LES ZONES GRISES DE LA FFR

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- Pas de conflits d'intérêt

1 au 3 juin 2022

Recommendations for risk assessment

Recommendation	Class	Level
Risk stratification is recommended based on clinical assessment and the result of the diagnostic test initially employed to make a diagnosis of CAD.	I	B
Resting echocardiography is recommended to quantify LV function in all patients with suspected CAD.	I	C
Risk stratification, preferably using stress imaging or coronary CTA (if local expertise and availability permit), or alternatively exercise stress ECG (if significant exercise can be performed and the ECG is amenable to the identification of ischaemic changes), is recommended in patients with suspected or newly diagnosed CAD.	I	B
In symptomatic patients with a high-risk clinical profile, ICA complemented by invasive physiological guidance (FFR) is recommended for cardiovascular risk stratification, particularly if the symptoms are inadequately responding to medical treatment and revascularization is considered for improvement of prognosis.	I	A
In patients with mild or no symptoms, ICA complemented by invasive physiological guidance (FFR/iwFR) is recommended for patients undergoing medical treatment in whom non-invasive risk stratification indicates a high event risk and revascularization is considered for the improvement of prognosis.	I	A

Symptomatic patients

Recommendation	Class	Level
Reassessment of CAD status is recommended in patients with deteriorating LV systolic function that cannot be attributed to a reversible cause (e.g. long-standing tachycardia or myocarditis).	I	C
Risk stratification is recommended for patients with new or worsening symptom levels, preferably using stress imaging or, alternatively, exercise stress ECG.	I	B
It is recommended that patients with significant worsening of symptoms be expeditiously referred for evaluation.	I	C
ICA (with FFR/iwFR when necessary) is recommended for risk stratification in patients with severe CAD, particularly if the symptoms are refractory to medical treatment or if they have a high-risk clinical profile.	I	C

RIPCORD 2

	Angiography n = 552	Angiography plus FFR n = 548
Age - mean (SD)	64.3 (10.2)	64.3 (10.0)
Male (n/d = p%)	426/552 = 77.2%	403/548 = 73.5%
Diabetes - any (n/d = p%)	97/552 = 17.6%	113/548 = 20.6%
ACS Presentation (n/d = p%)	292/550 = 53.1%	276/548 = 50.4%
History of: (n/d = p%)		
Previous Myocardial Infarction	129/551 = 23.4%	117/546 = 21.4%
Previous PCI	140/552 = 25.4%	147/547 = 26.9%
Any Smoking	356/548 = 65.0%	316/542 = 58.5%
Hypertension	294/550 = 53.5%	315/547 = 57.6%
Hyperlipidaemia	317/550 = 57.6%	315/548 = 57.5%
Angiographic Disease (n/d = p%)		
0 vessel disease	143/552 = 25.9%	156/548 = 28.5%
1 vessel disease	265/552 = 48.0%	218/548 = 39.8%
2 vessel disease	108/552 = 19.6%	112/548 = 20.4%
3 vessel disease	36/552 = 6.5%	62/548 = 11.3%
Left Main Stem Reported >50%	48/552 = 8.7%	43/548 = 7.8%
Proximal LAD Reported >70%	97/552 = 17.6%	95/548 = 17.3%
BCIS Jeopardy Score - median (IQR)	2 (0 - 6)	2 (0 - 6)

Final Management Plan	Angiography n - 552	Angiography plus FFR n = 548	P Value
Medical Therapy (n/d = p%)	165/552 = 29.9%	175/548 = 31.9%	0.20 *
PCI (n/d = p%)	336/552 = 60.9%	308/548 = 56.2%	
CABG (n/d = p%)	51/552 = 9.2%	65/548 = 11.9%	

Population	Intervention	Control	Outcome	Time
1,100 Patients in 17 UK centres. Undergoing angio for Chest Pain or NSTEMI. At least one stenosis >30% in a vessel >2.25mm	FFR in all epicardial vessels of a large enough calibre to carry out PCI or CABG. Management plan according to angio & FFR.	Angiogram alone. Management decided on angio alone. "Additional tests could be requested to determine management strategy	Total Hospital Costs £4510 vs £4136 p=0.137. Quality of Life EQ5d VAS 75 vs 75 p=0.88. MACE 9.5% vs 8.7% p=0.64	12 month. Follow up for all endpoint

Analysis according to the PICOT principle - courtesy of Nicola Ryan

Mostafa Elguindy Circ Cardiovasc Qual Outcomes. 2018

TONINO, JACC Vol. 55, No. 25, 2010

Etude FUTURE

Rioufol, G. et al. J Am Coll Cardiol. 2021;78(19):1875-1885.

