

Sketch for FFR

: Basics, Artifacts, Pitfalls, and Grey Zones

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Which is a significant stenosis?

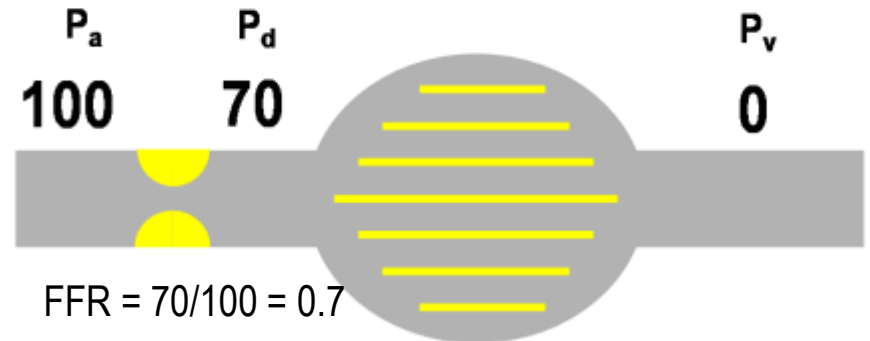
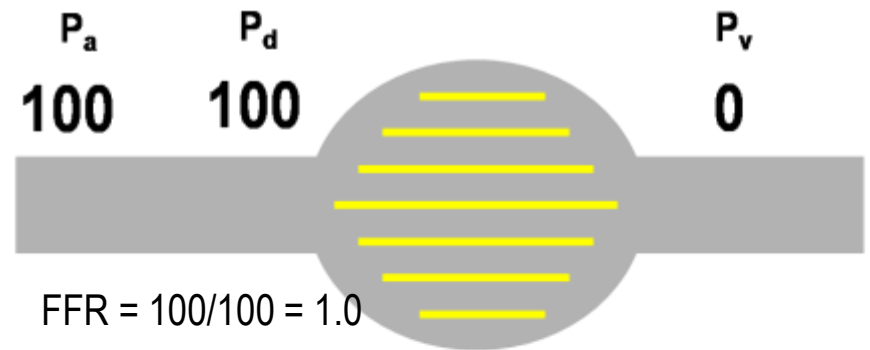
Anatomy vs. Ischemia

- Stenosis severity by CT, angiography, IVUS, OCT
- Extent of the perfusion territory
- Presence of myocardial infarction
- Myocardial blood flow including collaterals
- Microvascular function

→ ***Physiologic or functional evaluation***

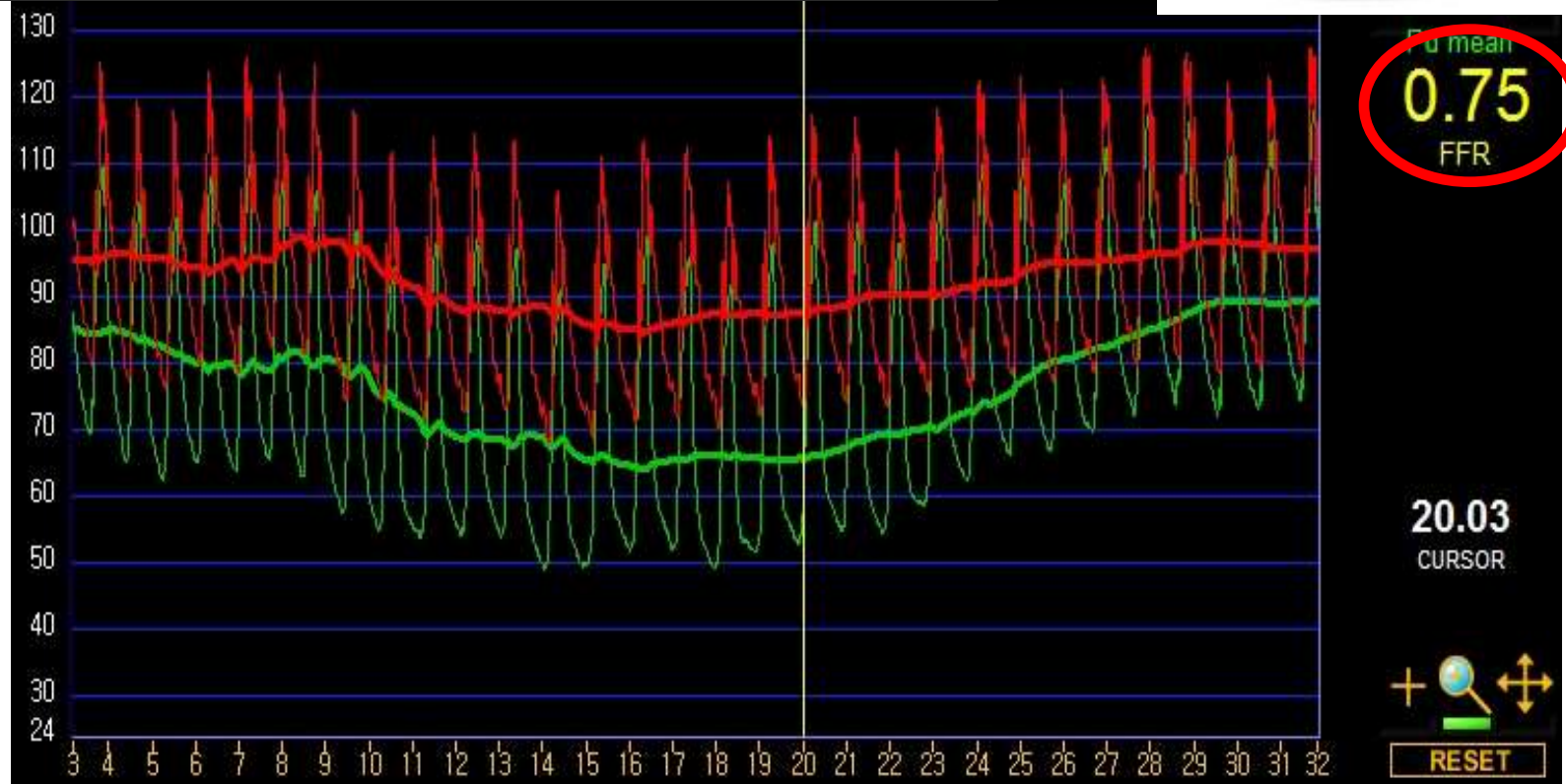
Fractional Flow Reserve (FFR)

$$\text{FFR} = \frac{\text{Maximum flow in presence of stenosis}}{\text{Normal maximum flow}} = \frac{Q_{max}^S}{Q_{max}^N} = \frac{(P_d - P_v)/R}{(P_a - P_v)/R} = \frac{\text{Distal Pr } (P_d)}{\text{Proximal Pr } (P_a)}$$

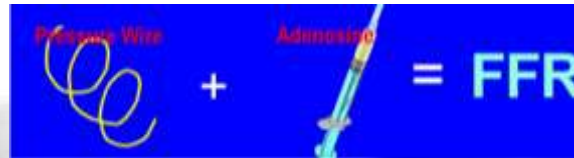


Fractional Flow Reserve

Easily obtained, Stenosis specific
Independent from the hemodynamic parameters
Applicable in multi-vessel disease, multiple lesions
Takes into account collateral flow



Which is a significant stenosis?



