FFR in Left Main Disease

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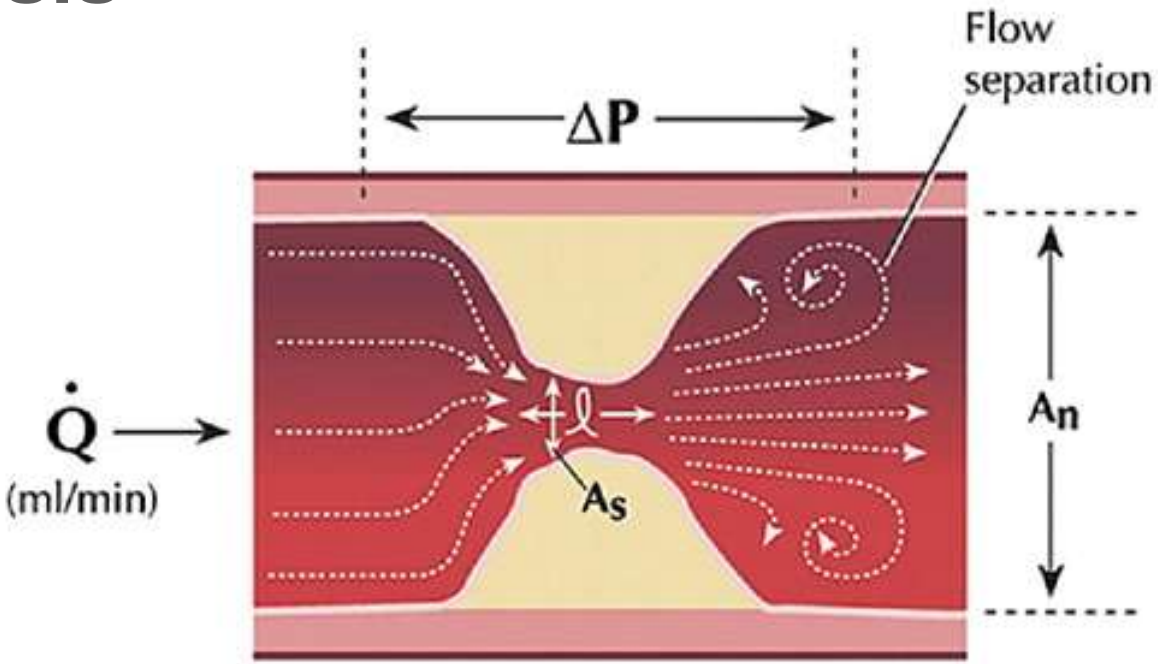
FFR of Left Main Disease

- Physiologic versus anatomic information
- Data supporting FFR assessment of LM
- Limitations/Practical Aspects of FFR of LM

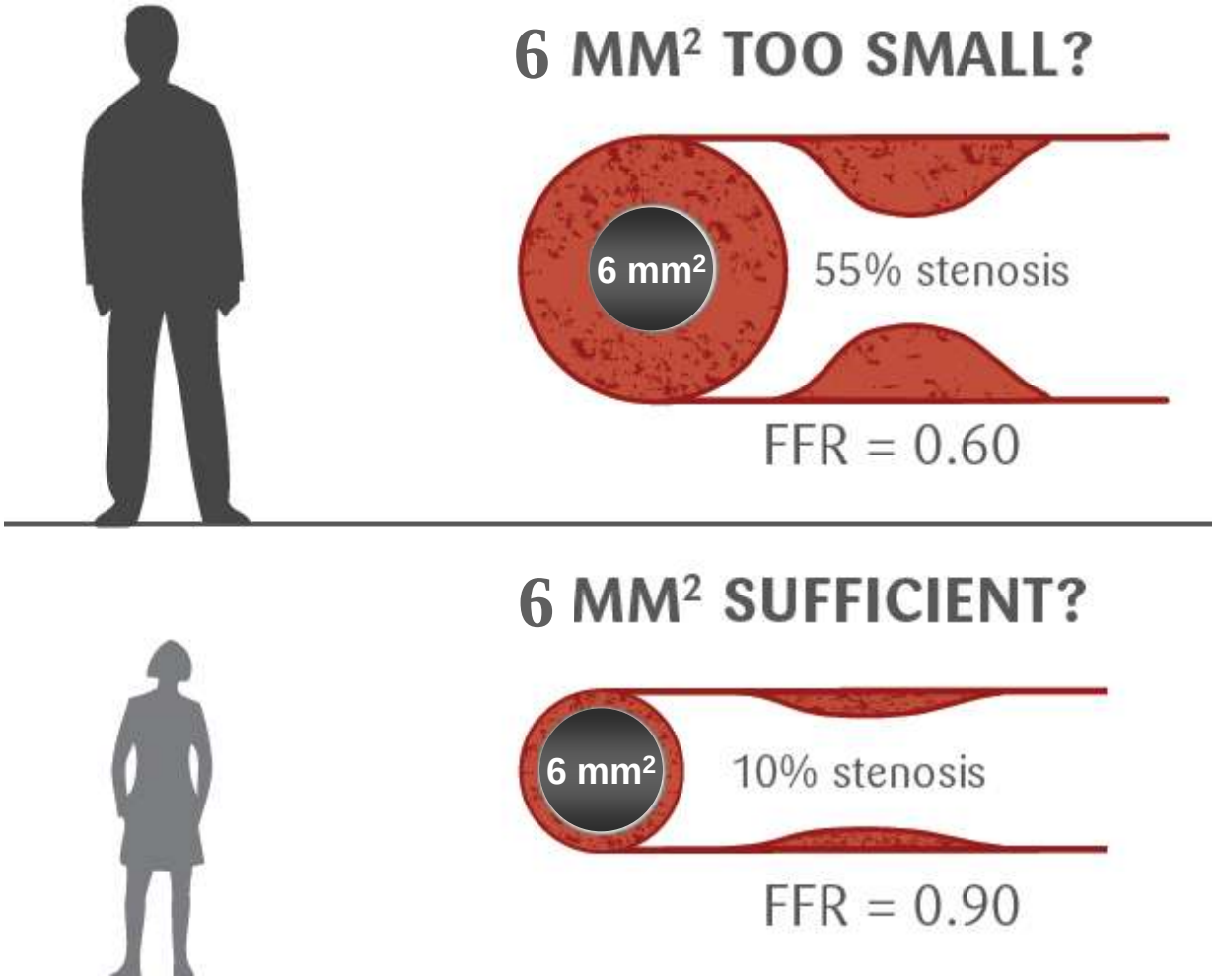
Factors impacting ischemic potential of a stenosis



$$\Delta P = \underbrace{f_1(1/A_s^2, \ell, \dot{Q})}_{\text{Viscous}} + \underbrace{f_2(1/A_s^2, 1/A_n^2, \dot{Q}^2)}_{\text{Separation}}$$

Braunwald's Heart Disease 2005, 7th edition, vol.2, p.1112.

Variability of IVUS Cuttoff Values



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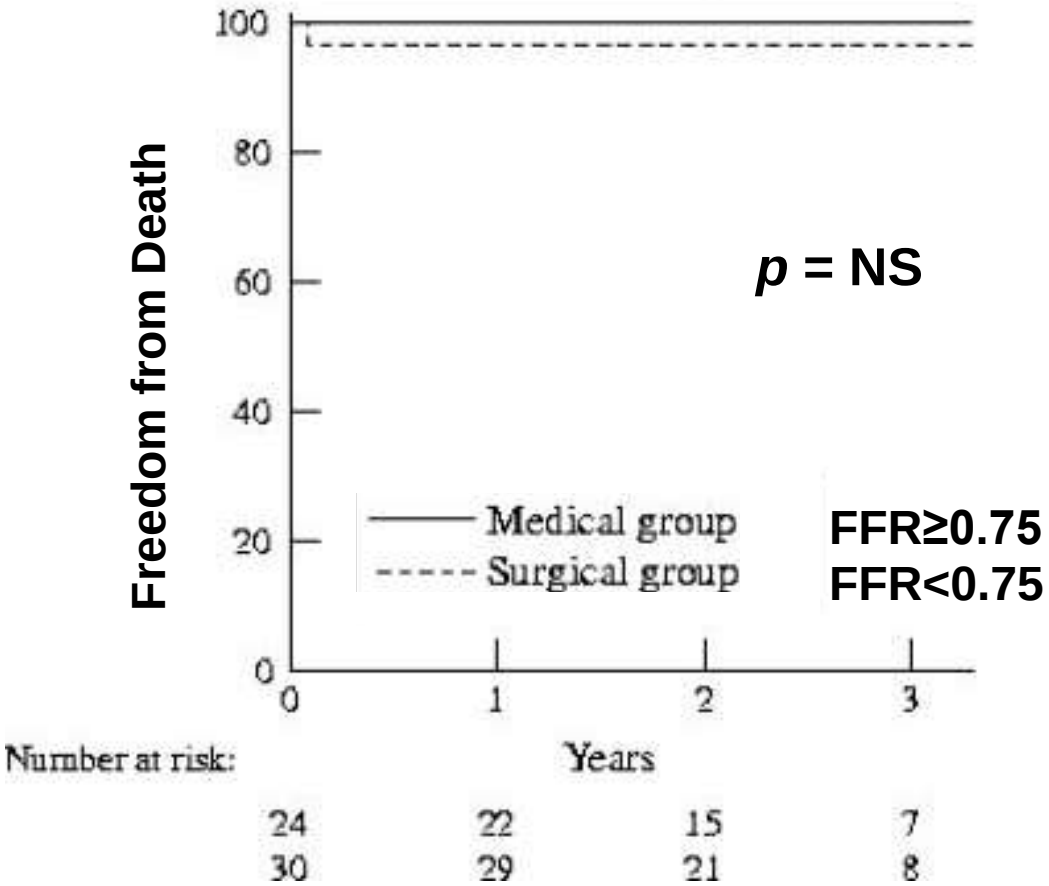
Is it safe to defer LM Rx based on FFR?

