FFR in Multivessel Disease

April, 26 2013
Coronary Physiology in the Catheterization Laboratory
Location: European Heart House, Nice, France

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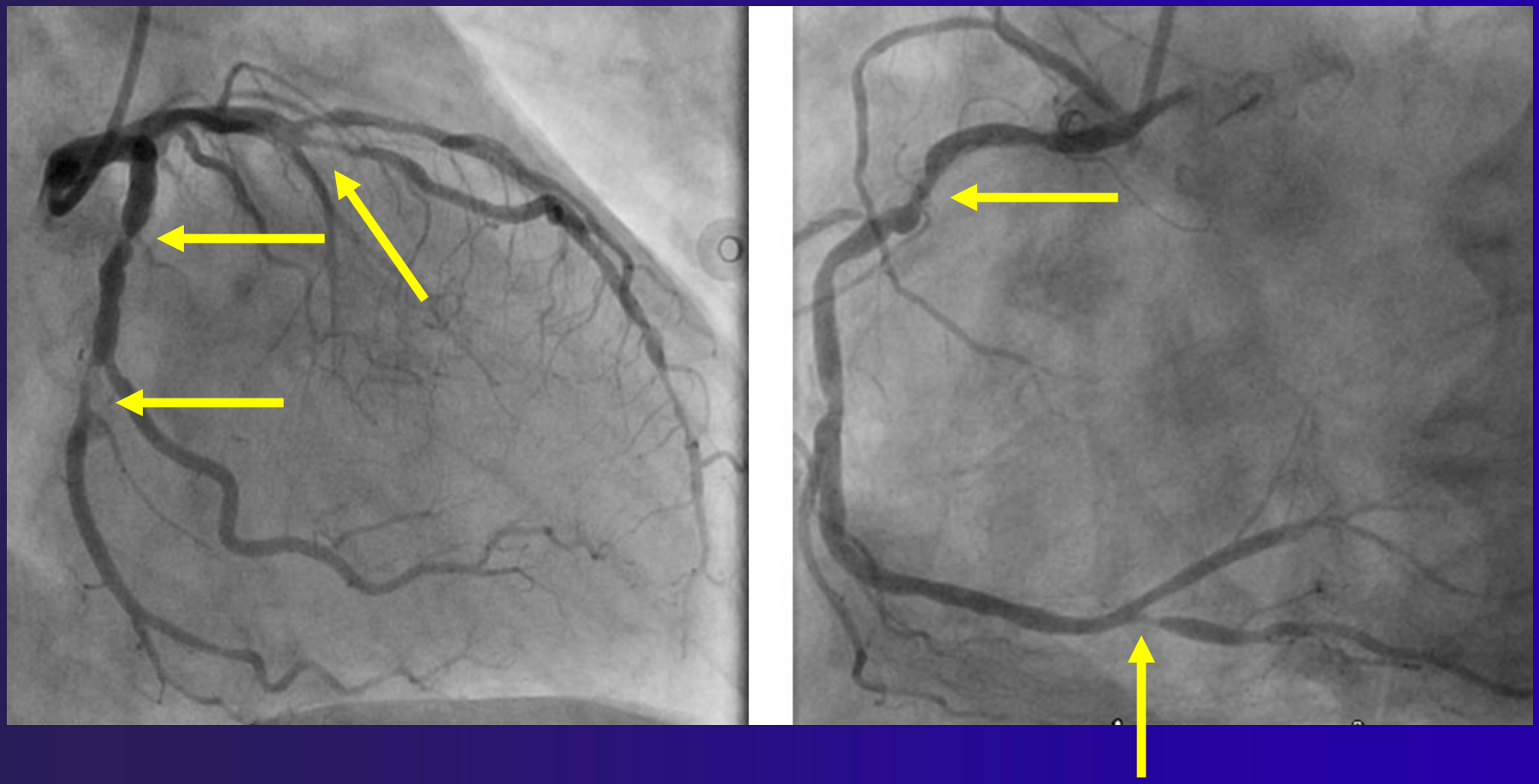
Advantages of FFR in MVD .....

- FFR is the only way to accurately discriminate ischemic from non-ischemic lesions in MVD; not possible with any other diagnostic modality
- FFR-guided revascularization in MVD improves outcome and lowers costs
- FFR can be of help in clinical decision making in MVD: PCI or CABG?

