FFR in Left Main Disease

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Why FFR instead of IVUS?

- Physiologic versus anatomic information
- Limitations of IVUS for assessing Left Main (LM)
- Data supporting FFR assessment of LM
- Limitations/Practical Aspects of FFR of LM

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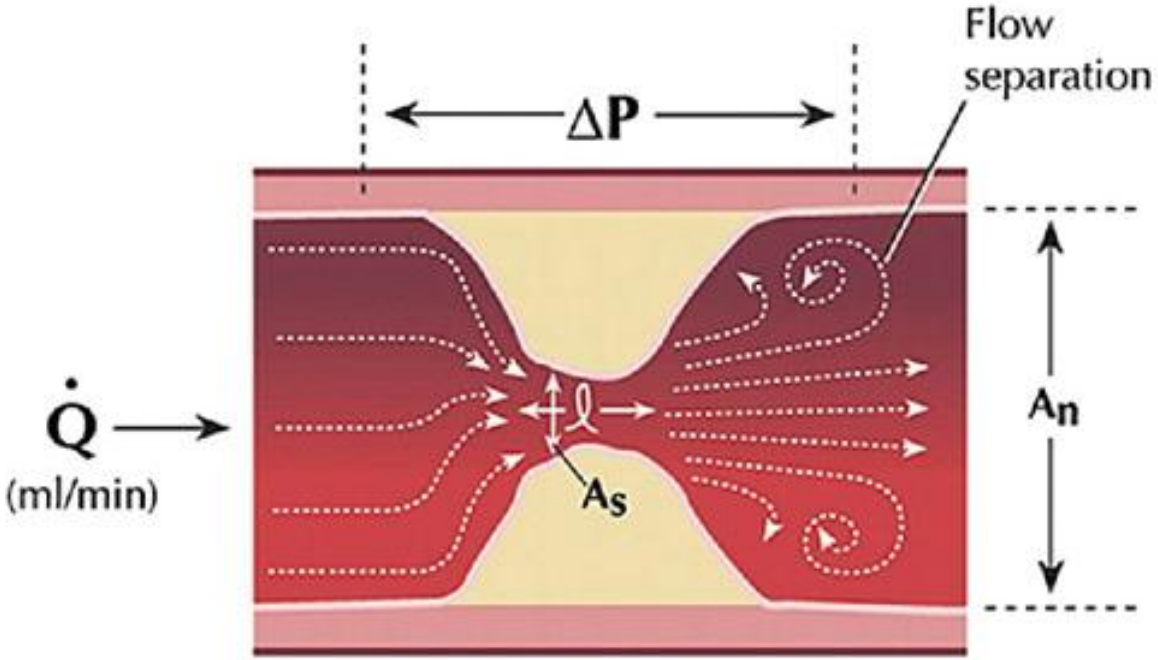
Factors impacting ischemic potential of a stenosis



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

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

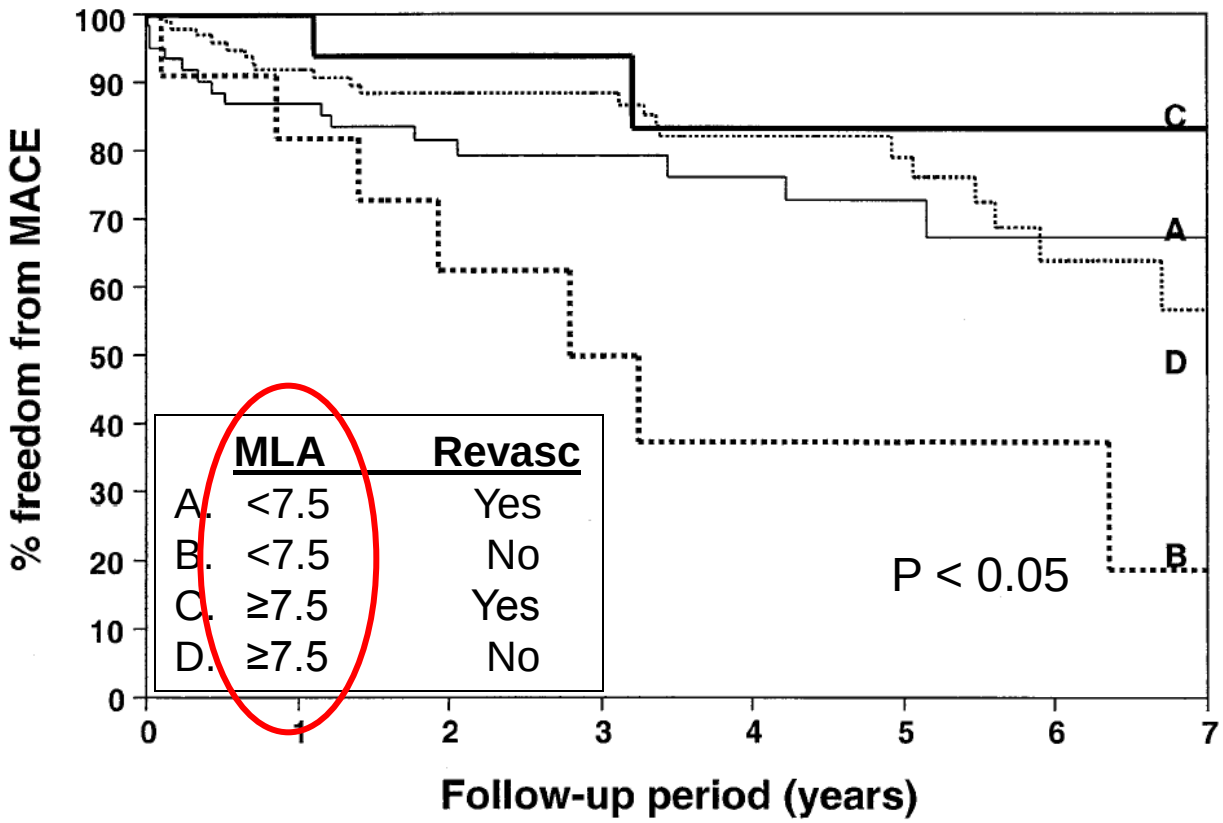
Variability of IVUS Assessment of the LM

- 73 patients with distal left main disease underwent IVUS pullback from the LAD and from the L Cx.
- The average MLA of the LM from the LAD pullback was 6.7 ±3.1 mm2 and from the L Cx pullback was 6.8 ±3.3 mm2
- However, in ½ the patients the L Cx measurement was smaller and in 11% the difference was > 1 mm2.
- In the other ½ of the patients the LAD measurement was smaller and in 16% the difference was > 1mm2

He, Maehara, Mintz, et al. Circulation 2009;120:S947

Variability of IVUS Cutoff Values

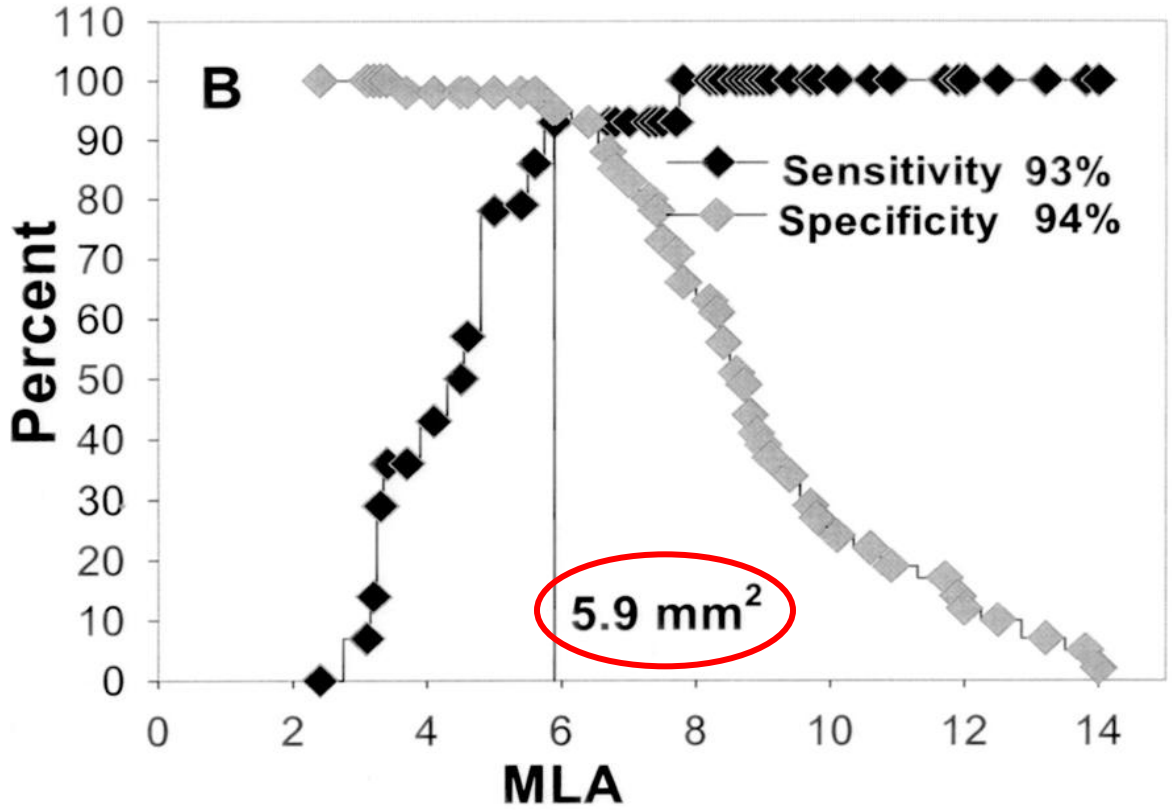
3 Yr Follow-up in 214 Intermediate Left Mains Assessed by IVUS



Fassa et al. J Am Coll Cardiol 2005;45:204-211

Variability of IVUS Cutoff Values

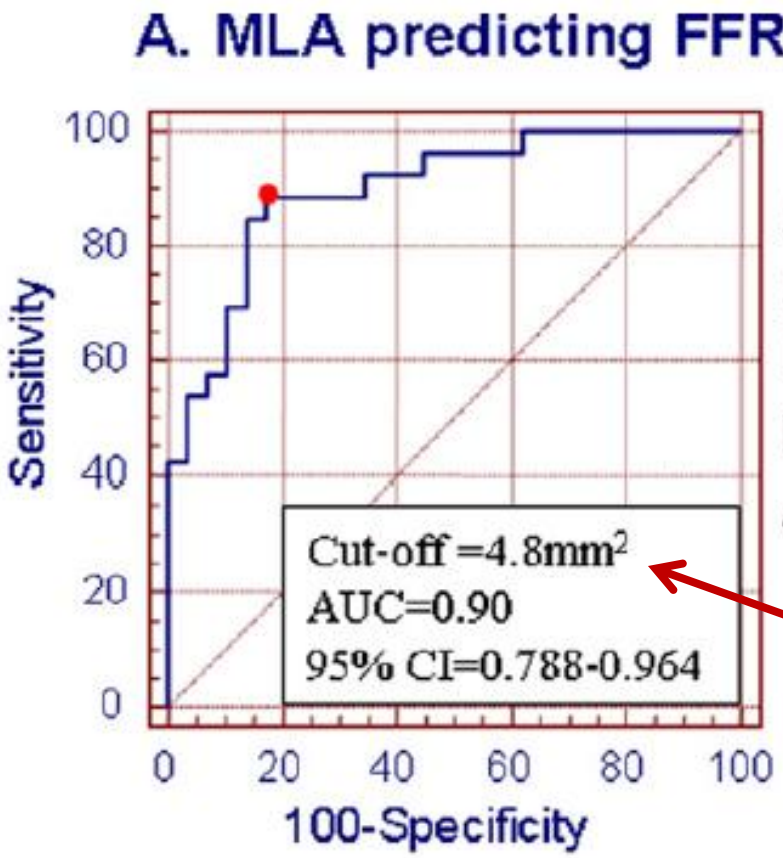
55 patients with ambiguous left main disease



