Unprotected Left Main and
Multivessel Disease: Clinical Session

We need to assess ischemia/viability

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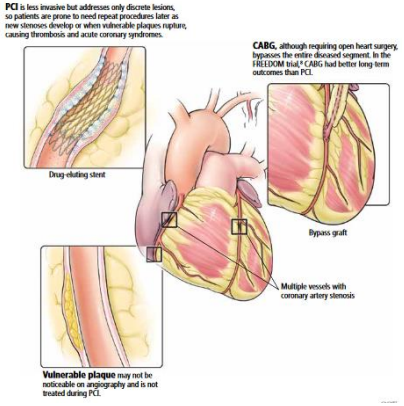
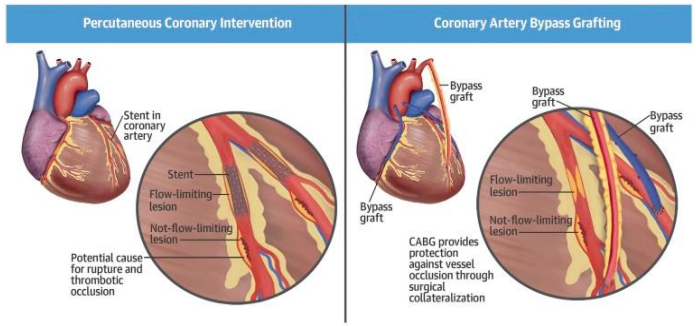
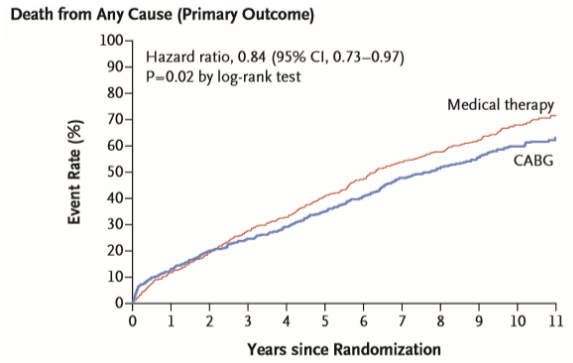
Disclosure

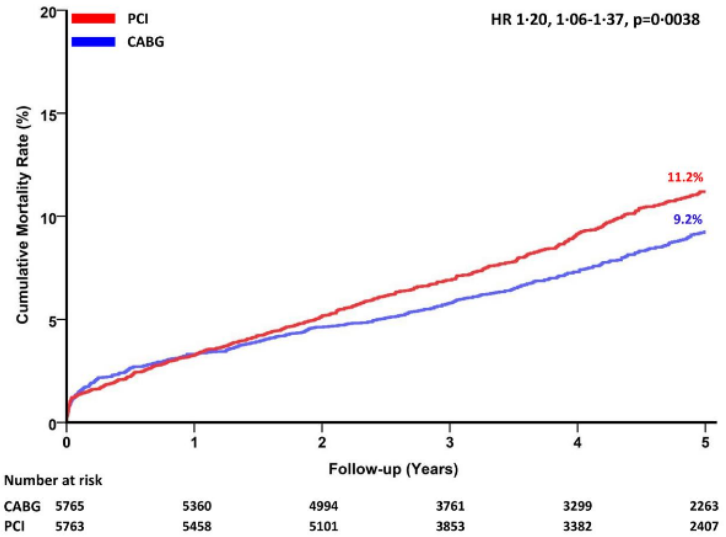
- None

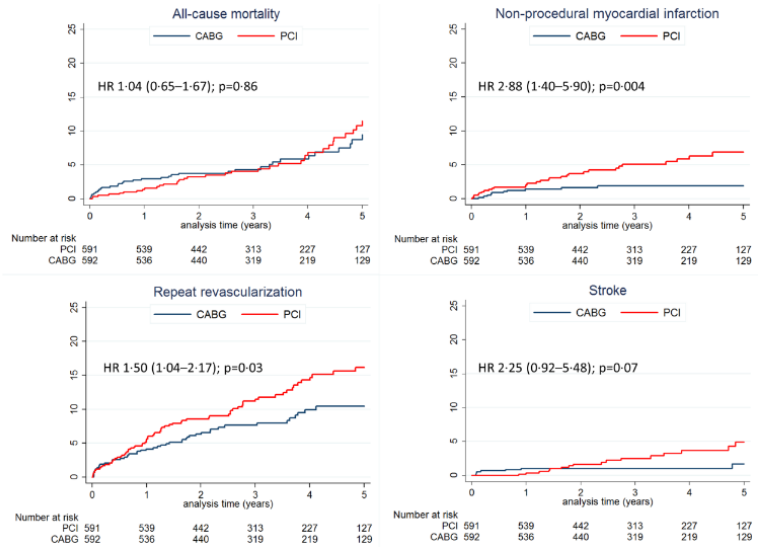
Comparative effectiveness of PCI vs. CABG











