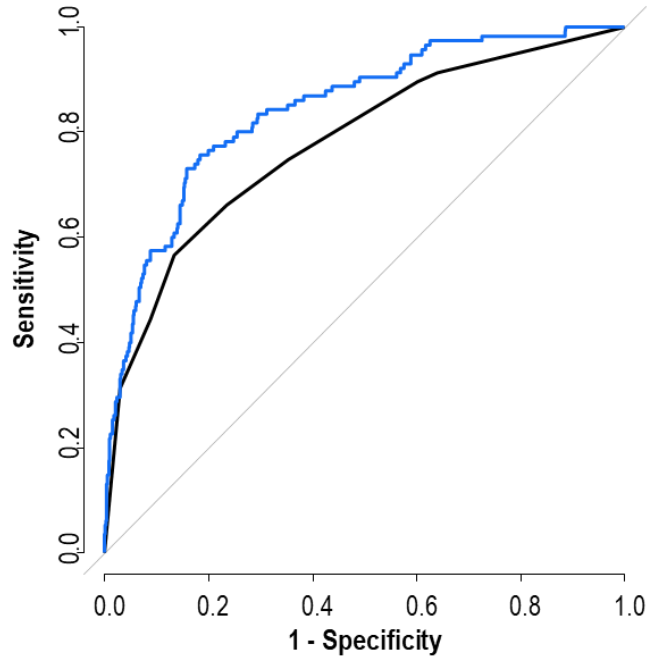
Hierarchical Clustering and Feature Selection



Five AI-QCPHA features
ΔFFR_{CT} , Plaque burden, Total plaque volume, Low-attenuation plaque volume, and Averaged % total myocardial blood flow

Validation Cohort (n=956 lesions)

Discrimination Ability for ACS Culprit Lesions

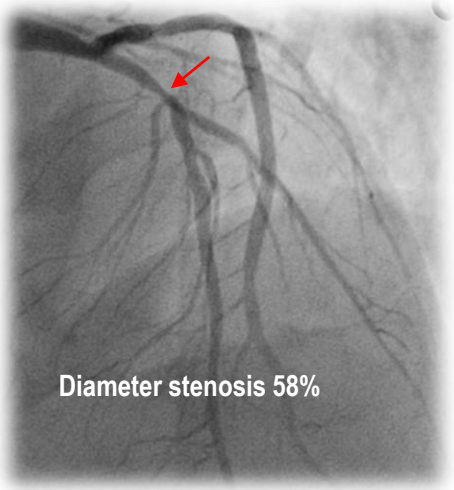


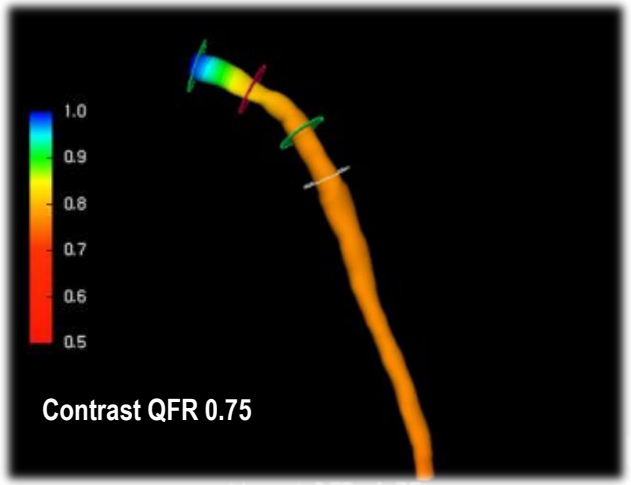
Model	AUC	P-value
— CAD-RADS + HRP	0.78	<0.001
— CAD-RADS + HRP + AI-QCPHA features	0.84	

Koo and Yang et al., JACC Cardiovasc Imaging. Just Accepted

Angio-FFR / Quantitative Flow Ratio (QFR)

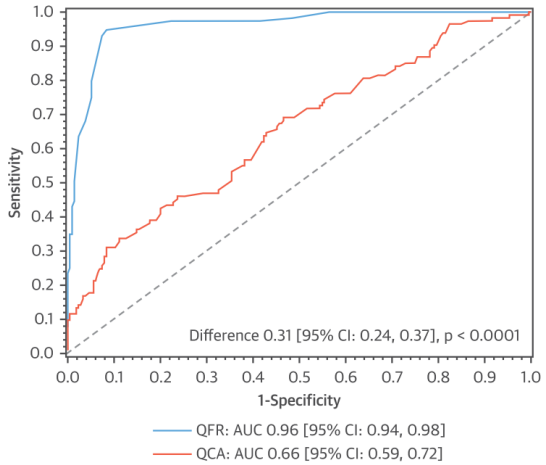
Process of QFR Acquisition



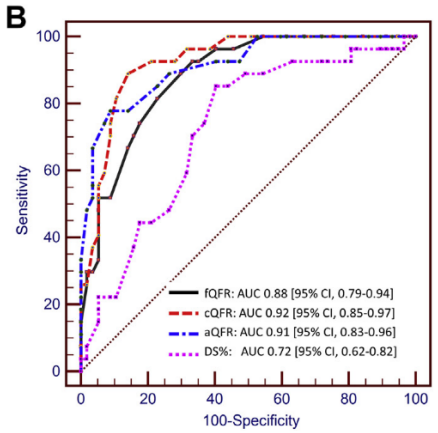


- Computation of FFR from Coronary Angiography
- No need of pressure wire or hyperemic agent
- Easy to measure

