6th Imaging & Physiology Summit 2013

Clinical Application of Integrated Use of FFR and IVUS

Left Main PCI

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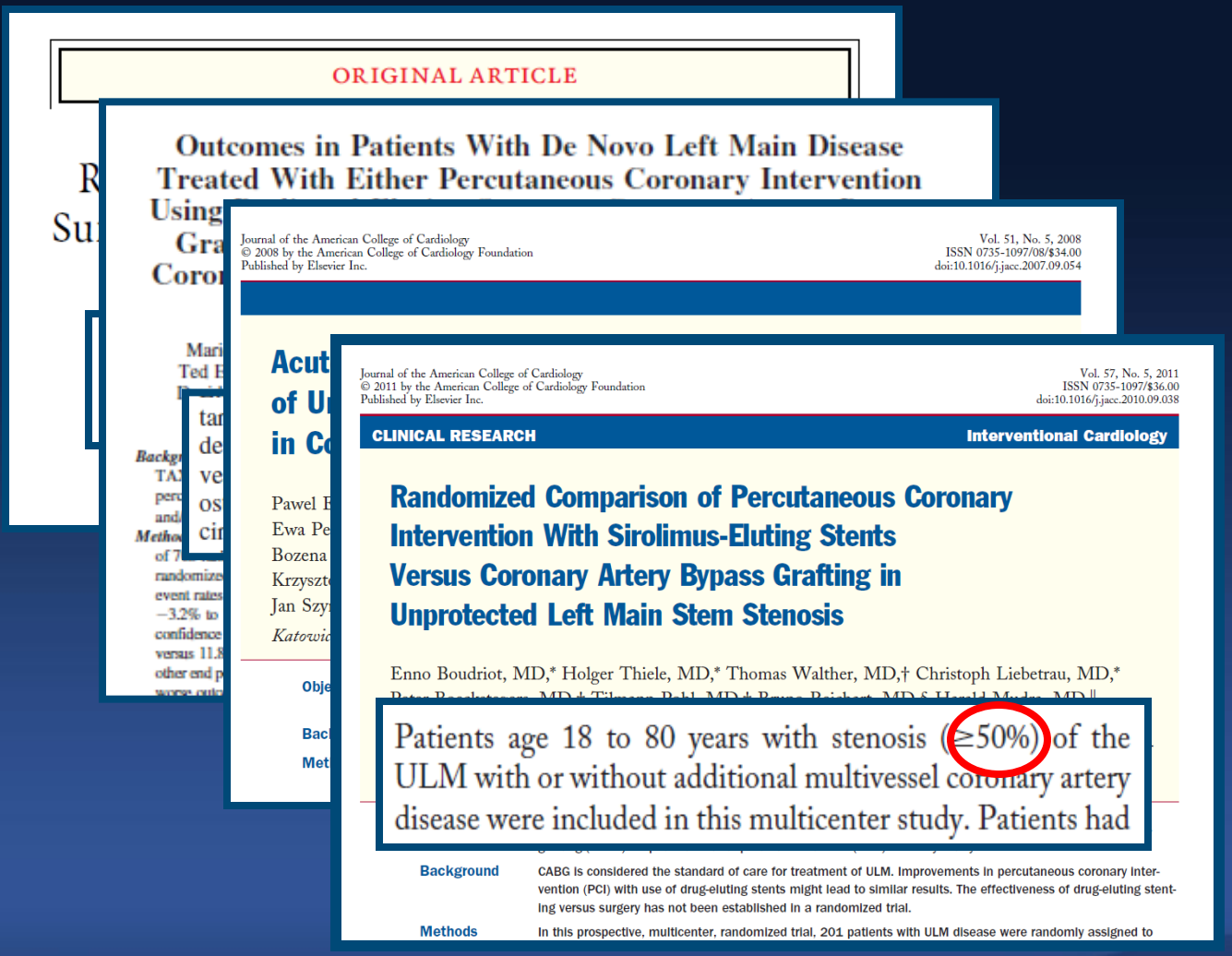
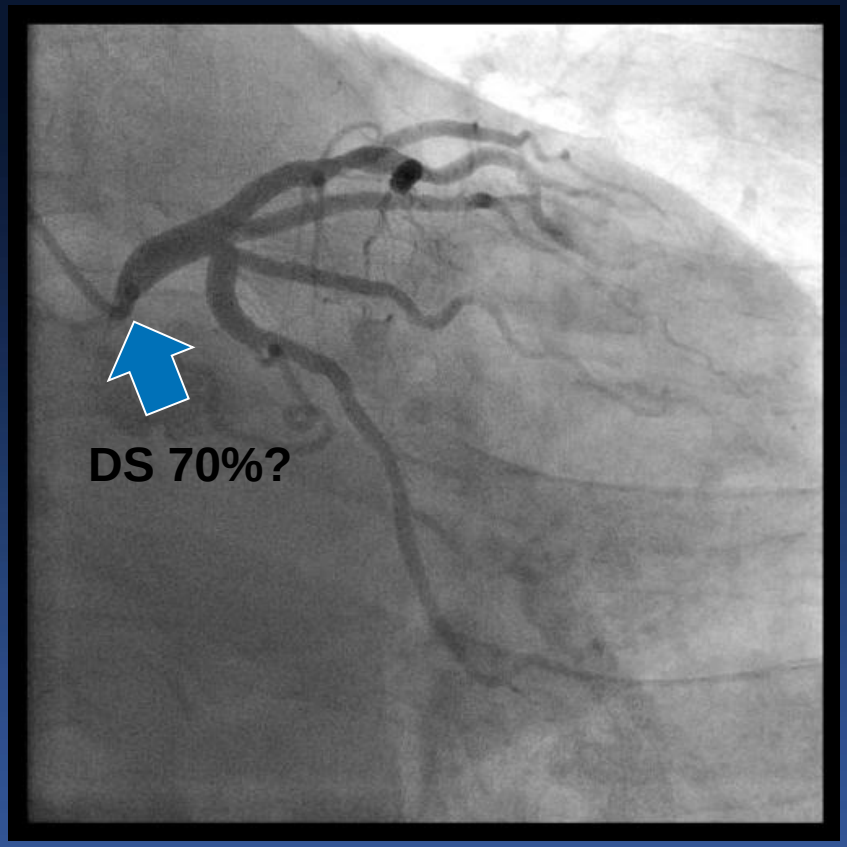
Why We Need FFR in LM Disease?

