Fractional Flow Reserve: Tips, Tricks and Pitfalls

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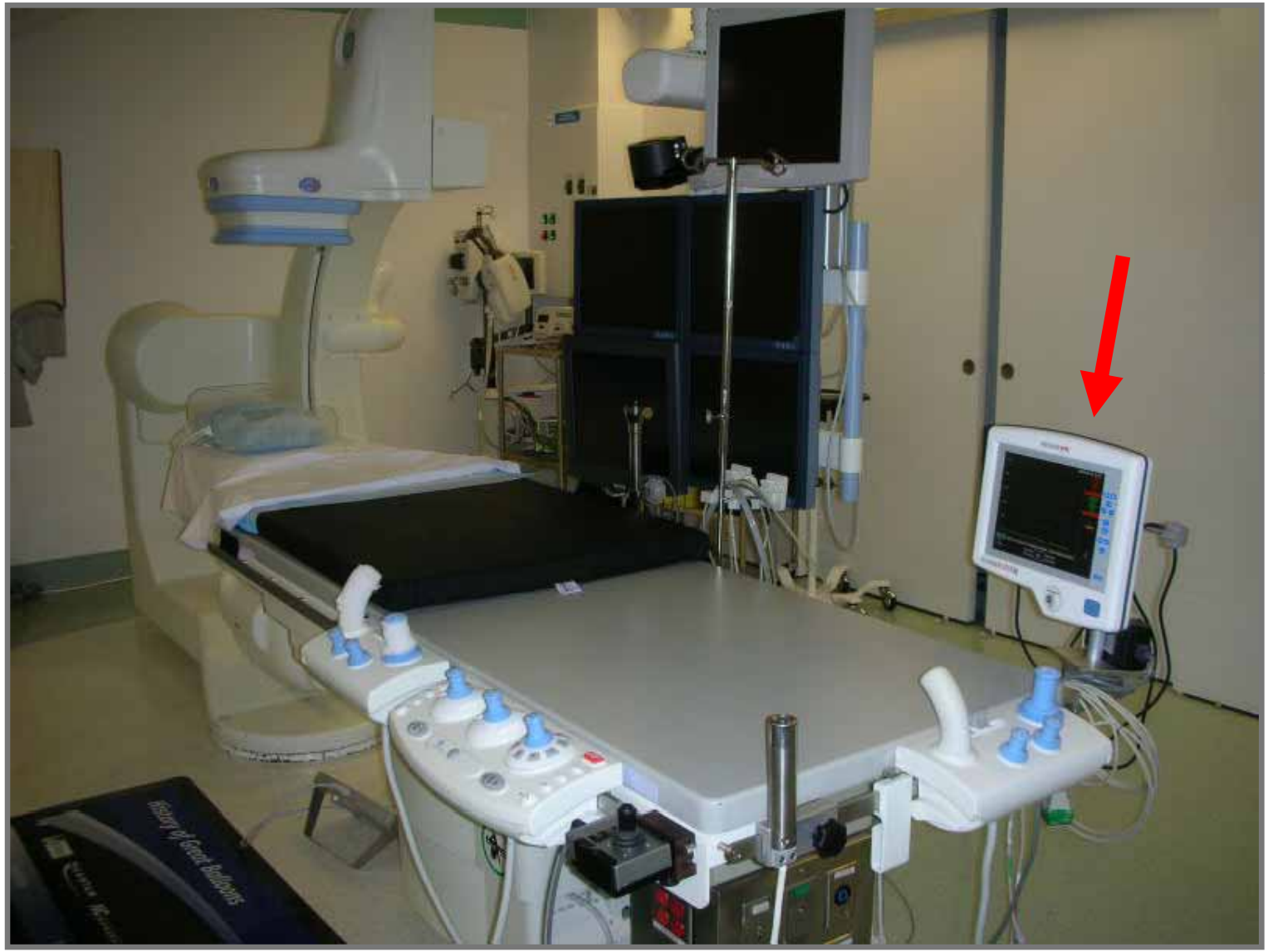
Conflict of Interest

- Advisory Board for HeartFlow
- Research grant from St. Jude Medical
- Research and salary support from National Institutes of Health: 1 R01 HL093475 (PI)

How to Measure FFR

Incorporating Physiology



Incorporating Physiology

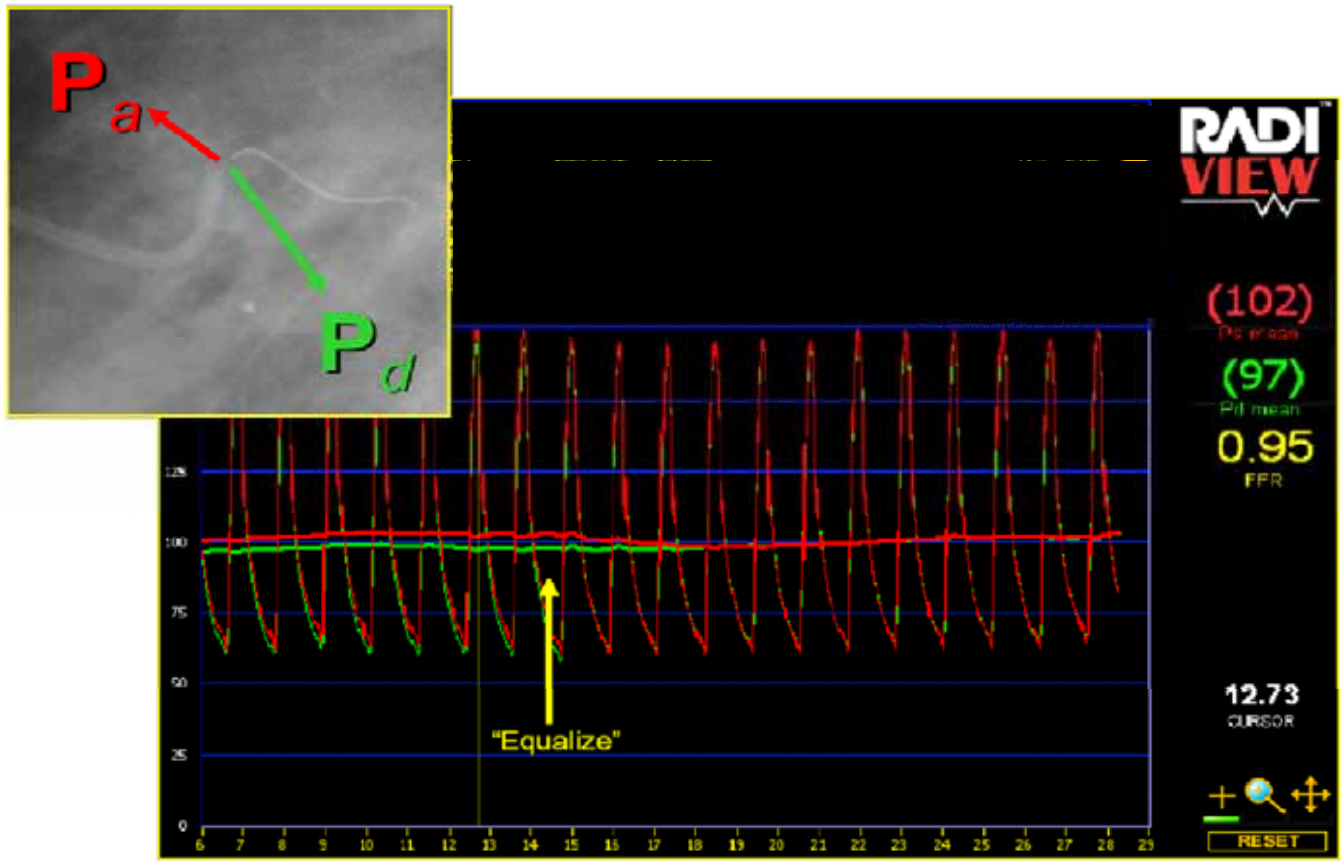
- Educating your assistants
  - Limitations of angiography
  - Benefits of physiology
  - Measure FFR in consecutive cases
  - Obey FFR result

- Streamlining set-up
  - Identify point person
  - Post medication mixing and dosing instructions
  - Keep analyzer connected at all times or use “wireless” system

Performing FFR

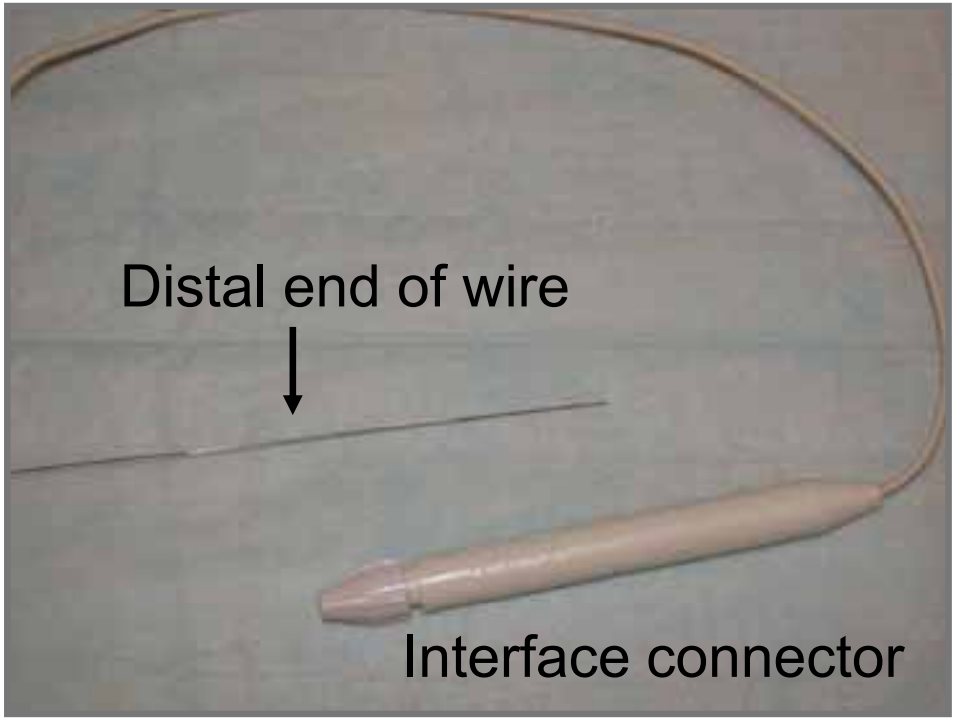
1. IC NTG and IV heparin/bivalirudin

2. Equalize Pressures



Potential Pitfalls

Wiring the Lesion



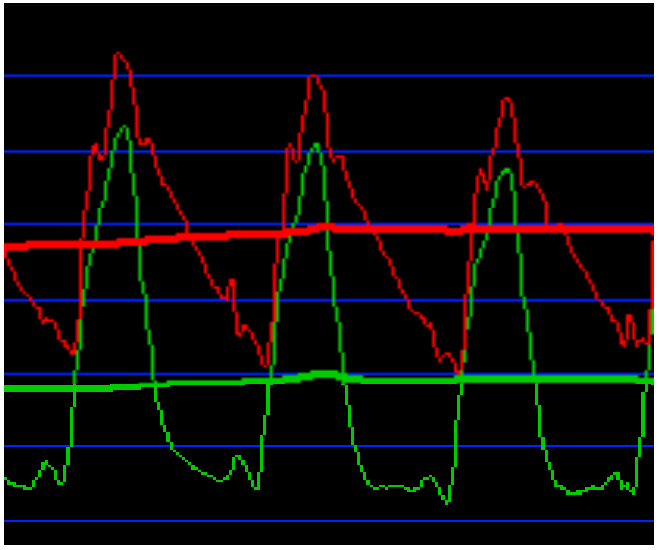
Consider disconnecting the wire from the interface connector