Velazquez et al, New Engl J Med 2016

Aggarwal et al, Cleve Clin J Med. 2013; Doenst et al, J Am Coll Cardiol 2019

Head et al, Lancet 2018; 27% BMS, 39% 1st-generation DES

Mäkikallio et al, Lancet 2016

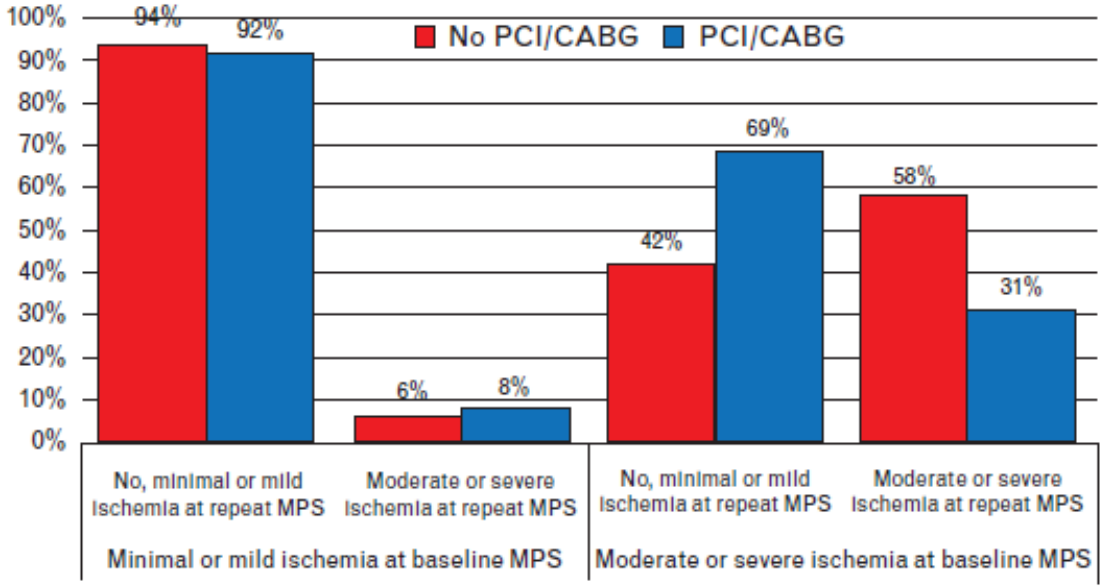
Comparative goals of testing and revascularization

- Tests aim at providing details on:
  - Diagnosis
  - Prognosis
  - Warranty period
  - Therapeutic choice

- Revascularization aims at reducing:
  - Fatality
  - Non-fatal events (e.g. MI, revascularization, rehospitalization)
  - Adverse remodeling
  - Symptom burden

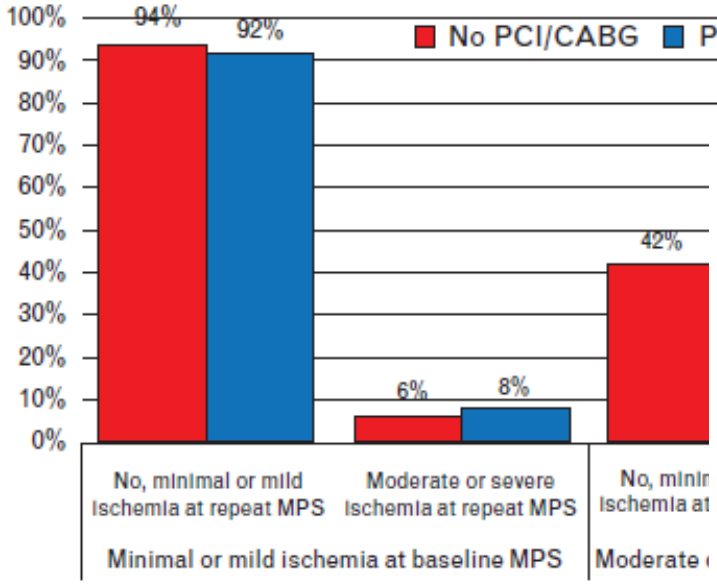
Nudi et al, editors.
Hybrid Cardiac Imaging.
Springer: 2020

Revascularization improves ischemia



Prevalence of maximal ischemia score (MIS) at repeat myocardial perfusion scintigraphy (MPS) according to MIS at baseline MPS and after propensity matching according to the occurrence of coronary revascularization as first event during follow-up. CABG, Coronary artery bypass grafting; PCI, percutaneous coronary intervention.