Angiographic multivessel disease



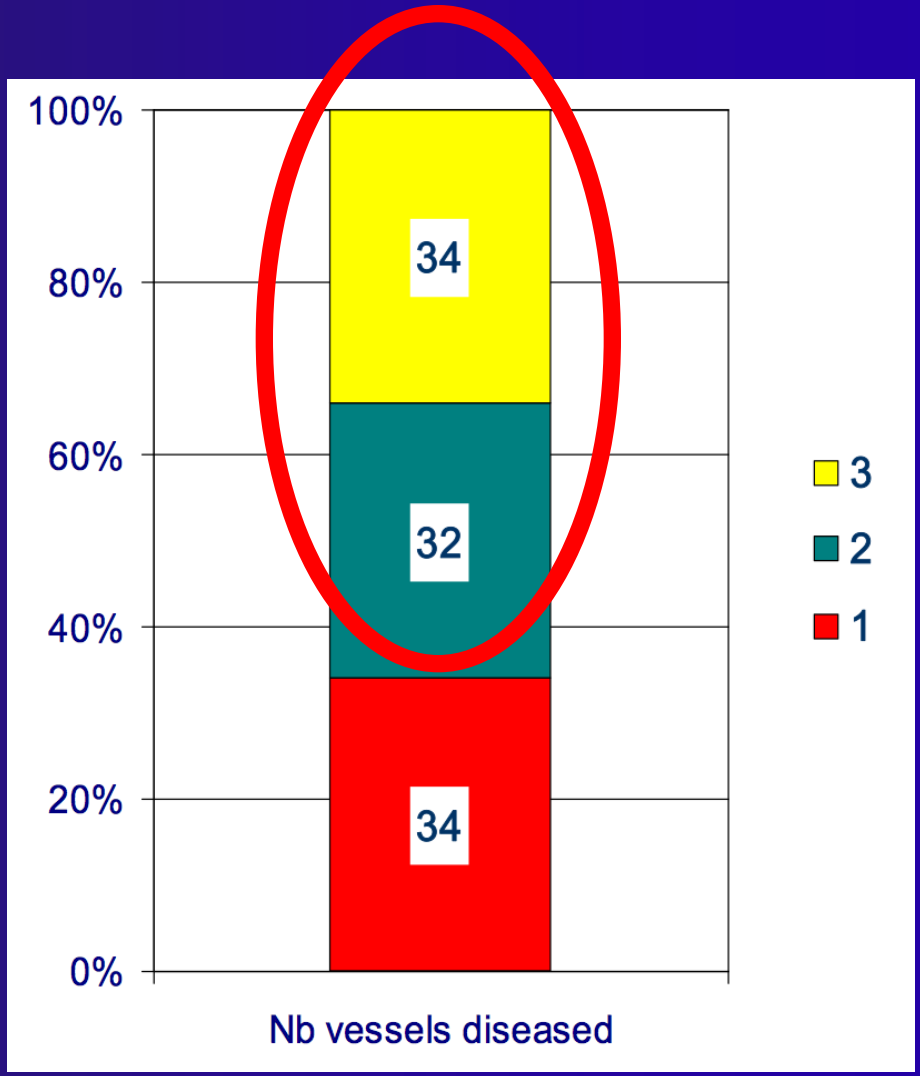
Occurence of MVD in PCI patients > 60%

Euro Heart Survey on PCI

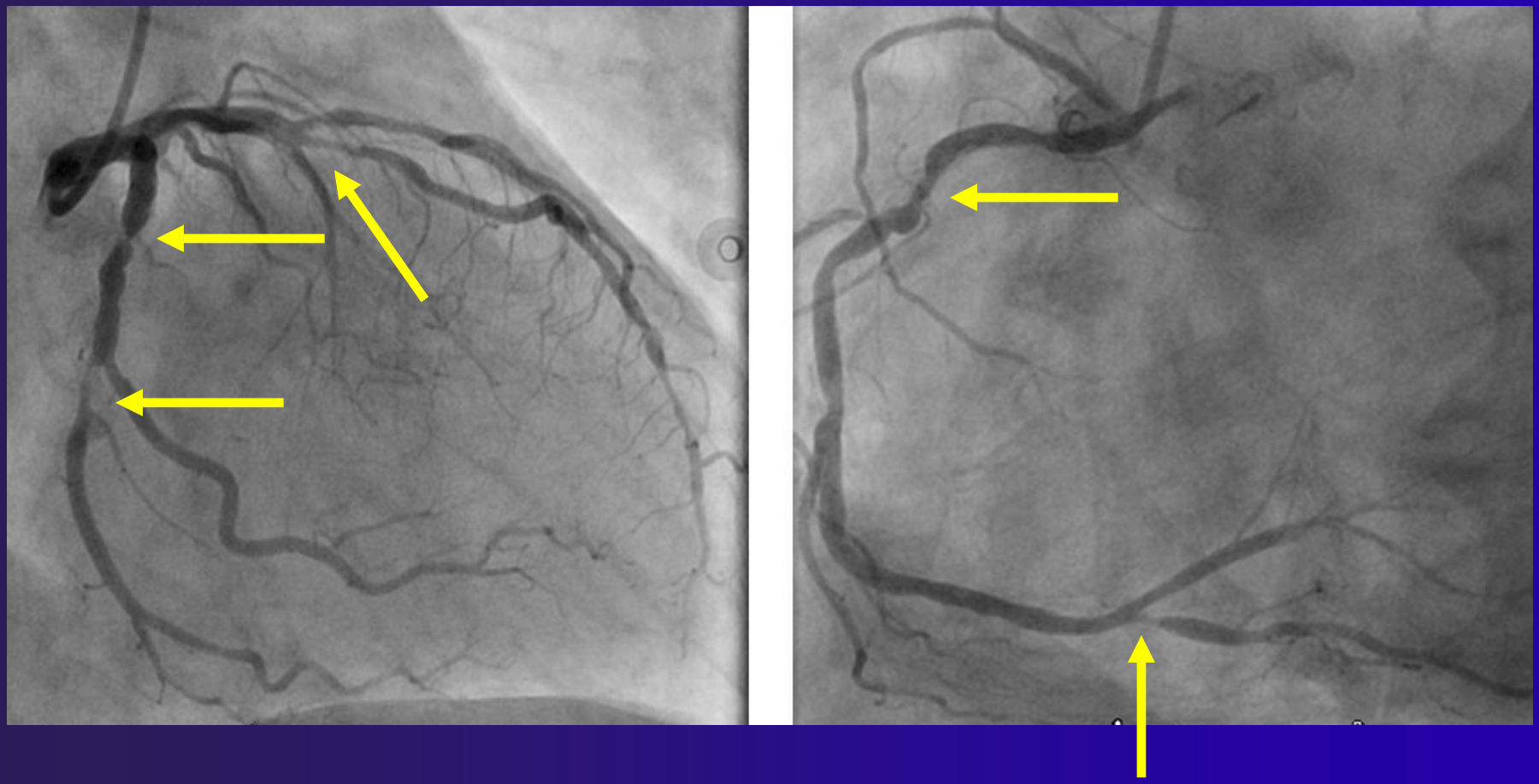
June 2005- January 2006

134 Centres, 39 ESC member countries

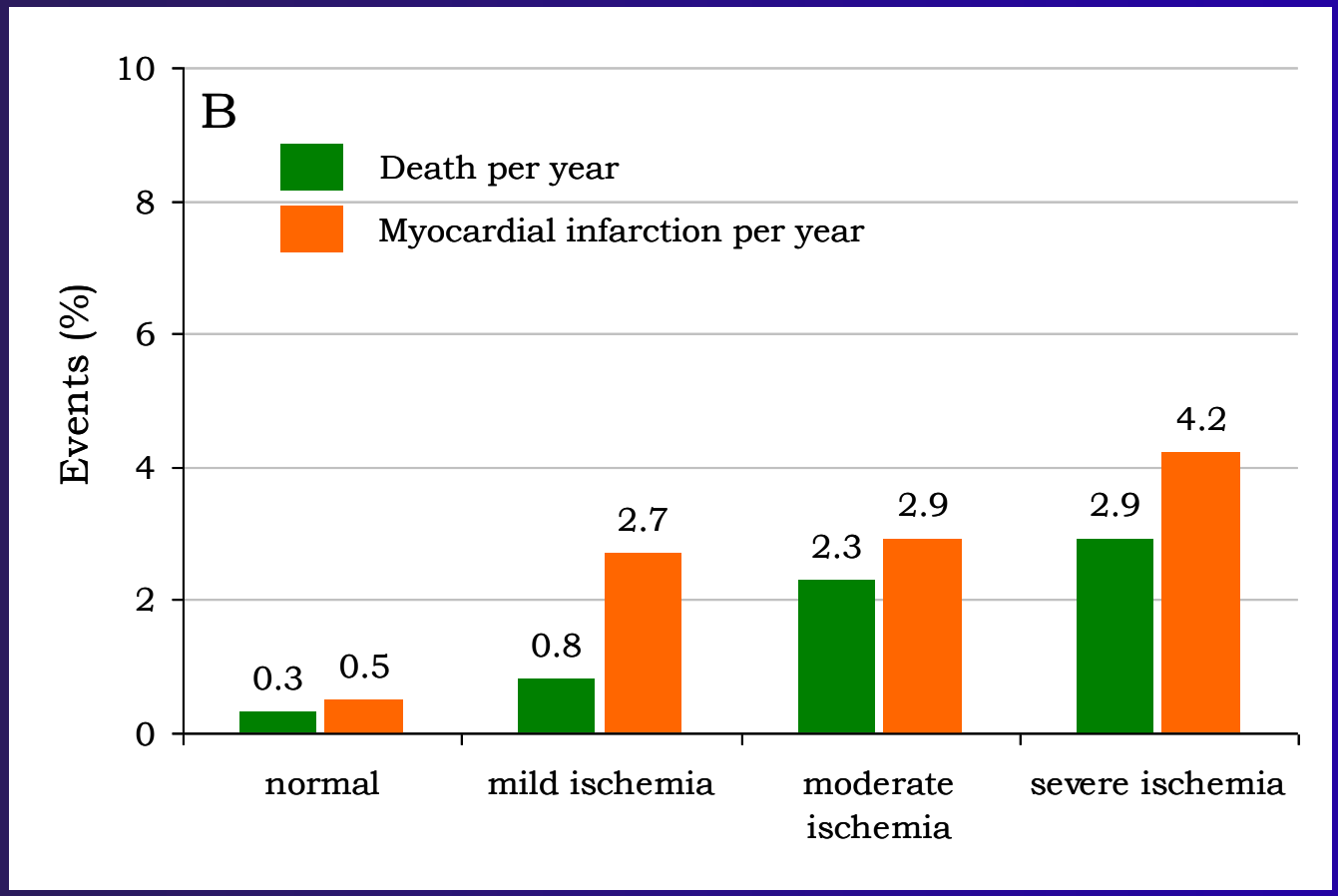
n=13,152 patients



Angiographic multivessel disease

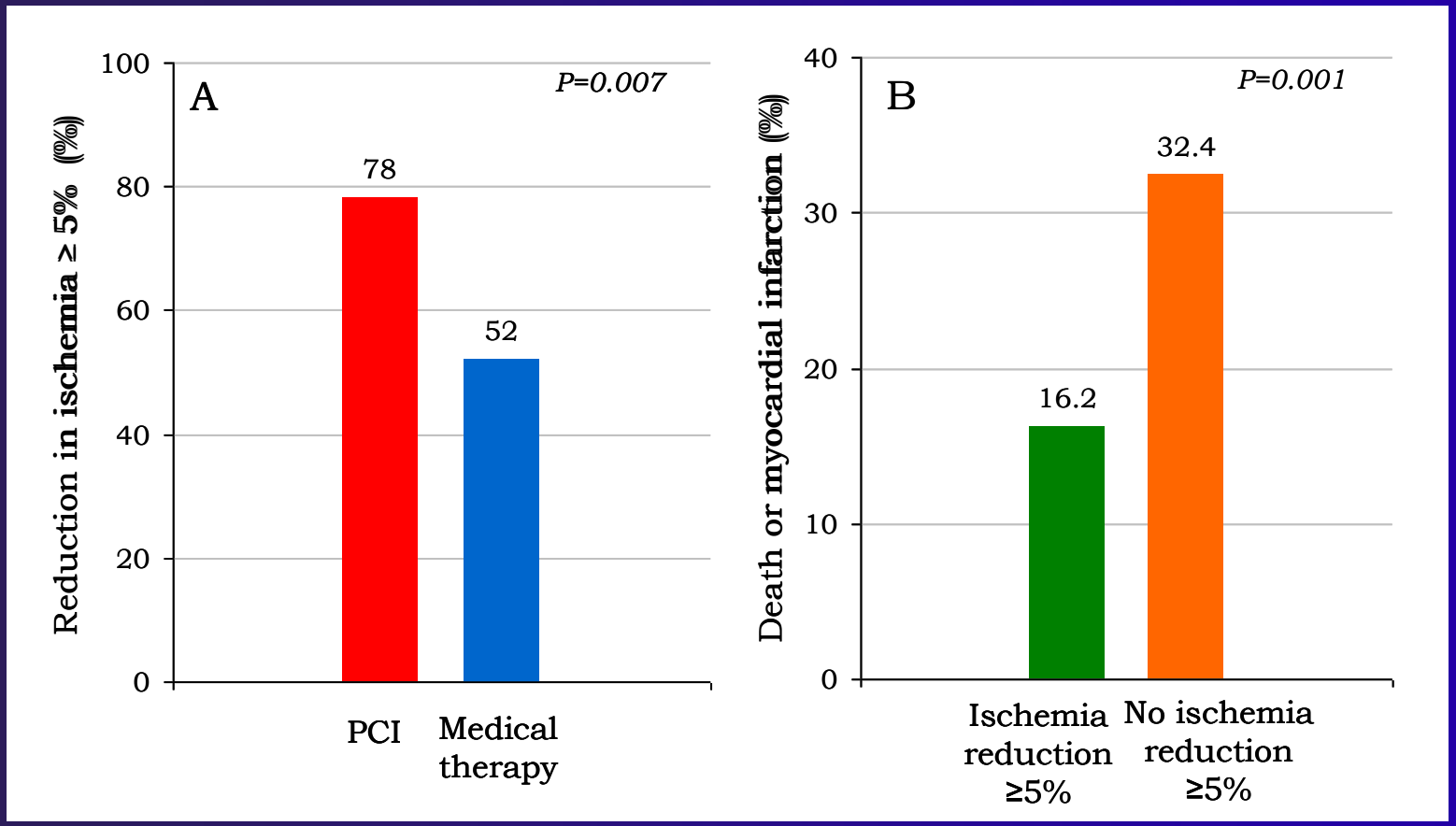


Ischemia-producing coronary lesions cause symptoms and cardiac events



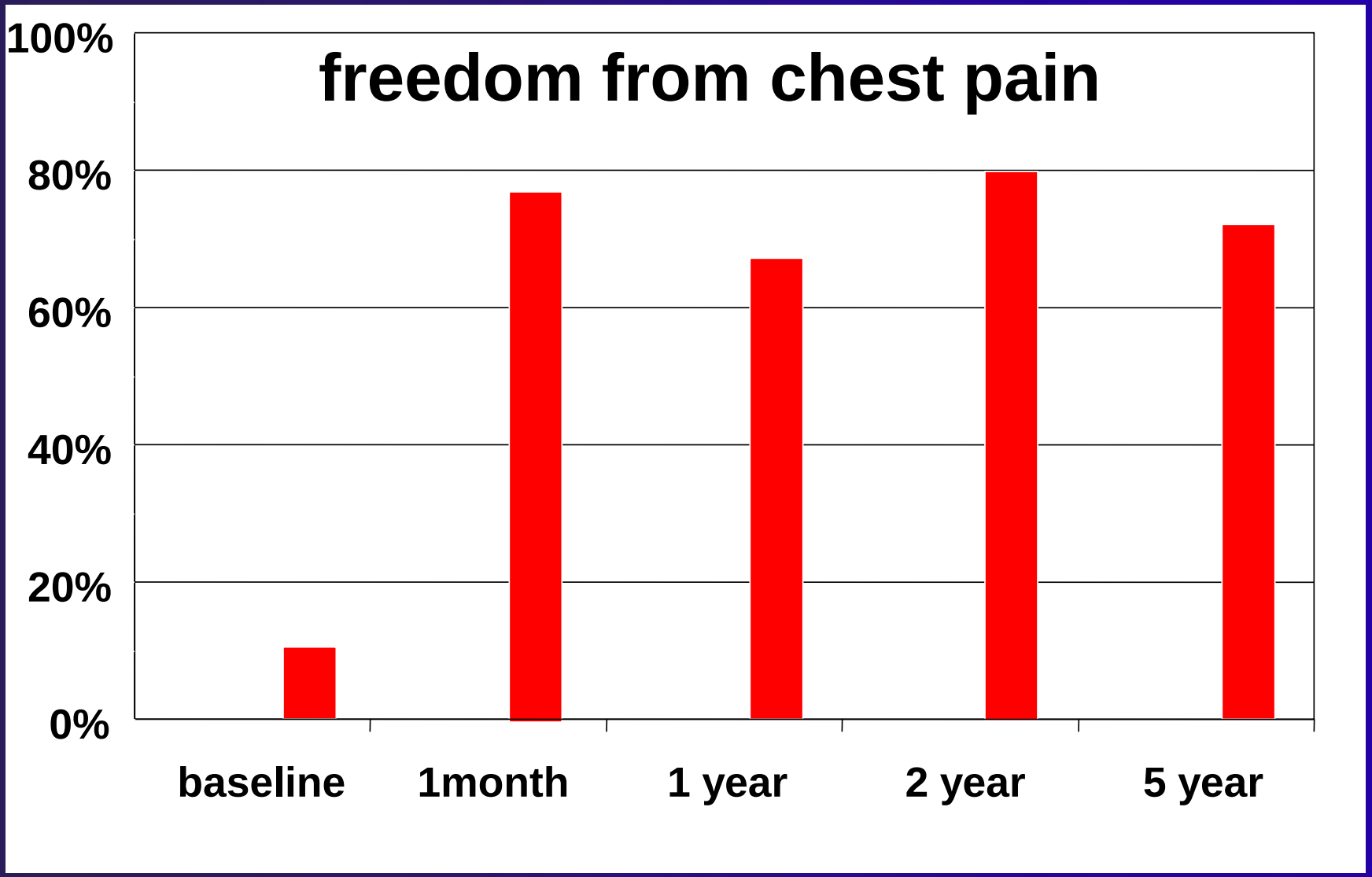
Hachamovitch et al., Circulation 1998

PCI of ischemic lesions → better outcome



Shaw et al. COURAGE trial nuclear substudy. Circulation 2008

PCI of ischemic lesions (FFR < 0.75) → effective symptom-relief



DEFER-study, JACC 2007; 49 : 2105-2111

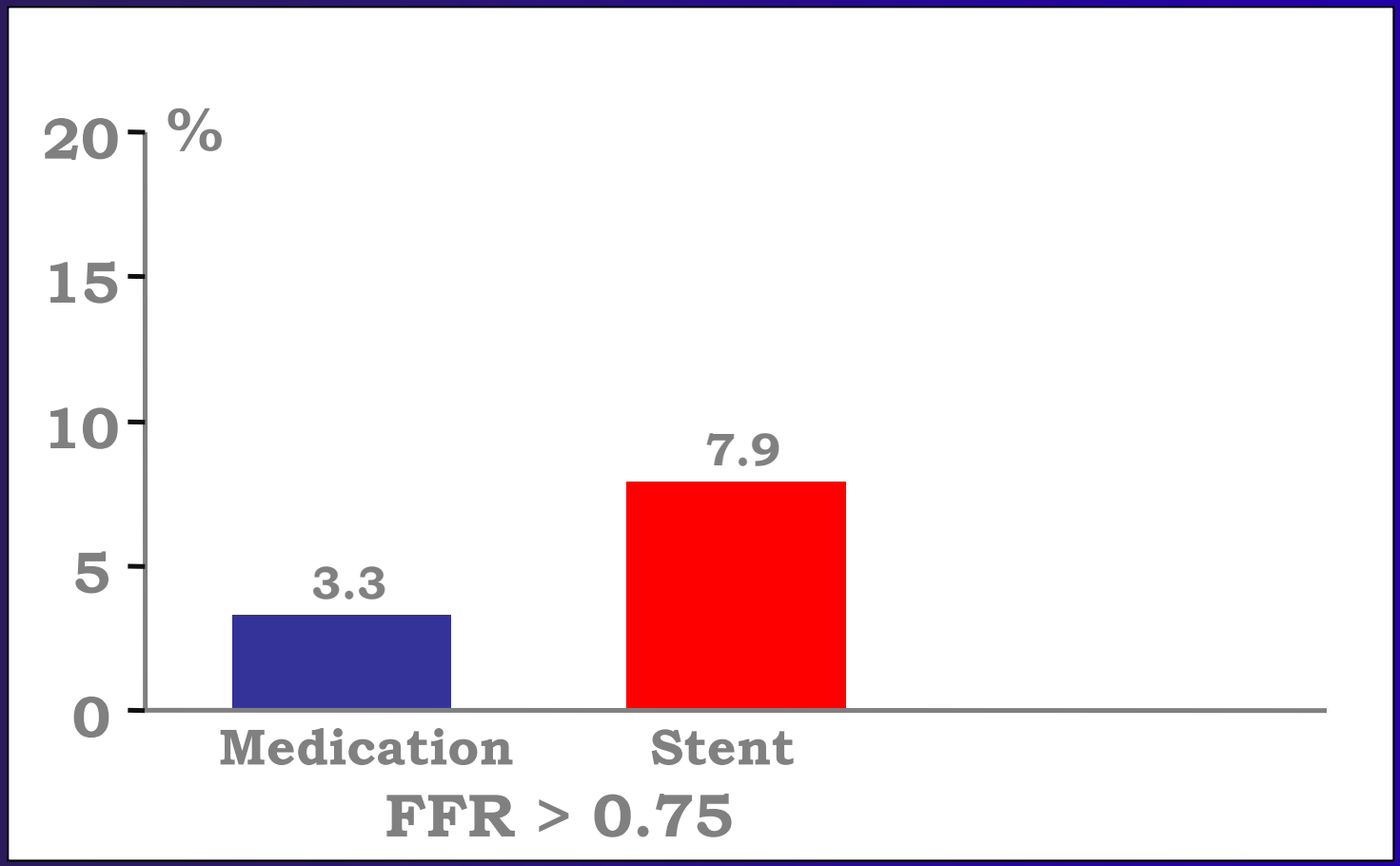
Functionally NON-significant stenoses

→ *a functionally non-significant stenosis ("non-ischemic stenosis") generally gives no complaints*