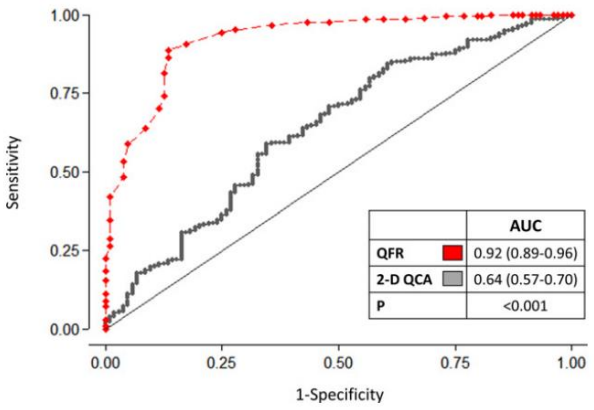
FAVOR II CHINA



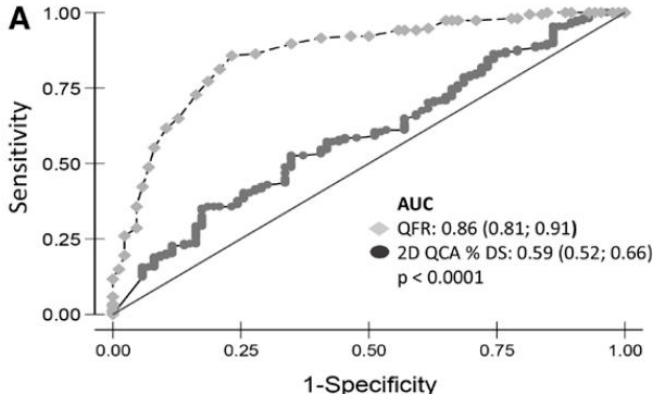
FAVOR PILOT



FAVOR II EUROPE-JAPAN



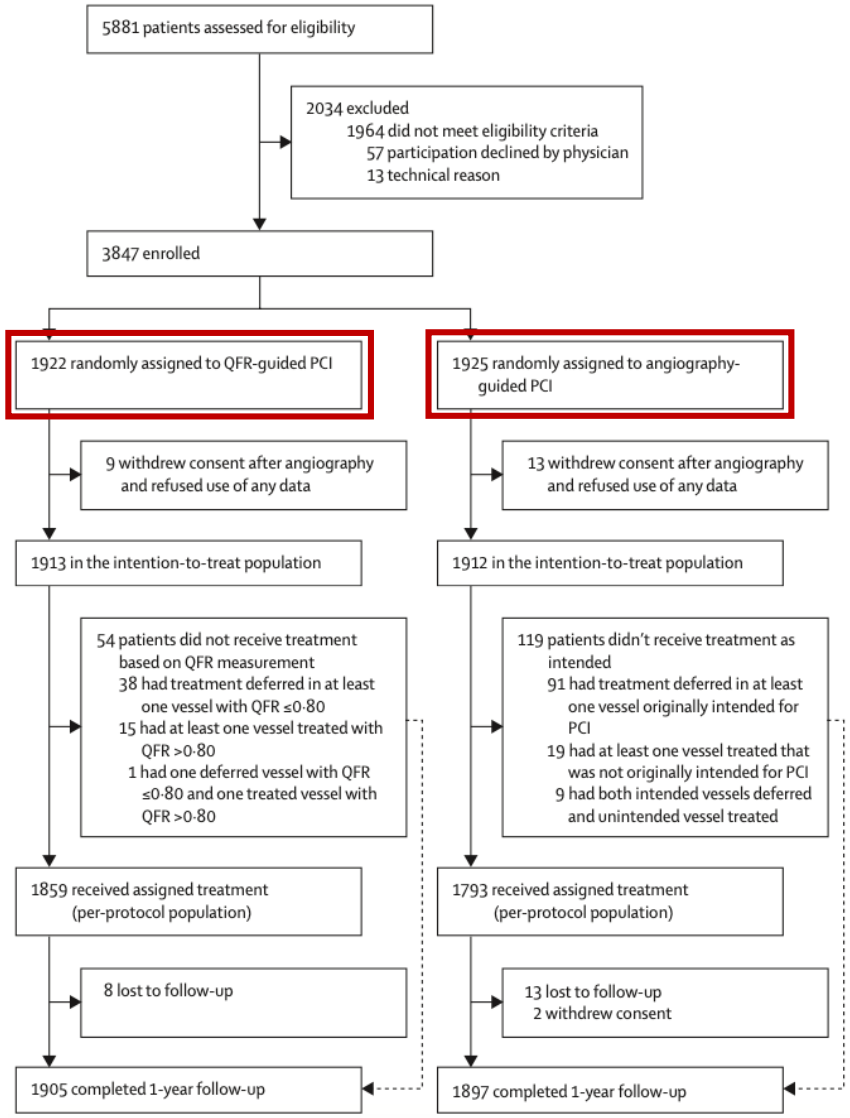
WIFI II

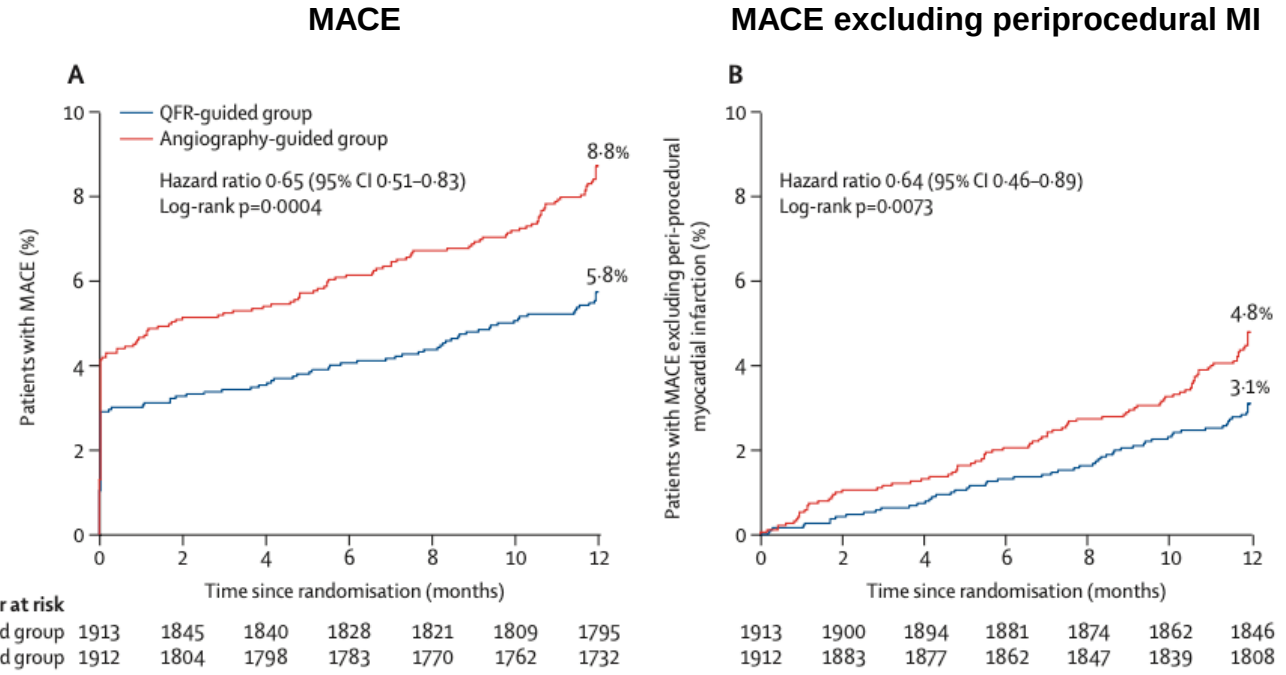


J Am Coll Cardiol 2017;70:3077–87. J Am Coll Cardiol Intv 2016;9:2024–35.
J Am Heart Assoc. 2018;7: e009603. Circ Cardiovasc Imaging. 2018;11:e007107.

Angio-vs. QFR-guided PCI

FAVOR III China trial

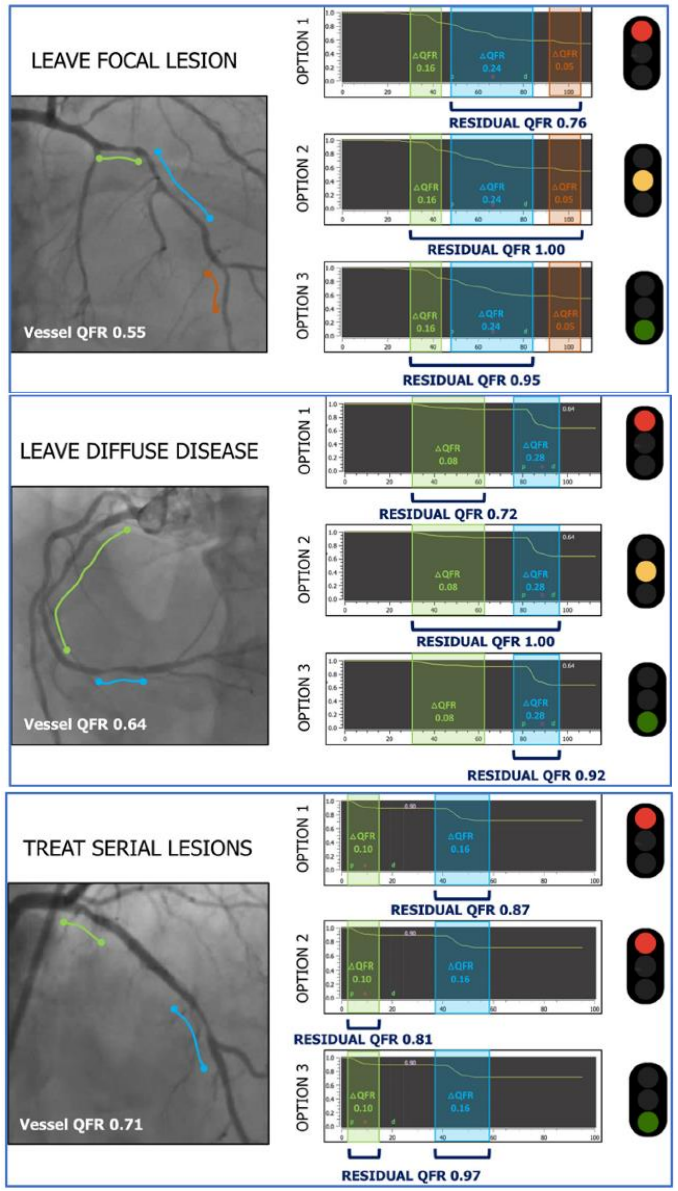




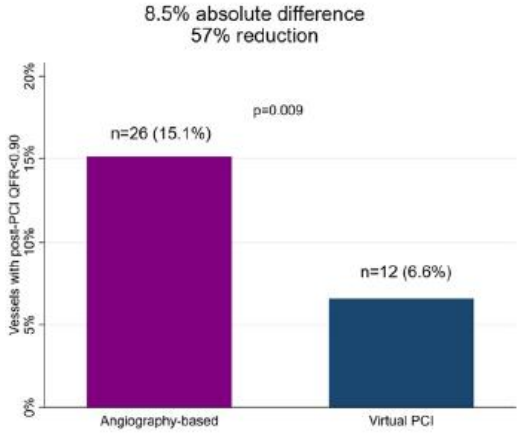
A QFR-guided strategy of lesion selection improved 1-year clinical outcomes compared with standard angiography guidance.

