FFR and CABG

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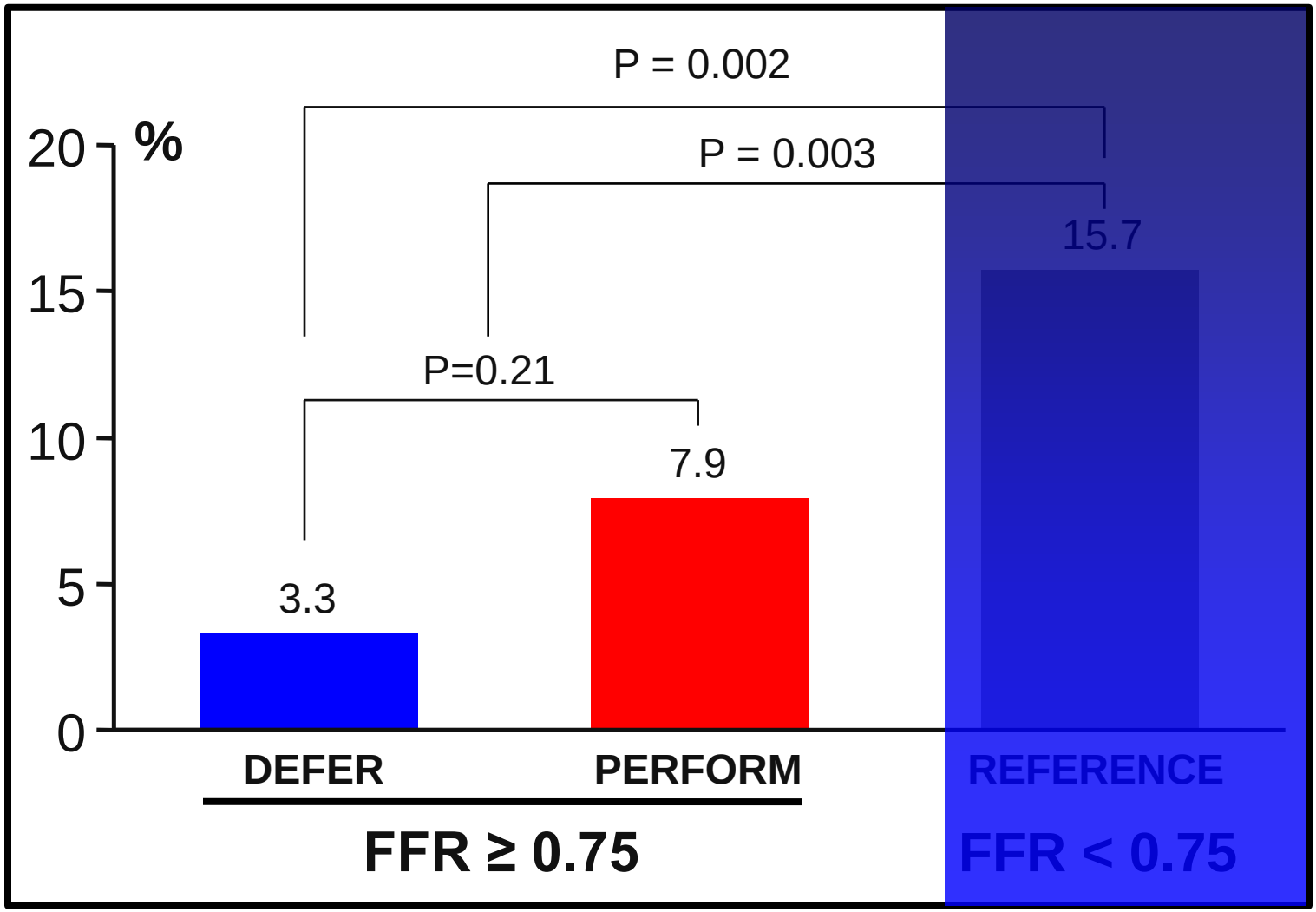
Background

- Revascularisation of intermediate stenosis can be targeted EITHER by angiographic guidance OR (with no documented ischemia at non-invasive stress testing) by angiography plus **FFR≤ 0.80**

Wijns et al. Eur Heart J 2010

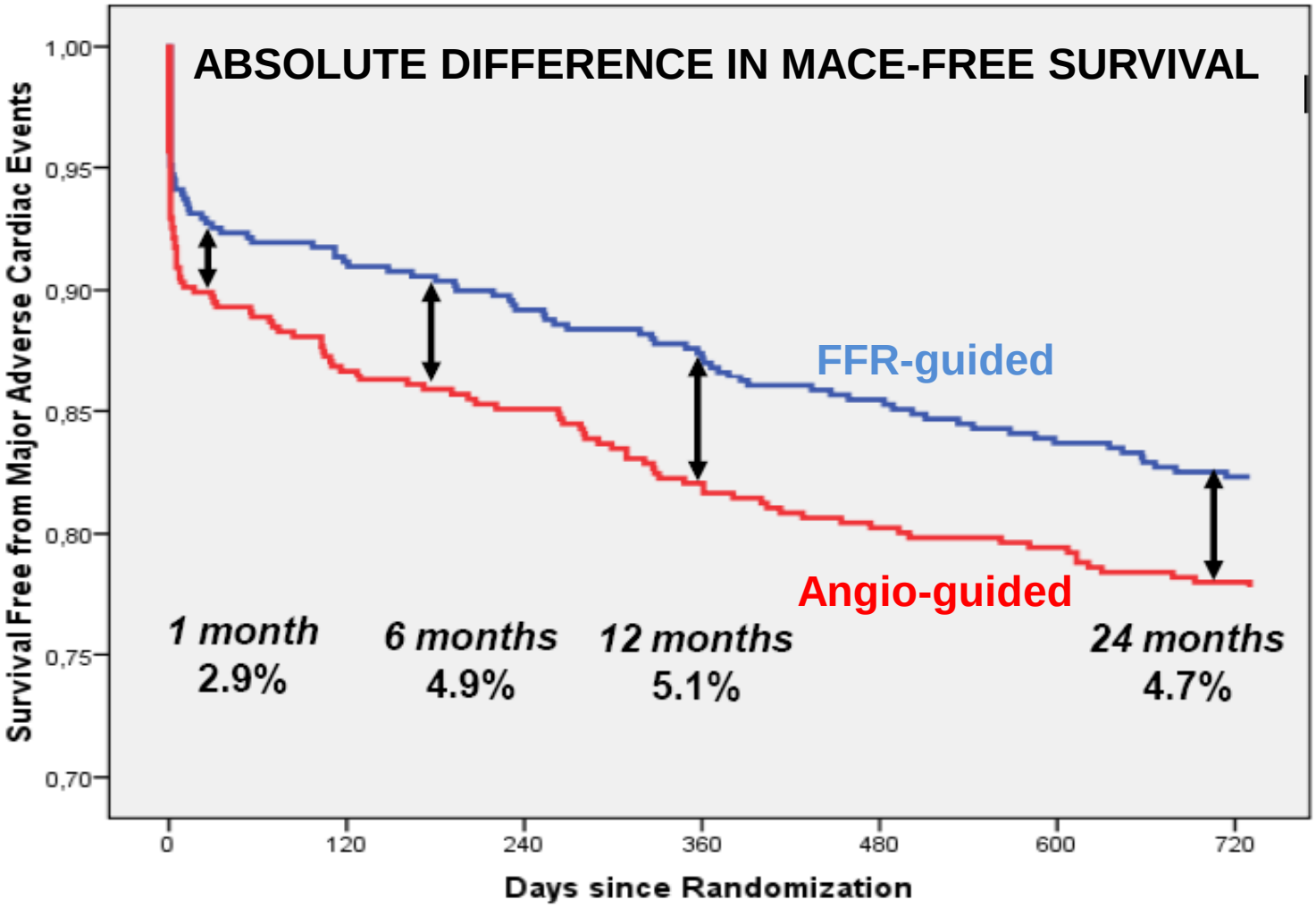
DEFER: Clinical Outcome at 5 Years

Rate of Death/MI after 5 years



NHJ Pijls et al JACC 2007

FAME trial



P Tonino et al NEJM 2009

Background

- Revascularisation of intermediate stenosis can be targeted EITHER by angiographic guidance OR (with no documented ischemia at non-invasive stress testing) by angiography plus **FFR≤ 0.80**
- **Nevertheless,** both DEFER and FAME trials **excluded** patients with left main coronary disease, previous CABG, coronary anatomy unsuitable for PCI, or significant valve disease

