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# Clinical Benefit of FFR

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Associate Professor

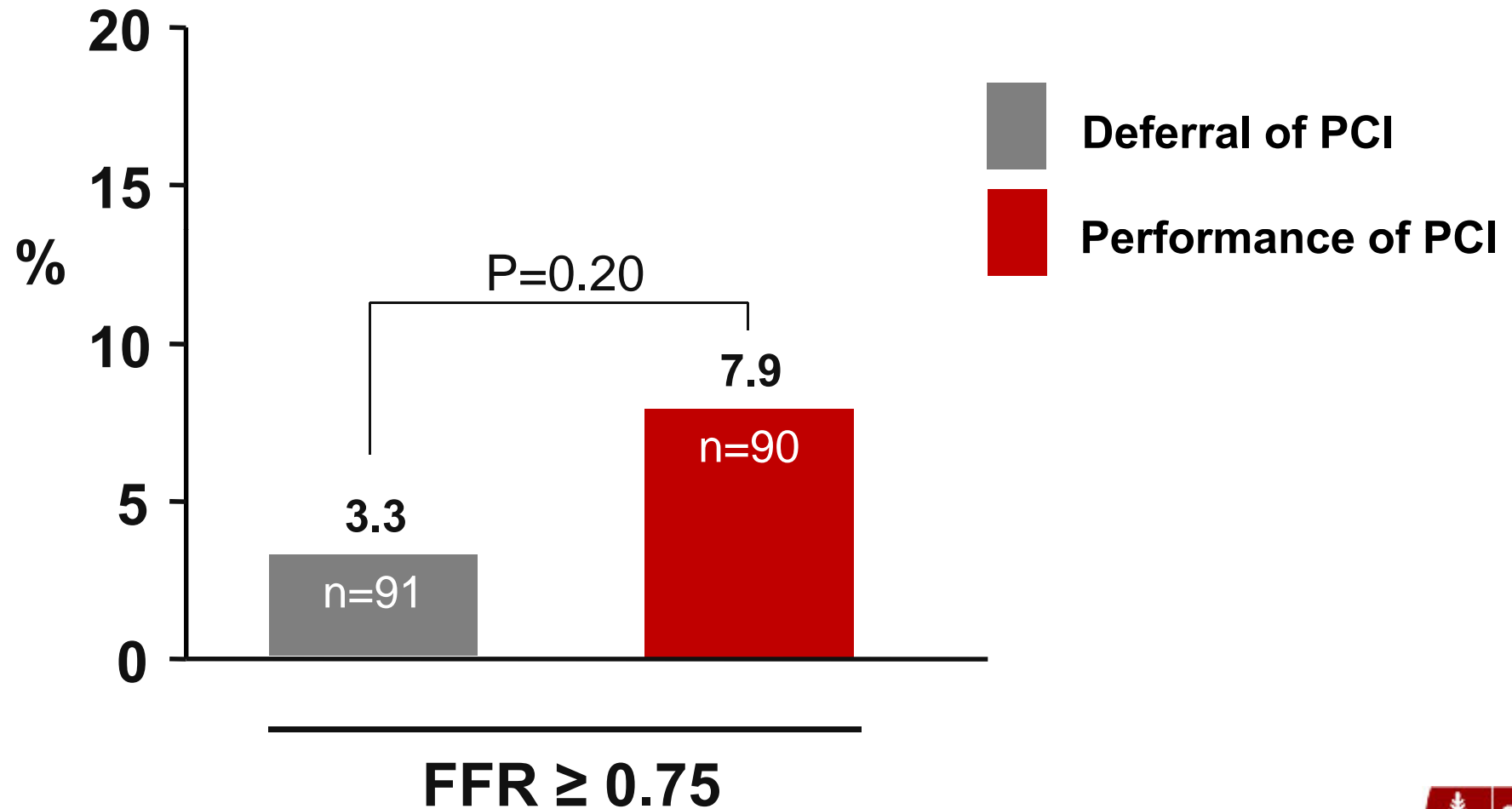
Director, Interventional Cardiology

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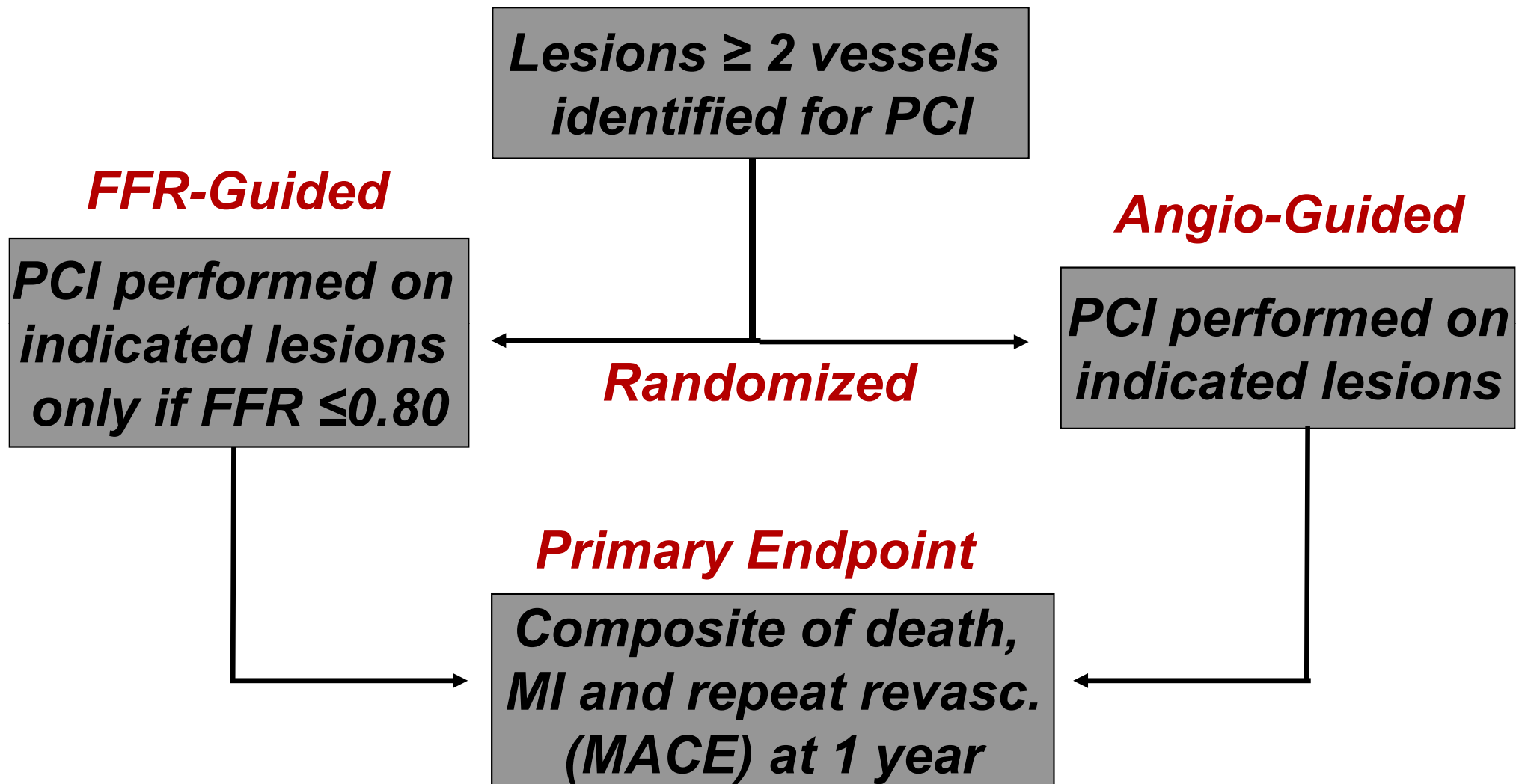


# Safety of Deferring PCI Based on FFR

## 5 Year Cardiac Death and MI rate in DEFER trial



# FAME Trial:



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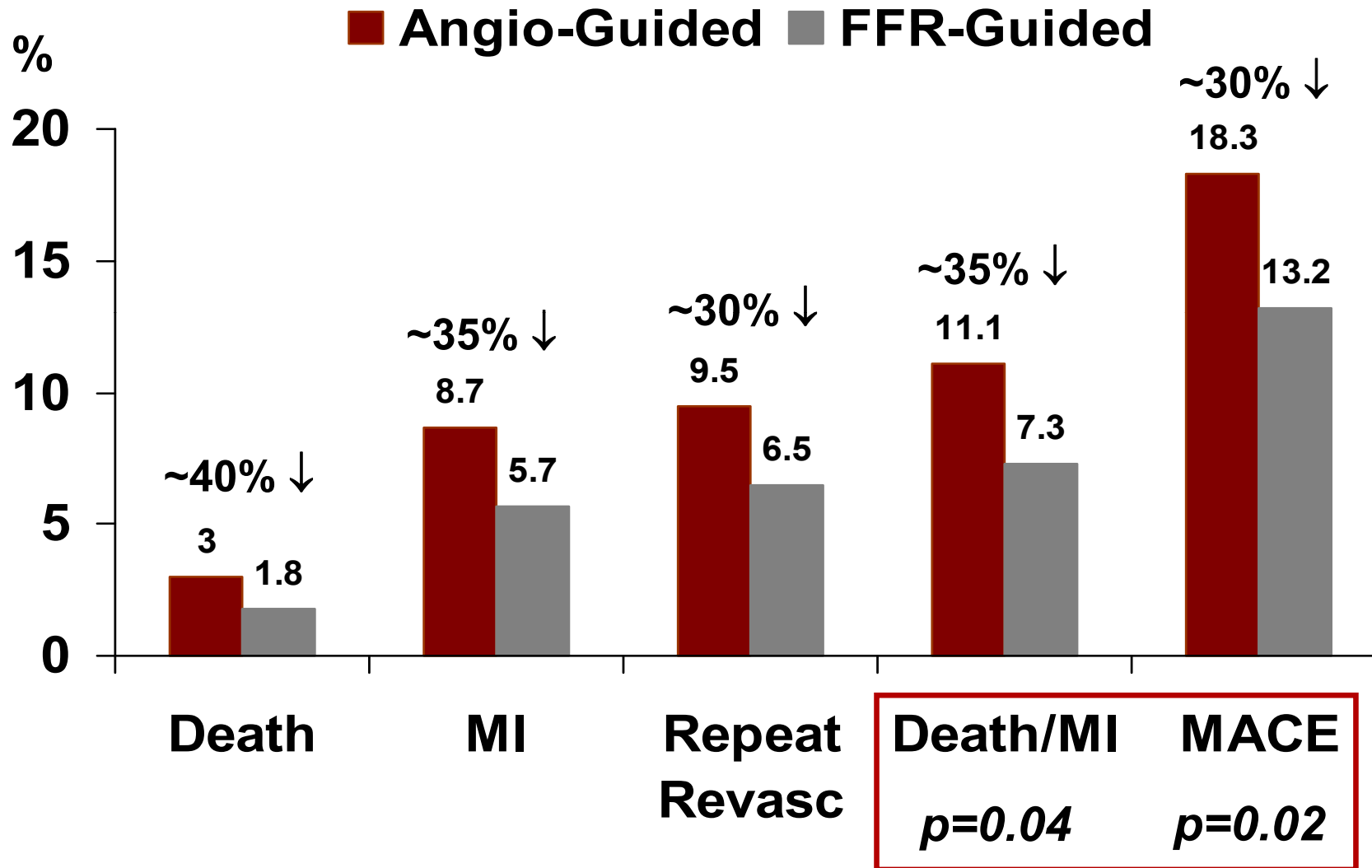
	<b>Angio-Guided n = 496</b>	<b>FFR-Guided n = 509</b>	<b>P Value</b>
<b>Indicated lesions / patient</b>	<b>2.7 ± 0.9</b>	<b>2.8 ± 1.0</b>	<b>0.34</b>
<b>Stents / patient</b>	<b>2.7 ± 1.2</b>	<b>1.9 ± 1.3</b>	<b>&lt;0.001</b>



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<b>Stents / patient</b>	<b>2.7 ± 1.2</b>	<b>1.9 ± 1.3</b>	<b>&lt;0.001</b>
<b>Procedure time (min)</b>	<b>70 ± 44</b>	<b>71 ± 43</b>	<b>0.51</b>
<b>Contrast agent used (ml)</b>	<b>302 ± 127</b>	<b>272 ± 133</b>	<b>&lt;0.001</b>
<b>Equipment cost (US \$)</b>	<b>6007</b>	<b>5332</b>	<b>&lt;0.001</b>
<b>Length of hospital stay (days)</b>	<b>3.7 ± 3.5</b>	<b>3.4 ± 3.3</b>	<b>0.05</b>