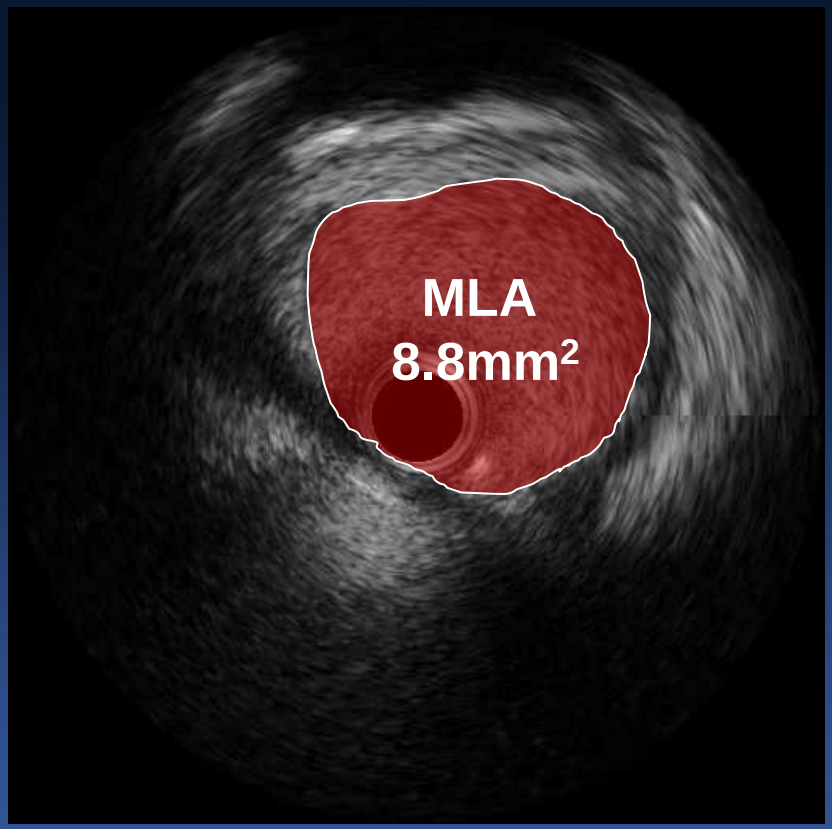
- Inaccuracy of Coronary Angiography
- Lack or Low Spatial Resolution of Non-Invasive Functional Study
- FFR guided PCI in LMCA Also Showed Favorable Outcomes

Major Randomized Studies in LM



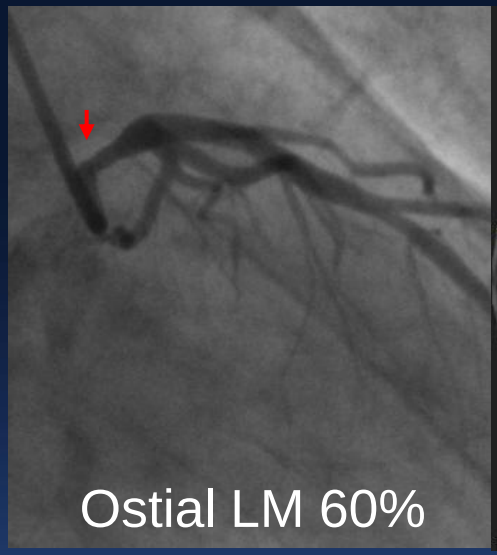
Why We Need FFR?



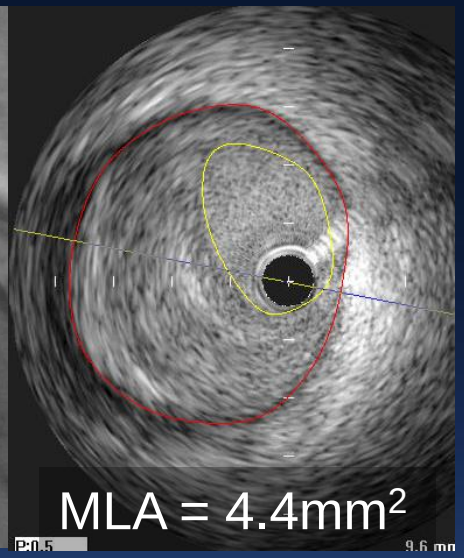


Why We Need FFR in LM?