Wijns et al. *Eur Heart J 2010*

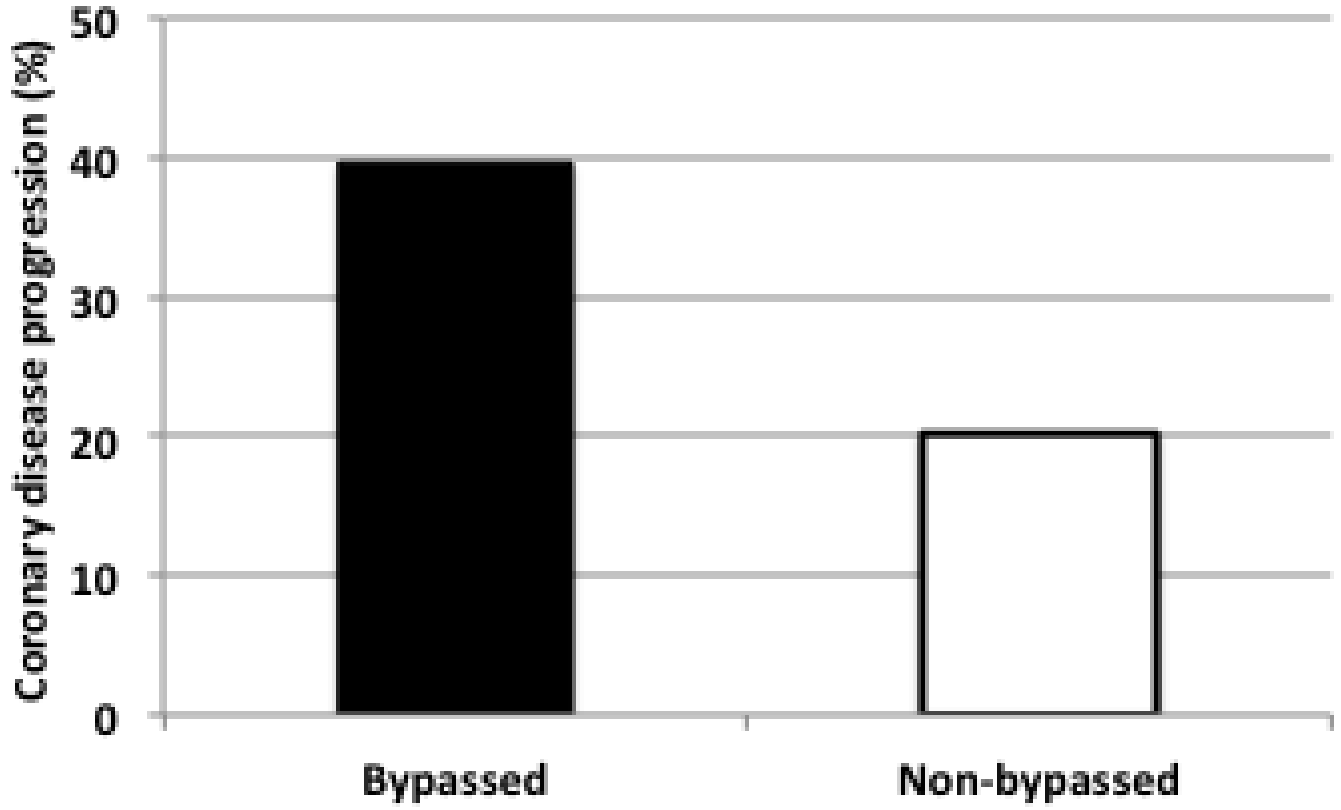
Role of FFR in CABG patients

Before CABG

In patients candidate to CABG:

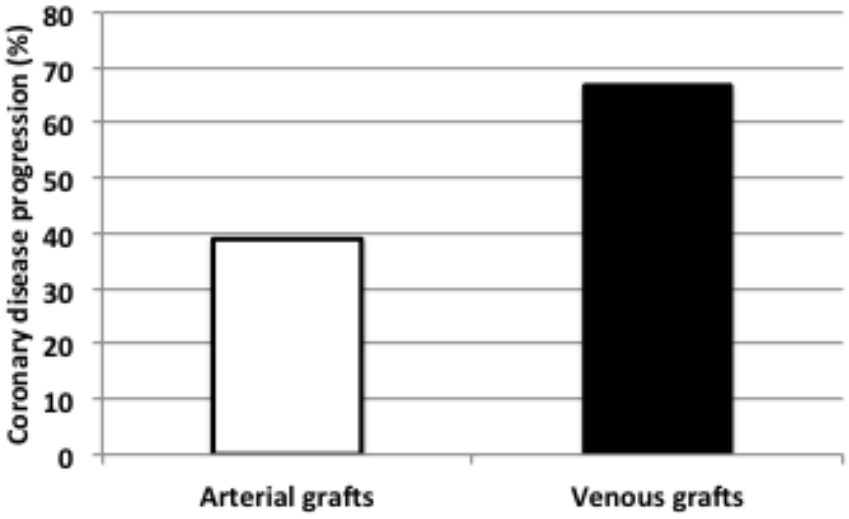
Does it matter an accurate assessment of the stenosis severity?