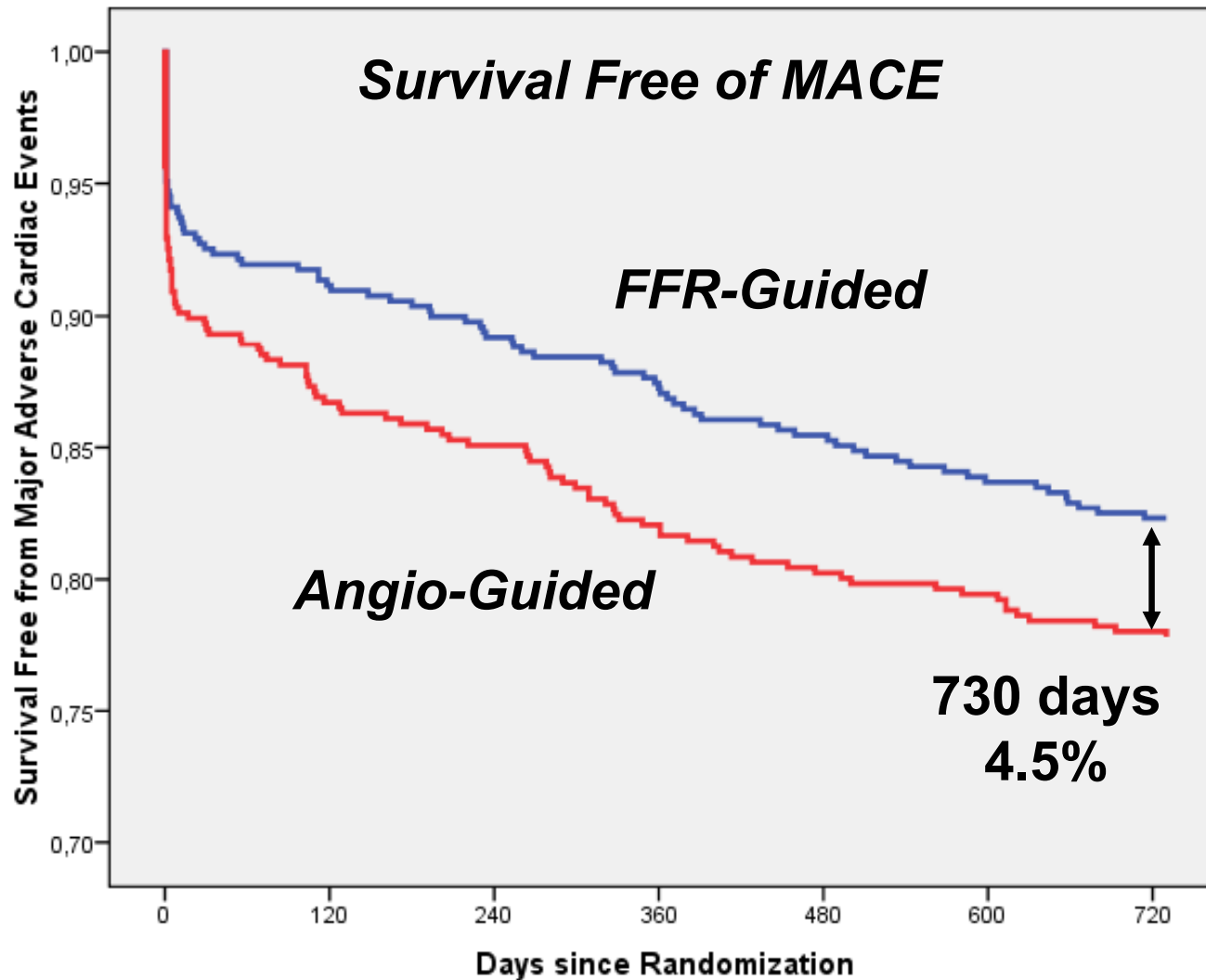


# FAME Study: One Year Outcomes

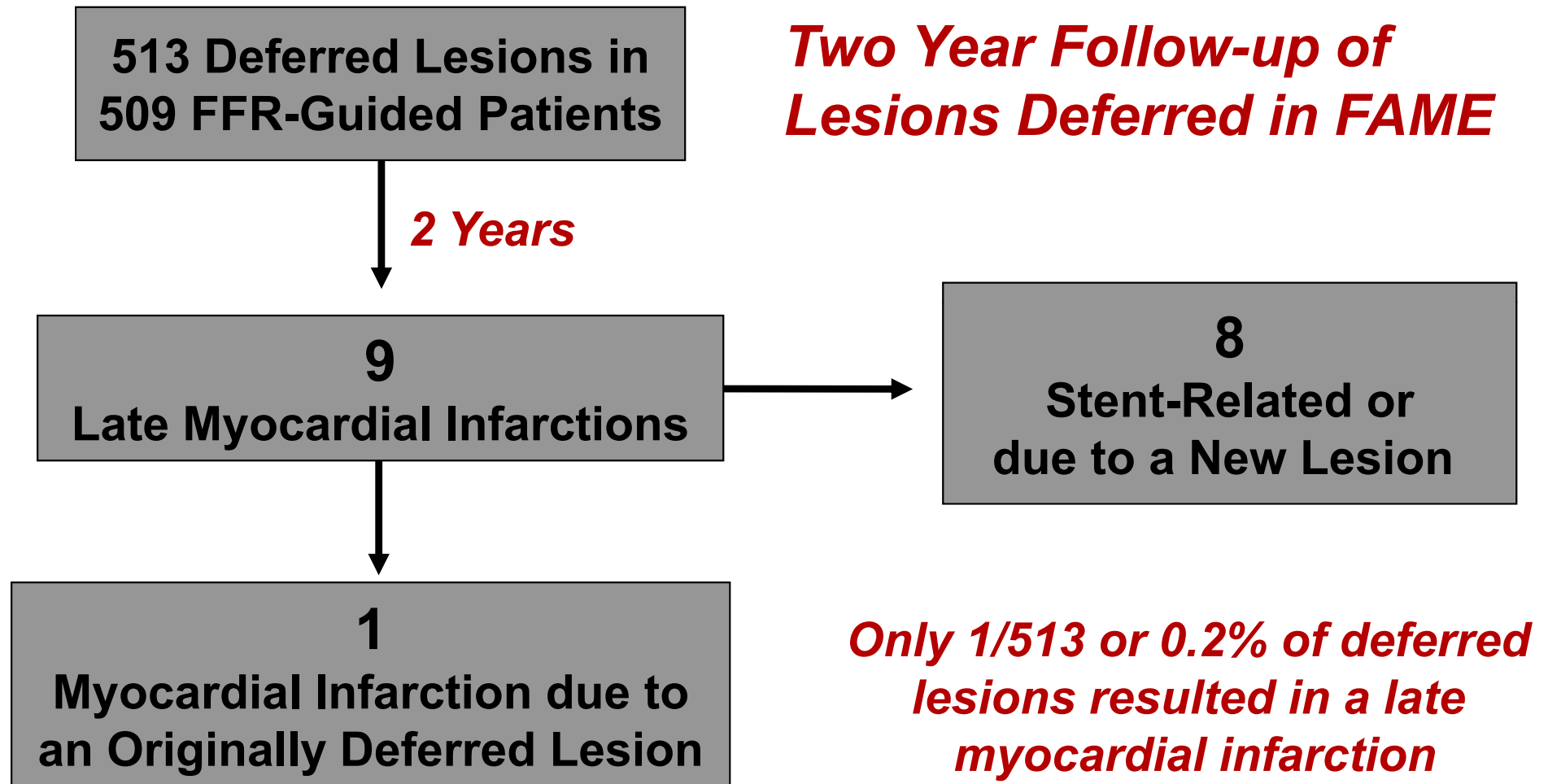


# FAME Study: Two Year Outcomes

**Death/MI was significantly reduced from 12.9% to 8.4% ( $p=0.02$ )**



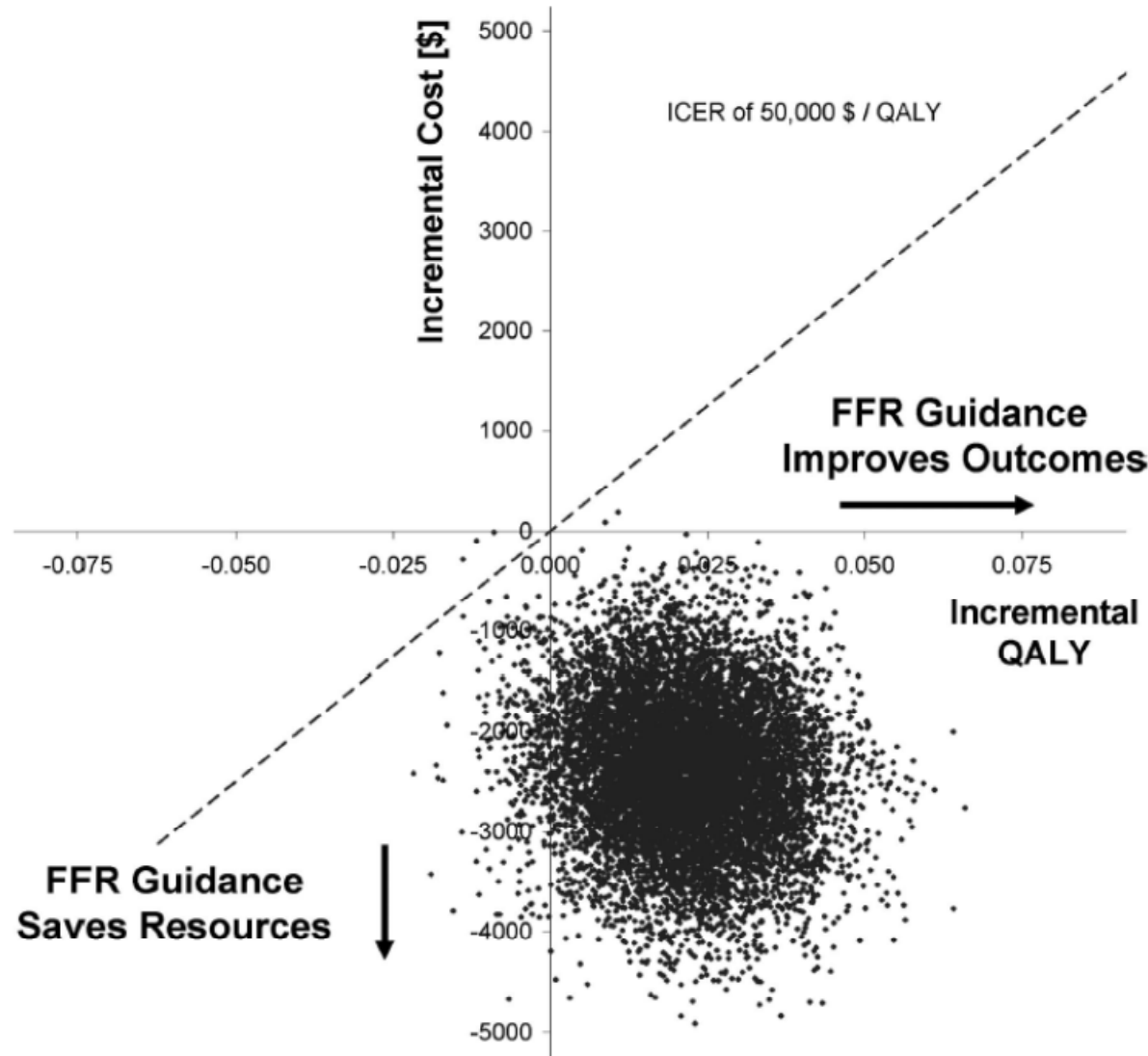
# What happens to deferred lesions?





# FAME: Economic Evaluation

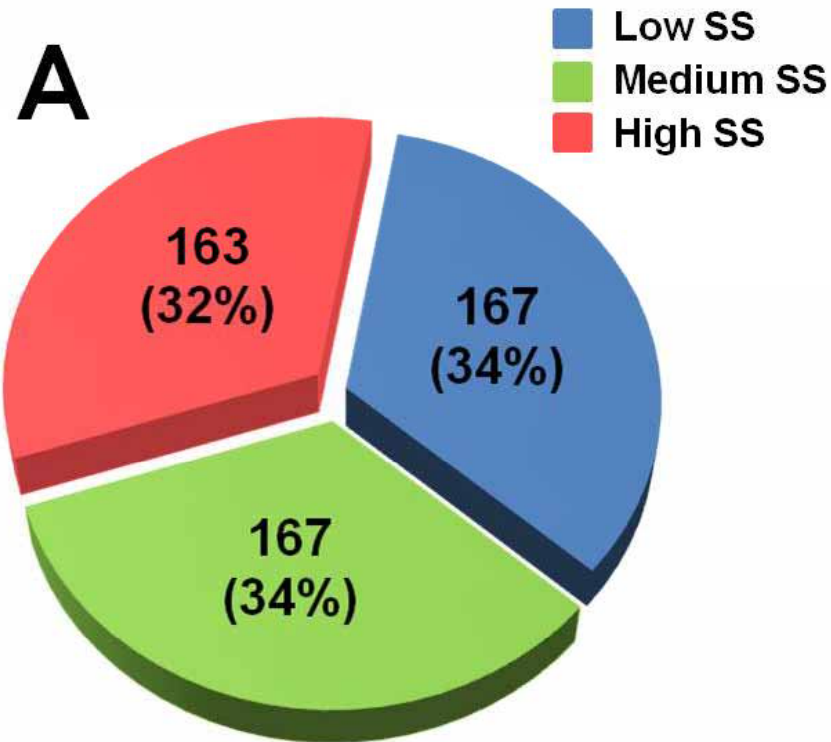
## *Bootstrap Analysis*



*FFR-guided PCI saved >\$2,000 per patient at one year compared to Angio-guided PCI*