47/M Stable angina



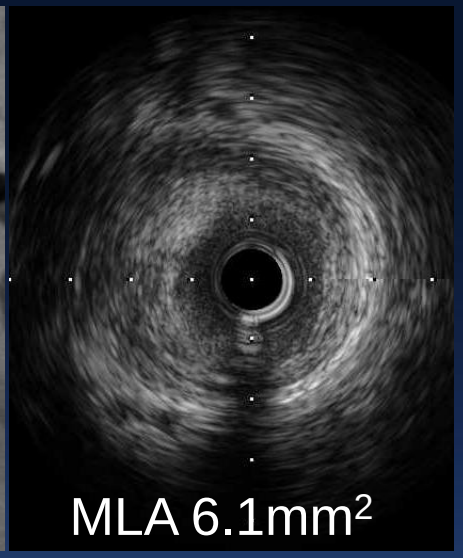
Ostial LM 60%



MLA = 4.4mm^2

50/M Stable angina

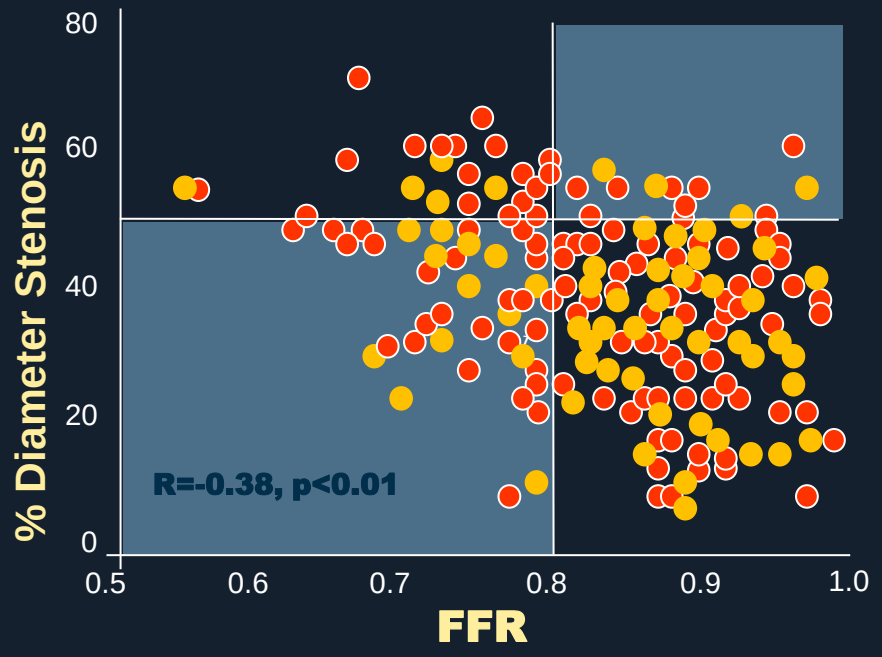
Ostial LM 20%



MLA 6.1mm^2

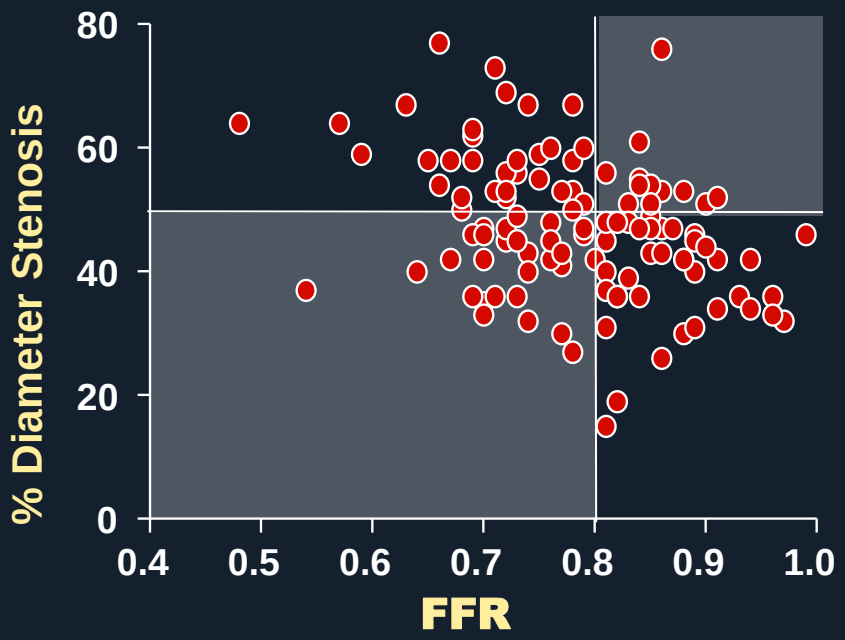
FFR and %DS in Equivocal LMCA

"Mismatch" is 29% in equivocal LMCA