Revascularization improves ischemia



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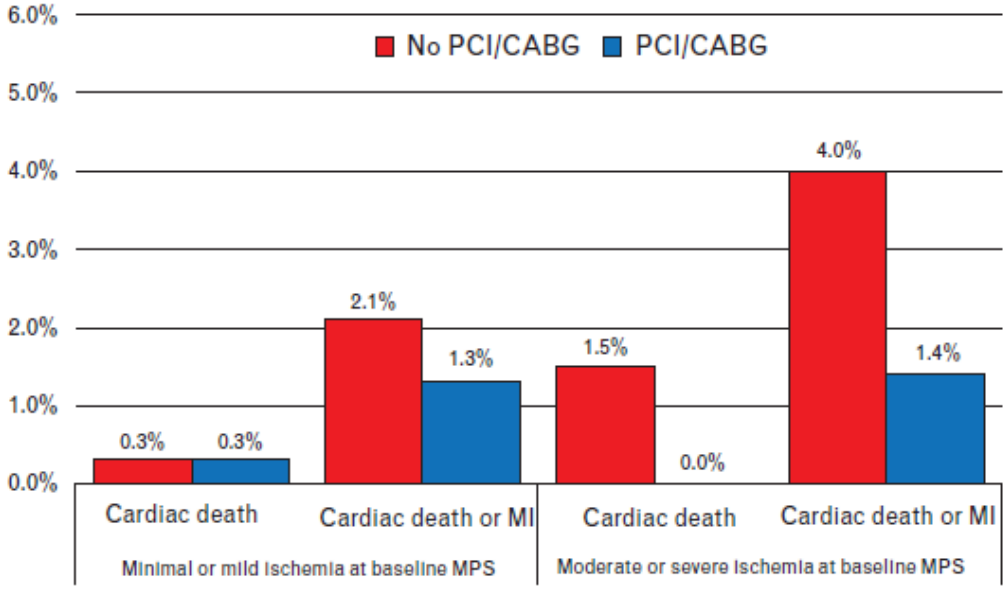


Incidence of clinical outcomes at long-term follow-up after propensity matching according to the occurrence of coronary revascularization as first event during follow-up, stratifying patients according to ischemia severity at baseline myocardial perfusion scintigraphy (MPS). CABG, coronary artery bypass grafting; MI, myocardial infarction, PCI, percutaneous coronary intervention.

Revascularization does not improve necrosis

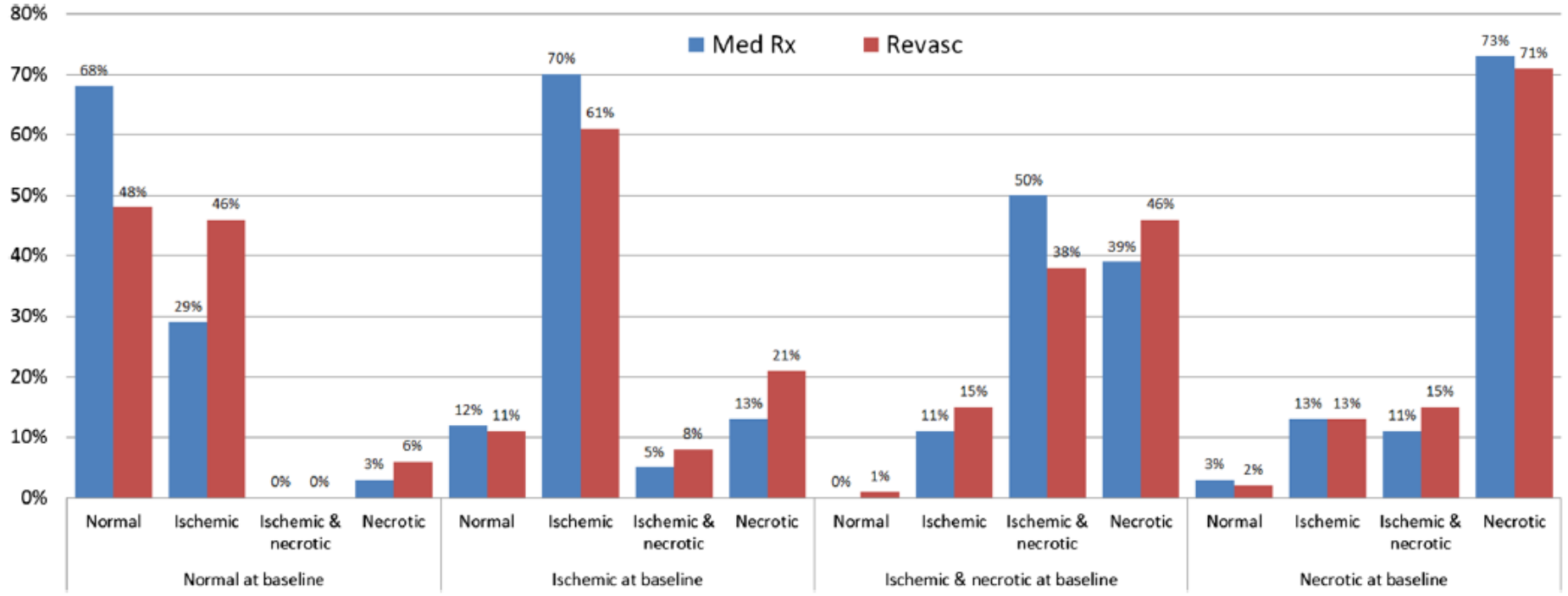
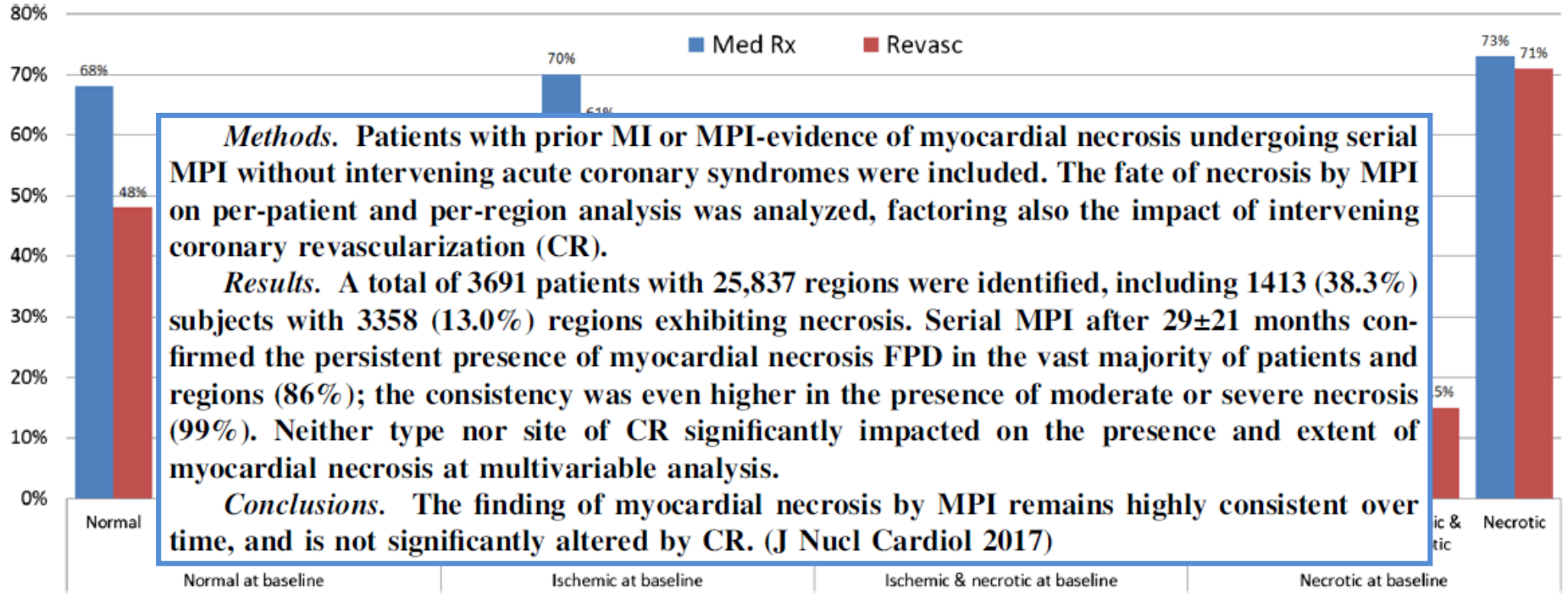