# Functional SYNTAX Score

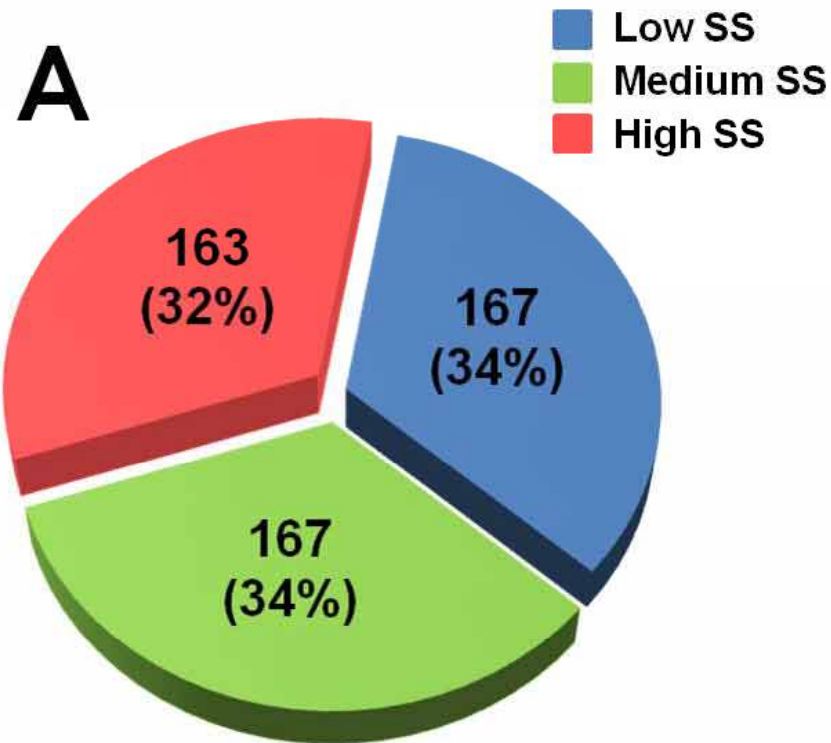


***Without FFR***

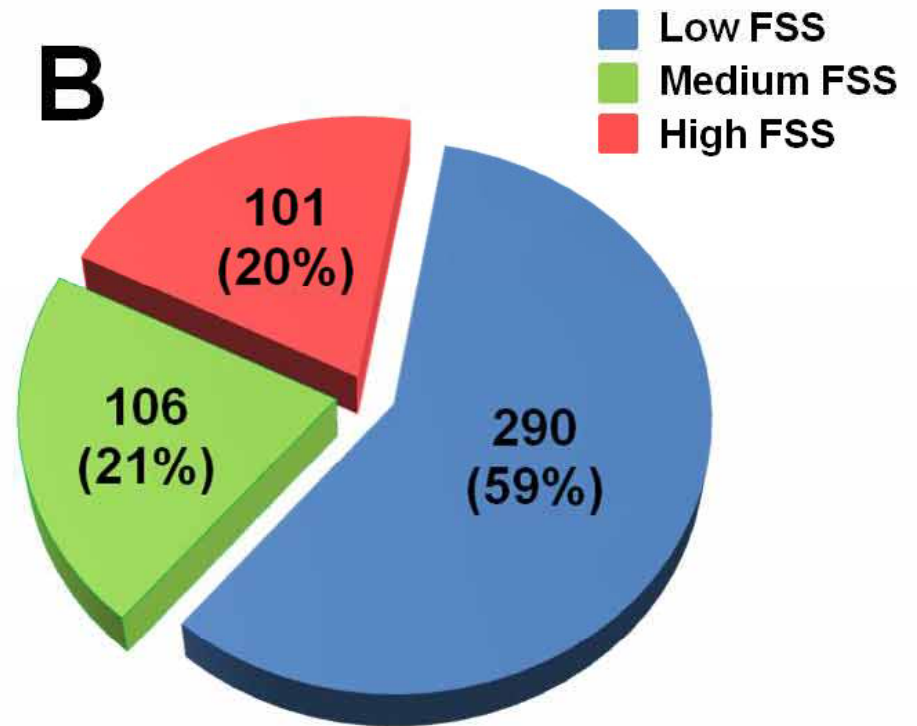


# Functional SYNTAX Score

***FSS Reclassifies >30% of patients***



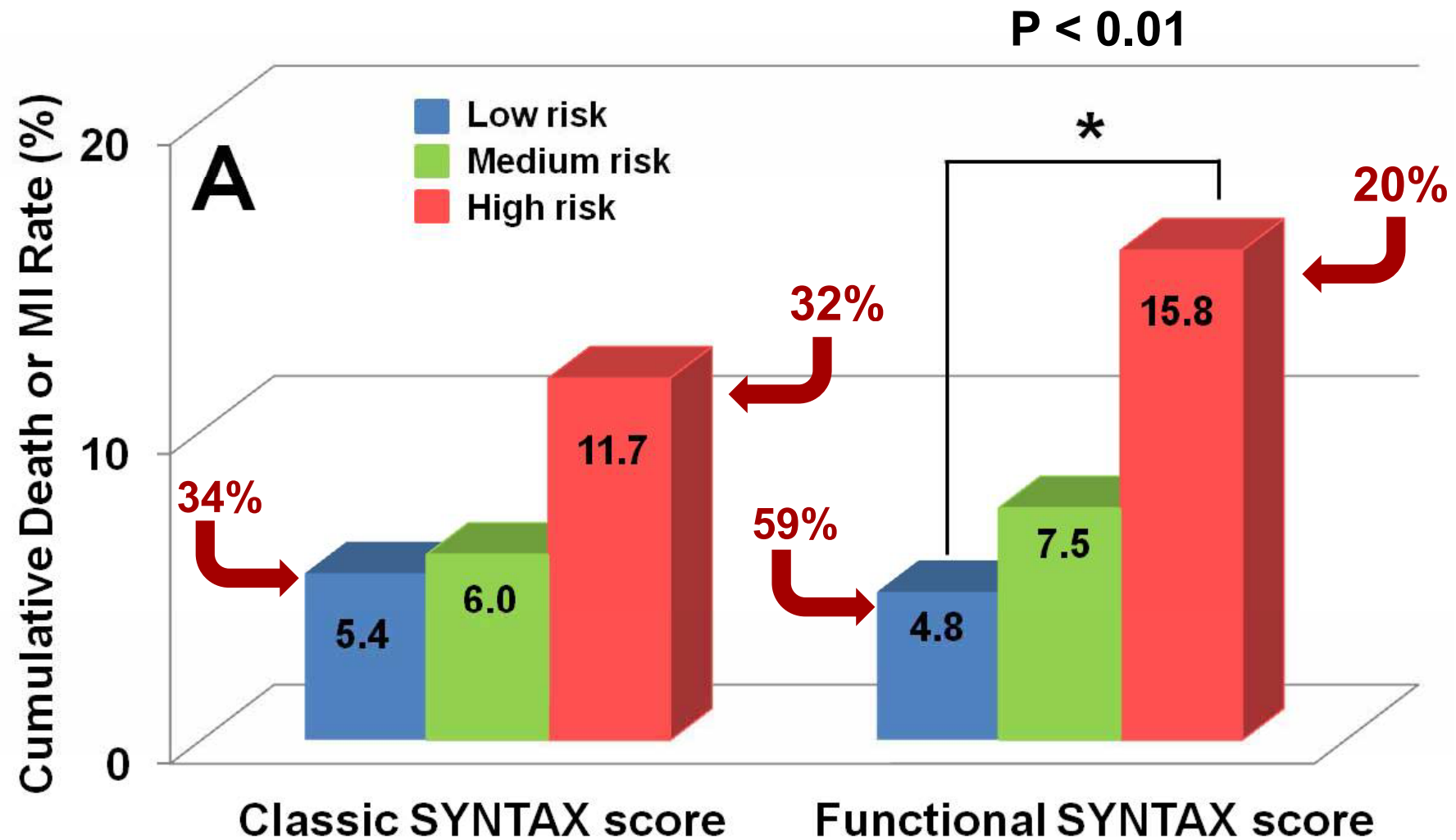
***Without FFR***



***With FFR***



# FSS Discriminates Risk for Death/MI



# FAME 2

Stable CAD patients scheduled for 1, 2 or 3 vessel DES-PCI  
N = 1220

FFR in all target lesions

**Randomized Trial**

**Registry**

At least 1 stenosis  
with FFR  $\leq 0.80$  (n=888)

Randomization 1:1

PCI + MT

MT

**73%**

When all FFR  $> 0.80$   
(n=332)

MT

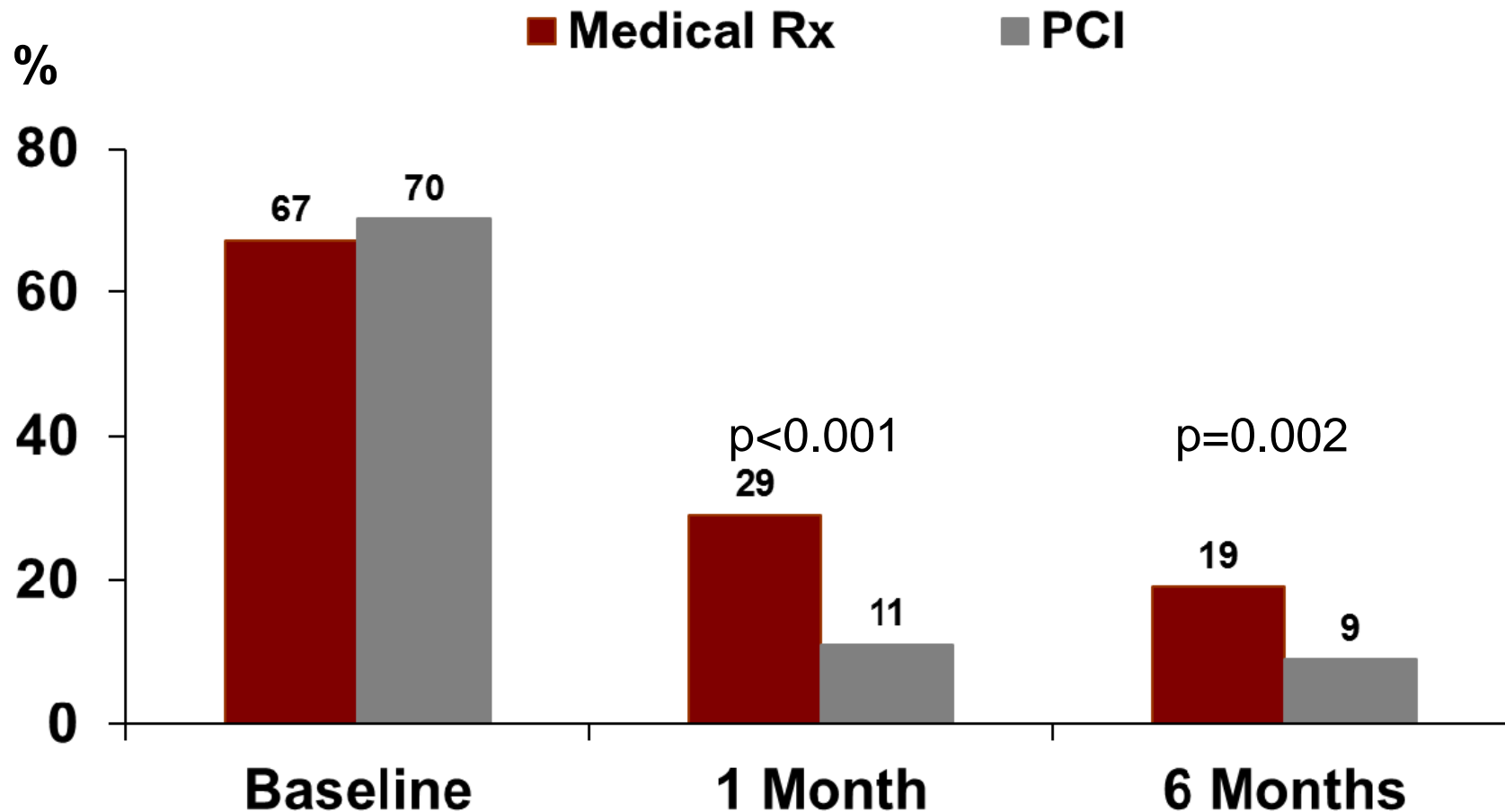
**27%**

50% randomly  
assigned to FU

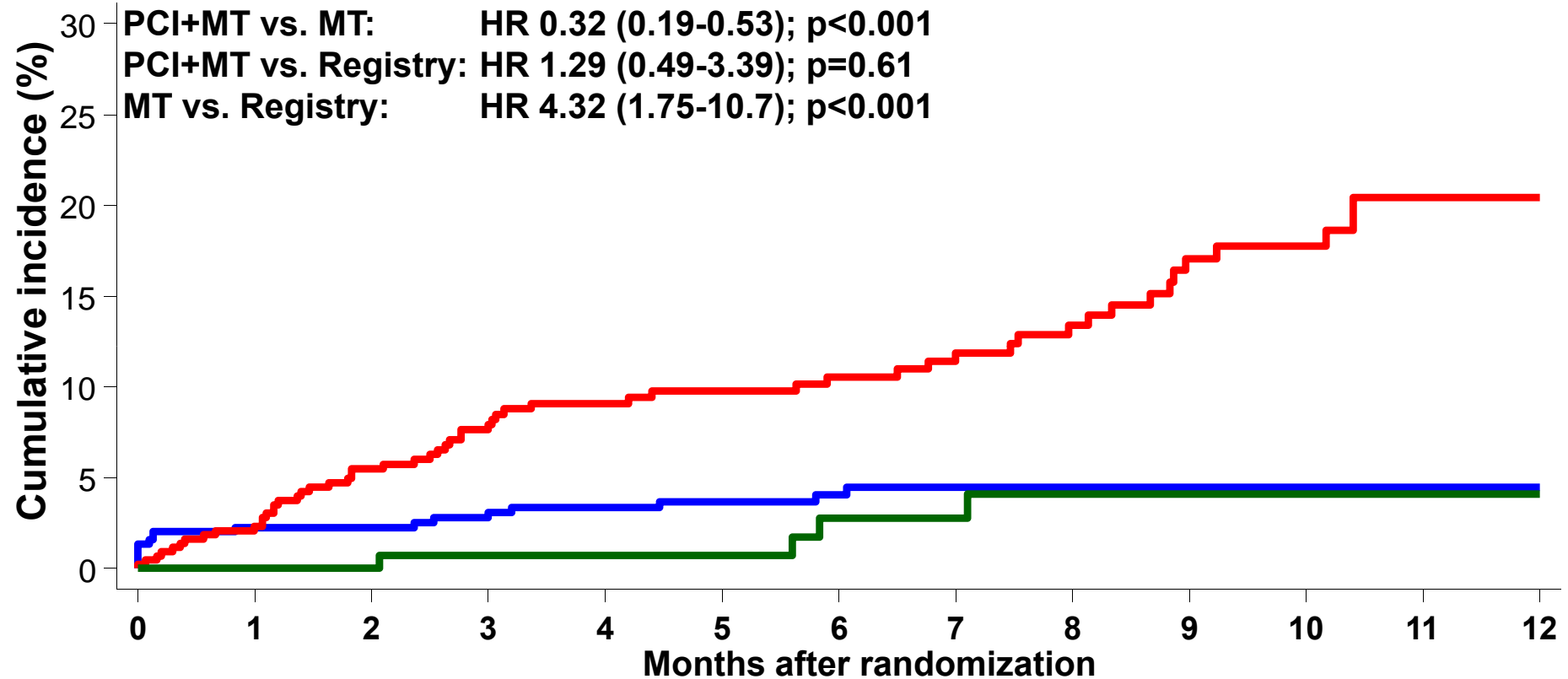
Primary Endpoint: Death, MI or Urgent Revascularization at 2 Yr



# Patients with Angina Class II to IV



# Primary Endpoint: *Death, MI, Urgent Revasc*

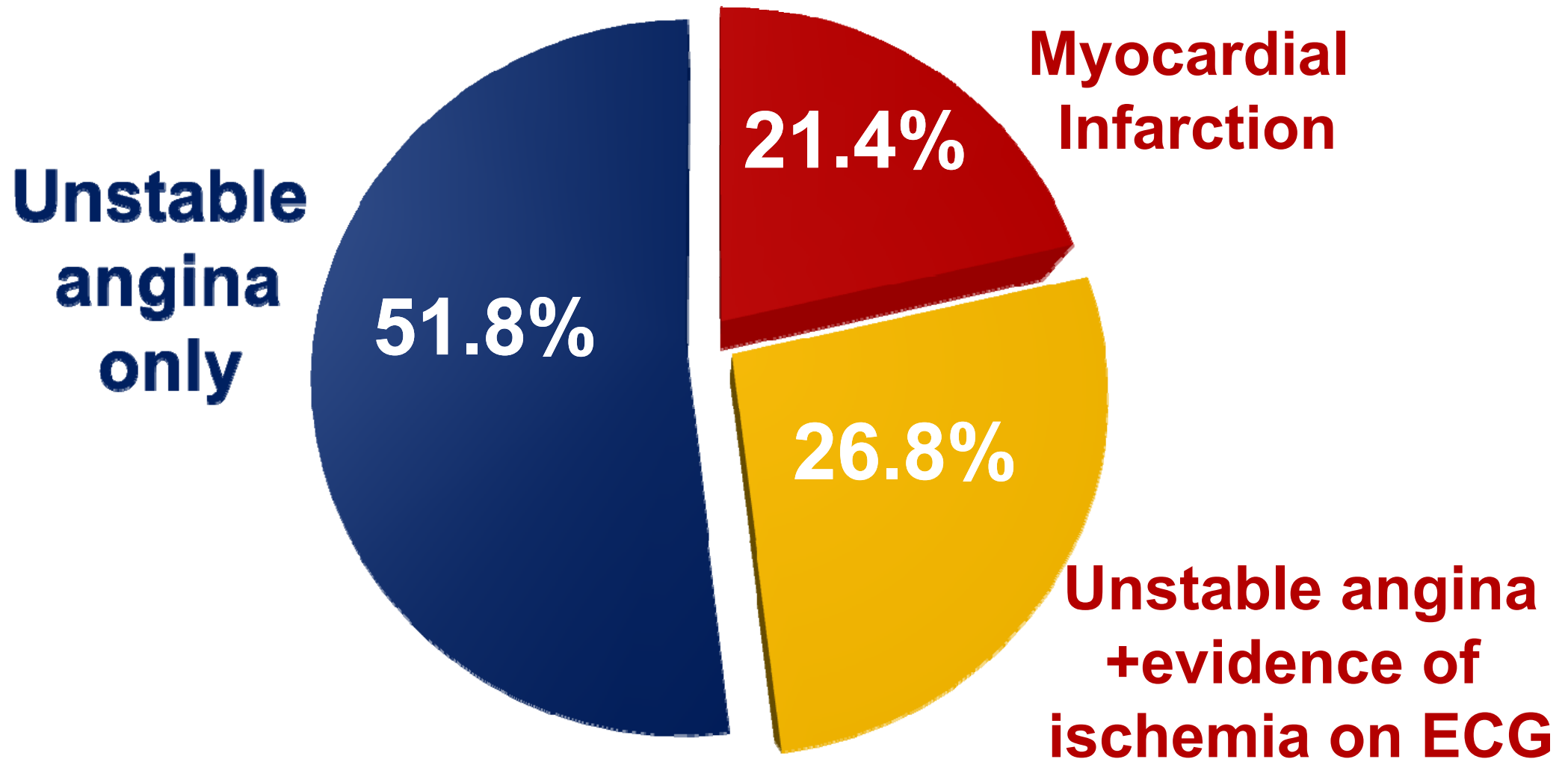


No. at risk

<b>MT</b>	<b>441</b>	<b>414</b>	<b>370</b>	<b>322</b>	<b>283</b>	<b>253</b>	<b>220</b>	<b>192</b>	<b>162</b>	<b>127</b>	<b>100</b>	<b>70</b>	<b>37</b>
<b>PCI+MT</b>	<b>447</b>	<b>414</b>	<b>388</b>	<b>351</b>	<b>308</b>	<b>277</b>	<b>243</b>	<b>212</b>	<b>175</b>	<b>155</b>	<b>117</b>	<b>92</b>	<b>53</b>
<b>Registry</b>	<b>166</b>	<b>156</b>	<b>145</b>	<b>133</b>	<b>117</b>	<b>106</b>	<b>93</b>	<b>74</b>	<b>64</b>	<b>52</b>	<b>41</b>	<b>25</b>	<b>13</b>