Hamilos M et al. *Circulation 2009;120:1505-1512*

"Mismatch" is 37% in equivocal LMCA



Park SJ et al. *JACC-CI (In Press)*

● Isolated LMCA disease

LM with 3VD

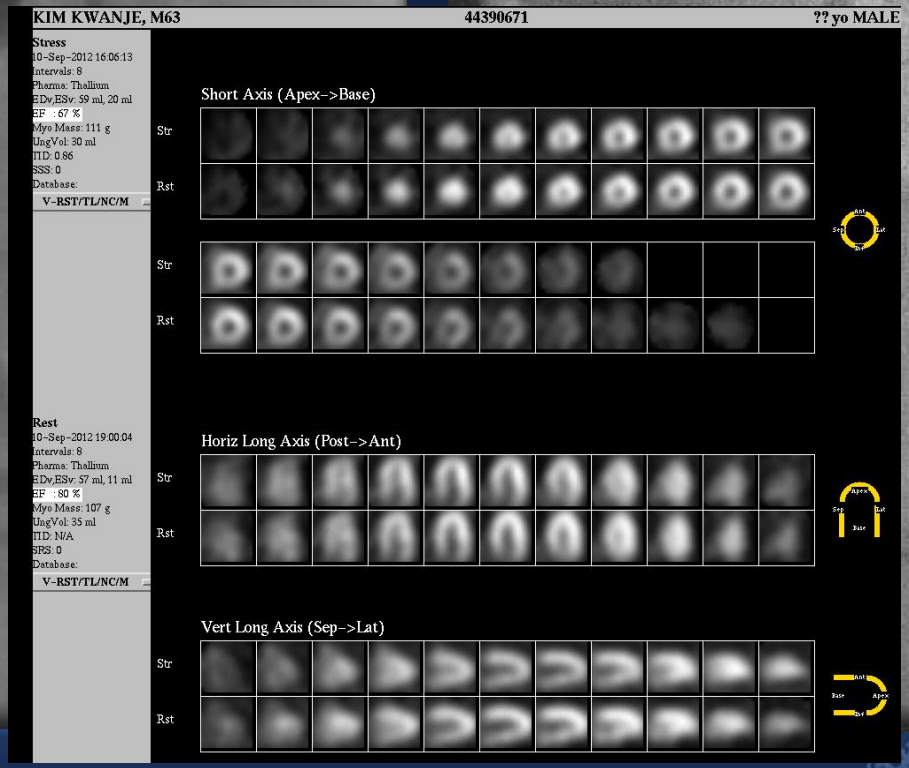
65yrs/M, eCP

RCA

LCA

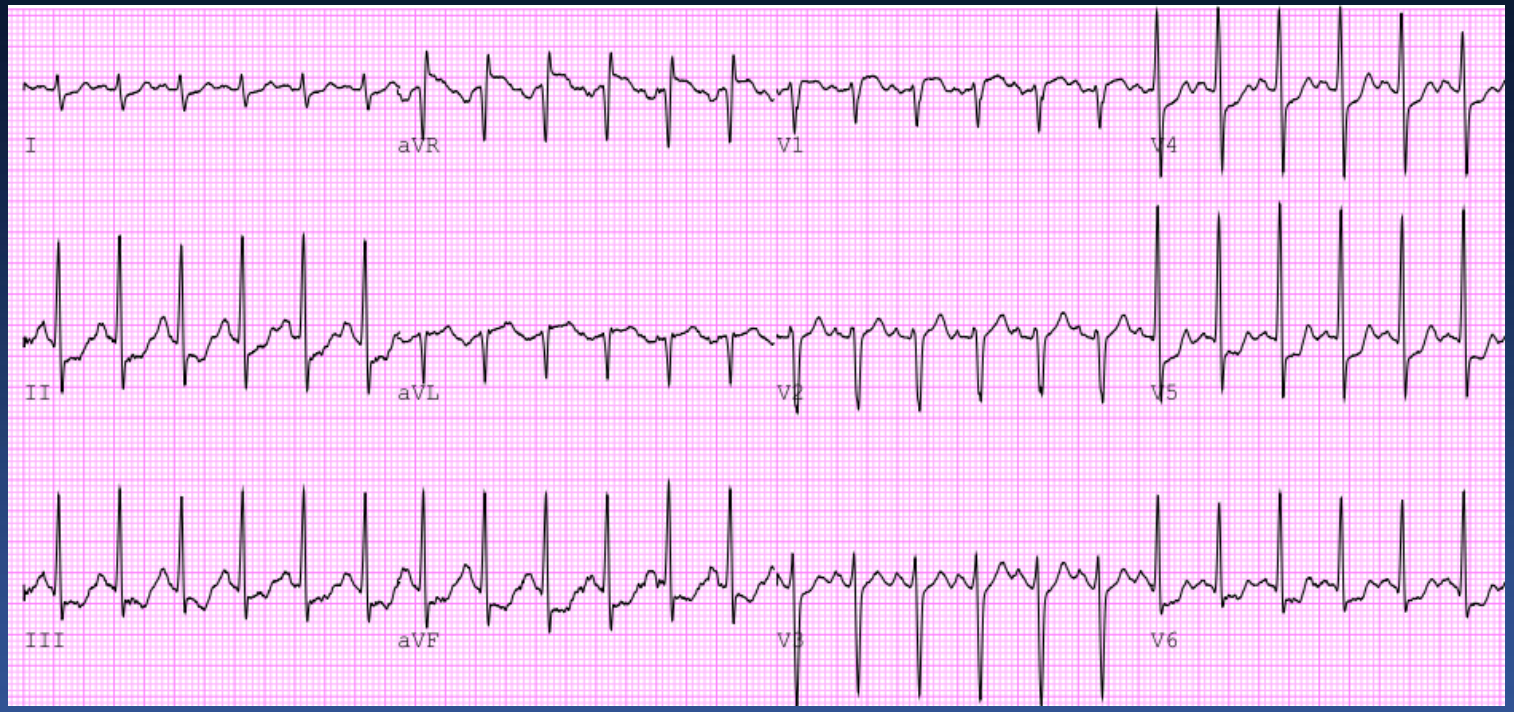
Normal Perfusion in Thallium SPECT

Balanced Ischemia?