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

Variability of IVUS Cutoff Values

55 patients with 30-80% LM and FFR and IVUS

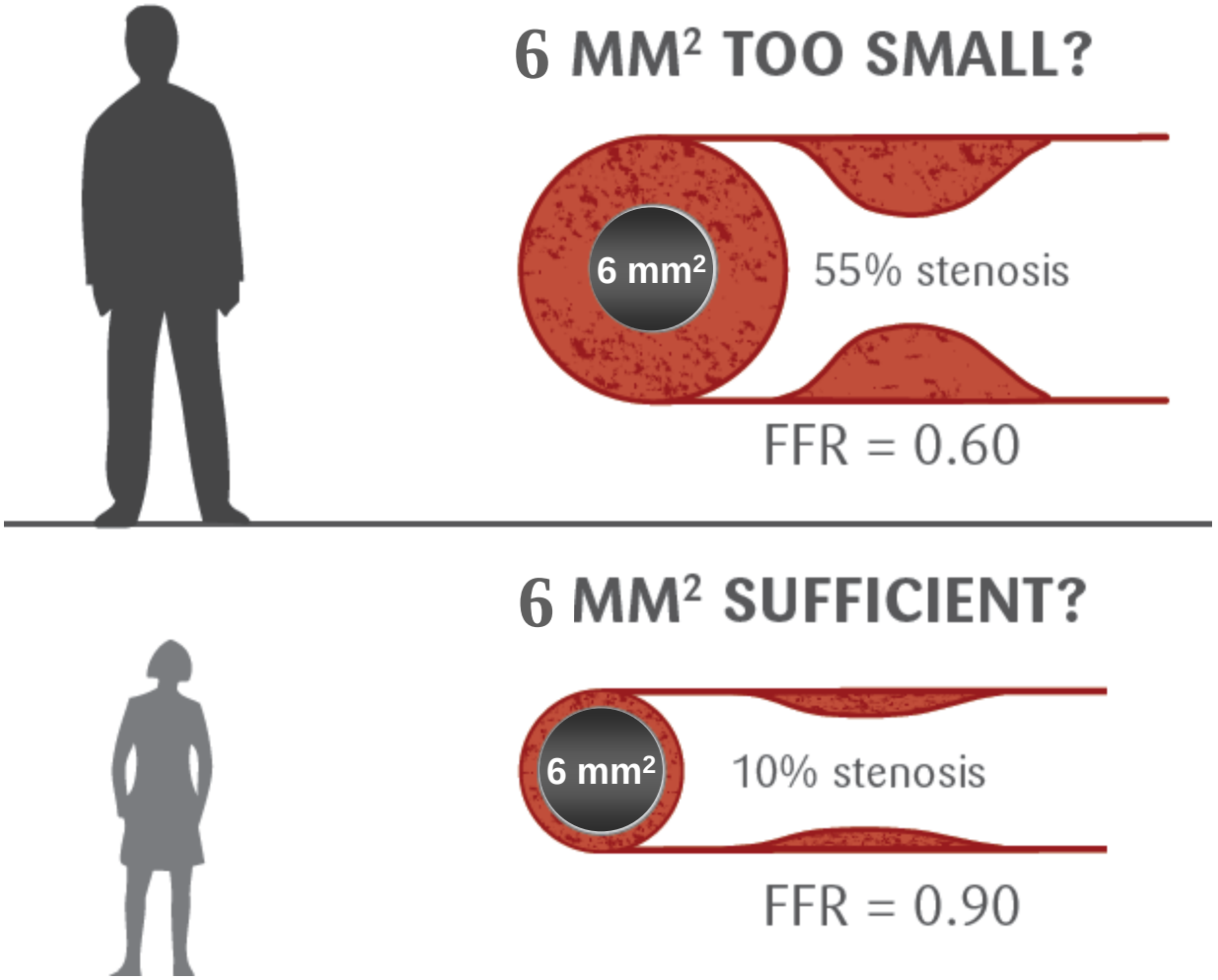


Sensitivity 89%
Specificity 83%
PPV 82%
NPV 89%
Accuracy 86%

Cutoff = 4.8 mm2

Kang, et al. J Am Coll Cardiol Intv 2011;4:1168-74

Variability of IVUS Cuttoff Values



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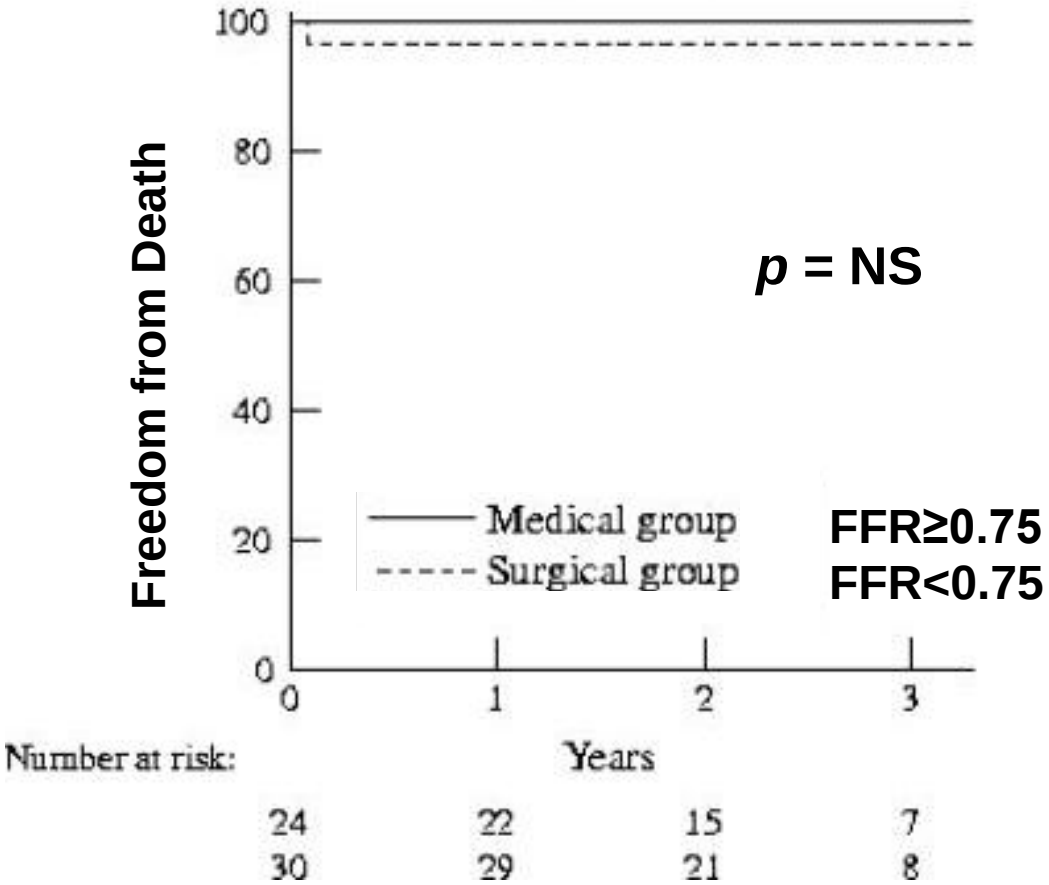
Is it safe to defer LM Rx based on FFR?

FFR measured in 54 patients with equivocal left main



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

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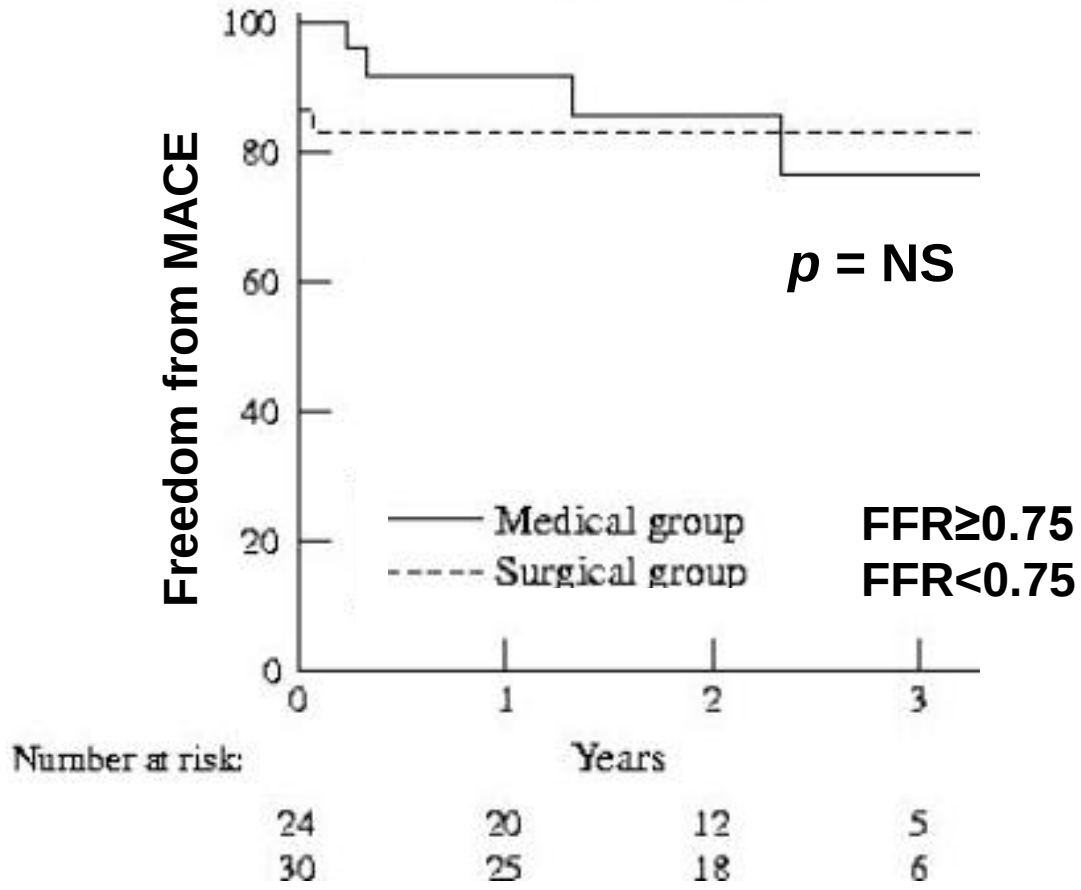

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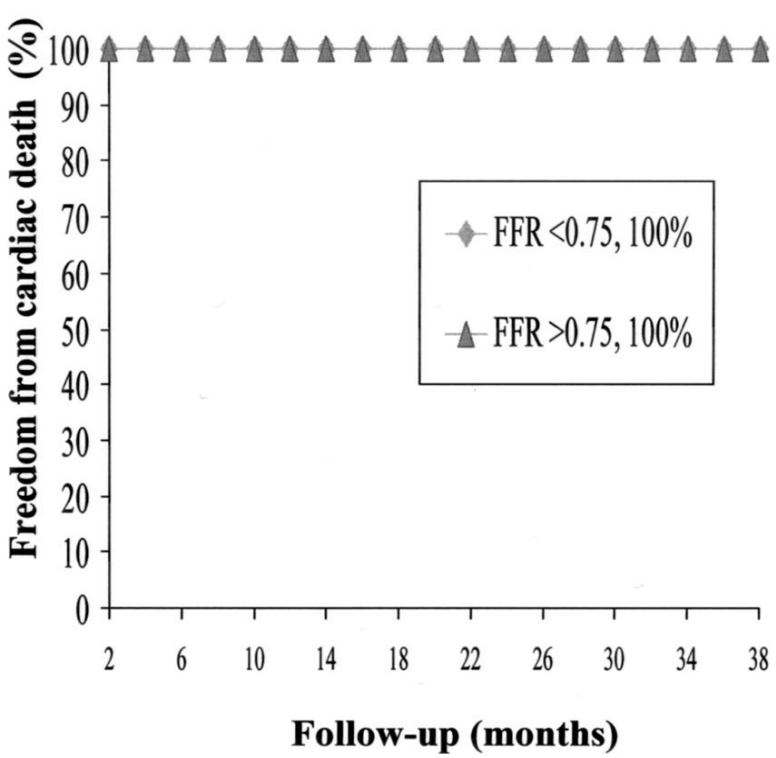
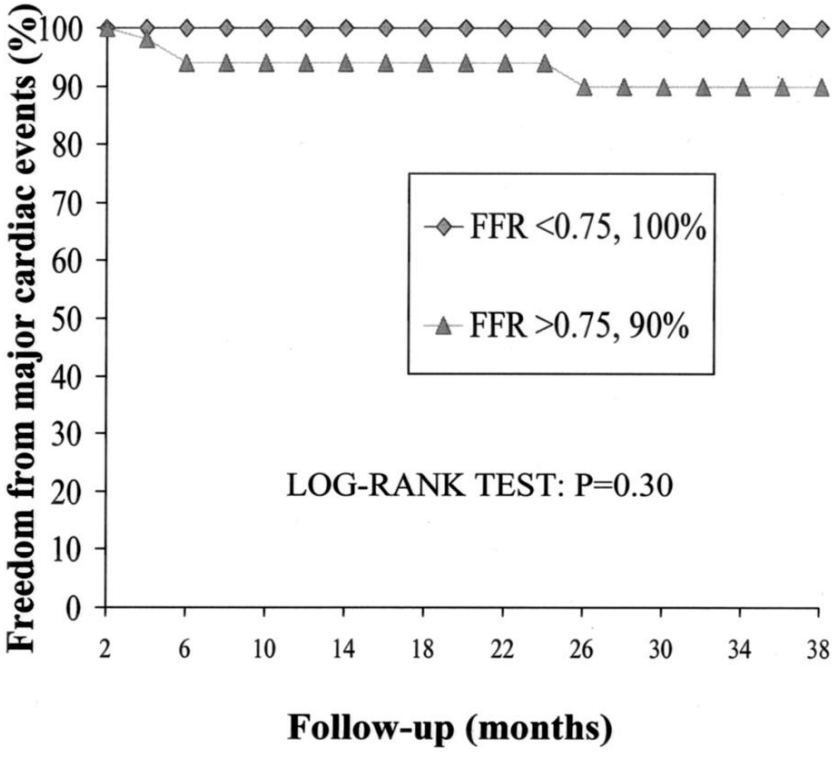