FFR measured in 54 patients with equivocal left main



Bech, et al. Heart 2001;86:547-552

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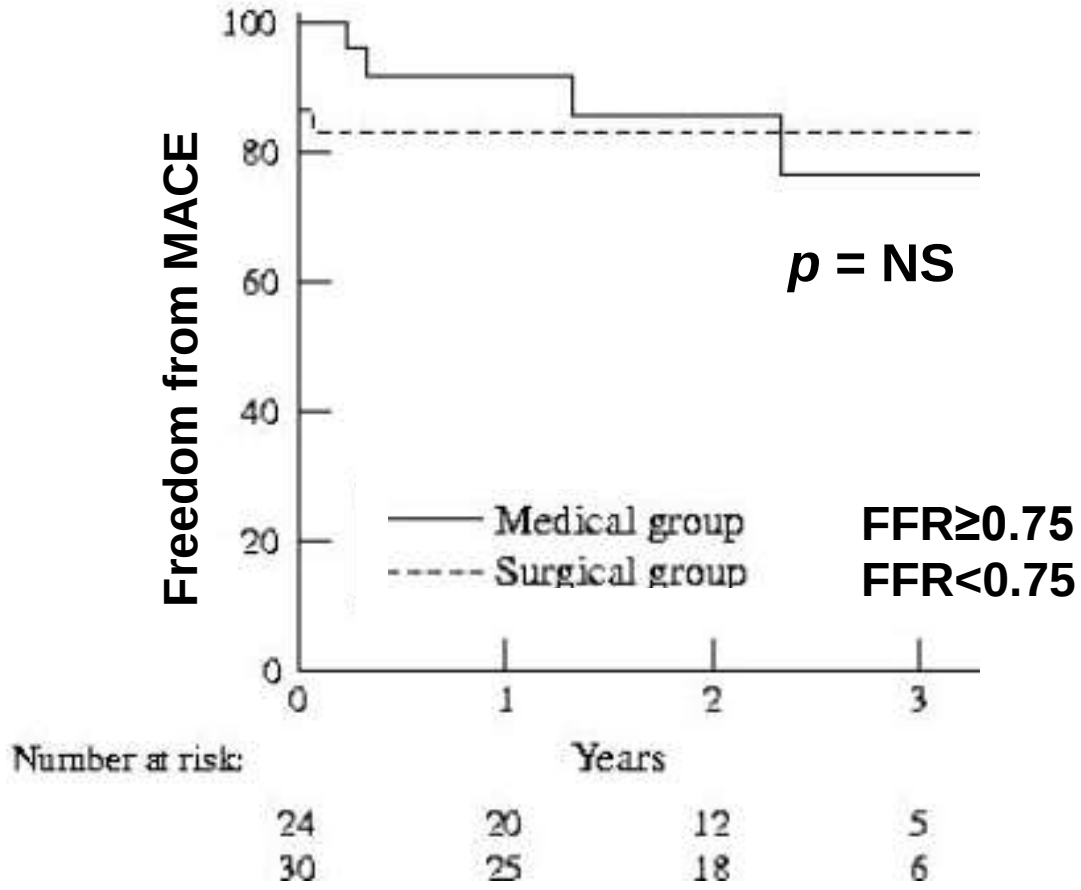
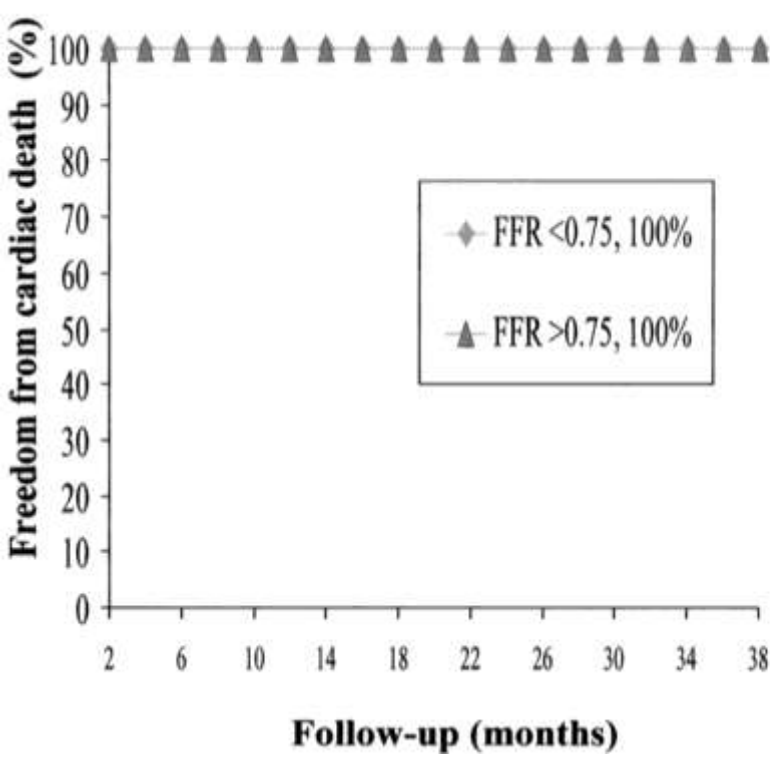
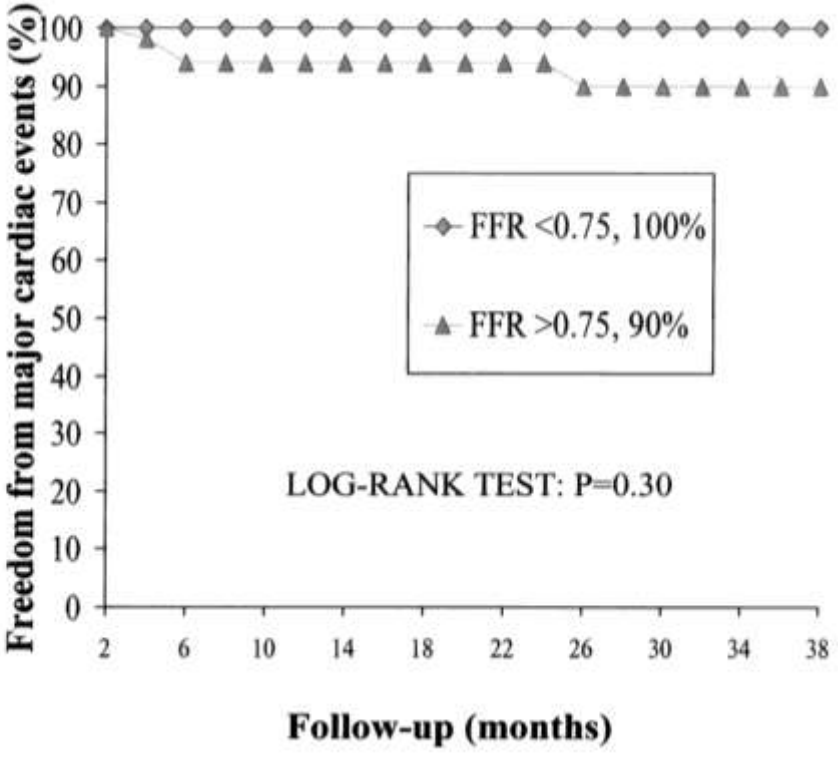


Bech, et al. Heart 2001;86:547-552

Is it safe to defer LM Rx based on FFR?

55 patients with ambiguous left main disease





Jasti, et al. Circulation 2004;110:2831-6

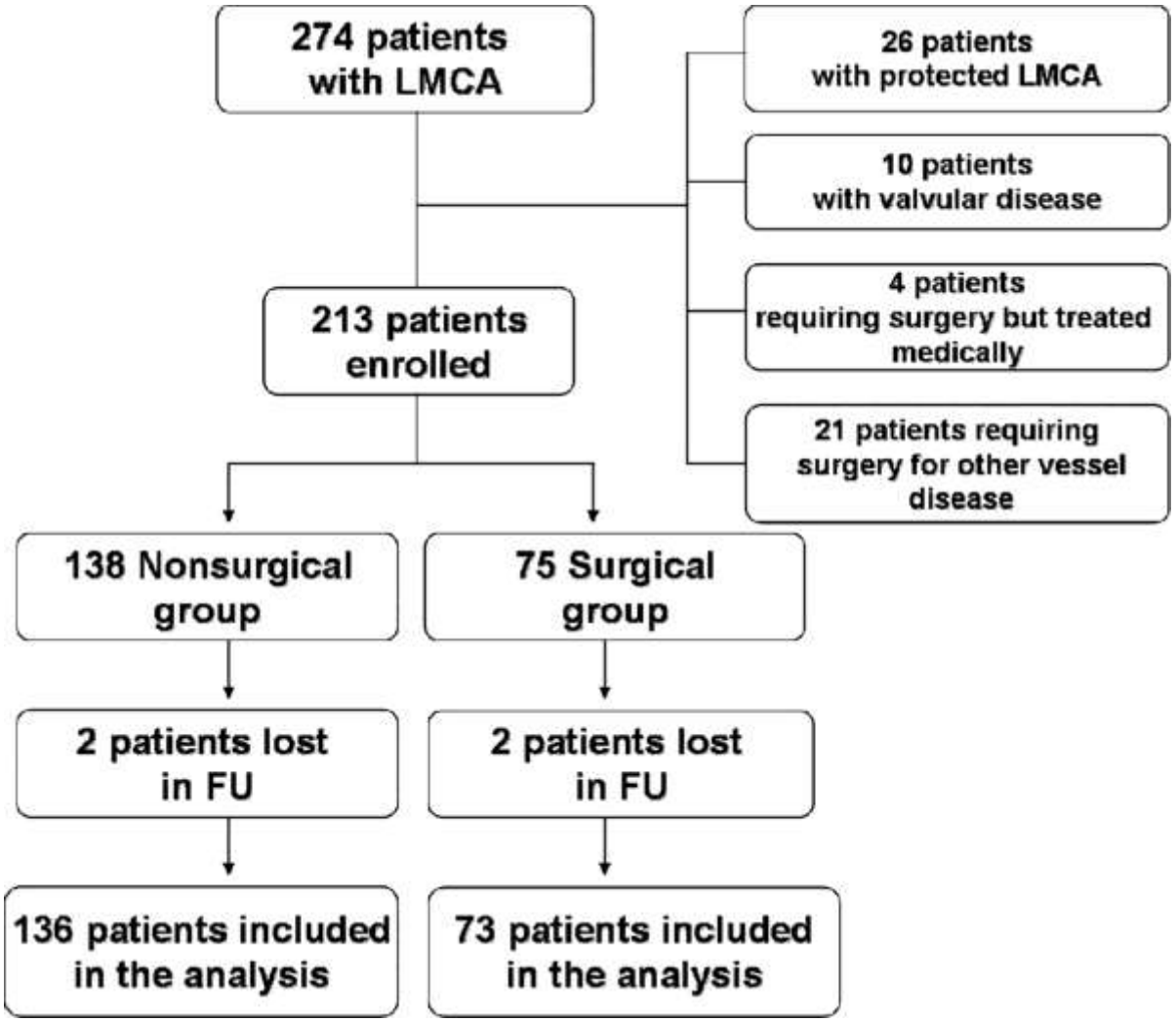
FFR for Assessing LM Significance

Summary of Published Studies

Patient #			FFR	FU	EFS		Survival	
Total population	Defer group*	Surgical group	Cut-off value	Mean (months)	Defer group* (%)	Surgical group (%)	Defer group* (%)	Surgical group (%)
54	24	30	0.75	29±15	76	83	100	97
51	37	14	0.75	25±11	90	100	100	100
27	20	7	0.75	26±12	90	86	100	86
38	20	18	0.75	24±12	90	89	100	89
15	8	7	0.75	33±10	100	71	100	100
51	24	27	0.75	29±16	69	66	100	81
(236)	(133)	(103)						

Lindstaedt. Int J Cardiol 2008;130:326

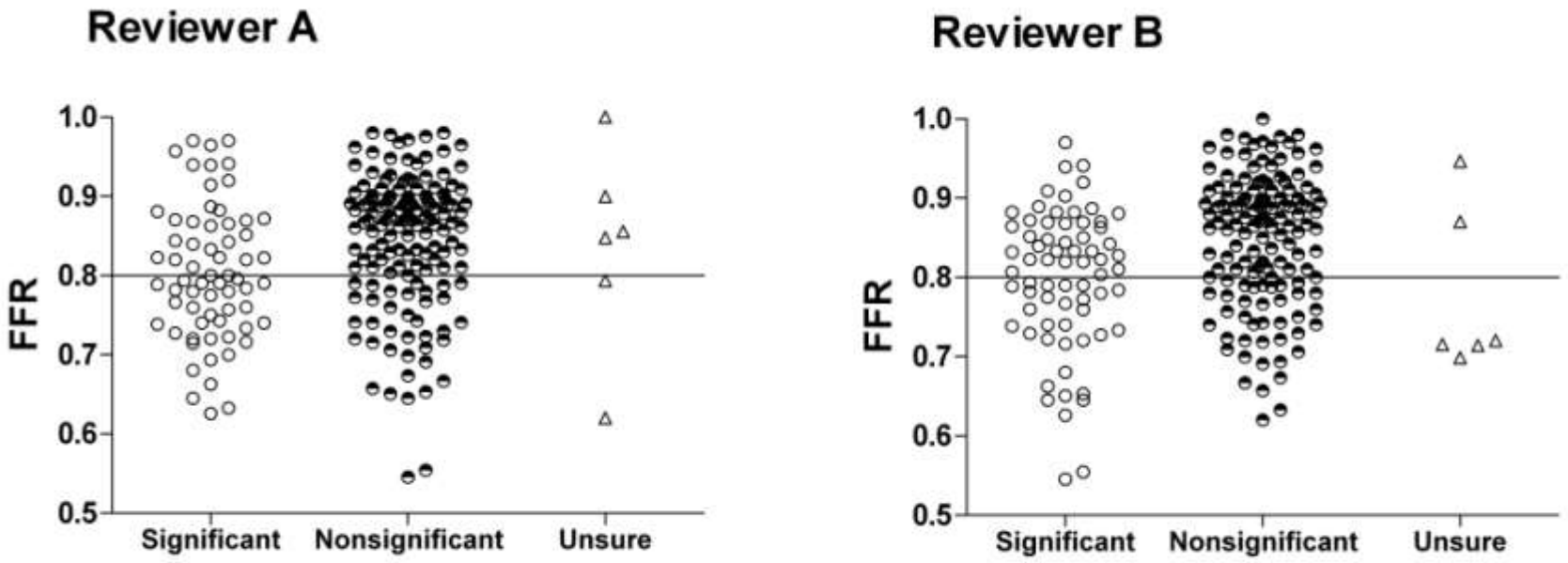
FFR and Intermediate Left Main



Hamilos, et al. Circulation 2009;120:1505

FFR for Assessing LM Significance

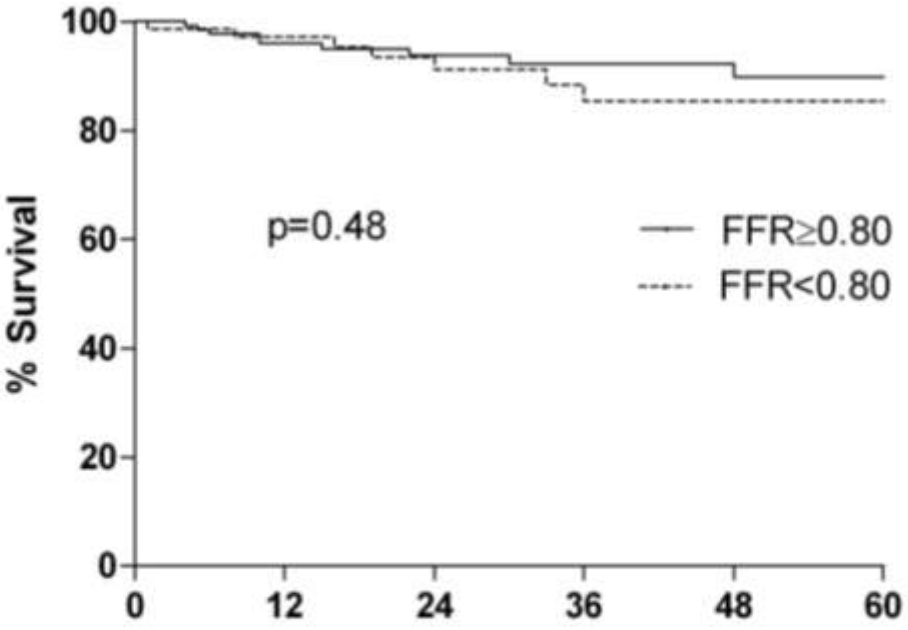
Poor correlation between "eyeball" and FFR