FFR vs. Myocardial ischemia



Overall results for FFR _{myo}	Percentage
Sensitivity	88 %
Specificity	100 %
Pos. Pred. Value	100 %
Neg. Pred. Value	88 %
Accuracy	93 %

All pts with FFR below 0.75 (21 pts) had inducible ischemia whereas in the majority, 87.5 % (21/24 pts) of patients with FFR higher than 0.75 ischemia could not be induced.

FFR for “Presence of ischemia”

Author	Number	Stress Test	BCV	Accuracy
Pijls et al.	60	Ex-ECG	0.74	97
De Bruyne et al.	60	Ex-ECG/SPECT	0.72	85
Pijls et al.	45	Ex-ECG/SPECT/DSE	0.75	93
Bartunek et al.	37	DSE	0.68	90
Abe et al.	46	SPECT	0.75	91
Chamuleau et al.	127	SPECT	0.74	77
Caymaz et al.	40	SPECT	0.76	95
Jimenez-Navarro et al.	21	DSE	0.75	90
Usui et al.	167	SPECT	0.75	79
Yanagisawa et al.	167	SPECT	0.75	76
Meuwissen et al.	151	SPECT	0.74	85
DeBruyne et al.	57	MIBI-SPECT post-MI	0.78	85
Samady et al.	48	MIBI-SPECT post-MI	0.78	85

Interventional Cardiol

Long-Term Clinical
Outcome After Fractional Flow
Reserve-Guided Percutaneous Coronary
Intervention in Patients With Multivessel Disease

Alexandre Berger, MD,* Kees-Joost Botman, MD,* Philip A. MacCarthy, MD, PhD, MRCP,*
William Wijns, MD, PhD,* Jozef Bartunek, MD, PhD,* Guy R. Heyndrickx, MD, PhD,*
Nico H. J. Pijls, MD, PhD,† Bernard De Bruyne, MD, PhD*
Aalst, Belgium; and Eindhoven, the Netherlands

Clinical Significance of Fractional Flow
Reserve for Evaluation of Functional
Lesion Severity in Stent Restenosis and
Native Coronary Arteries*

Stefan Krüger, MD; Karl-Christian Koch, MD; Ira Kaumanns, MD;
Marc W. Merx, MD; Peter Hawrath, MD; and Rainer Hoffmann, MD

Interventional Cardiology

Clinical outcome in patients with intermediate
equivocal left main coronary artery disease after
deferral of surgical revascularization on the basis of
fractional flow reserve measurements

Michael Lindstaedt, MD,¹ Aydan Yazar, MD,² Alfried Germing, MD,³ Markus K. Fritz, MD,⁴
Tim Holland-Letz, MSc,⁵ Andreas Mügge, MD,⁶ and Waldemar Bojara, MD³ *Bochum, Germany*

Coronary Pressure Measurement After Stenting Predicts
Adverse Events at Follow-Up
A Multicenter Registry



Nico H.J. Pijls, MD, PhD; Volker Klauss, MD; Uwe Siebert, MPh, MSc; Eric Powers, MD;
Kenji Takazawa, MD; William F. Fearon, MD; Javier Escaned, MD; Yukio Tsurumi, MD;
Takashi Akasaka, MD; Habib Samady, MD; Bernard De Bruyne, MD, PhD;
for the Fractional Flow Reserve (FFR) Post-Stent Registry Investigators

Reliability of Pressure-Derived Myocardial Fractional
Flow Reserve in Assessing Coronary Artery Stenosis in
Patients With Previous Myocardial Infarction

Yasuhiro Usui, MD, Taishiro Chikamori, MD, Hidefumi Yanagisawa, MD,
Takayuki Morishima, MD, Satoshi Hida, MD, Nobuhiro Tanaka, MD,
Kenji Takazawa, MD, and Akira Yamashina, MD

Physiologic Assessment of Jailed Side
Branch Lesions Using Fractional Flow Reserve

Bon-Kwon Koo, MD, PhD,* Hyun-Jai Kang, MD, PhD,* Tae-Jin Youn, MD, PhD,†
In-Ho Chae, MD, PhD,† Dong-Joo Choi, MD, PhD,† Hyo-Soo Kim, MD, PhD,*
Dae-Won Sohn, MD, PhD,* Byung-Hee Oh, MD, PhD, FACC,*
Myoung-Mook Lee, MD, PhD, FACC,* Young-Bae Park, MD, PhD,*
Yun-Shik Choi, MD, PhD* *Seoul, Seoul, Gyeonggi-*

Seoul, Seongnam, Gyeonggi-

Physiological evaluation of the provisional
side-branch intervention strategy for bifurcation
lesions using fractional flow reserve