Can use exchange catheter to more safely position pressure wire

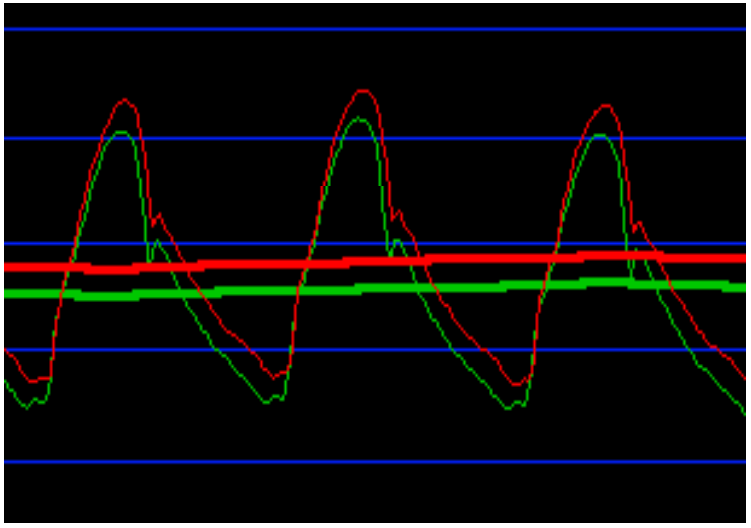
Potential Pitfalls

Recognizing Drift

True Gradient



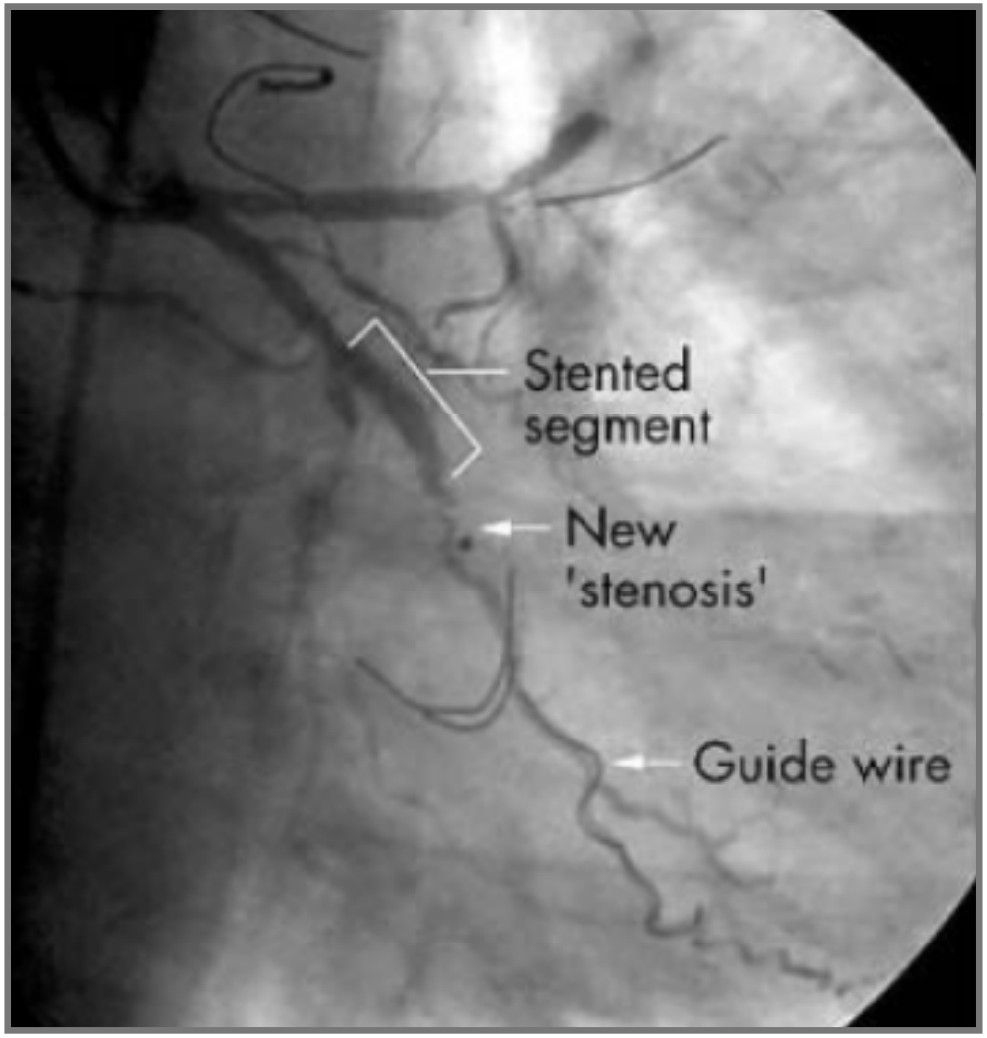
Drift

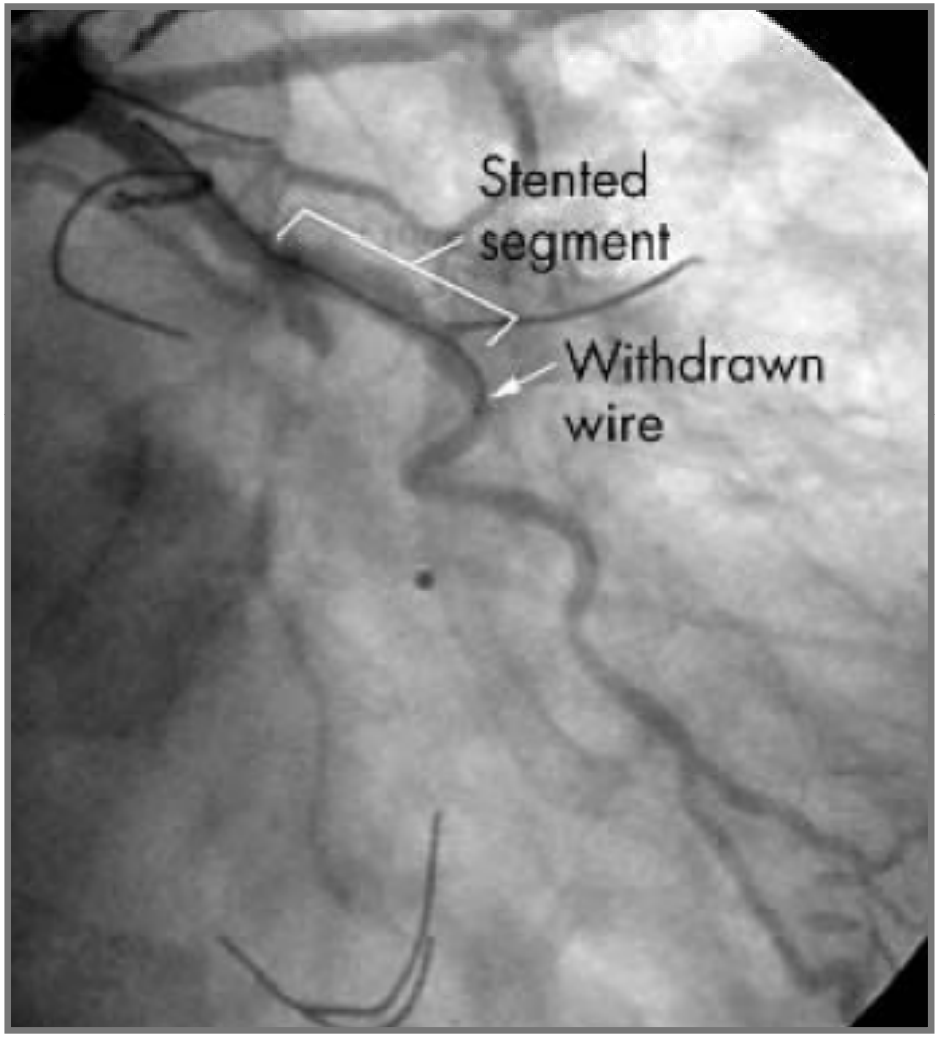


Potential Pitfalls

- Pressure Drift
  - Causes of artifactual drift
    - Wire introducer
    - Paradoxical gradient
    - Guides with sideholes
    - Contrast