TABLE 2 Comparison of Treatment Strategy Between Control and FFR Group Patients

	Control Group (n = 467)	FFR Group (n = 460)	P Value*
Revascularization strategy			0.002
Optimal medical treatment only	43 (9.0)	78 (17.0)	
CABG	55 (12.0)	54 (12.0)	
PCI	369 (79.0)	328 (71.0)	
PCI			
Lesions with 50%-70% stenosis	517 (42.7)	548 (49.5)	0.94
Lesions with CTO	55 (4.5)	63 (6.0)	0.96
3-vessel disease patients	258 (69.9)	247 (75.3)	0.13
SYNTAX score	17 ± 7	19 ± 8	0.007
Stents per patient	2.2 ± 1.2	2.1 ± 1.2	0.54
Drug-eluting stents	745 (94.0)	657 (95.0)	
Complete revascularization	148 (57.4)	135 (54.7)	0.84
CABG			
Lesions with 50%-70% stenosis	87 (40.3)	90 (40.2)	0.96
Lesions with CTO	21 (10.0)	23 (10.0)	0.97
3-vessel disease patients	48 (13.5)	51 (15.9)	0.33
SYNTAX score	26 ± 9	24 ± 6	0.034
Mean of total anastomoses	2.9 ± 0.9	2.9 ± 0.9	0.81
Mean of arterial anastomoses	2.3 ± 0.9	2.2 ± 0.9	0.40
Complete revascularization	30 (62.5)	30 (58.8)	1
Optimal medical treatment			
Lesions with 50%-70% stenosis	90 (70.0)	164 (72.0)	0.15
Lesions with CTO	10 (6.8)	13 (5.4)	0.72
SYNTAX score	17 ± 9	16 ± 7	0.56

FIGURE 1 Revascularization Strategy in the Intention-to-Treat Population

P = 0.002

Control Group: CABG 55, PCI 369, Optimal Medical Treatment Alone 43
FFR Group: CABG 54, PCI 328, Optimal Medical Treatment Alone 78

■ Optimal Medical Treatment Alone ■ PCI ■ CABG

J Am Coll Cardiol 2021;78:1875–1885

Angiography findings			
Radial access	428 (92.0)	412 (90.0)	0.28
Vessels with			
1-vessel disease	13 (3.0)	12 (3.0)	0.44
2-vessel disease	223 (48.0)	201 (44.0)	
3-vessel disease	231 (50.0)	247 (54.0)	
Left main coronary lesion	50 (11.0)	58 (13.0)	0.37
SYNTAX score	18 ± 8	19 ± 8	0.27
Lesion characteristics			
Total number of lesions	1,634	1,632	
Lesions with stenosis of >50% of diameter per patient	3 (2-4)	3 (2-4)	0.50
FFR findings			
Patients with FFR	NA	450 (98.0)	
FFR failure	NA	27/1,147 (2.4)[f]	
FFR complication	NA	9/450 (2.0)	
Lesions with FFR (per patient)	NA	1.38 ± 1.00	
Mean FFR	NA	0.77 ± 0.13	
Lesions with FFR >0.80	NA	470/1,090 (43.0)	
Mean FFR in lesions with FFR ≤0.80	NA	0.68 ± 0.11	
Mean FFR in lesions with FFR >0.80	NA	0.88 ± 0.05	

TABLE 3 Primary and Secondary Endpoints in the Intention-to-Treat Population at 1 Year of Follow-Up

Events	Control Group (n = 467)	FFR Group (n = 460)	HR (95% CI)	P Value*
Composite of death from any cause, myocardial infarction, stroke, and unplanned revascularization	67 (14.4)	67 (14.6)	0.97 (0.69-1.36)	0.85
Death from any cause	7 (1.5)	17 (3.7)	2.34 (0.97-5.68)	0.06
Cardiovascular death	5 (1.1)	12 (2.6)	2.37 (0.83-6.76)	0.11
Myocardial infarction	28 (6.0)	28 (6.1)	1.03 (0.61-1.74)	0.90
Stroke	7 (1.5)	1 (0.2)	0.13 (0.02-1.07)	0.06
Unplanned revascularization	46 (9.9)	37 (8.0)	0.79 (0.51-1.22)	0.28

FIGURE 3 Subgroup Analyses for the Primary Endpoint at 1 Year

Subgroups	Control Group	FFR Group	Total		Hazard Ratio (95% CI)	P Value
Overall	467	460	927		0.97 (0.69-1.36)	0.85
Diabetes						
Yes	31% (147)	31% (143)	31% (290)		0.89 (0.49-1.62)	0.70
No	69% (320)	69% (317)	69% (637)		1.09 (0.71-1.66)	0.70
SYNTAX						
SYNTAX ≤22	75% (345/462)	73% (336/459)	74% (681/921)		0.98 (0.65-1.46)	0.90
22 <SYNTAX ≤32	19% (88/462)	22% (100/459)	20% (188/921)		0.69 (0.29-1.68)	0.42
32 >SYNTAX	6% (29/462)	5% (23/459)	6% (52/921)		3.32 (0.65-16.84)	0.15
Angina						
Stable Angina or Atypical chest pain	54% (254)	53% (244)	54% (498)		0.96 (0.60-1.54)	0.86
ACS (STEMI or NSTEMI)	46% (213)	47% (216)	46% (429)		1.03 (0.61-1.73)	0.92
Strategy						
OMT (Optimized medical treatment)	9% (43)	17% (78)	13% (121)		0.44 (0.10-1.94)	0.28
PCI (Percutaneous Coronary Intervention)	79% (369)	71% (328)	75% (697)		1.05 (0.72-1.52)	0.81
CABG (Coronary artery bypass grafting)	12% (55)	12% (54)	12% (109)		0.84 (0.11-6.61)	0.87

0   1   2   3   4

Favors FFR Favors Angio
Strategy   Strategy

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Table 1. (Continued.)