Hamilos, et al. Circulation 2009;120:1505

FFR for Assessing LM Significance

Survival Rate

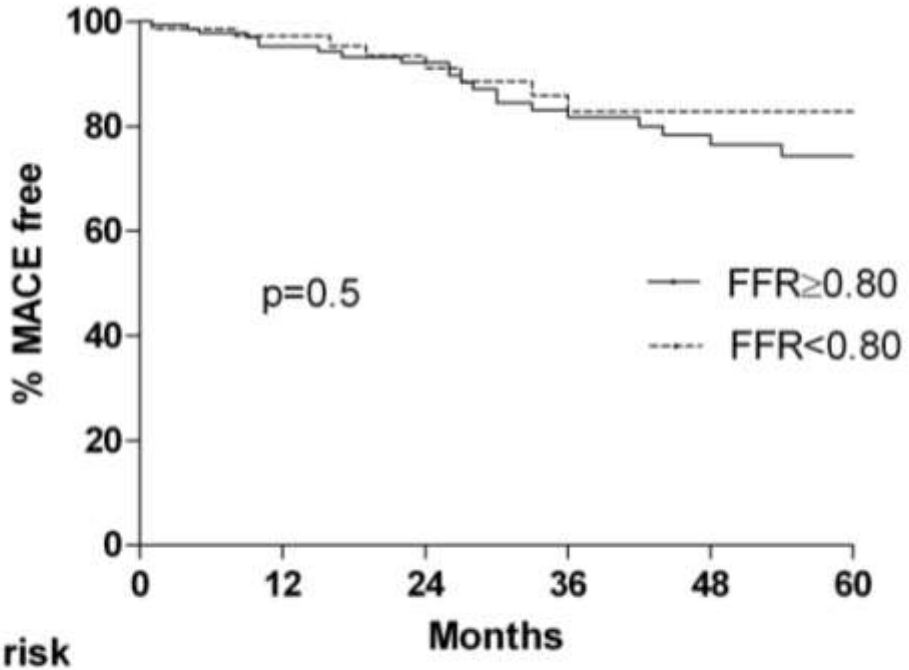


No at risk						
FFR≥0.80	136	103	72	52	38	26
FFR<0.80	73	56	41	30	14	10

Hamilos, et al. Circulation 2009;120:1505

FFR for Assessing LM Significance

MACE Rate



No at risk						
FFR≥0.80	136	106	77	57	42	30
FFR<0.80	73	56	40	29	15	10

Hamilos, et al. Circulation 2009;120:1505

FFR of Left Main Disease

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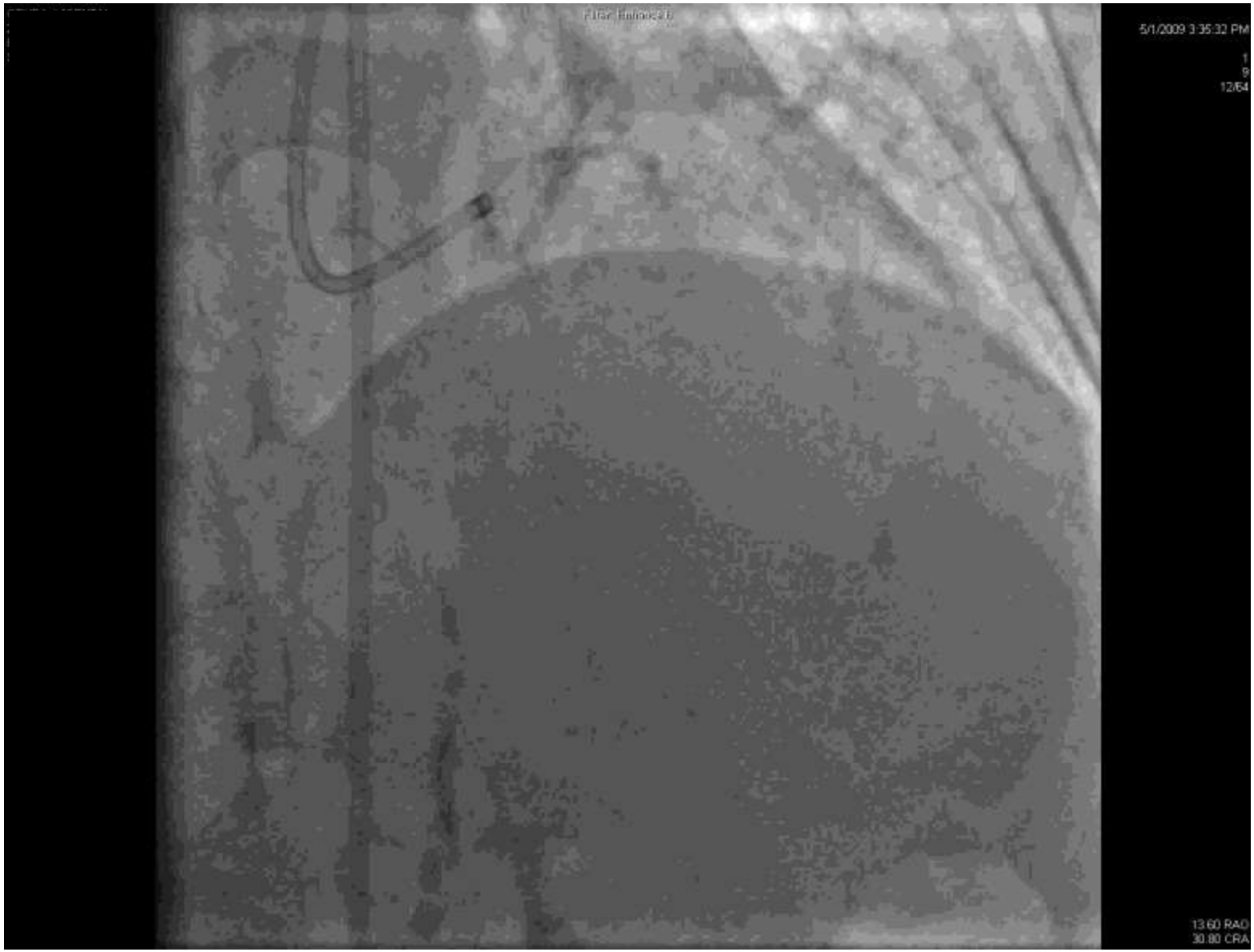
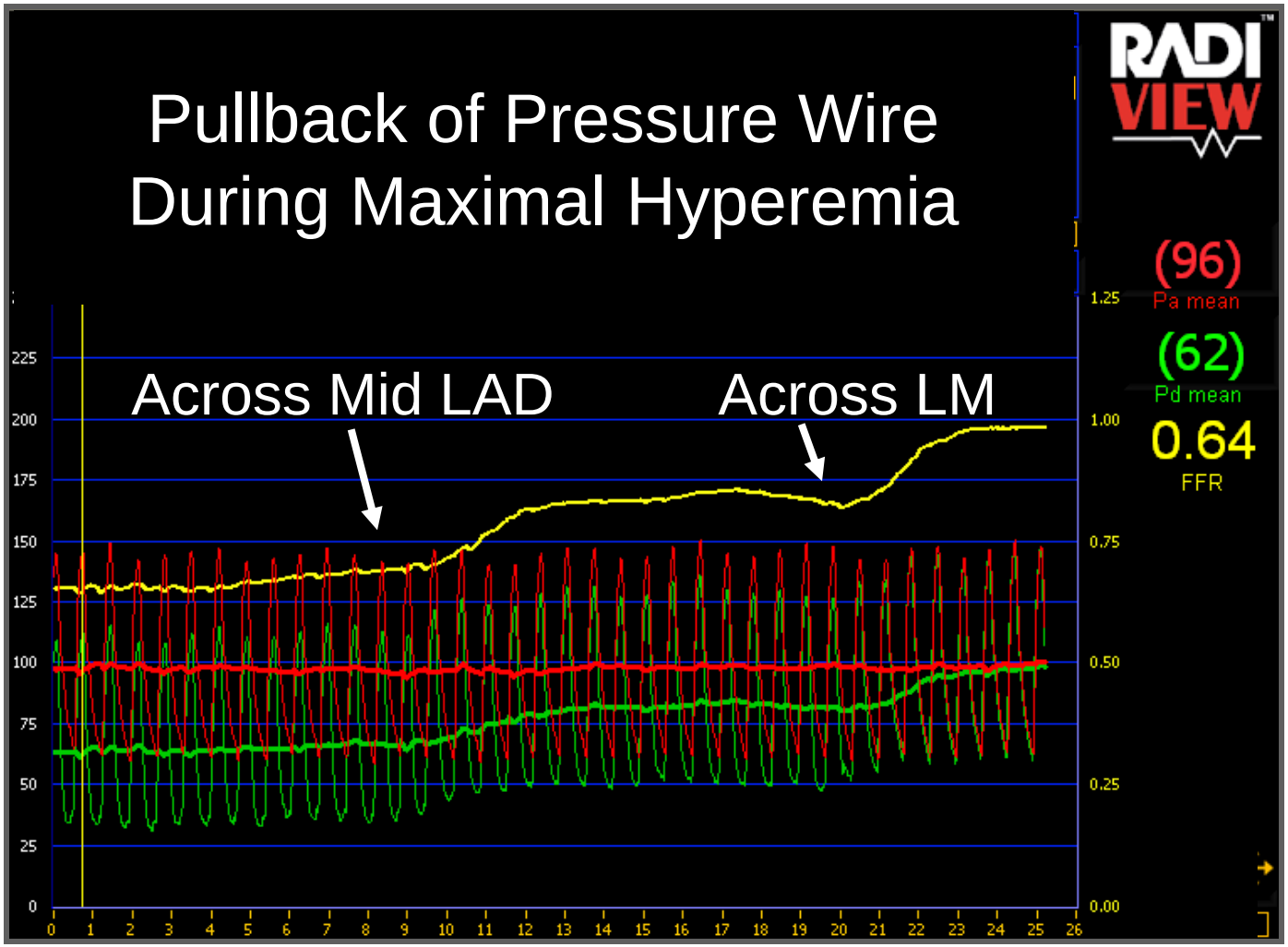