Figure 2. Comparison between baseline and serial myocardial perfusion imaging (MPI) highlighting changes in the prevalence of necrosis according to medical therapy (Med Rx) versus intervening revascularization (Revasc).

Revascularization does not improve necrosis



Methods. **Patients with prior MI or MPI-evidence of myocardial necrosis undergoing serial MPI without intervening acute coronary syndromes were included. The fate of necrosis by MPI on per-patient and per-region analysis was analyzed, factoring also the impact of intervening coronary revascularization (CR).**

Results. **A total of 3691 patients with 25,837 regions were identified, including 1413 (38.3%) subjects with 3358 (13.0%) regions exhibiting necrosis. Serial MPI after 29±21 months confirmed the persistent presence of myocardial necrosis FPD in the vast majority of patients and regions (86%); the consistency was even higher in the presence of moderate or severe necrosis (99%). Neither type nor site of CR significantly impacted on the presence and extent of myocardial necrosis at multivariable analysis.**

Conclusions. **The finding of myocardial necrosis by MPI remains highly consistent over time, and is not significantly altered by CR. (J Nucl Cardiol 2017)**

Figure 2. Comparison between baseline and serial myocardial perfusion imaging (MPI) highlighting changes in the prevalence of necrosis according to medical therapy (Med Rx) versus intervening revascularization (Revasc).

Potential test combinations

	Hx PE	EKG	Echo	Stress EKG	Stress Echo	MPS	MPS-CFR	PET	CMR	CT	CTA	CT-FFR	CTP
Hx PE	/	√	√	√	√	√	√	√	√	√	√	√	√
EKG	√	/	√	√	√	√	√	√	√	√	√	√	√
Echo	√	√	/	√	√	√	√	√	√	√	√	√	√
Stress EKG	√	√	√	/	√	√	√	√	√	√	√	√	√
Stress Echo	√	√	√	√	/	X	X	X	X	√	√	√	X
MPS	√	√	√	√	X	/	√	X	X	√	√	√	X
MPS-CFR	√	√	√	√	X	√	/	X	X	√	√	√	X
PET	√	√	√	√	X	X	X	/	X	√	√	√	X
CMR	√	√	√	√	X	X	X	X	/	√	√	√	X
CT	√	√	√	√	√	√	√	√	√	/	√	√	√
CTA	√	√	√	√	√	√	√	√	√	√	/	√	√
CT-FFR	√	√	√	√	√	√	√	√	√	√	√	/	√
CTP	√	√	√	√	X	X	X	X	X	√	√	√	/