Characteristic	Angiography Group (N=496)	FFR Group (N=509)	P Value†
Angiographic Findings			
Indicated lesions per patient — no.§	2.7±0.9	2.8±1.0	0.34
Extent of occlusion — no. of lesions/total no. (%)			
50–70% narrowing	550/1350 (40.7)	624/1414 (44.1)	
71–90% narrowing	553/1350 (41.0)	530/1414 (37.5)	
91–99% narrowing	207/1350 (15.3)	202/1414 (14.3)	
Total occlusion	40/1350 (3.0)	58/1414 (4.1)	
Patients with total occlusion — no. (%)	37 (7.5)	54 (10.6)	
Quantitative coronary analysis			
Extent of stenosis — %	61.2±16.6	60.4±17.6	0.24
Minimal luminal diameter — mm	1.0±0.4	1.0±0.5	0.35
Reference diameter — mm	2.5±0.6	2.5±0.7	0.81
Lesion length — mm	12.6±6.9	12.5±6.5	0.42
SYNTAX score¶	14.5±8.8	14.5±8.6	0.95
EQ-5D score‖	64.7±19.2	66.5±18.3	0.24

FAME, N Engl J Med 2009;360:213-24.

Angiography findings			
Radial access	428 (92.0)	412 (90.0)	0.28
Vessels with			
1-vessel disease	13 (3.0)	12 (3.0)	0.44
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3-vessel disease	231 (50.0)	247 (54.0)	
Left main coronary lesion	50 (11.0)	58 (13.0)	0.37
SYNTAX score	18 ± 8	19 ± 8	0.27
Lesion characteristics			
Total number of lesions	1,634	1,632	
Lesions with stenosis of >50% of diameter per patient	3 (2-4)	3 (2-4)	0.50

J Am Coll Cardiol 2021;78:1875–1885

TABLE 2. Angiographic Data and FFR Results

	FFR ≥0.75		FFR <0.75:
	Deferral Group (n=91)	Performance Group (n=90)	Reference Group (n=144)
Target coronary artery, %			
Left anterior descending	52	48	51
Right	23	24	38*
Left circumflex	25	28	12*
Baseline severity of CAD, %			
Single-vessel disease	65	68	74
Two-vessel disease	27	29	22
Three-vessel disease	8	3	4
FFR by adenosine			
Intravenously (n=188)	0.87±0.06	0.86±0.07	0.56±0.16*
Intracoronary (n=137)	0.86±0.07	0.88±0.07	0.58±0.16*
Angiography at baseline			
Reference diameter, mm	3.00±0.64	2.94±0.57	2.97±0.58
Percent stenosis	48±9	48±10	57±12†
Minimal lumen diameter, mm	1.55±0.37	1.50±0.36	1.28±0.39*
Angiography after PTCA			
Reference diameter, mm	...	3.02±0.61	3.04±0.53
Percent stenosis	...	17±12	18±13
Minimal lumen diameter, mm	...	2.50±0.62	2.49±0.64
Stenting, %	...	46	59