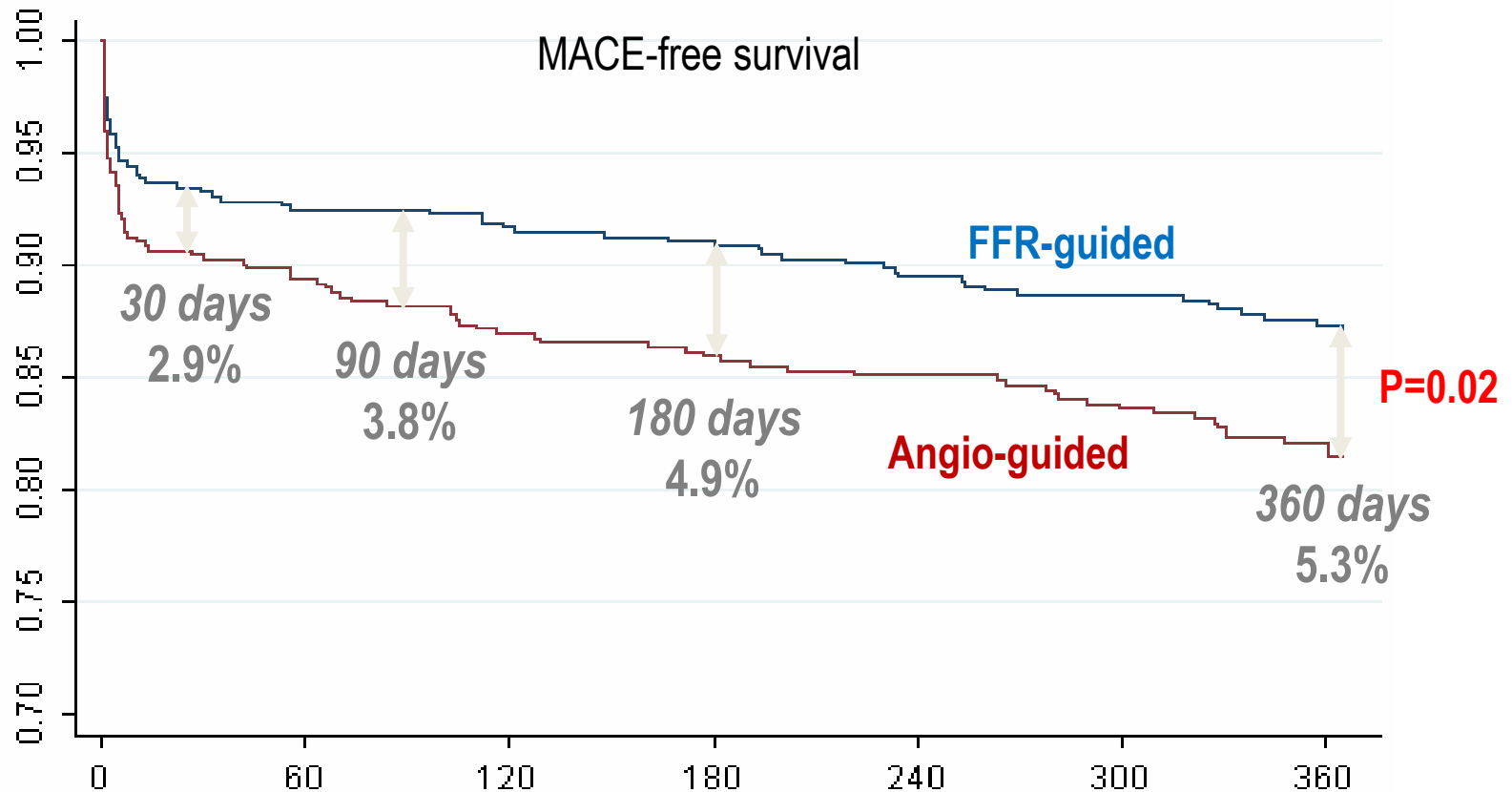
Bon-Kwon Koo¹, Kyung-Woo Park¹, Hyun-Jae Kang¹, Young-Seok Cho²,
Woo-Young Chung², Tae-Jin Youn², In-Ho Chae², Dong-Ju Choi², Seung-Jae Tahk¹,
Byung-Hee Oh¹, Young-Bae Park¹ and Hyo-Soo Kim^{1*}

¹Division of Cardiology, Department of Internal Medicine, Seoul National University College of Medicine, Cardiovascular Center and Cardiovascular Research Institute, Seoul National University Hospital, Yongon-dong 51, Yongsong-gu, Seoul 151-747, Republic of Korea; ²Heart Center, Samsung Seoul National University Hospital, Gyeonggi-do, Republic of Korea; and ³Seoul National University School of Medicine, Gyeonggi-do, Republic of Korea

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FAME - I

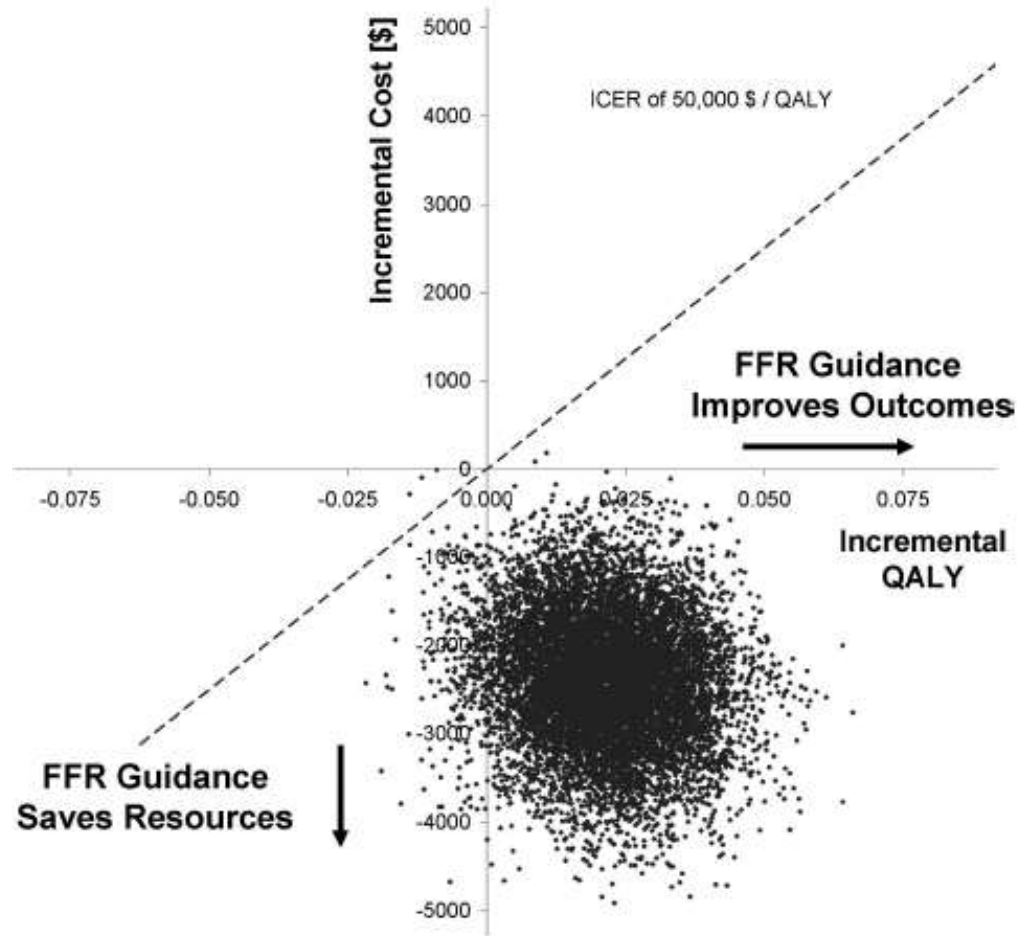
FFR vs. Angio-guided DES for multivessel disease