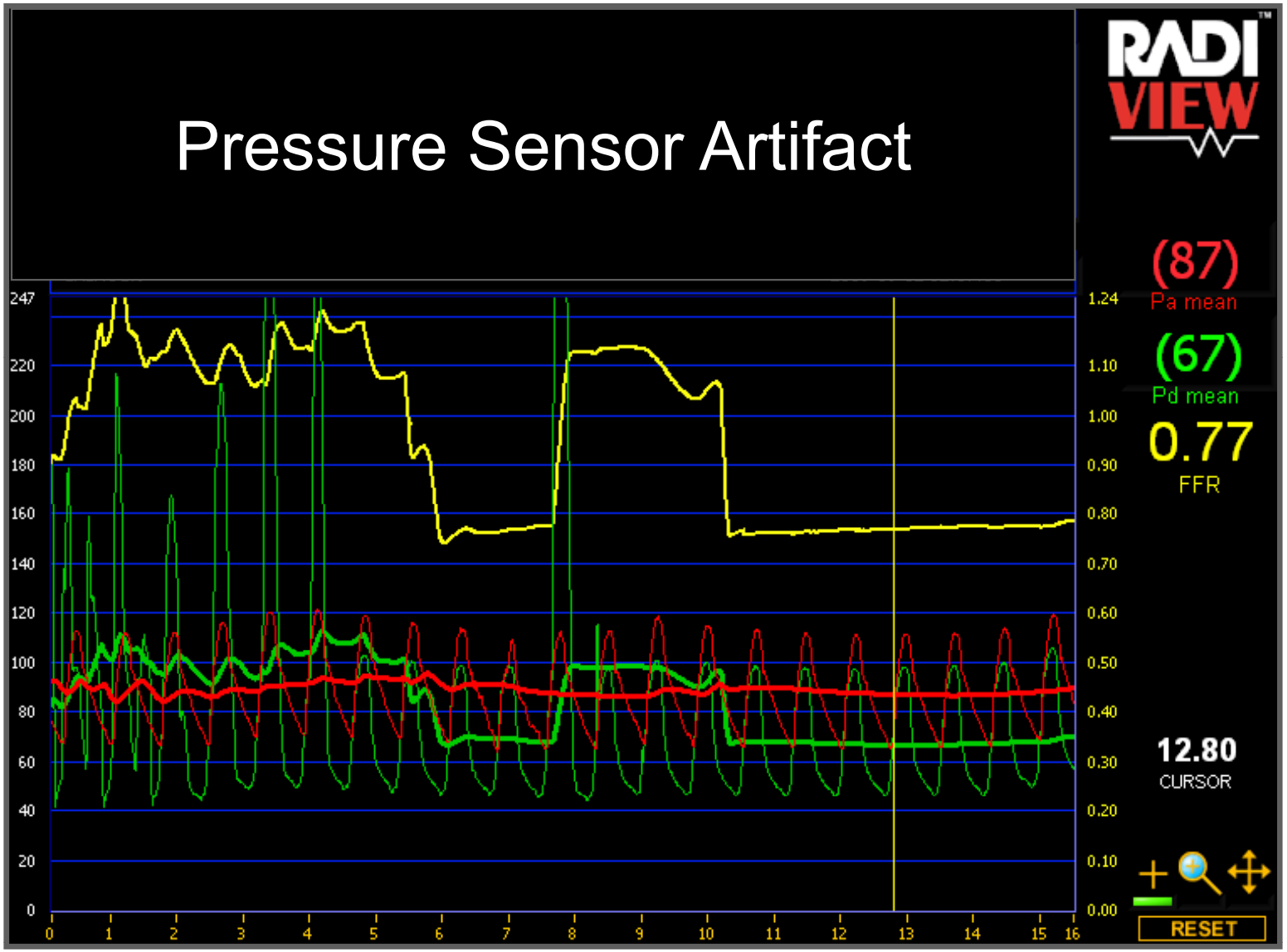
“Accordion Effect”





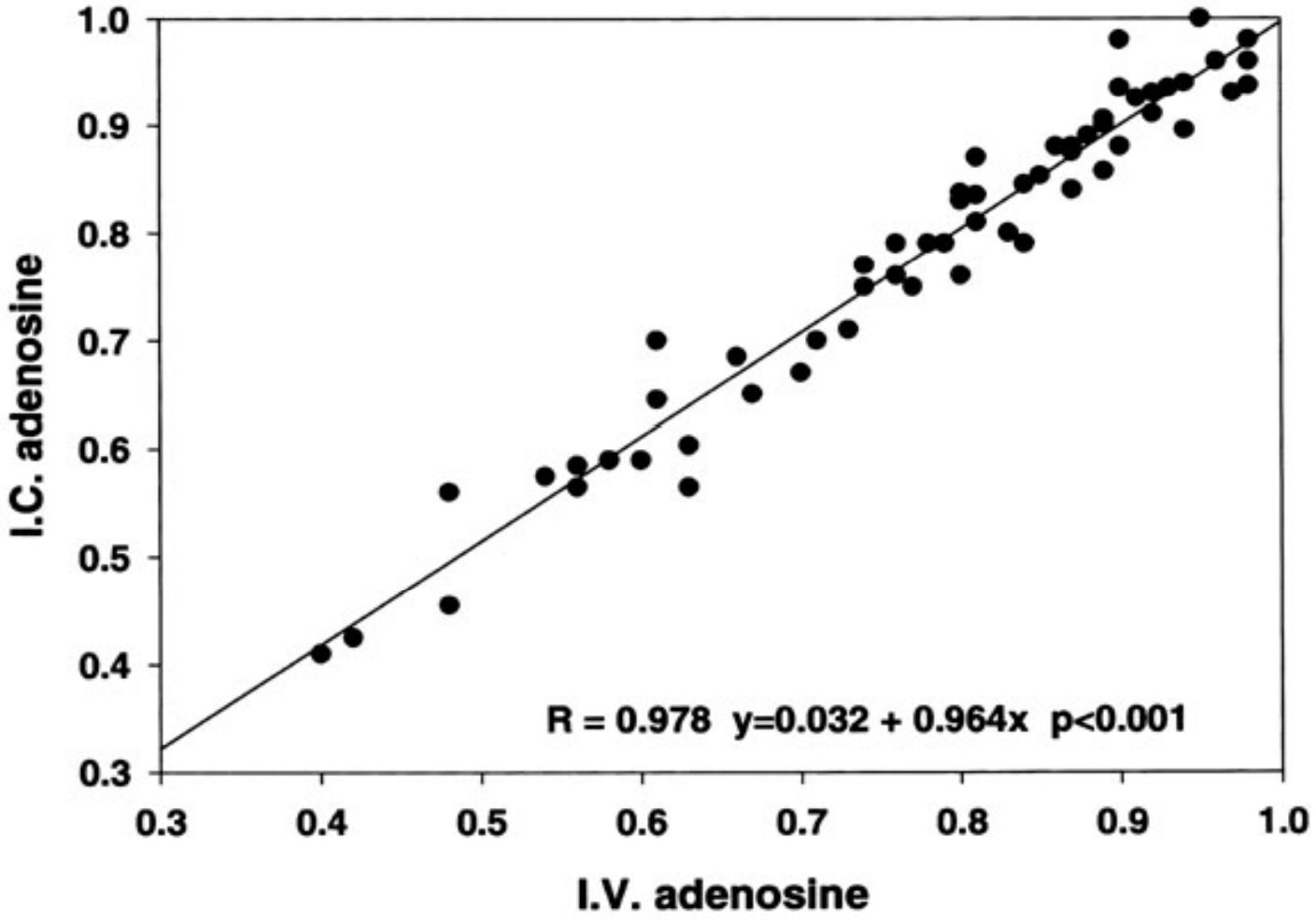
Davidavicius, et al. Heart 2005;91:471

Potential Pitfalls



Inadequate Hyperemia

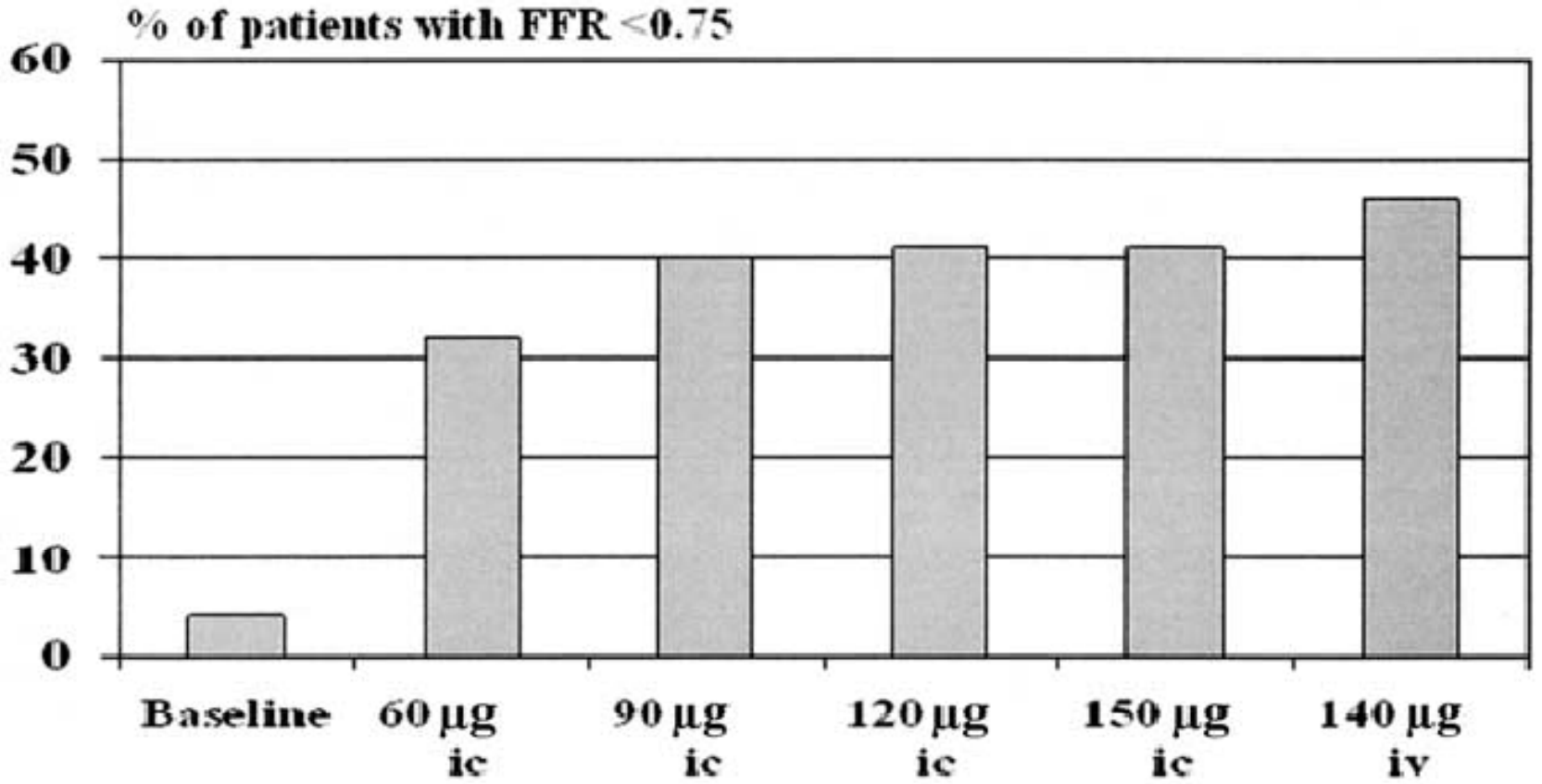
IC vs. IV Adenosine



Jeremias et al. Am Heart J 2000;140:651-657.