5/1/2009 3:35:32 PM
1
9
12/64
13.60 RAO
30.80 CRA

FFR of Left Main



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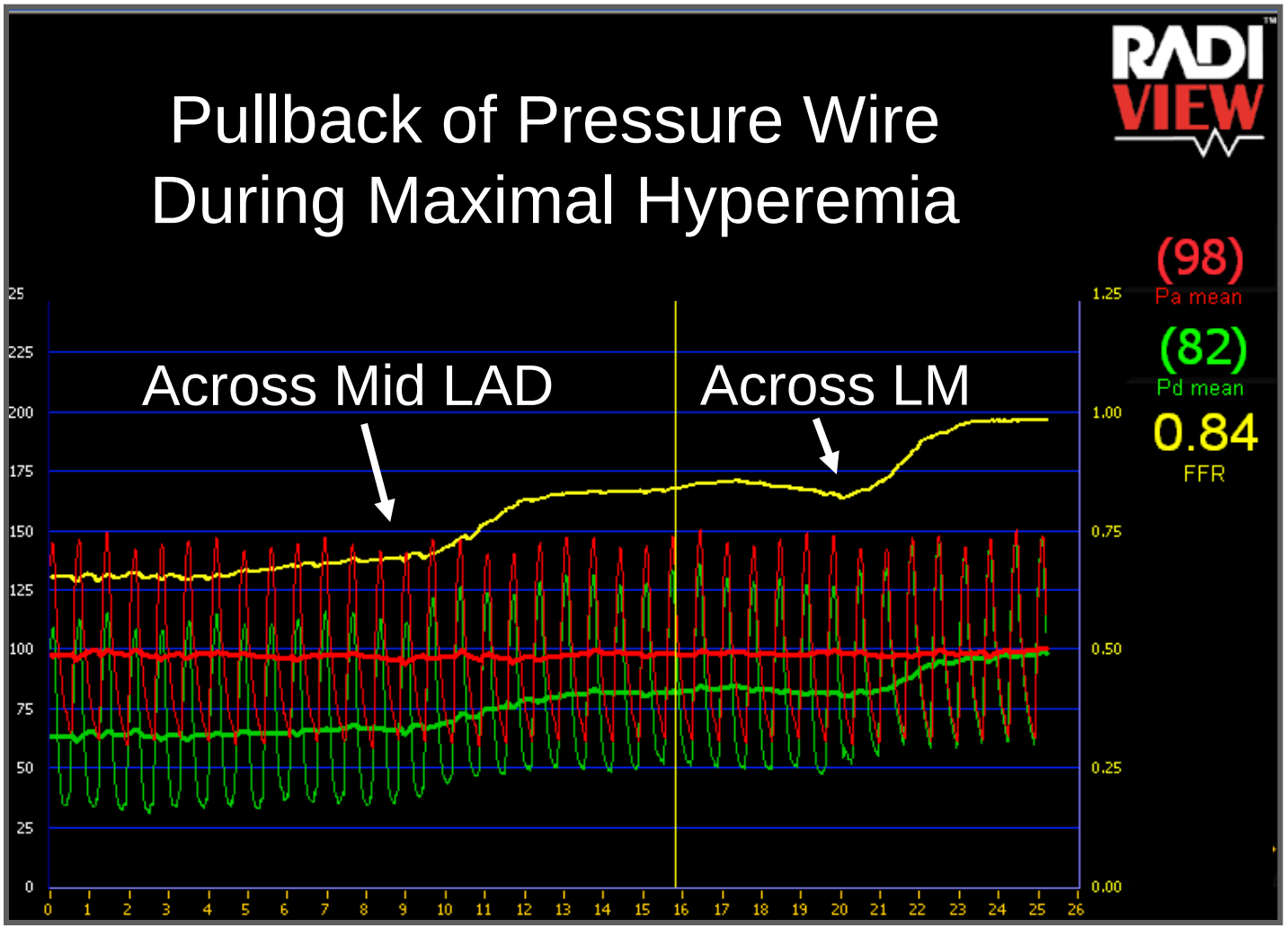
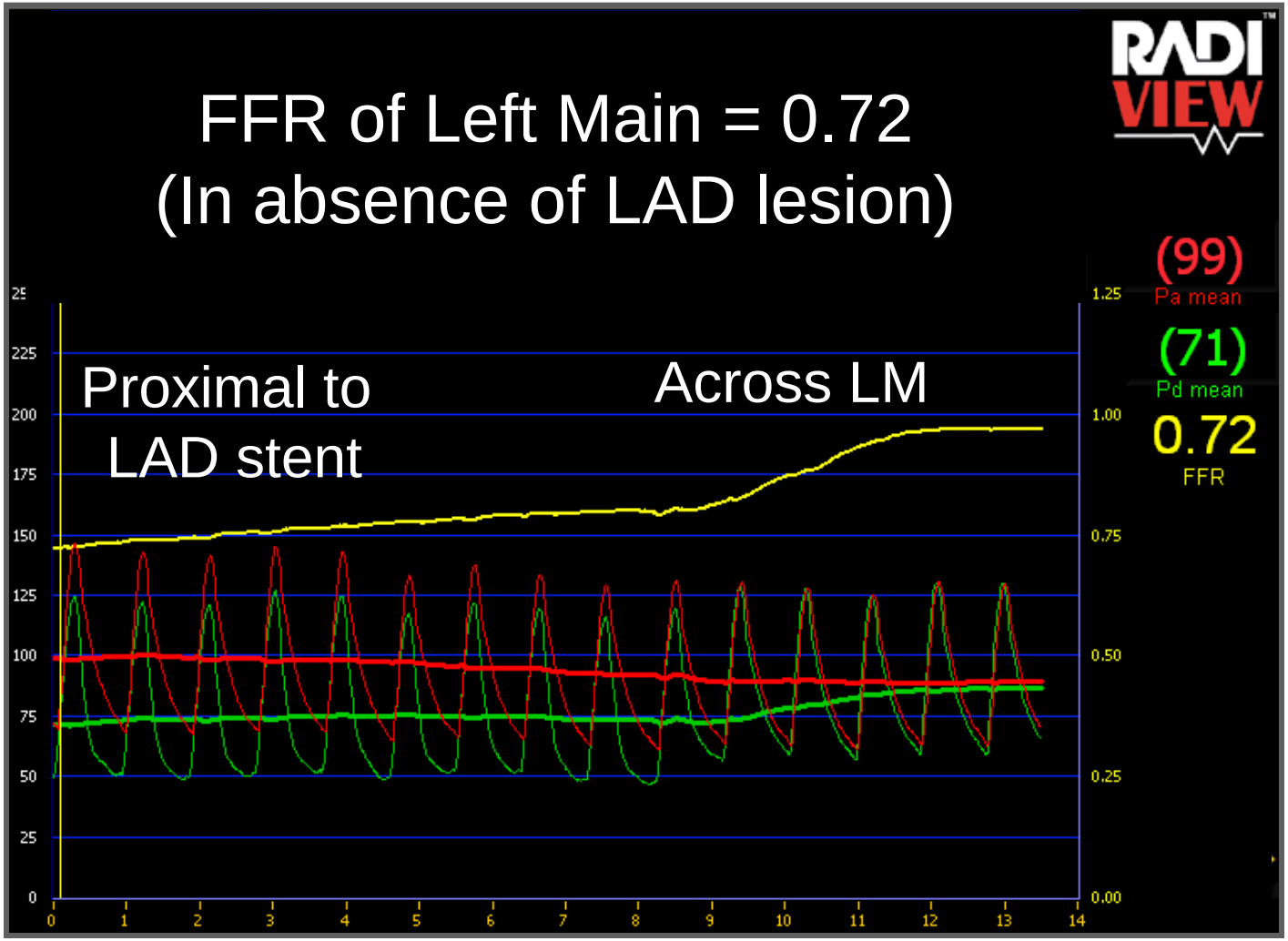
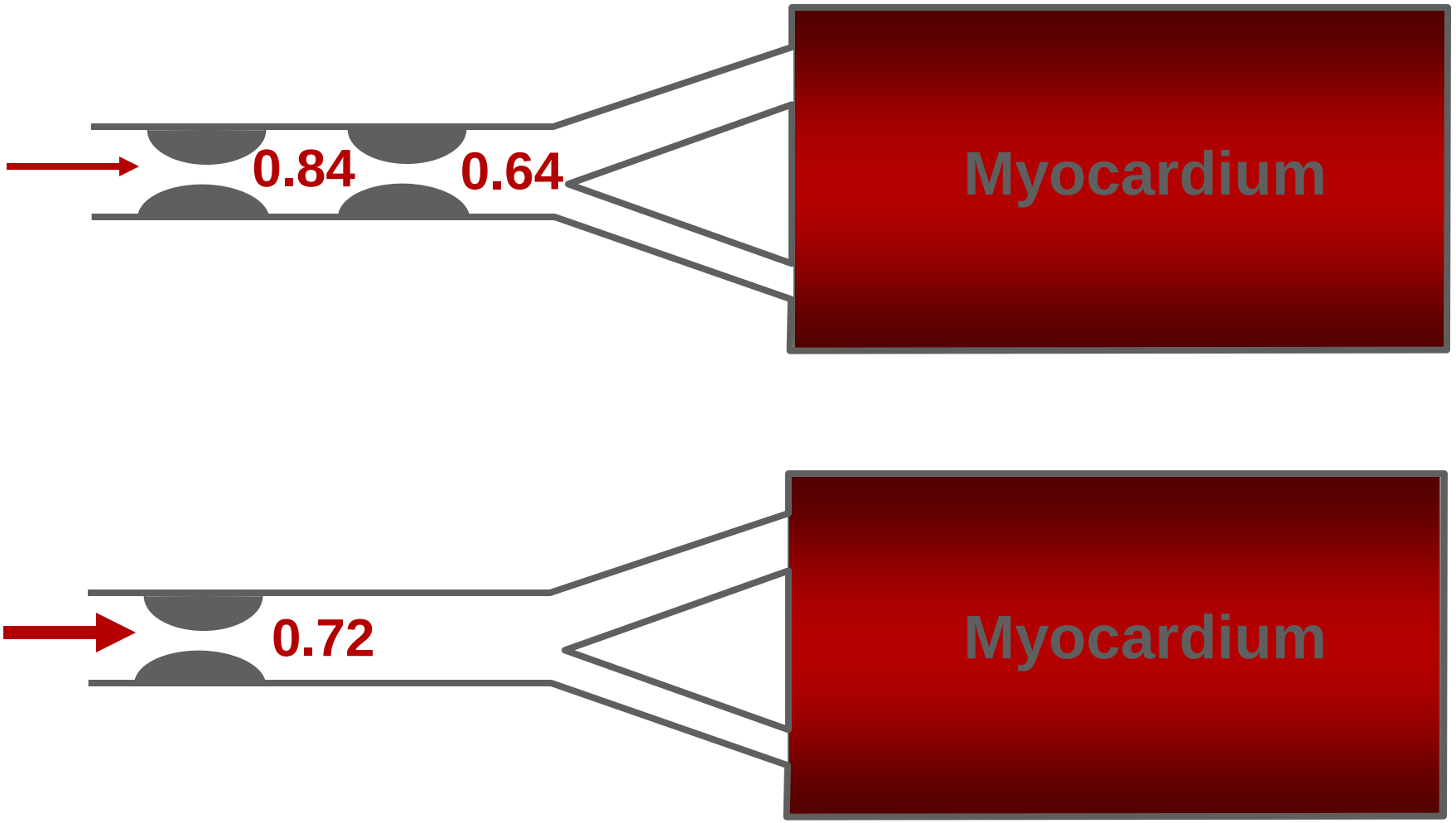


After rotational atherectomy and 2.5x28 mm DES, post-dilated to 3.0 mm

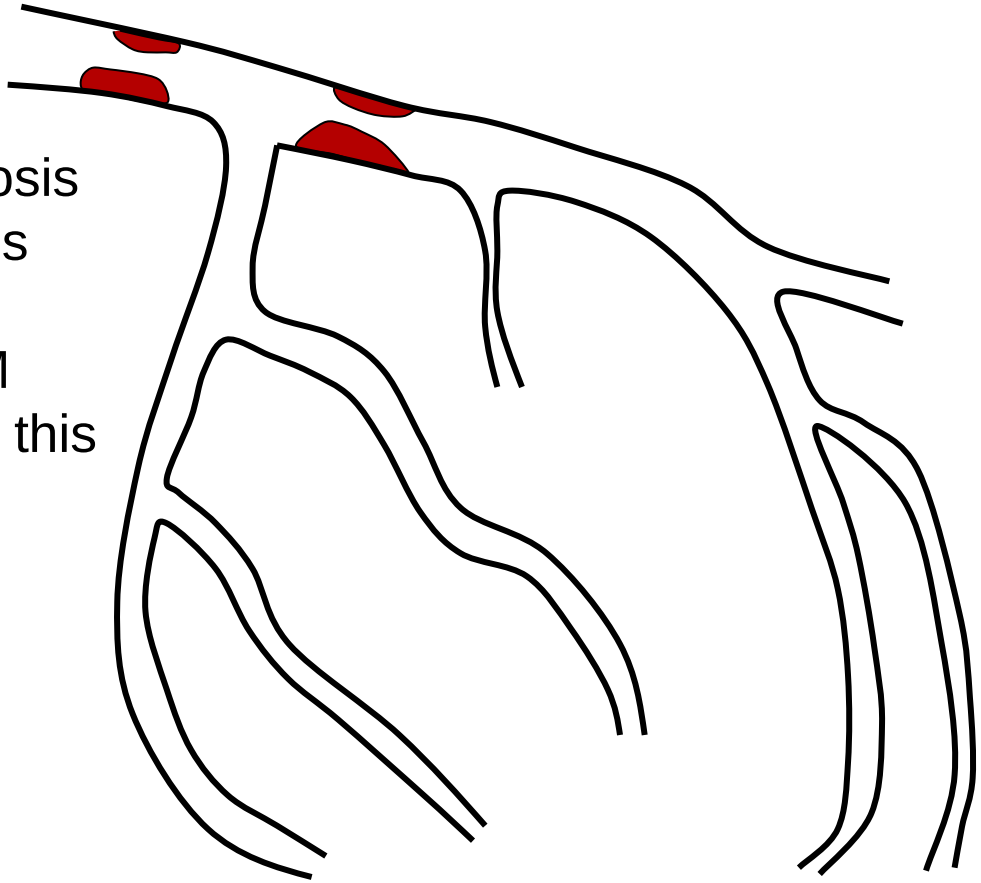
FFR of Left Main



Effect of Tandem Lesions



Left Main Stem Stenoses are Rarely Isolated



The influence of a distal stenosis on the FFR of the LM depends on the extent to which hyperemic flow across the LM stenosis will be decreased by this distal lesion