Coronary disease progression after CABG

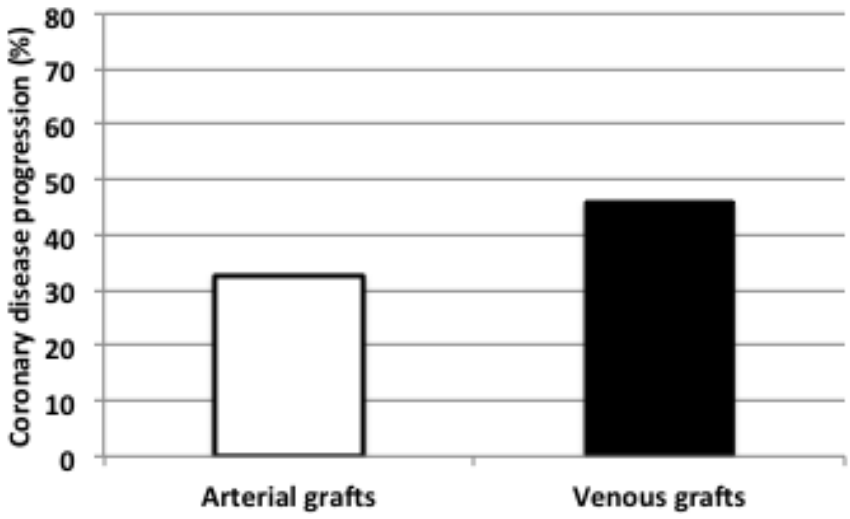


Manninen HI et al. Ann Thorac Surg 1998

Coronary disease progression after CABG

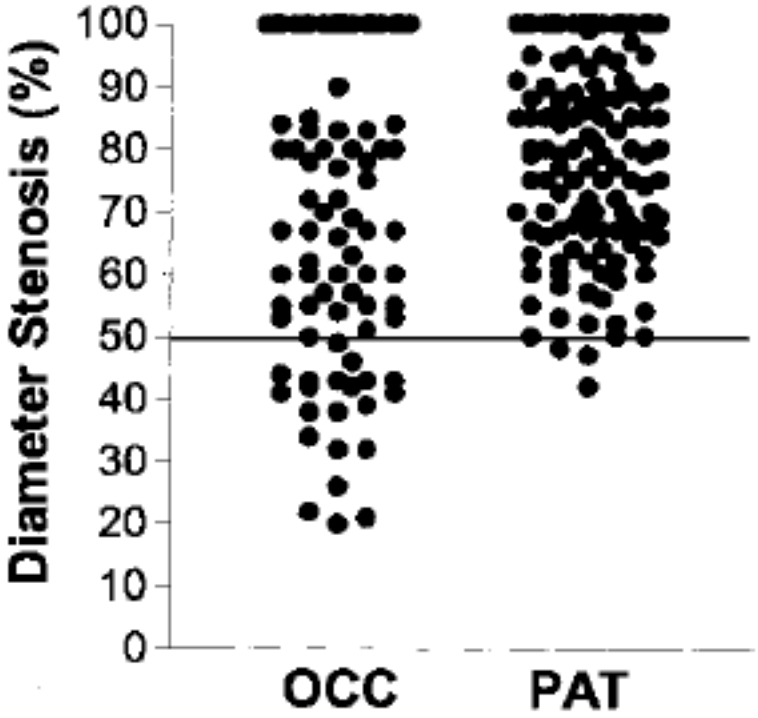


Cosgrove DM, J Thorac Cardiovasc Surg 1981



Manninen HI, Ann Thorac Surg 1998

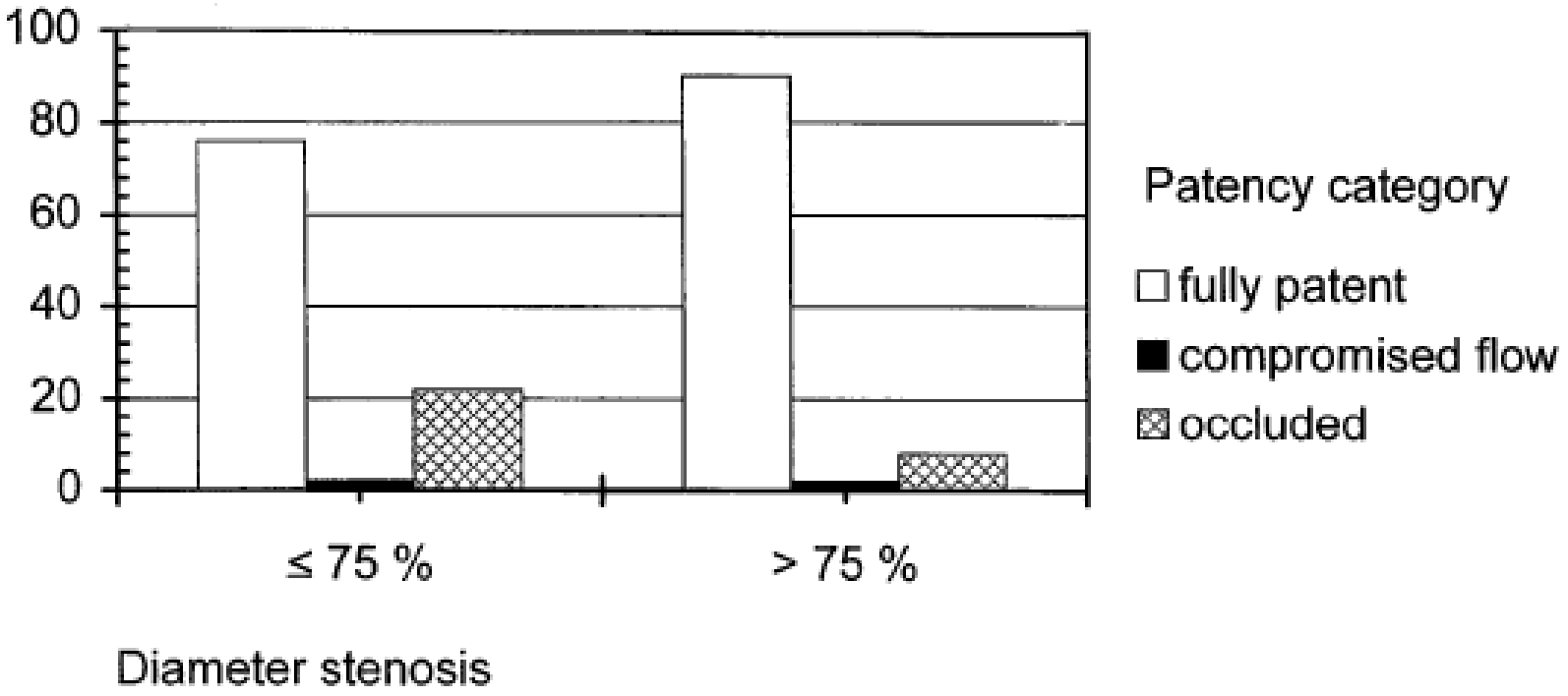
IMA graft patency and stenosis severity of native vessel



DS < 50% is a strong predictor of IMA occlusion (OR 21.5 [5.2-64.4])

Berger A et al, Circulation 2004

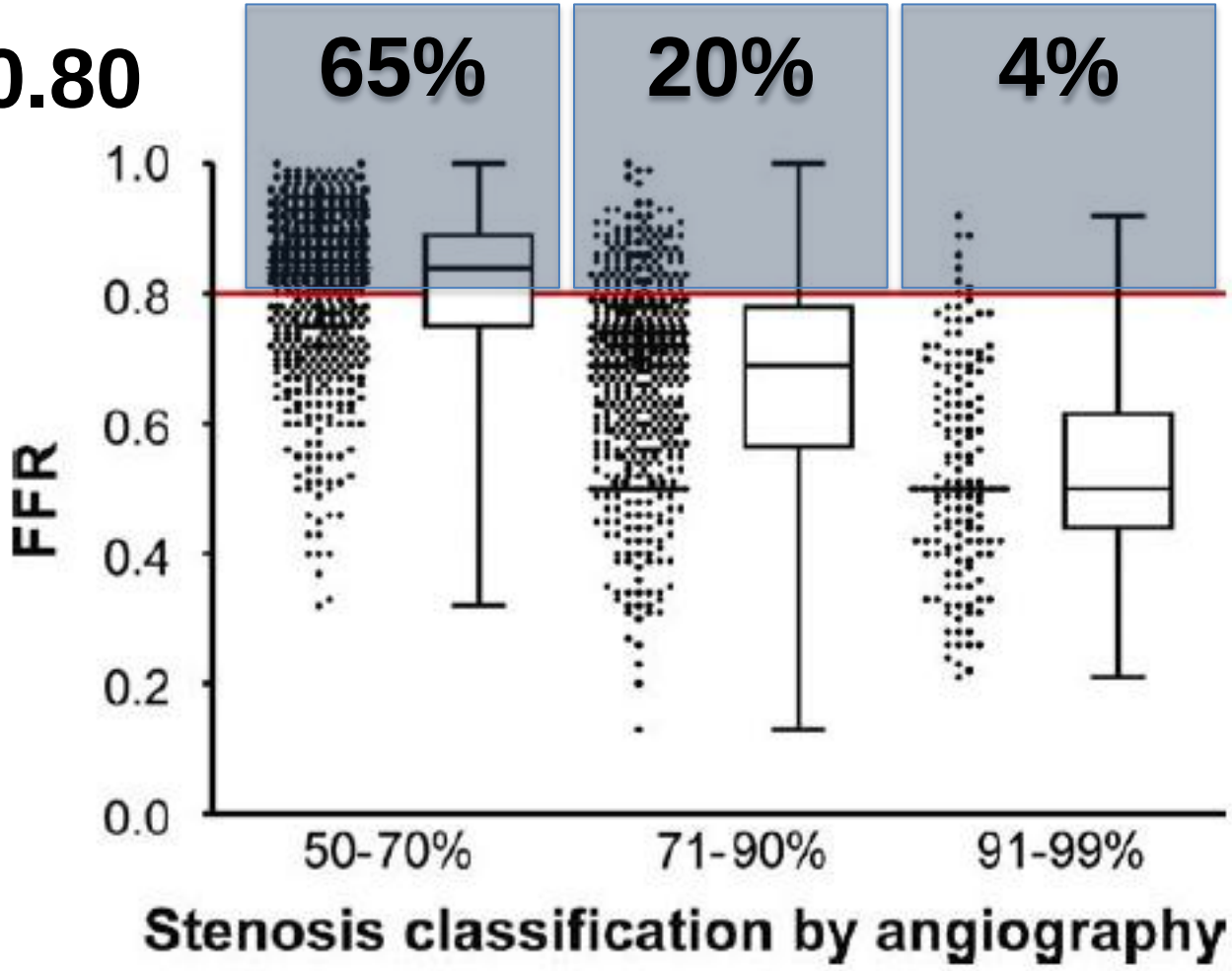
Venous graft patency and stenosis severity of native vessel



Manninen HI et al. Ann Thorac Surg 1998

Poor correlation between angiographic and functional stenosis severity in MVD

FFR > 0.80



Tonino P et al. JACC 2010

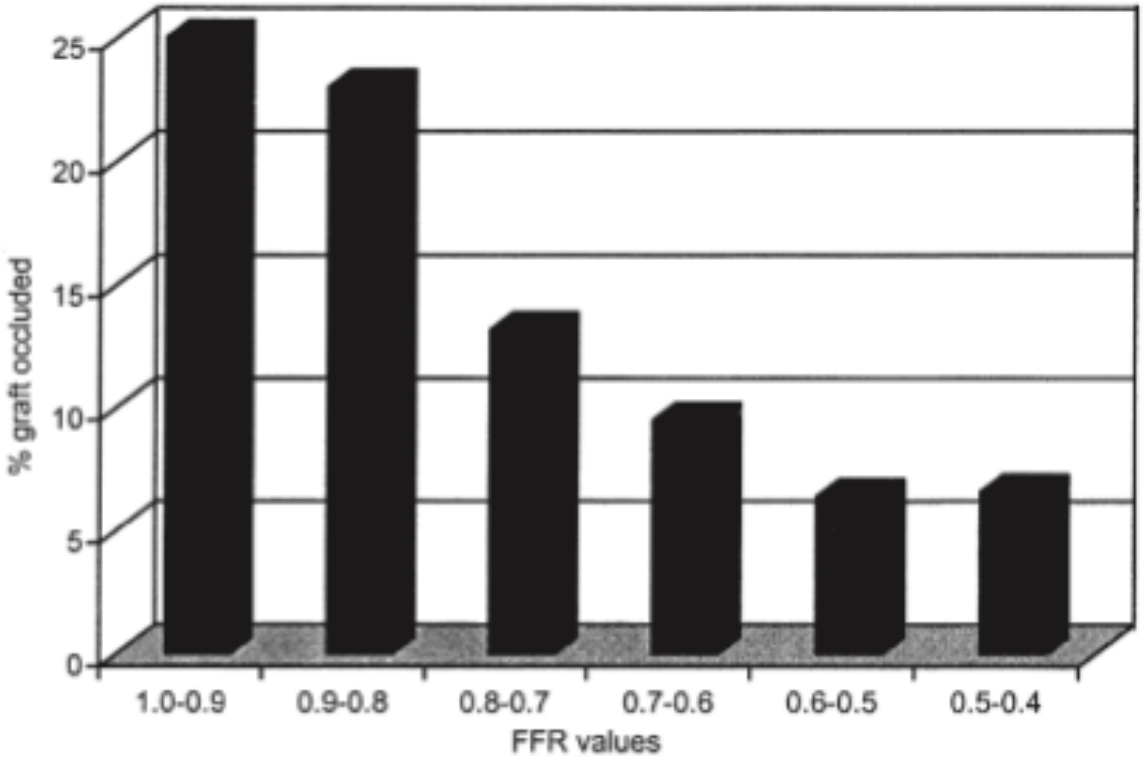
Role of FFR in CABG patients

Before CABG

In patients candidate to CABG:

Is an FFR-guided superior to an Angio-guided strategy?