Jasti, et al. Circulation 2004;110:2831-6

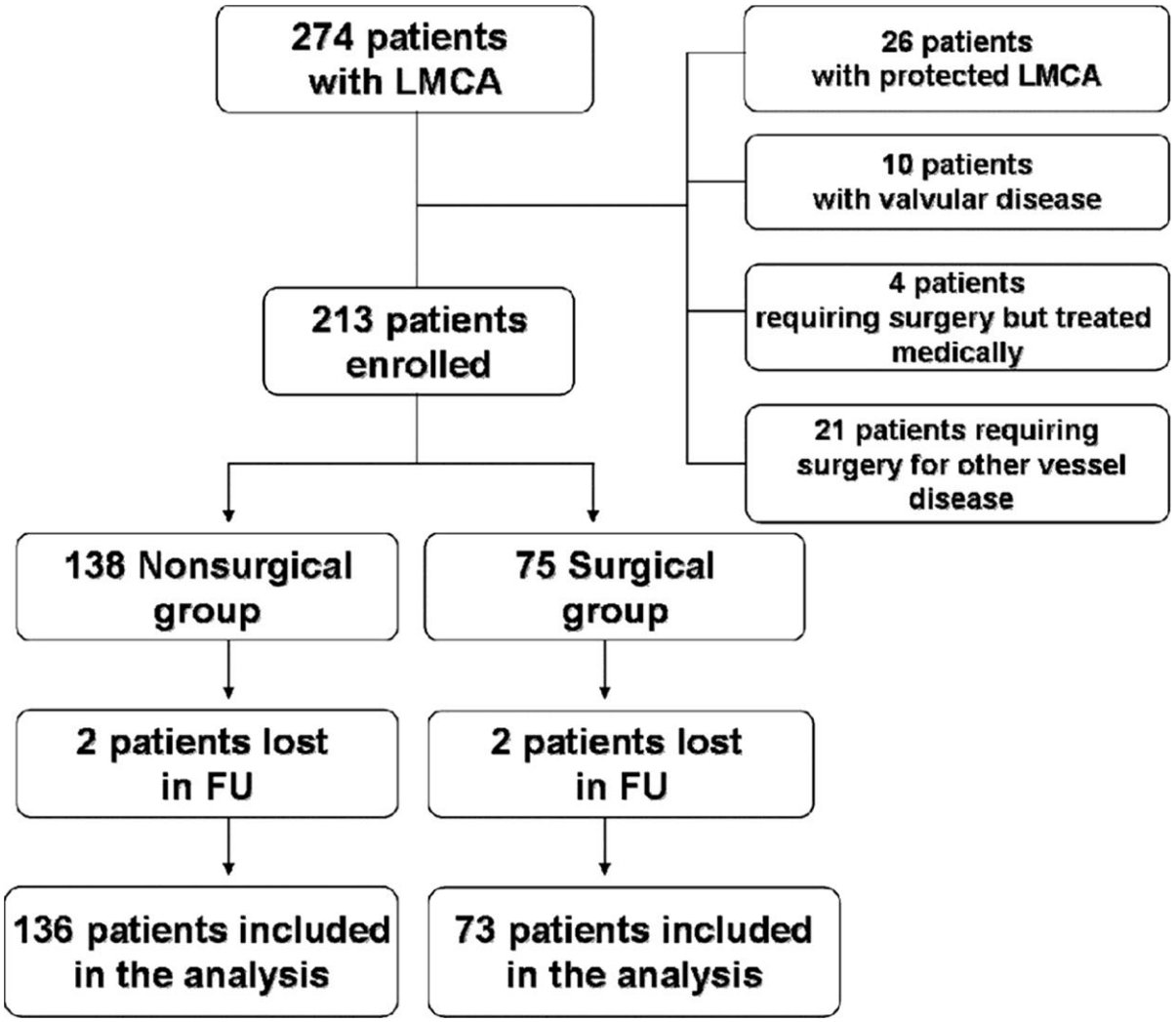
FFR for Assessing LM Significance

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

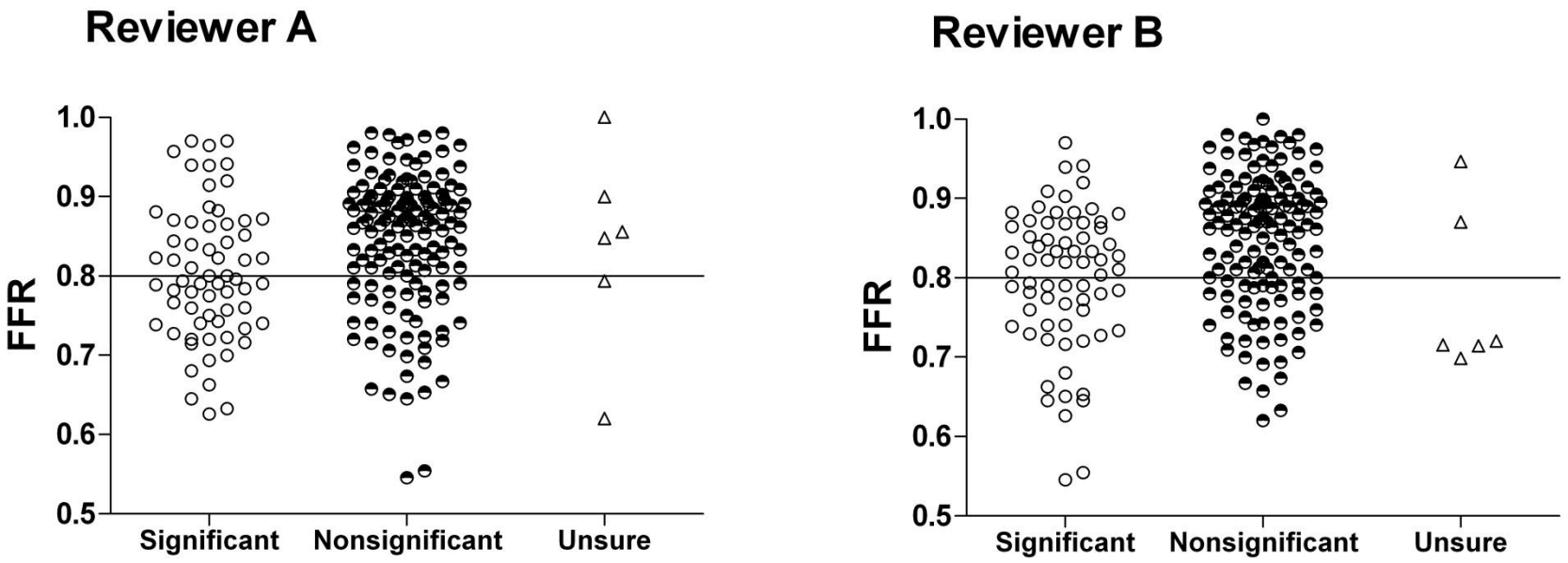
FFR and Intermediate Left Main



Hamilos, et al. Circulation 2009;120:1505

FFR for Assessing LM Significance

Poor correlation between "eyeball" and FFR



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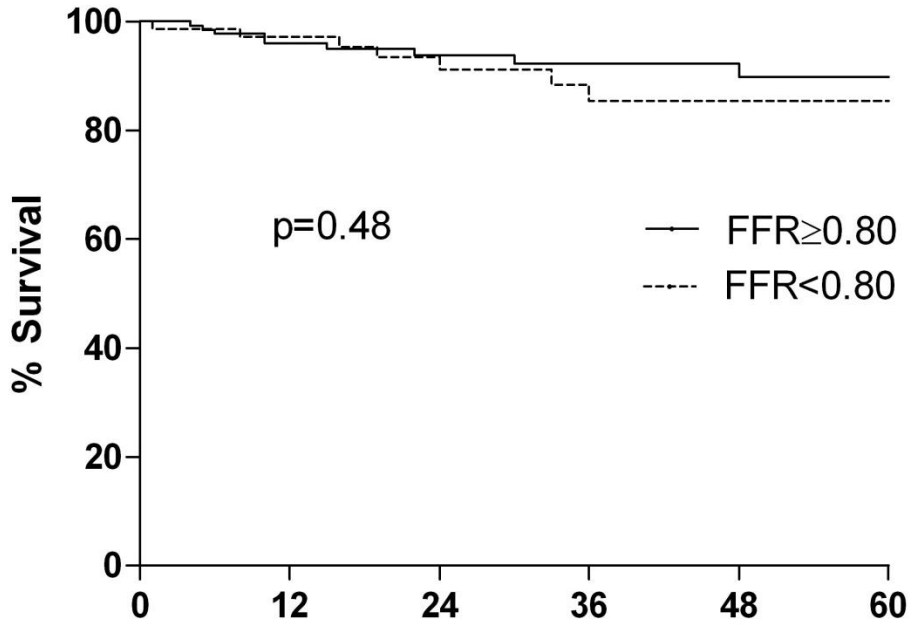
FFR for Assessing LM Significance

Survival Rate

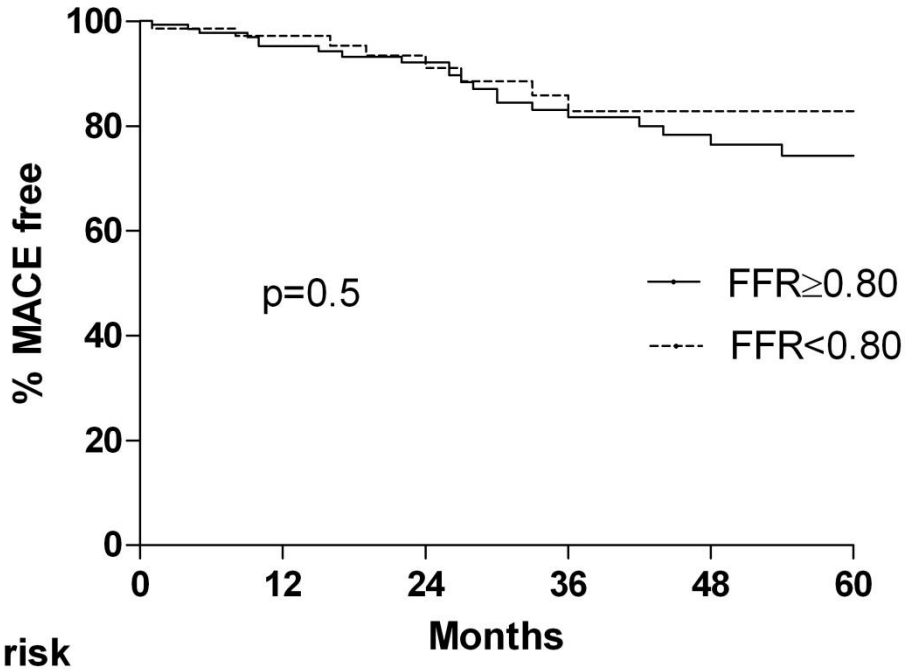


No at risk						
FFR≥0.80	136	103	72	52	38	26
FFR<0.80	73	56	41	30	14	10

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

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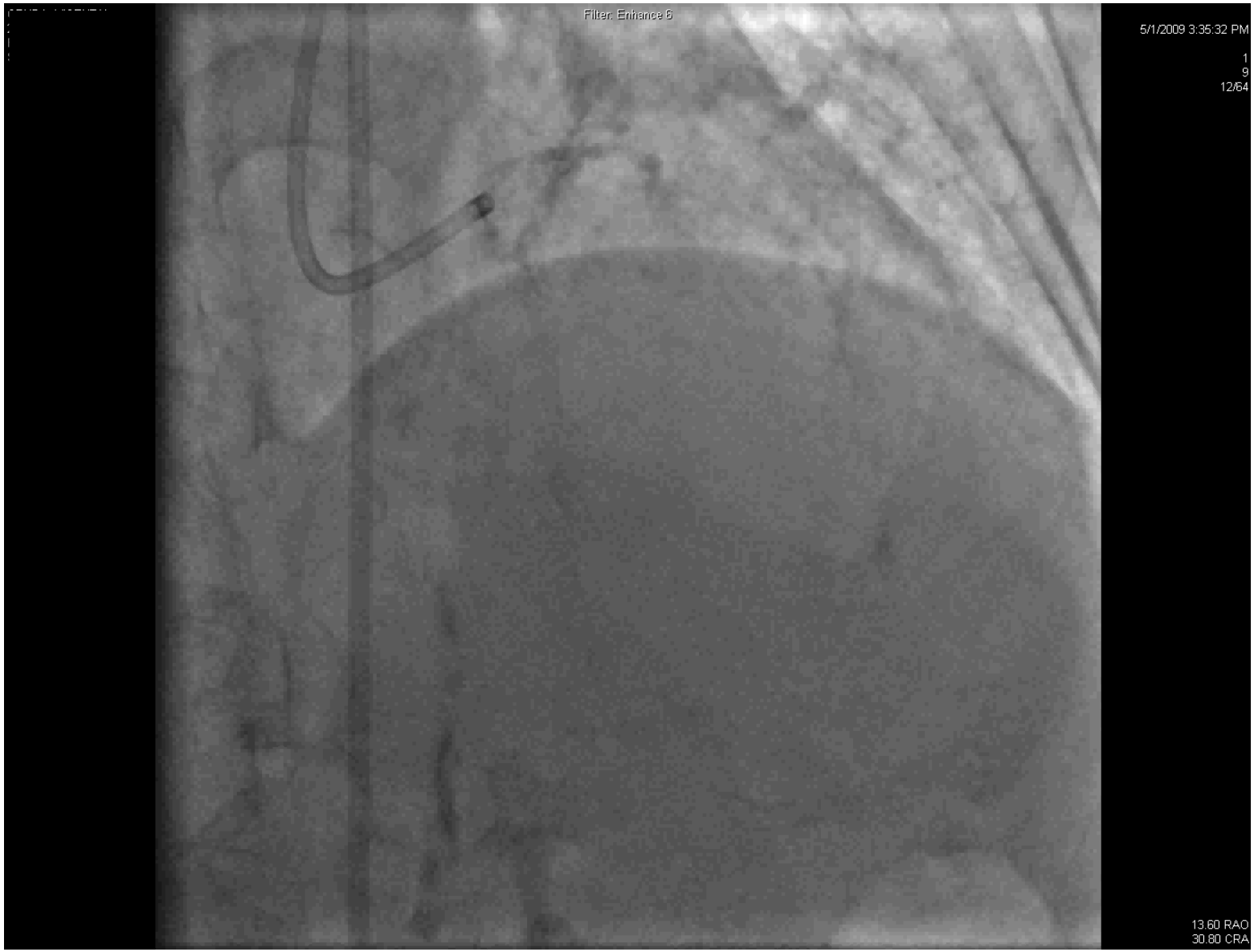
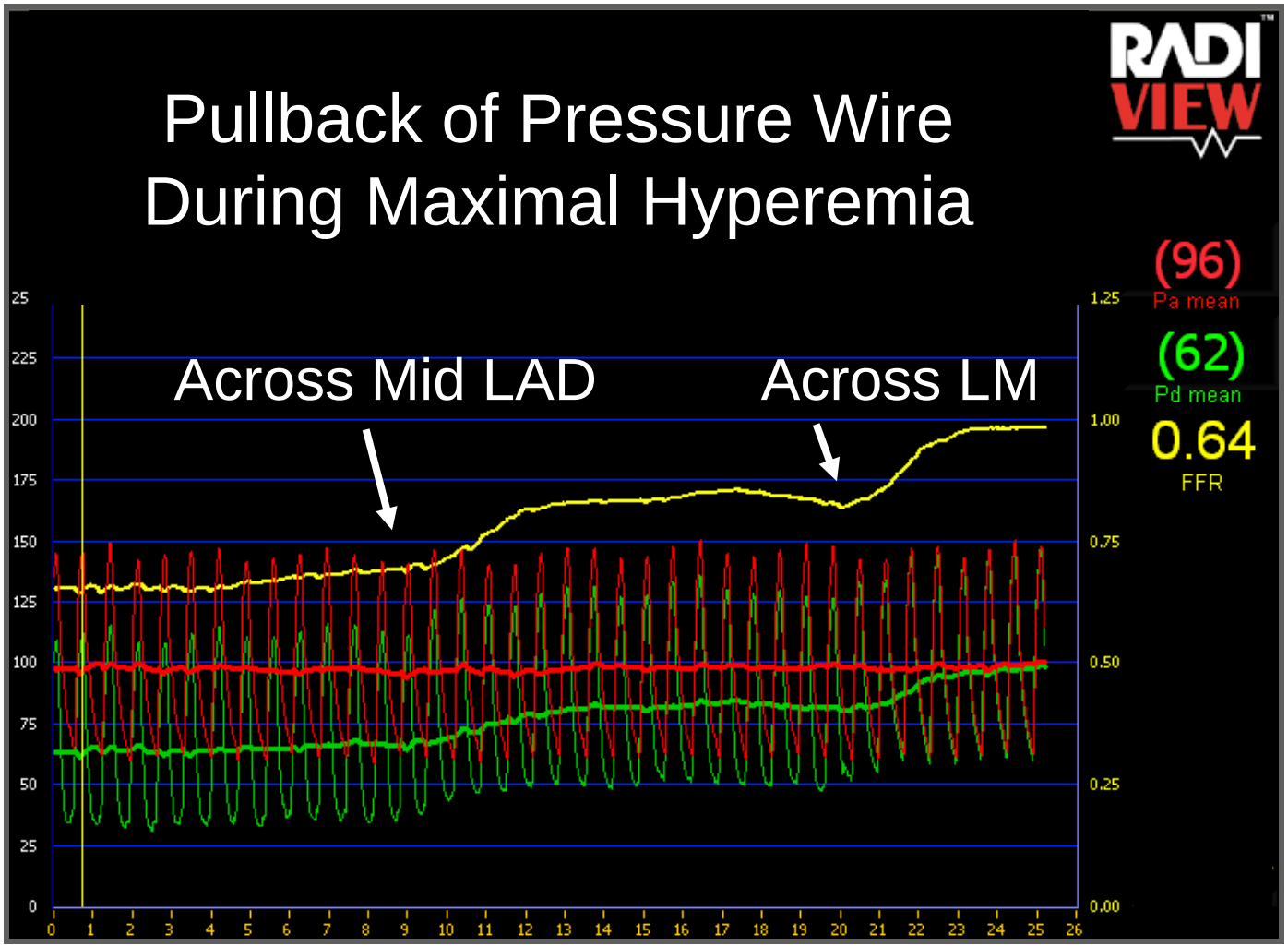