Inadequate Hyperemia

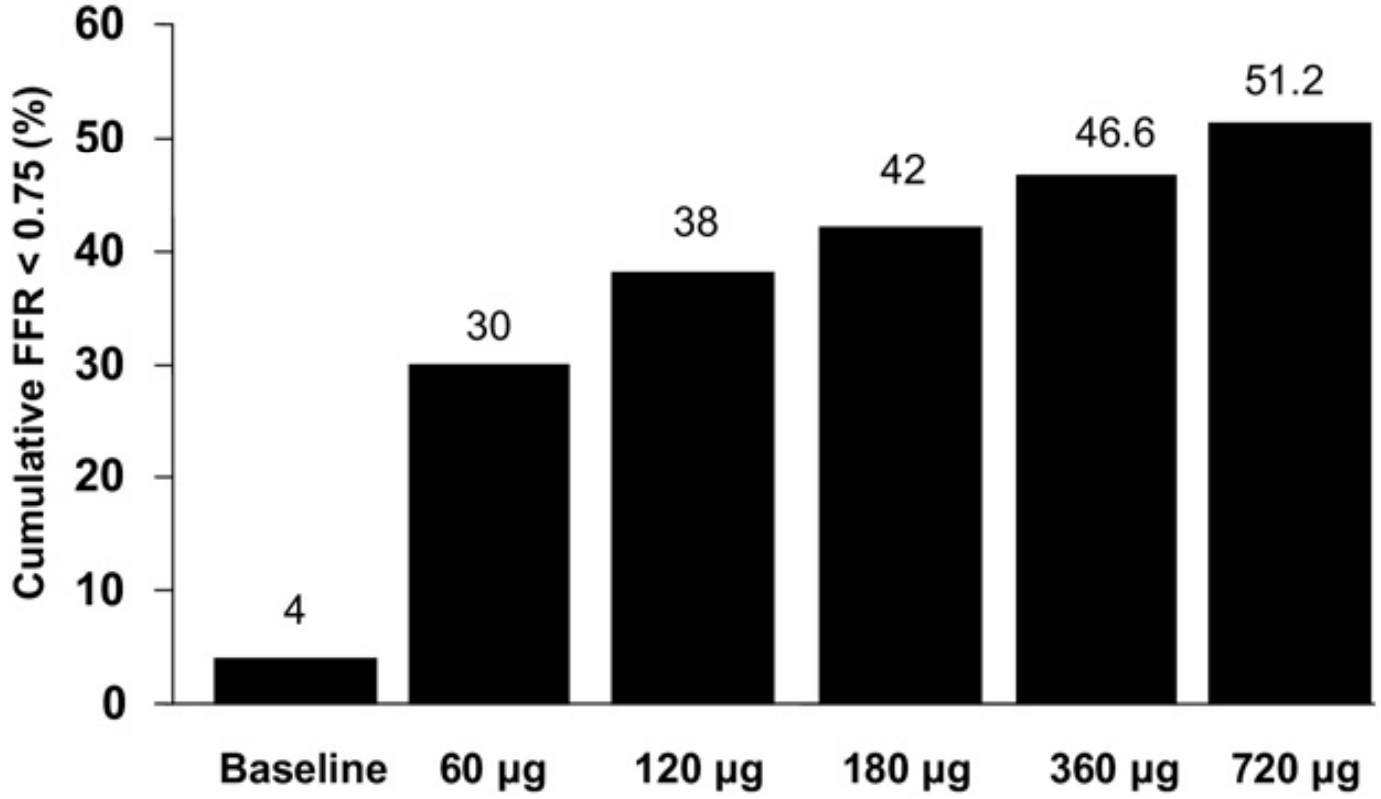
FFR measured in 50 patients with intermediate lesions



Casella et al. Am Heart J 2004;148:590-5.

Inadequate Hyperemia

FFR measured in 46 patients with intermediate lesions and increasing doses of IC Adenosine were administered



De Luca, et al. J Am Coll Cardiol Intv 2011;4:1079-84

Potential Pitfalls

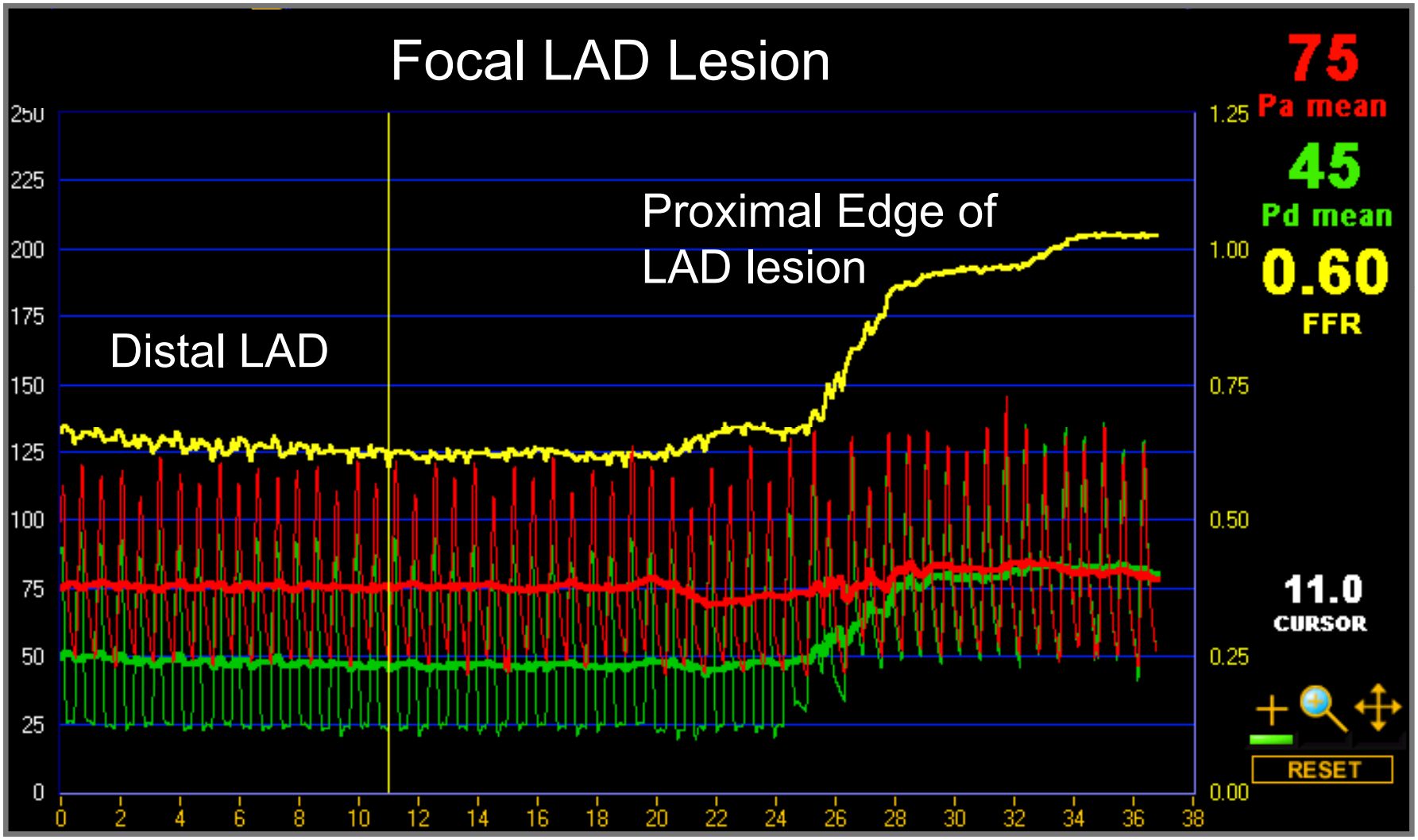
- Inadequate hyperemia
  - Intracoronary adenosine
    - Short-lasting peak effect (~10-15 seconds)
    - Don’t use a guiding catheter with sideholes
    - If one suspects inadequate hyperemia, then increase dose or use intravenous adenosine

Potential Pitfalls

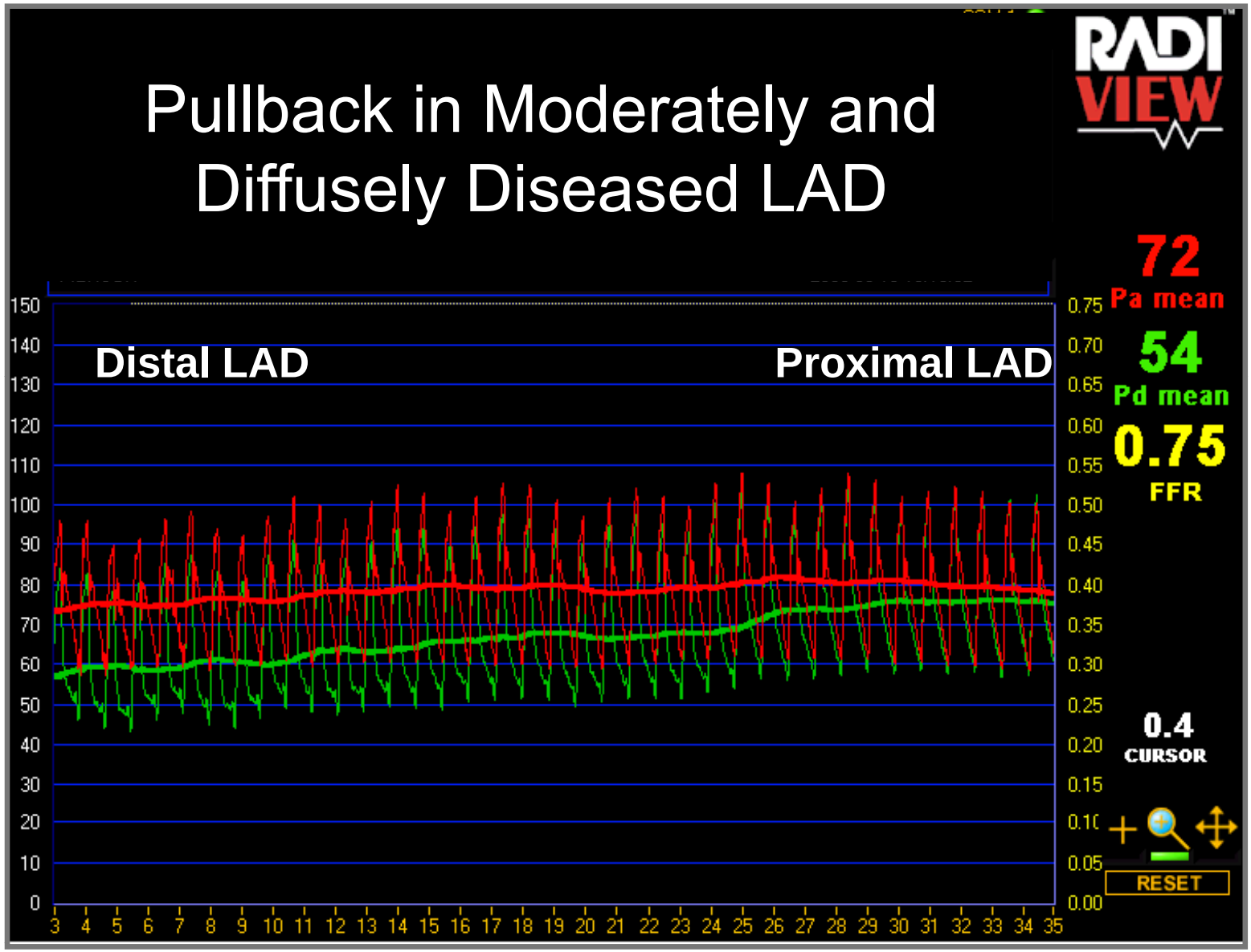
- Inadequate hyperemia
  - Intravenous adenosine
    - Should be administered via central vein
    - May require higher doses (>140 ug/kg/min) if given peripherally
    - If the patient doesn't develop symptoms and/or hemodynamic changes, the patient is likely not receiving IV adenosine