DEFER Circulation. 2001;103:2928-2934
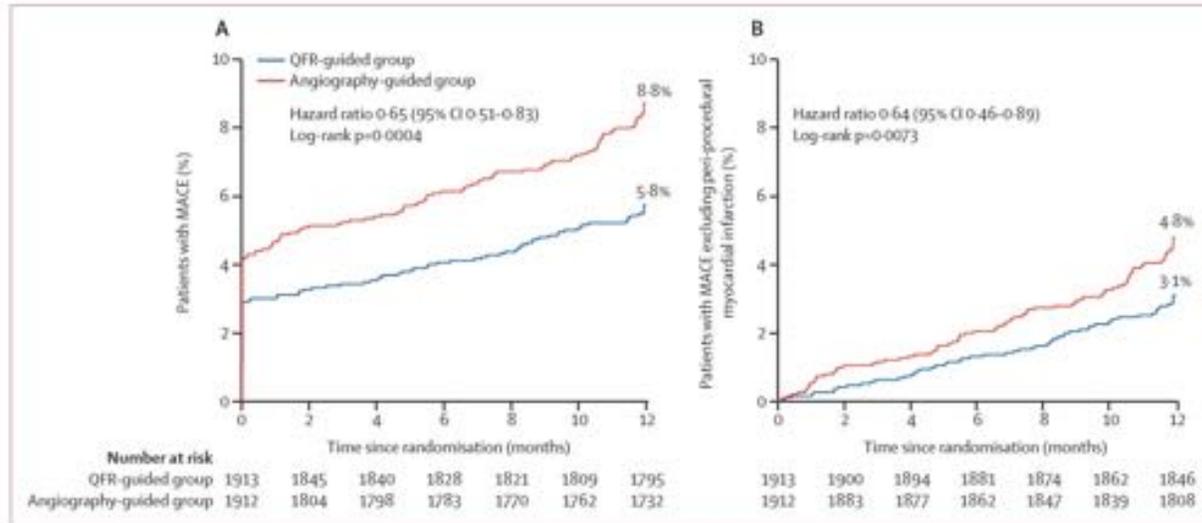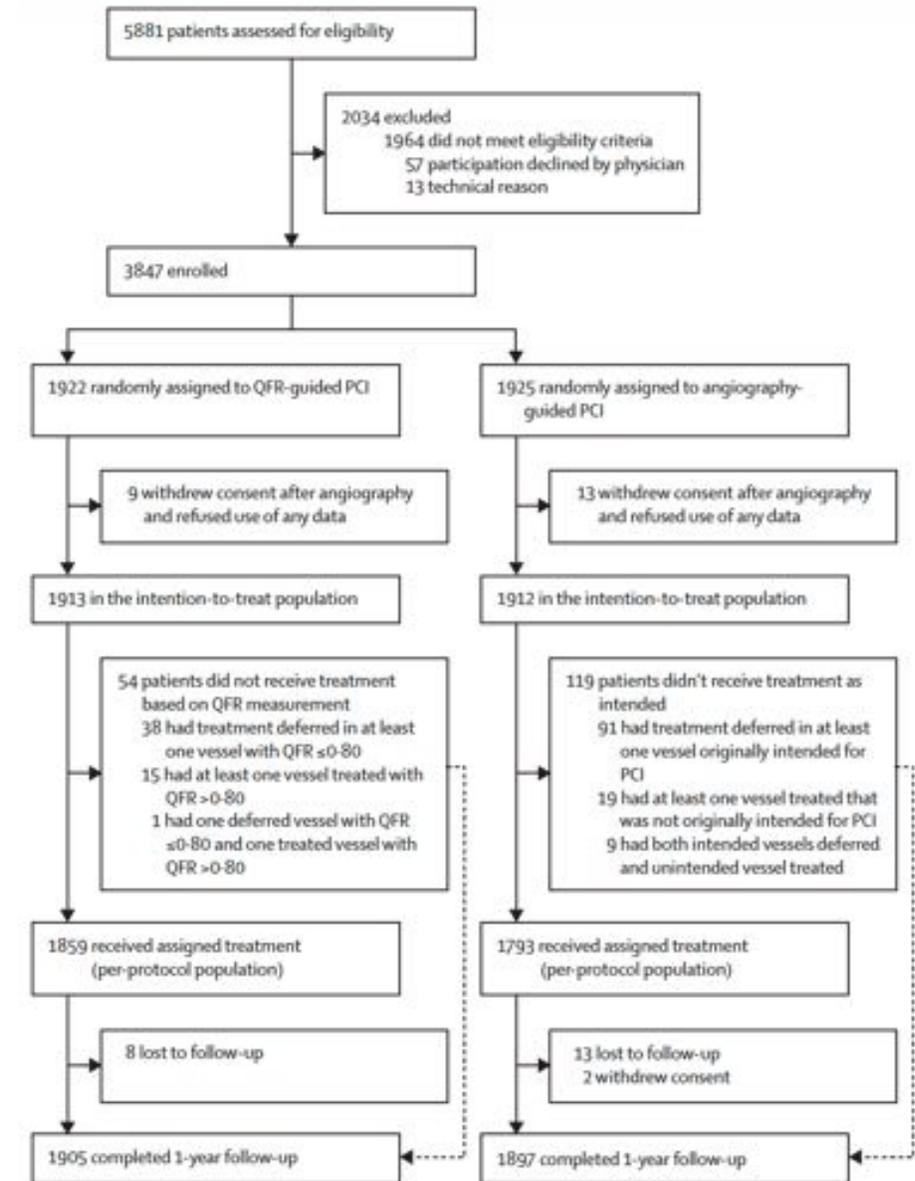
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Figure 2: Kaplan-Meier curves for the primary (A) and major secondary (B) endpoints in the intention-to-treat population
MACE=major adverse cardiac events. QFR=quantitative flow ratio.

Left table (top)

Clinical presentation*		
Asymptomatic ischaemia	207 (10·8%)	204 (10·7%)
Stable angina	493 (25·8%)	493 (25·8%)
Unstable angina	1111 (58·1%)	1110 (58·1%)
Post myocardial infarction (within 30 days)	102 (5·3%)	105 (5·5%)
Stable angina (Canadian Cardiovascular Society functional classification)		
I	176/493 (35·7%)	191/493 (38·7%)
II	164/493 (33·3%)	146/493 (29·6%)
III	103/493 (20·9%)	93/493 (18·9%)
IV	50/493 (10·1%)	63/493 (12·8%)
Unstable angina (Braunwald class)		
I	511/1111 (46·0%)	511/1110 (46·0%)
II	510/1111 (45·9%)	503/1110 (45·3%)
III	90/1111 (8·1%)	96/1110 (8·6%)
Estimated glomerular filtration rate (Cockcroft-Gault formula), mL/min per 1·73m²	70·3 (58·4–83·4)	70·0 (58·0–83·9)
Left ventricular ejection fraction, %	63·0 (61·0–66·0)	63·0 (60·0–66·0)
Number of diseased vessels reported		
One-vessel disease	890 (46·5%)	869 (45·4%)
Two-vessel disease	674 (35·2%)	684 (35·8%)
Three-vessel disease	306 (16·0%)	316 (16·5%)
Left main disease	43 (2·2%)	43 (2·2%)
Any vessel with one or more lesions with diameter stenosis >90% and TIMI flow <3	170 (8·9%)	182 (9·5%)
Anatomic SYNTAX score†	9·3 (6·0)	9·6 (6·3)
Functional SYNTAX score‡	8·1 (6·3)	8·0 (6·6)