Filter: Enhance 6
5/1/2009 3:35:32 PM
1
9
12/64
13.60 RAO
30.80 CRA

FFR of Left Main



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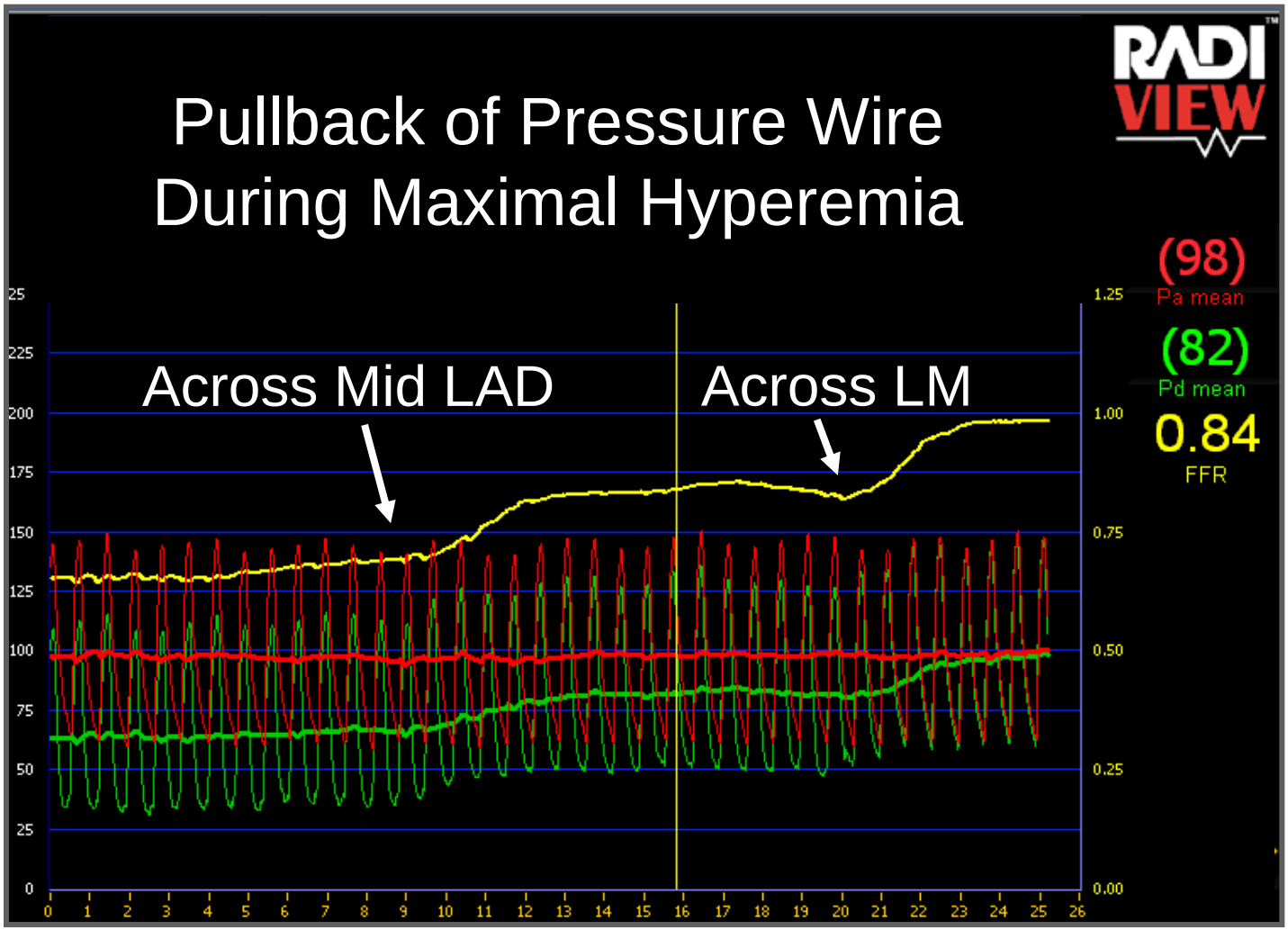
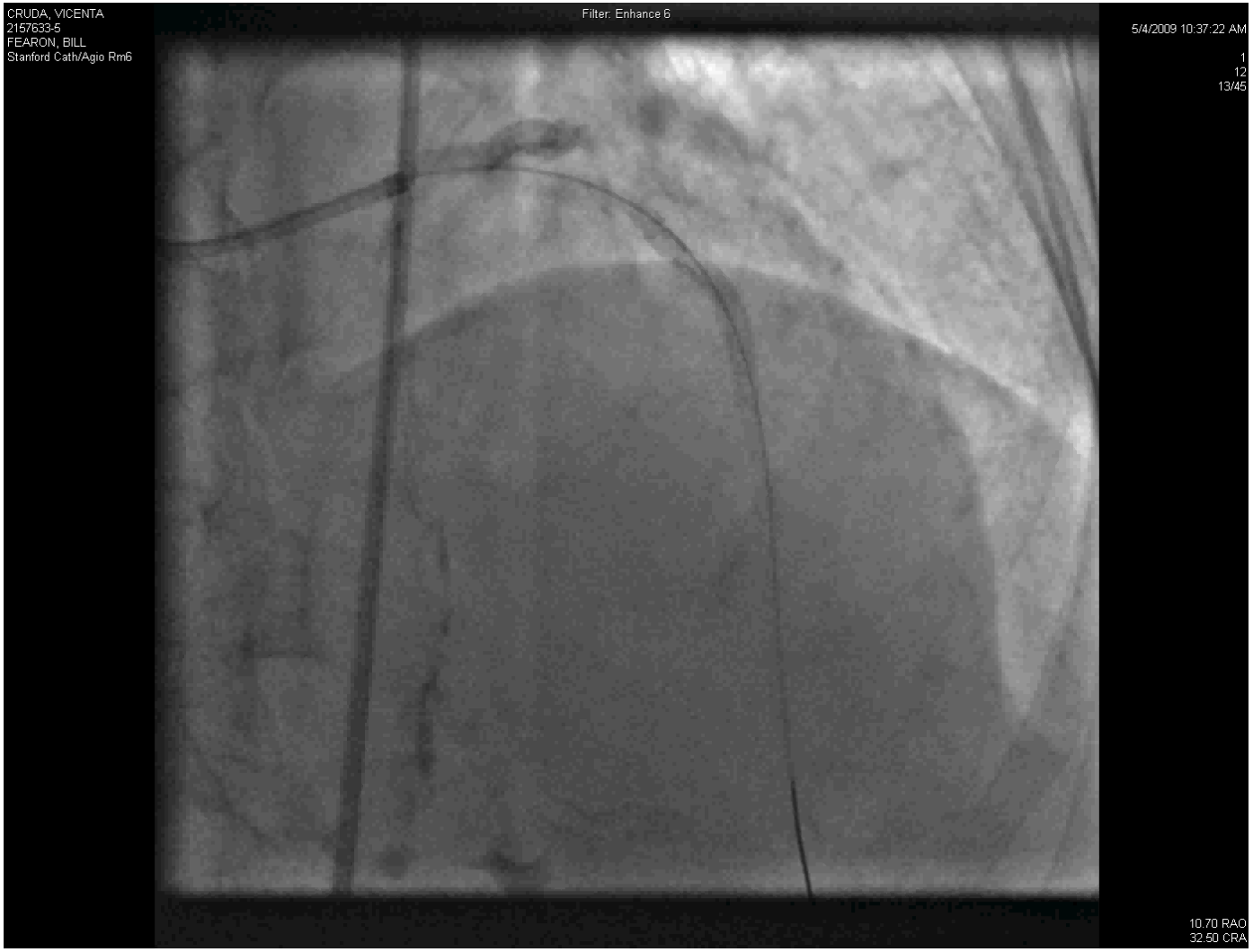


After rotational atherectomy and 2.5x28 mm DES, post-dilated to 3.0 mm



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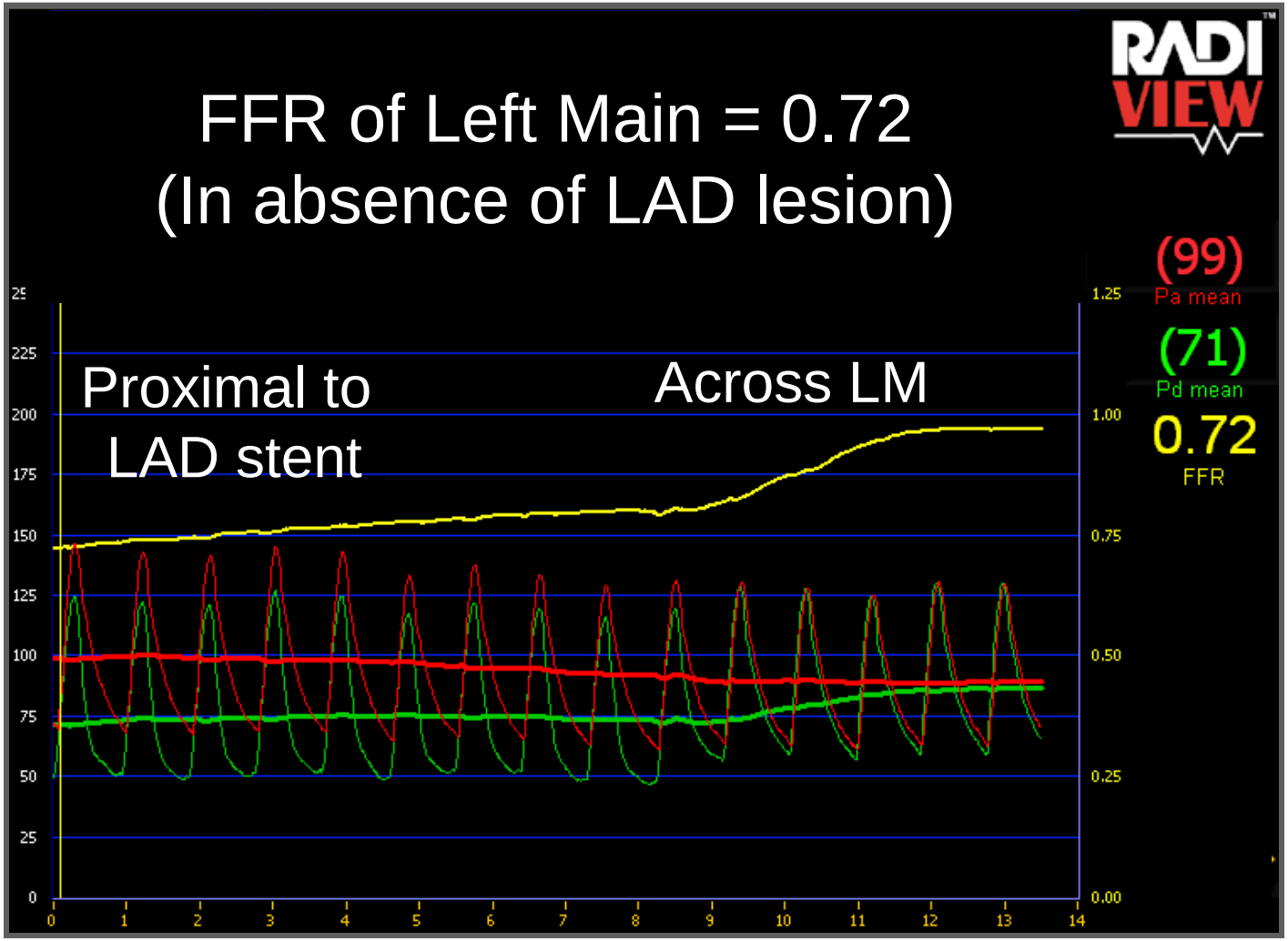
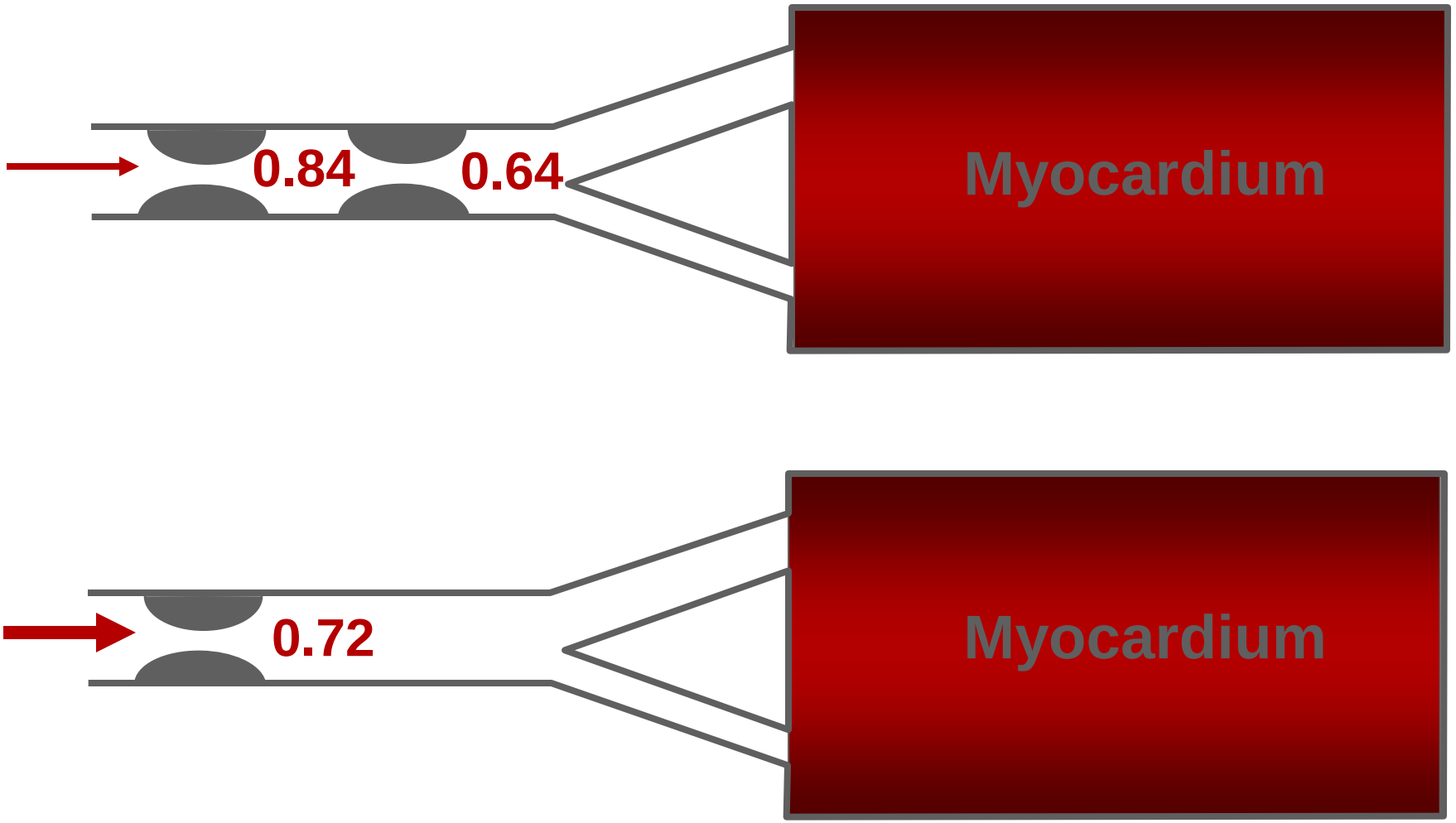
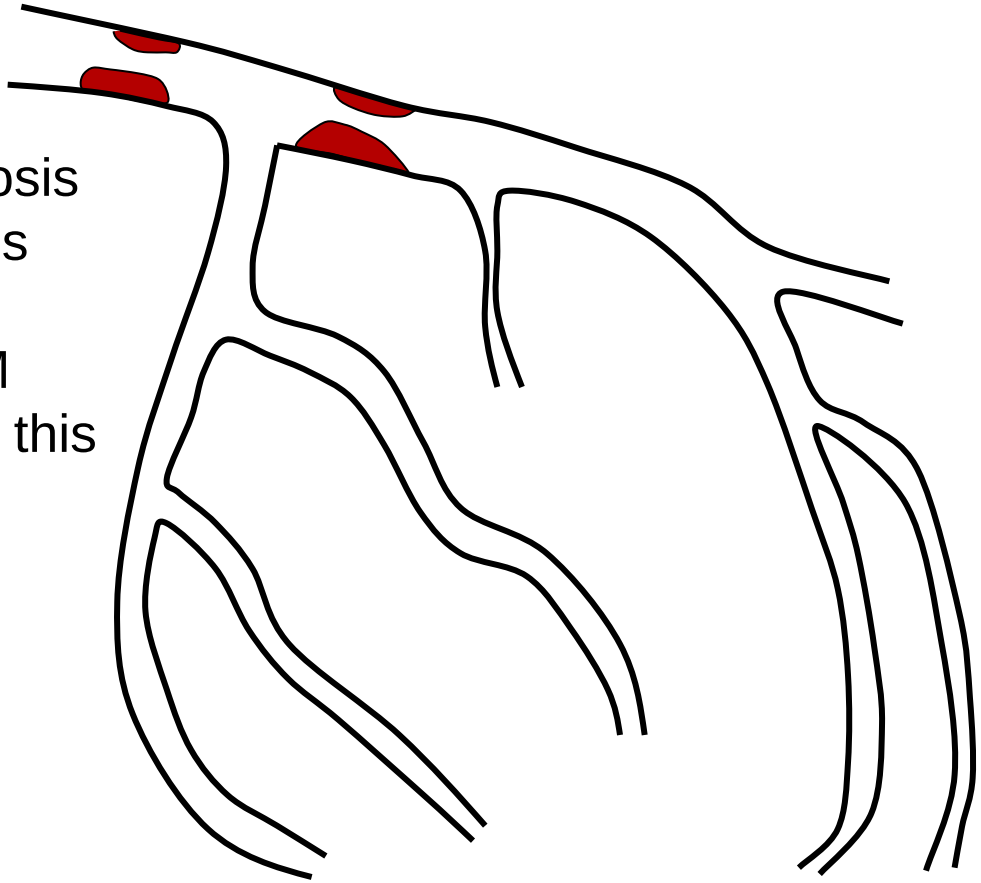