Functional significance of coronary stenosis and Graft failure



- 164 CABG pts
- Graft failure:
  - 14% arterial
  - 6 venous

Failure of grafts @ 1 year implanted on arteries with non-significant FFR was 3 times higher

Botman et al. Ann Thorac Surg 2007

Aim

To compare retrospectively the **long-term clinical outcome** in patients treated with **FFR-guided CABG** versus patients treated with **Angio-guided CABG**

Toth et al. Circulation 2013

Methods 1

Primary endpoint

The rate of major adverse cardiac events, defined as all cause death, myocardial infarction and target vessel revascularization during 36-month follow-up

Toth et al. Circulation 2013

Methods 2

Inclusion criteria

- Stable angina / unstable angina

- Catheterization in our department between 2006 and 2010

- Indication for Coronary Artery Bypass Graft Surgery

- Having at least one intermediate stenosis (DS 30-70%)

Exclusion criteria

- STEMI / NSTEMI

- Concomitant valvular surgery

Toth et al. Circulation 2013

Methods 3

Patients were divided into

Angio-guided group

If CABG occurred **without prior FFR** assessment of any intermediate stenosis. Grafting was justified purely by the angiographic severity

FFR-guided group

If CABG occurred **with prior FFR** assessment of **at least one** intermediate stenosis. Grafting was done with FFR ≤ 0.80 or deferred with FFR > 0.80

Toth et al. Circulation 2013

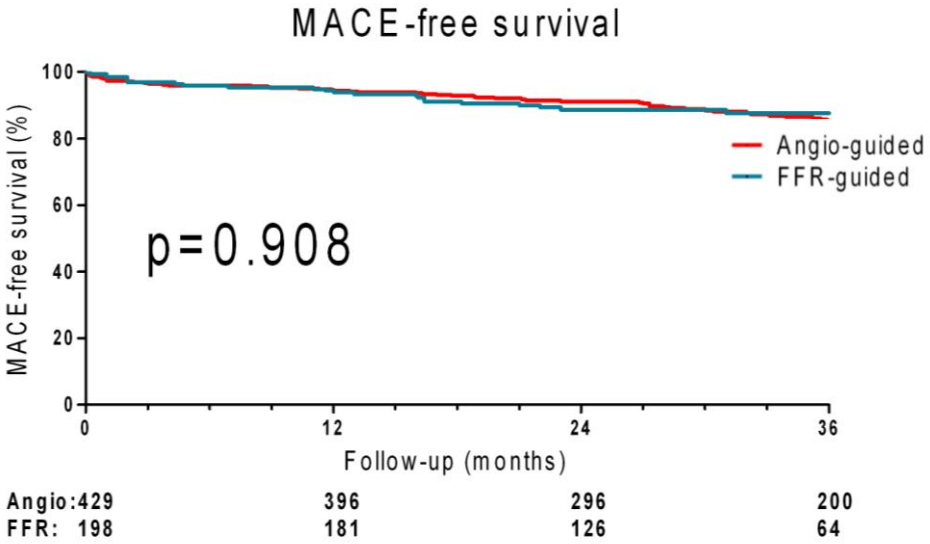
	Angio-guided n=429	FFR-guided n=198	p
Age, years	70 (63-76)	65 (56-72)	**<0.001**
Male gender, %	72	82	**0.010**
BMI, kg/m²	27 (24-30)	28 (25-30)	0.069
Hypertension, %	79	78	0.917
Hypercholesterolemia, %	67	65	0.587
Diabetes, %	30	22	**0.034**
Previous MI, %	14	20	0.081
Previous PCI, %	24	49	**<0.001**
Smoking habit, %	41	42	0.794
Family history, %	24	24	1.000
LVEF, %	71 (60-80)	71 (61-79)	0.931