# Patients with urgent revascularization



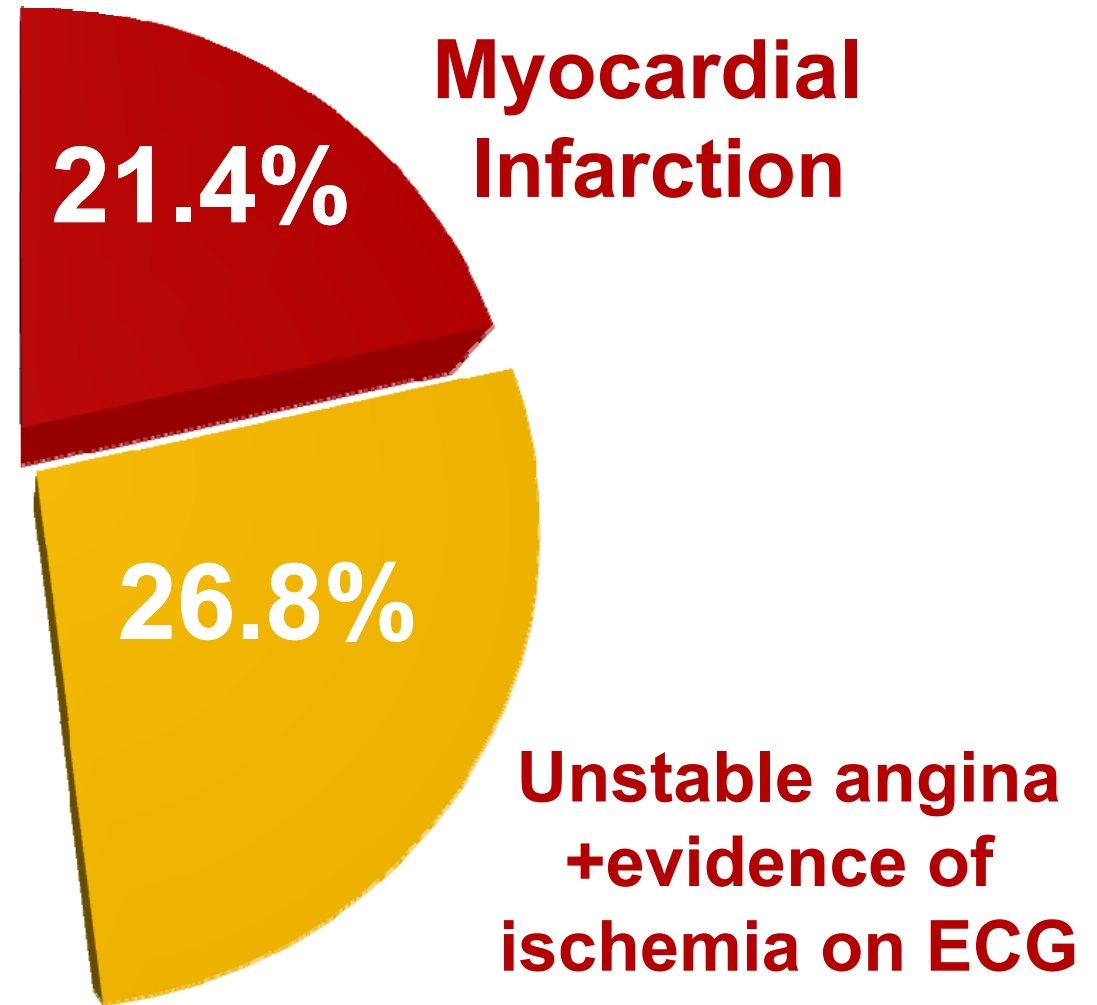


# Patients with urgent revascularization

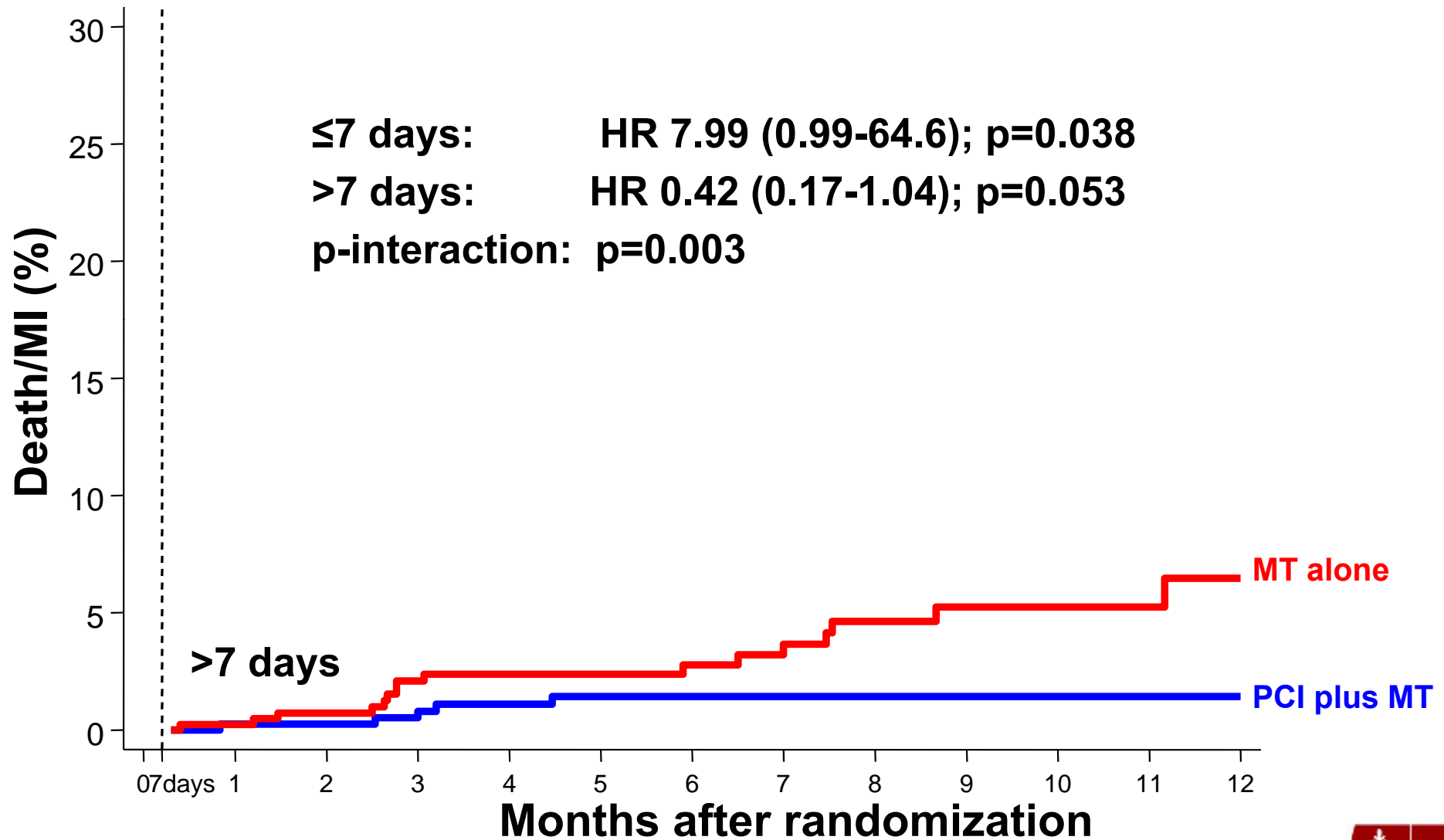
**Urgent revascularization driven by MI or unstable angina with ECG changes**

<b>FFR-Guided PCI + MT</b>		<b>MT</b>
<b>0.9%</b>	<b>vs.</b>	<b>5.2%</b>

**p<0.001**  
**83% Relative Risk Reduction**

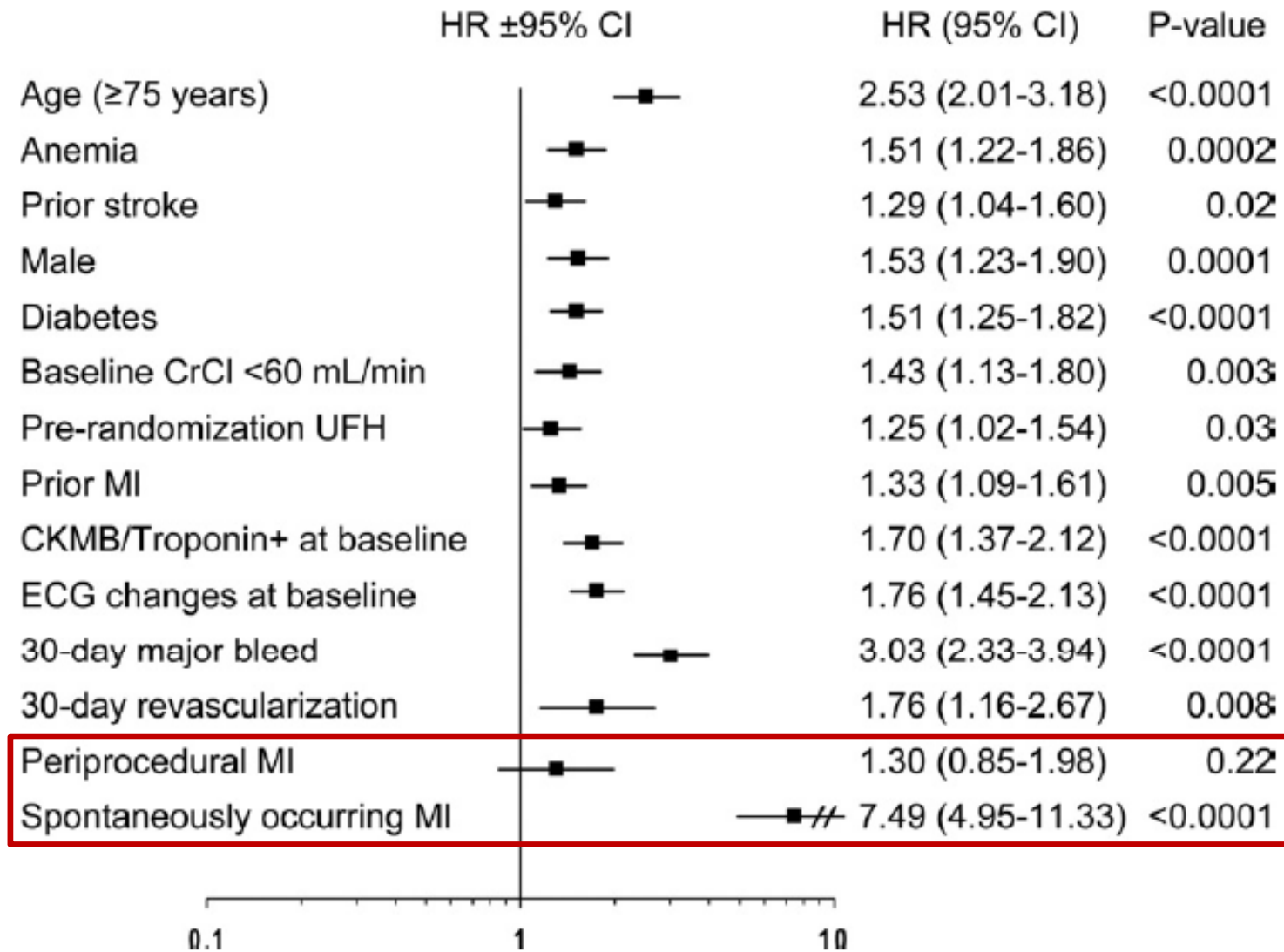


# Landmark Analysis for Death/MI

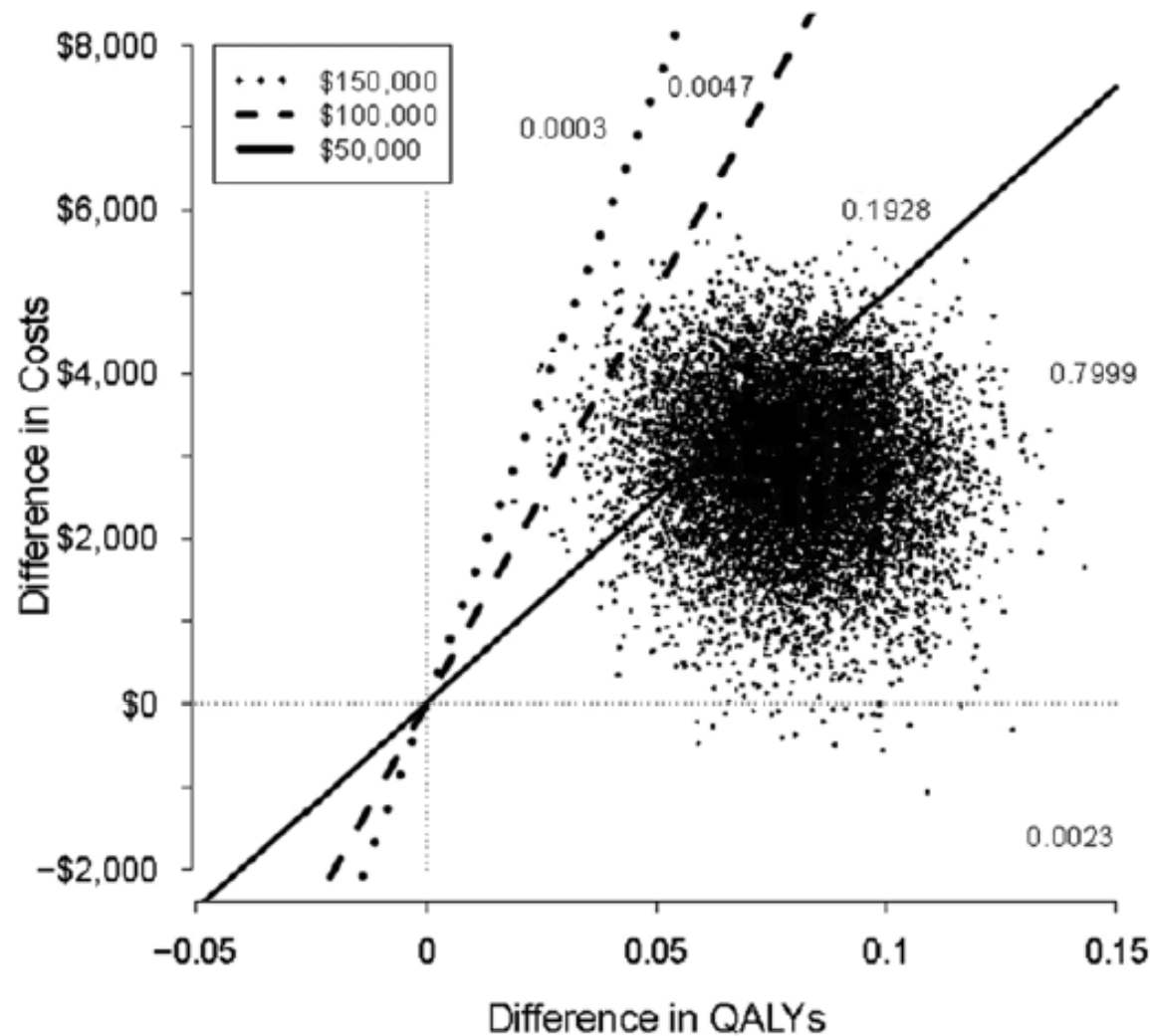


# Spontaneous vs. Procedural MI

*Independent predictors of subsequent mortality in 7,773 patients in ACUITY*



# Bootstrap Simulation



**80% of the 10,000 replications were below the \$50,000/QALY willingness-to-pay threshold and 99.5% were below the \$100,000/QALY threshold**