Effect of Tandem Lesions



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

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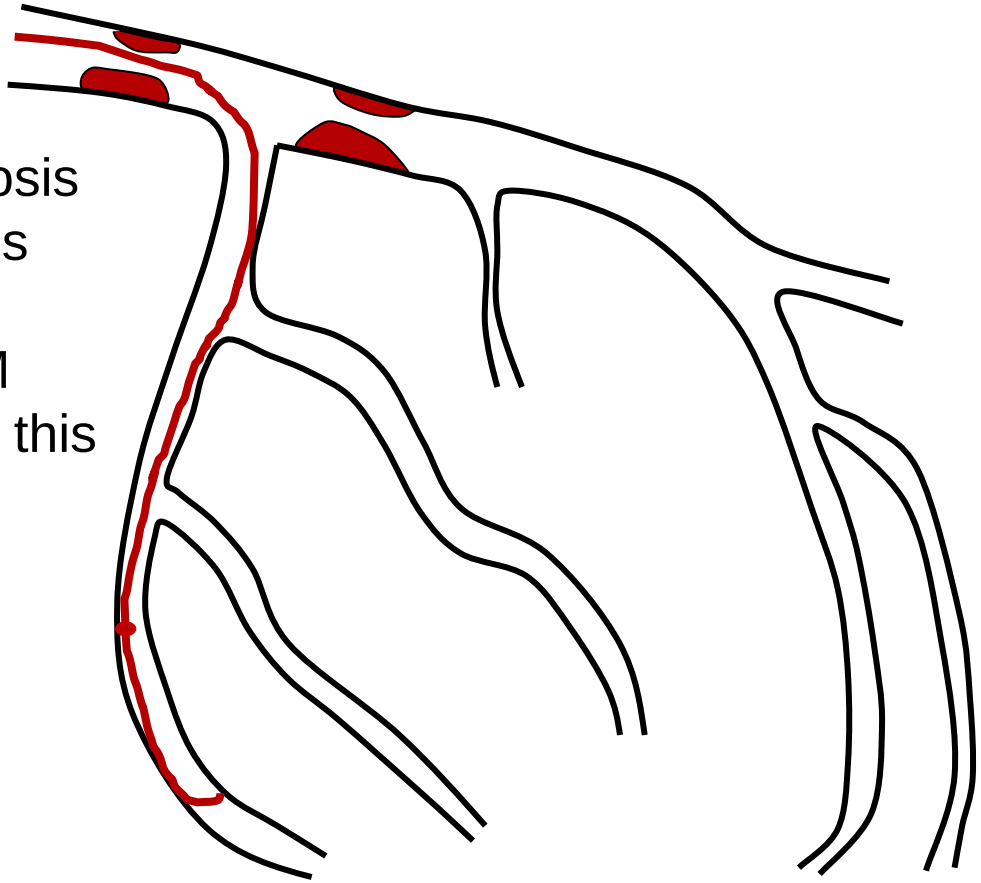

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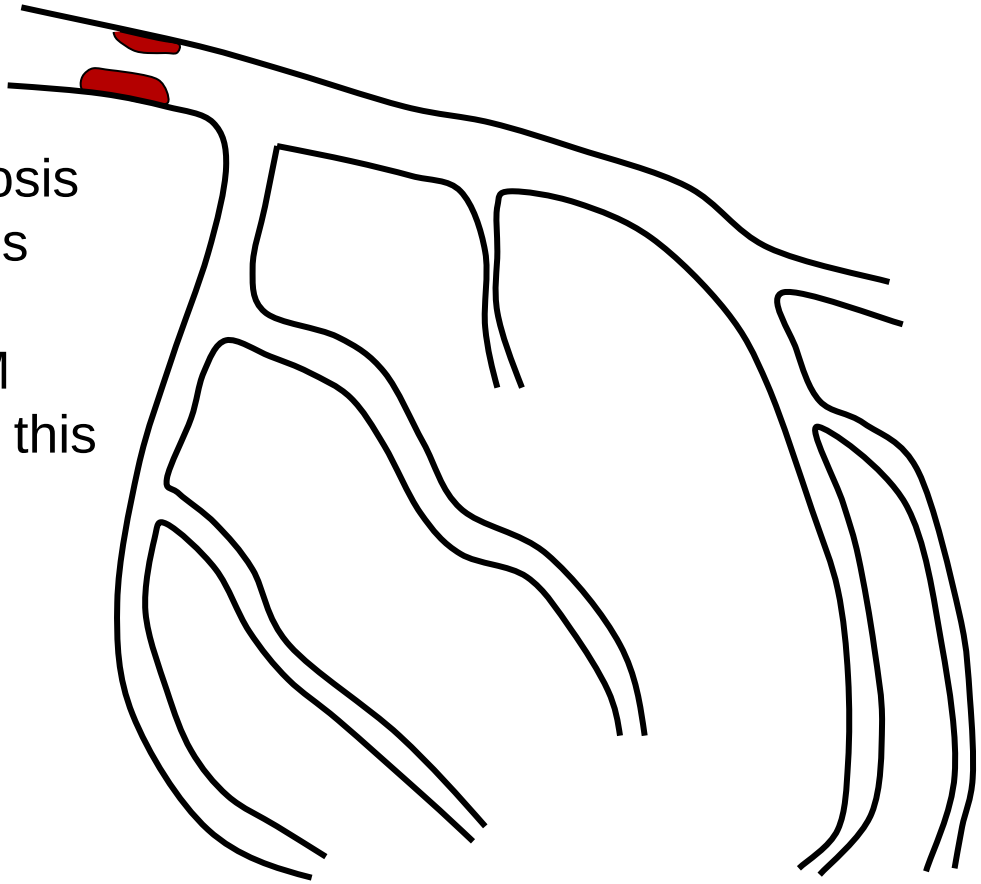

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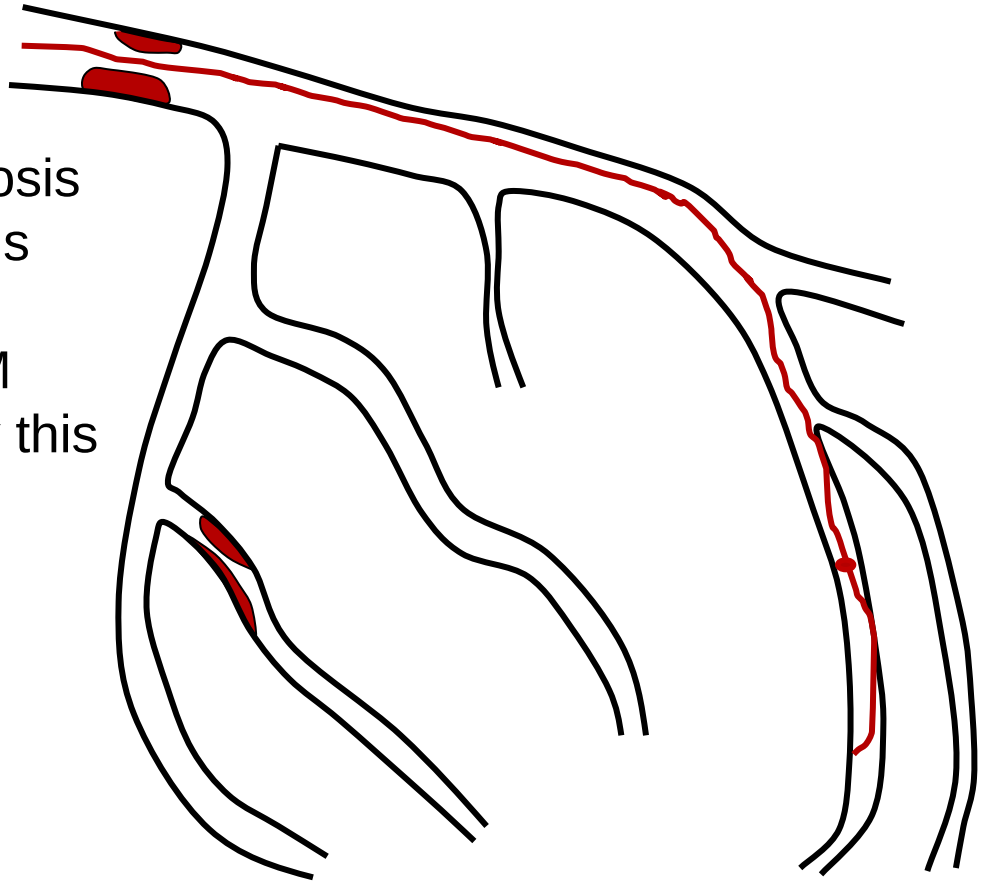

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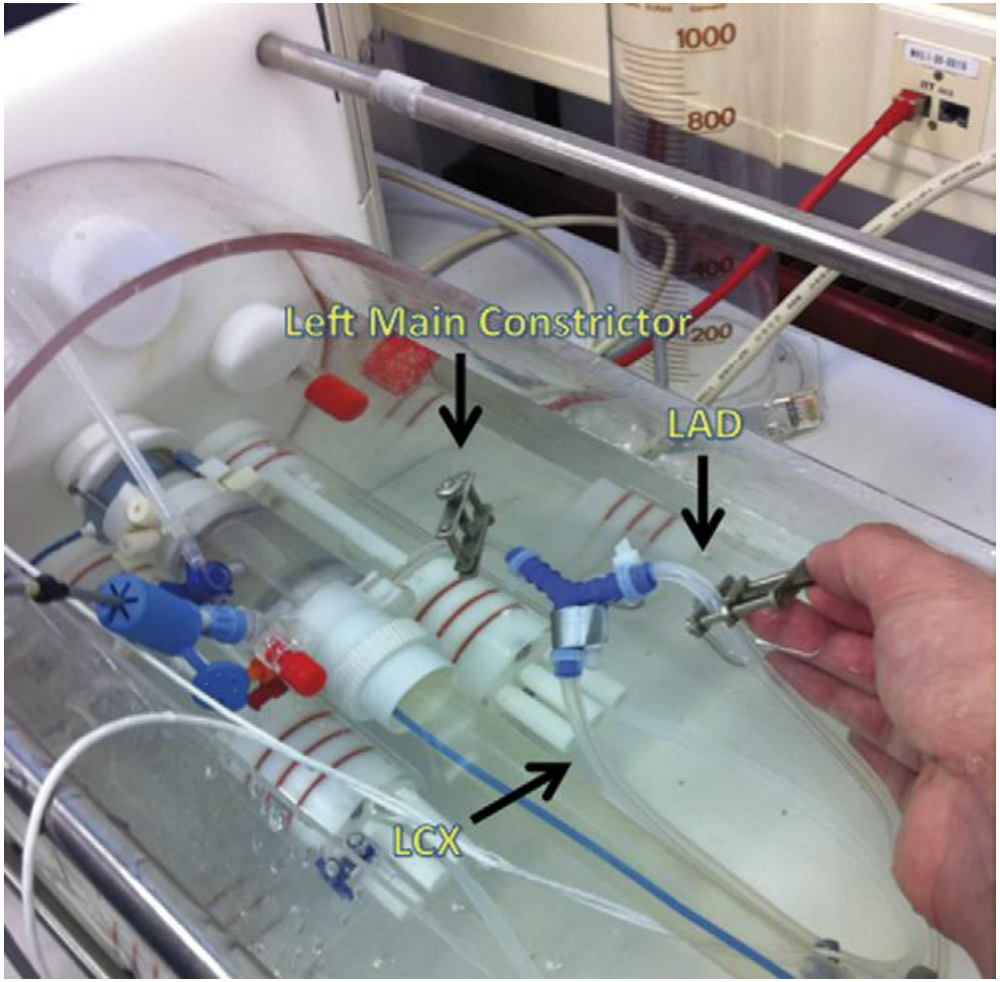
Effect of Epicardial Lesions on FFR Assessment of Intermediate LM Disease