MACE: Death, MI, re-PCI, CABG

Tonino, NEJM 2009

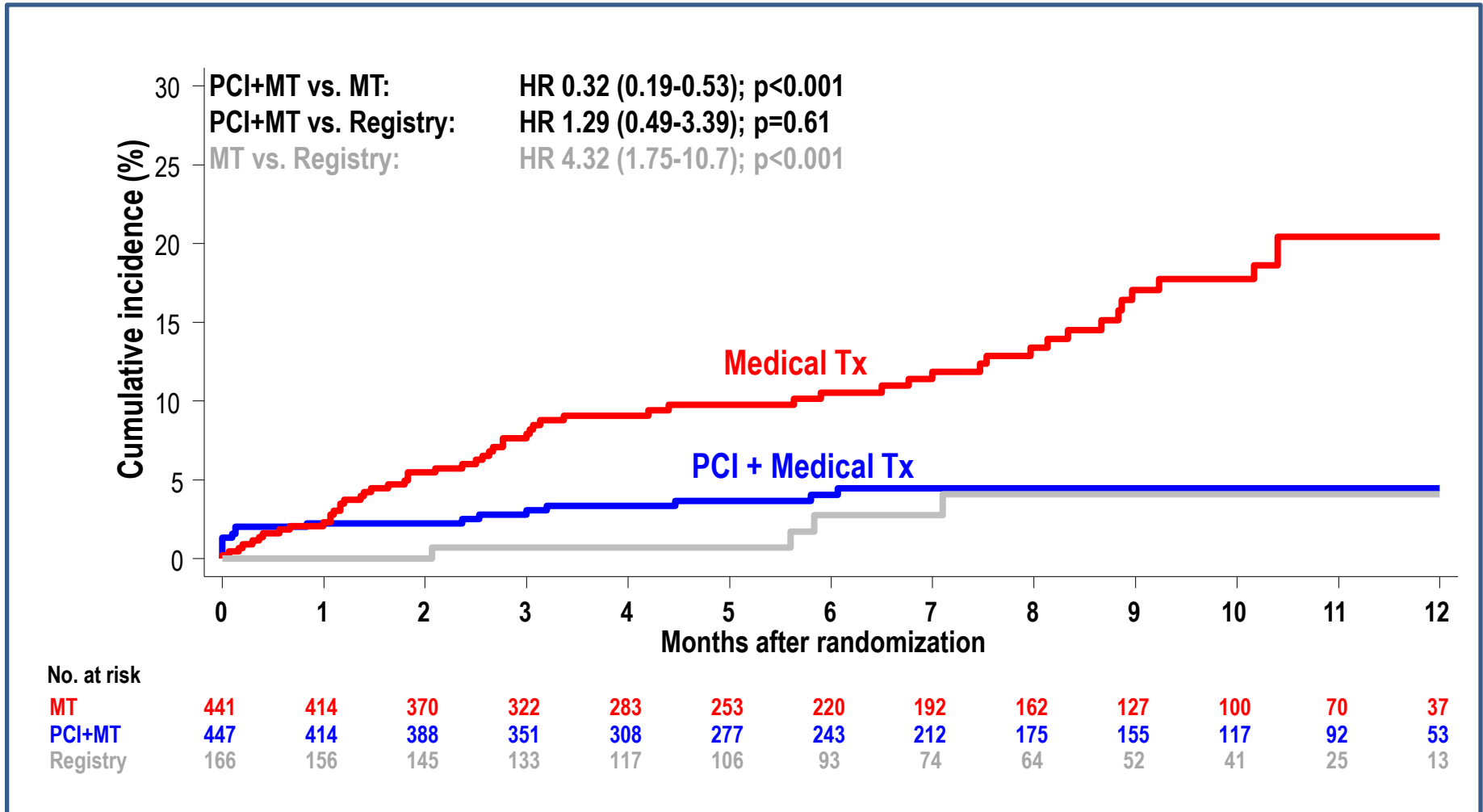
FAME study: Cost-effectiveness



Fearon, et al. Circulation 2010

FAME - II

FFR-guided DES vs. Medical tx for ischemic lesion



Primary outcomes: all death, nonfatal MI and urgent revascularization

FFR has become the gold standard invasive method to detect the ischemia-related lesion in a catheterization laboratory.....



European Heart Journal (2010) 31, 2501–2555
doi:10.1093/eurheartj/ehq377

ESC/EACTS GUIDELINES

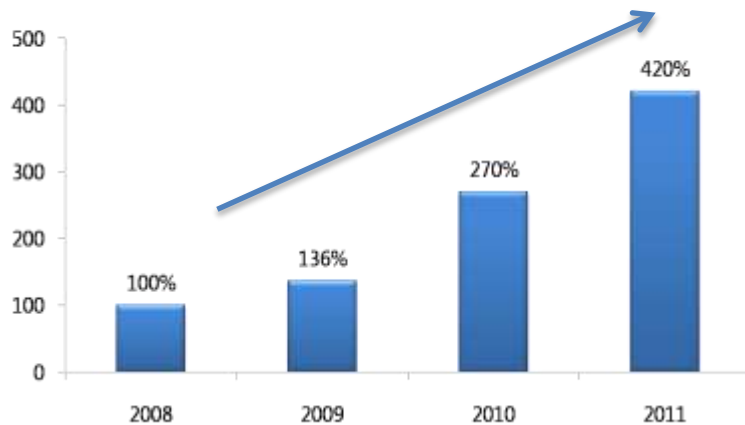


Guidelines on myocardial revascularization

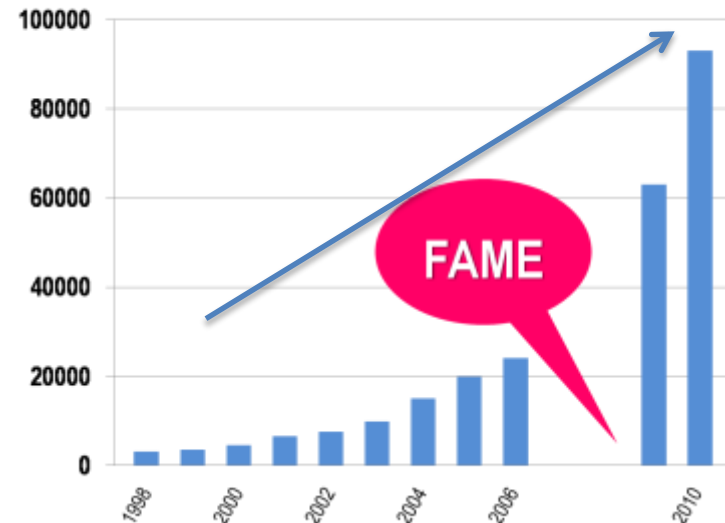
The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