So, from the symptomatic point of view there is no reason to stent such lesion

Cardiac Death And Acute MI After 5 Years:

functionally non-significant stenoses



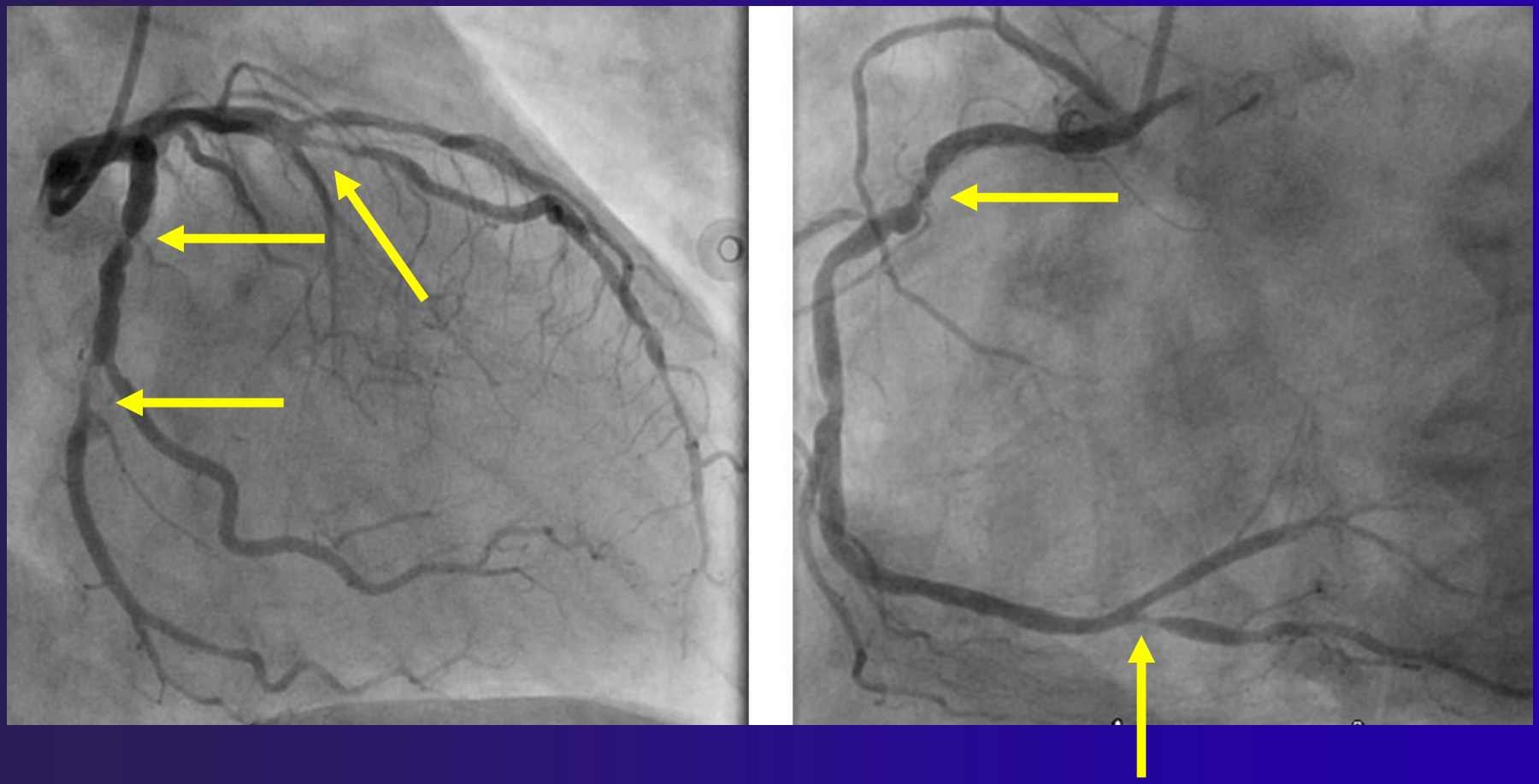
Defer, JACC, 2008

So, *functionally significant (= ischemic) lesions should be revascularized*, …..

……whereas it makes *no sense to stent non-ischemic lesions*

So, if we are able to accurately discriminate ischemic from non-ischemic lesions in MVD-patients we can selectively treat ischemic lesions by PCI and leave non-ischemic lesions for medical treatment

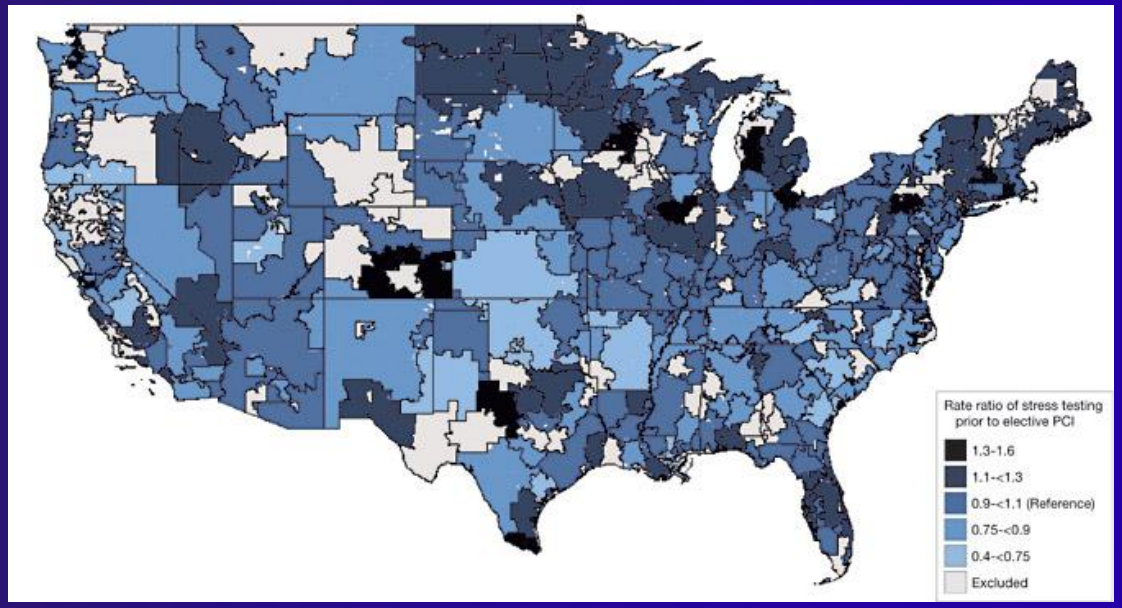
Particularly in MVD we often have insufficient information about stenosis-related myocardial ischem**ia**



Because …

Non-invasive tests aren't always performed pre-PCI

Only 44.5% (20.1% - 70.6%) of Medicare patients undergoing elective PCI, underwent stress-testing < 90 days before PCI



Lin et al. JAMA 2008

Because …

Non-invasive tests are frequently inaccurate in multivessel disease:

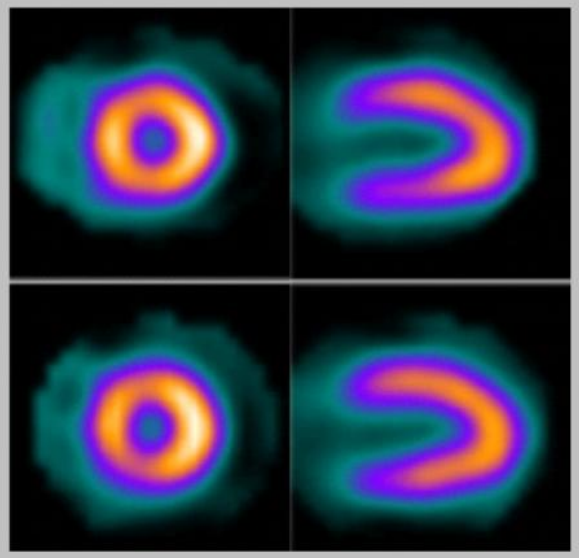
- ***Excercise test:***

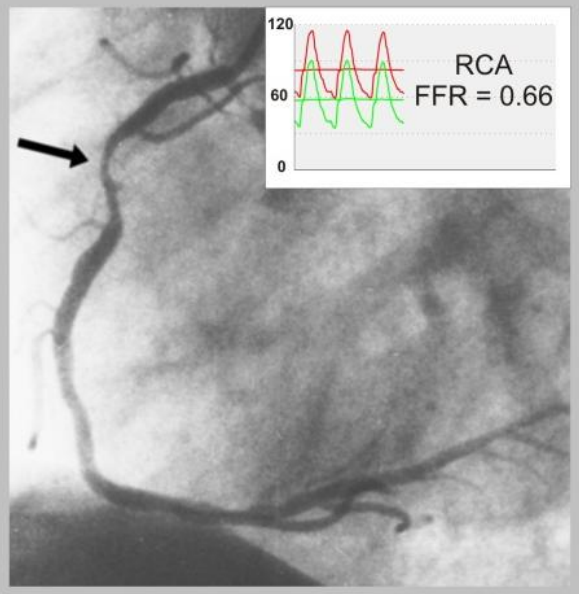
  non-conclusive, information per patient

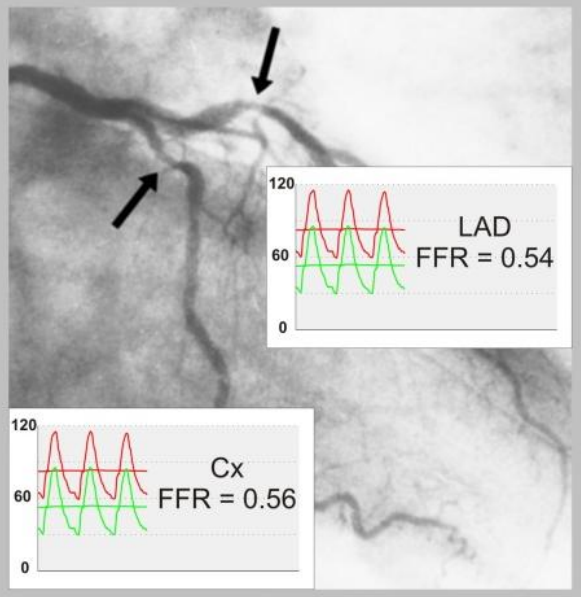
- ***Nuclear scan:***

  inaccurate in MVD *(balanced ischemia, serial stenosis)*

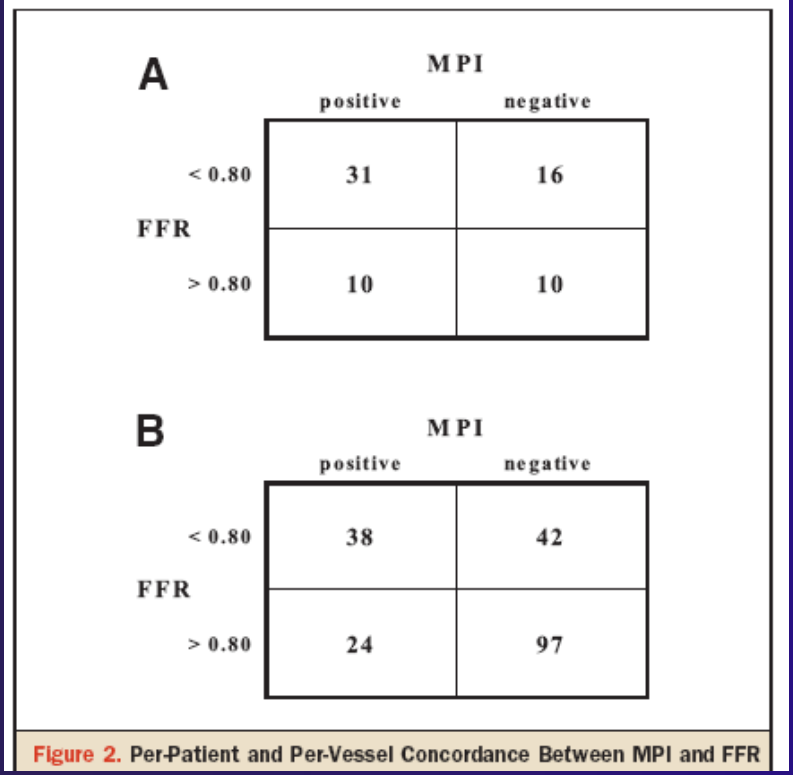
Balanced ischemia …







Nuclear imaging …. poorly discriminates in MVD



A

FFR	MPI positive	MPI negative
< 0.80	31	16
> 0.80	10	10

B

FFR	MPI positive	MPI negative
< 0.80	38	42
> 0.80	24	97

Figure 2. Per-Patient and Per-Vessel Concordance Between MPI and FFR

Poor concordance at a per-patient (n=67) and a per-vessel level

In 42% of pts. with angiographic 2- or 3VD, MPI and FFR identified identical ischemic territories