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

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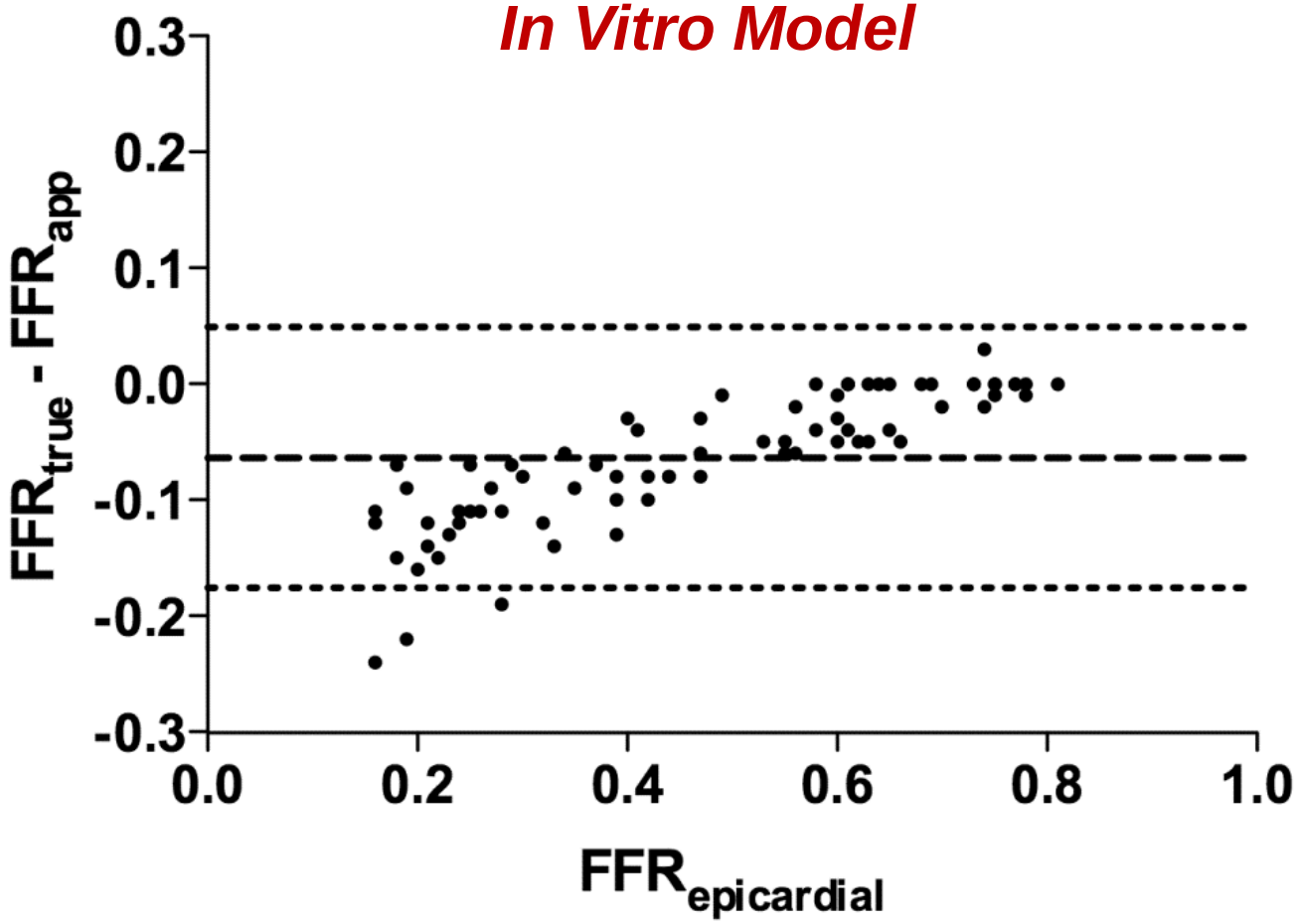

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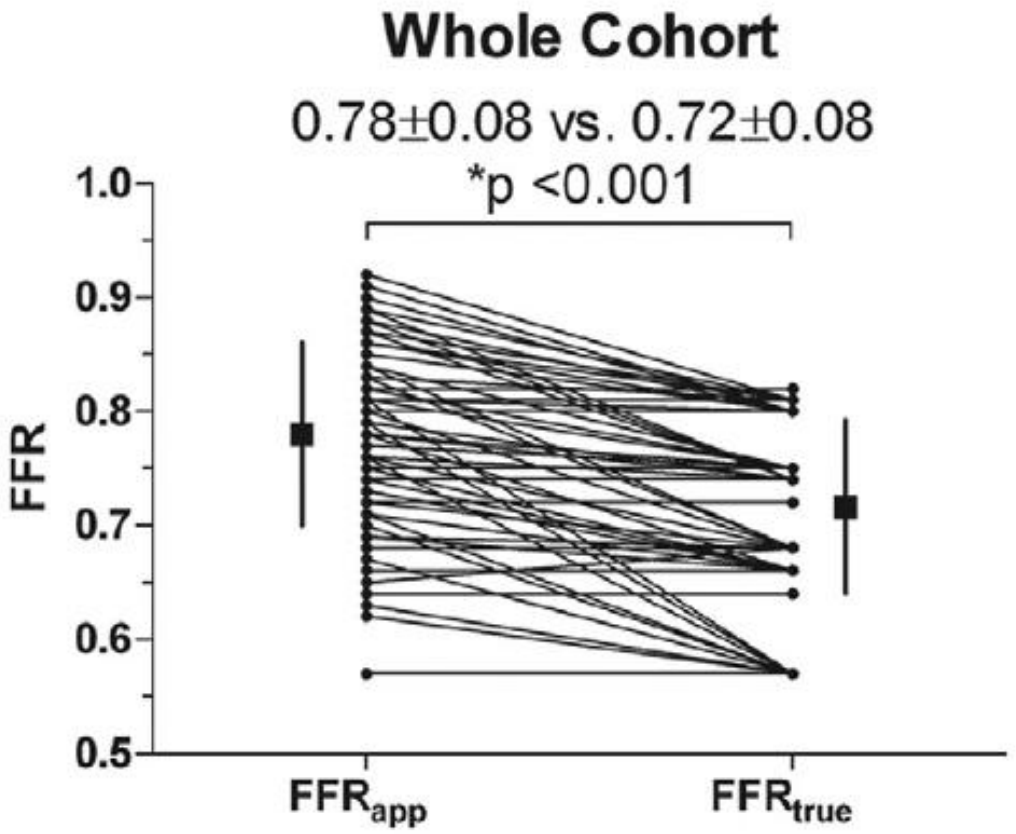

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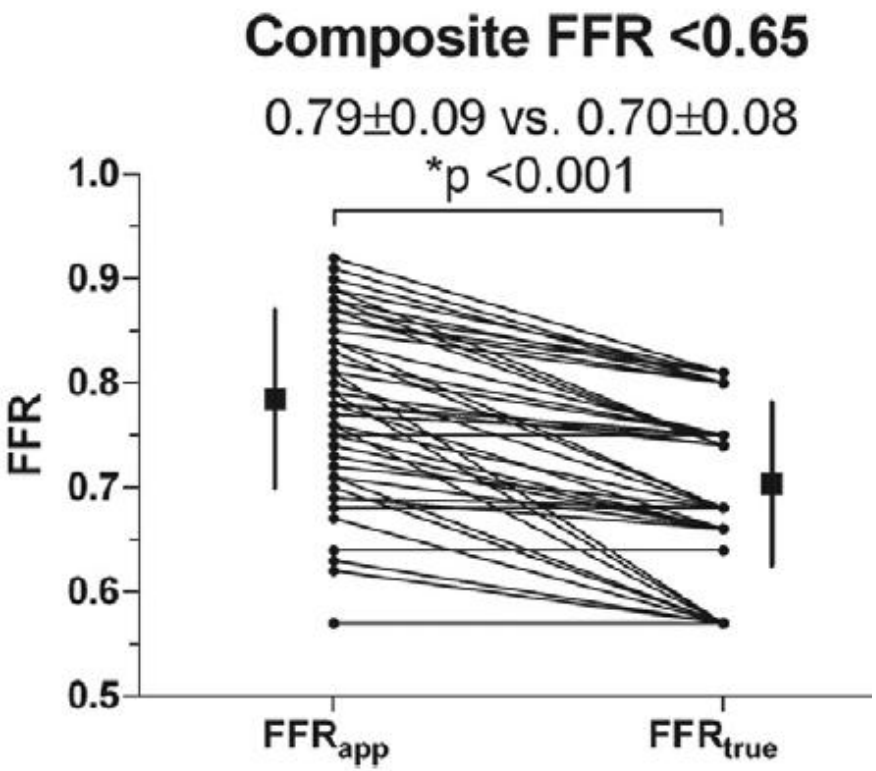

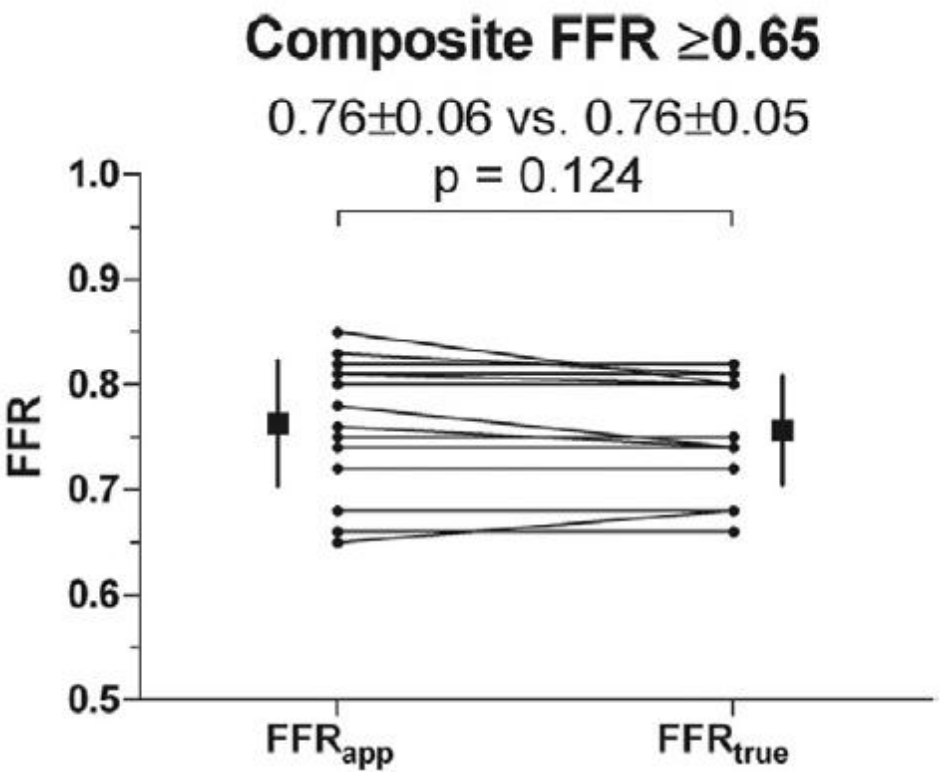

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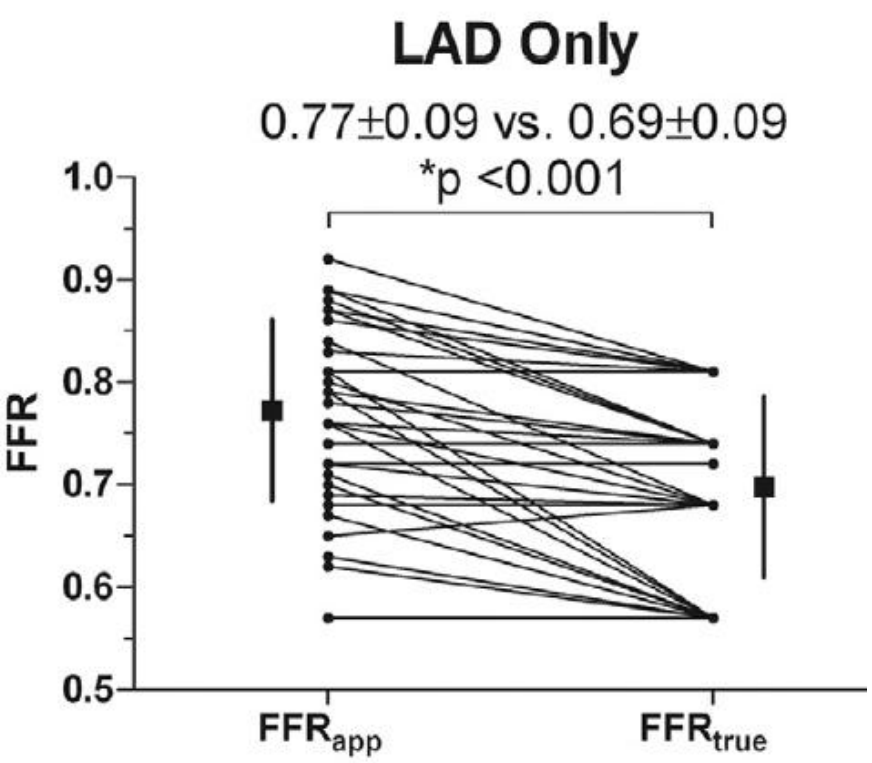