M/76, eCP

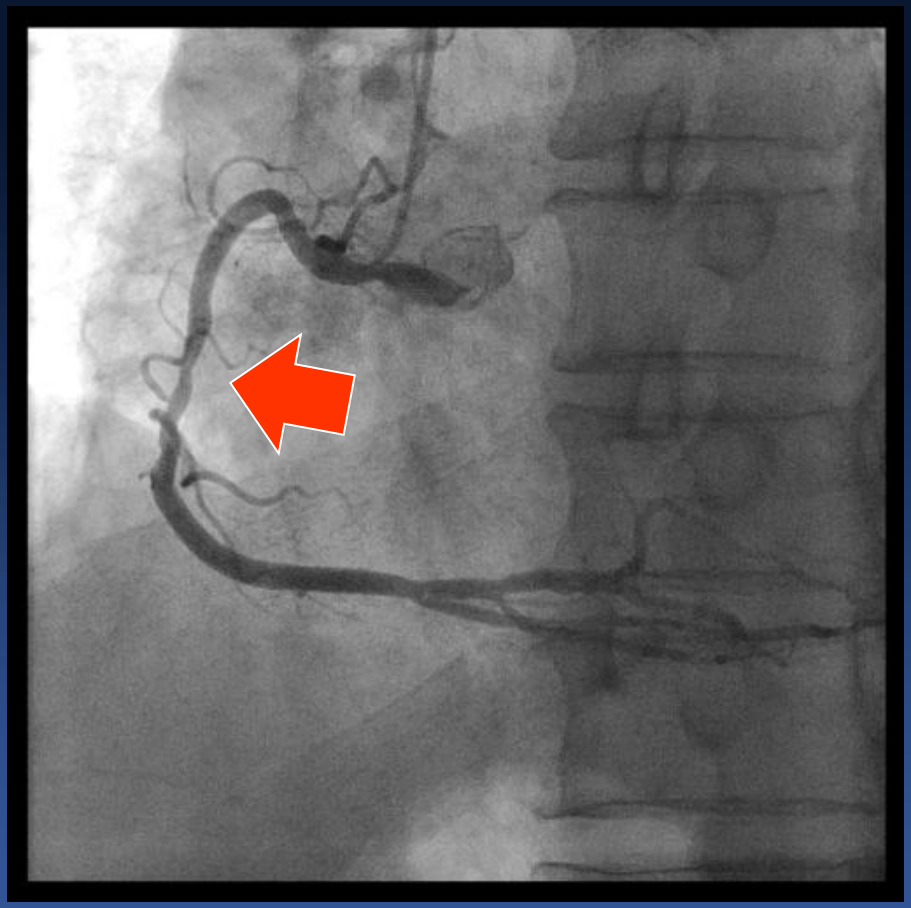
Treadmill Test

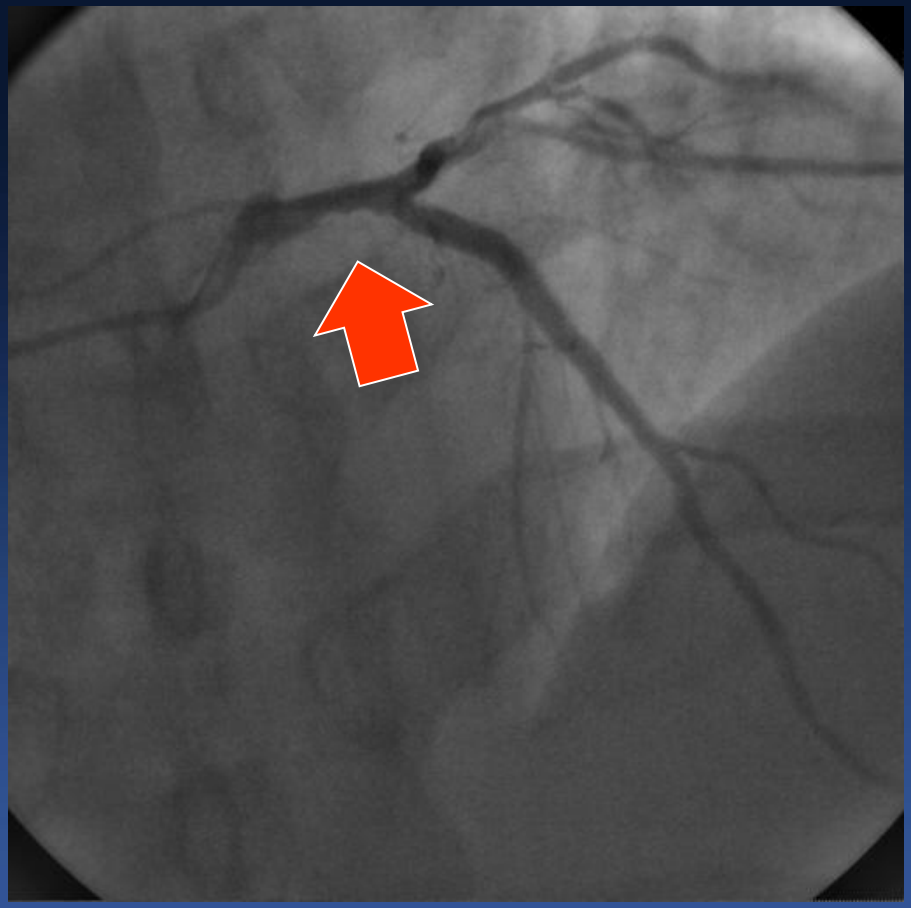


Positive at Stage 4

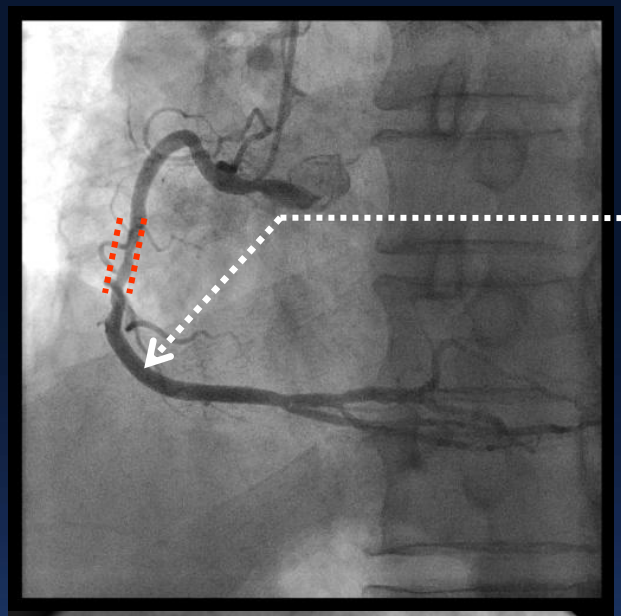
Coronary Angiography

Intermediate RCA and LM stenosis

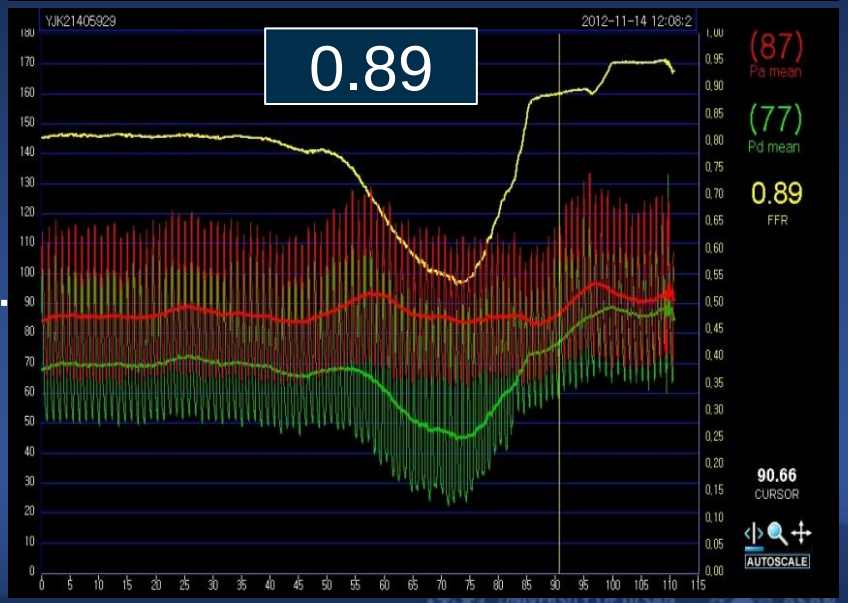




FFR

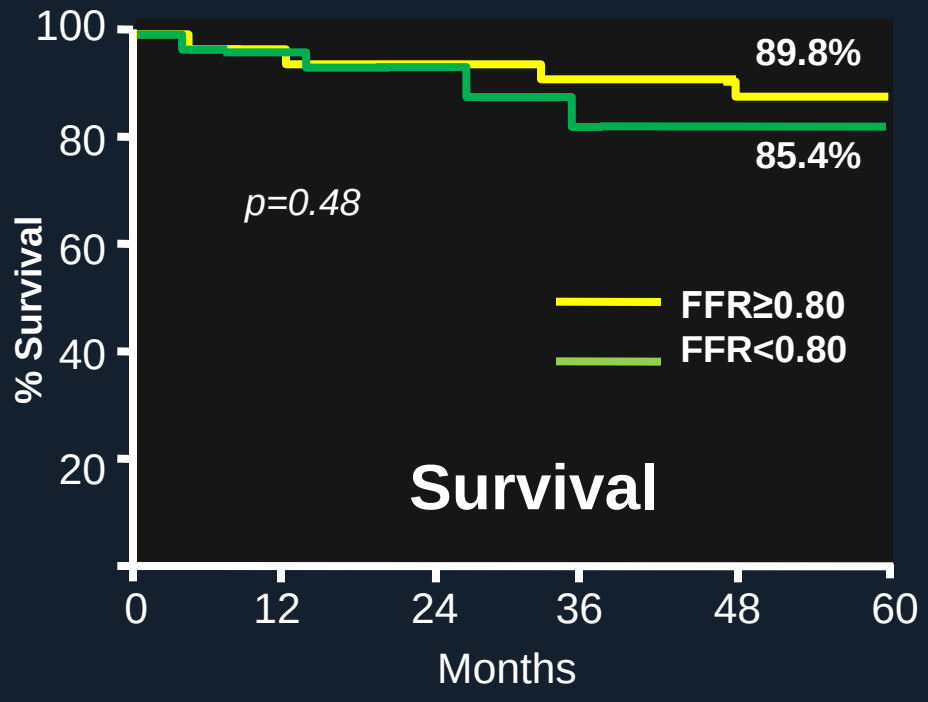


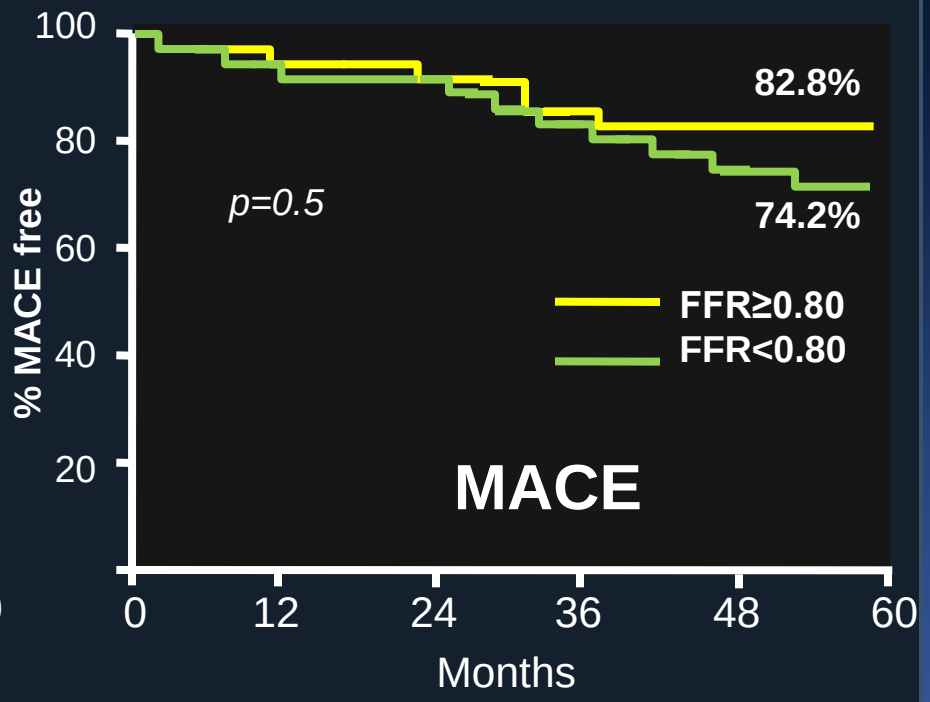
DEFER LM stenting



FFR Guided PCI in Equivocal LMCA