Performing FFR

Pressure Pullback



Performing FFR

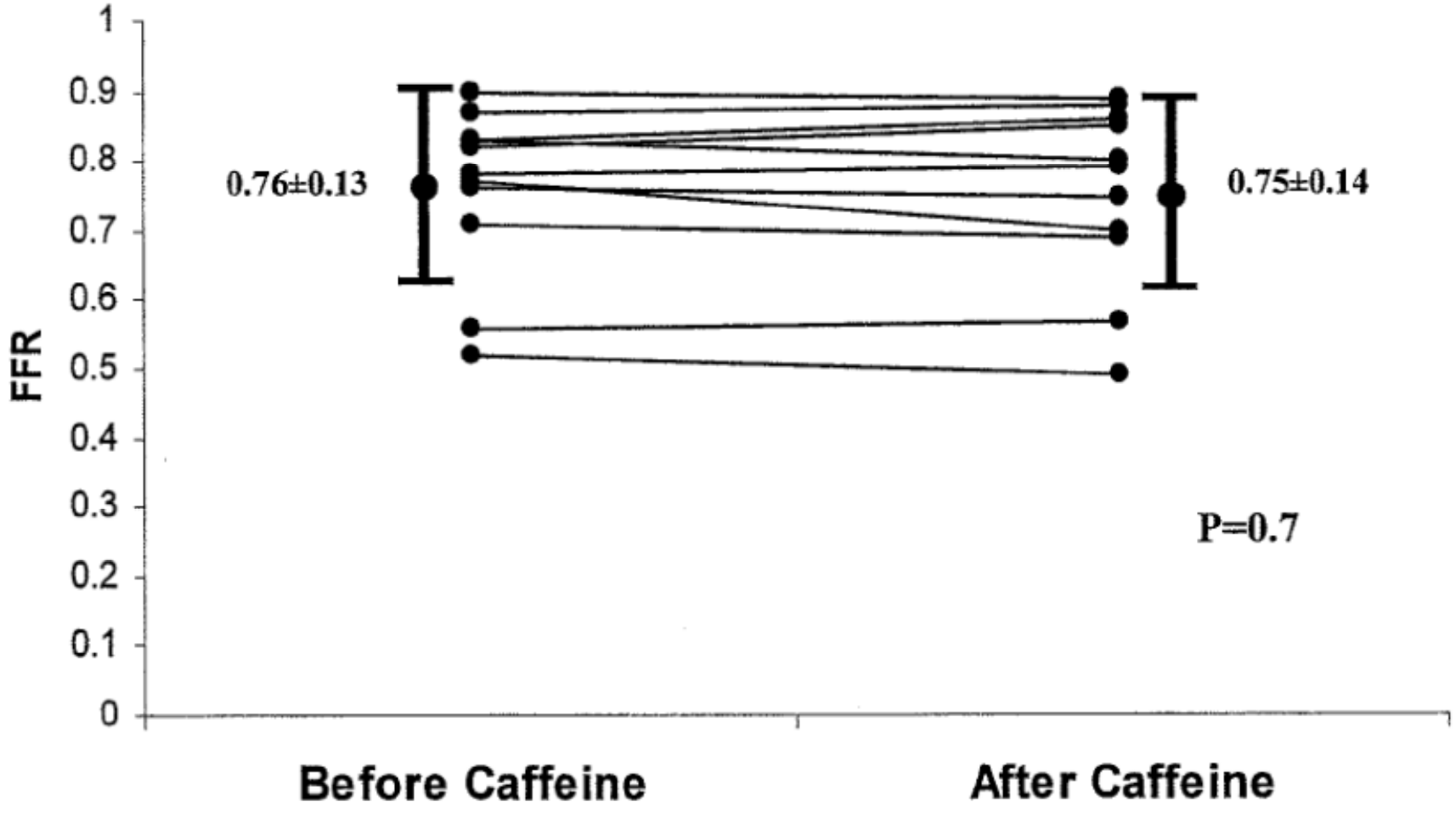


Potential Pitfalls

- Inadequate hyperemia
  - Caffeine
    - Competitive inhibitor of the adenosine A2a receptor
    - Small studies have shown that caffeine may decrease the sensitivity of dipyridamole stress tests
    - Dipyridamole indirectly increases endogenous adenosine by blocking the cellular reuptake mechanism

FFR and Caffeine

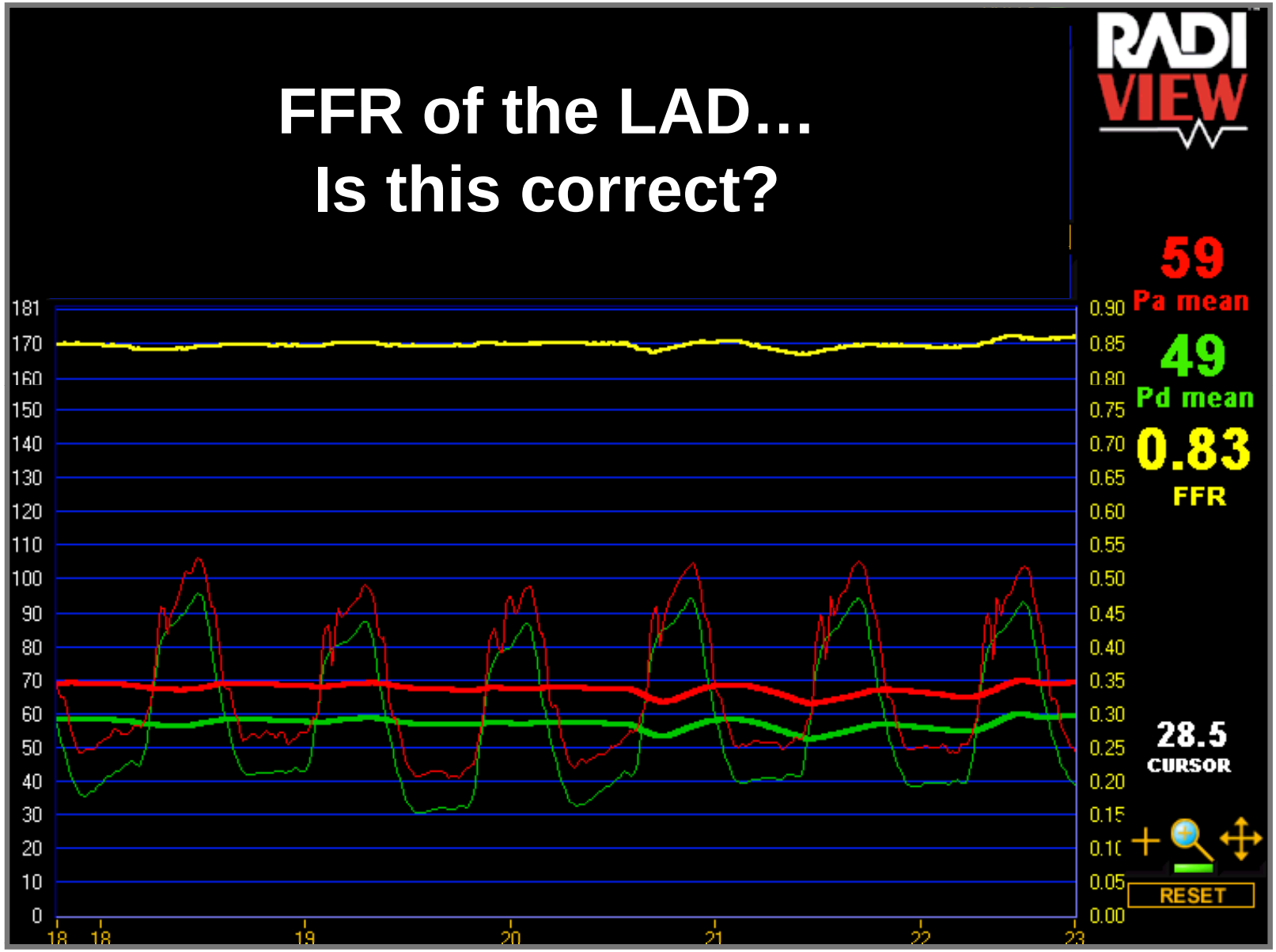
FFR measured with 30-50 ugs of IC adenosine before and after 2-3 "cups" of coffee



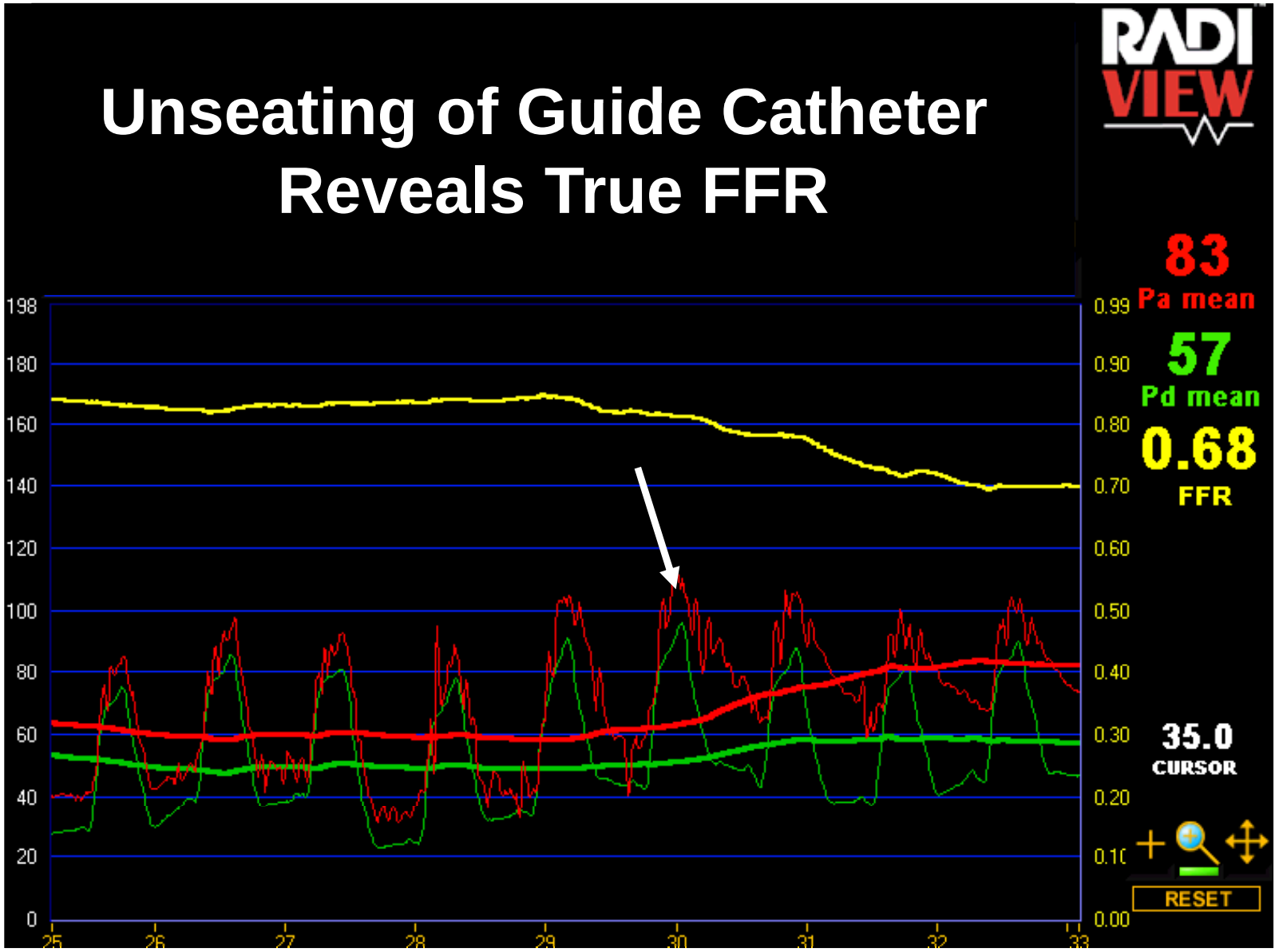
Aqel, et al. Am J Cardiol 2004;93:343-346.