Nudi et al, J Nucl Cardiol 2019

Diagnostic accuracy of competing tests

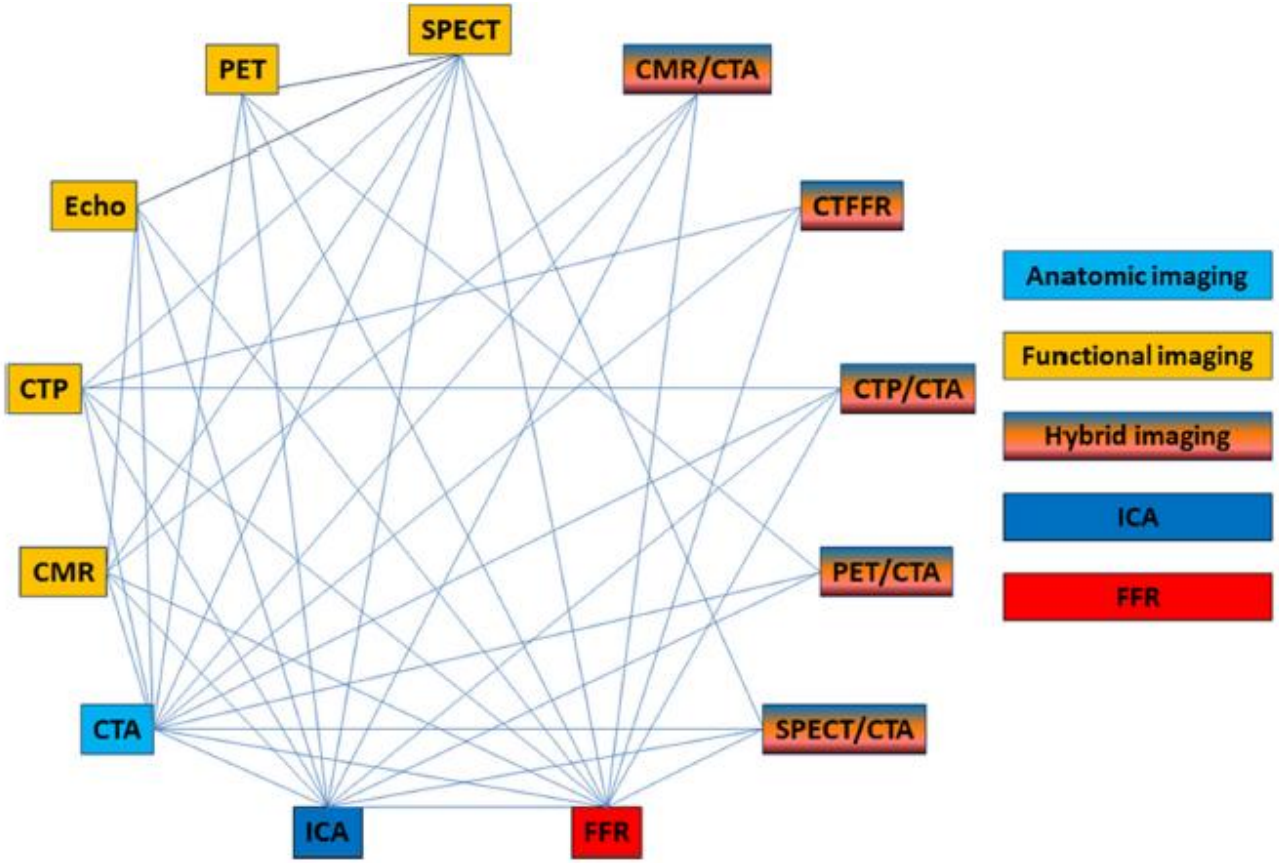


Figure 1. Evidence geometry distinguishing anatomic, functional, and hybrid imaging tests. *CMR*, cardiac magnetic resonance; *CTA*, computed tomography angiography; *CTFFR*, computed tomography-fractional flow reserve; *CTP*, computed tomography perfusion; *Echo*, stress echocardiography; *FFR*, fractional flow reserve; *ICA*, invasive coronary angiography; *PET*, positron emission tomography; *SPECT*, single photon emission computed tomography.