# Real World FFR Use

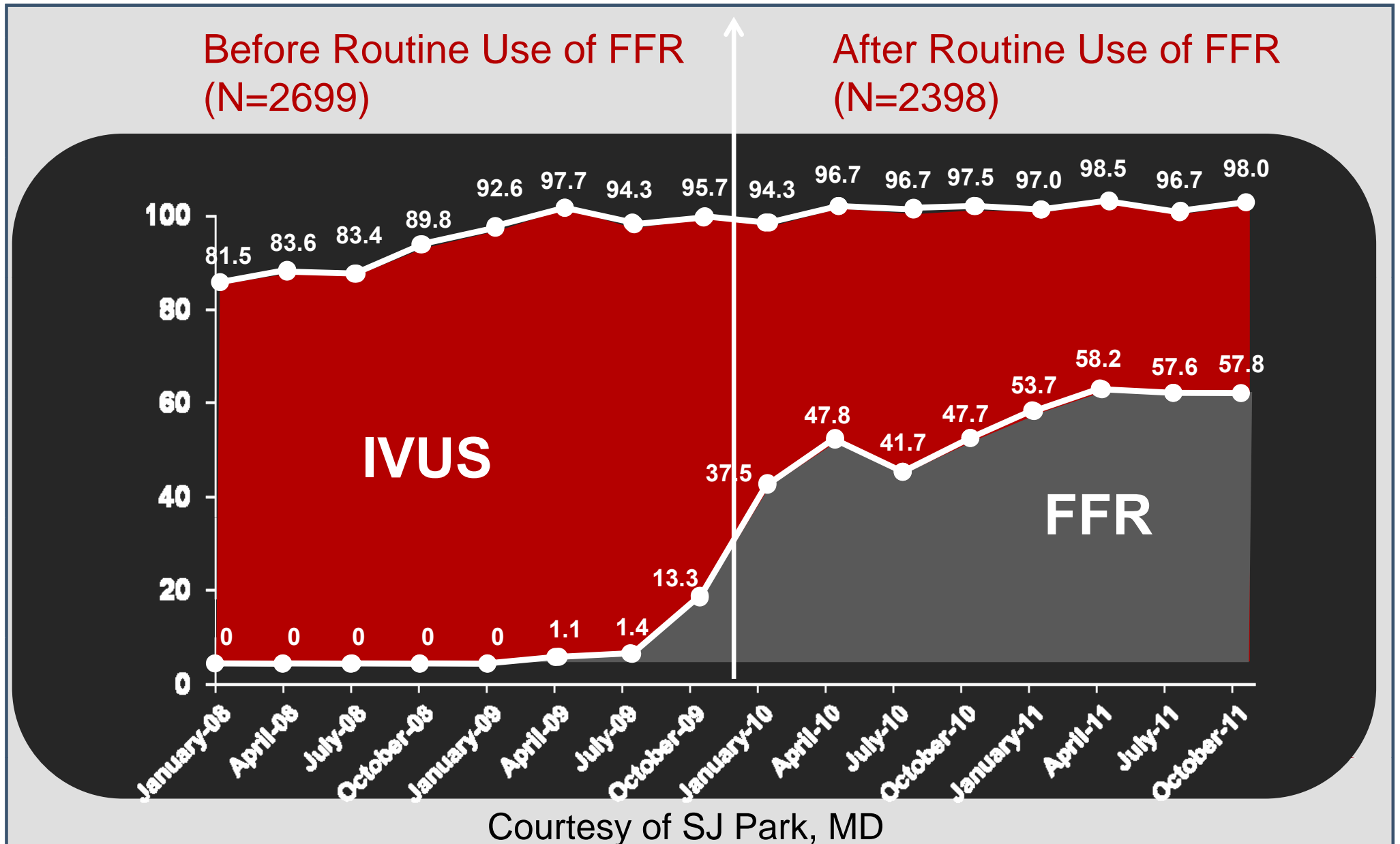
*7,358 consecutive patients referred for PCI (1,090 FFR-Guided)*

<b>Events</b>	<b>Adjusted<sup>a</sup> HR</b>	<b>95% CI</b>	<b>P-value</b>
.....			
FFR use vs. no FFR			
MACE	1.01	0.89–1.14	0.93
Death	0.89	0.73–1.10	0.28
MI	0.79	0.58–1.07	0.12
Death/revascularization	1.003	0.88–1.14	0.96
Death/MI	0.85	0.71–1.01	0.06



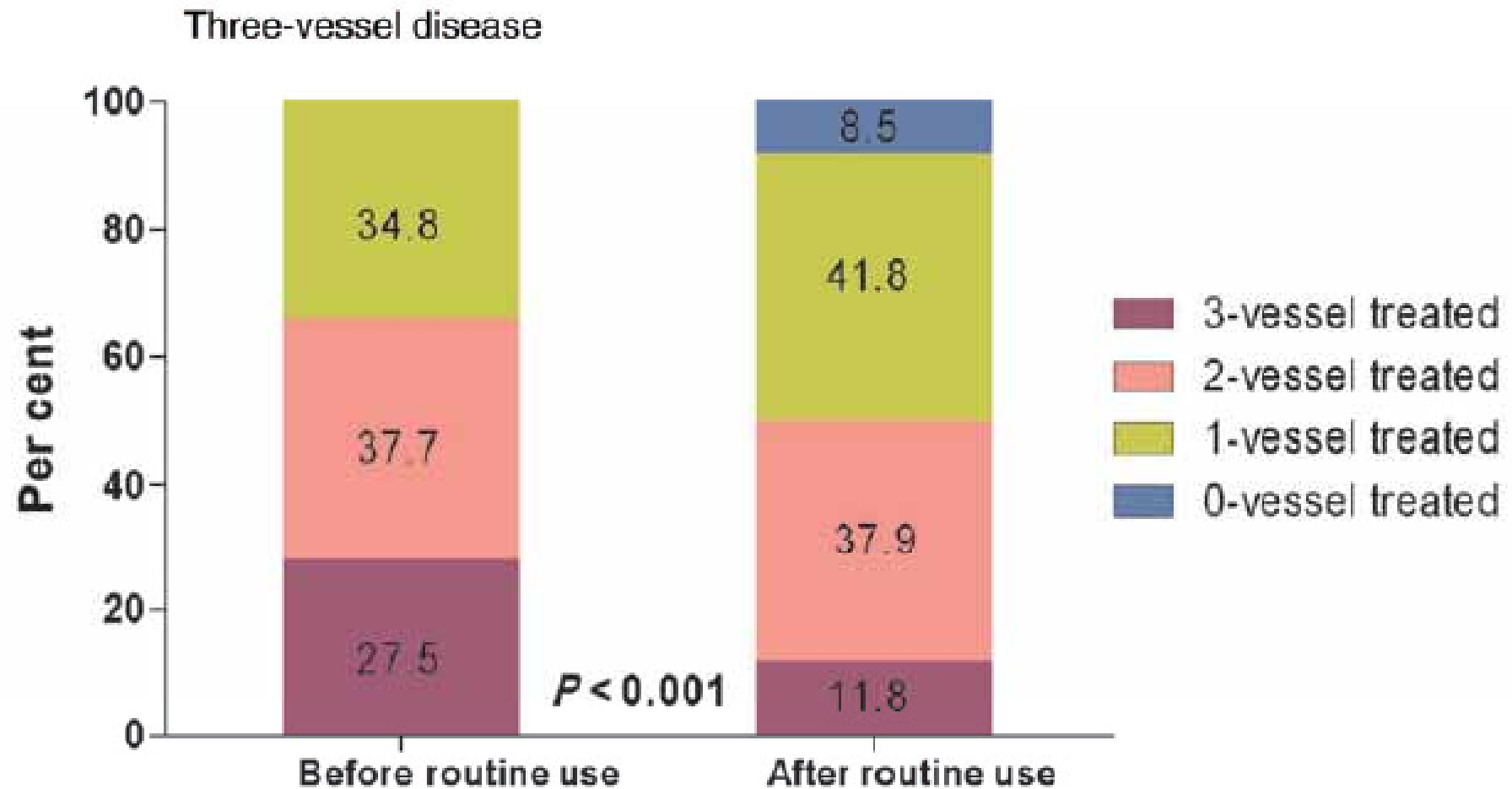
# Integrated Use of FFR and IVUS

(AMC data, n=5097)



# Real World FFR Use

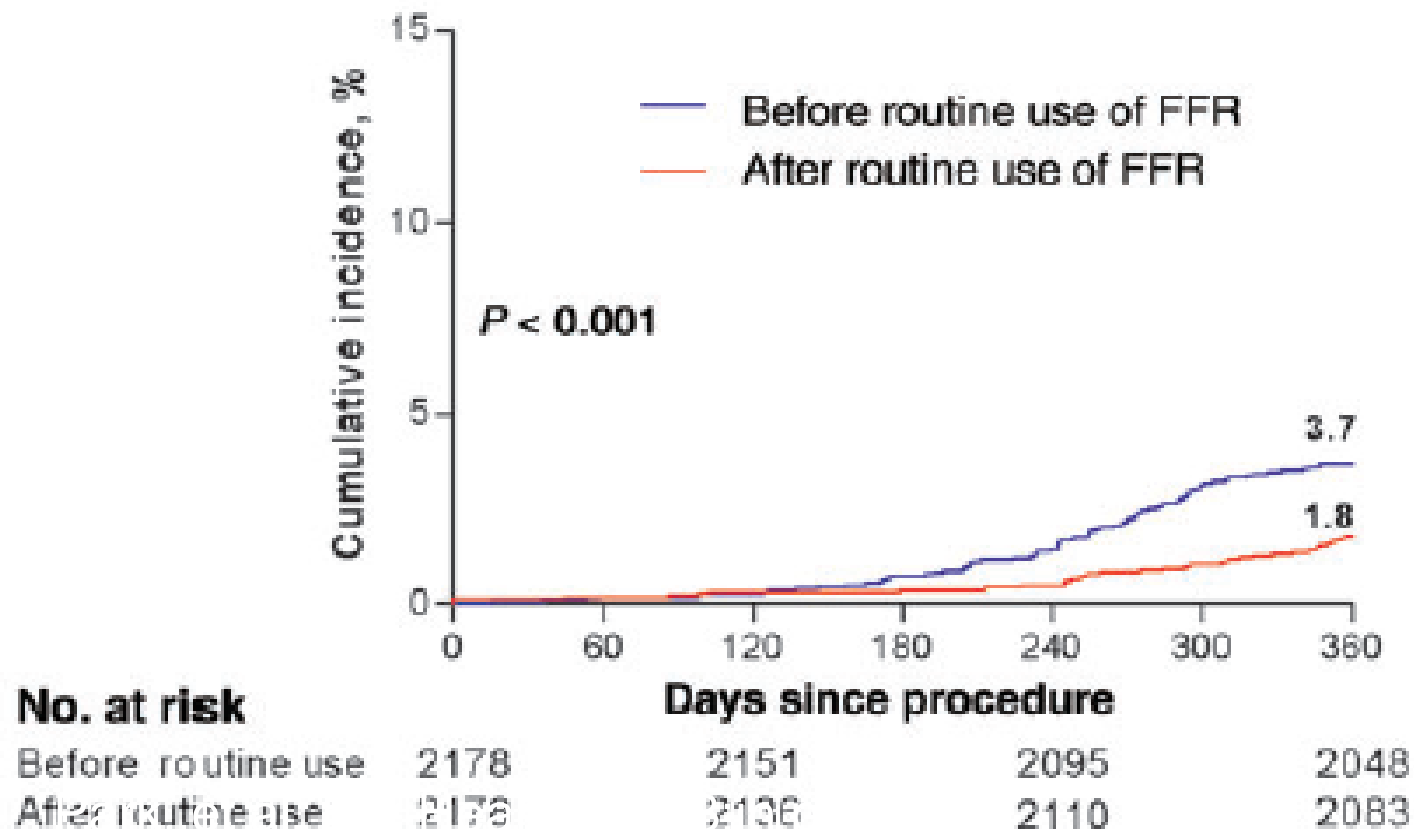
*2,178 pairs of propensity matched patients before and after routine FFR use*