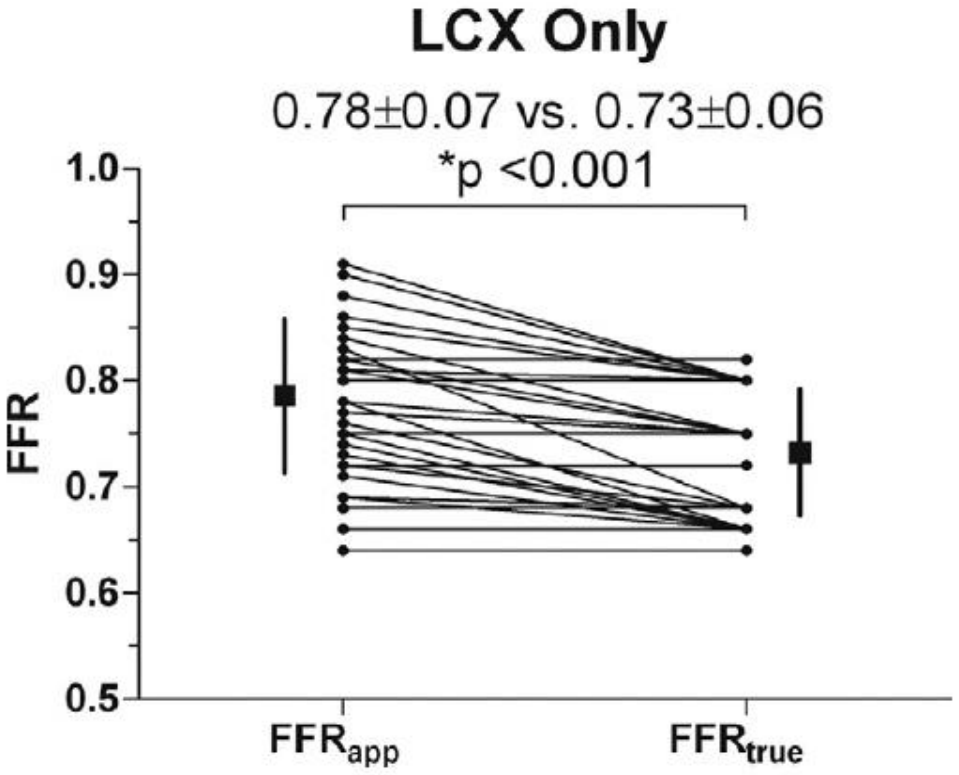

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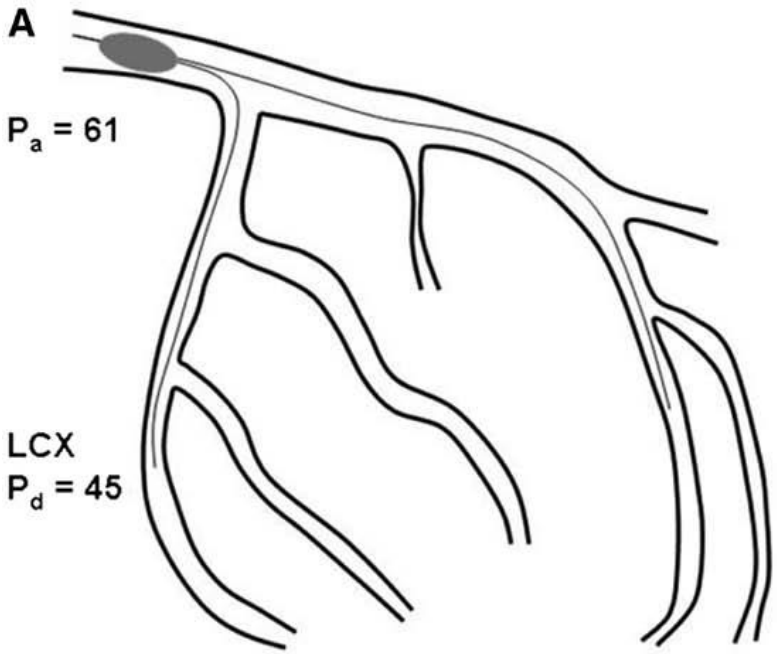
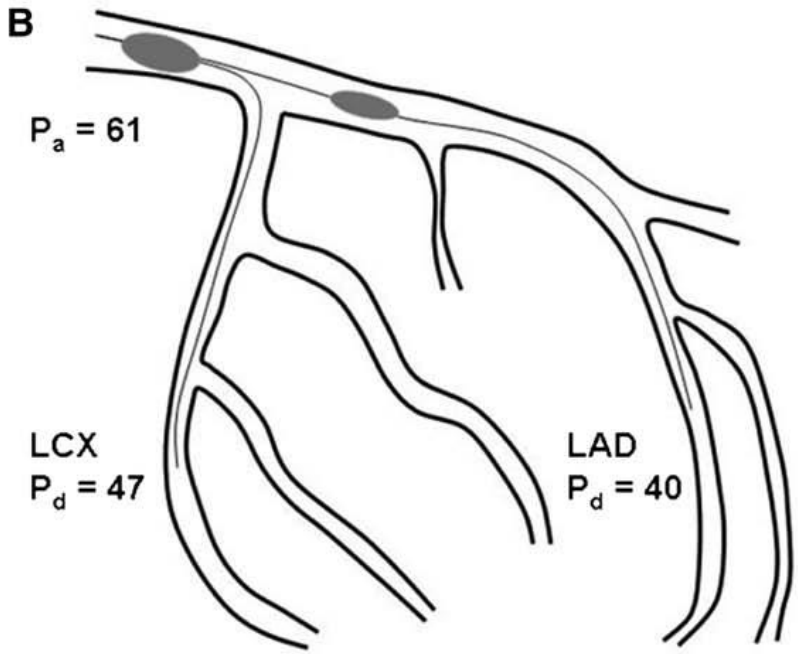
Effect of Epicardial Lesions on FFR Assessment of Intermediate LM Disease

Animal Model



FFR_{true} = 45/61 = 0.74

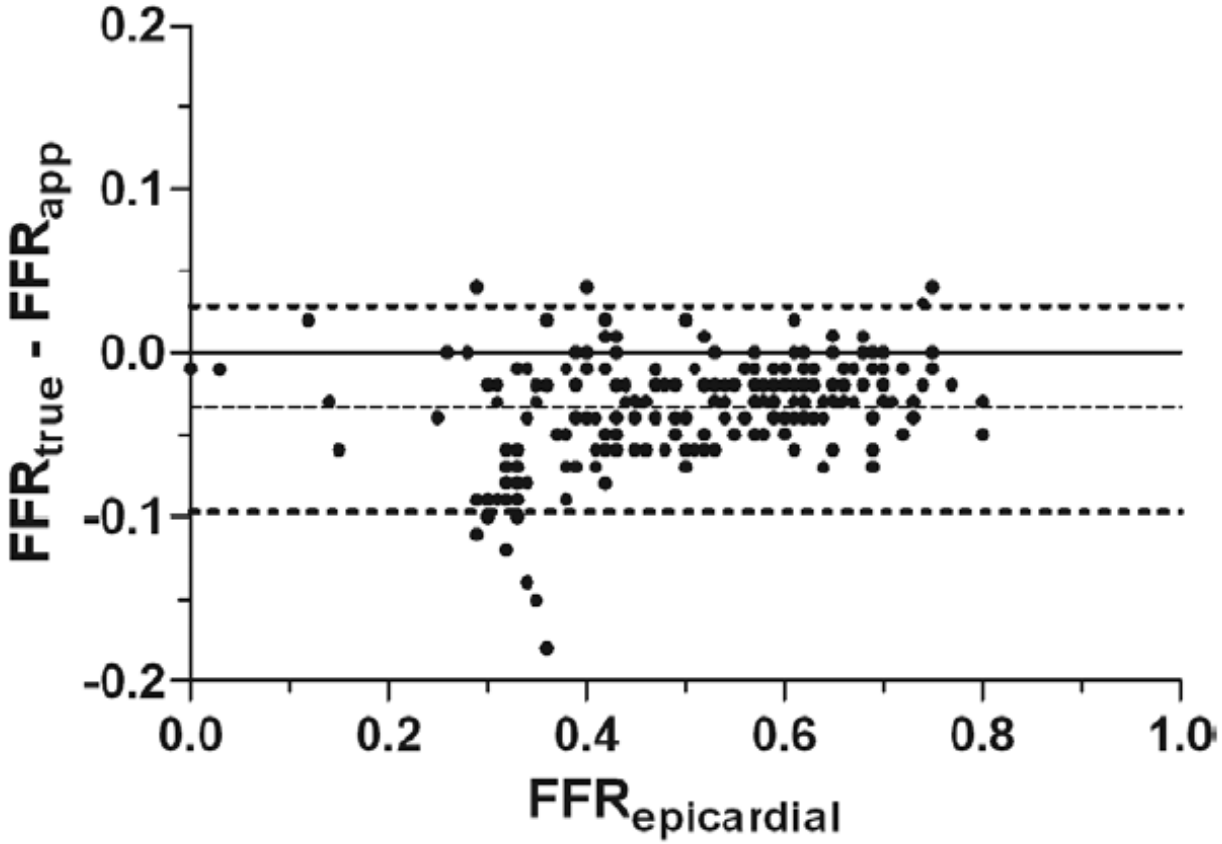


FFR_{app} = 47/61 = 0.77 $FFR_{epicardial}$ = 40/61 = 0.66

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

Effect of Epicardial Lesions on FFR Assessment of Intermediate LM Disease

Animal Model

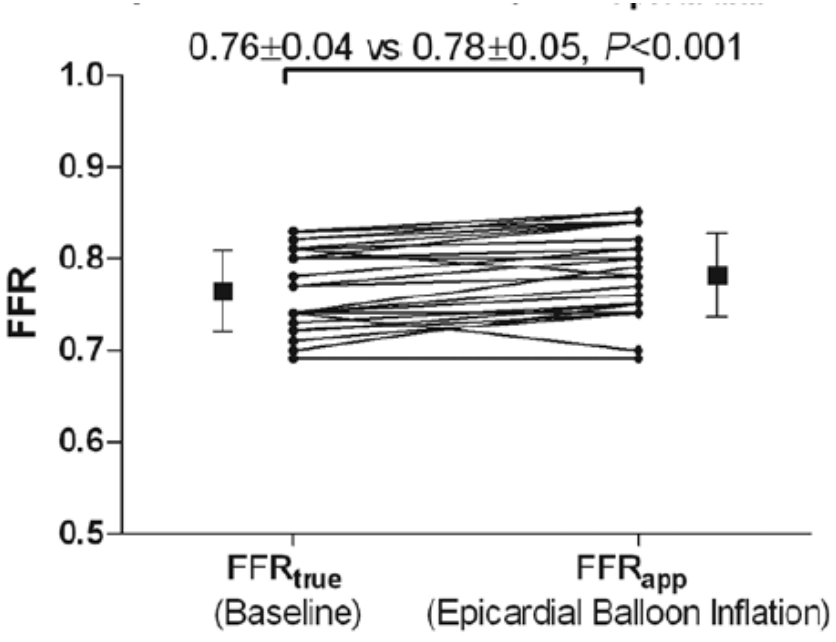


Yong, et al. Circ Cardiovasc Interv 2013;6:161-5.

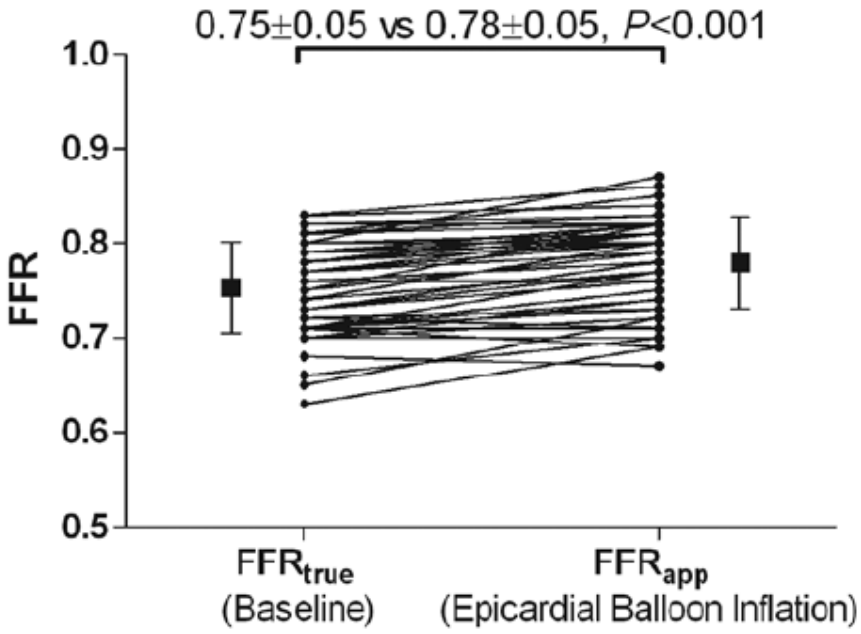
Effect of Epicardial Lesions on FFR Assessment of Intermediate LM Disease

Animal Model

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



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

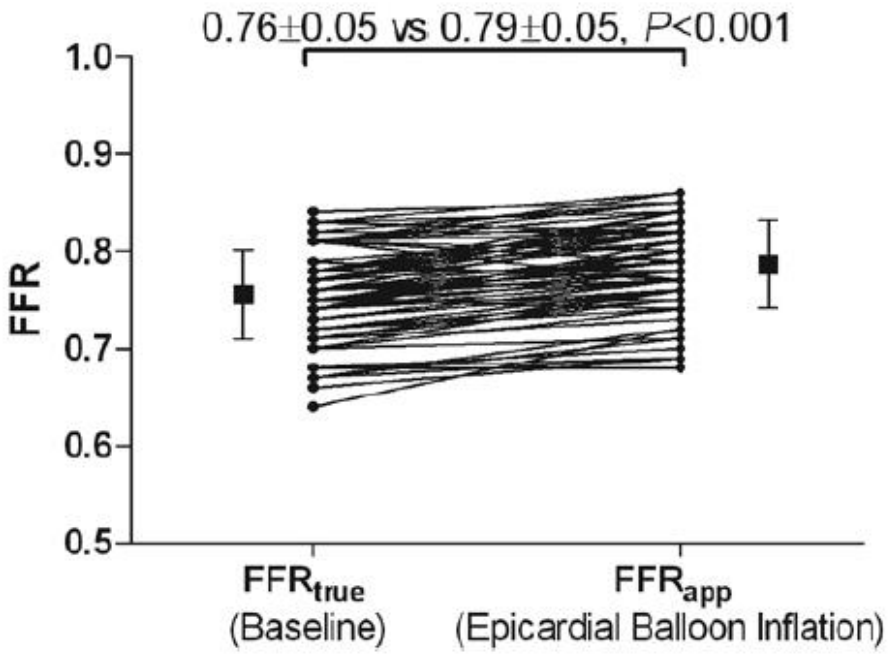


Yong, et al. Circ Cardiovasc Interv 2013;6:161-5.

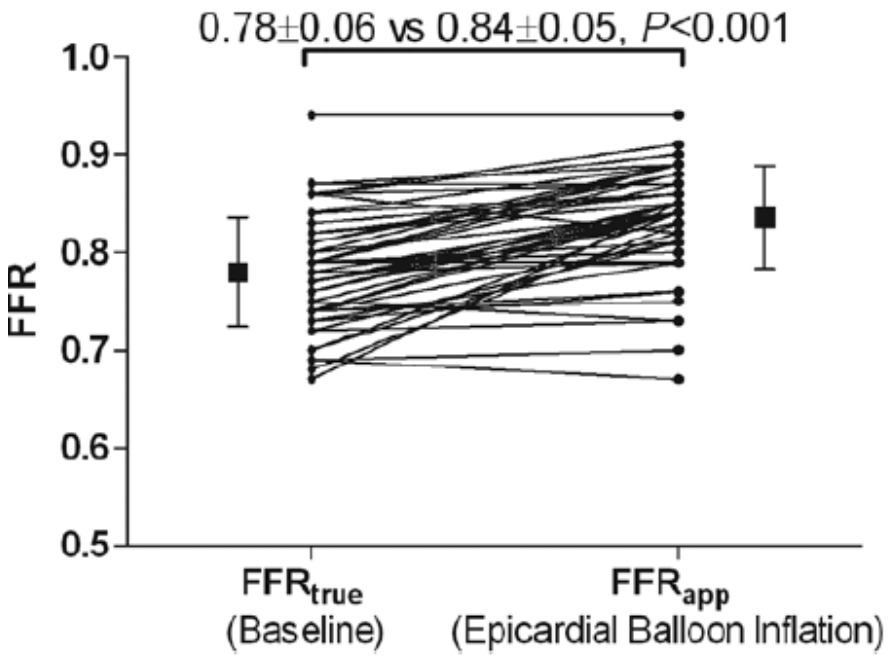
Effect of Epicardial Lesions on FFR Assessment of Intermediate LM Disease