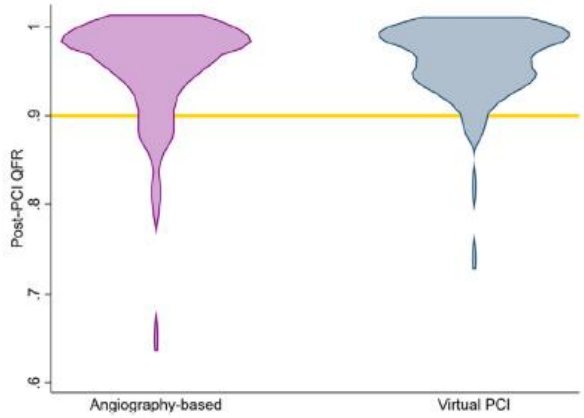
J Am Coll Cardiol 2017;70:3077–87. J Am Coll Cardiol Intv 2016;9:2024–35.
J Am Heart Assoc. 2018;7: e009603. Circ Cardiovasc Imaging. 2018;11:e007107.

QFR-Based Virtual PCI - AQVA Trial

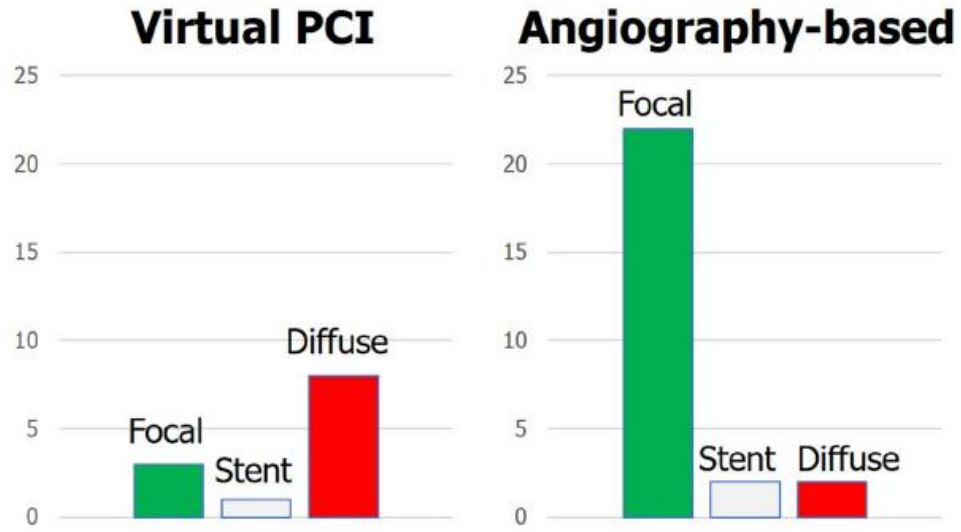


The primary outcome was the rate of study vessels with a suboptimal post-PCI QFR value.





Reasons for suboptimal results.

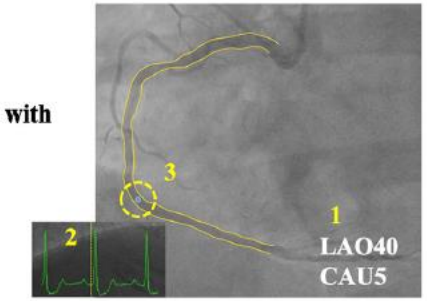


Biscaglia et al., JACC Cardiovasc Interv. 2023 Apr 10;16(7):783-794.

Diagnostic Performance of QFR

444 vessels were screened by Matcher Investigator (MI)

MI provide provided the 4 other independent analysts with
1. Optimal angiographic 2 views (≥30 degrees apart)
2. Optimal frame ideally in the ED phase
3. Site of measurement of the pressure wire



390 vessels were selected and provided to each independent analysts

Analyst A | Analyst B | Analyst C | Analyst D

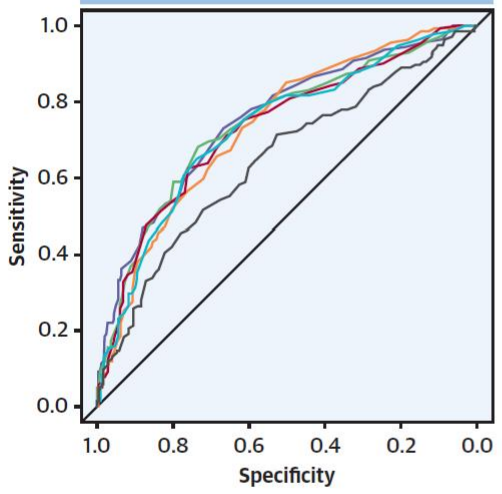
Carry out analysis in a "blind" fashion

Objectives of the present study:
Head-to-head comparison of diagnostic performance of 4 software (5 methods)

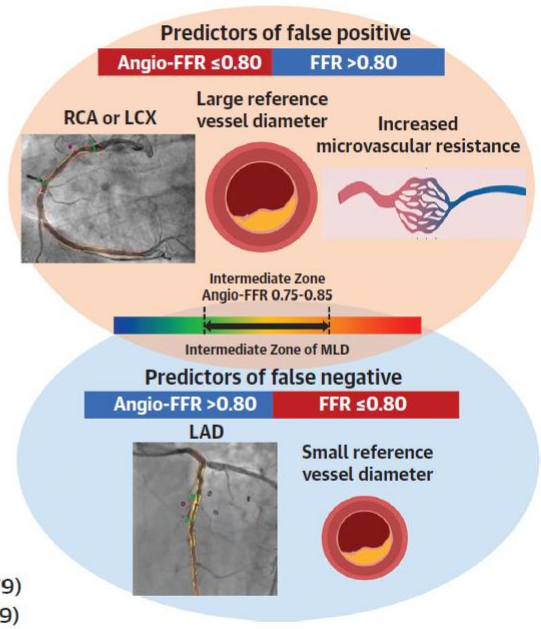
Multimethod Core Laboratory Assessment of Diagnostic Accuracies of 4 Angiographic FFR Software Versus Wire-Based FFR or iFR, N = 390 Vessels

All analysts were blinded to the results of the wire-FFR/iFR and other angio-FFR software

ROC Curves for Each Angiography Derived FFR to Detect an FFR of ≤0.80



A: AUC 0.75 (0.70-0.80)
B: AUC 0.74 (0.69-0.80)
C: AUC 0.74 (0.68-0.79)
D: AUC 0.73 (0.68-0.79)
E: AUC 0.73 (0.68-0.79)
2D-QCA %DS: 0.65 (0.59-0.71)