# Real World FFR Use

*2,178 pairs of propensity matched patients before and after routine FFR use*

## Repeat revascularization

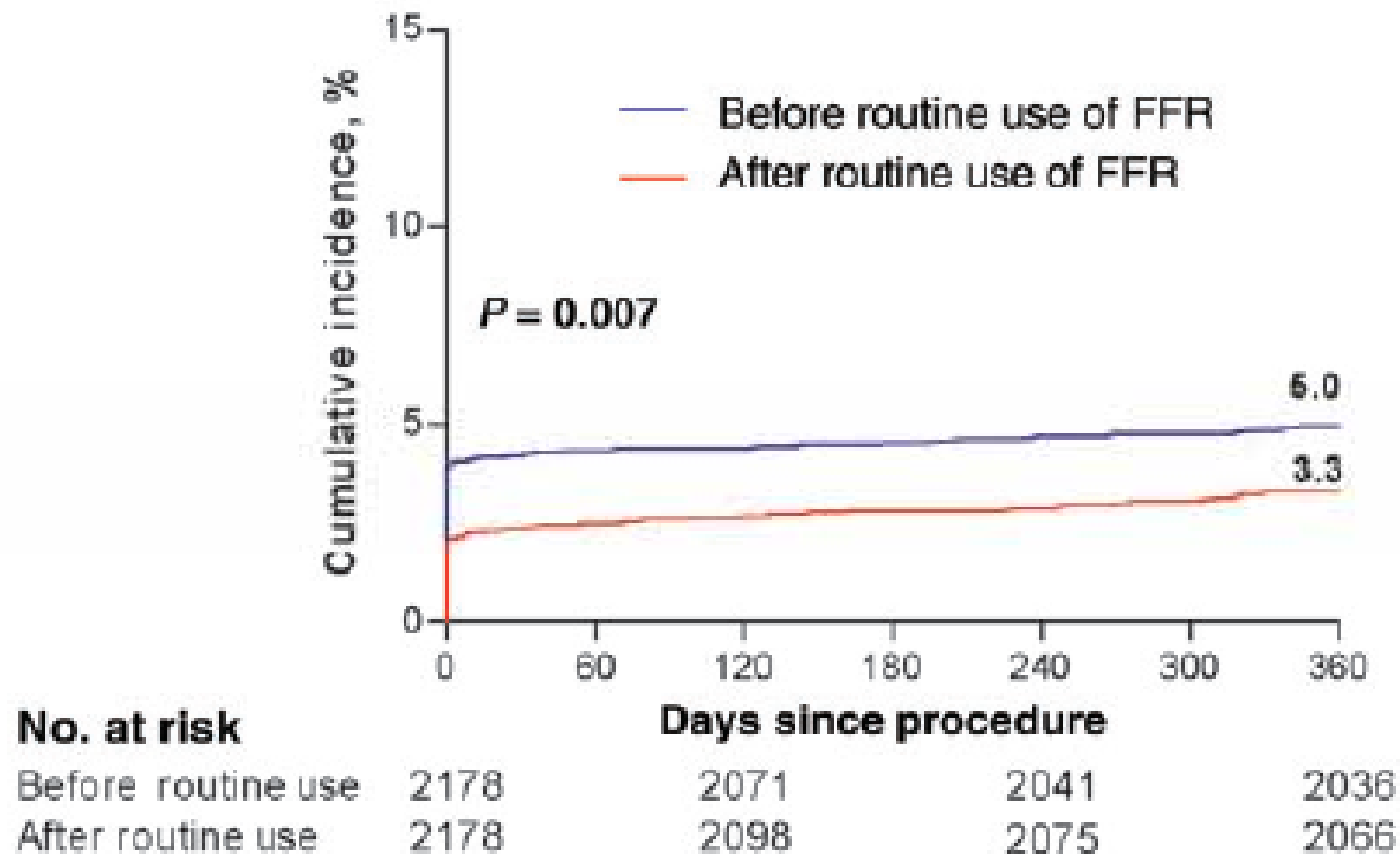




# Real World FFR Use

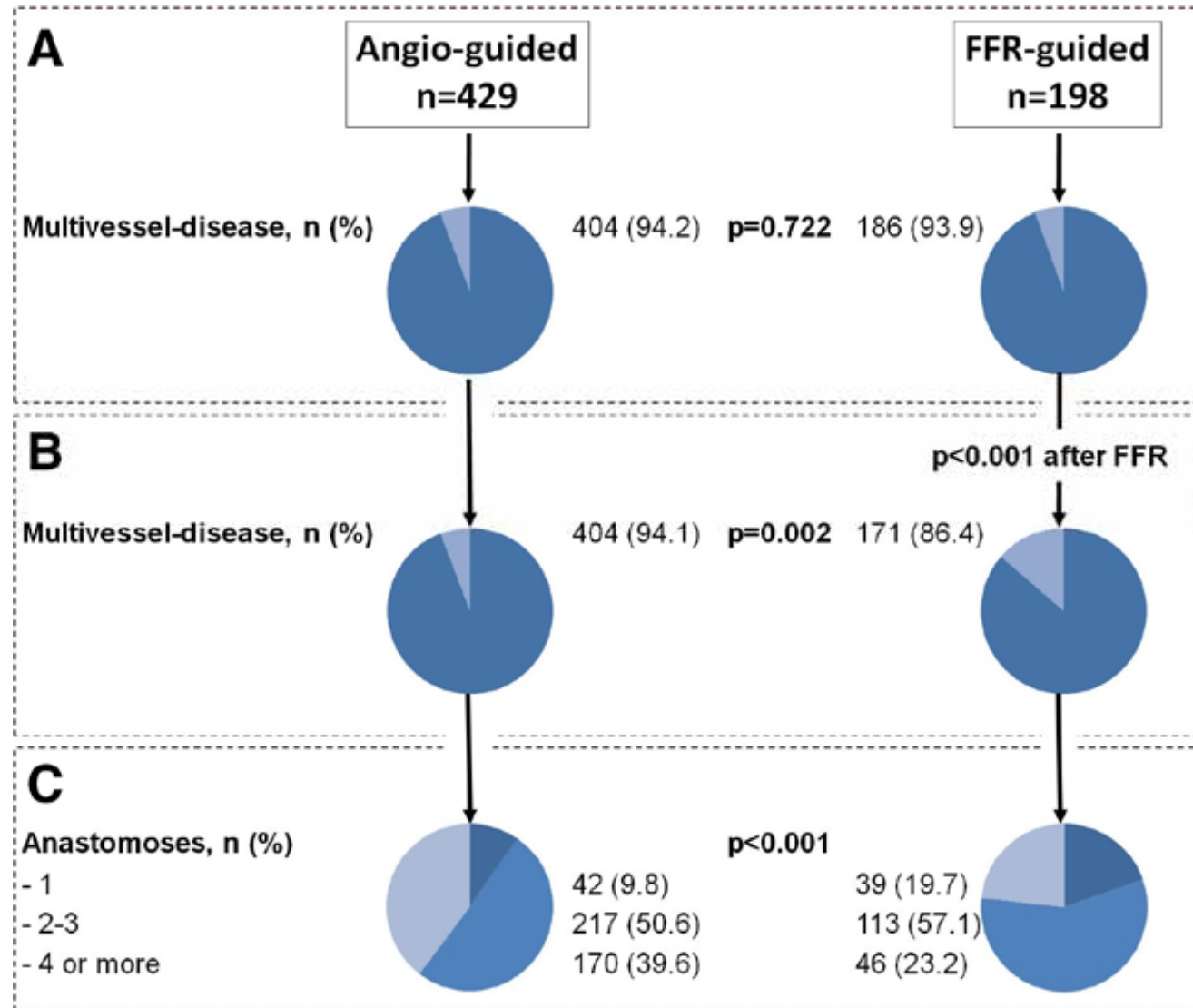
*2,178 pairs of propensity matched patients before and after routine FFR use*

## Death or myocardial infarction



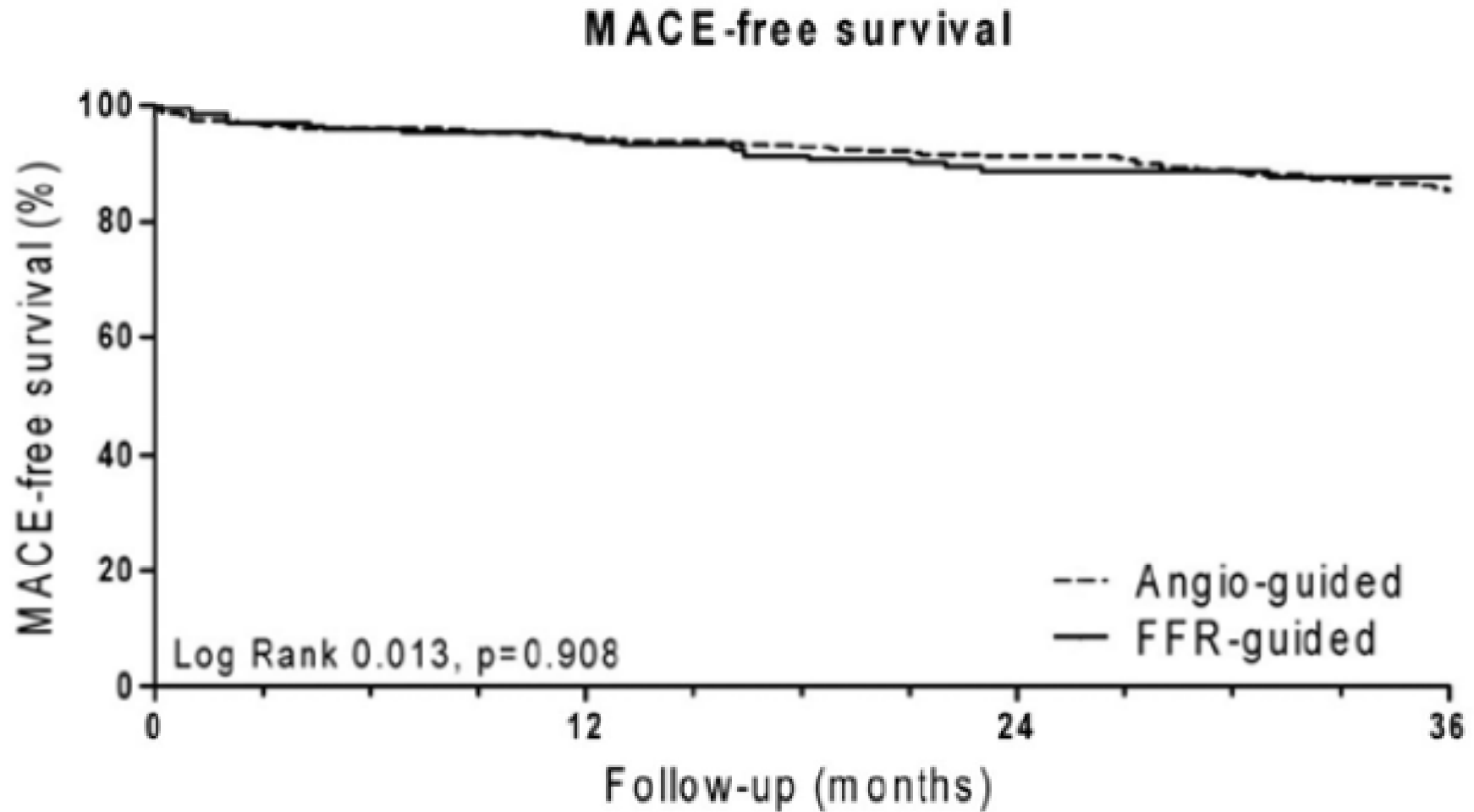
# FFR-Guided CABG?

*Of 627 consecutive CABG patients, 198 had FFR guidance on at least one lesion*



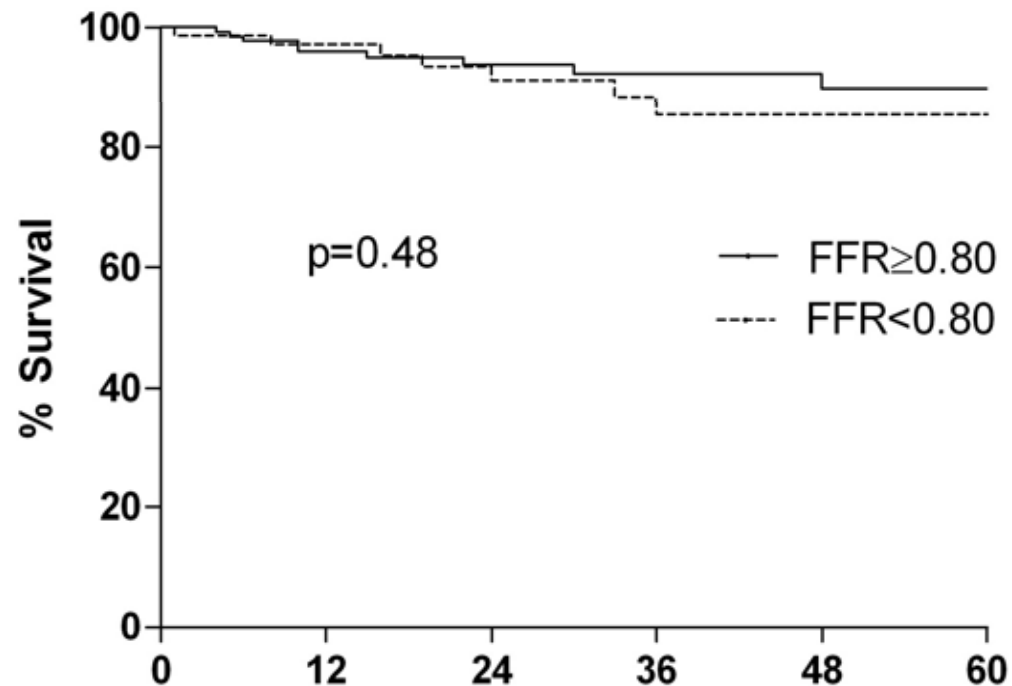
# FFR-Guided CABG?

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# FFR in Intermediate Left Main Disease

**5 year survival rate of 209 patients with moderate LM disease treated medically if FFR $\geq$ 0.80 and revascularized if FFR $<$ 0.80**



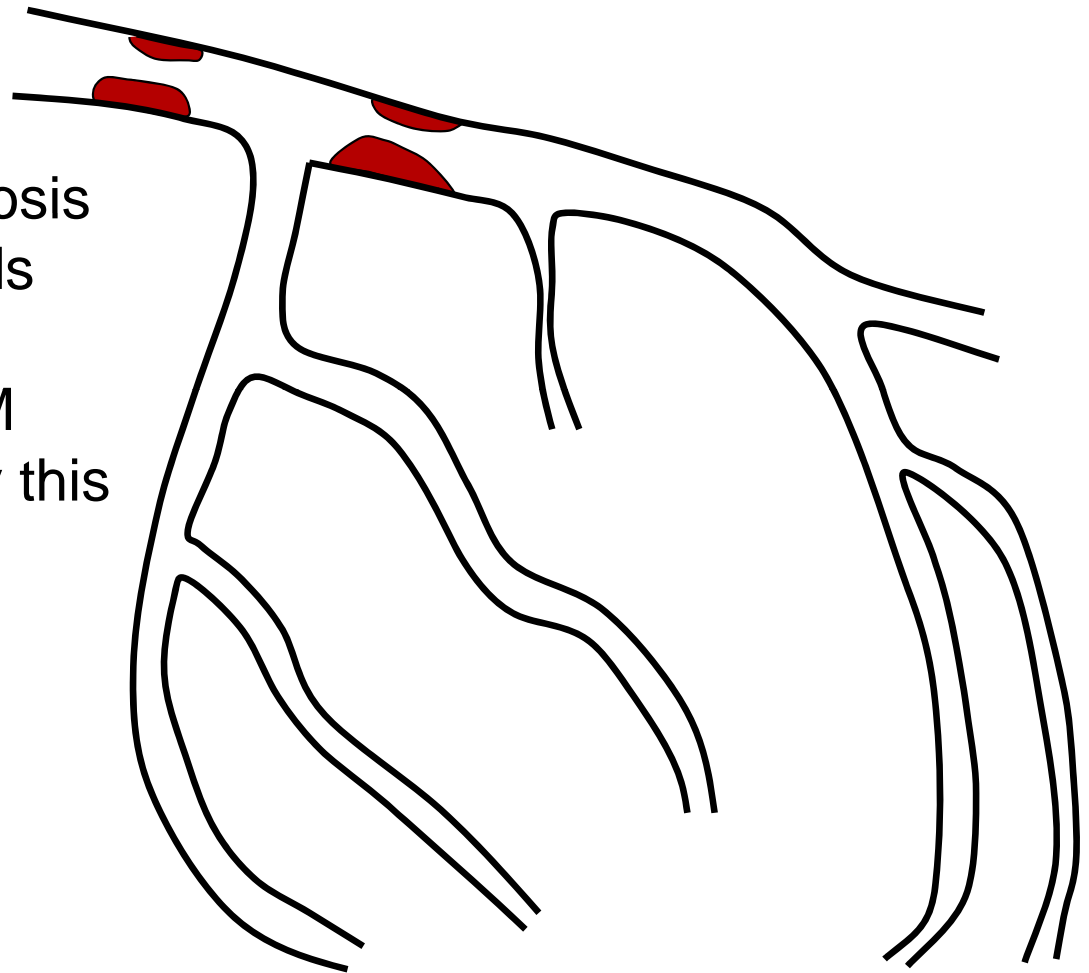
No at risk	Months					
FFR $\geq$ 0.80	136	103	72	52	38	26
FFR $<$ 0.80	73	56	41	30	14	10