Table S6. Quantitative coronary angiography assessment of the treated lesions

	QFR-guided group (N=1913)	Angiography-guided group (N=1912)	p value
Number of treated lesions	2267	2580	
Pre-procedure			
Reference vessel diameter, mm	2·77 ± 0·53	2·75 ± 0·51	0·30
Diameter stenosis, %	62·8 ± 12·2	61·6 ± 12·2	0·0005
Minimum lumen diameter, mm	1·03 ± 0·39	1·06 ± 0·39	0·022
Lesion length, mm	22·4 ± 13·1	21·0 ± 12·4	0·0005
Post-procedure			
Diameter stenosis, %			
In-segment	15·9 ± 10·6	16·0 ± 11·0	0·88
In-stent	11·2 ± 9·0	11·3 ± 9·0	0·66
Minimum lumen diameter, mm			
In-segment	2·19 ± 0·50	2·18 ± 0·51	0·80
In-stent	2·41 ± 0·47	2·40 ± 0·47	0·31

Lancet 2021; 398: 2149–59

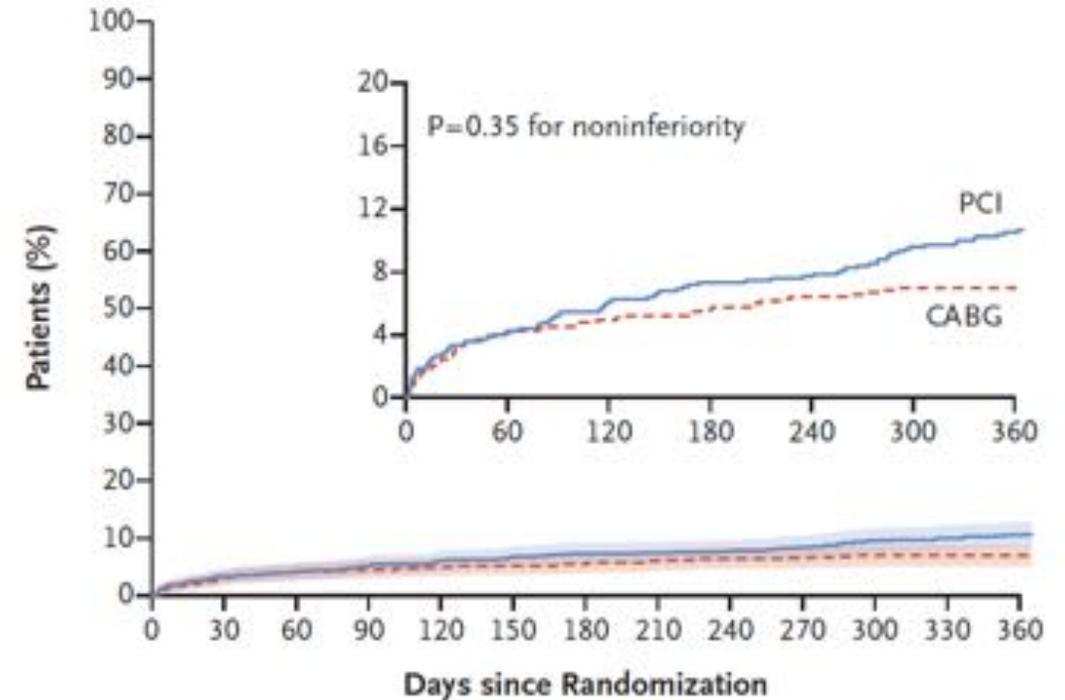## TABLE 2 Comparison of Treatment Strategy Between Control and FFR Group Patients

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SYNTAX score	26 ± 9	24 ± 6	0.034
Mean of total anastomoses	2.9 ± 0.9	2.9 ± 0.9	0.81
Mean of arterial anastomoses	2.3 ± 0.9	2.2 ± 0.9	0.40
Complete revascularization	30 (62.5)	30 (58.8)	1
Optimal medical treatment			
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FAME 3

Table 3. End Points at 1 Year.