In 36% MPI underestimated ,and in 22% MPI overestimated the number of ischemic territories

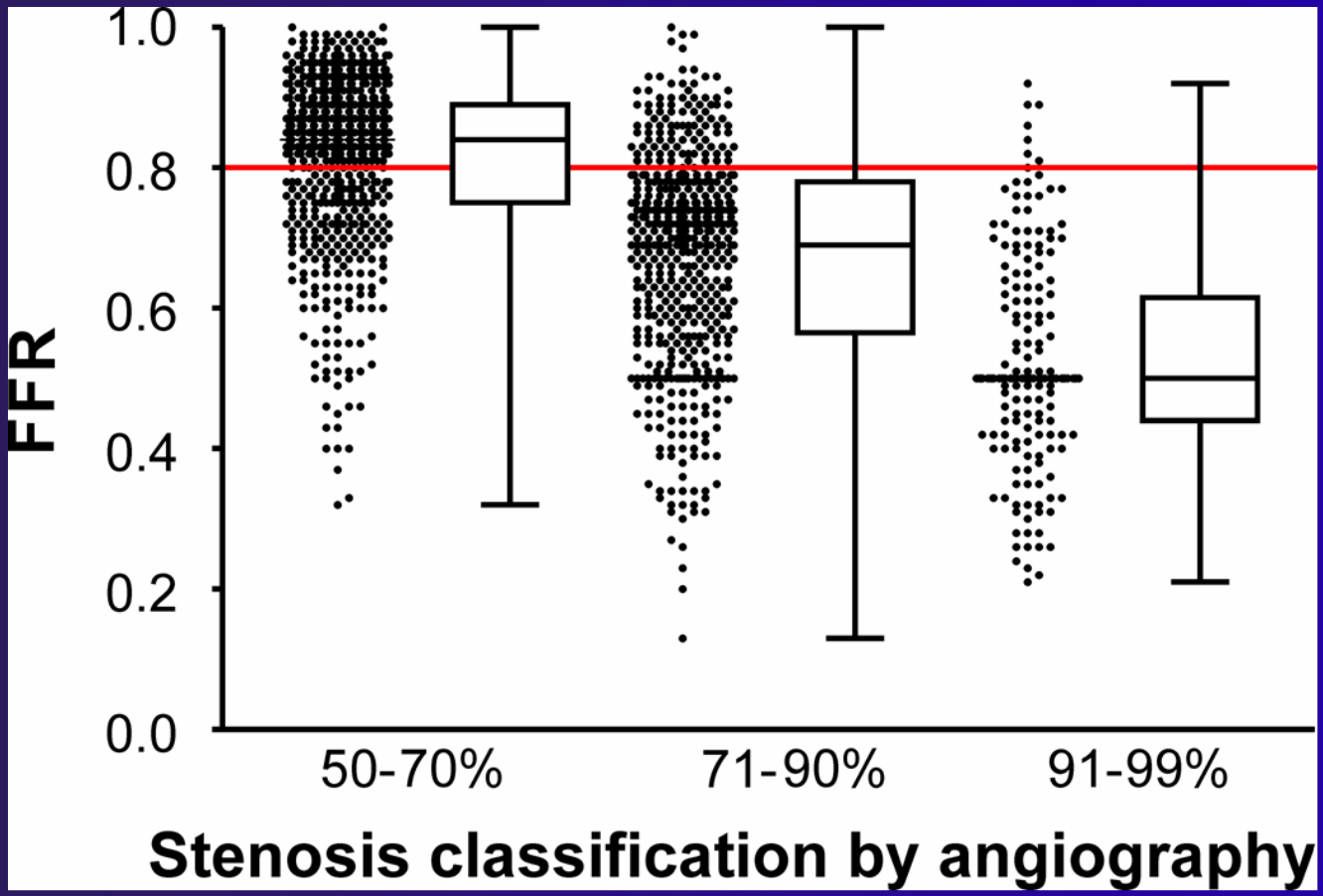
Melikian et al. J. Am. Coll. Cardiol. Intv. 2010;3;307-314

‘Until MPI more reliably identifies all physiologically significant stenoses in patients with multivessel CAD, FFR remains the gold standard for this important evaluation.’

George Beller commenting In JACC interventions on the article by Melikian et al. about comparison between FFR and MPI

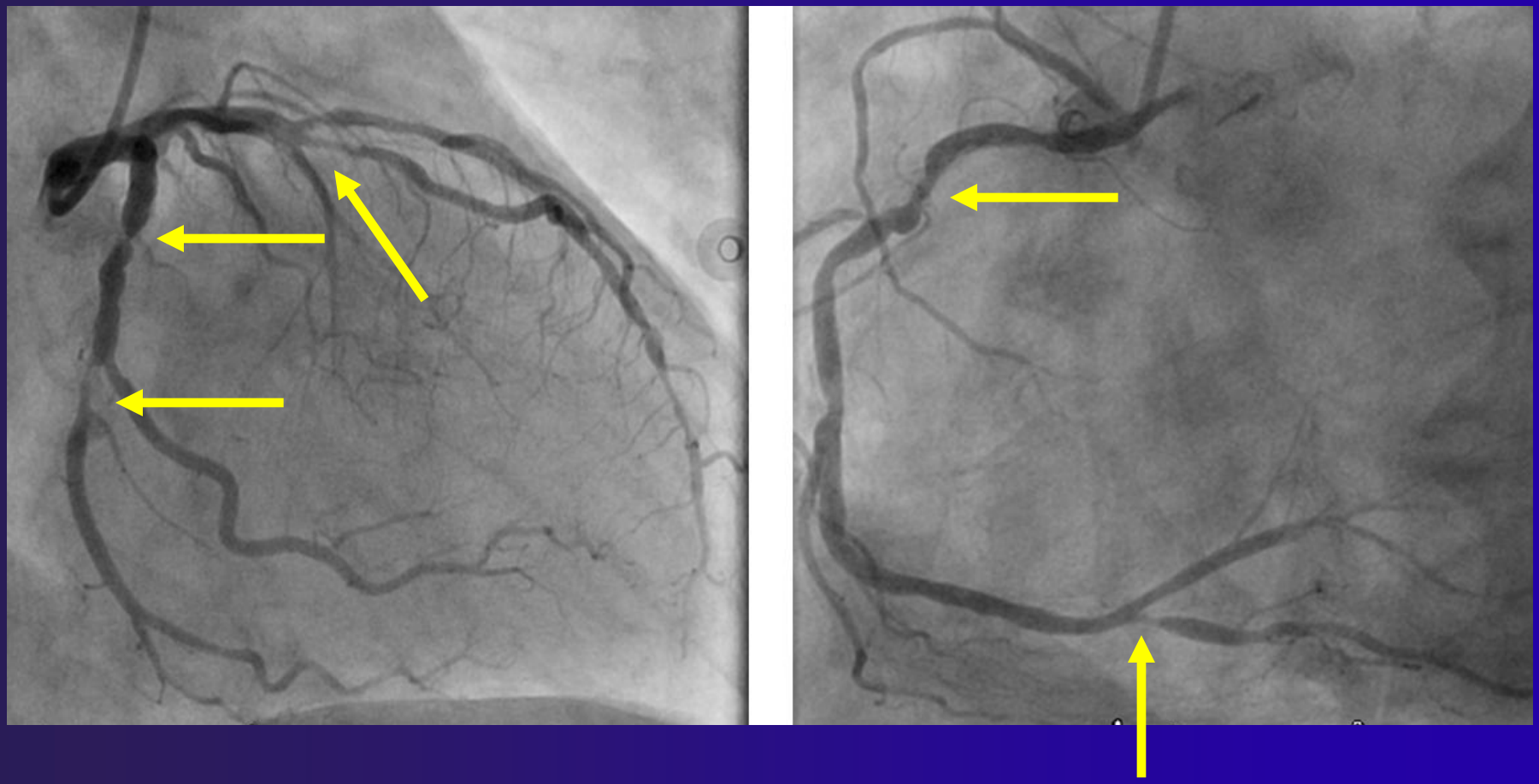
Because …

The angiogram poorly predicts presence of myocardial ischemia related to a specific coronary stenosis



Tonino et al., JACC, June 2010

For selective stenting of ischemic lesions in MVD… FFR is needed



However, …

- does it matter to selectively stent ischemic stenoses?
- does routine use of FFR in MVD impact prognosis?
- what about functional class?
- what about procedure time?

→ for testing such an FFR-guided PCI strategy a randomized trial is mandatory

Flow Chart FAME study

Lesions warranting PCI identified

FFR-Guided

PCI performed on indicated lesions only if FFR <0.80

Angio-Guided

PCI performed on indicated lesions

Randomized

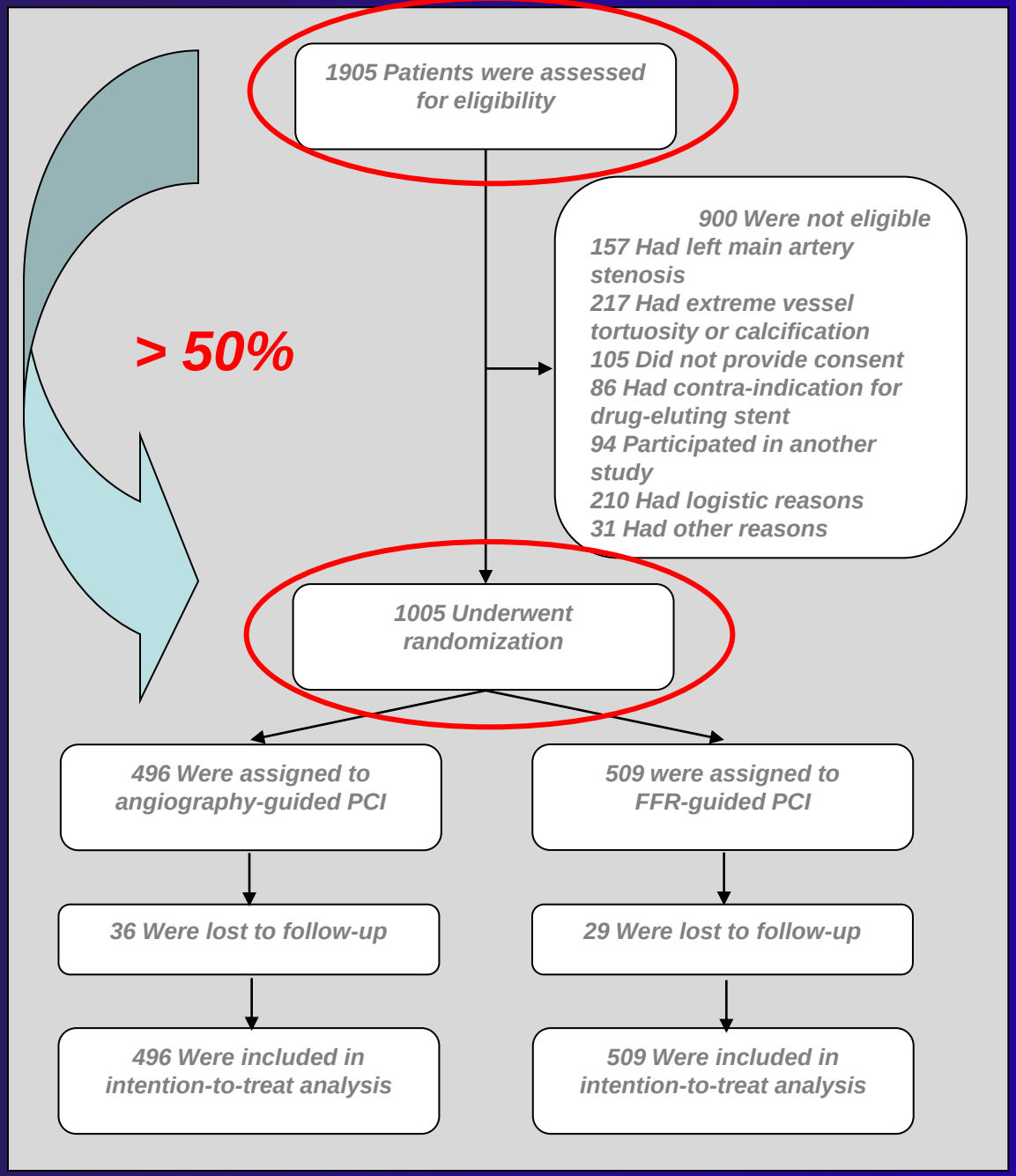
Primary Endpoint

Composite of death, MI and repeat revasc. (MACE) at 1 year

Key Secondary Endpoints

Individual rates of death, MI, and repeat revasc., MACE, and functional status at 2 years