Diagnostic accuracy of competing tests

Table 4. Results of pairwise meta-analysis

Reference test	Index test	Sensitivity	Specificity	+ LR	− LR	DOR	AUC of SROC
Invasive coronary angiography	Anatomic imaging	0.95 (0.94-0.96)	0.83 (0.81-0.85)	5.7 (5.0-6.5)	0.06 (0.05-0.07)	94.7 (73.1-122.8)	0.99 (0.99-0.99)
	Functional imaging	0.83 (0.82-0.84)	0.76 (0.23-0.26)	3.5 (3.3-3.6)	0.22 (0.21-0.23)	15.8 (14.5-17.2)	0.90 (0.90-0.90)
	Hybrid imaging	0.90 (0.85-0.93)	0.89 (0.83-0.92)	7.8 (5.3-11.9)	0.11 (0.08-0.17)	68.8 (37.9-124.8)	0.98 (0.97-0.99)
Invasive fractional flow reserve	Anatomic imaging	0.94 (0.90-0.96)	0.46 (0.38-0.55)	1.7 (1.5-2.1)	0.14 (0.09-0.22)	12.2 (7.0-21.4)	0.93 (0.88-0.98)
	Functional imaging	0.78 (0.74-0.82)	0.80 (0.76-0.84)	4.0 (3.3-4.8)	0.27 (0.22-0.32)	14.9 (11.0-20.2)	0.88 (0.86-0.91)
	Hybrid imaging	0.87 (0.83-0.90)	0.82 (0.76-0.87)	4.9 (3.6-6.9)	0.16 (0.12-0.20)	31.0 (19.6-49.3)	0.94 (0.92-0.96)

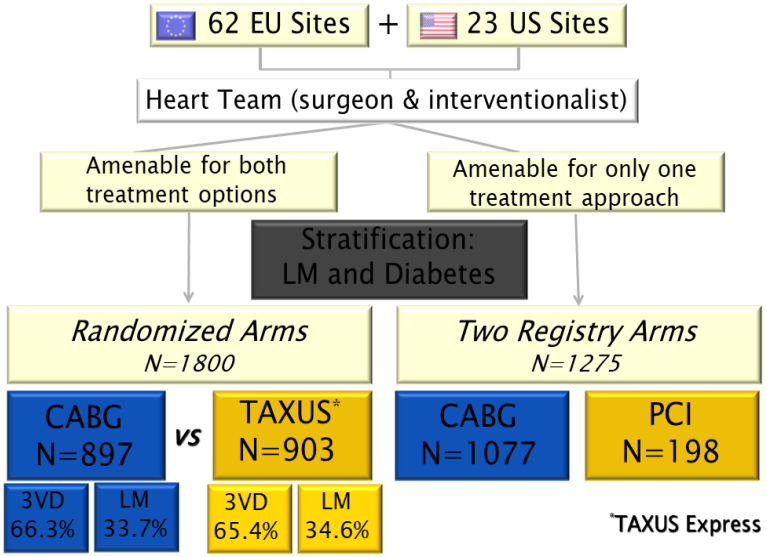
+ *LR*, positive likelihood ratio; − *LR*, negative likelihood ratio; *AUC*, area under the curve; *DOR*, diagnostic odds ratio; *SROC*, summary receiver-operating curve

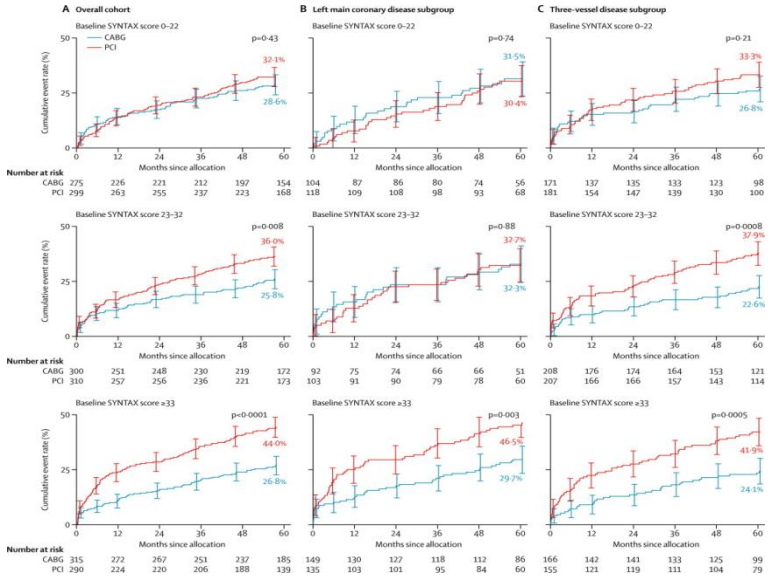
Table 5. Results of multivariate meta-analysis

Reference test	Index test	Sensitivity	Specificity	+ LR	− LR
Invasive coronary angiography	Anatomic imaging	0.96 (0.95-0.97)	0.83 (0.81-0.85)	12.3 (8.7-15.9)	0.16 (0.05-0.27)
	Functional imaging	0.84 (0.83-0.85)	0.77 (0.76-0.78)	6.1 (5.4-6.7)	0.32 (0.29-0.35)
	Hybrid imaging	0.91 (0.89-0.93)	0.87 (0.84-0.90)	13.6 (8.3-19.0)	0.17 (0-0.39)
Invasive fractional flow reserve	Anatomic imaging	0.95 (0.93-0.97)	0.46 (0.38-0.55)	2.0 (1.6-2.5)	0.38 (0.16-0.61)
	Functional imaging	0.79 (0.75-0.83)	0.81 (0.77-0.85)	6.3 (4.5-8.2)	0.42 (0.33-0.50)
	Hybrid imaging	0.88 (0.86-0.91)	0.82 (0.77-0.87)	7.2 (0-15.4)	0.27 (0.12-0.42)