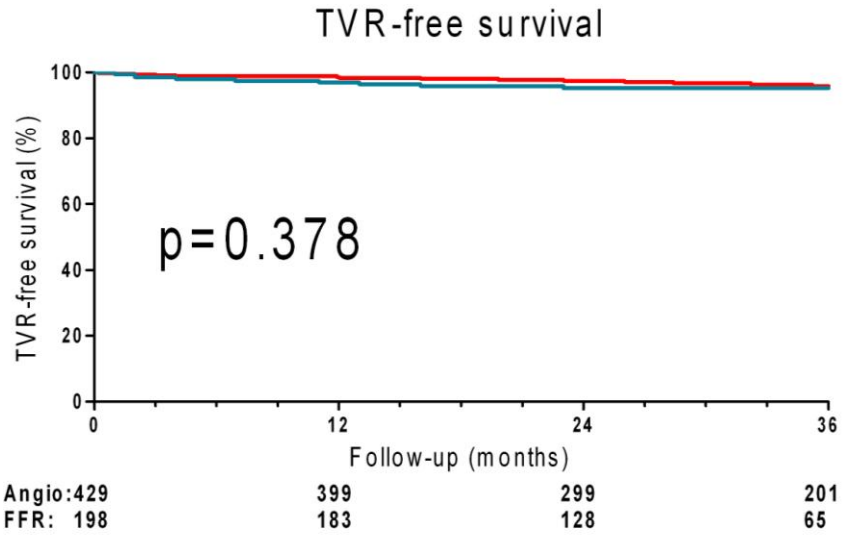
Angio-guided
n=429

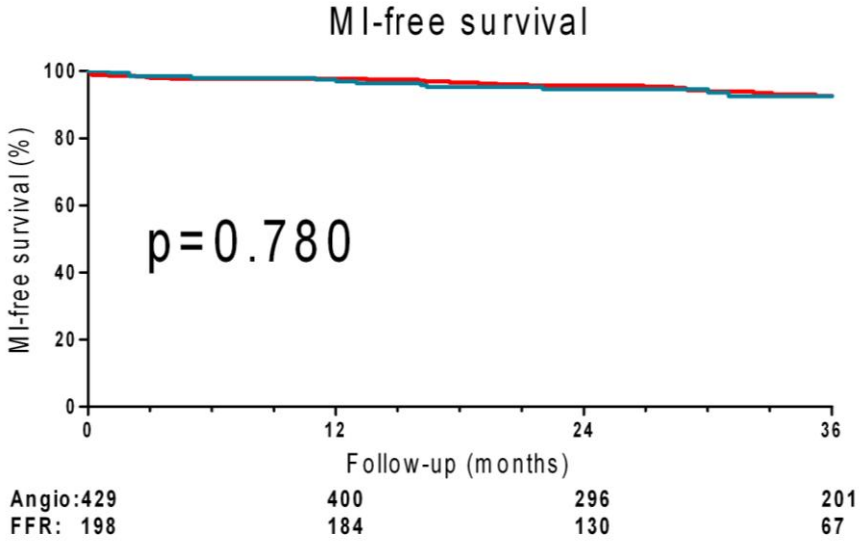
FFR-guided
n=198

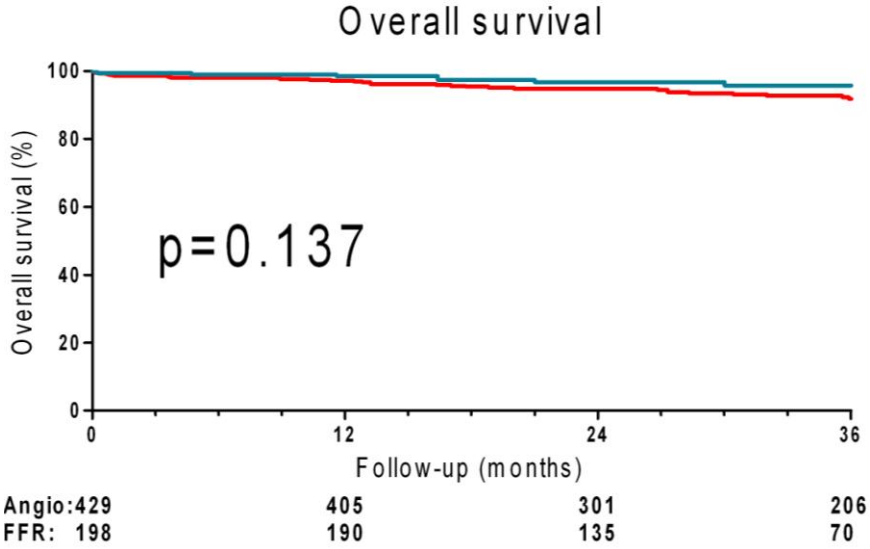
Toth et al. Circulation 2013

Clinical endpoints @ 36 months



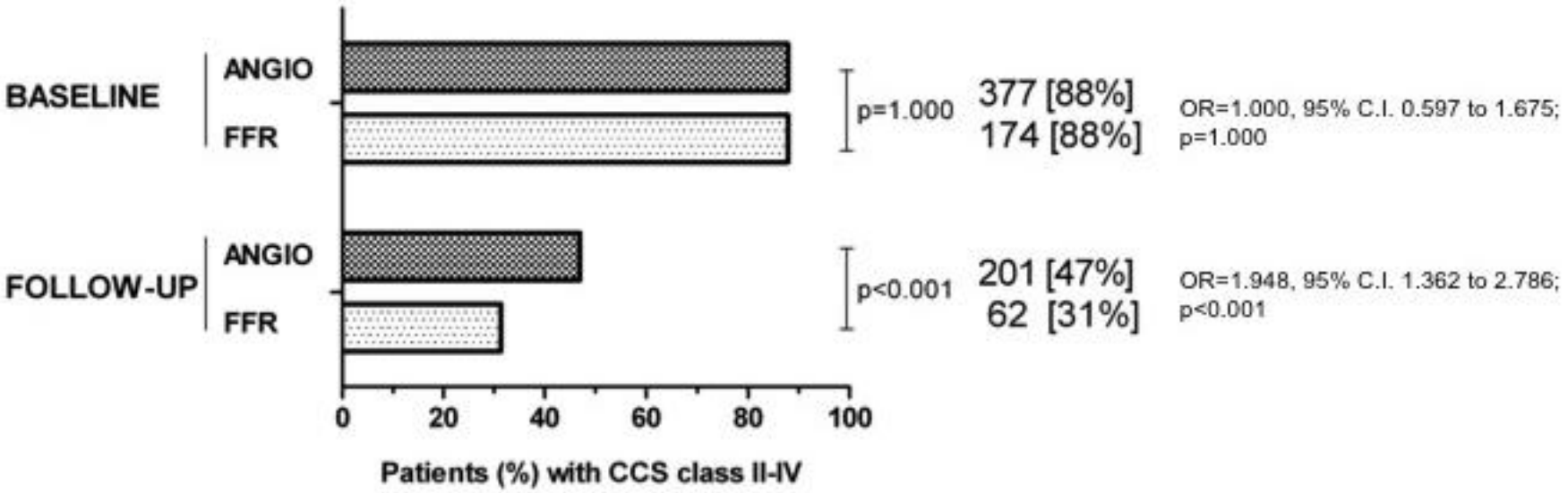






Toth et al. Circulation 2013

CCS II-IV @ 36 months



Toth et al. Circulation 2013

Sub-analysis

Post hoc subanalysis on graft level

- Inclusion criteria

- From the same patient population, as described above
- Patients, where angiographic control performed for any reason

(n_{pat}=160)

- Grafts, placed on vessel with intermediate stenosis (n_{graft}=234)

- Endpoint

- Graft patency at latest follow-up

Toth et al. Circulation 2013

Sub-analysis

Analysed grafts were divided in two groups according to the guidance of revascularization:

Angio-guided grafts

Graft was placed on a vessel with intermediate stenosis, based on angiographic appearance

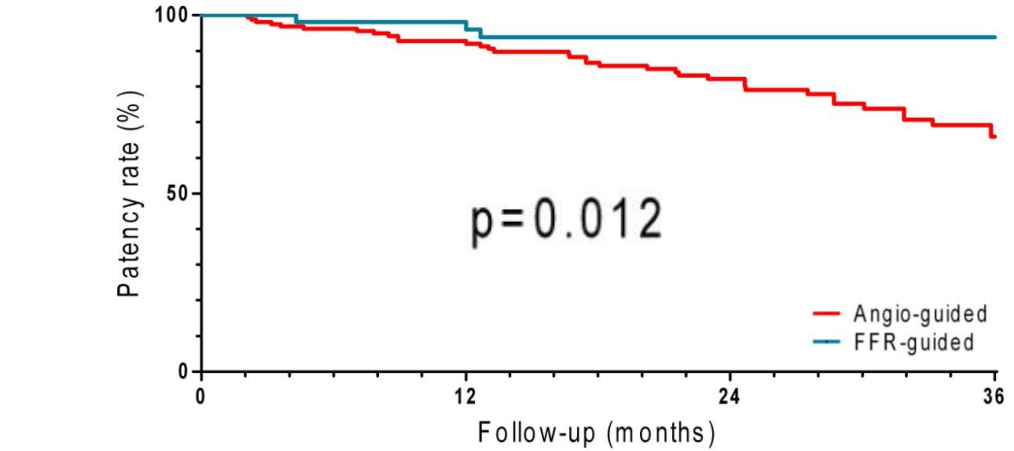
FFR-guided grafts

Graft was placed on a vessel with intermediate stenosis, based on proven functional significance (FFR ≤ 0.80)

Toth et al. Circulation 2013

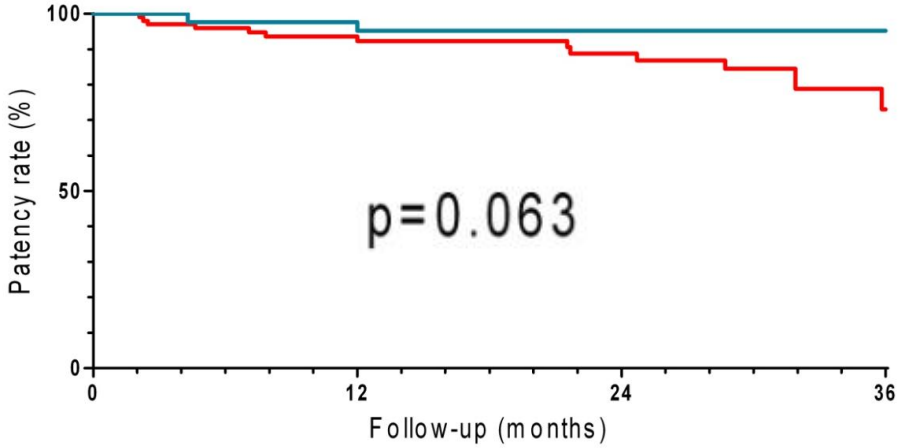
Graft patency @ 36 months

All grafts



Angio-guided:	174	128	83	39
FFR-guided:	60	47	26	16

Arterial grafts



Angio-guided:	110	75	49	24
FFR-guided:	51	39	22	15

Toth et al. Circulation 2013

Conclusion

- FFR-guidance of CABG is associated:
  - **lower number of grafts**
  - **higher rate of off-pump** surgery
  - **better functional class**
- Despite the lower number of grafts there is **no excess in events** after FFR-guided CABG

Toth et al. Circulation 2013

GRaft Patency After FFR-guided versus Angio-guided CABG: a randomized clinical Trial (GRAFFITI trial)

www.clinicaltrial.gov NCT01810224

Principal investigators:

Emanuele Barbato

Bernard De Bruyne

Gabor Toth

Patient with

- **Significant LAD / LM lesion**

AND

- ***At least* one more lesion**

~ 200 pts

- proved by FFR (<0.80) / Angio (>69%)

- angiographically intermediate (30-90%)

DS 30 - 90%

FFR measurement

FFR blinded HEART TEAM consultation

(Surgeons will be asked to identify by visual estimation the target vessels to be revascularized, number of anastomosis and grafts)

PATIENT 1:1 RANDOMIZATION

FFR-GUIDED GROUP

INFORM surgeons about FFR-values

GRAFT **ONLY THE FUNCTIONALLY SIGNIFICANT** LESIONS

ANGIO-GUIDED GROUP

Let surgeons **BLINDED** for FFR-values

GRAFT **ALL THE ANGIOGRAPHICALLY SIGNIFICANT** LESIONS

12 ± 2M FOLLOW-UP

GRAFT PATENCY CONTROLLED BY CCTA and/or CA

Endpoints

Primary : - Rate of **occluded grafts** at 12M FU

Secondary: - Graft **patency** at 12M FU (defined as average percent of patent graft per patient)