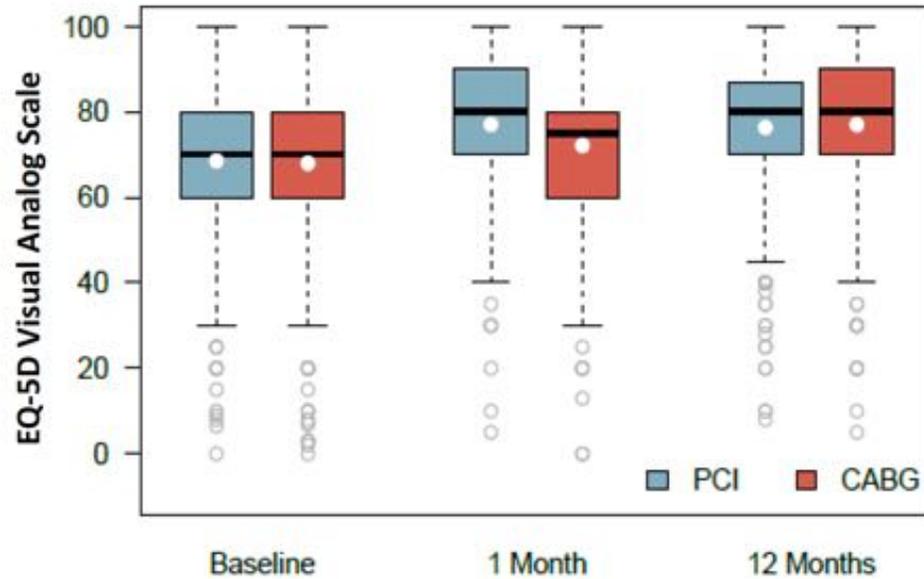| End Point	PCI (N=757)	CABG (N=743)	Hazard Ratio (95% CI)	P Value
	no. of patients (%)*			
Primary end point				
Death from any cause, myocardial infarction, stroke, or repeat revascularization	80 (10.6)	51 (6.9)	1.5 (1.1–2.2)	0.35†
Secondary end points‡				
Death	12 (1.6)	7 (0.9)	1.7 (0.7–4.3)	
Death from cardiac causes	6 (0.8)	4 (0.5)		
Myocardial infarction	39 (5.2)	26 (3.5)	1.5 (0.9–2.5)	
Spontaneous	25 (3.3)	17 (2.3)		
Procedural	13 (1.7)	9 (1.2)		
Stroke	7 (0.9)	8 (1.1)	0.9 (0.3–2.4)	
Death, myocardial infarction, or stroke	55 (7.3)	39 (5.2)	1.4 (0.9–2.1)	
Repeat revascularization	45 (5.9)	29 (3.9)	1.5 (0.9–2.3)	
PCI	39 (5.2)	26 (3.5)		
CABG	6 (0.8)	3 (0.4)		
Safety end points§				
BARC type 3–5 bleeding¶	12 (1.6)	28 (3.8)		<0.01
Acute kidney injury‖	1 (0.1)	7 (0.9)		<0.04
Atrial fibrillation or clinically significant arrhythmia	18 (2.4)	105 (14.1)		<0.001
Definite stent thrombosis	6 (0.8)	NA		
Definite symptomatic graft occlusion	NA	10 (1.3)		
Rehospitalization within 30 days	42 (5.5)	76 (10.2)		<0.001

P=0.35 for noninferiority

N Engl J Med 2022;386:128-37

Subgroup	PCI	CABG	PCI	CABG	Adjusted Hazard Ratio (95% CI)
	total no.		1-yr incidence (%)		
All patients	757	743	10.6	6.9	
Age					
≥65 yr	434	409	9.4	8.1	
<65 yr	323	334	12.1	5.4	
Sex					
Female	141	124	11.3	13.7	
Male	616	619	10.4	5.5	
Diabetes					
No	543	529	9.4	7.0	
Yes	214	214	13.6	6.5	
NSTE-ACS					
No	456	454	10.1	5.9	
Yes	300	287	11.3	8.4	
LVEF					
>50%	616	610	10.4	6.6	
30–50%	137	130	10.9	8.5	
Previous PCI					
No	658	637	9.3	6.8	
Yes	98	104	19.4	7.7	
SYNTAX score					
0–22	237	245	5.5	8.6	
23–32	365	343	13.7	6.1	
≥33	132	122	12.1	6.6	