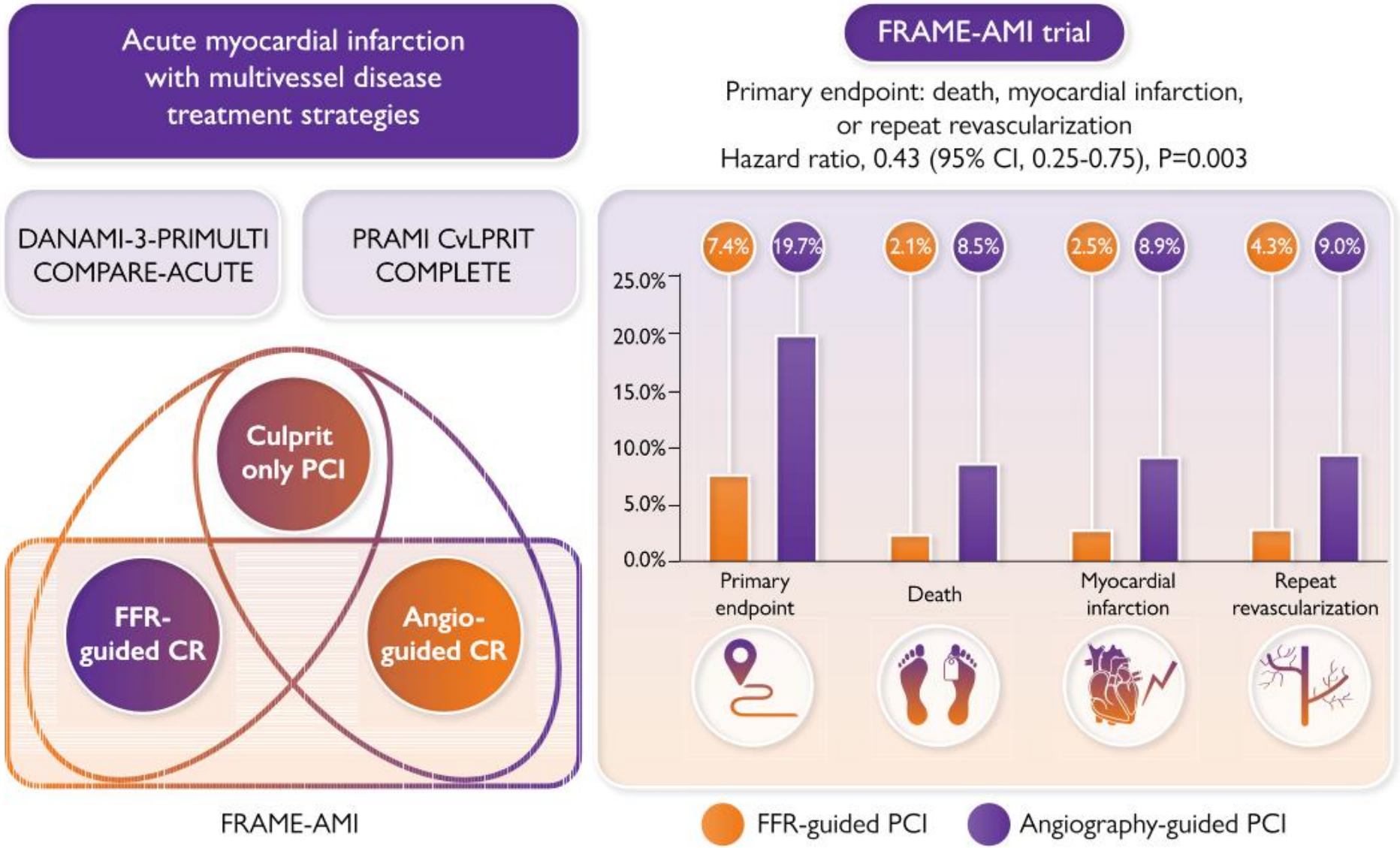


Key Findings

1. All five angio-FFR software/methods had comparable diagnostic accuracies with a higher discrimination compared to 2D-QCA.
2. The diagnostic performances of angio-FFR did not reach the diagnostic performance (AUC ≥0.9) reported in validation studies from the various vendors.
3. Pressure-wire based physiologic evaluation is still needed in specific lesion subsets.

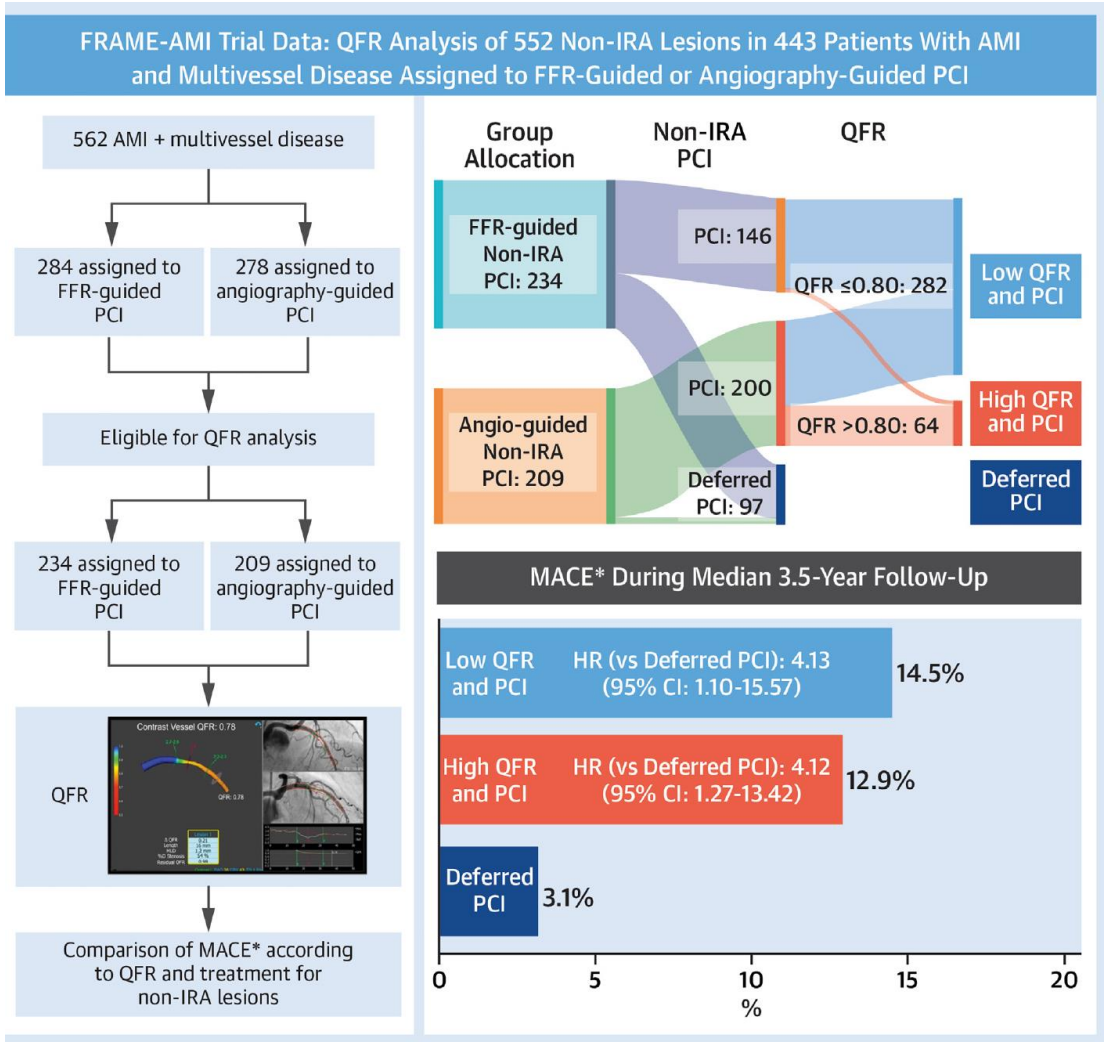
Ninomiya et a., JACC Cardiovasc Interv. 2023 Jul 24;16(14):1778-1790.

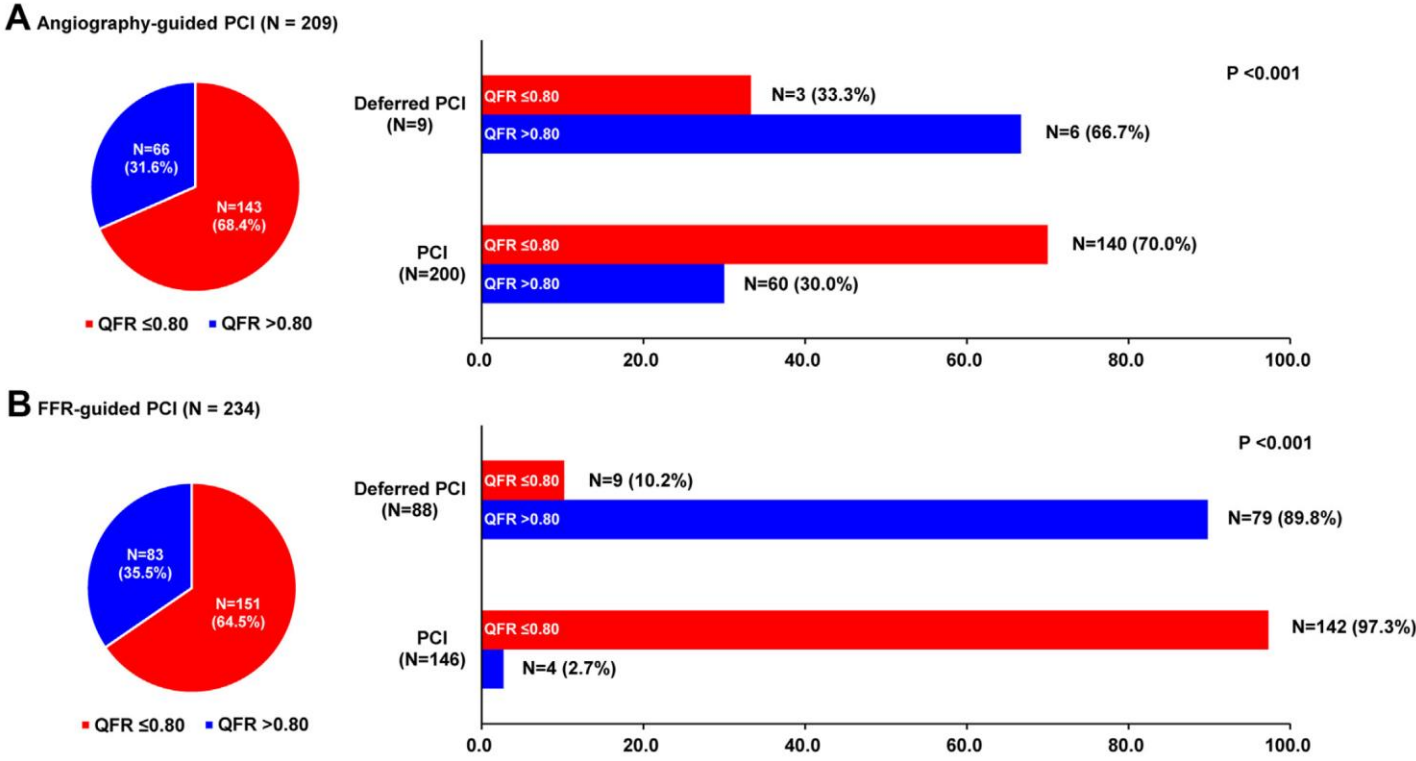
AMI with Multivessel disease – FRAME-AMI



Eur Heart J. 2023 Feb 7;44(6):473-484.