Tonino et al. N Engl J Med. 2009


1905 Patients were assessed for eligibility
900 Were not eligible
157 Had left main artery stenosis
217 Had extreme vessel tortuosity or calcification
105 Did not provide consent
86 Had contra-indication for drug-eluting stent
94 Participated in another study
210 Had logistic reasons
31 Had other reasons
> 50%
1005 Underwent randomization
496 Were assigned to angiography-guided PCI
509 were assigned to FFR-guided PCI
36 Were lost to follow-up
29 Were lost to follow-up
496 Were included in intention-to-treat analysis
509 Were included in intention-to-treat analysis

Baseline Characteristics

	Angio-Guided n = 496	FFR-Guided n = 509	P Value
Age, mean ±SD	64±10	65±10	0.47
Male, %	73	75	0.30
Diabetes, %	25	24	0.65
Hypertension, %	66	61	0.10
Current smoker, %	32	27	0.12
Hyperlipidemia, %	73	72	0.62
Previous MI, %	**36**	**37**	**0.84**
NSTE ACS, %	**36**	**29**	**0.11**
Previous PCI , %	**26**	**29**	**0.34**
LVEF < 50% , %	27	29	0.47

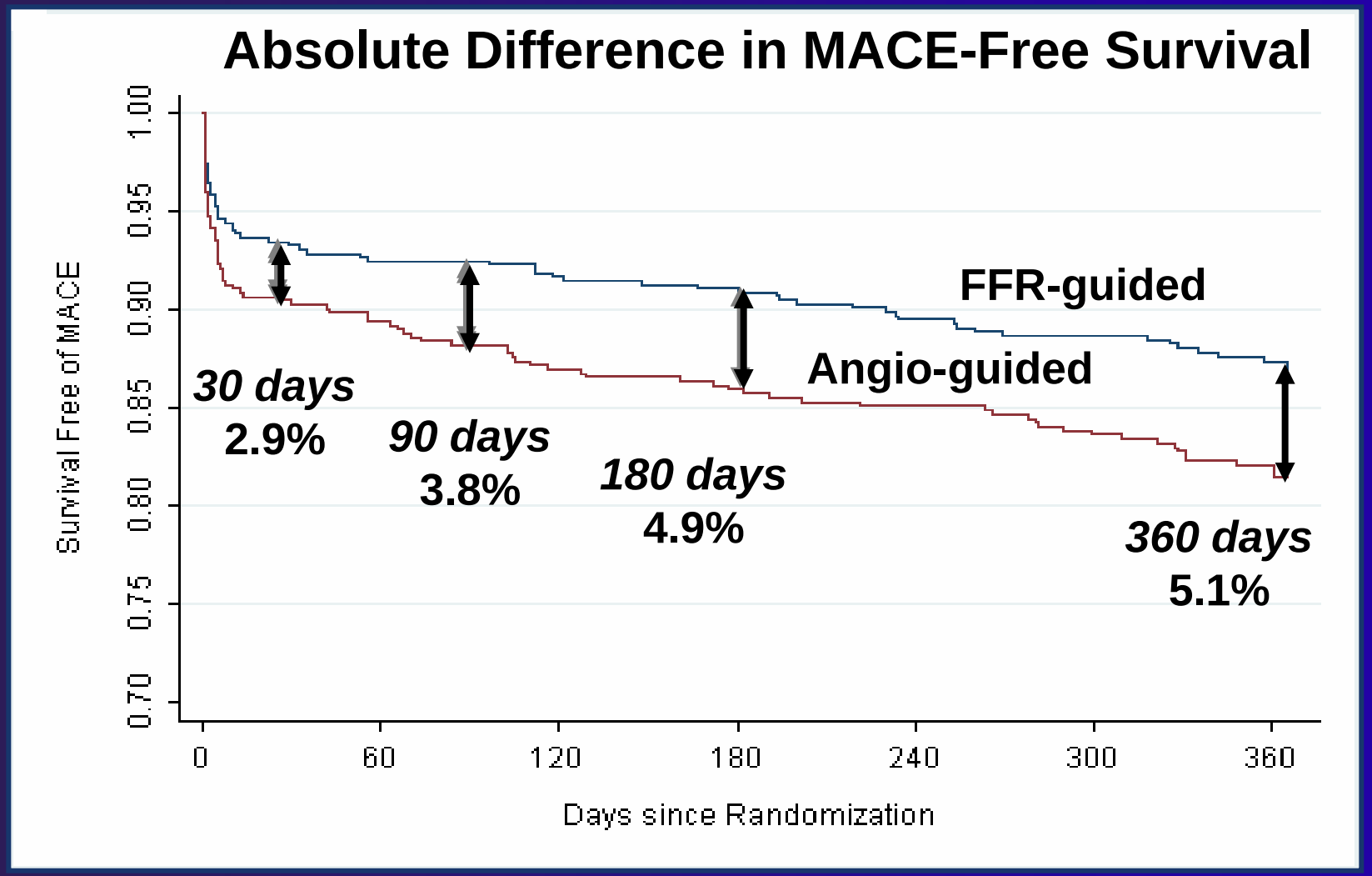
Tonino et al. N Engl J Med. 2009

Procedural Characteristics

	Angio-Guided n = 496	FFR-Guided n = 509	P Value
Indicated lesions / patient	2.7 ± 0.9	2.8 ± 1.0	0.34
Stents / patient	2.7 ± 1.2	1.9 ± 1.3	<0.001
Procedure time (min)	70 ± 44	71 ± 43	0.51
Contrast agent used (ml)	302 ± 127	272 ± 133	<0.001
Length of hospital stay (days)	3.7 ± 3.5	3.4 ± 3.3	0.05

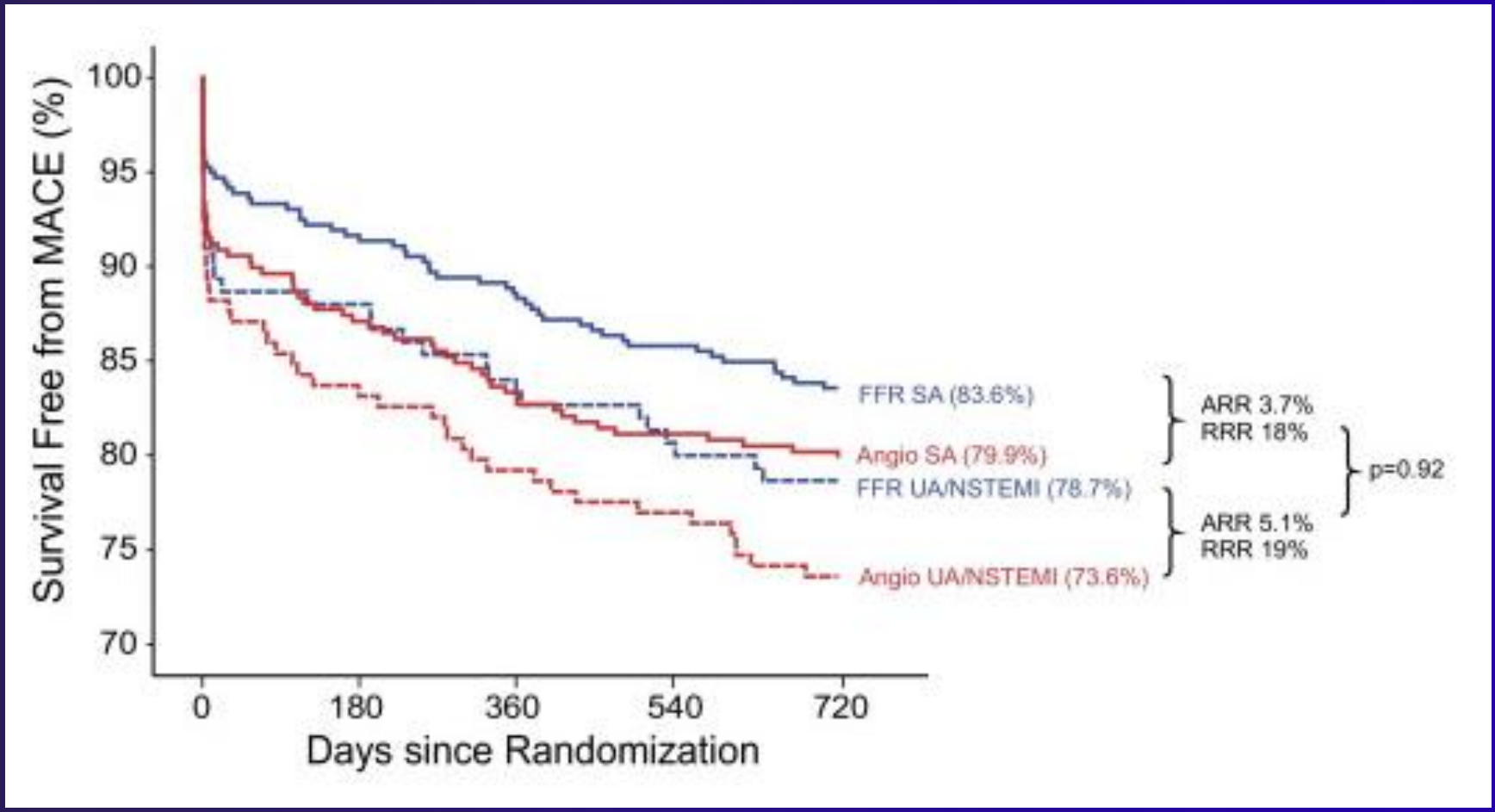
Tonino et al. N Engl J Med. 2009

1 year outcome



Tonino et al. N Engl J Med. 2009

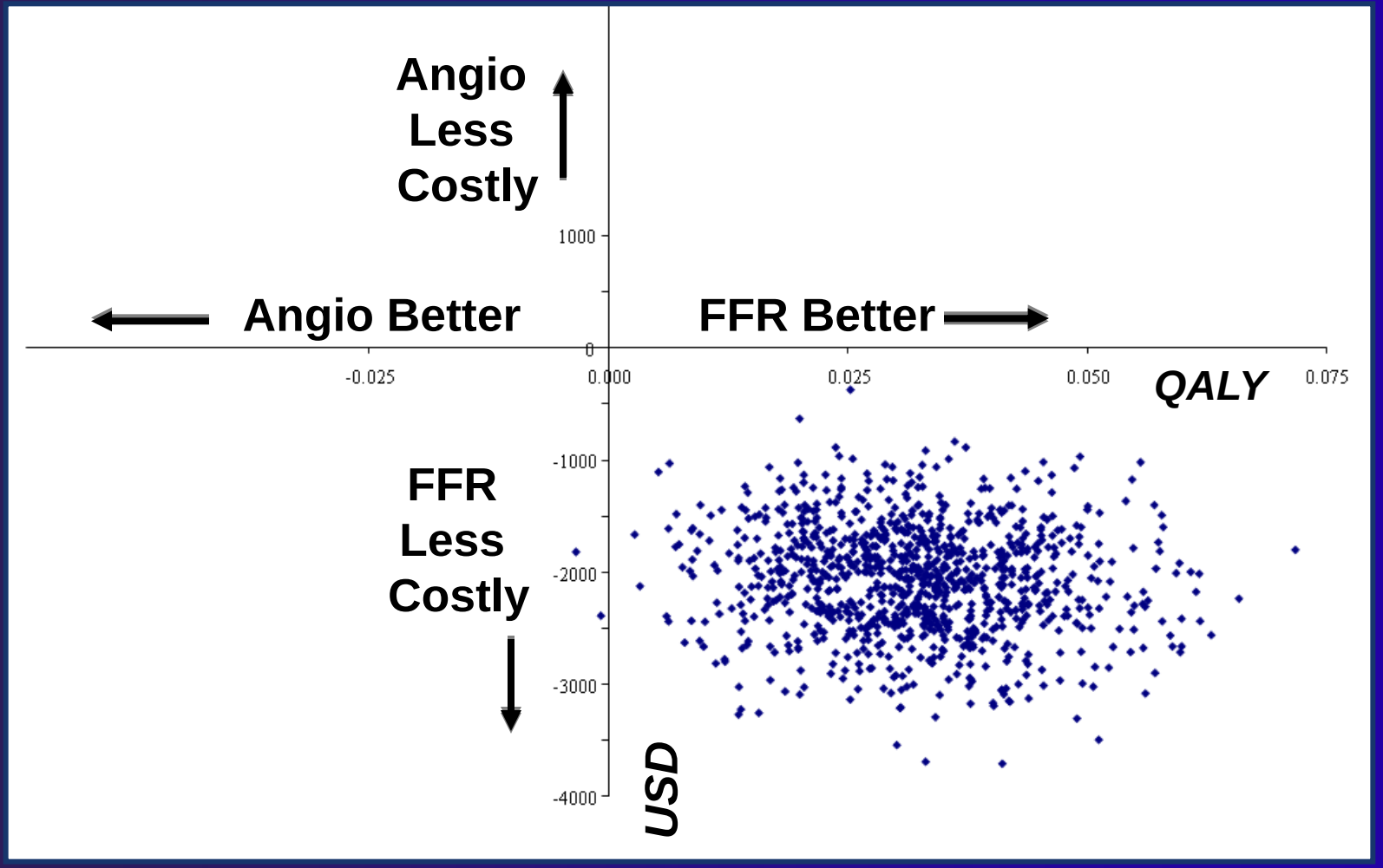
FAME:
Beneficial effect of FFR in stable angina *and* in ACS