- In 213 patients with an equivocal LMCA stenosis
- FFR ≥0.80: Medication (n=138) vs. FFR<0.80: CABG (n=75)





An FFR-guided strategy showed the favorable outcome.

Circulation. 2009;120:1505-1512

FFR Guided Decision Making in LM Disease

	Hamilos et al [1]		Bech et al [2]		Courtis et al [3]		Lindstaedt et al [4]		Jasti et al [5]	
Age, y	64 ± 9	68 ± 11	63 ± 9	60 ± 9	61 ± 10	63 ± 10	61 ± 10	64 ± 9	**62 ± 11**	
Mean follow up, mo.	35 ± 25		29 ± 15		13 ± 10	14 ± 12	29 ± 18	29 ± 14	**38**	
No. of patients	75	138	30	24	60	82	27	24	14	**37**
FFR cut off value	<0.80	≥0.80	<0.75	≥0.75	<0.75	>0.80	<0.75	>0.80	<0.75	**≥0.75**
Clinical outcomes										
Death, n (%)	7 (9.6)	9 (6.5)	1	0	3 (5)	3 (4)	4 (14.8)	0	0	**3**
MI, n (%)	0	1	1	0	1 (2)	4 (5)	1 (3.7)	0	0	**0**
RR, n (%)	**4 (5.5)**	**17 (12.3)**	**2**	**5**	**0**	**9 (11)**	**1 (3.7)**	**6 (25)**	**0**	**4**