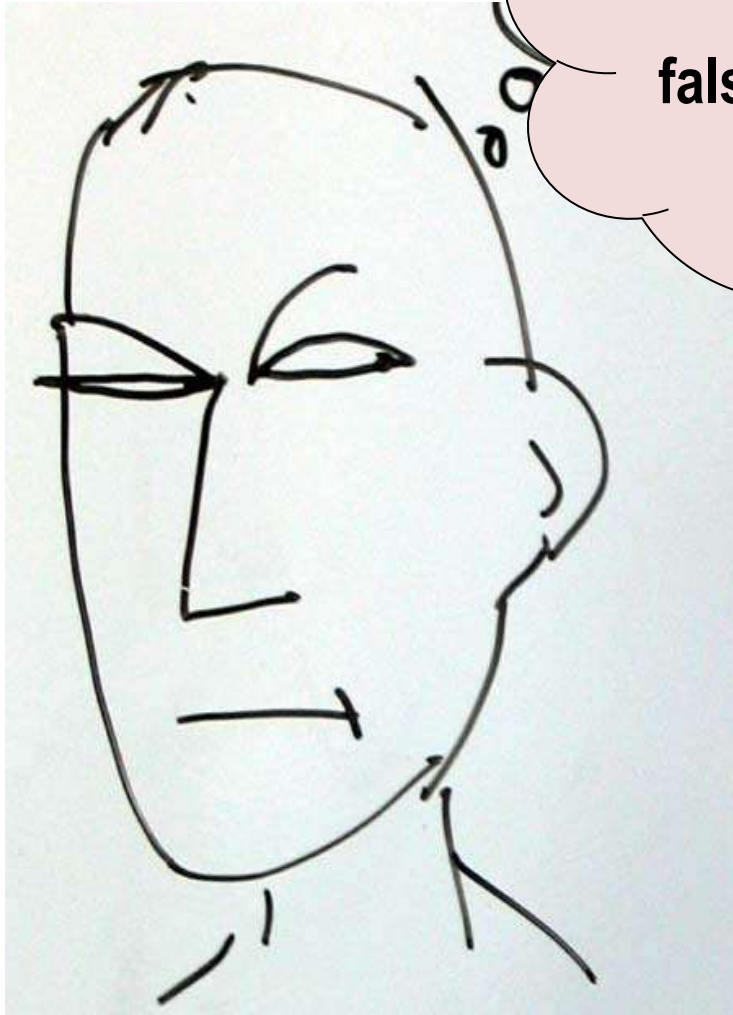
	Class ^a	Level ^b
FFR-guided PCI is recommended for <u>detection of ischaemia-related lesion(s)</u> when objective evidence of vessel-related ischaemia is not available.	I	A
DES ^d are recommended for reduction of restenosis/re-occlusion, if no contraindication to extended DAPT.	I	A
Distal embolic protection is recommended during PCI of SVG disease to avoid distal embolization of debris and prevent MI	I	B