Catheter Issues

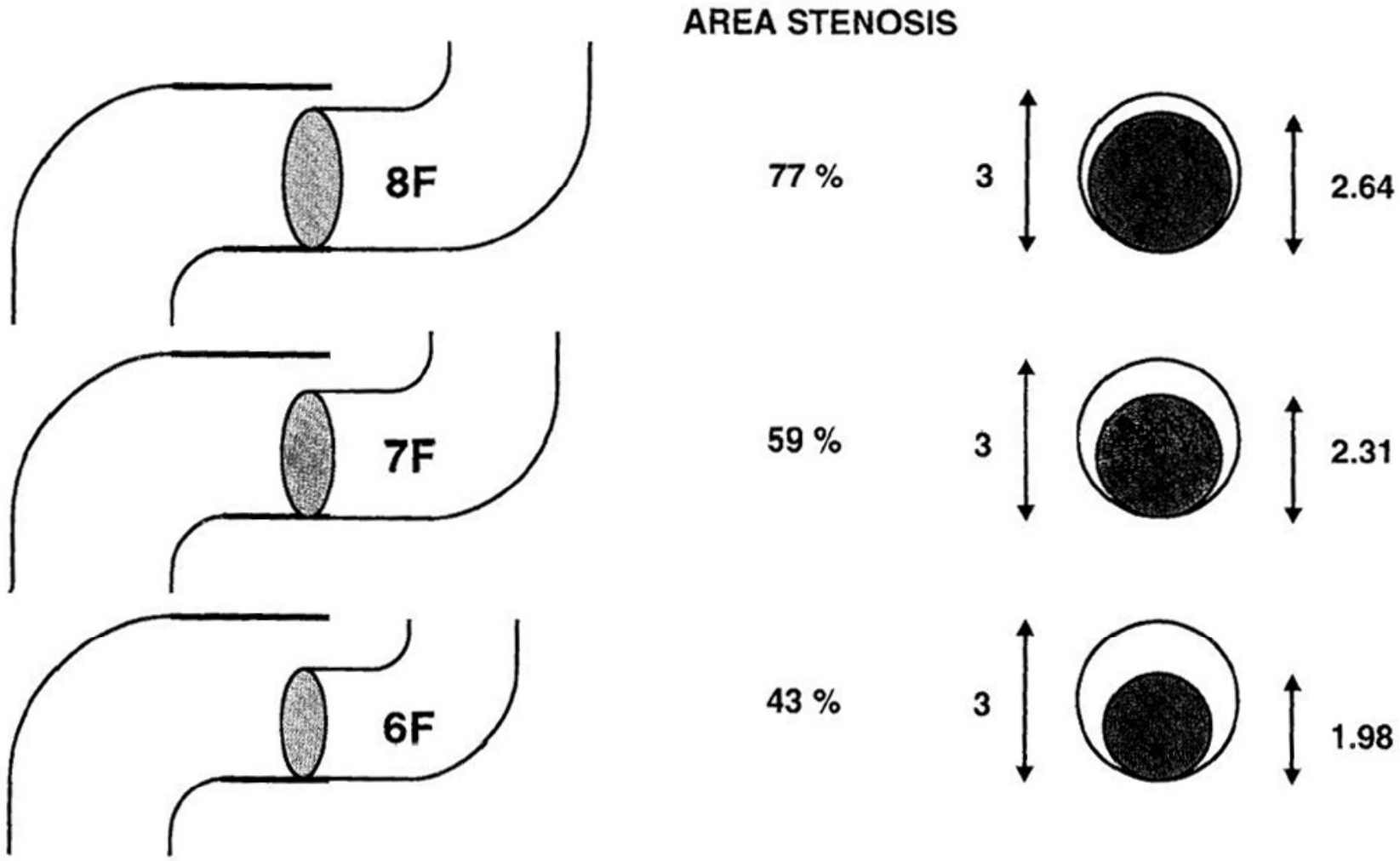
Catheter Issues



Catheter Issues



Impact of Catheter Size on Hyperemic Flow



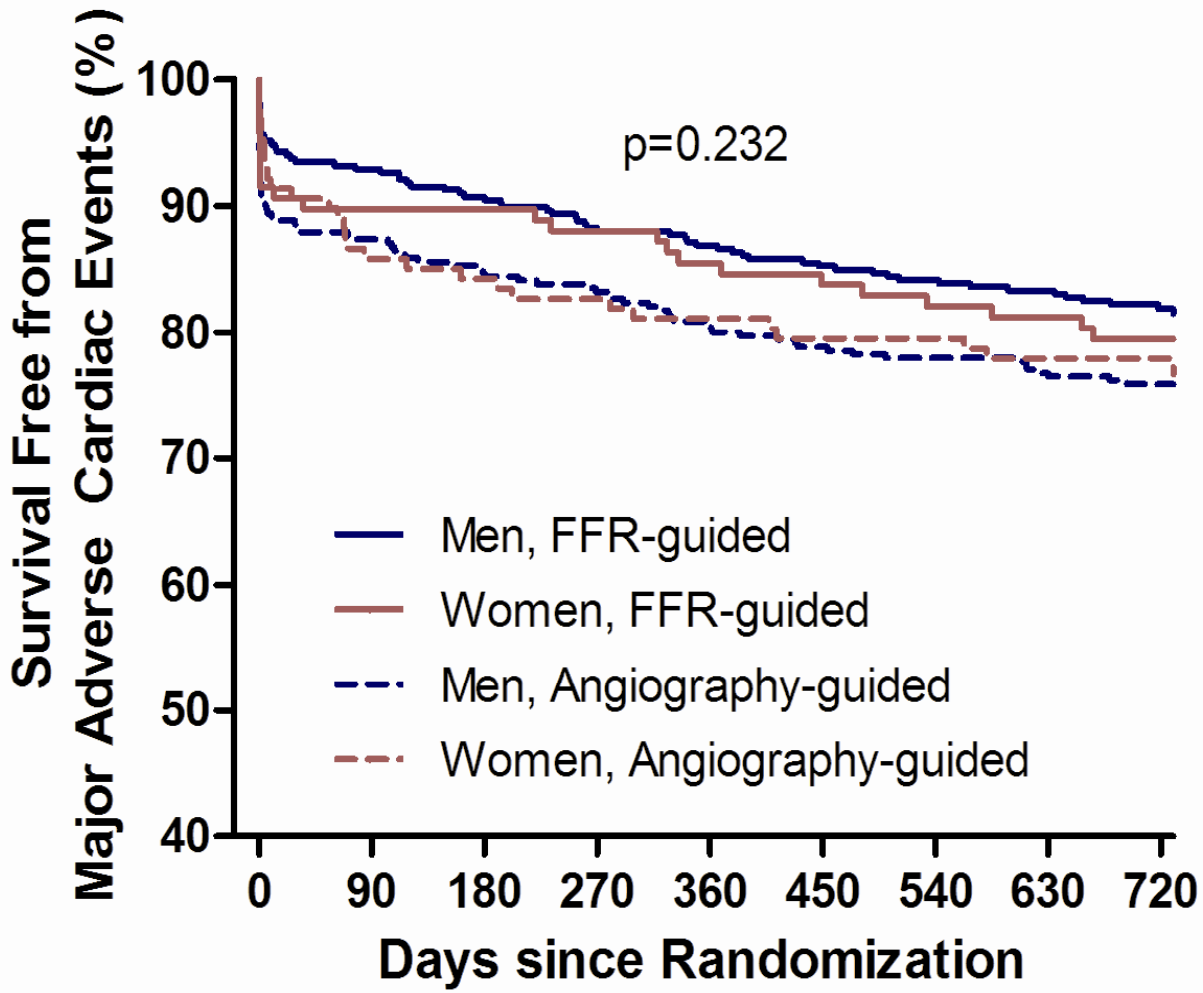
De Bruyne, et al. Cathet Cardiovasc Diagn 1994;33:145-152.

Potential Pitfalls

- Particular patient subsets
  - Left Ventricular Hypertrophy
    - ↑↑ muscle mass compared to vasculature
    - FFR cuttoff value may be higher than 0.75
  - Exercise-induced vasoconstriction
    - Greater stenosis with exercise compared to adenosine
  - Acute Coronary Syndromes

Are there Sex Differences with FFR?