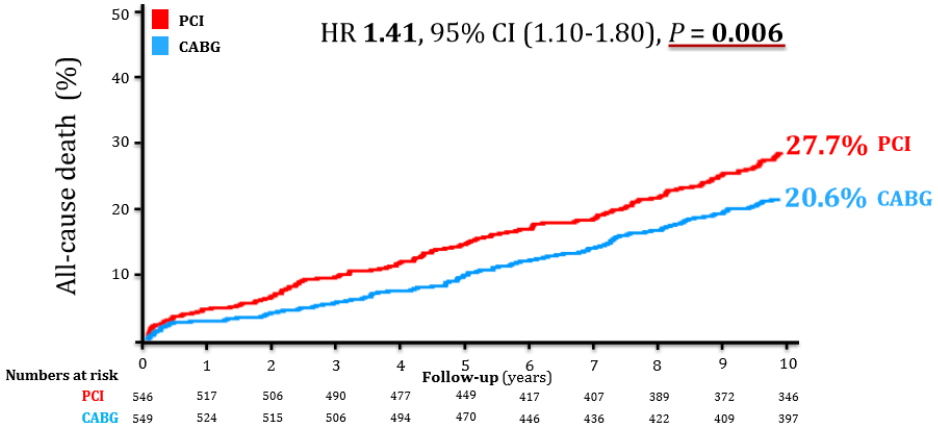
+ *LR*, positive likelihood ratio; − *LR*, negative likelihood ratio

Heterogeneity of ULM/MVD

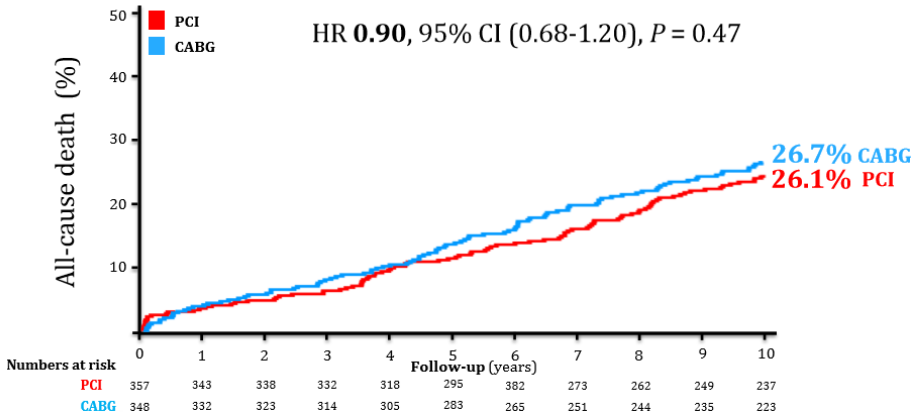




Three-Vessel



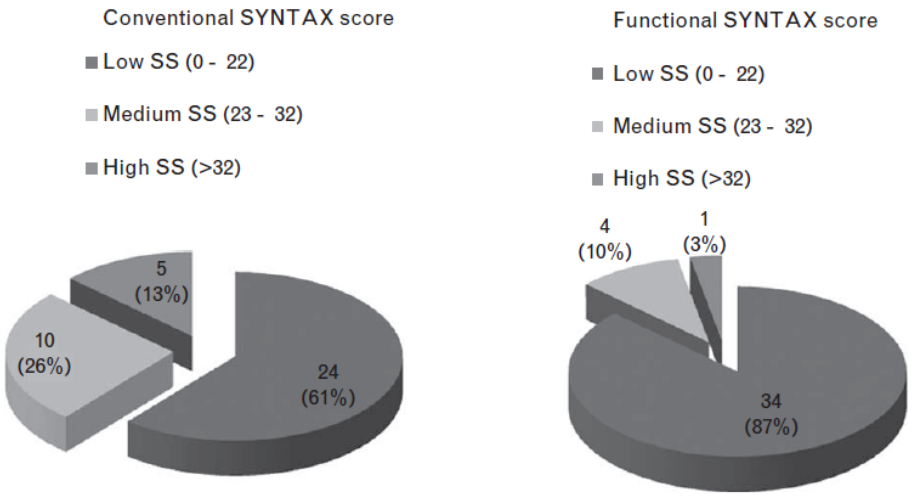
Left Main



Mohr et al, Lancet 2013

Thuijs et al, Lancet 2019

From angiographic SYNTAX score to functional SYNTAX score



Redistribution of patients in tertiles of risk after assessing F-SYNTAX score.