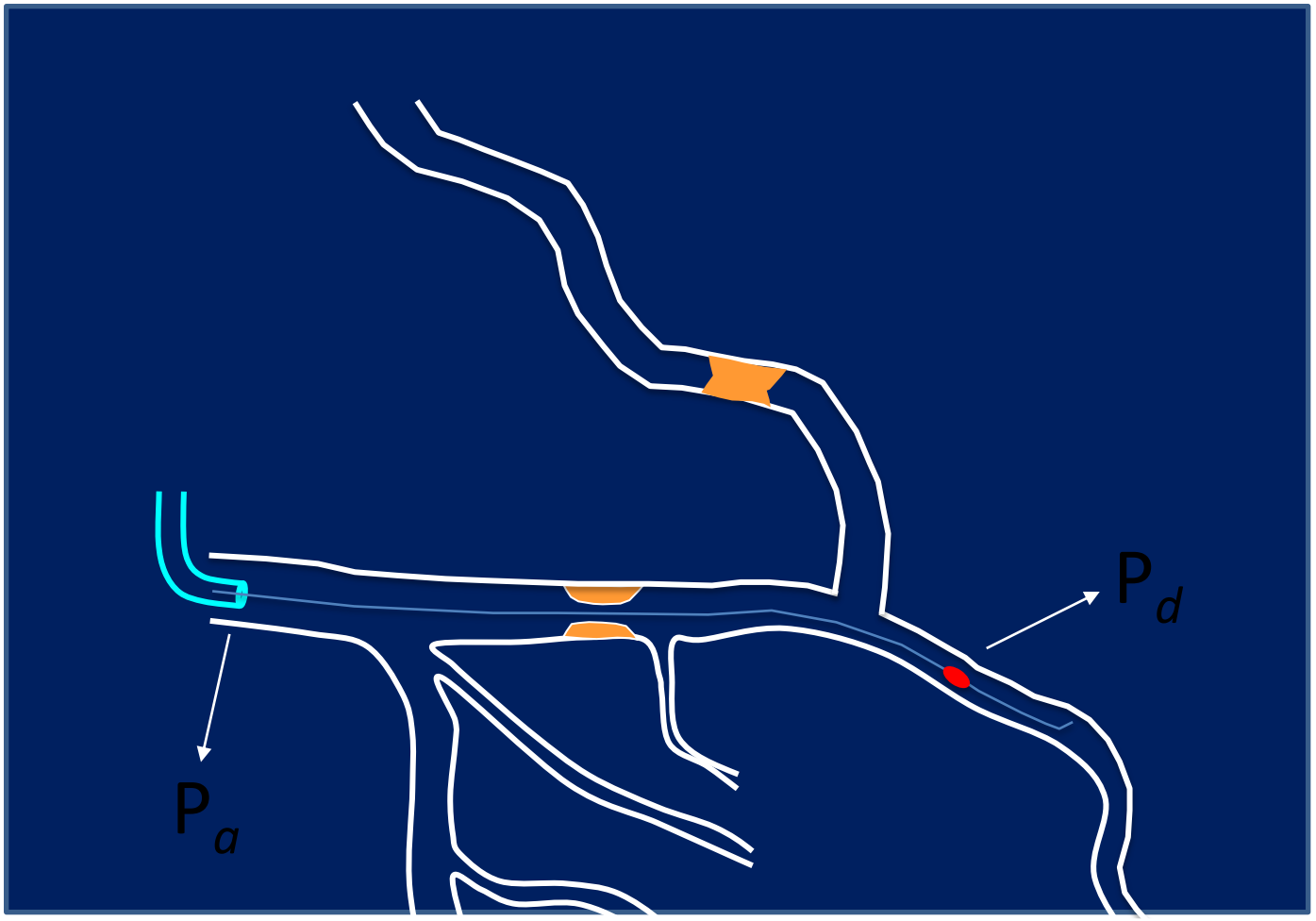
- Perioperative **myocardial infarction** and **periprocedural necrosis**
- Changes in Syntax Score classification regarding to Angio-guided vs FFR guided calculation
- Length of **hospitalizatio**n after surgery
- **Cost of Care**: defined as costs of index hospitalization, re-hospitalization, repeat revascularization (redo-CABG or PCI)
- Changes in **surgical strategy** depending upon FFR results i.e. Open-chest vs. Minithoracotomy, On-pump vs. Off-pump, etc.(*in FFR-guided group only*)
- Changes in **functional state** (CCS classification)
- Rate of **Major Adverse Cardiovascular Events** (Death, Myocardial Infarction, Symptom-driven revascularisation)

Role of FFR in CABG patients

After CABG

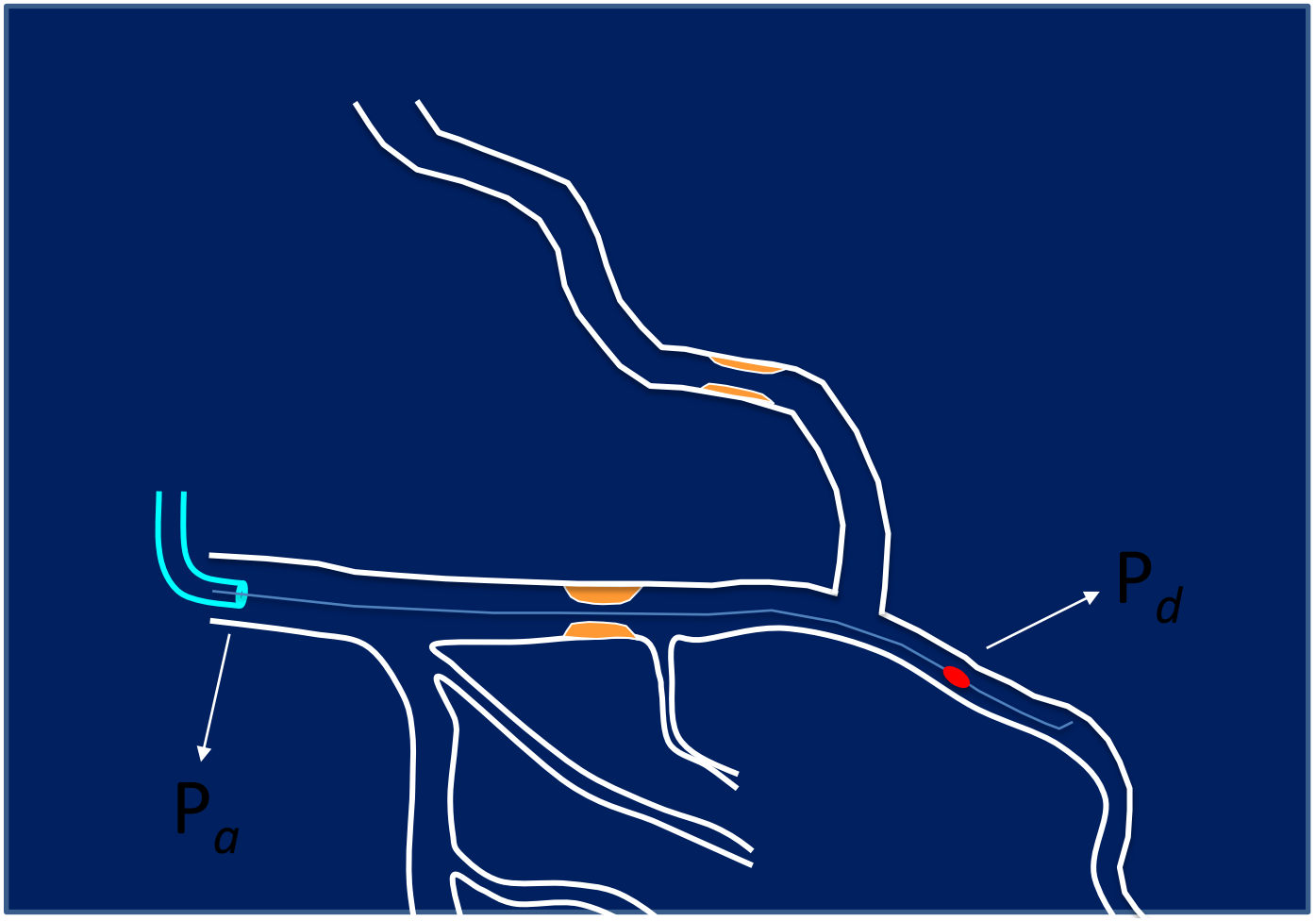
Is FFR guidance also viable in bypassed arteries?

How to ... FFR with occluded bypass graft



FFR of the native stenotic vessel is not different from non-CABG setting

How to ... FFR with open bypass graft



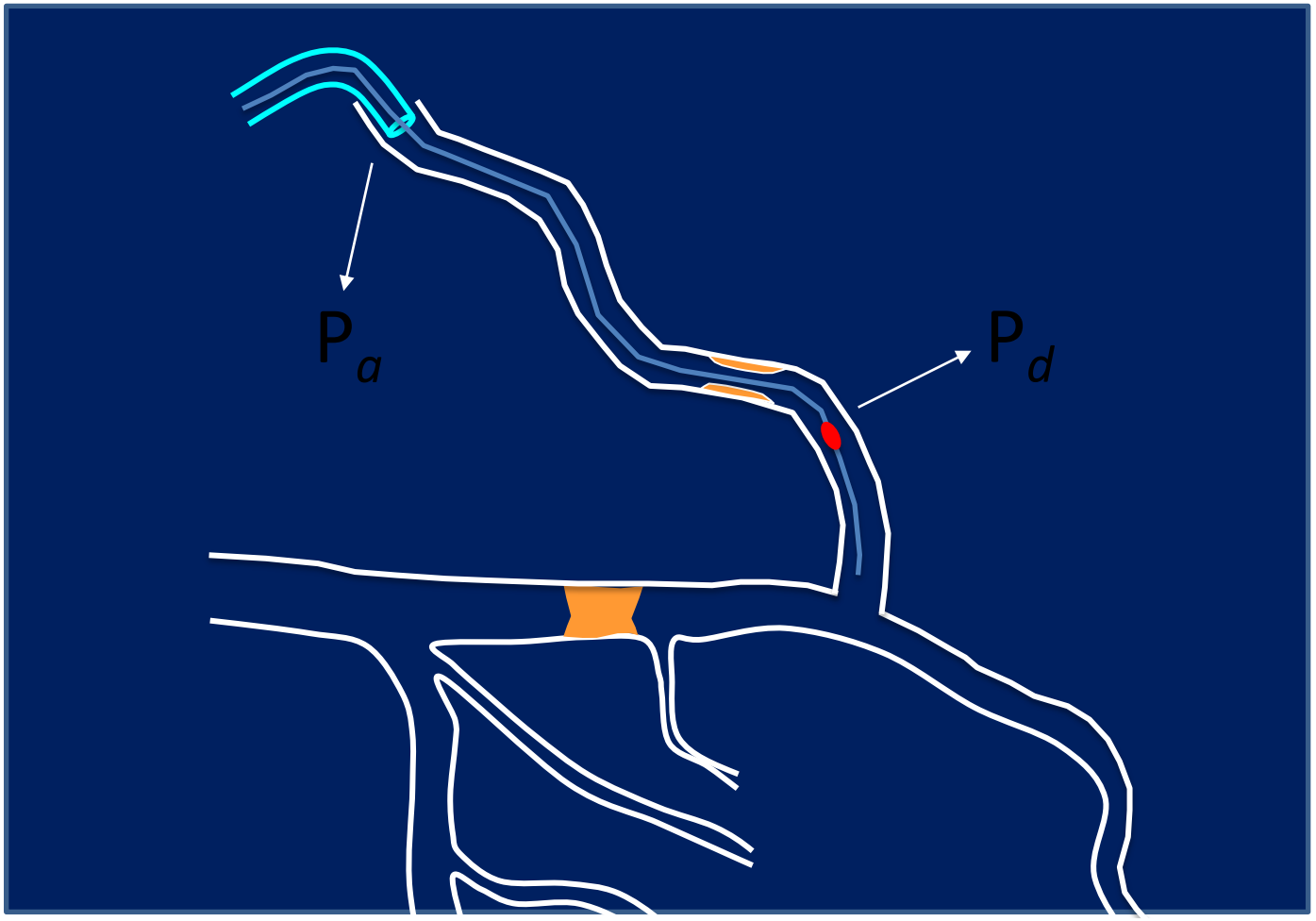
FFR of native stenotic vessel reflects the summation of hyperemic flow depending from both by-pass graft and stenotic native coronary artery