- Severity
- Myocardial mass

Courtesy Bernard De Bruyne, MD, PhD

Left Main Stem Stenoses are Rarely Isolated

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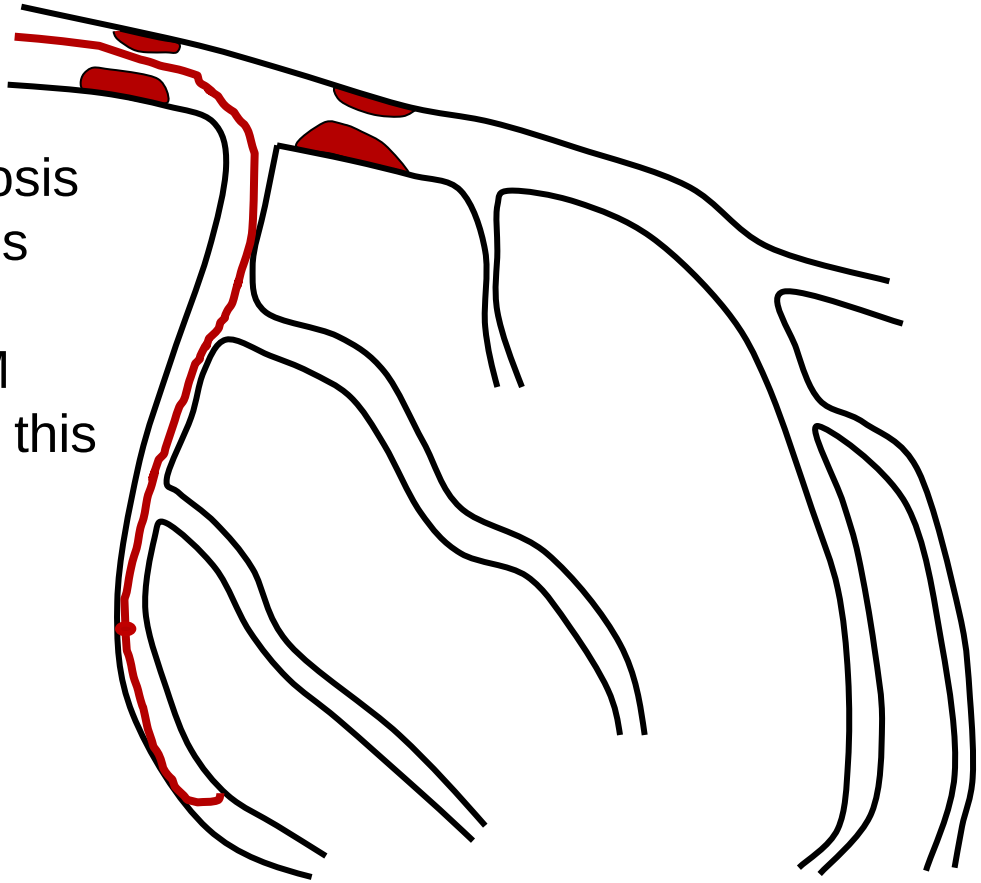

Courtesy Bernard De Bruyne, MD, PhD

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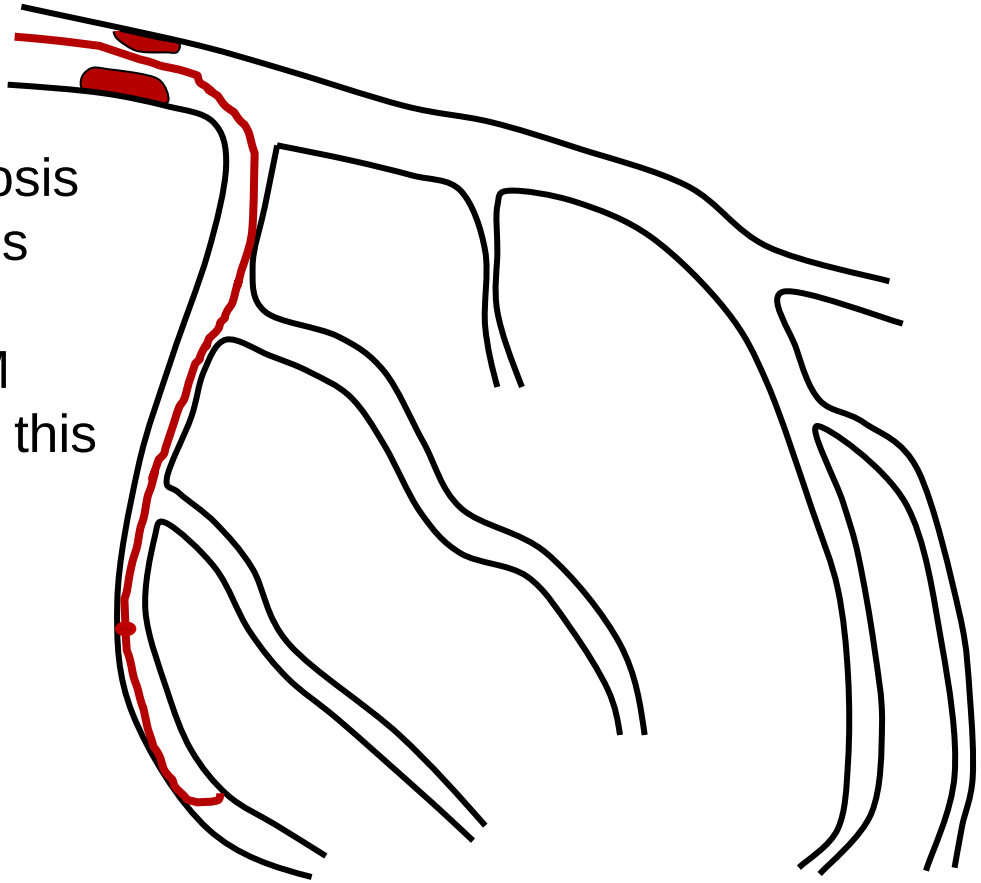


Courtesy Bernard De Bruyne, MD, PhD

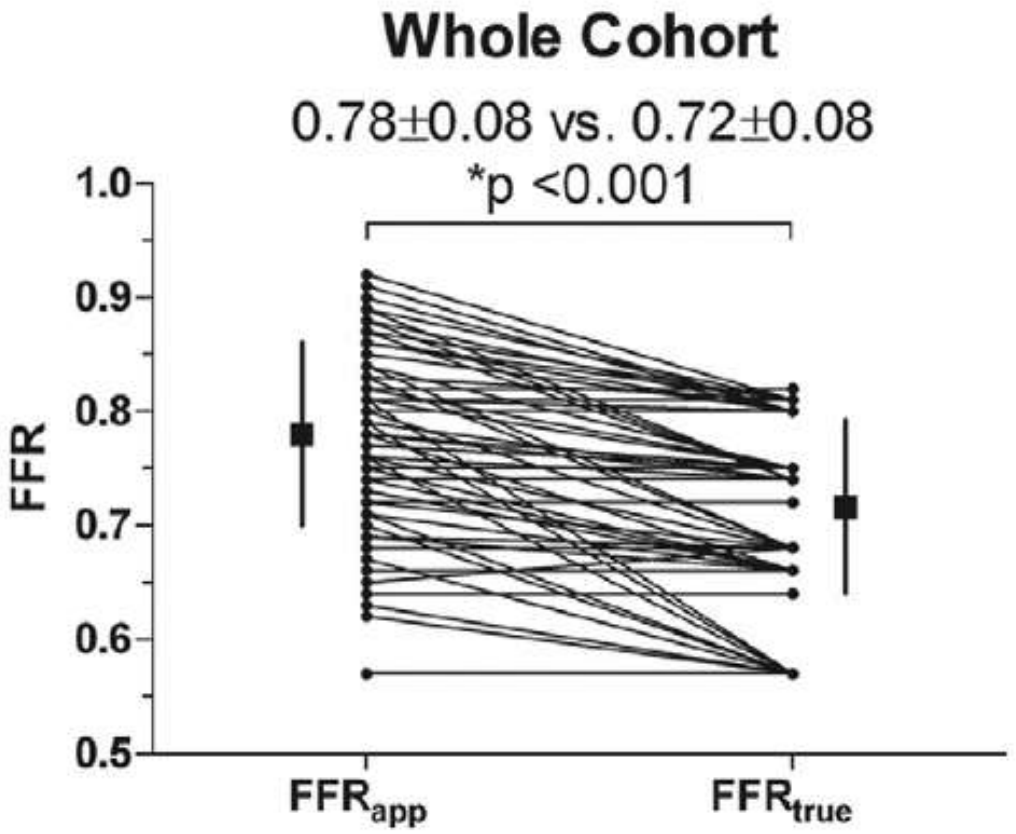
Effect of Epicardial Lesions on FFR Assessment of Intermediate LM Disease

In Vitro Model

Daniels, et al. J Am Coll Cardiol Intv 2012;5:1021-5.

Effect of Epicardial Lesions on FFR Assessment of Intermediate LM Disease

In Vitro Model



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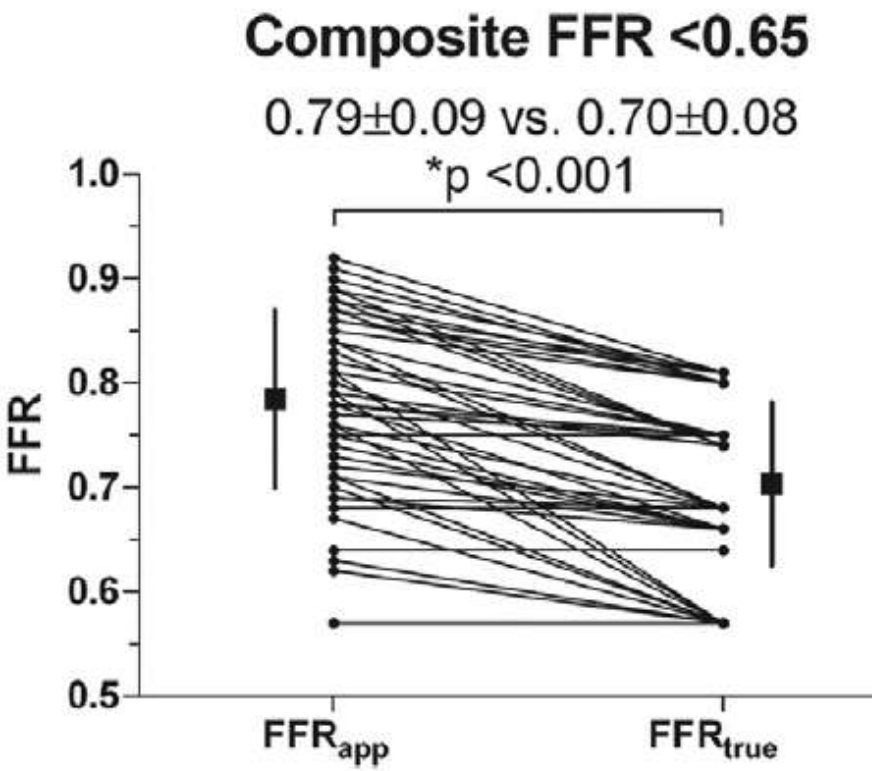