Sels et al. JACC CV interventions 2011

Economic evaluation

Bootstrap Simulation



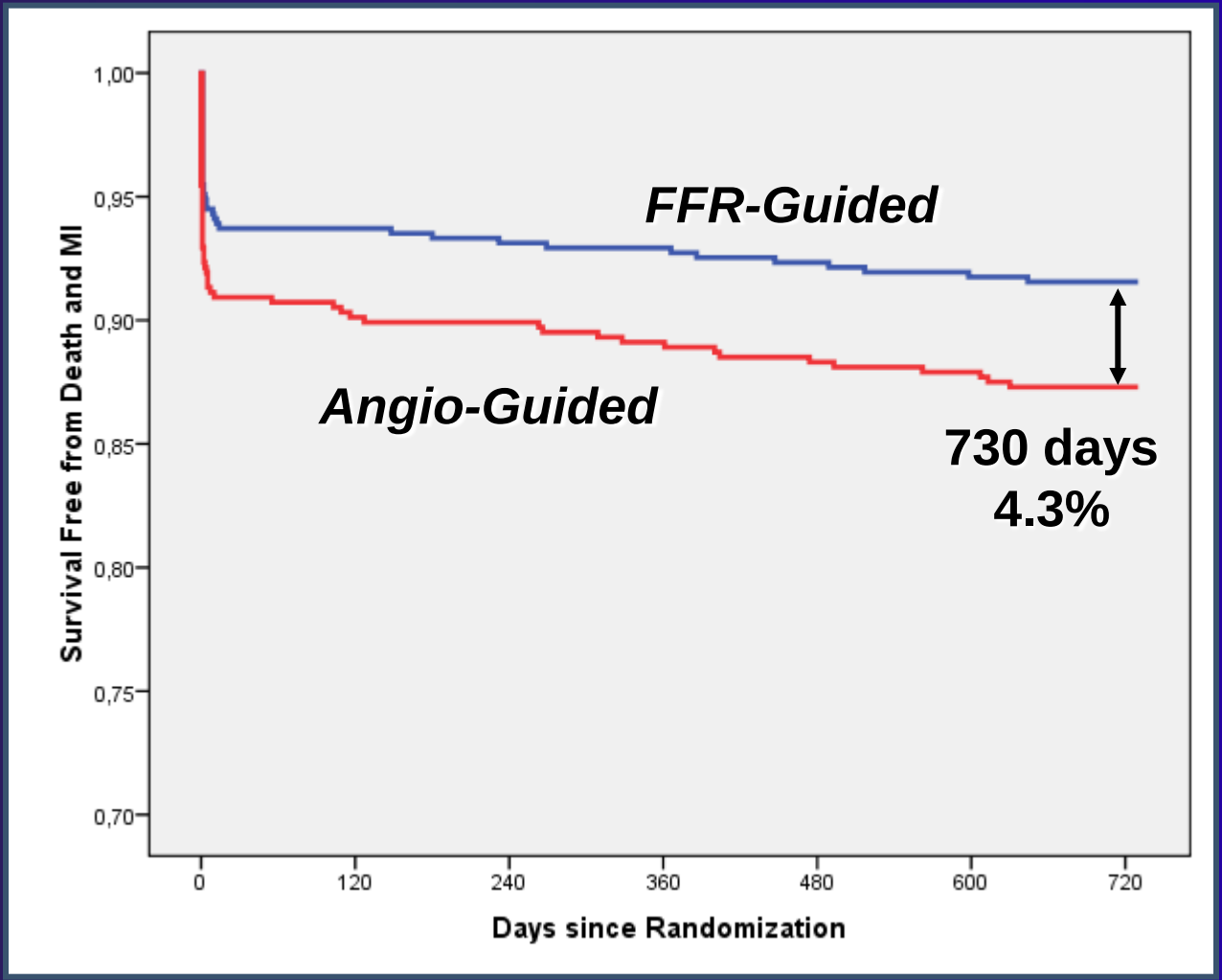
Fearon et al. Circulation, December, 2010

Adverse events after 2 years

	Angio-Guided n = 496	FFR-Guided n = 509	P Value
Individual Endpoints			
Death	**19 (3.8)**	**13 (2.6)**	**0.25**
Myocardial Infarction	**48 (9.7)**	**31 (6.1)**	**0.03**
CABG or repeat PCI	**61 (12.3)**	**53 (10.4)**	**0.35**
Composite Endpoints			
Death or Myocardial Infarction	**63 (12.7)**	**43 (8.4)**	**0.03**
Death, MI, CABG, or re-PCI	**110 (22.2)**	**90 (17.7)**	**0.07**

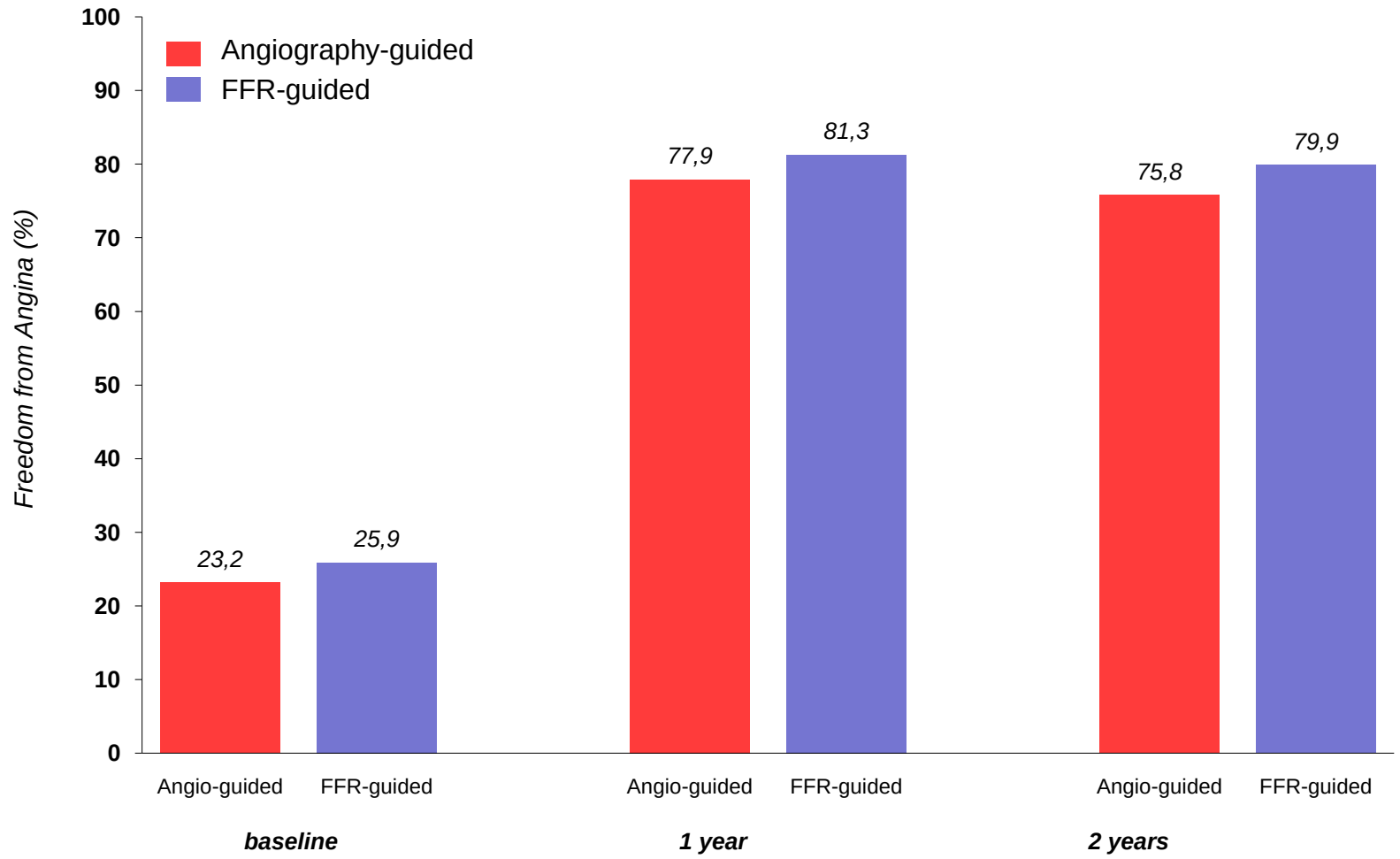
Pijls et al. JACC, 2010

2 year death or MI



Pijls et al., JACC, 2010

Freedom from angina



Pijls et al., JACC, 2010

Outcome of deferred lesions

513 Deferred Lesions in 509 FFR-Guided Patients

2 Years

31 Myocardial Infarctions → **22** Peri-procedural

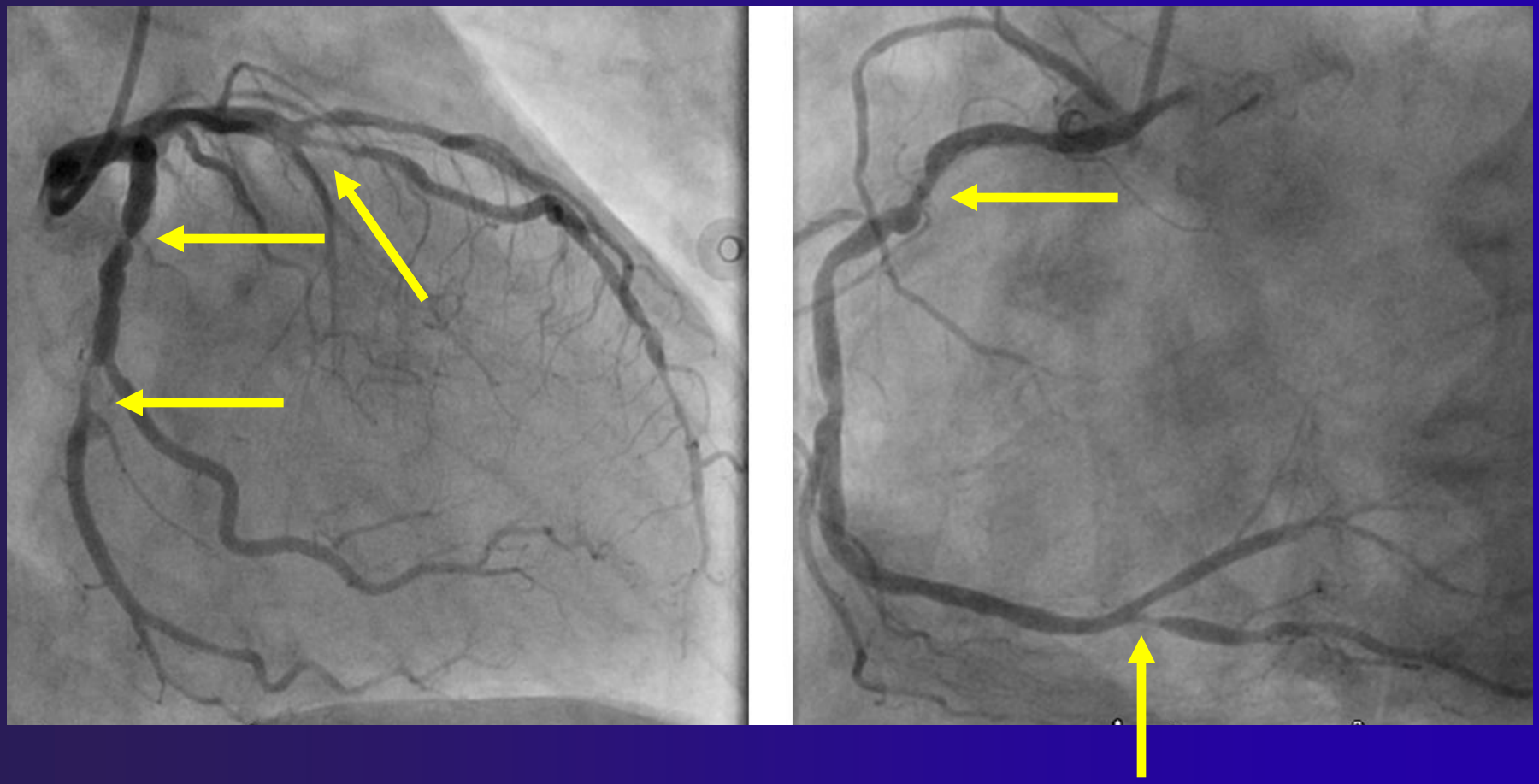
9 Late Myocardial Infarctions → **8** Due to a New Lesion or Stent Related

1 Myocardial Infarction due to an Originally Deferred Lesion

Only 1/513 or 0.2% of deferred lesions resulted in a late myocardial infarction

Pijls et al., JACC, July 2010

Angiographic multivessel disease



FFR now Class I Level A in ESC guidelines!