# 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

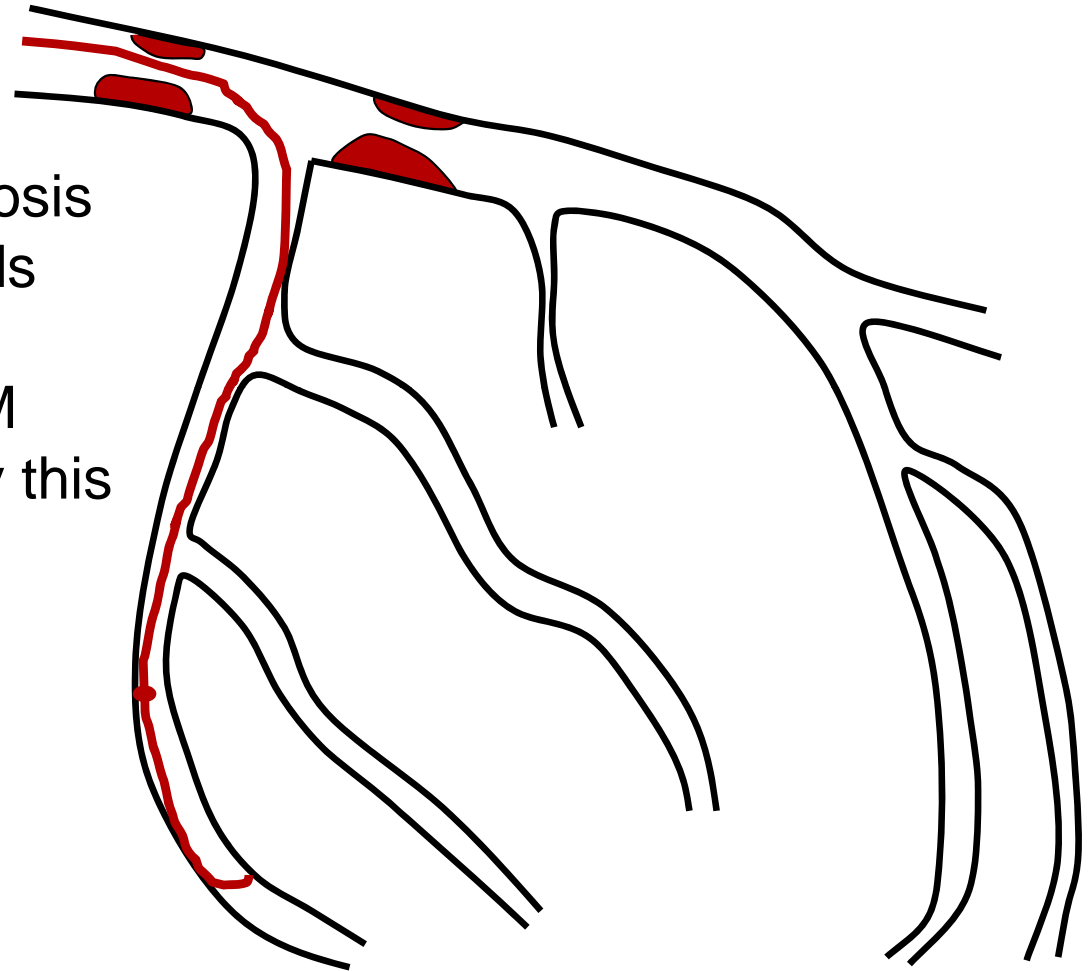
- Severity
- Myocardial mass



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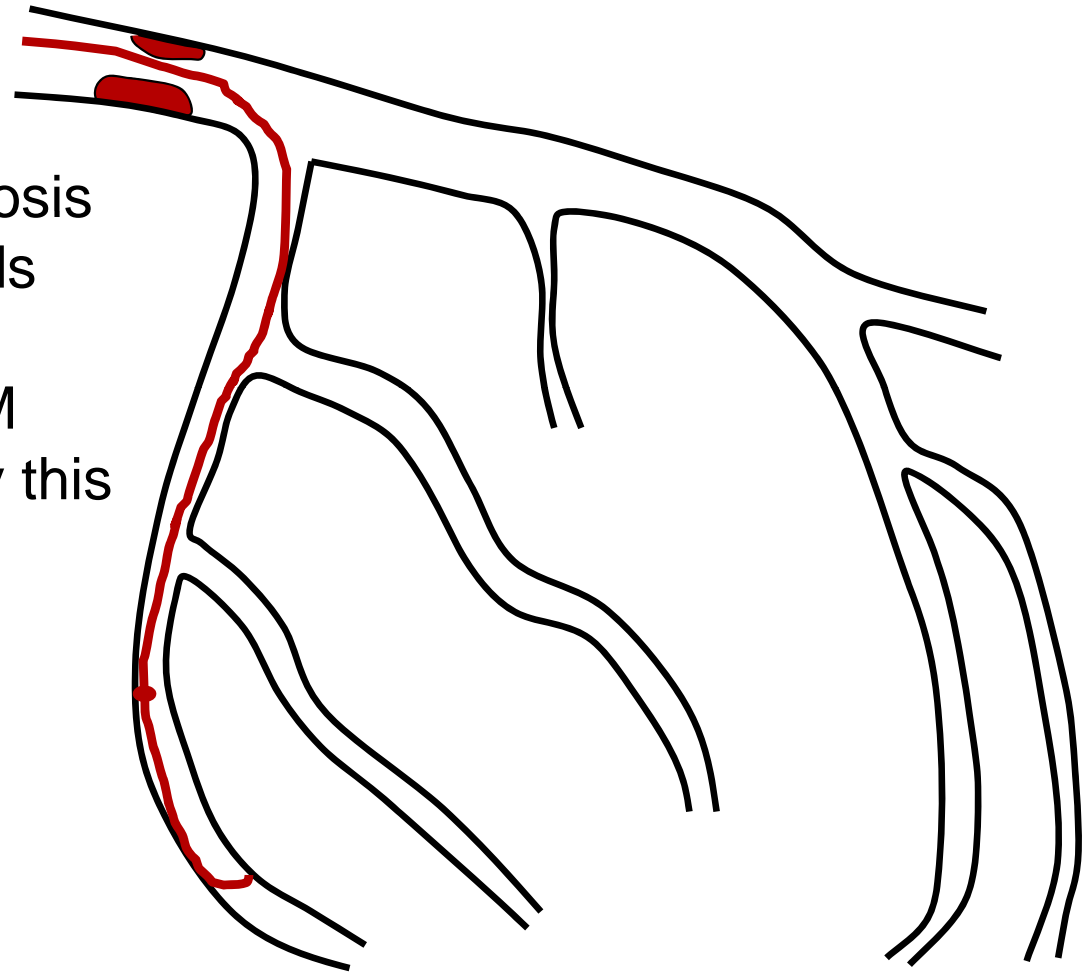
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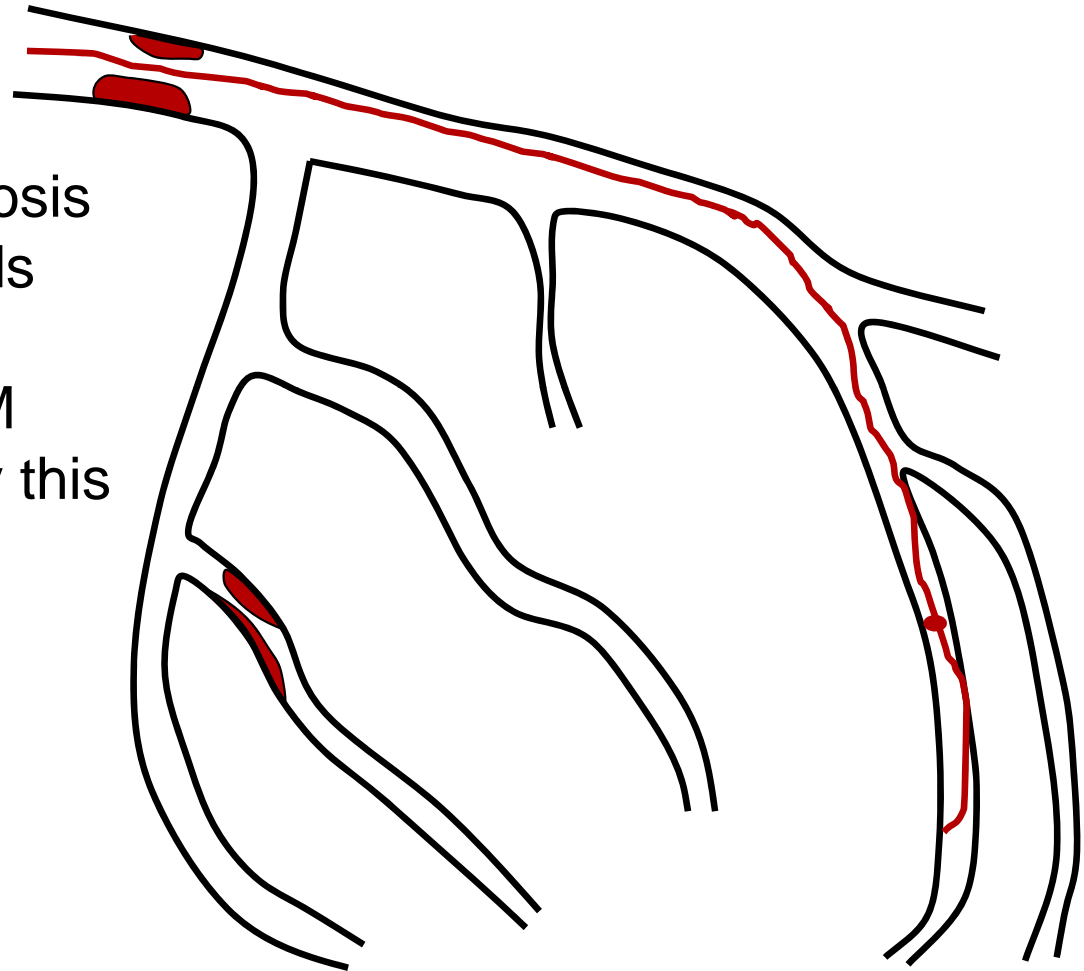
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# Effect of Epicardial Lesions on FFR

## Assessment of Intermediate LM Disease

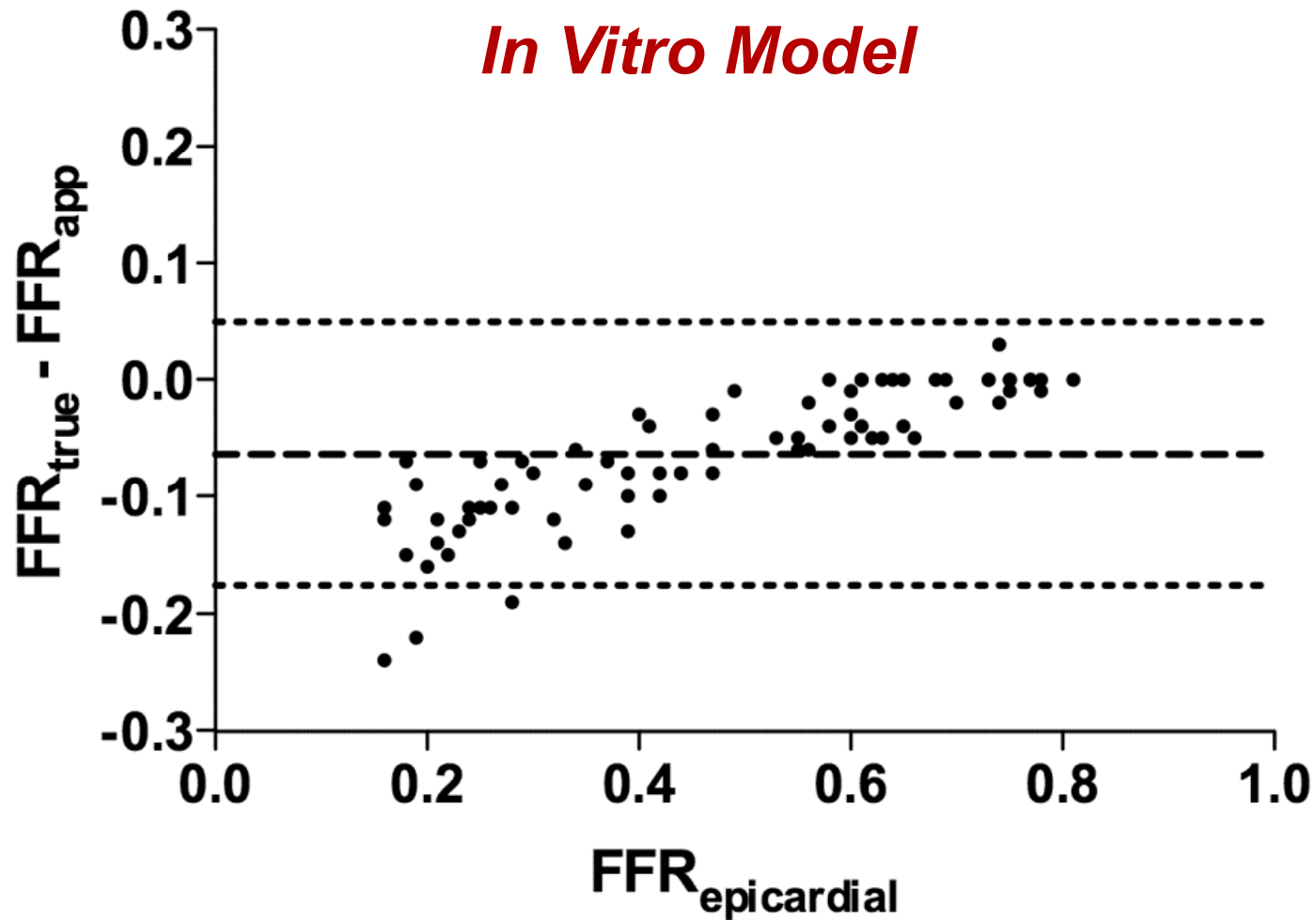


*In Vitro Model*



# Effect of Epicardial Lesions on FFR

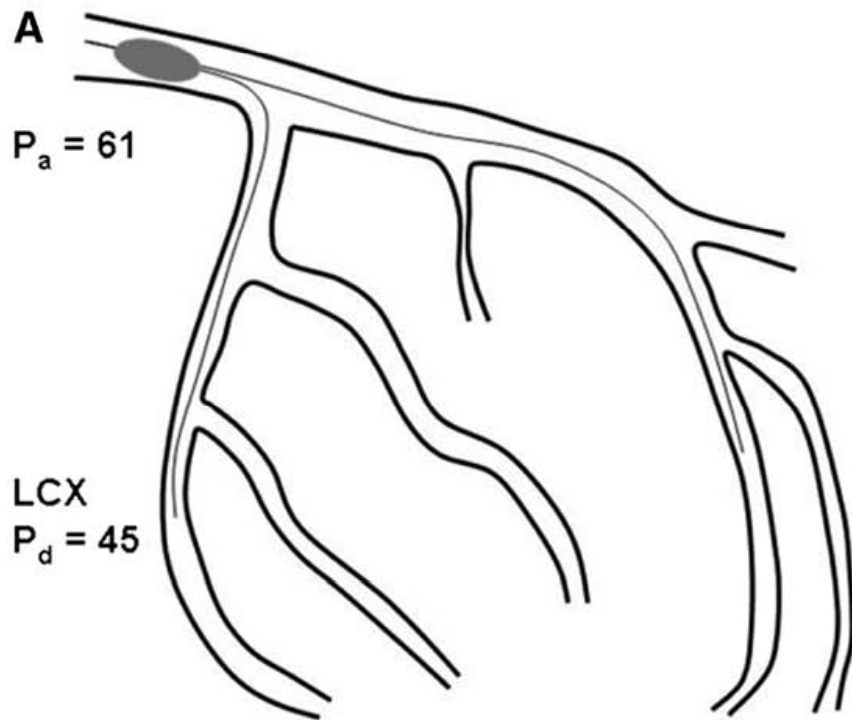
## Assessment of Intermediate LM Disease