QFR in Nonculprit PCI after AMI – FRAME-AMI substudy



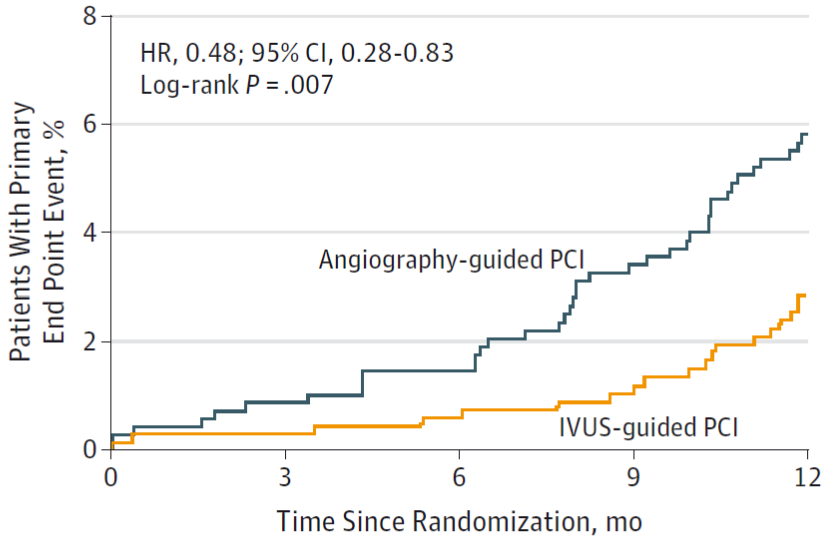


Lee et al., JACC Cardiovasc Interv. 2023 Oct 9;16(19):2365-2379.

Imaging-guided PCI

The IVUS-XPL trial

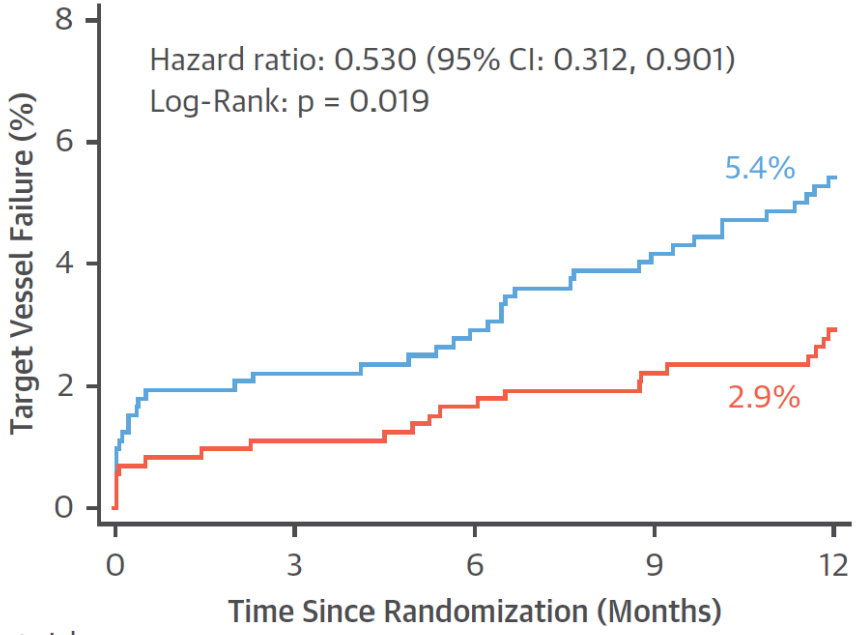
Major adverse cardiac events, including cardiac death, target lesion-related myocardial infarction, or ischemia-driven target lesion revascularization at 1 year



No. at risk PCI					
Angiography-guided	700	673	660	643	624
IVUS-guided	700	671	665	654	641

The ULTIMATE trial

Target vessel failure



Number at risk					
Angiography	724	706	698	685	676
IVUS	724	715	710	704	696

Image-guided PCI is associated with better clinical outcomes.

JAMA. 2015 Nov 24;314(20):2155-63.
J Am Coll Cardiol. 2018 Dec 18;72(24):3126-3137.

Imaging-guided PCI

From recent guidelines

2018 ESC/EACTS guideline

Recommendations on intravascular imaging for procedural optimization

Recommendations	Class[a]	Level[b]
IVUS or OCT should be considered in selected patients to optimize stent implantation.[603,612,651–653]	IIa	B
IVUS should be considered to optimize treatment of unprotected left main lesions.[35]	IIa	B

2021 ACC/AHA/SCAI guideline

Recommendations for Use of Intravascular Imaging
Referenced studies that support the recommendations are summarized in Online Data Supplement 25.

COR	LOE	Recommendations
2a	B-R	1. In patients undergoing coronary stent implantation, IVUS can be useful for procedural guidance, particularly in cases of left main or complex coronary artery stenting, to reduce ischemic events.[1-10]
2a	B-R	2. In patients undergoing coronary stent implantation, OCT is a reasonable alternative to IVUS for procedural guidance, except in ostial left main disease.[11-13]
2a	C-LD	3. In patients with stent failure, IVUS or OCT is reasonable to determine the mechanism of stent failure.[14-17]

Eur Heart J. 2019 Jan 7;40(2):87-165.
Circulation. 2022 Jan 18;145(3):e4-e17.

Imaging-guided PCI

ILUMIEN III: OPTIMIZE PCI

OCT-guided PCI using a specific reference segment external elastic lamina-based stent optimisation strategy was safe and resulted in similar minimum stent area to that of IVUS-guided PCI.

	OCT (n=140)	IVUS (n=135)	Angiography (n=140)	OCT *vs* IVUS p value	OCT *vs* angiography p value
Minimum stent area (mm²)	5·79 (4·54–7·34)	5·89 (4·67–7·80)	5·49 (4·39–6·59)	0·42	0·12
Minimum stent expansion (%)	87·6% (16·6)	86·5% (15·9)	82·9% (12·9)	0·77	0·02
Mean stent expansion (%)	105·8% (97·8–119·8)	106·3% (96·7–116·6)	101·4% (91·9–110·2)	0·63	0·001
Acute procedural success					
Optimal (≥95%)	36 (26%)	32/130 (25%)	23/136 (17%)	0·84	0·07
Acceptable (90 to <95%)	22 (16%)	16/130 (12%)	5/136 (4%)	0·42	0·0008
Unacceptable (<90%)	82 (59%)	82/130 (63%)	108/136 (79%)	0·45	0·0002
Intrastent flow area (mm²)	5·54 (4·34–7·05)	5·71 (4·59–7·58)	5·42 (4·25–6·36)	0·56	0·32
Total flow area (mm²)	5·68 (4·59–7·30)	5·87 (4·76–7·59)	5·52 (4·42–6·63)	0·72	0·27
Any dissection	39 (28%)	53/134 (40%)	61 (44%)	0·04	0·006
Major	19 (14%)	35/134 (26%)	26 (19%)	0·009	0·25
Minor	20 (14%)	18/134 (13%)	35 (25%)	0·84	0·02
Intimal	16 (11%)	11/134 (8%)	21 (15%)	0·37	0·38
Medial	27 (19%)	45/134 (34%)	40 (29%)	0·007	0·07
Adventitial	1 (1%)	0/134	0	1	1
Any malapposition	58 (41%)	52 (39%)	83 (59%)	0·62	0·003
Major	15 (11%)	28 (21%)	44 (31%)	0·02	<0·0001
Minor	43 (31%)	24 (18%)	39 (28%)	0·01	0·60
Any plaque or thrombus protrusion	94 (67%)	100 (74%)	95 (68%)	0·21	0·90
Major	27 (19%)	27 (20%)	25 (18%)	0·88	0·76
Minor	67 (48%)	73 (54%)	70 (50%)	0·30	0·72
Reference segment disease	44 (31%)	45 (33%)	39 (28%)	0·74	0·51

Lancet. 2016 Nov 26;388(10060):2618-2628.