European Heart Journal
doi:10.1093/eurheartj/ehq277

ESC/EACTS GUIDELINES

Guidelines on myocardial revascularization

Table 33 Recommendations for specific percutaneous coronary intervention devices and pharmacotherapy

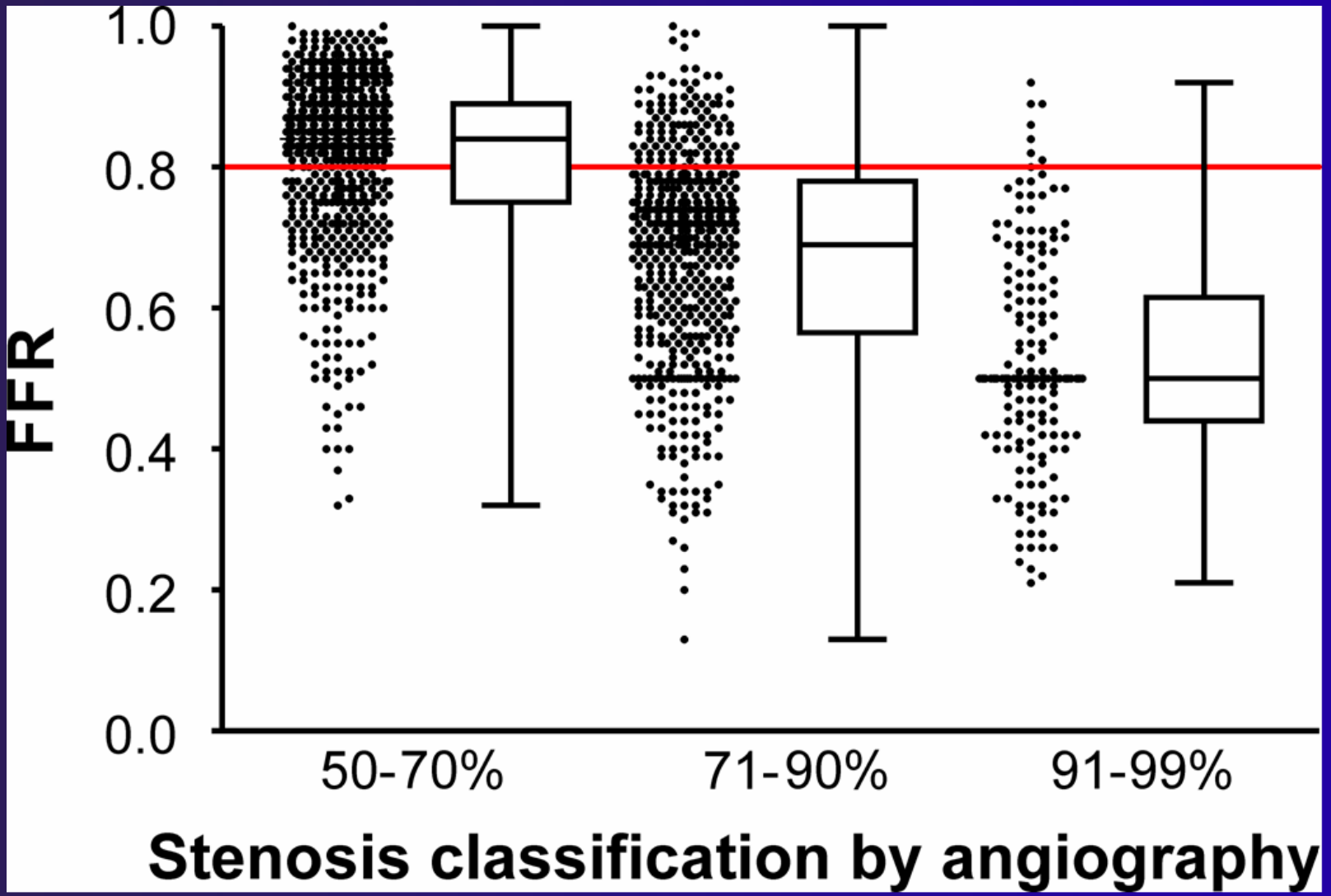
	Class[a]	Level[b]	Ref.[c]
FFR-guided PCI is recommended for detection of ischaemia-related lesion(s) when objective evidence of vessel-related ischaemia is not available.	I	A	15, 28
DES[d] are recommended for reduction of restenosis/re-occlusion if no contraindication to extended DAPT	I	A	45, 46,

Is FFR mandatory in all lesions in MVD?

FAME angiographic substudy:

FFR in MVD PCI in all stenoses of 50-90%

FFR – ischemic threshold 0.80



Tonino et al., JACC, 2010

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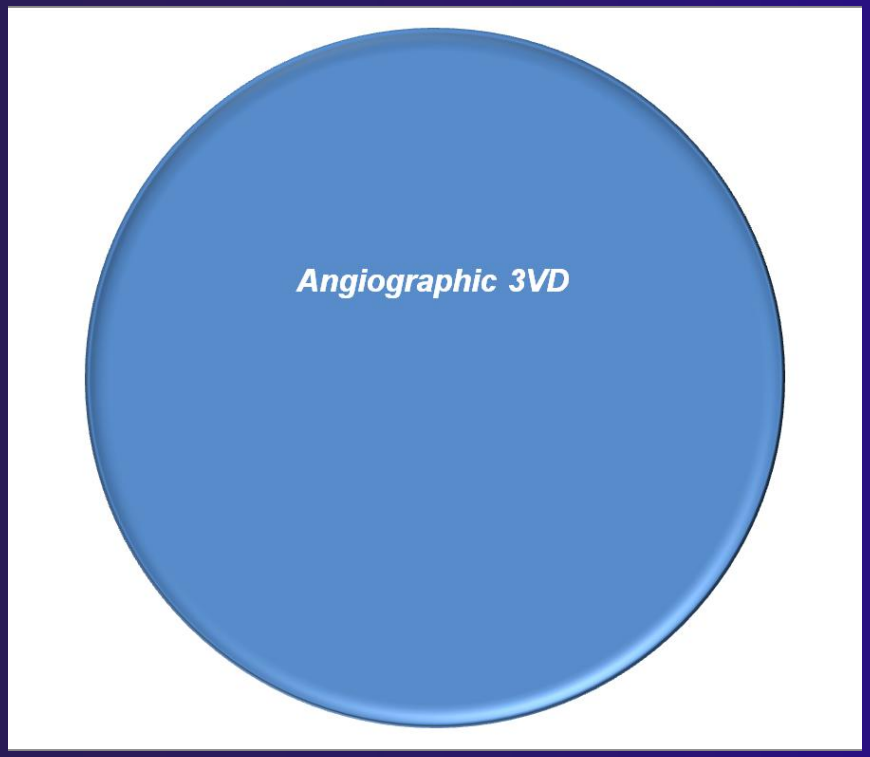
- FFR-guided revascularization in MVD improves outcome and lowers costs
- *FFR can be of help in clinical decision making in MVD: PCI or CABG?*

Angiography vs physiology in FAME: angiographic 3VD



Tonino et al., JACC, 2010

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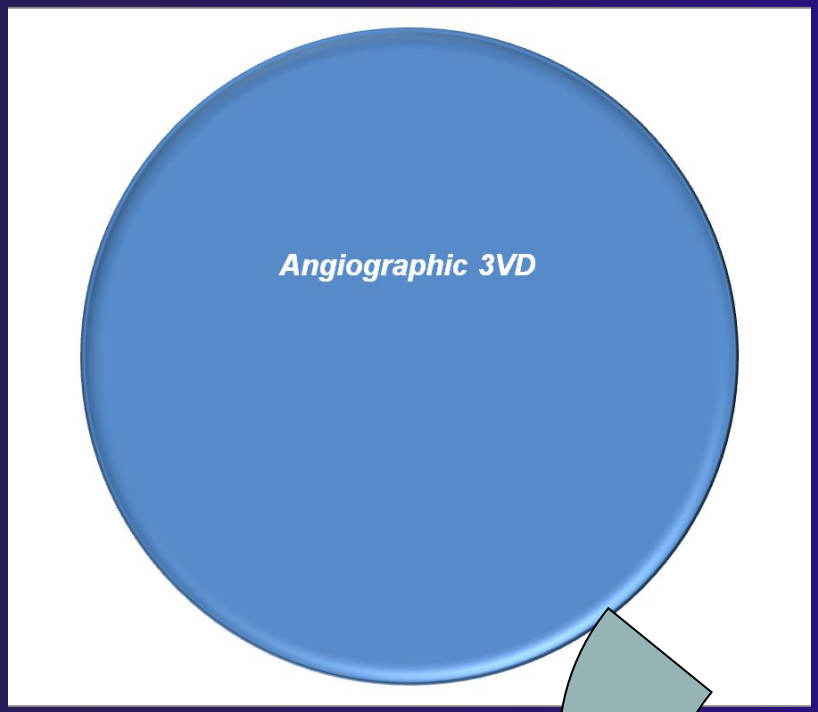
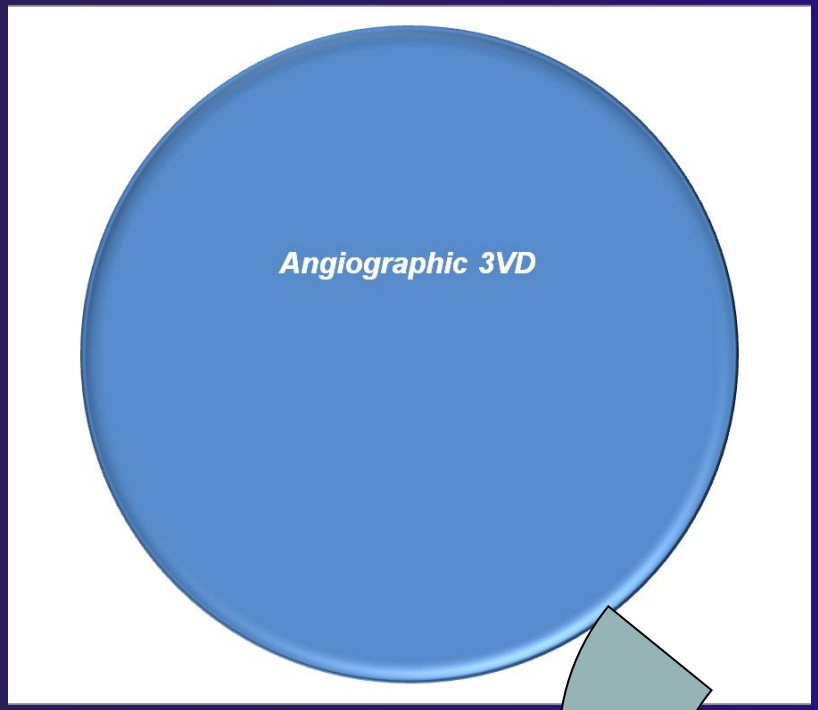