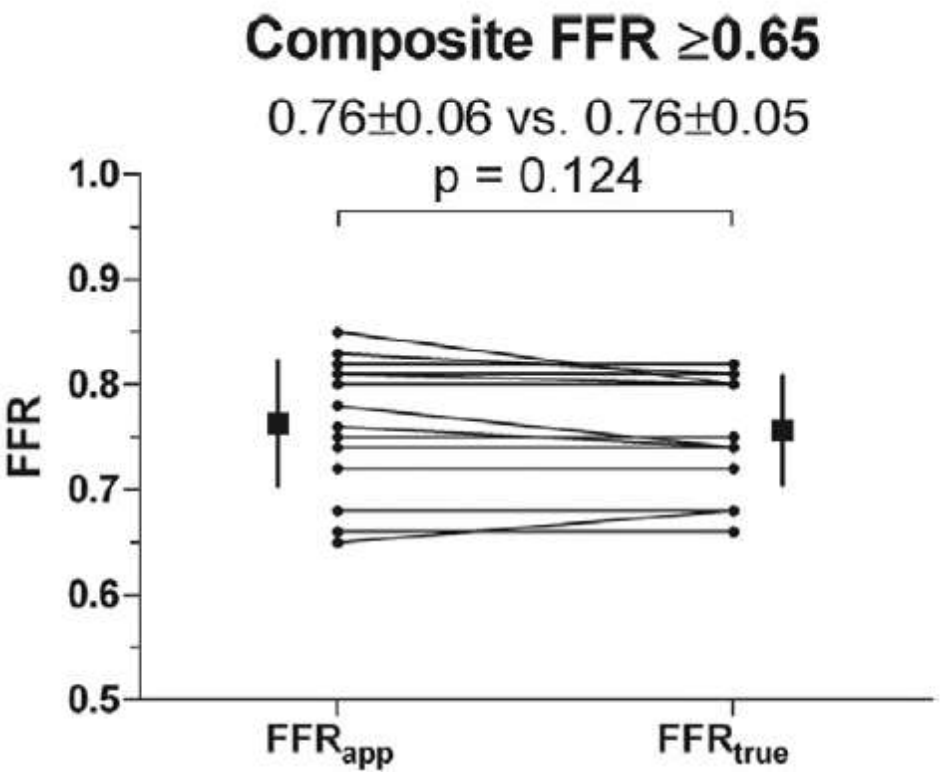

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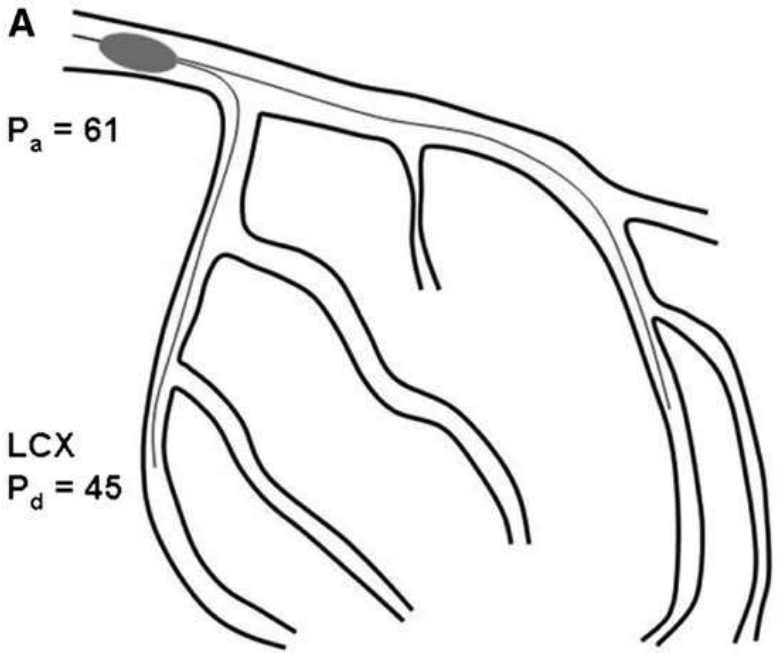
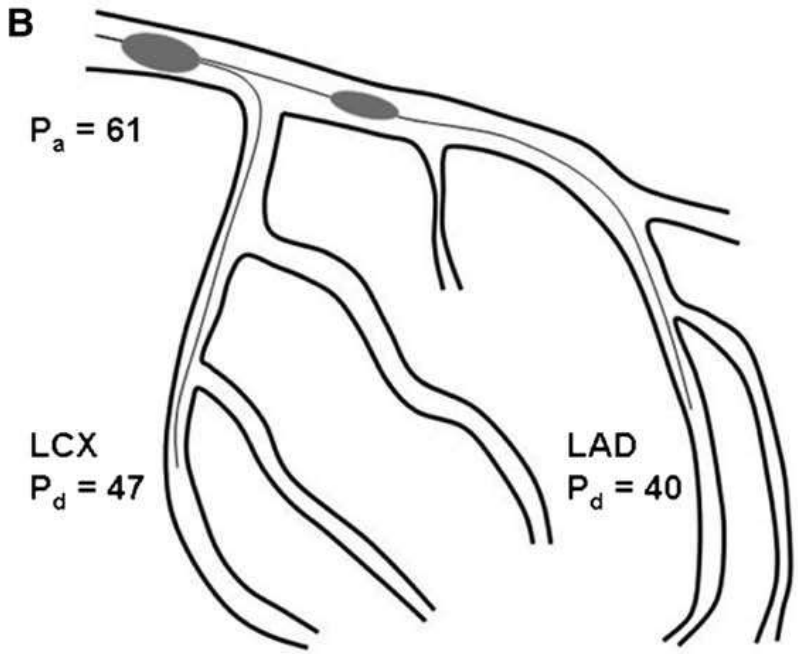
Effect of Epicardial Lesions on FFR Assessment of Intermediate LM Disease

Animal Model



FFR_{true} = 45/61 = 0.74



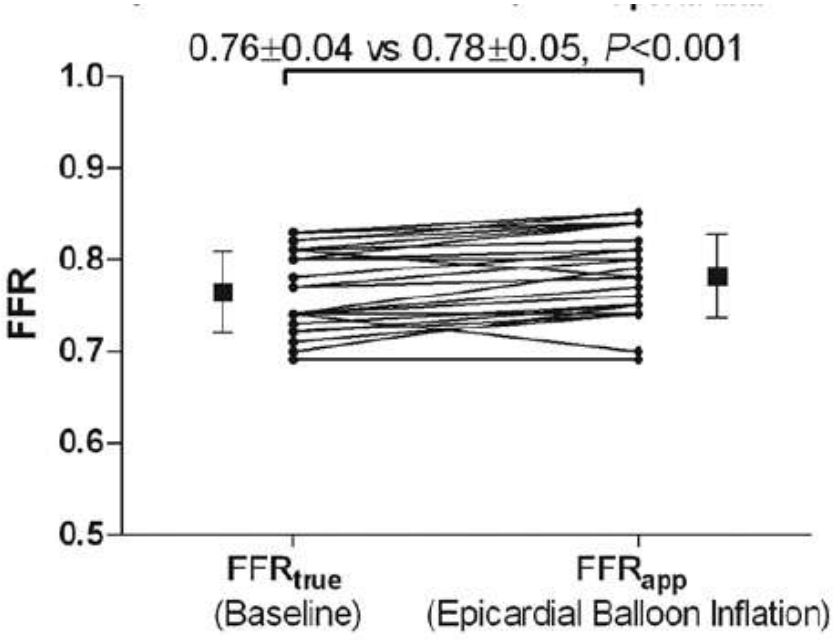
FFR_{app} = 47/61 = 0.77 $FFR_{epicardial}$ = 40/61 = 0.66

Yong, et al. Circ Cardiovasc Interv 2013;6:161-5.

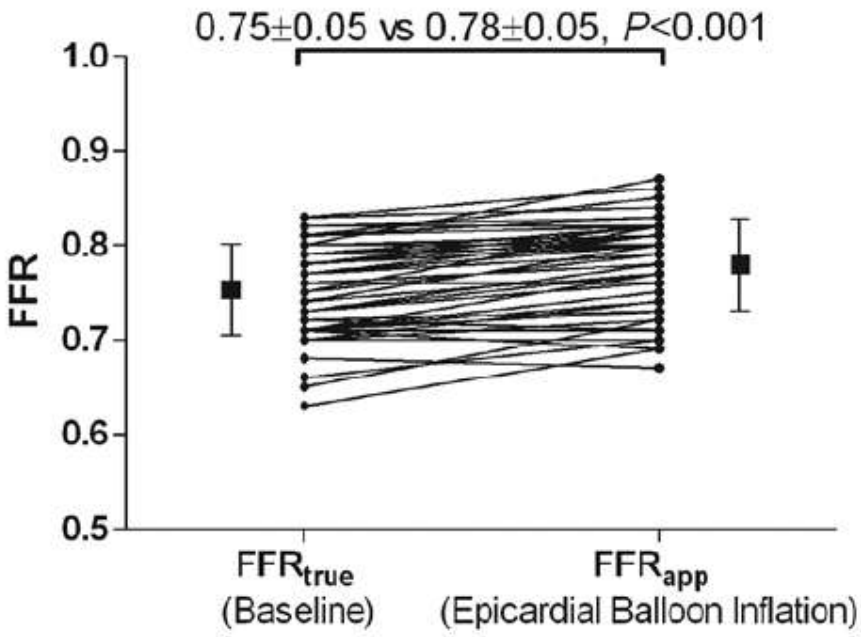
Effect of Epicardial Lesions on FFR Assessment of Intermediate LM Disease

Animal Model

Mild Epicardial Disease
($FFR_{epicardial}$ 0.70-0.80)



Moderate Epicardial Disease
($FFR_{epicardial}$ 0.60-0.69)

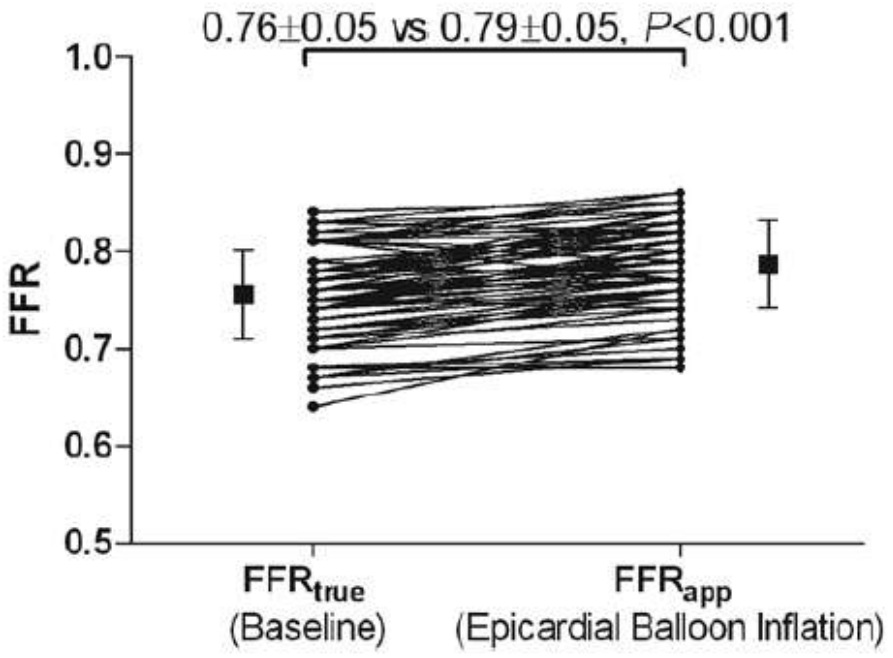


Yong, et al. Circ Cardiovasc Interv 2013;6:161-5.

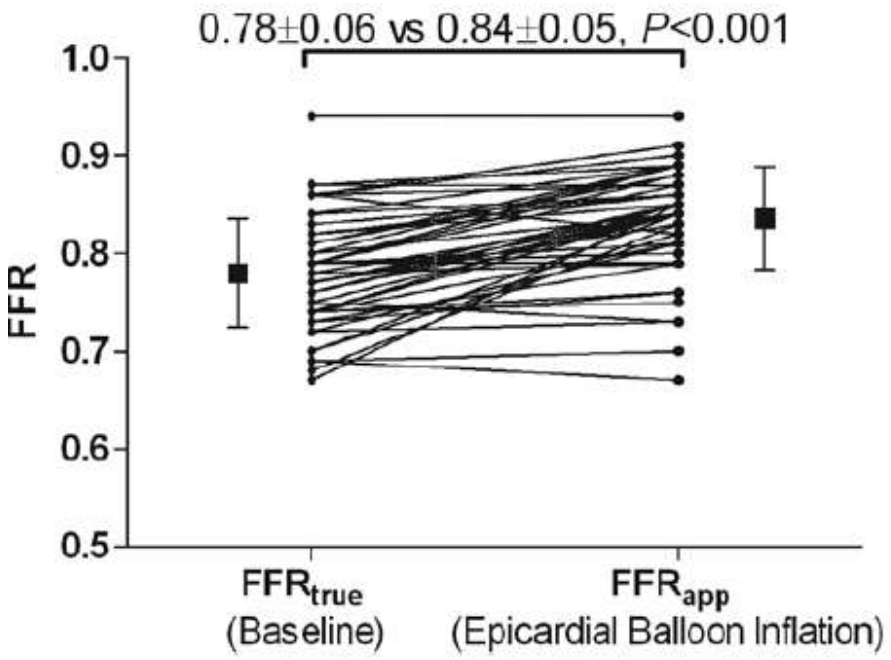
Effect of Epicardial Lesions on FFR Assessment of Intermediate LM Disease

Animal Model

Severe Epicardial Disease
($FFR_{epicardial}$ 0.40-0.59)