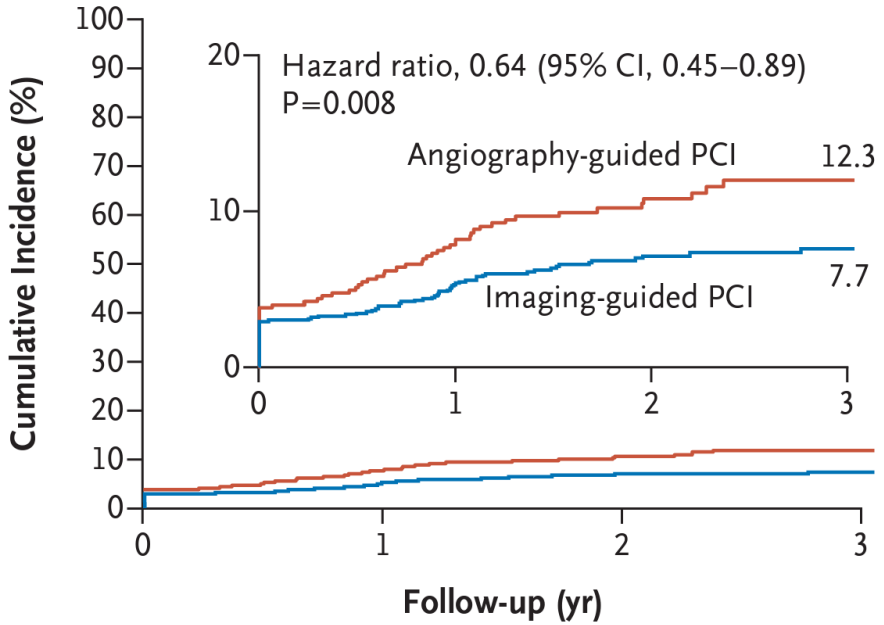
Imaging-guided PCI

RENOVATE-COMPLEX-PCI

A total of 1,639 patients with complex coronary artery lesions were randomized

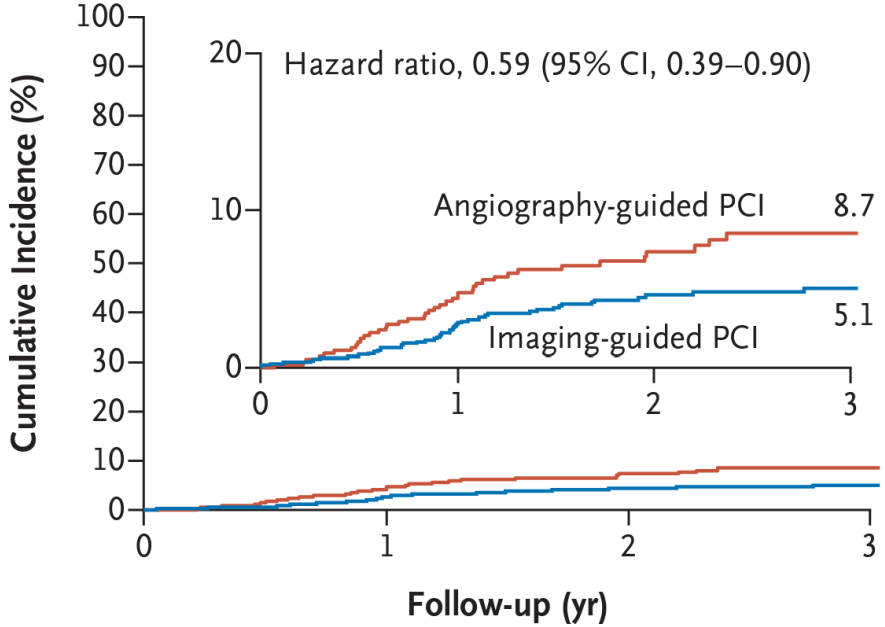
Also showed mortality benefits.

A Target-Vessel Failure



No. at Risk				
Angiography-guided PCI	547	496	280	120
Imaging-guided PCI	1092	1023	591	255

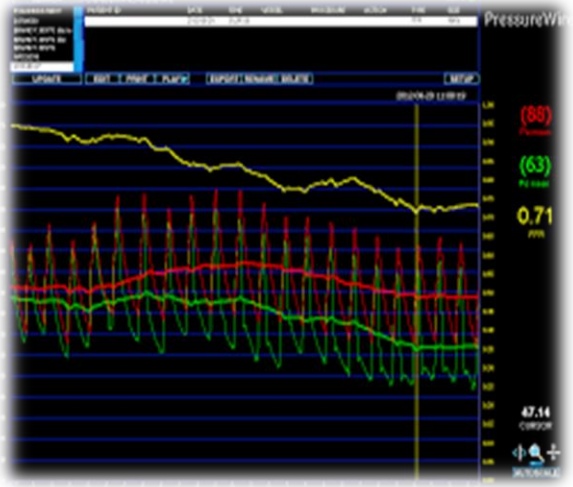
B Target-Vessel Failure without Procedure-Related Myocardial Infarction



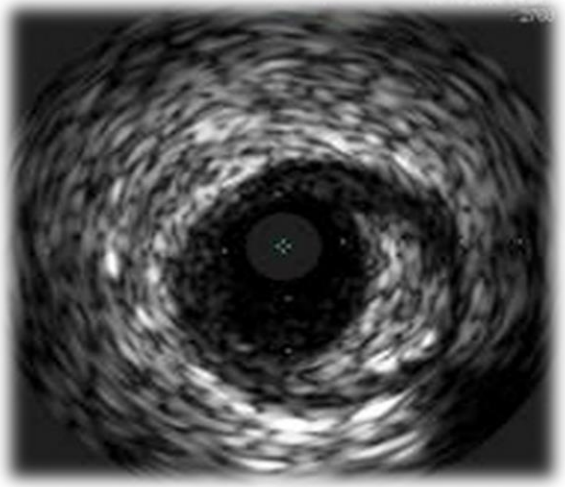
No. at Risk				
Angiography-guided PCI	547	516	284	121
Imaging-guided PCI	1092	1051	596	256

N Engl J Med. 2023 May 4;388(18):1668-1679.

Physiology-based vs. Image-based Assessment



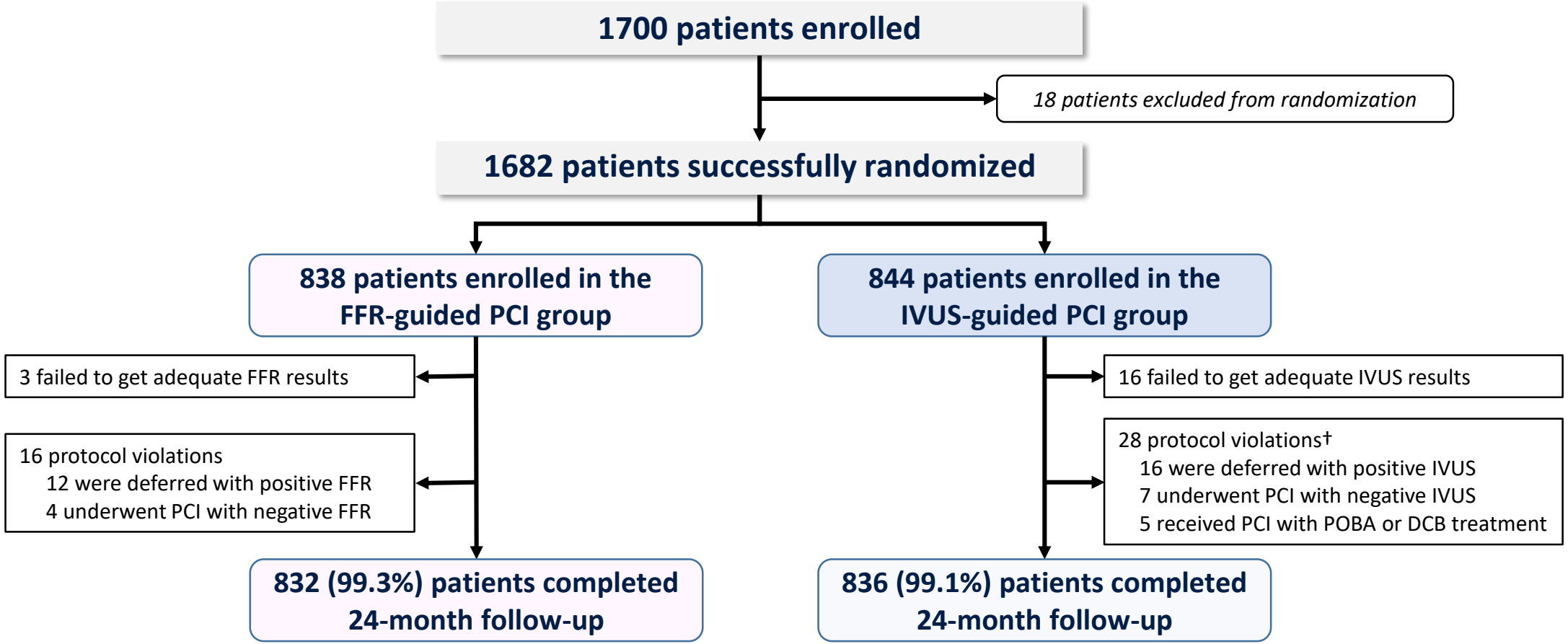
&



- Physiology-based and image-based assessments reflect different aspects of coronary atherosclerosis and have developed with different objectives.
- However, many clinicians substitute one method for the other to a certain extent.