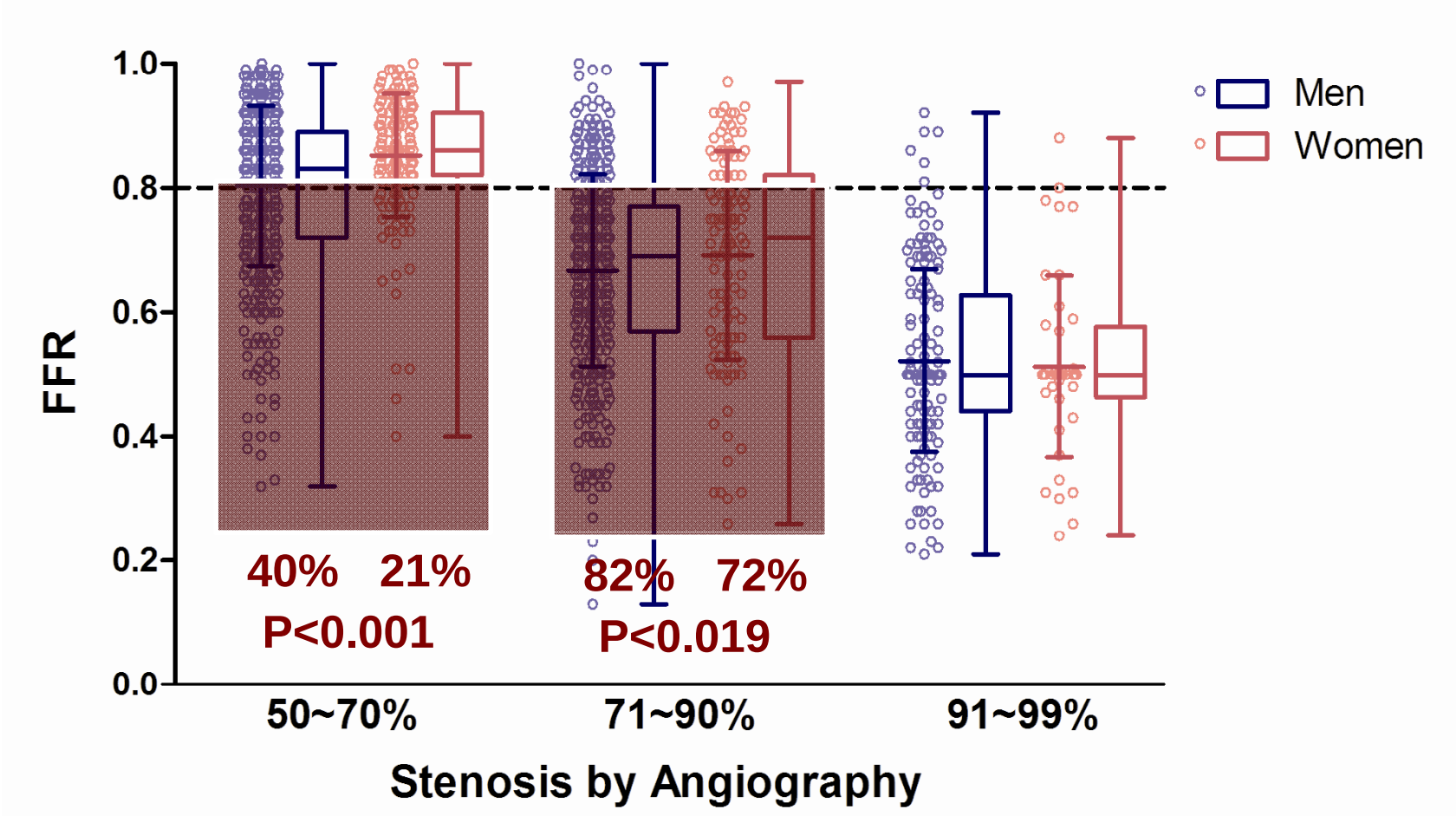
FFR-Guidance benefits women in the same manner as men



Kim HS, et al. JACC Interventions 2012;5:1037– 42.

Sex Differences in the FAME Study

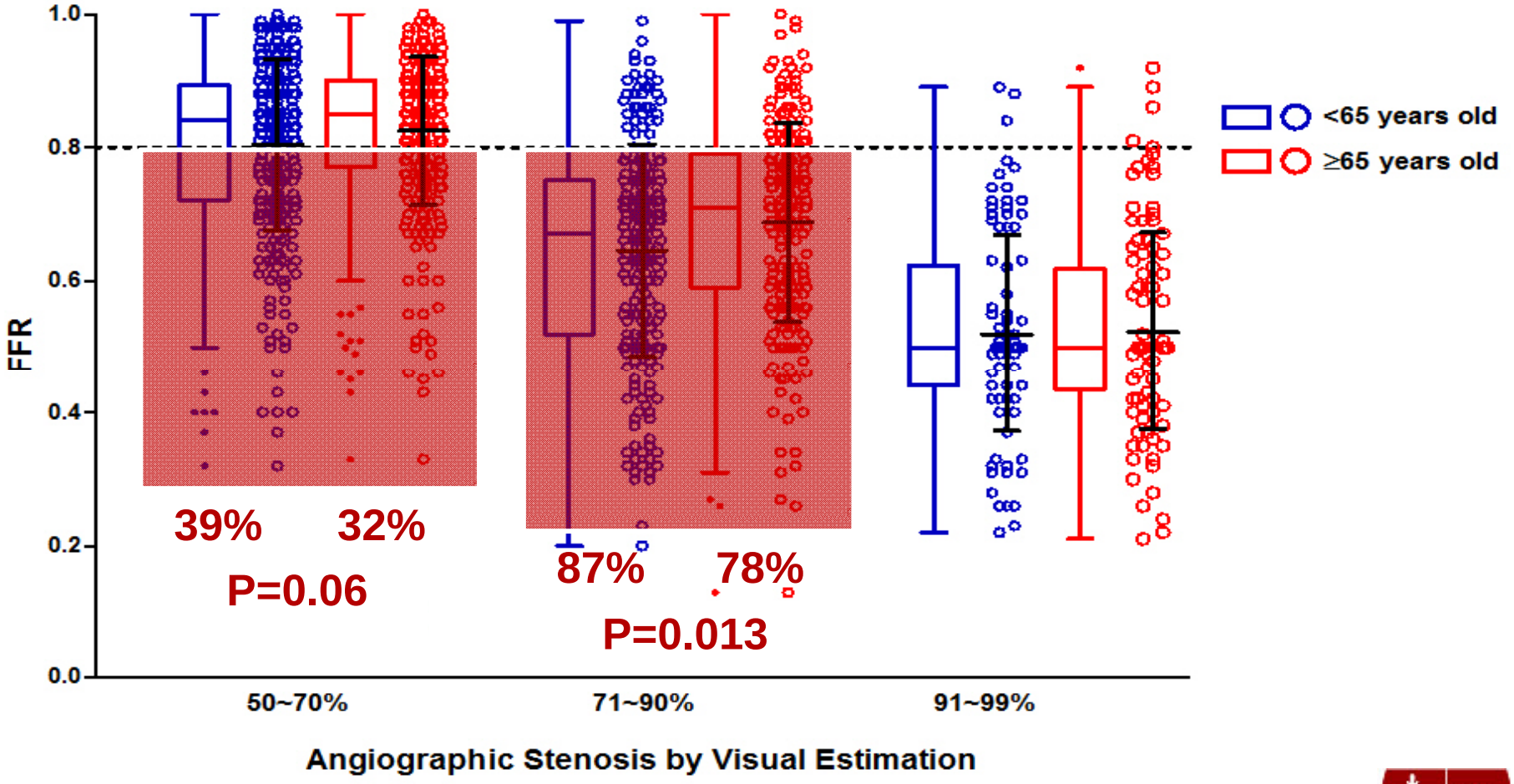
FFR was significantly higher in women than men (0.75±0.18 vs. 0.71±0.17, p=0.001)



Kim HS, et al. JACC Interventions 2012;5:1037– 42

Age and FFR

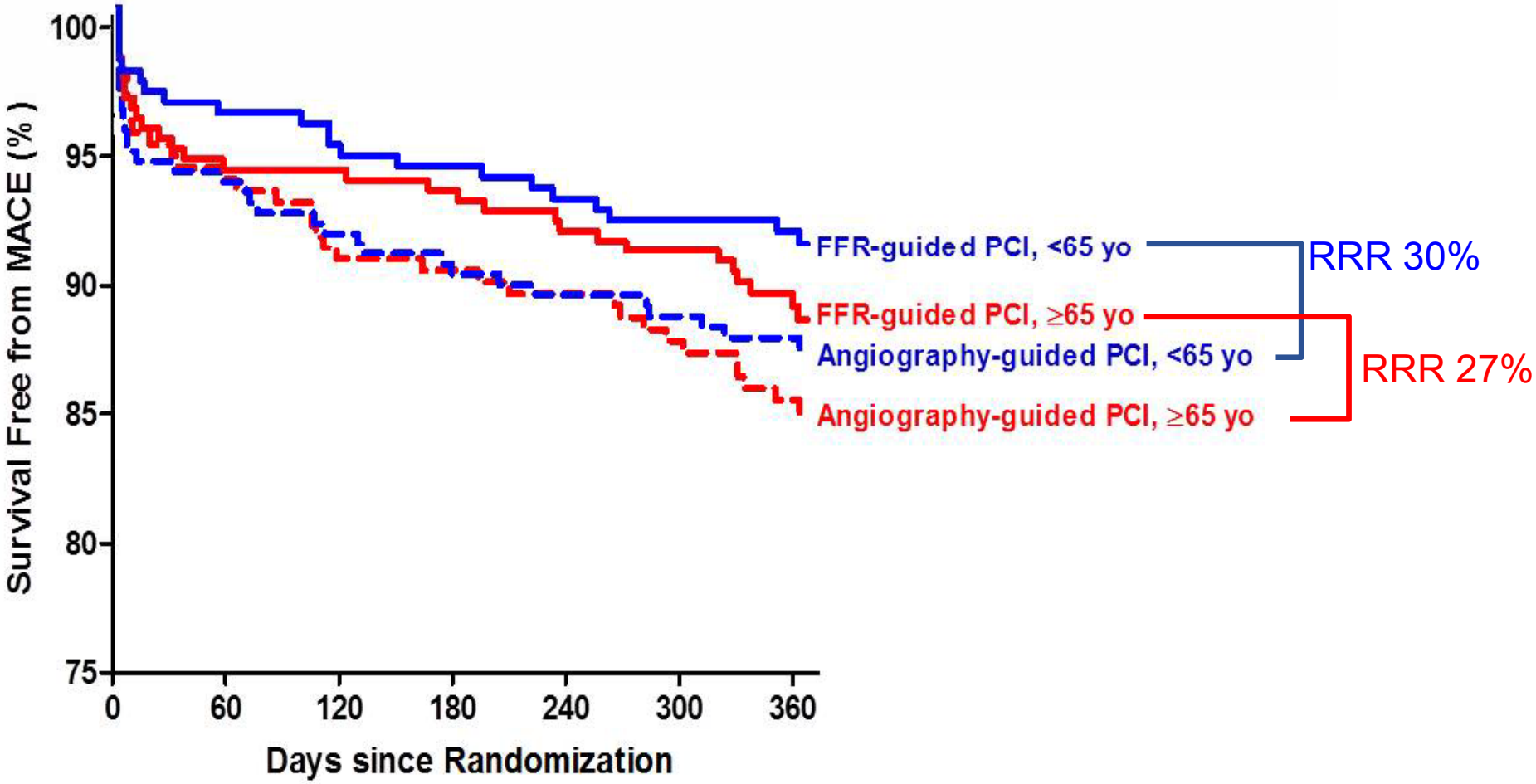
Patients ≥ 65 years old had a significantly higher mean FFR across all lesions as compared to patients < 65 years old (0.73 vs. 0.70, p=0.029)