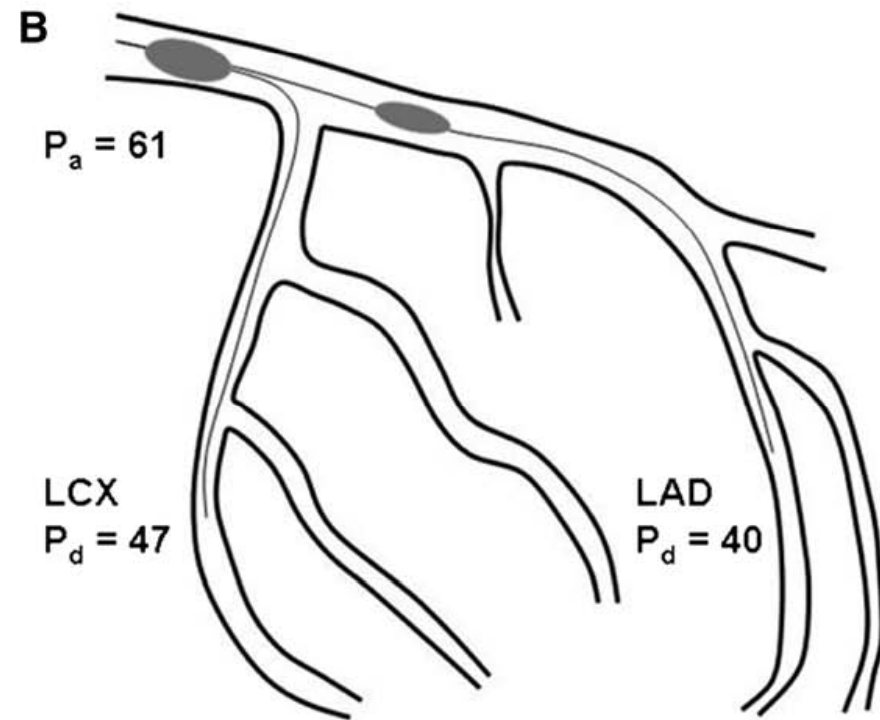
# Effect of Epicardial Lesions on FFR

## Assessment of Intermediate LM Disease

### *Animal Model*



$$FFR_{\text{true}} = 45/61 = 0.74$$



$$FFR_{\text{app}} = 47/61 = 0.77$$

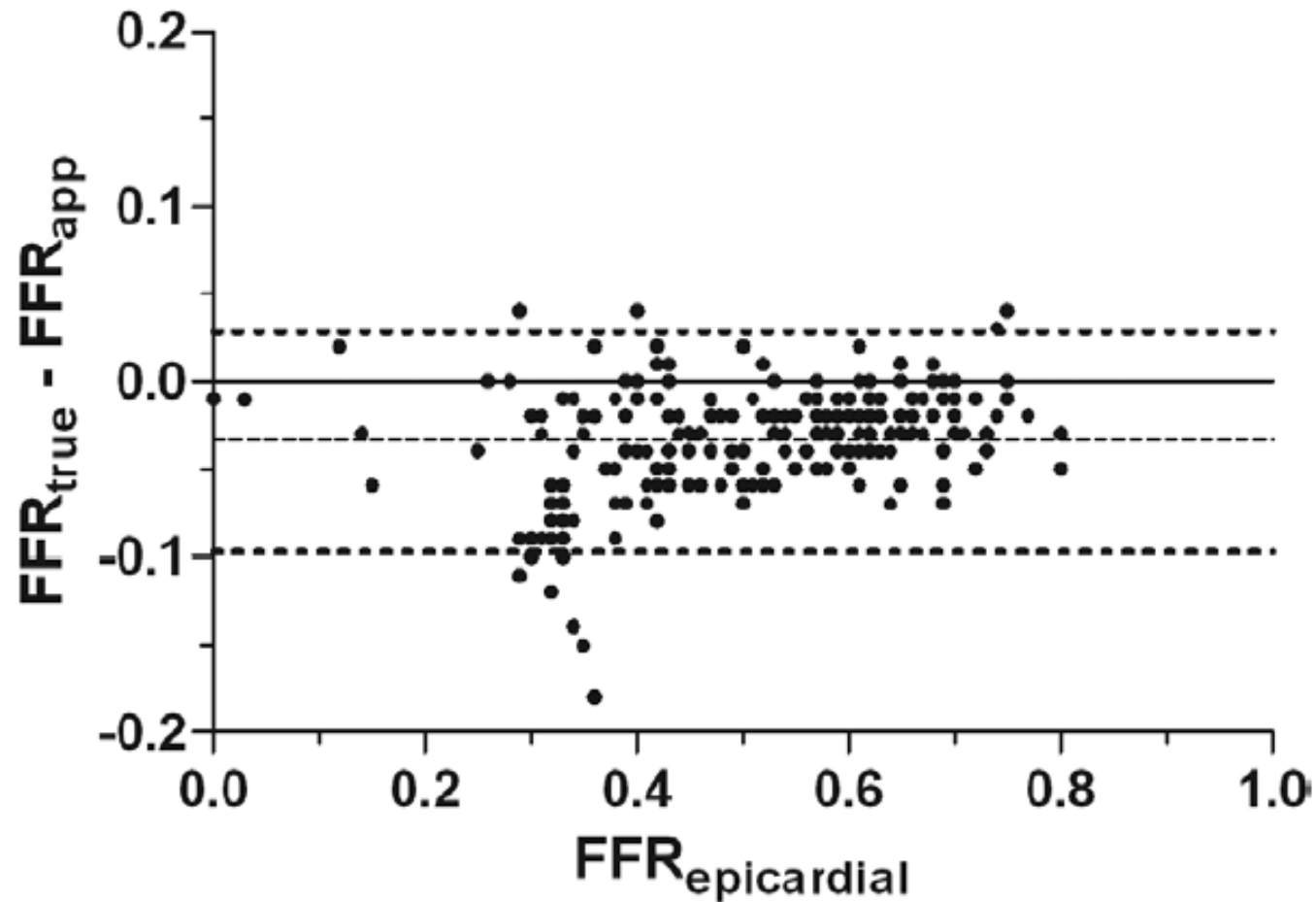
$$FFR_{\text{epicardial}} = 40/61 = 0.66$$



# Effect of Epicardial Lesions on FFR

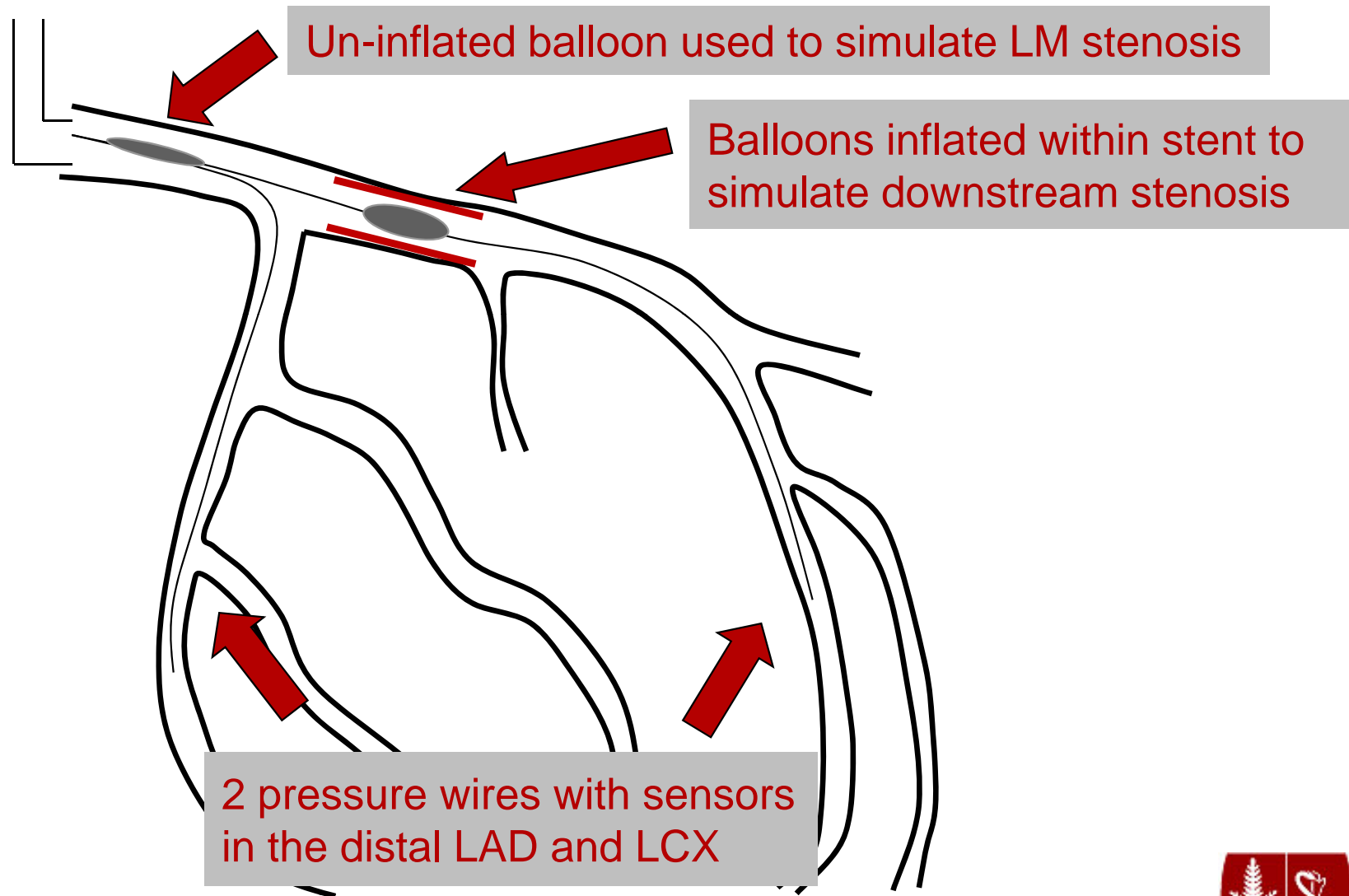
## Assessment of Intermediate LM Disease

### *Animal Model*



# Effect of Downstream Stenosis on LM FFR:

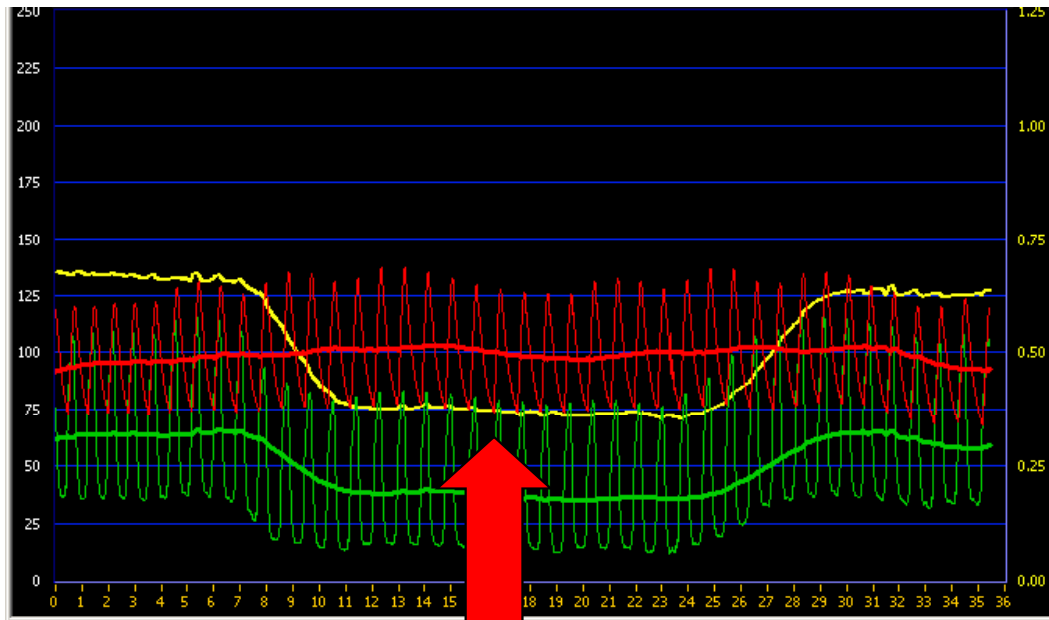
## *Human Validation*



# Effect of Downstream Stenosis on LM FFR:

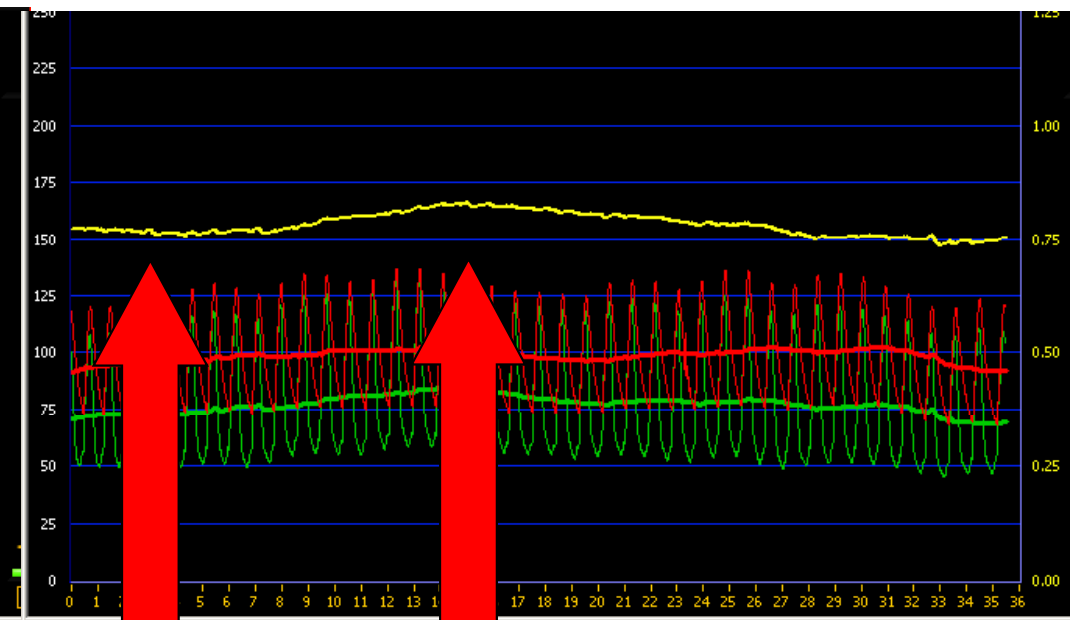
## *Human Validation*

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

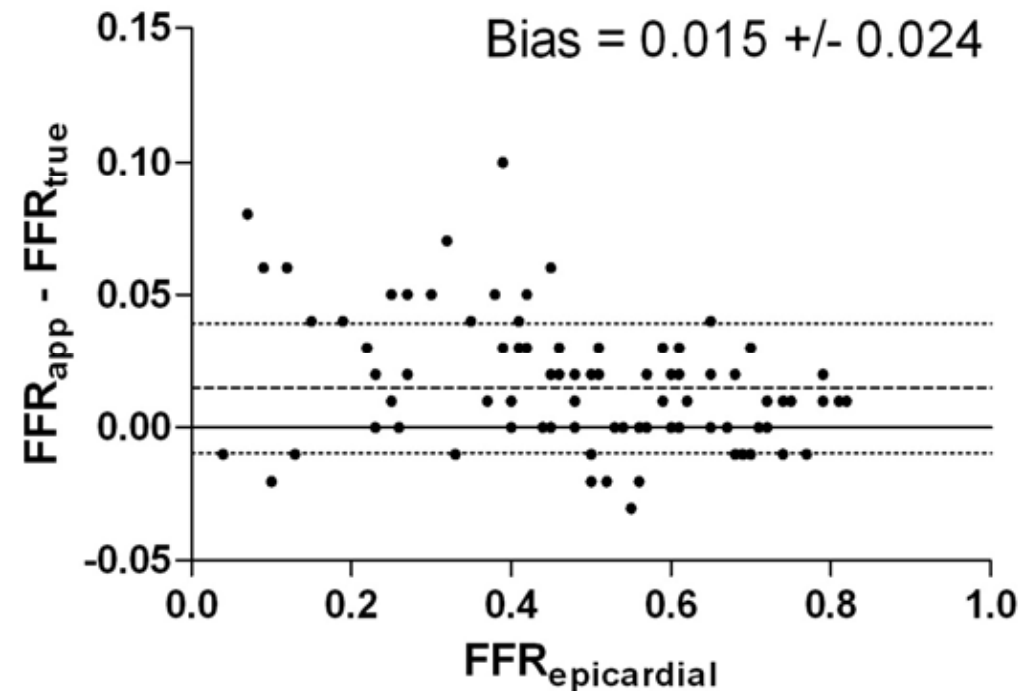
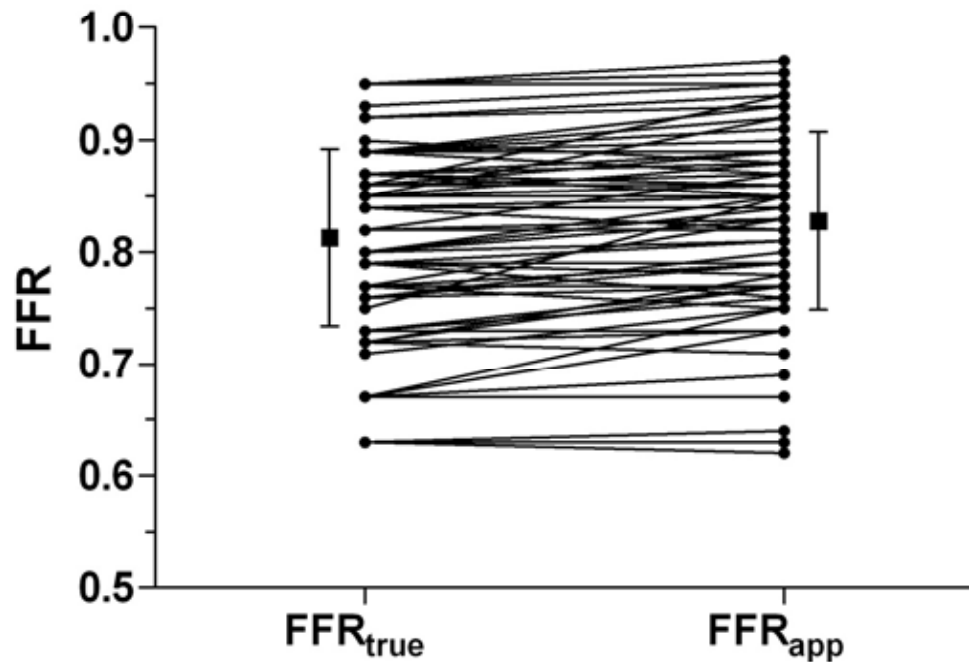


# Effect of Downstream Stenosis on LM FFR:

## *Human Validation*

91 paired measurements obtained in 24 patients

$0.81 \pm 0.08$  vs.  $0.83 \pm 0.08$ ,  $P < 0.001$



***When  $FFR_{app} > 0.85$ ,  $FFR_{true} > 0.80$  100% of the time.***



# Conclusion:

- The role of FFR in guiding PCI continues to be demonstrated in unique populations (MVD, Stable CAD, LM Disease) by a variety of investigators in both prospective randomized trials and retrospective registry studies.