Study Flow of the FLAVOUR trial

***1,700 eligible patients** (Patients with de novo intermediate stenosis (40-70% stenosis by visual estimation) eligible for PCI) from 18 centers in China and Korea*



N Engl J Med. 2022 Sep 1;387(9):779-789.

Indications for PCI and PCI optimization

FFR-guided PCI	IVUS-guided PCI
Indication for PCI	
FFR ≤ 0.80	Minimum lumen area (MLA) ≤ $3mm^2$ or $3< MLA \leq 4mm^2$ & Plaque burden > 70%
Criteria for optimal PCI	
Post-PCI FFR ≥ 0.88 or Post-PCI ΔFFR (FFR across the stent) < 0.05	Plaque burden at stent edge ≤ 55% Minimal stent area ≥ $5.5mm^2$ or Minimal stent area ≥ distal reference lumen area

N Engl J Med. 2022 Sep 1;387(9):779-789.

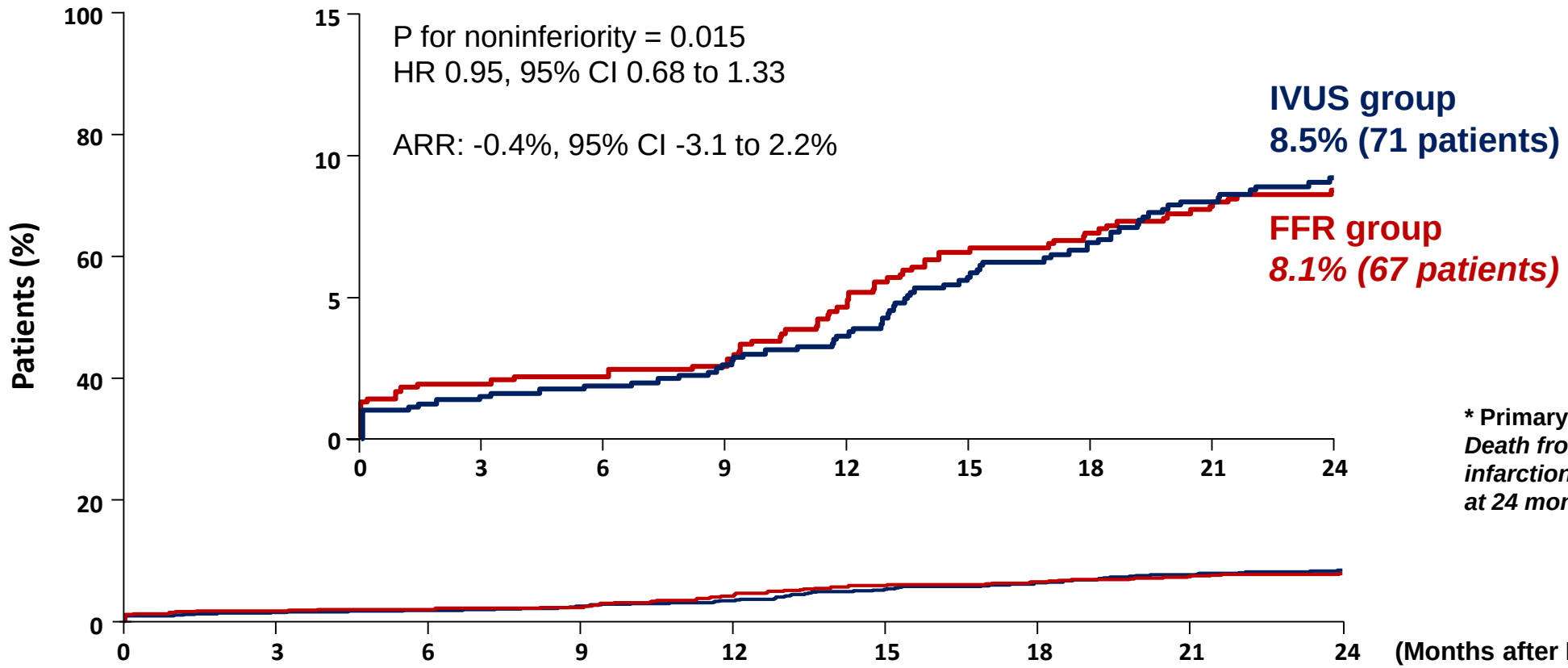
Results of the FLAVOUR trial

Characteristic	FFR Group	IVUS Group	Difference (95% CI)†
Angiographic findings			
No. of patients	838	844	
Multivessel disease — no. (%)	445 (53.1)	430 (50.9)	2.2 (−2.7 to 7.0)‡
Diseased vessels — no. (%)§			
Nonobstructive	15 (1.8)	16 (1.9)	
1 vessel	378 (45.1)	398 (47.2)	
2 vessels	295 (35.2)	273 (32.3)	
3 vessels	150 (17.9)	157 (18.6)	
Trial target vessels — no. (%)			
1 vessel	763 (91.1)	791 (93.7)	
2 vessels	69 (8.2)	49 (5.8)	
3 vessels	6 (0.7)	4 (0.5)	
Patients who underwent PCI — no. (%)			
Any procedure	372 (44.4)	551 (65.3)	−20.9 (−25.7 to −16.1)‡
Multivessel	66 (7.9)	125 (14.8)	−6.9 (−10.1 to −3.8)‡
Stent data			
Total no. per patient	0.6±0.9	0.9±1.0	−0.3 (−0.4 to −0.3)
Total length per patient — mm	16.5±24.1	25.2±28.1	−8.7 (−11.2 to −6.2)
Total no. per patient who underwent PCI	1.4±0.8	1.5±0.8	−0.1 (−0.2 to 0.0)
Total length per patient who underwent PCI — mm	37.2±23.2	38.6±26.4	−1.4 (−4.7 to 1.9)
SYNTAX score¶			
At baseline	8.4±5.8	8.9±6.2	−0.5 (−1.1 to 0.1)
After PCI	5.4±4.6	4.6±4.7	0.8 (0.3 to 1.2)

Less procedure was done,
And less stents were used
In the FFR-guided PCI group.

N Engl J Med. 2022 Sep 1;387(9):779-789.

Results of the FLAVOUR trial



*** Primary Endpoint:**
Death from any cause, myocardial infarction, and any revascularization at 24 months after randomization

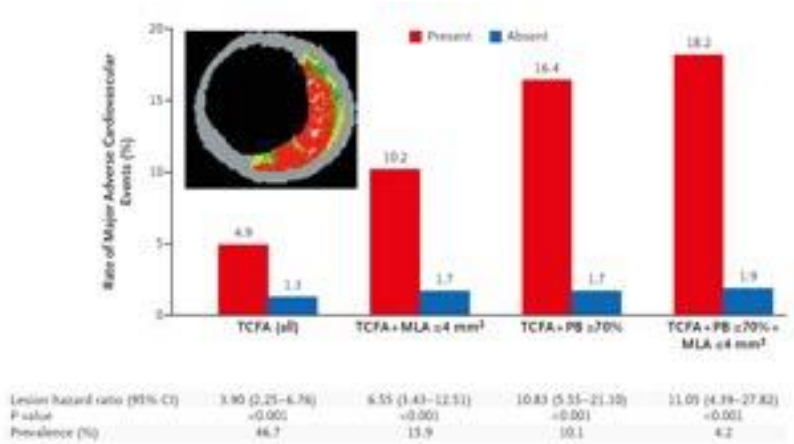
Number at risk

IVUS	844	828	825	820	809	792	784	771	690
FFR	838	818	816	812	796	781	778	770	699

N Engl J Med. 2022 Sep 1;387(9):779-789.