H.S. Lim, et al. TCT 2013

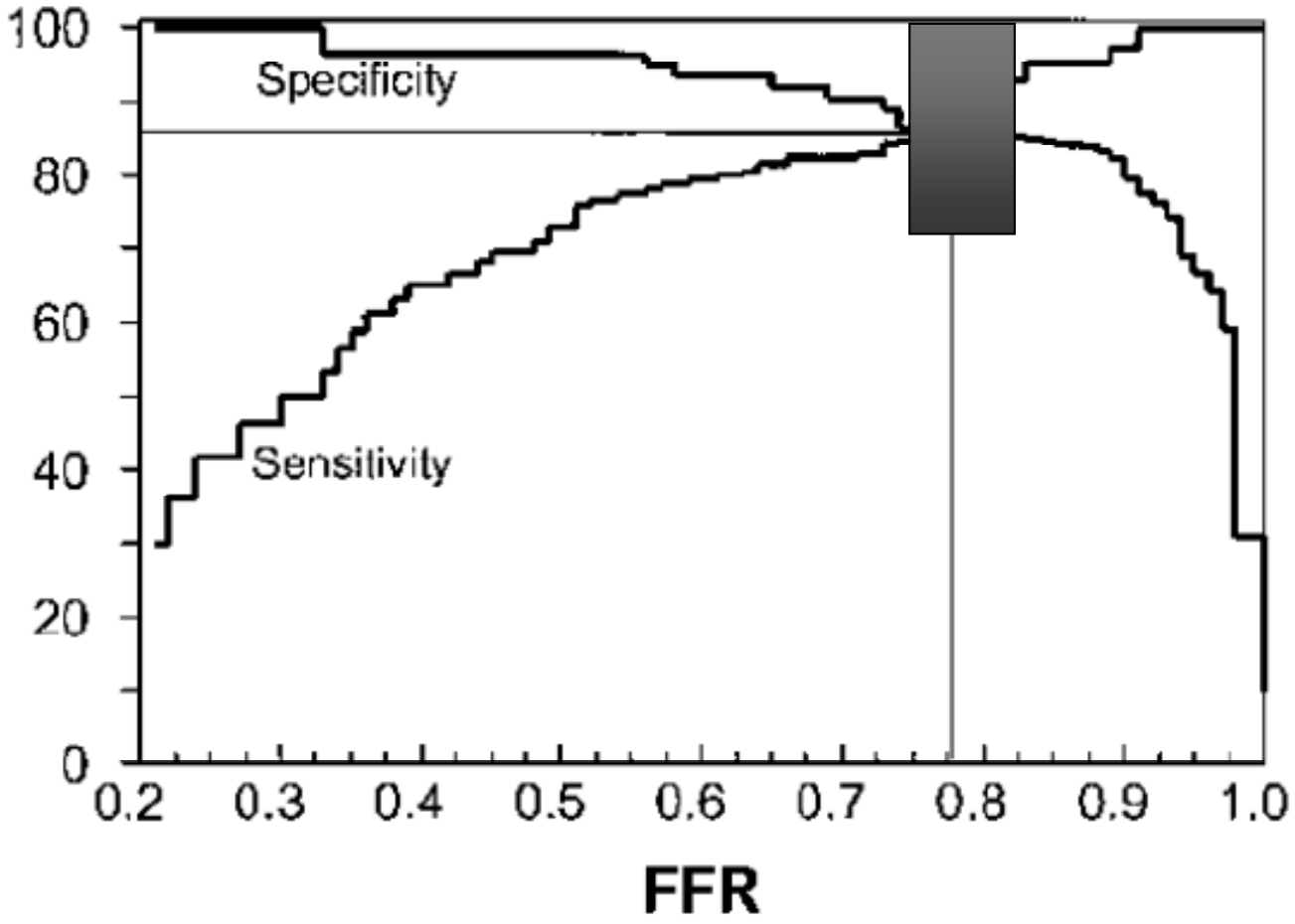
Age and FFR

Despite a different proportion of FFR positive lesions, FFR-guided PCI remained equally beneficial in patients ≥ 65 years old vs. < 65 years old



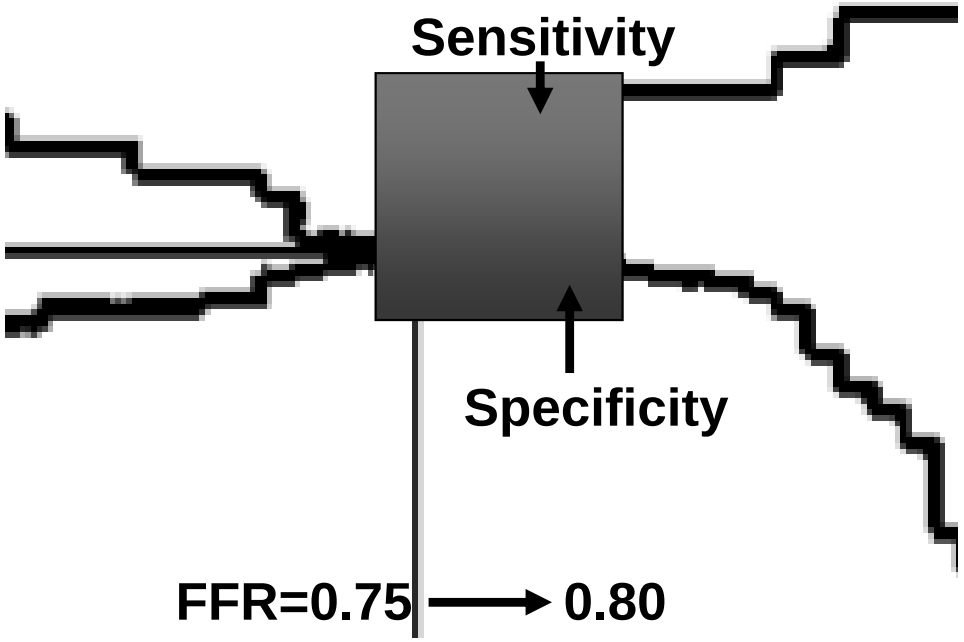
H.S. Lim, et al. TCT 2013

FFR and the “Grey Zone”



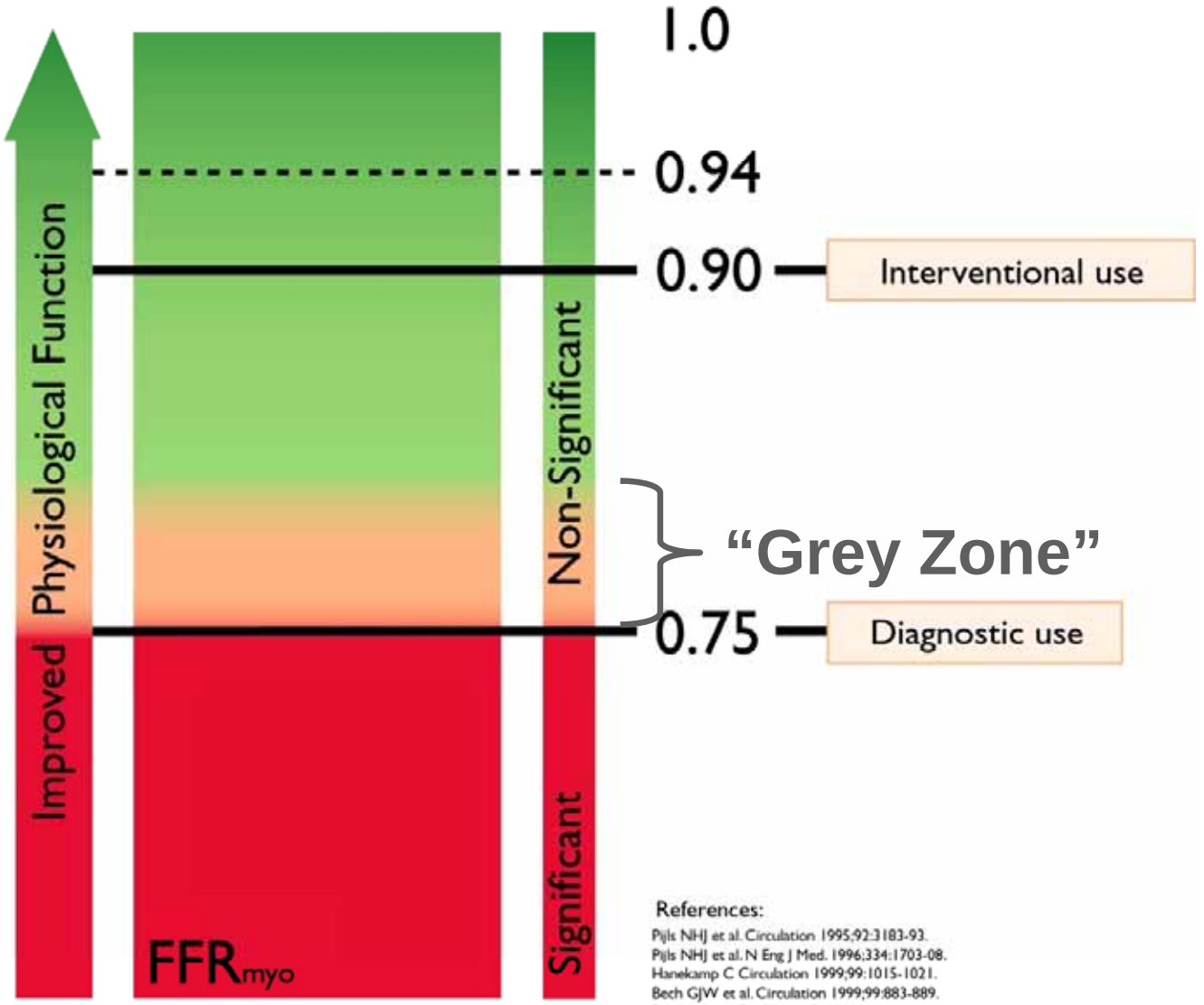
De Bruyne, et al. Circulation 2001;104:157-62

FFR and the “Grey Zone”



De Bruyne, et al. Circulation 2001;104:157-62

FFR for decision-making in the cath lab



Based on the teaching file of Paul G. Yock MD, Stanford University.

Note: The specificity of this cut-off value is 100% and the sensitivity is 88%.

References:
Pijls NHJ et al. Circulation 1995;92:3183-93.
Pijls NHJ et al. N Eng J Med. 1996;334:1703-08.
Hanekamp C Circulation 1999;99:1015-1021.
Bech GJW et al. Circulation 1999;99:883-889.
Pijls NHJ and De Bruyne B. 2000.
Coronary Pressure 2nd Edition. Kluwer Academic Publishers

When shouldn't we use FFR?

- Culprit vessel of acute STEMI

- Patient with typical symptoms, angiographically significant single vessel CAD, and a noninvasive test showing myocardial ischemia in the region subtended by the diseased vessel.

When should we use FFR?

- In patients with coronary narrowings <90% diameter stenosis and unclear, equivocal or absent noninvasive stress imaging studies.
  - Most commonly in patients with multivessel CAD.