FFR market in Korea



FFR market in EU



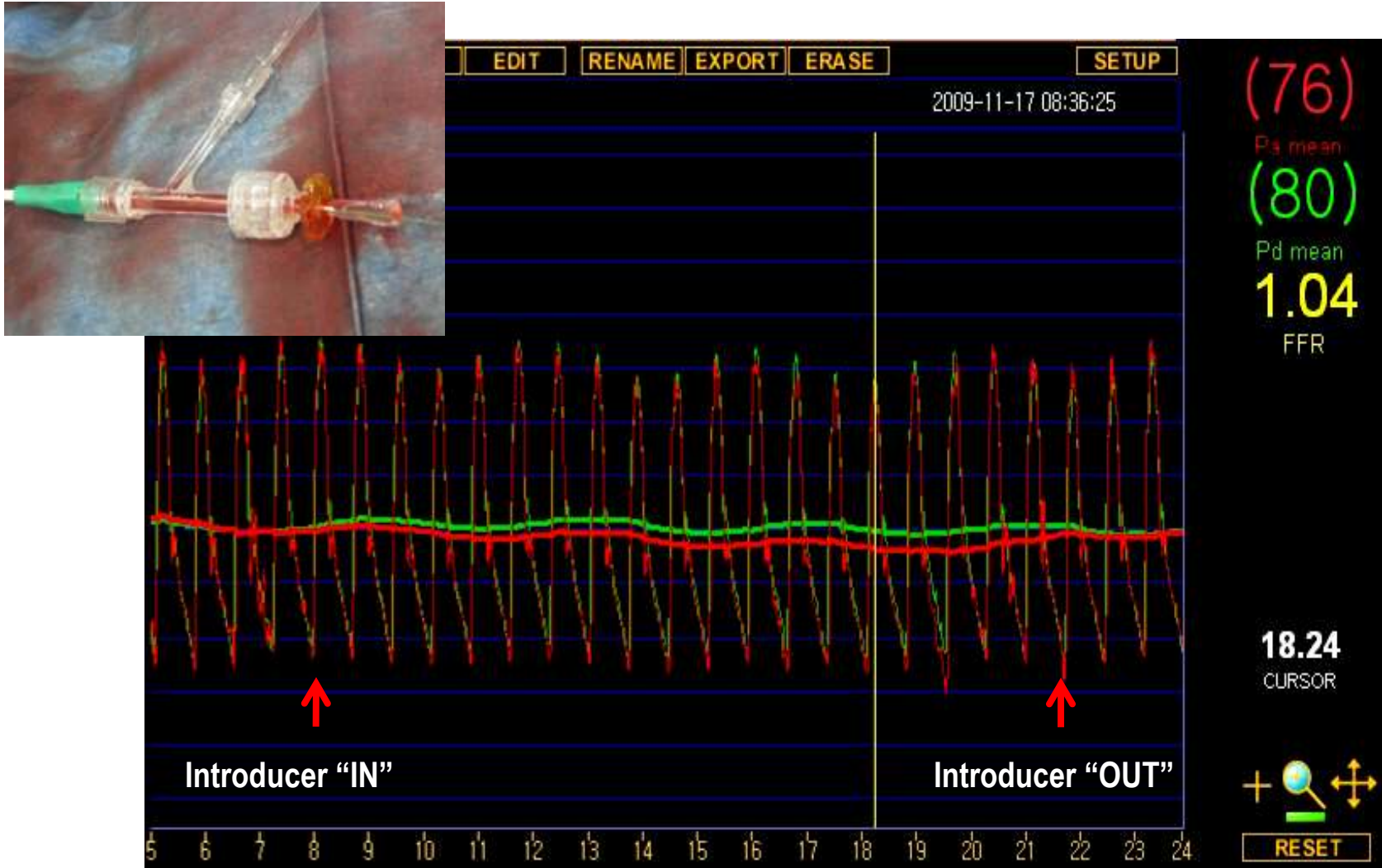


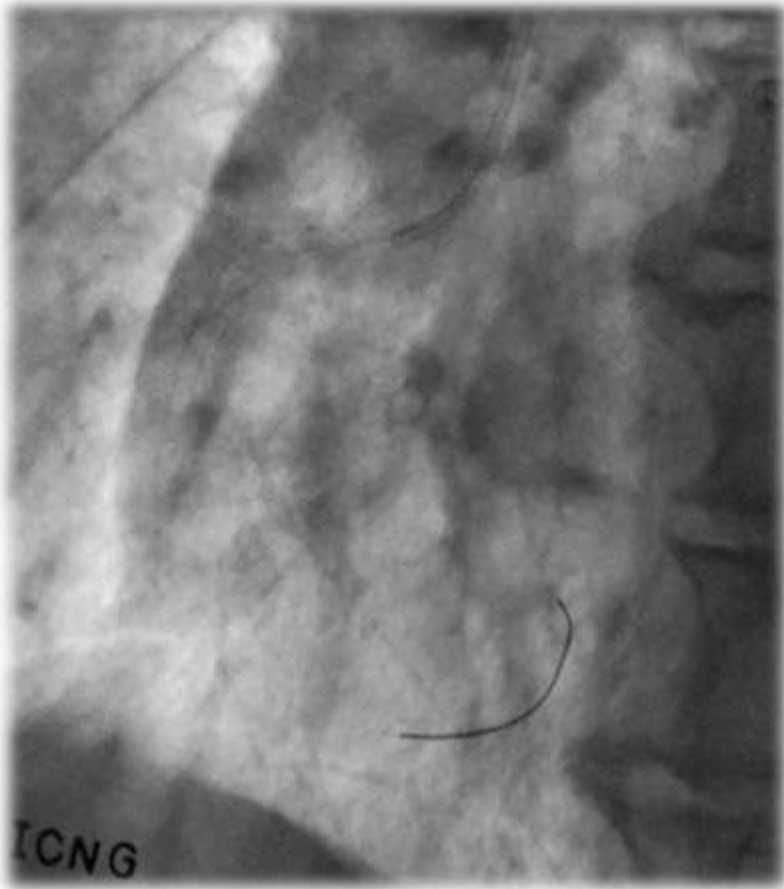
**I have witnessed many
false (+)/false(-) FFR cases...**

Checklists for possible pitfall/artifact

- **Infusion pump or connection site:** IV infusion or IC bolus
- **Adequate dosage** of hyperemic agent?
- **Introducer in place?**
- **Check the cursor location**
- **Check the shape of pressure curves**
- **Guide catheter problem**
 - Side-holes, Flush
 - Disengage during recording/pullback tracing
- **Drift**
 - Re-equalise or change a wire
- **Spasm/Accordion effects**
 - Nitro before measurement