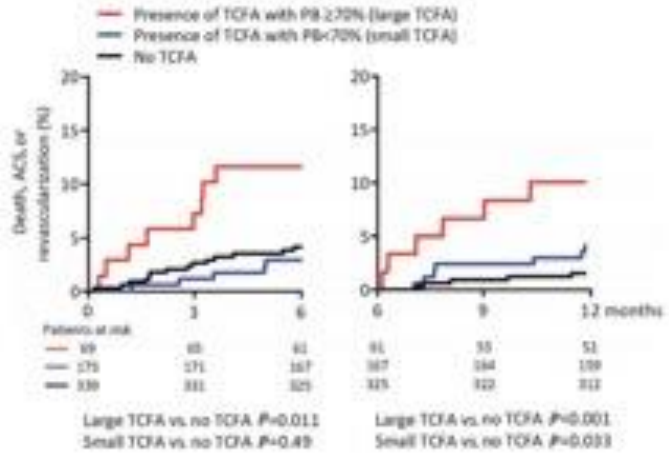
Vulnerable Plaque

PROSPECT Trial



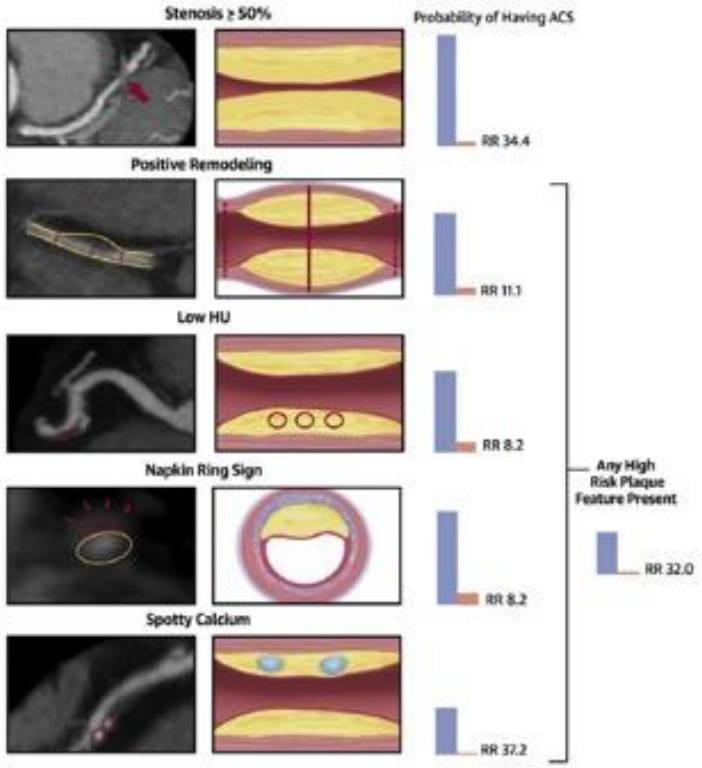
Predictor	Multivariable HR (95% CI)	P value
PB (MLA) ≥ 70%	5.03 (2.51-10.11)	<0.001
VH-TCFA	3.35 (1.77-6.36)	<0.001
MLA ≤ 4.0mm²	3.21 (1.61-6.42)	0.001

ATHEROREMO



Predictor	Adjusted HR (95% CI)	P value
PB (MLA) ≥ 70%	2.90 (1.60-5.25)	<0.001
VH-TCFA	1.98 (1.09-3.60)	0.026
MLA ≤ 4.0mm²	1.23 (0.67-2.26)	0.05

ROMICAT-II Trial



Vulnerable features from IVUS and CCTA is associated with worse clinical outcome.

N Engl J Med. 2011 Jan 20;364(3):226-35.
Eur Heart J. 2014 Mar;35(10):639-47.
J Am Coll Cardiol. 2014 Aug 19;64(7):684-92.

How to treat vulnerable plaque

PREVENT trial

The **PREVENT**ive Coronary Intervention on Stenosis With Functionally Insignificant Vulnerable Plaque

PREVENT Trial

Any Significant Epicardial Coronary Stenosis (DS>50%) with *FFR >0.80* and with *Two* of the following

1. IVUS MLA <4.0mm^2
2. IVUS Plaque Burden >70%
3. Lipid-Rich Plaque on NIRS ($_{max}LCBI_{4mm}$>315)
4. TCFA by OCT or VH-IVUS

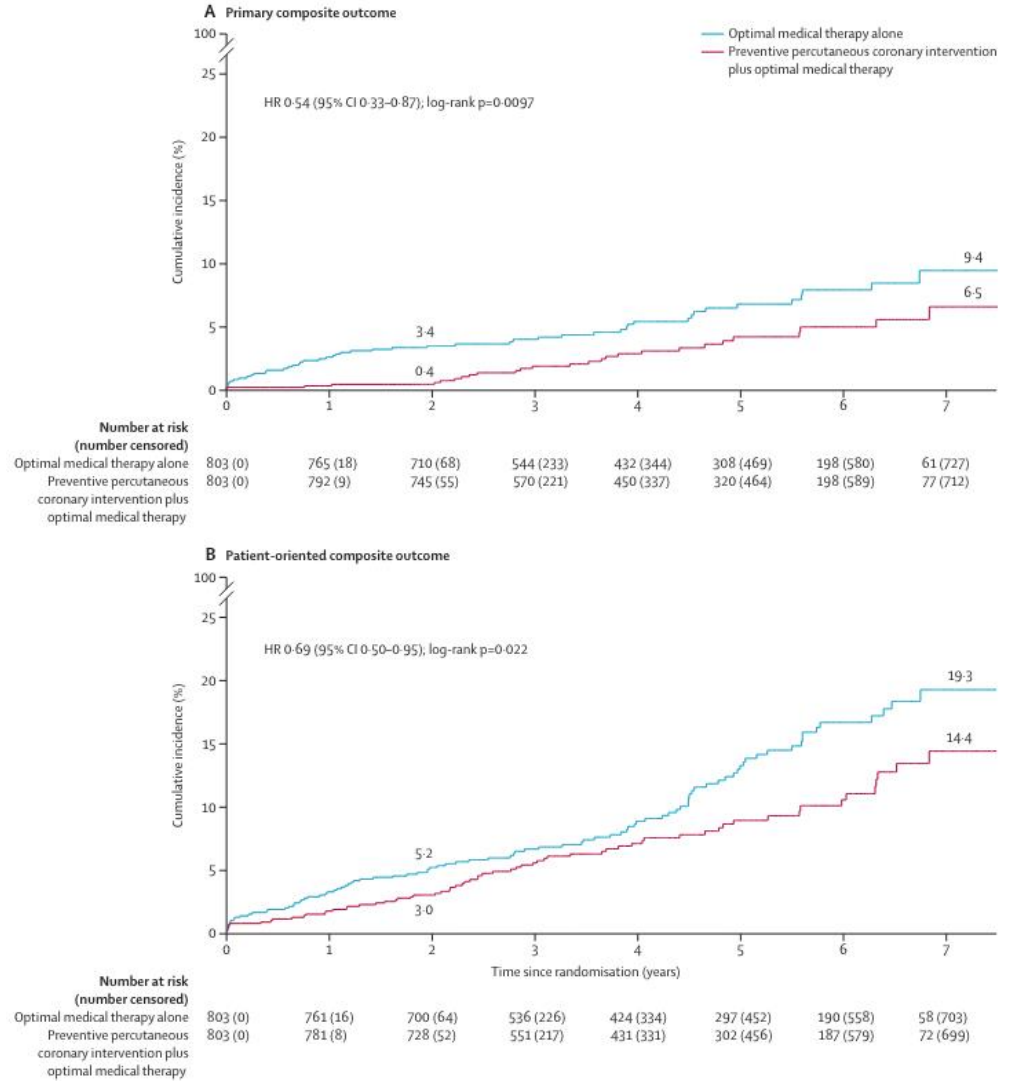
R

PCI+GDMT N=800

GDMT N=800

Primary endpoint: Target Vessel Failure at 2 years

(Death from cardiac cause, target vessel myocardial infarction, ischemic-driven target vessel revascularization, or unplanned hospitalization due to unstable or progressive angina)



Lancet. 2024 May 4;403(10438):1753-1765.

Conclusion

- Although the decision strategy for the revascularization of CCS patients has been changed, the invasive physiologic test still plays a role in that.
- CT-FFR is associated with even long-term clinical outcomes, can change our daily practice, and can improve the efficacy of treatment decision-making.
- Recent studies regarding QFR demonstrated the benefit of risk stratification when combined with image modalities and procedure planning. However, its diagnostic performance is still controversial.
- Imaging guidance for PCI optimization has shown its consistent benefits.
- Revascularization of non-obstructive vulnerable plaque is a recent concern for cardiologists.

SNUH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Thank you for your attention.
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