PCI Better   CABG Better

N Engl J Med 2022;386:128-37

FFR post angioplastie

Wolfrum et al. BMC Cardiovascular Disorders (2016) 16:177
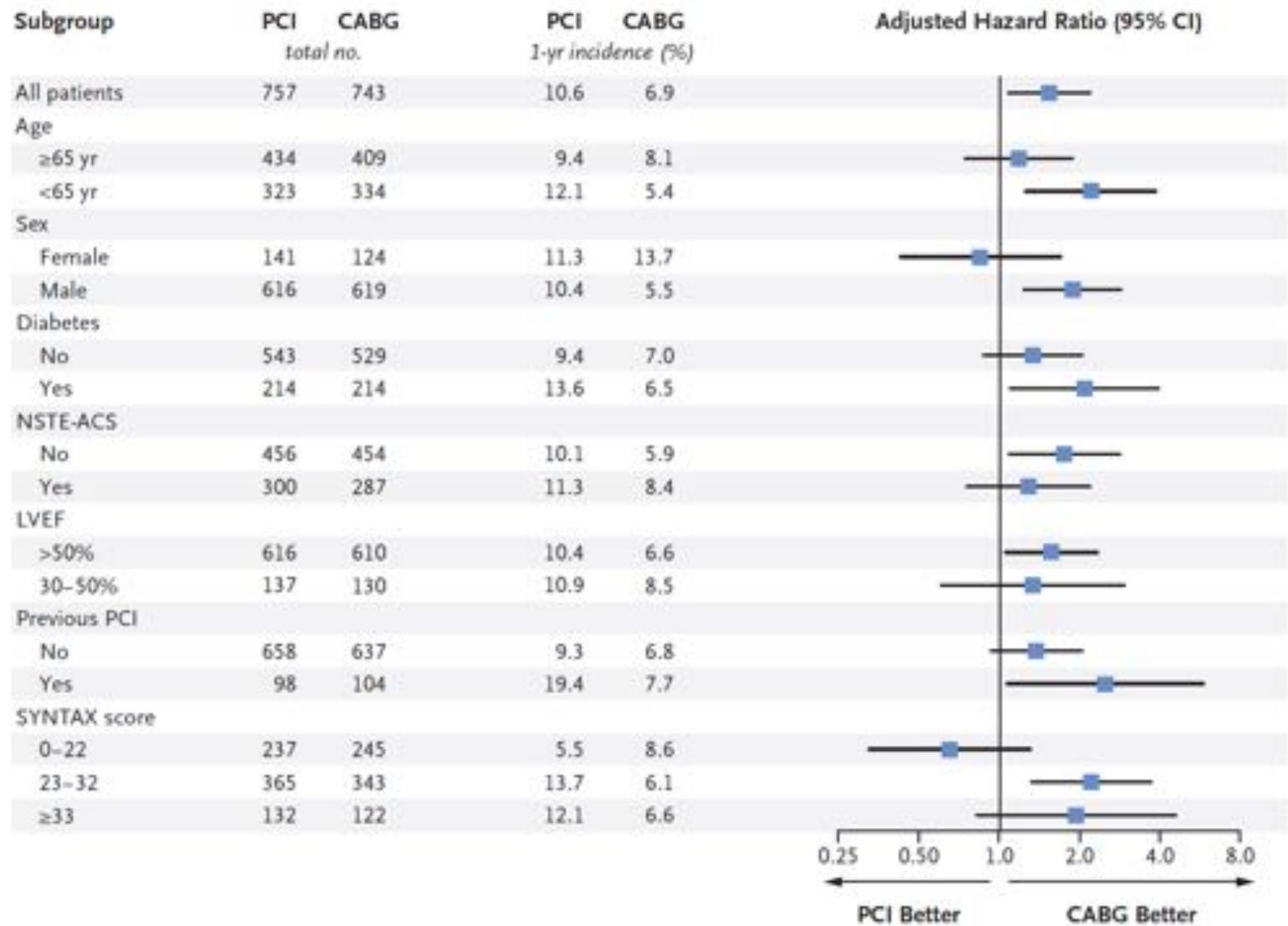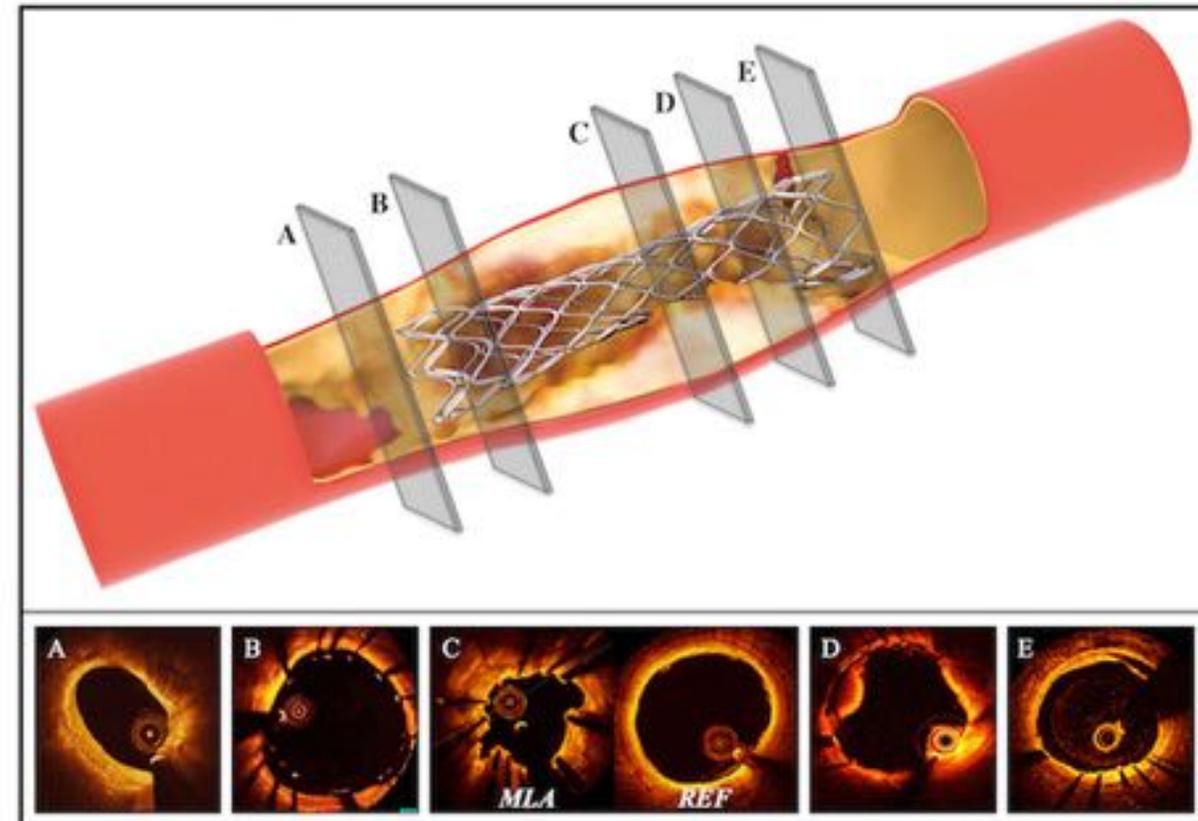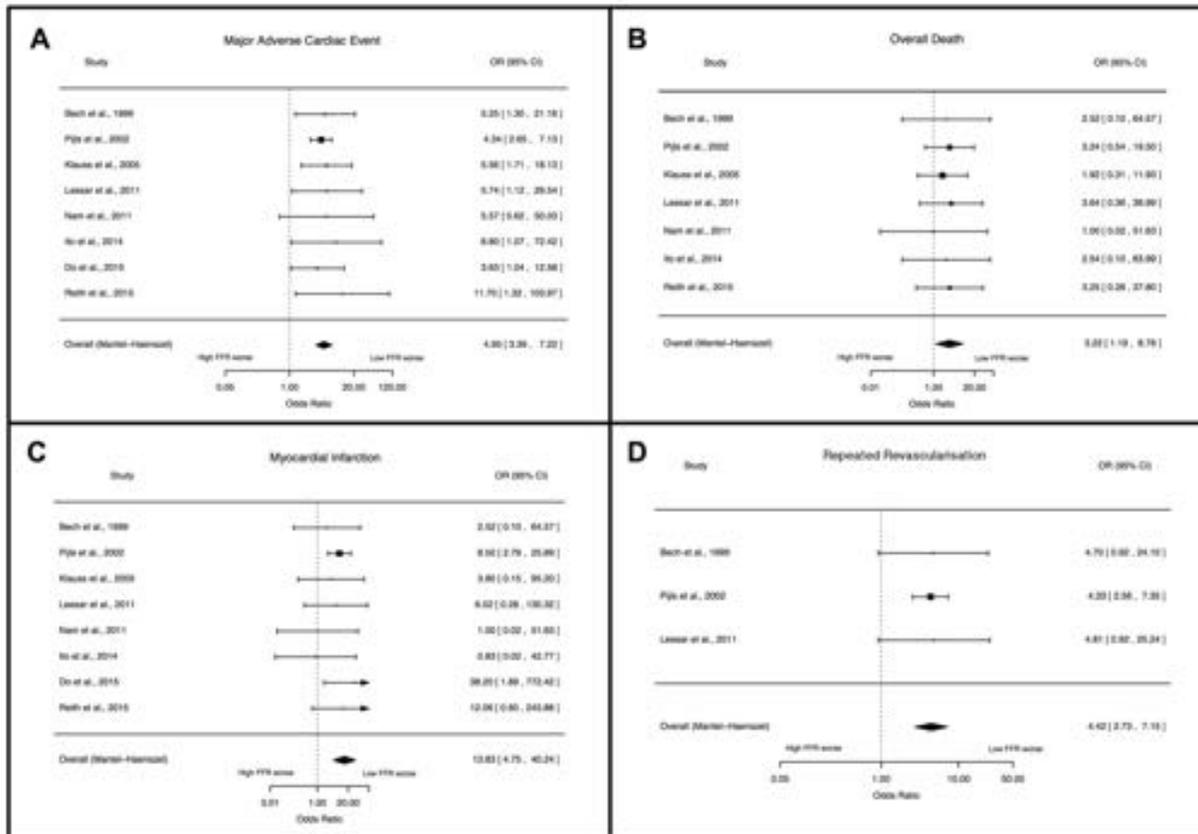
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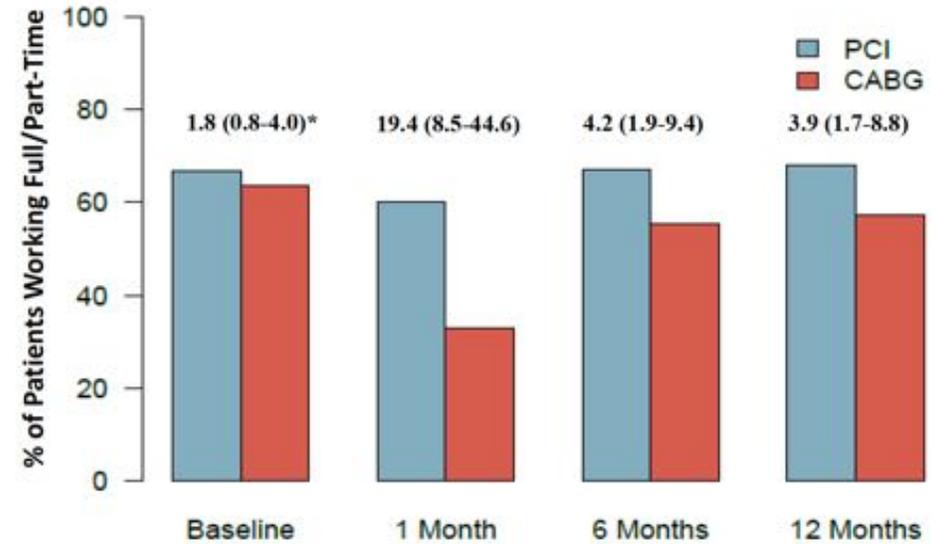
*OR and 95% CI for comparisons at each time point.

CONCLUSIONS

- Mauvais temps pour la FFR ?

- Le concept de deferal reste d'actualité

- Concept certainement plus adapté aux lésions intermédiaires

- Probablement pas encore abouti dans son utilisation et dans son modèle physique

- De la FFR 1.0 à la FFR 2.0

EVB