FFR of all 3 arteries

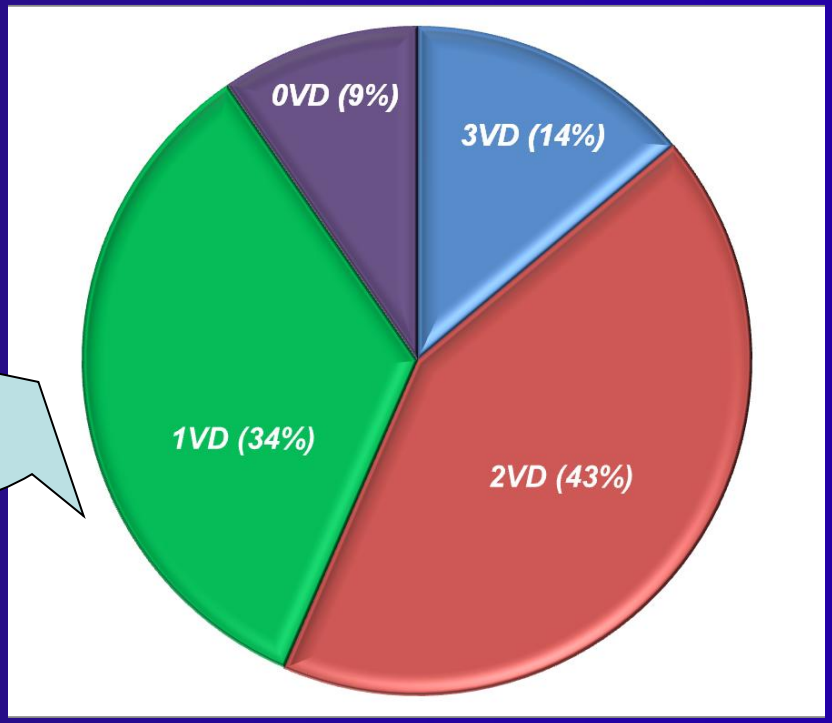
Tonino et al., JACC, 2010

Angiography vs physiology in FAME: angiographic 3VD



FFR of all 3 arteries

Angiographic 3VD becomes 'less disease' from a functional point of view



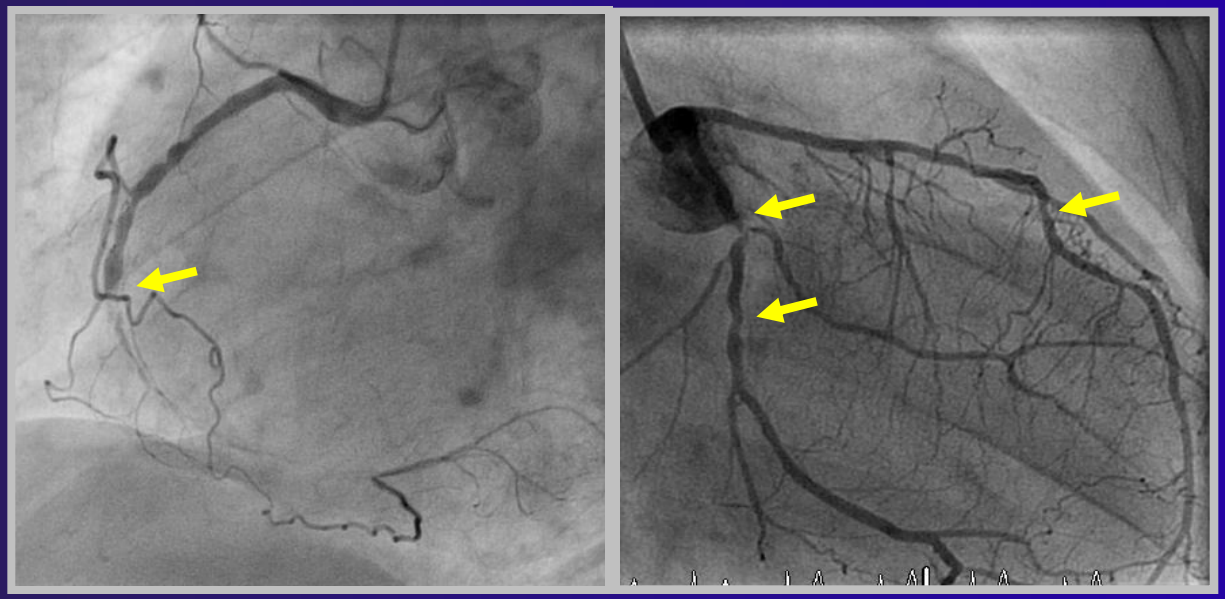
Tonino et al., JACC, 2010

FFR can be of great help in clinical decision making in MVD: PCI or CABG?

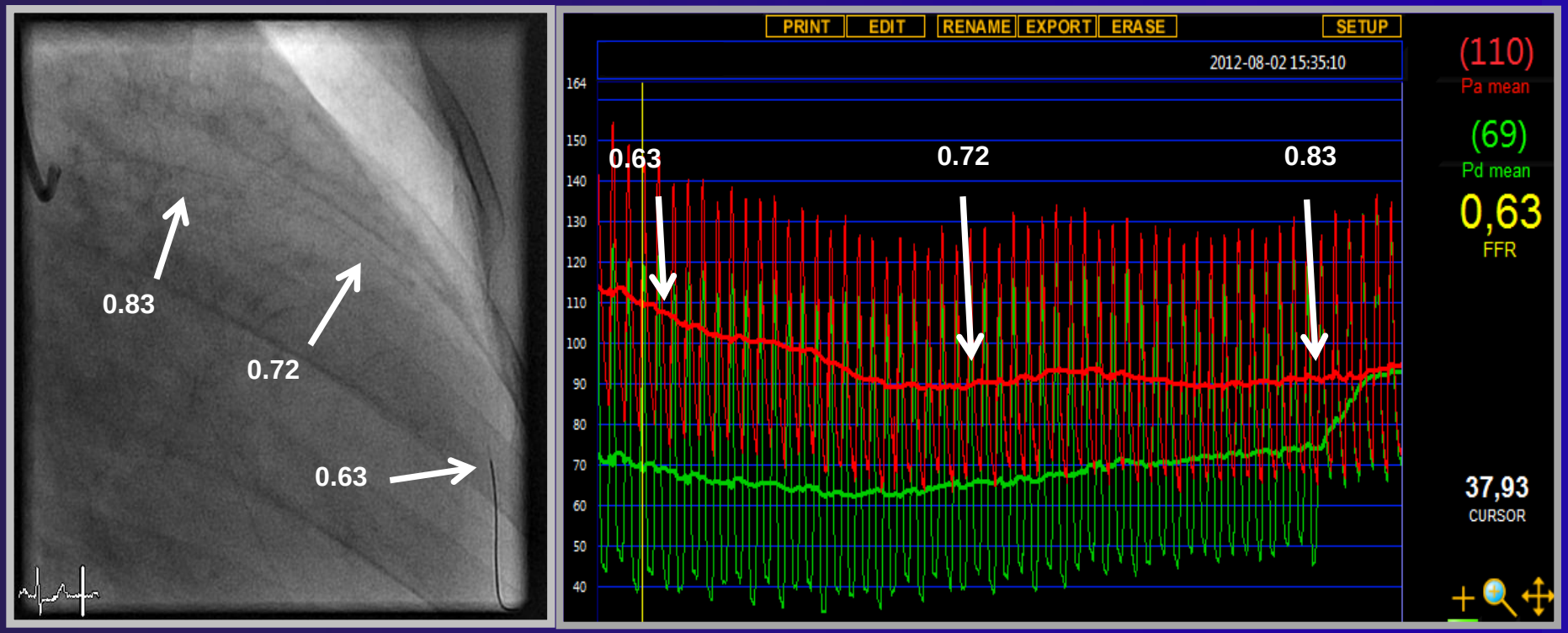
- ‘Downgrading’ angiographic 3VD with FFR to functional 2VD or 1VD might change revascularization strategy from CABG →PCI

Clinical decision: PCI or CABG?

- 4 stenoses
- Syntax score with LAD: 29 (intermediate tertile)
- Syntax score without LAD: 22 (low tertile)



FFR of LAD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2012-08-02 15:35:10
164
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120
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80
70
60
50
40
0.63
0.72
0.83
(110)
Pa mean
(69)
Pd mean
0,63
FFR
37,93
CURSOR

Notes from this case

- FFR can reduce angiographic 3VD
- Vice versa, FFR can reveal ischemia which is not revealed by anatomic assessment
- PCI of RCX and RCA would have left a large territory at risk
- Because of the diffuse disease in the LAD, the hartteam decided for CABG

Conclusions

Advantages of FFR in MVD .....

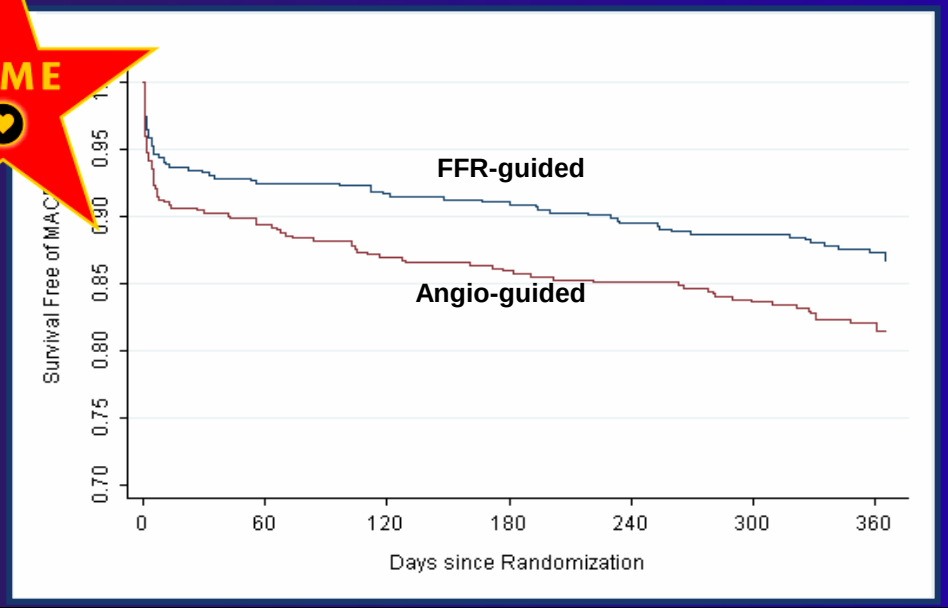
- FFR is the only way to accurately discriminate ischemic from non-ischemic lesions in MVD; not possible with any other diagnostic modality
- FFR-guided revascularization in MVD improves outcome and lowers costs
- FFR can be of help in clinical decision making in MVD: PCI or CABG?

FFR in MVD: future directions

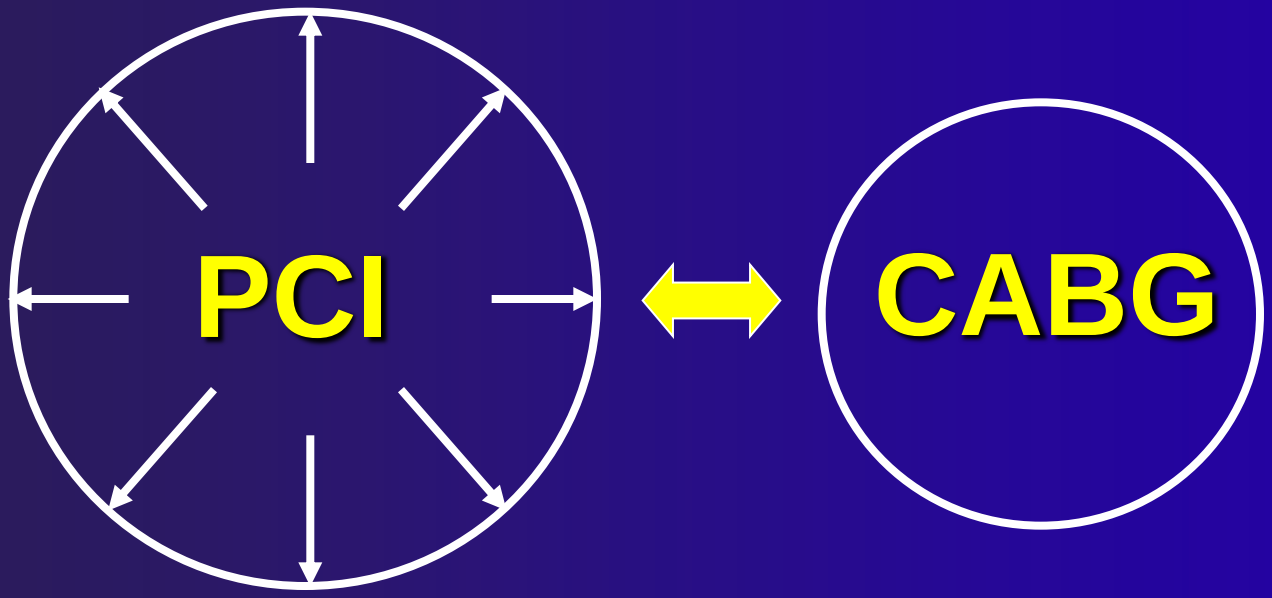
PCI ⟷ CABG

SYNTAX

FAME



FFR in MVD: future directions



What about FFR-guided PCI vs CABG??