Don't equalise with an "INTRODUCER" in place



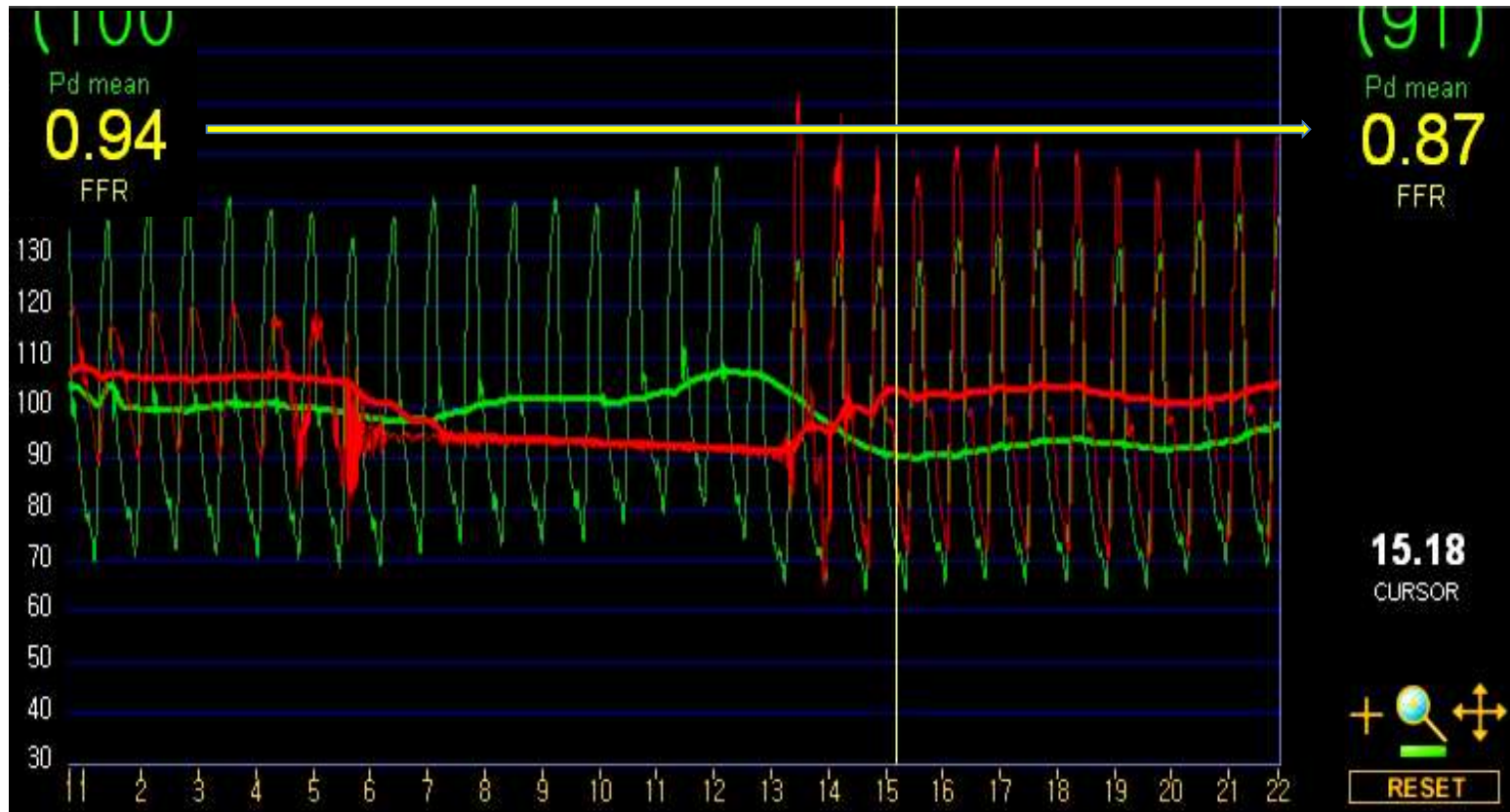


5 Fr guiding catheter, radial approach



Hyperemia: IV adenosine infusion

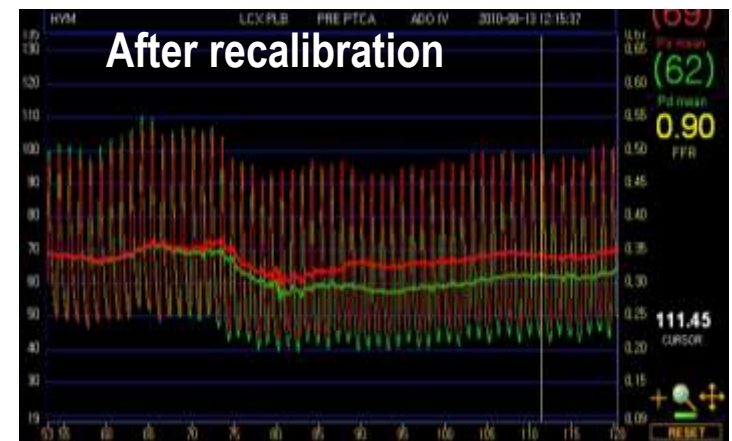
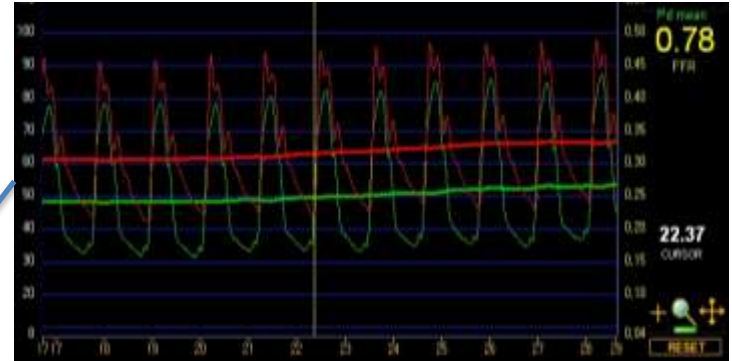
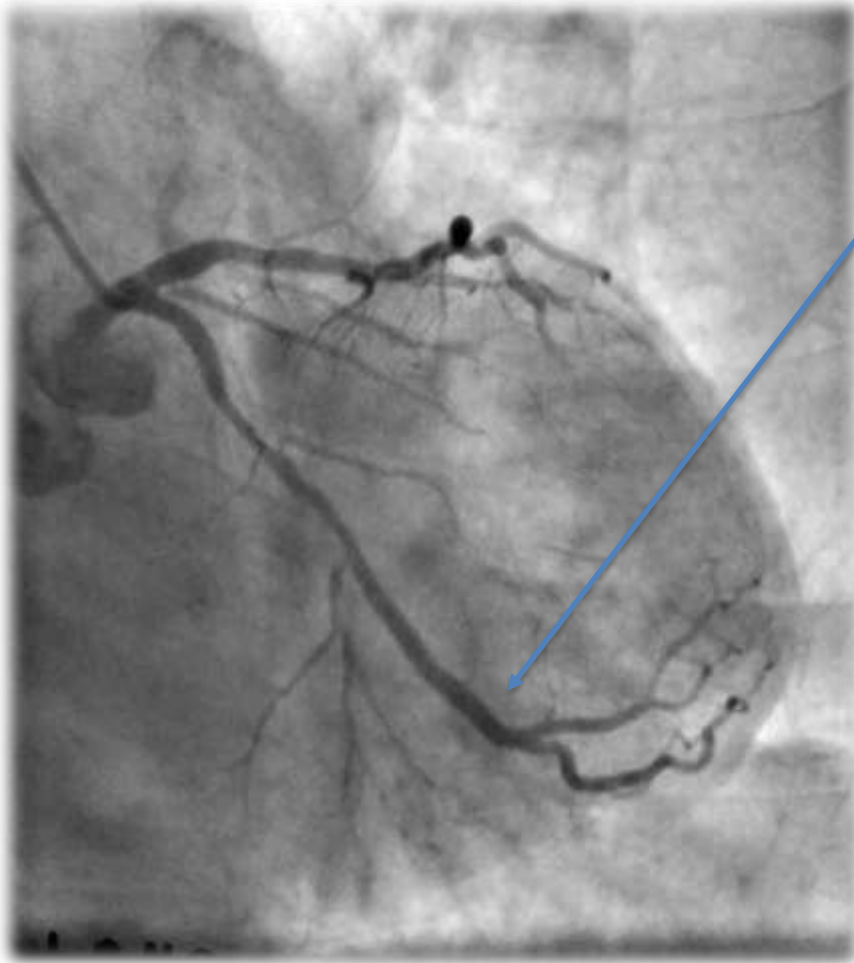
“FLUSH” the guiding catheter