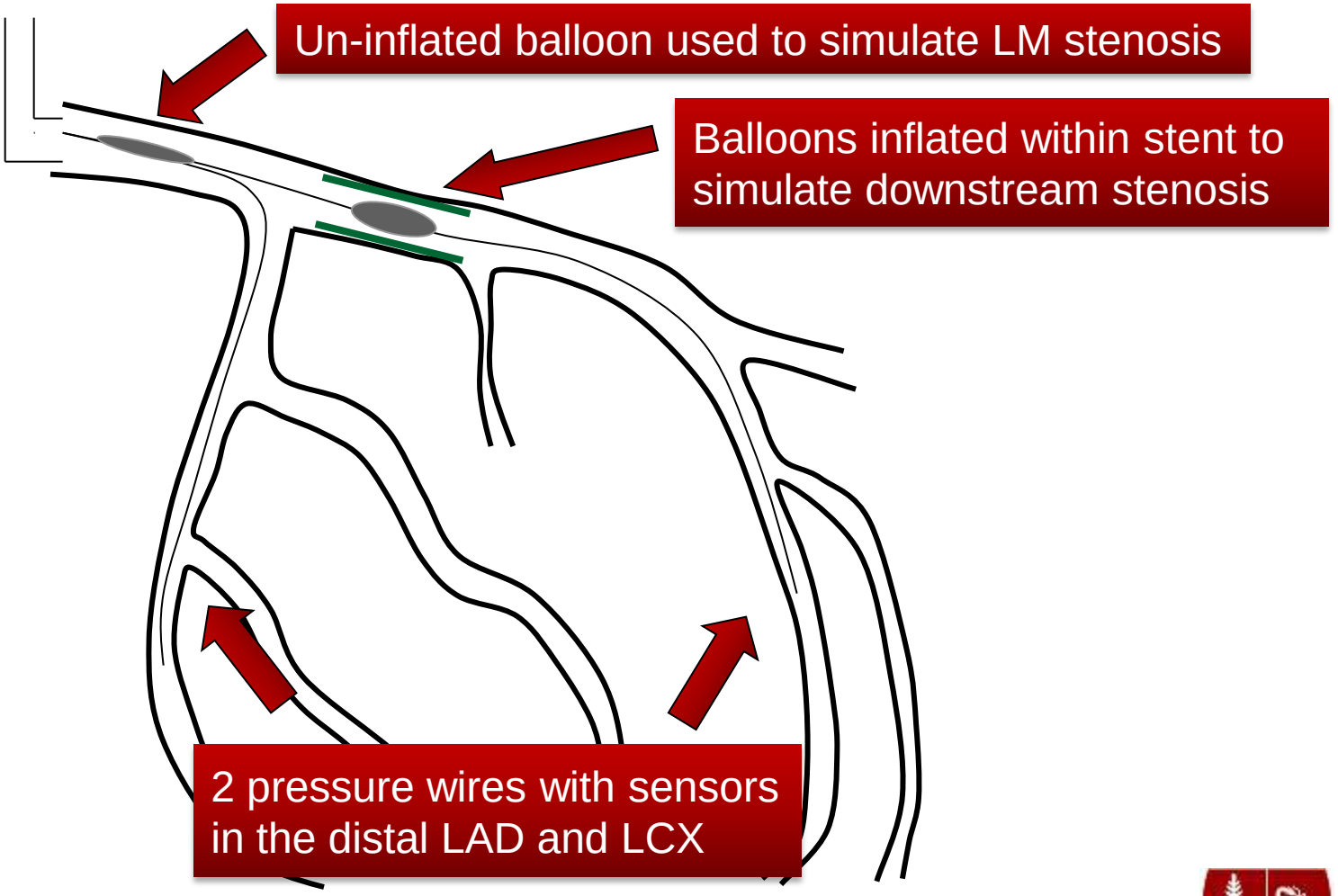
Complete Epicardial Occlusion
($FFR_{epicardial}$ < 0.40)



Yong, et al. Circ Cardiovasc Interv 2013;6:161-5.

Effect of Downstream Stenosis on LM FFR:

Human Validation

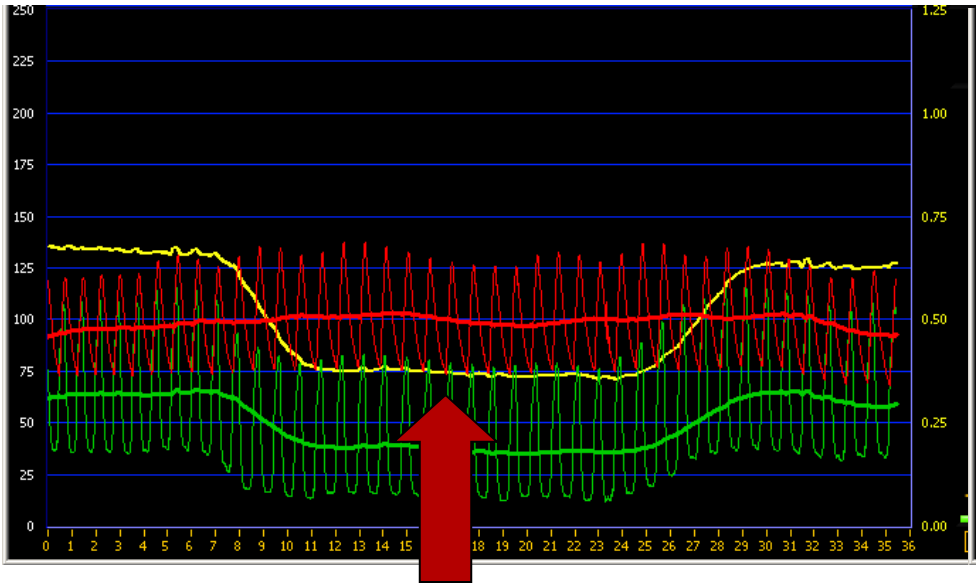


Yong, et al. Circulation 2012;126:A11981.

Effect of Downstream Stenosis on LM FFR:

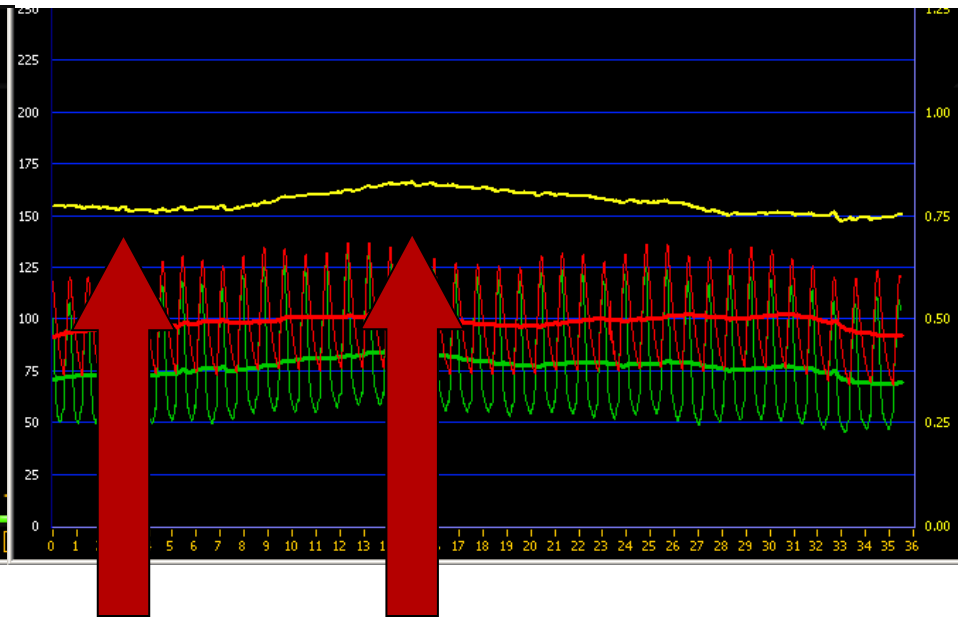
Human Validation

Pressure wire in LAD:



Balloon inflated in LAD
Epicardial FFR 0.35

Pressure wire in LCX (LMain FFR):



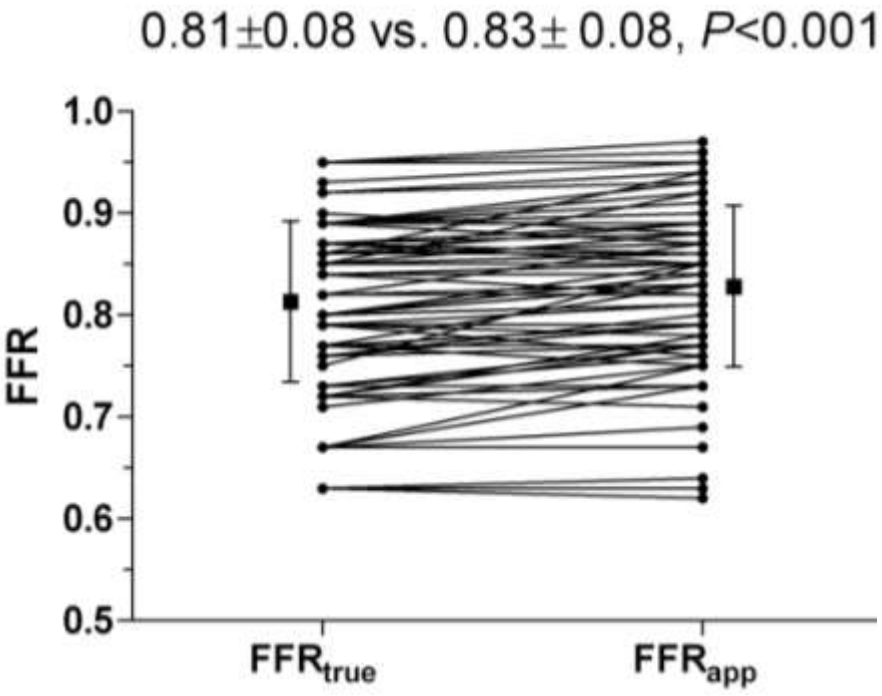
FFR without balloon inflation 0.76
FFR with balloon inflation 0.84

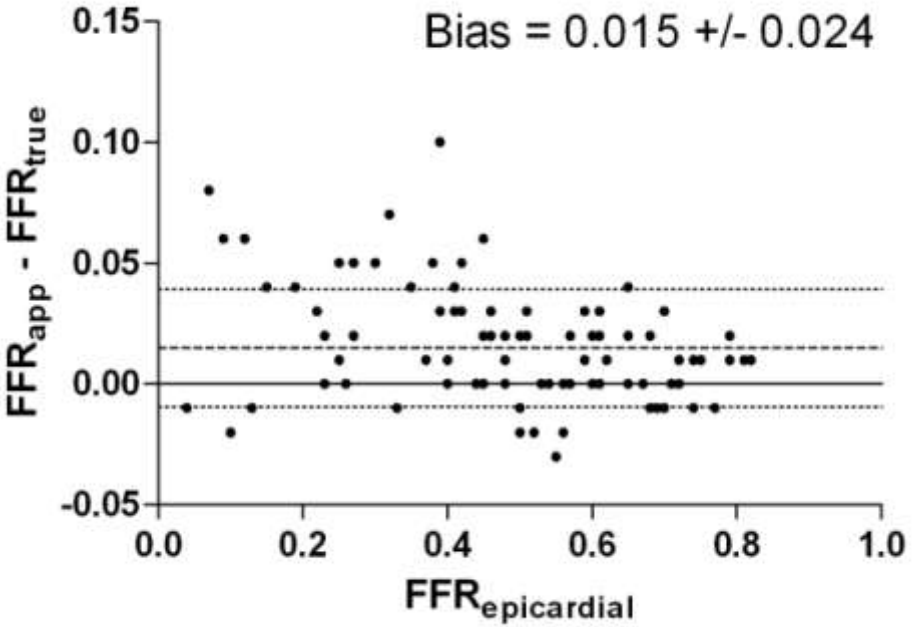
Yong, et al. Circulation 2012;126:A11981.