Animal Model

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



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



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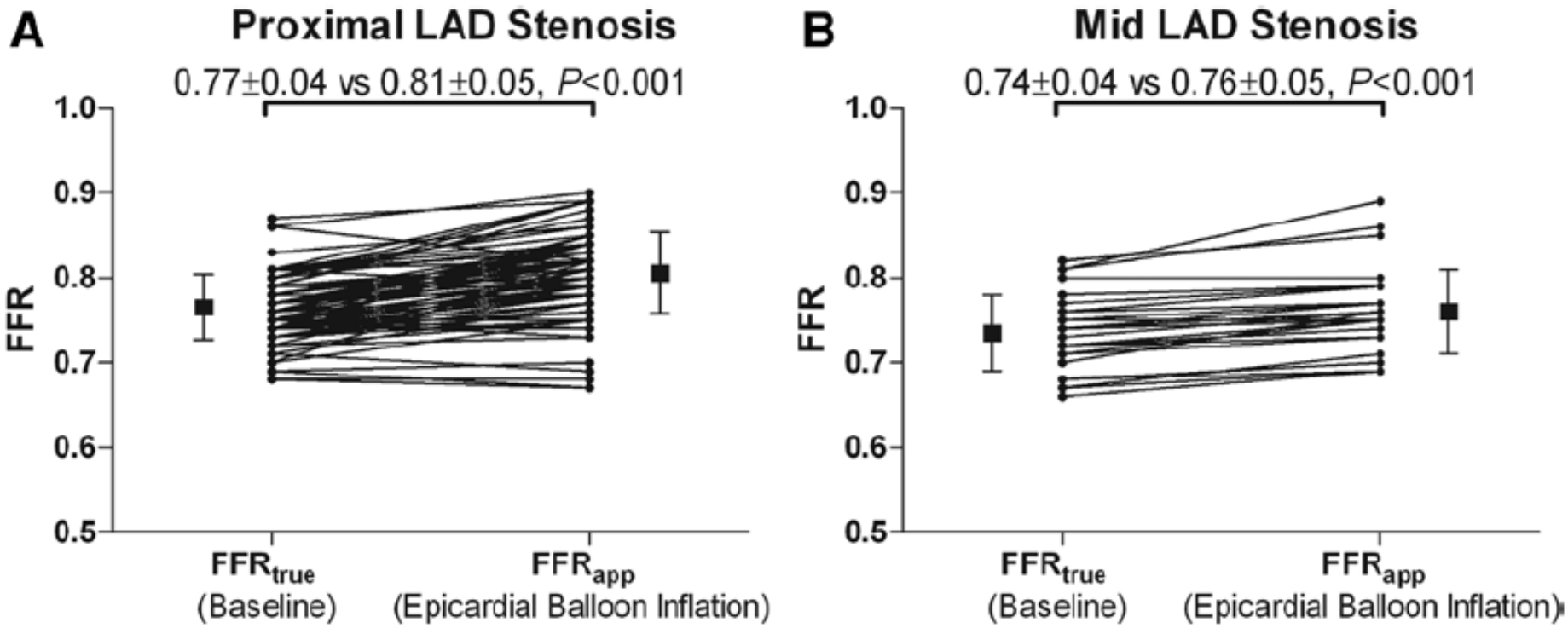

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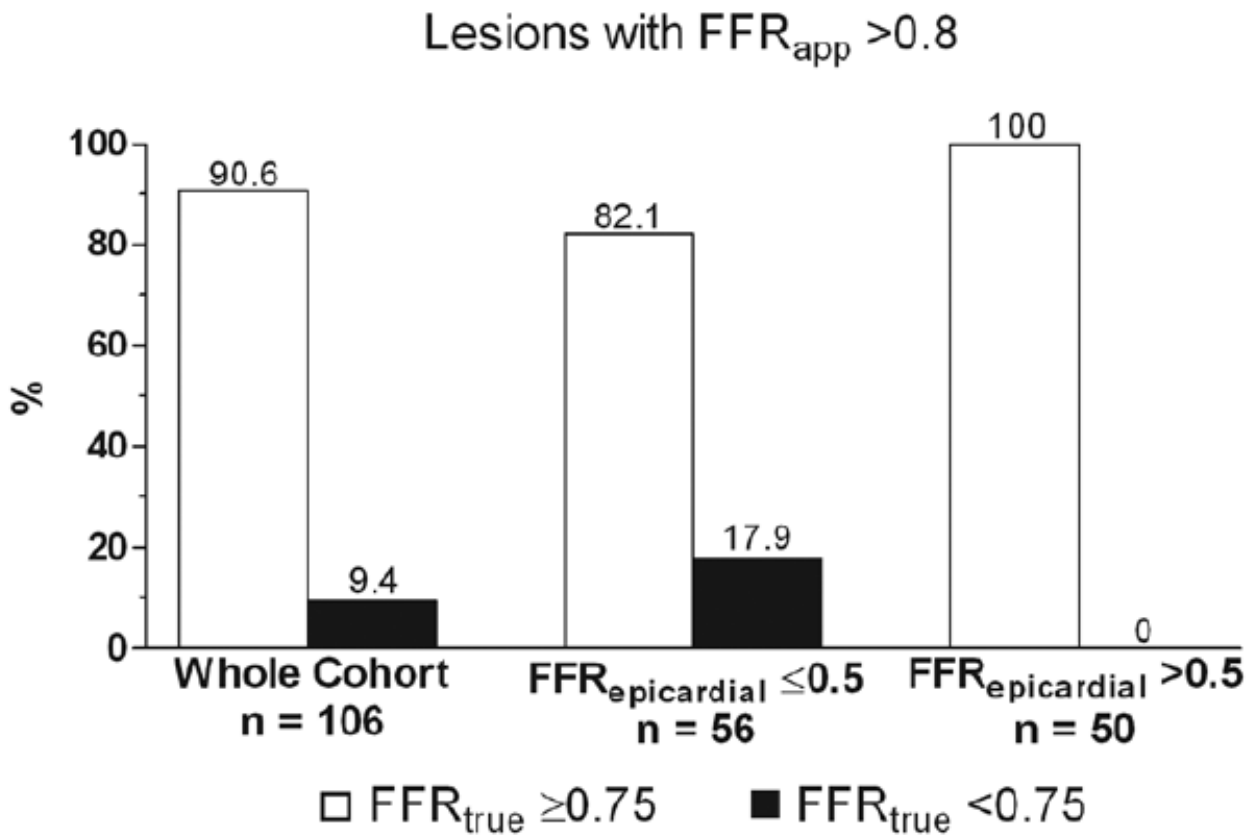

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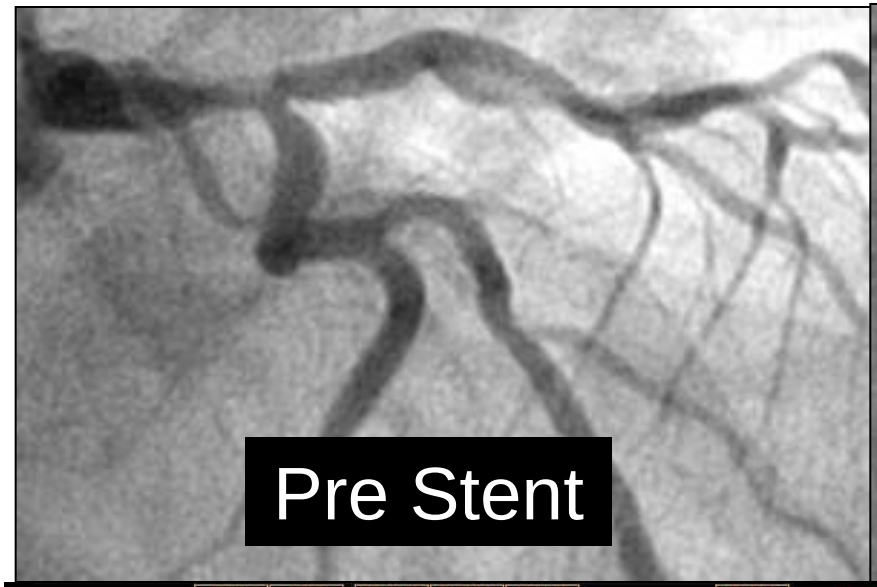
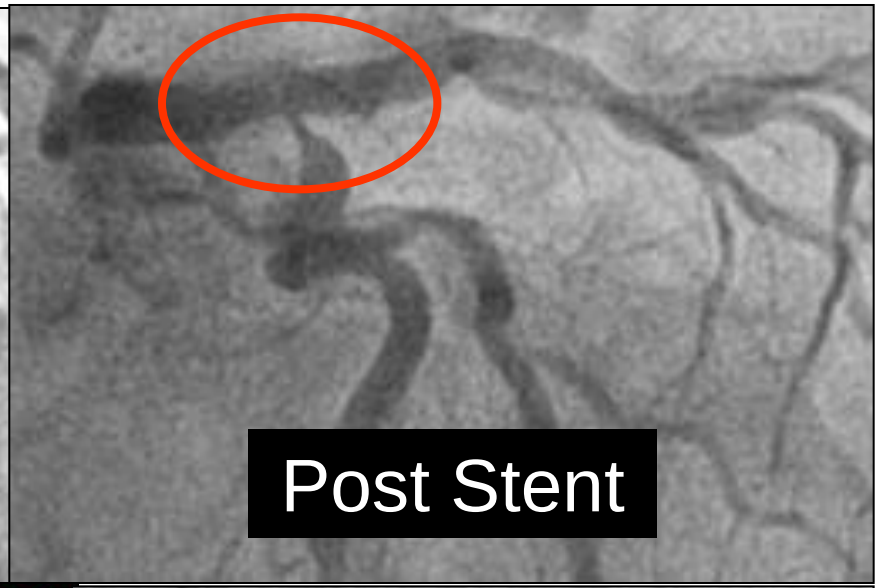
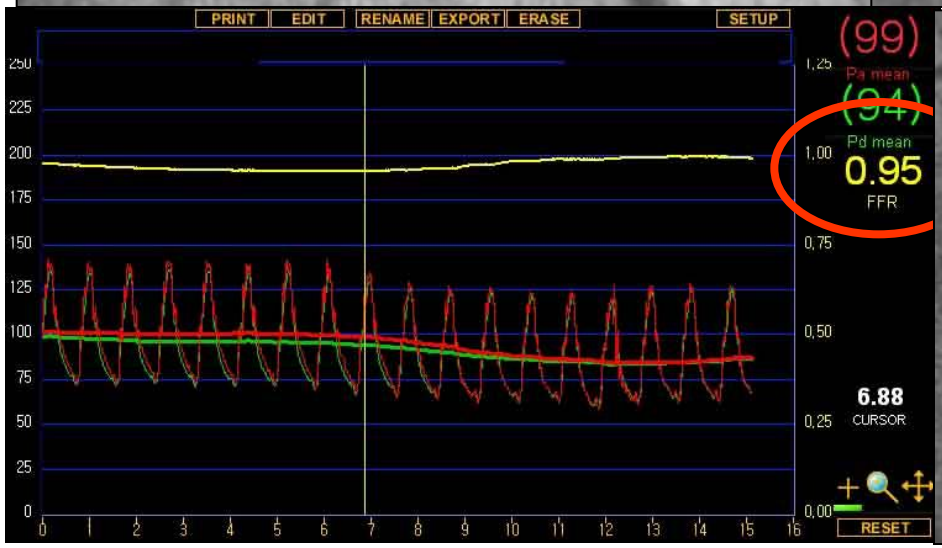
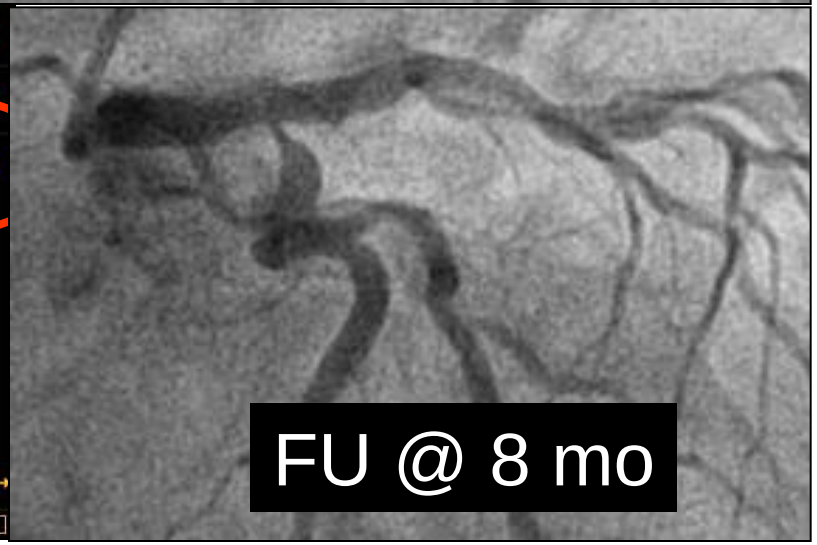




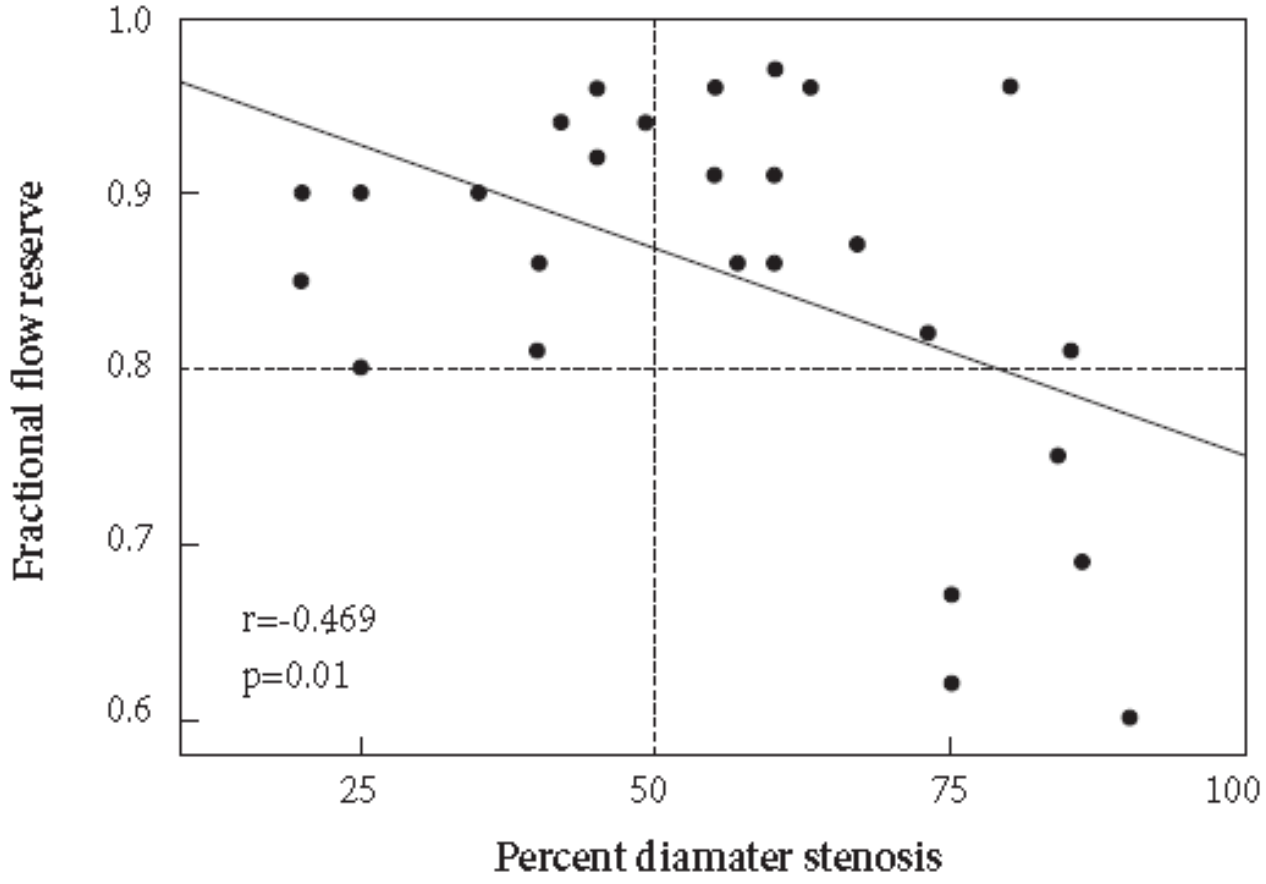




Courtesy of Chang-Wook Nam, MD

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.

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.