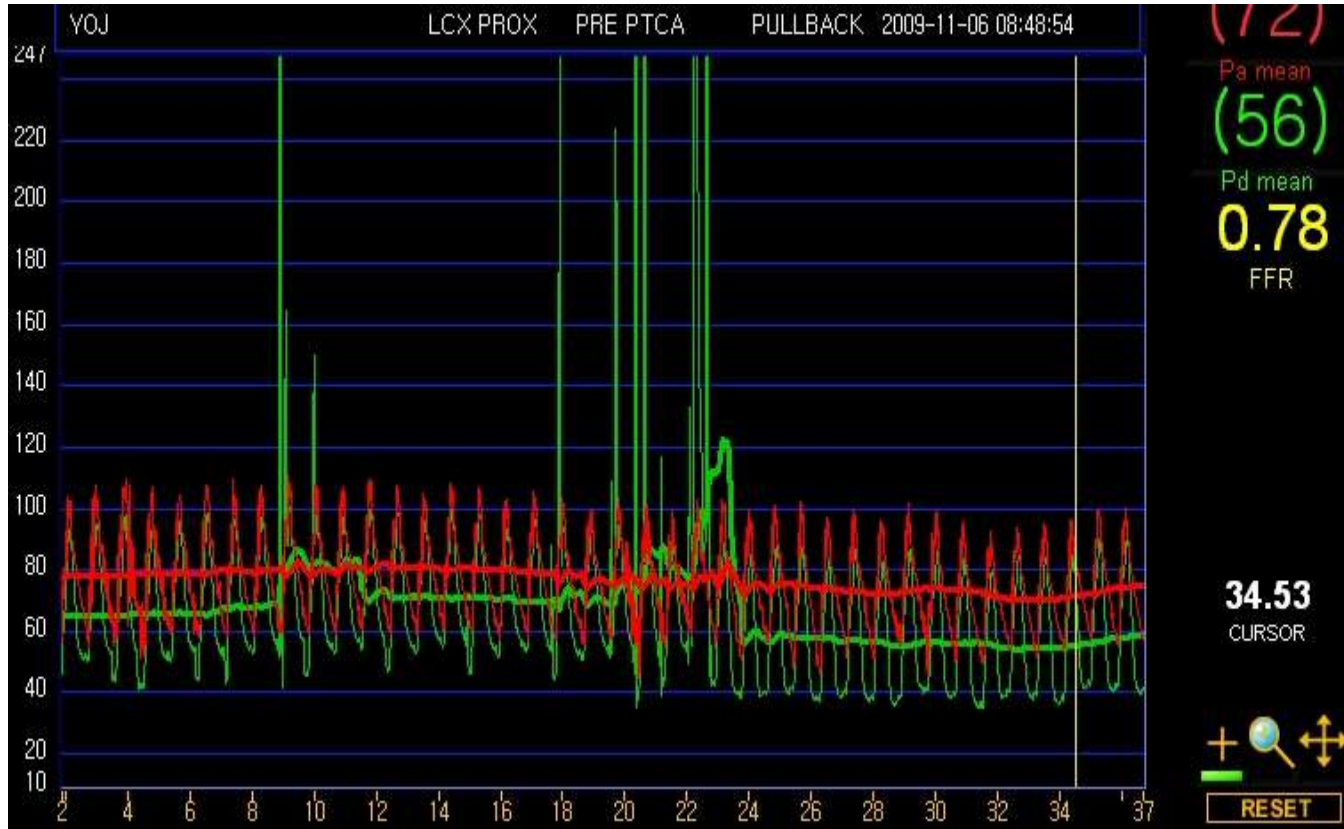
Check the shape of “PRESSURE CURVE”



Artificial gradient due to “DRIFT”

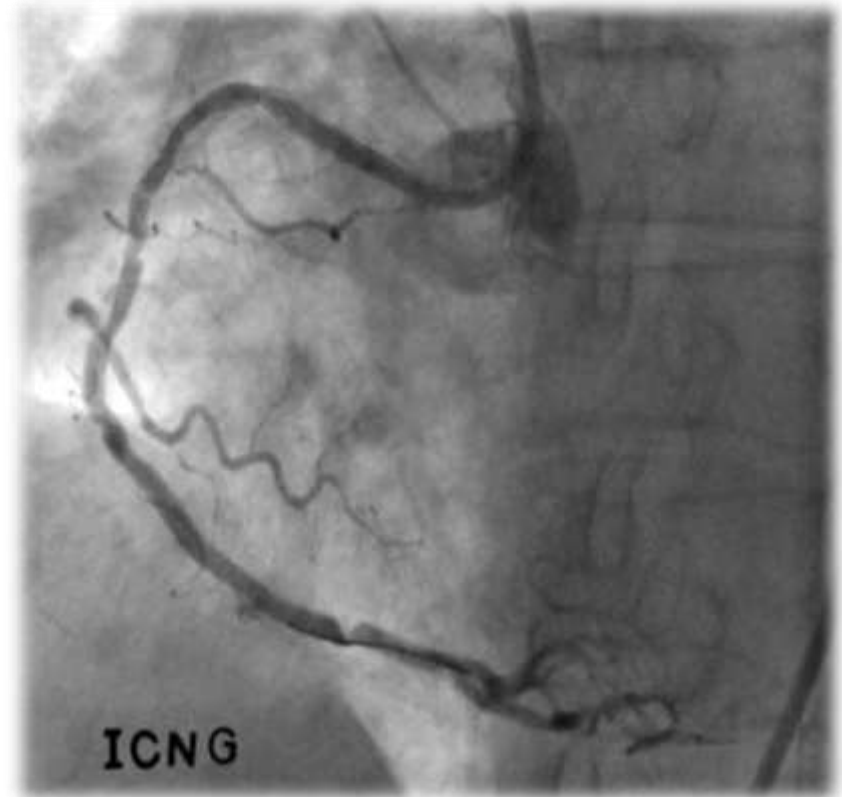
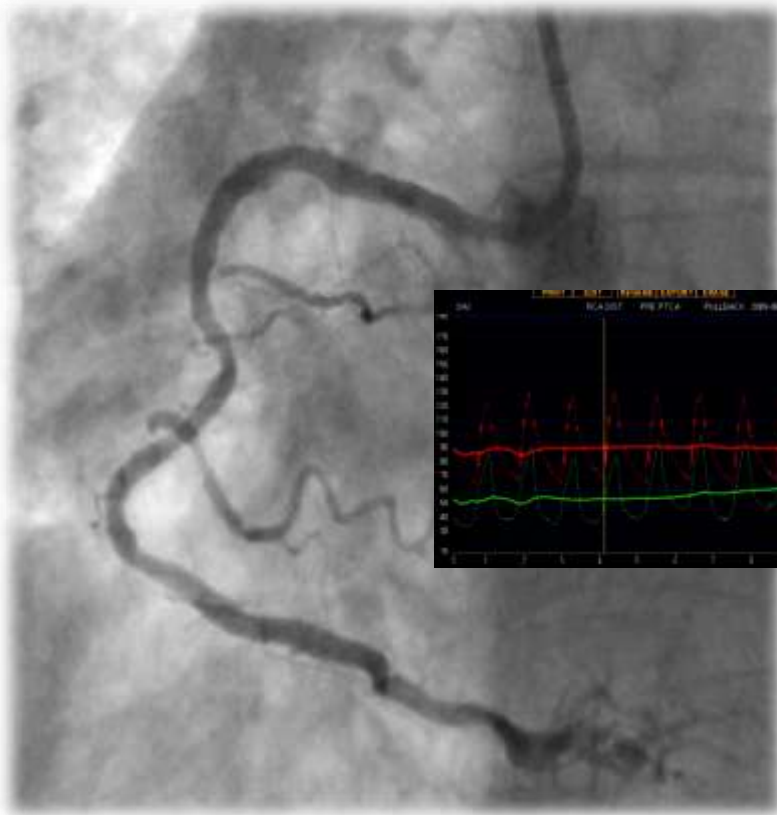


Aware of “Whipping artefact”



PW sensor hits the coronary wall → Move the PW sensor

Aware of “Accordion effect”



Sketch for FFR

- FFR is the gold standard to define the functional significance of coronary stenosis in a catheterization laboratory.
- FFR-guided PCI is feasible and effective and reduces unnecessary revascularization and related complications.
- However, adequate knowledge on coronary physiology and potential pitfalls of FFR is needed to properly use FFR in daily practice.