Role of FFR in CABG patients

After CABG

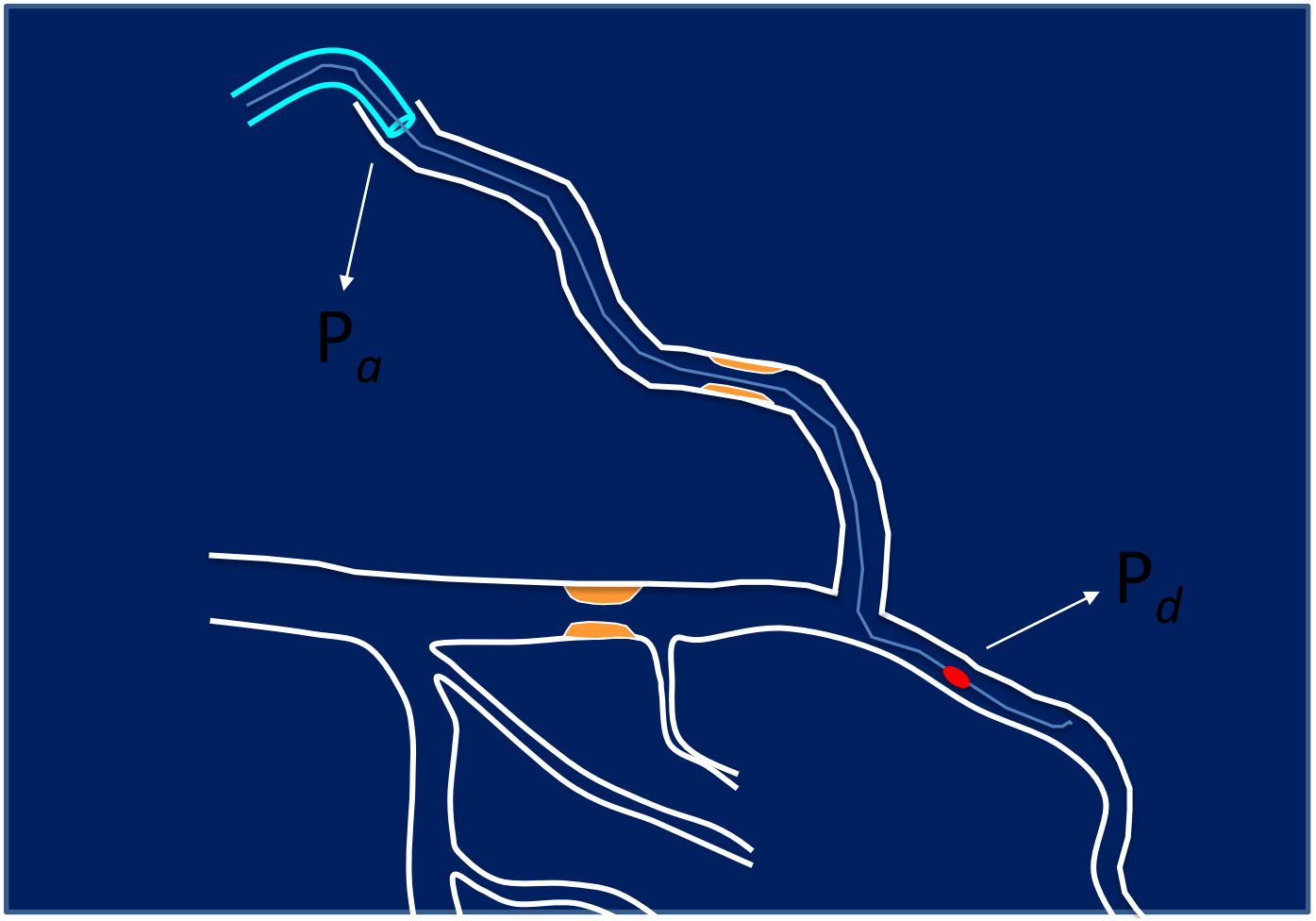
Is FFR guidance also viable in bypass grafts?

How to ... FFR with occluded native vessel



Sensor of the pressure wire can be positioned beyond the graft stenosis!

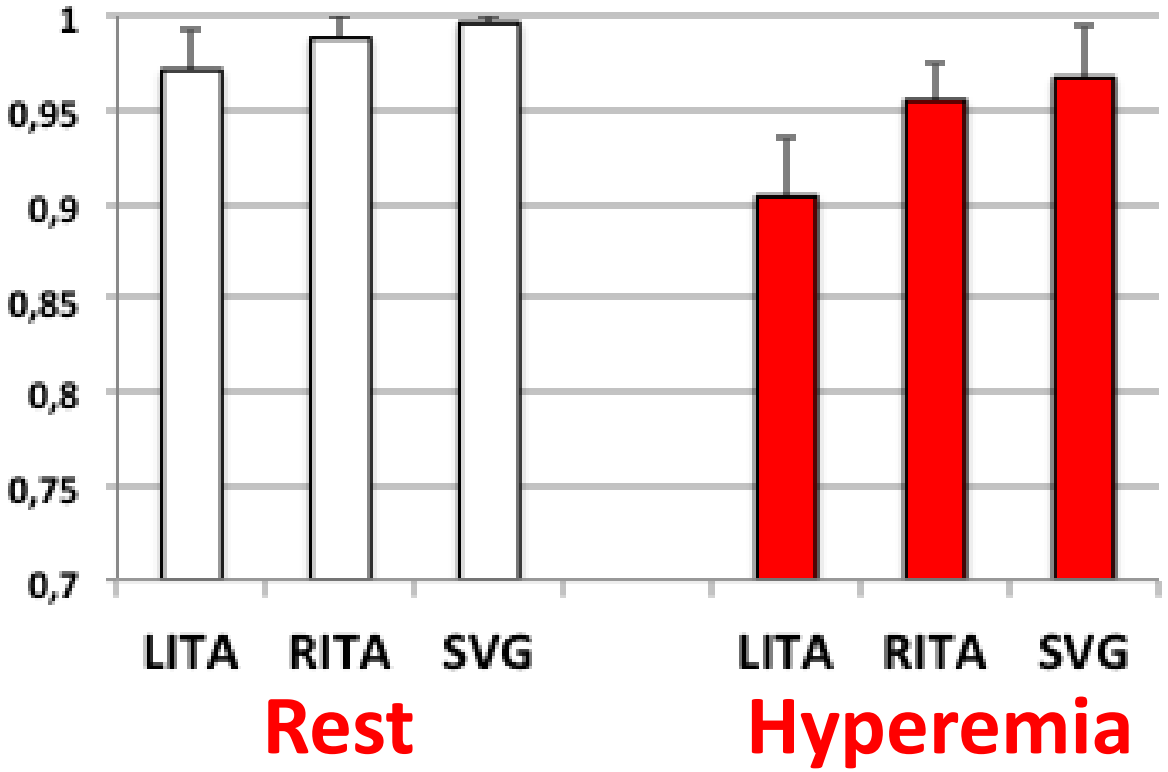
How to ... FFR with open native vessel



Sensor of the pressure wire should be positioned beyond the graft stenosis and the distal anastomosis!

Resistance in bypass grafts and FFR

Pd/Pa



***LITA always implanted on LAD**

Adapted by Glineur D et al. Eur J Cardiothorac Surg 2007

Role of FFR in CABG patients

After CABG

Is FFR-guided PCI better than Angio-guided PCI in bypass grafts?