Effect of Downstream Stenosis on LM FFR:

Human Validation

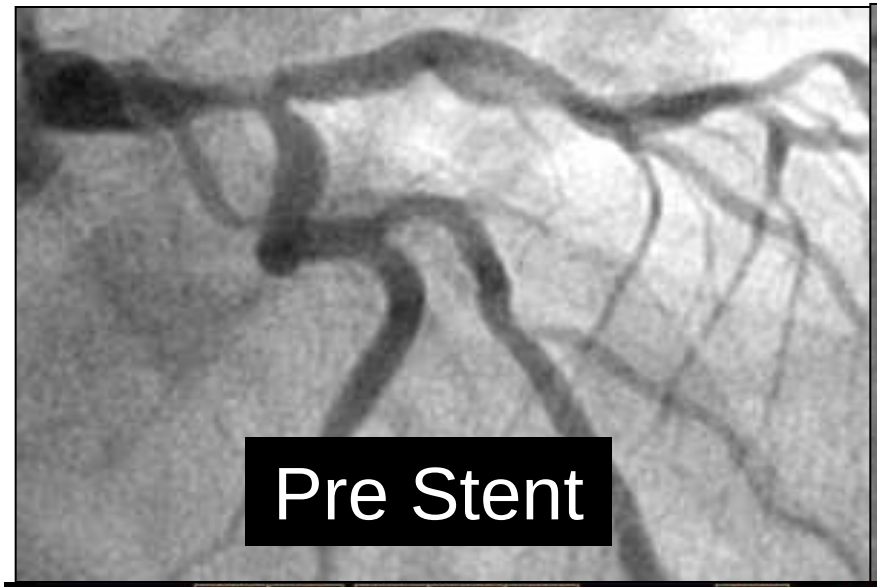
91 paired measurements obtained in 24 patients

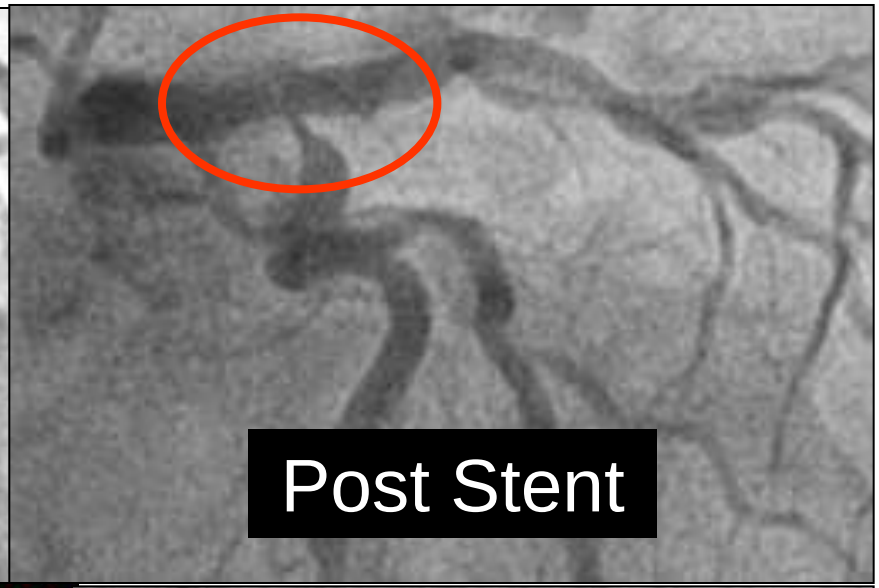


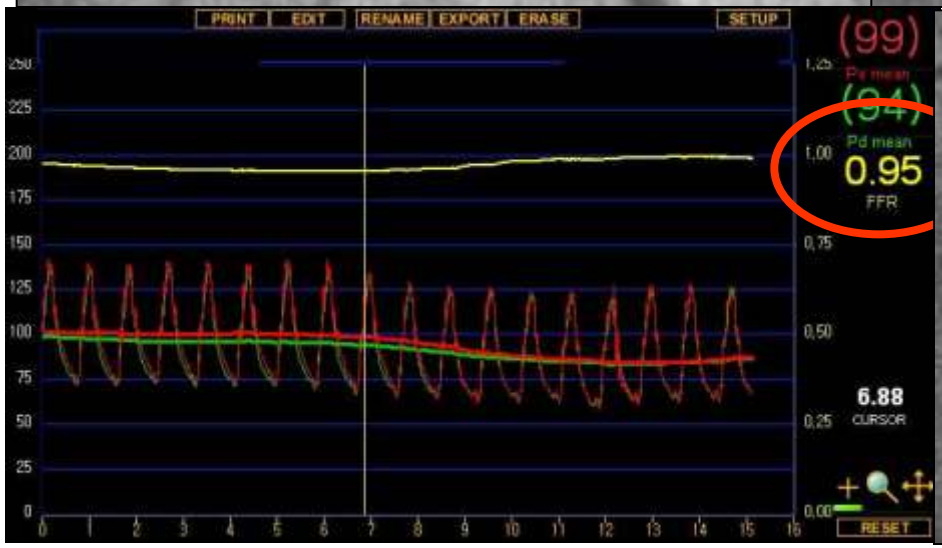


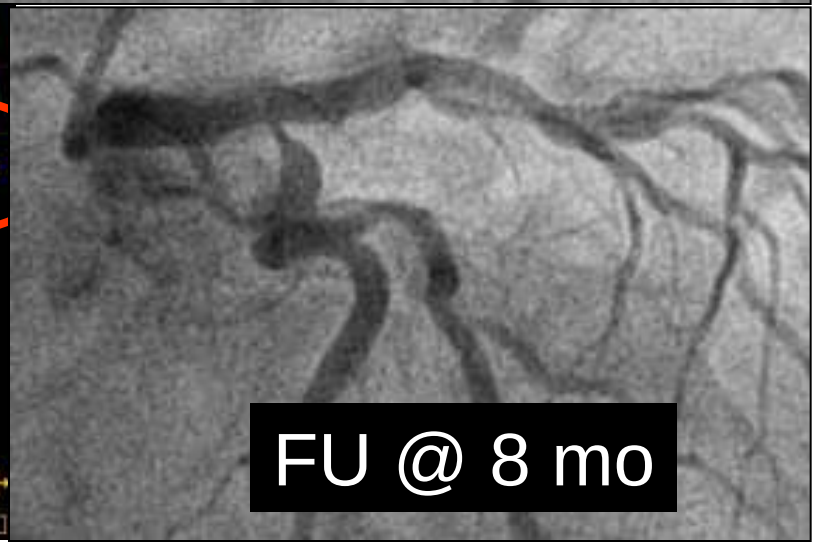
When FFRapp >0.85, FFRtrue >0.80 100% of the time.

Yong, et al. Circulation 2012;126:A11981.





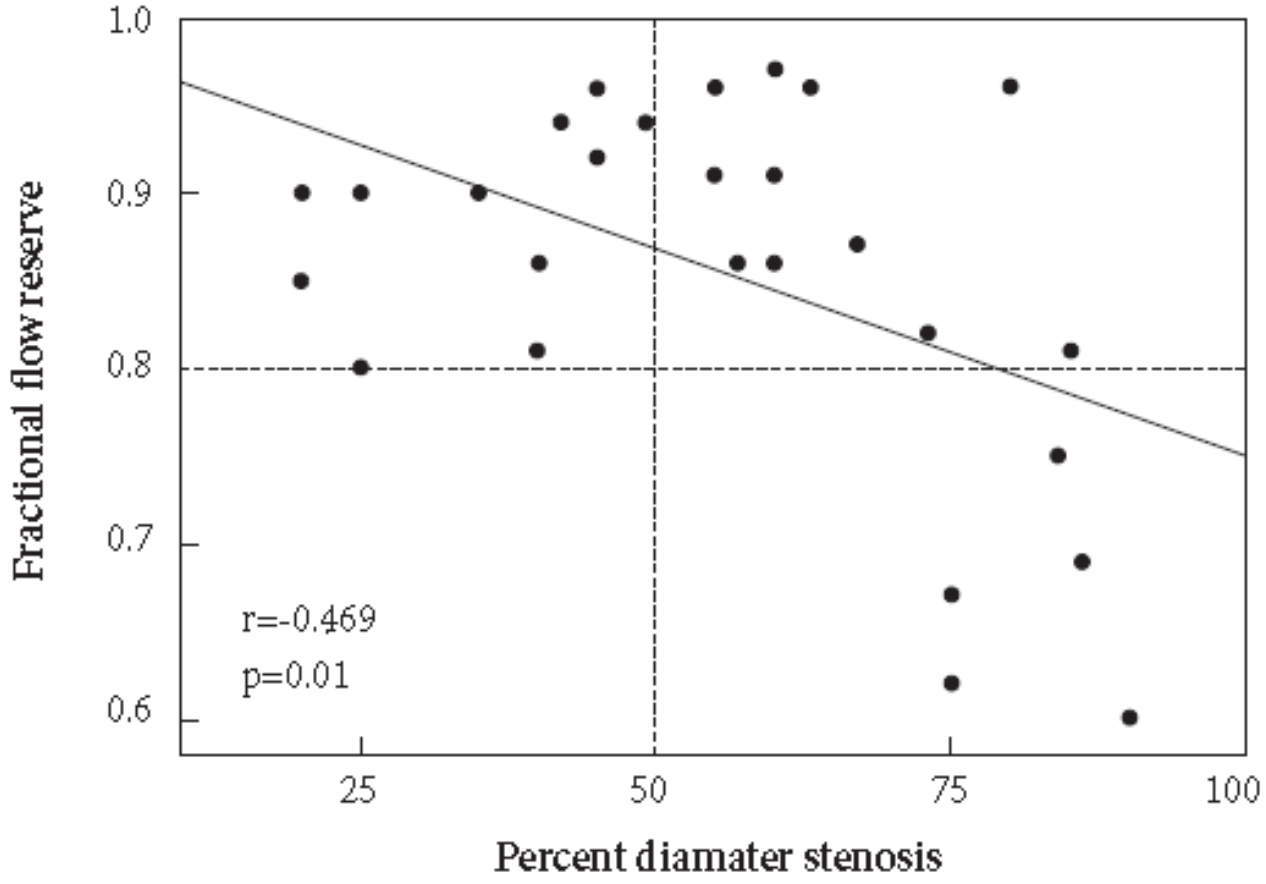




Courtesy of Chang-Wook Nam, MD

FFR of “Jailed” Left Circumflex

29 patients with LM/LAD crossover stenting with FFR of “jailed” Cx



Nam CW, et al. Korean Circ J 2011;41:304-7.

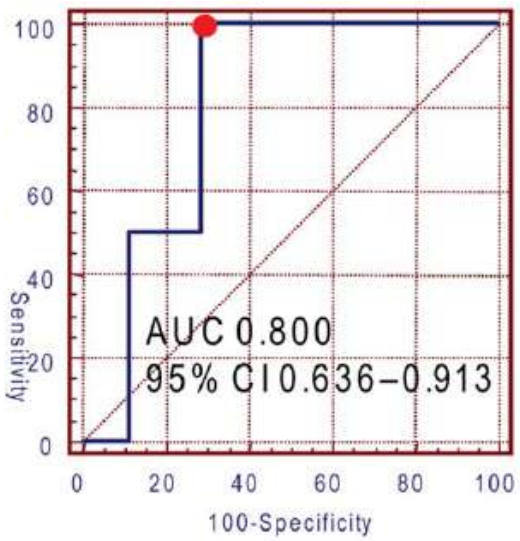
FFR of “jailed” Circumflex

Mean 20 month follow-up	Defer group n = 24	PCI group n = 5
Death, n	0	1
Myocardial Infarction, n	0	0
TLR, n	3	1
Stent Thrombosis, n	0	0
Total Events, n	3	2

Nam CW, et al. Korean Circ J 2011;41:304-7.

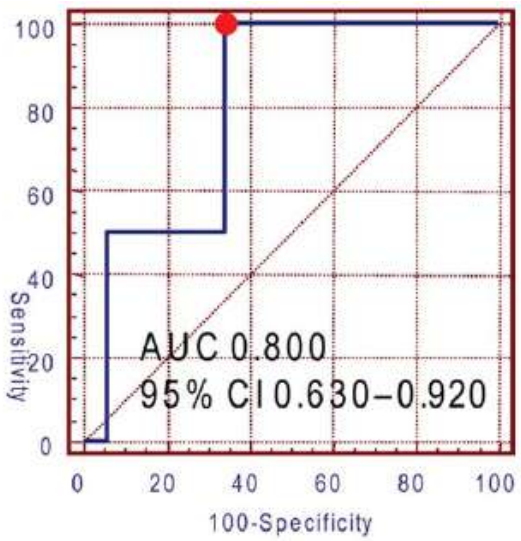
FFR of “Jailed” Circumflex

Pre-PCI IVUS predictors of functionally significant “jailed” circumflex



MLA 3.7mm²

Sensitivity 100%
Specificity 71%
PPV 16%
NPV 100%



Plaque burden 56%

Sensitivity 100%
Specificity 65%
PPV 14%
NPV 100%

Only 3 out of 43 (7%) patients had an FFR of L Cx<0.80 post PCI

Kang SJ, et al. Catheter Cardiovasc Interv 2014;83:545-52.

An Approach to the Equivocal LM

- First measure FFR in the least diseased vessel, preferably the LAD, with a pullback
  - If FFR < 0.80, then revascularize
  - If FFR >0.85, then treat medically
  - If FFR between 0.80 and 0.85 and there is significant downstream epicardial disease in the other epicardial vessel, then consider IVUS

- Never forget the patient and the clinical scenario

Practical Aspects

- **Intravenous adenosine is the ideal hyperemic agent because it allows time to pull the guide catheter out of the ostium.**

- **If possible, confirm pressure gradient across left main by checking FFR in both the LAD and Circumflex and by performing a pullback of the pressure wire.**

- **A physiologic evaluation of left main disease, compared to an anatomic evaluation alone, is safe and appropriate, just as it is in non-left main CAD.**