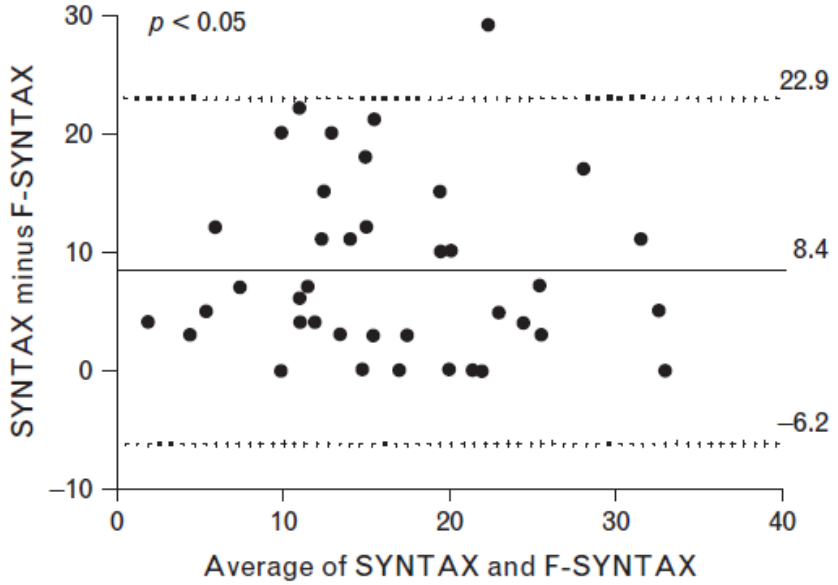


Table 3 Lesion characteristics per category of angiographic stenosis severity

Variable	Lesions ($n=97$)[a]	% Stenosis by angiography		*P* value
		50–70% ($n=72$)	71–94% ($n=25$)	
FFR > 0.80	53 (44%)	49 (68%)	4 (16%)	<0.001
FFR ≤ 0.80	44 (36%)	23 (32%)	21 (84%)	<0.001
Mean FFR	0.82 ± 0.10	0.86 ± 0.09	0.73 ± 0.11	<0.001
Mean FFR > 0.80	0.90 ± 0.04	0.90 ± 0.04	0.88 ± 0.05	0.34
Mean FFR ≤ 0.80	0.72 ± 0.07	0.74 ± 0.04	0.70 ± 0.09	0.04

Making it simple with virtual FFR

TABLE 1. AVAILABLE SOFTWARE FOR CORONARY ANGIOGRAPHY-BASED FFR CALCULATION

Company	Product Name	Acronym Index	Validation Study	Correlation With Pressure Wire FFR	Bias Mean ± SD	AUC CI (95% CI)	Interobserver Variability
Medis Medical Imaging Systems, BV	QAngio XA	QFR	FAVOR Pilot Study[31]	0.77	0.001 ± 0.06	0.92 (0.85–0.97)	N/A
			FAVOR II China[32]	0.86	0.01 ± 0.06	0.96 (0.94–0.98)	N/A
			FAVOR II Europe-Japan[36]	0.83	0.01 ± 0.06	0.92 (0.89–0.96)	N/A
CathWorks	FFRangio system	FFRangio				N/A	R = 0.92
						0.94 (0.92–0.97)	N/A
Pie Medical Imaging	CAAS 3D-QCA	vFFR				0.93 (0.88–0.97)	R = 0.95
						*	*

Abbreviations: 3D, three-dimensional; AUC, area … ve; N/A, not available; QCA, quantitative coronary angiography; QFR, quantitative flo…
*Multicenter, international, prospective, observa…

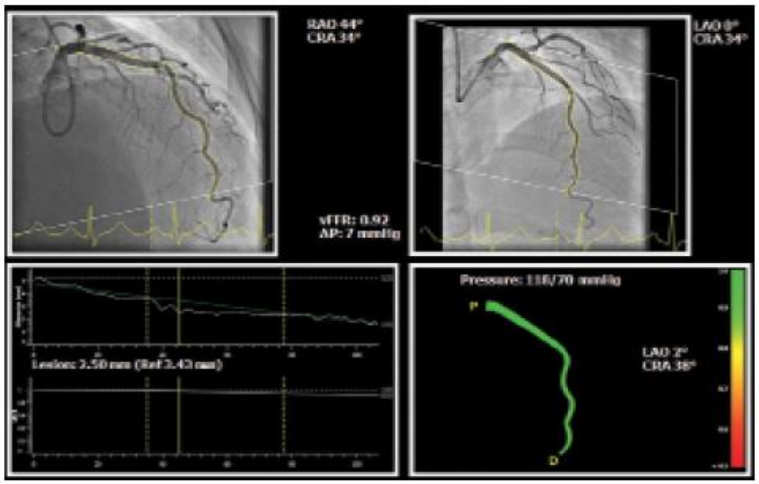


Figure 1. Example of vFFR analysis using CAAS Workstation software. 3D reconstruction of a coronary artery and computation of vFFR using two angiographic projections (with at least 30° apart) and invasively measured aortic root pressure. CRA, cranial; LAO, left anterior oblique; RAO, right anterior oblique.

What about you?

Take home messages

- Substantial heterogeneity exists between patients with ULM/MVD
- Further differences are due to the goals, strengths, and limitations of PCI and CABG
- Appraisal of ischemia severity and extent, as well as concomitant necrosis/viability is crucial to guide diagnosis, prognosis, decision-making and warranty period
- Eventually, combination of anatomic and functional appraisal of CAD will become routine practice, irrespective of the chosen tests

Many thanks for your attention

For any query:
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