Aim

To compare retrospectively the **long-term clinical outcome** in patients undergoing **FFR-guided PCI** versus contemporary patients undergoing **Angio-guided PCI** of intermediate stenosis in **bypass graft**

Di Serafino L et al. Am Heart J 2013

Methods 1

Primary endpoint

The rate of major adverse cardiac and cerebrovascular events (MACCEs), defined as all cause death, non-fatal infarction, target vessel failure and cerebrovascular events

Di Serafino L et al. Am Heart J 2013

Methods 2

Inclusion criteria

- Stable angina / unstable angina

- Catheterization in our department between 2000 and 2011

- Having at least one intermediate stenosis (40-70%) of an arterial or a venous bypass graft

Exclusion criteria

- STEMI / NSTEMI
- Presence of serial stenosis located in bypass graft or in both bypass graft and its subtended native vessel
- Presence of sequential anastomosis in the target bypass graft

Di Serafino L et al. Am Heart J 2013

Methods 3

Patients were divided into:

Angio-guided group

If PCI of an intermediate bypass graft stenosis was performed or deferred based on the angiographic appearance of the coronary lesion

FFR-guided group

If PCI of an intermediate bypass graft stenosis was performed in case of FFR≤0.80 and deferred to medical therapy in case of FFR >0.80

Di Serafino L et al. Am Heart J 2013

Clinical characteristics

	FFR guided (n = 65)	Angio guided (n = 158)	P
Age (y)	69 ± 9.3	71 ± 8.9	.15
Male, n (%)	50 (77)	121 (77)	1.00
BMI (kg/m^2)	27 ± 4	27 ± 4	.24
EF (%)	63 ± 16	63 ± 17	.84
SBP (mm Hg)	144 ± 30	149 ± 33	.40
DBP (mm Hg)	67 ± 13	67 ± 10	.87
Smoker, n (%)	30 (46)	65 (41)	.55
Hypertension, n (%)	37 (57)	90 (57)	1.00
Hyperlipidemia, n (%)	43 (66)	97 (61)	.54
Diabetes, n (%)	15 (21)	46 (29)	.41
Previous MI, n (%)	23 (35)	56 (35)	1.00
PVD, n (%)	12 (18)	31 (20)	1.00
CVD, n (%)	6 (9)	19 (12)	.64
Previous PCI, n (%)	30 (46)	64 (40)	.46
Redo-CABG, n (%)	12 (18)	19 (12)	.21
CABG to angio Time (mo)	118 ± 78	126 ± 82	.19
Clinical presentation, n (%)			.30
Stable angina	53 (81)	117 (74)	
Unstable angina	12 (18)	41 (26)	

Di Serafino L et al. Am Heart J 2013

Procedural characteristics

	FFR guided	Angio guided	P
PCI performed, n (%)	23 (35)	90 (57)	<.01
PCI on arterial grafts, n (%)	16 (70)	12 (13)	<.01
PCI-related myocardial territory, n (%)			<.01
LAD	14 (61)	19 (21)	
LCx	5 (22)	32 (36)	
RCA	4 (17)	39 (43)	
Embolic protection device, n (%)	0 (0)	3 (3)	.26
Stent per patient, n (%)	0.3 ± 0.5	0.7 ± 0.8	<.01
DES, n (%)	9 (14)	21 (13)	.83
Stent diameter (mm)	3.0 ± 0.3	3.5 ± 0.6	.06
Stent length (mm)	16.9 ± 5.2	21.1 ± 12.2	.12
PCI deferred, n (%)	42 (65)	68 (43)	<.01
Myocardial deferred territory, n (%)			.47
LAD	10 (24)	22 (32)	
LCx	16 (38)	27 (40)	
RCA	16 (38)	19 (28)	
Procedural time (min)	68 ± 26	62 ± 33	.23
X-ray time (min)	19 ± 14	17 ± 11	.37
Contrast medium (mL)	277 ± 110	294 ± 112	.44
Cost of procedure (€)	2240 ± 652	2416 ± 522	.03
Inhospital outcome			
PMI, n (%)	1 (1)	18 (11)	<.01
TIMI major bleedings, n (%)	1 (1)	3 (1)	1.00
AKIN, n (%)	0 (0)	5 (3)	.32

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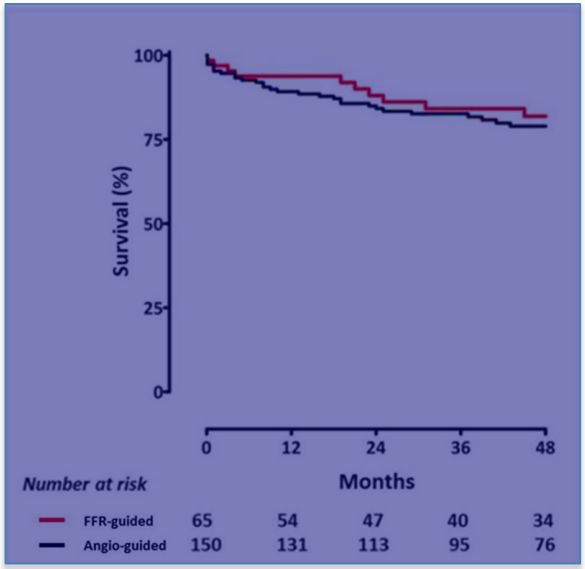
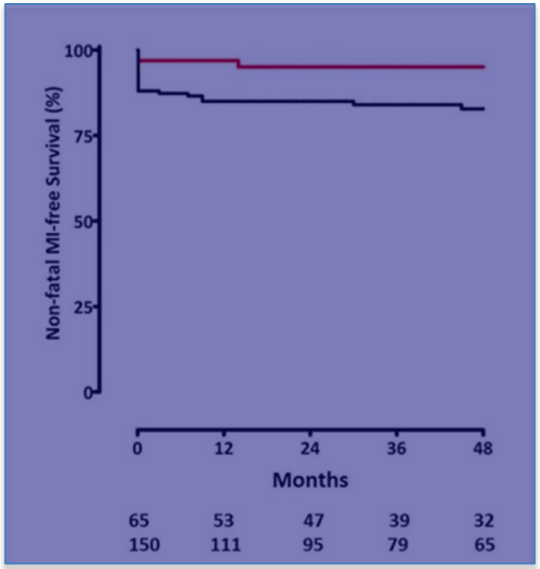
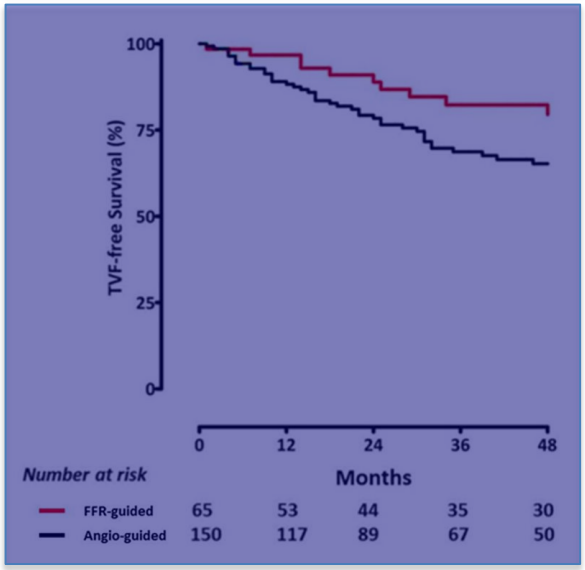
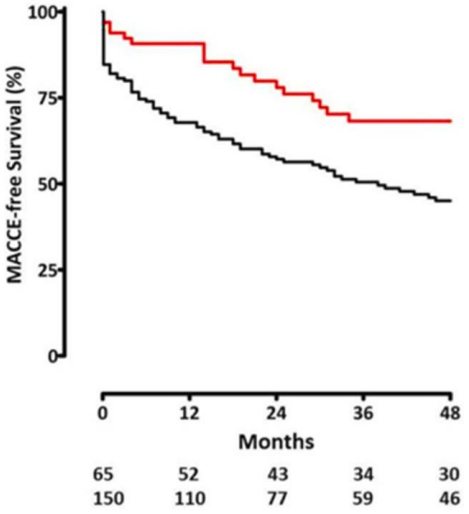
Clinical outcome









FFR-guided

Angio-guided

Di Serafino L et al. Am Heart J 2013

Clinical outcome

Overall	FFR guided	Angio guided	Unadjusted HR (95% CI)	P	PS-adjusted HR (95% CI)	P
Death, n (%)	10 (15)	29 (19)	0.81 (0.39-1.66)	.566	–	–
Death or nonfatal MI, n (%)	12 (18)	50 (33)	0.52 (0.28-0.97)	.041	–	–
Nonfatal MI, n (%)	3 (5)	24 (16)	0.28 (0.08-0.93)	.037	–	–
CVA, n (%)	0 (0)	5 (3)	0.03 (0.0-87.76)	.384	–	–
TVR, n (%)	9 (14)	33 (22)	0.60 (0.29-1.25)	.17		
TVF, n (%)	10 (15)	41 (27)	0.52 (0.26-1.03)	.061	–	–
MACCE, n (%)	18 (28)	77 (51)	0.46 (0.28-0.77)	.003	0.47 (0.30-0.75)	.001
Arterial grafts						
TVF, n (%)	3 (11)	7 (30)	0.11 (0.01-0.90)	.04	–	–
MACCE, n (%)	4 (15)	13 (56)	0.22 (0.07-0.66)	.008	–	–
Venous grafts						
TVF, n (%)	7 (18)	34 (27)	0.68 (0.30-1.53)	.35	–	–
MACCE, n (%)	14 (37)	64 (50)	0.67 (0.37-1.19)	.17	–	–

Di Serafino L et al. Am Heart J 2013

Conclusion

- FFR-guided PCI of intermediate stenosis in bypass graft is safe and results in a better clinical outcome as compared with an Angio-guided PCI
- This clinical benefit was more pronounced in arterial grafts, whereas it was limited to a reduced incidence of PMI in SVGs

Di Serafino L et al. Am Heart J 2013