[1]Circulation 2009;120:1505-1512;[2]Heart 2001;86:547-552;[3]Am J Cardiol 2009;103:943-949;
[4]Am Heart J 2006;152:156.e151-156;[5]Circulation 2004;110:2831-2836

Clinical Outcomes After Deferral of LM Disease

(6 studies, 296 patients)

Outcomes	Incidence (%/year)
All Death	2.6 (1.3-5.2)
Cardiac Death	2.6 (1.3-5.2)
Myocardial Infarction	2.0 (0.7-5.1)
TVR	5.5 (3.3-8.8)
MACE	8.2 (5.5-12.1)

Hamilos M, Circulation. 2009;120:1505-1512
Bech GJ, Heart. 2001;86:547-552
Courtis J, Am J Cardiol. 2009;103:943-949
Lindstaedt M, Am Heart J. 2006;152:151-159
Jasti V, Circulation. 2004;110:2831-2836
Sueman, Heart Vessels. 2005;20:271-7

Clinical Outcomes After Deferral of LM Disease

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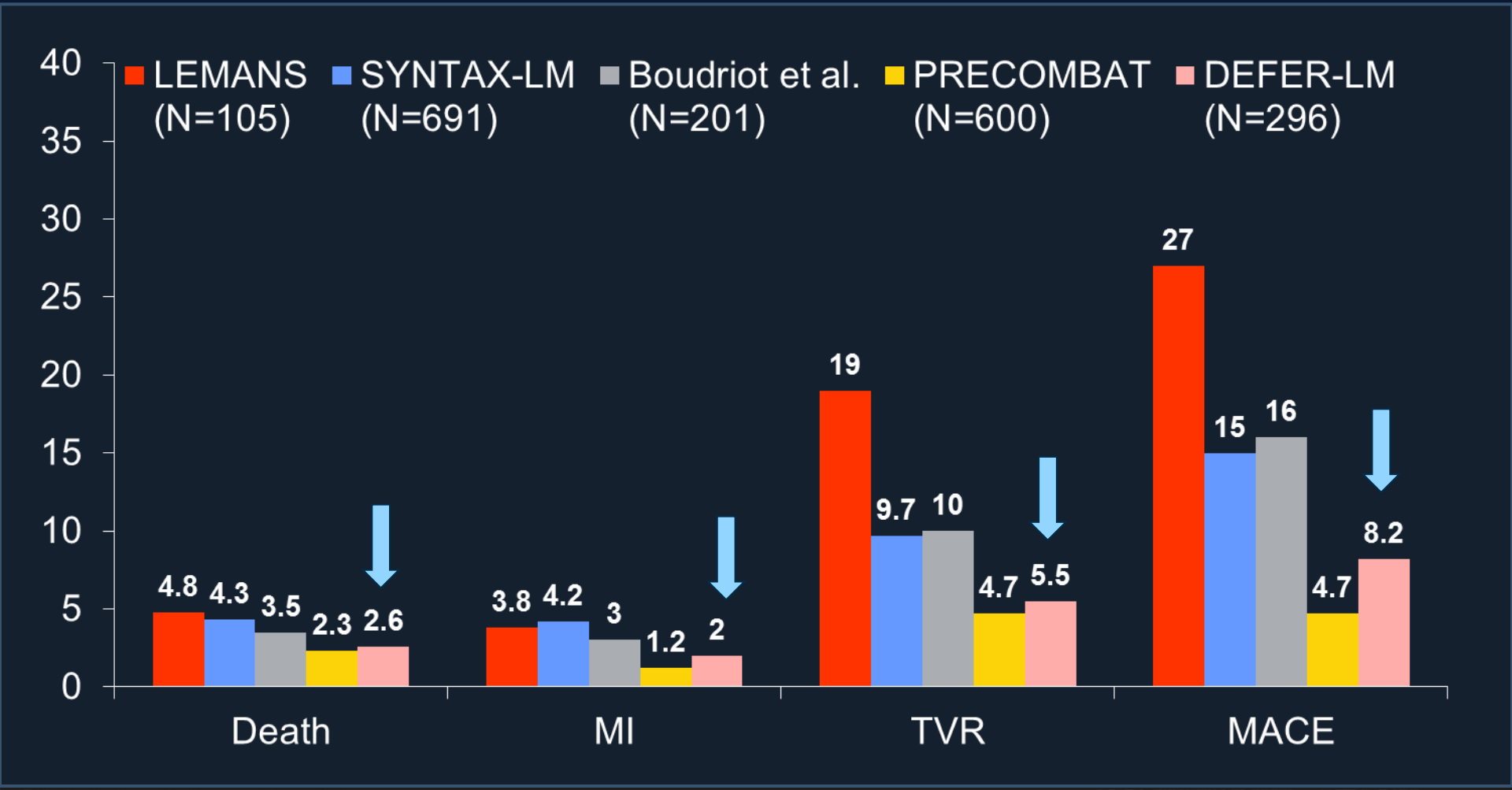


Why We Need FFR in LM Disease?

- Inaccuracy of Coronary Angiography
- Lack or Low Spatial Resolution of Non-Invasive Functional Study
- FFR guided PCI in LMCA Also Showed Favorable Outcomes

Therefore, We Have To Measure LM FFR

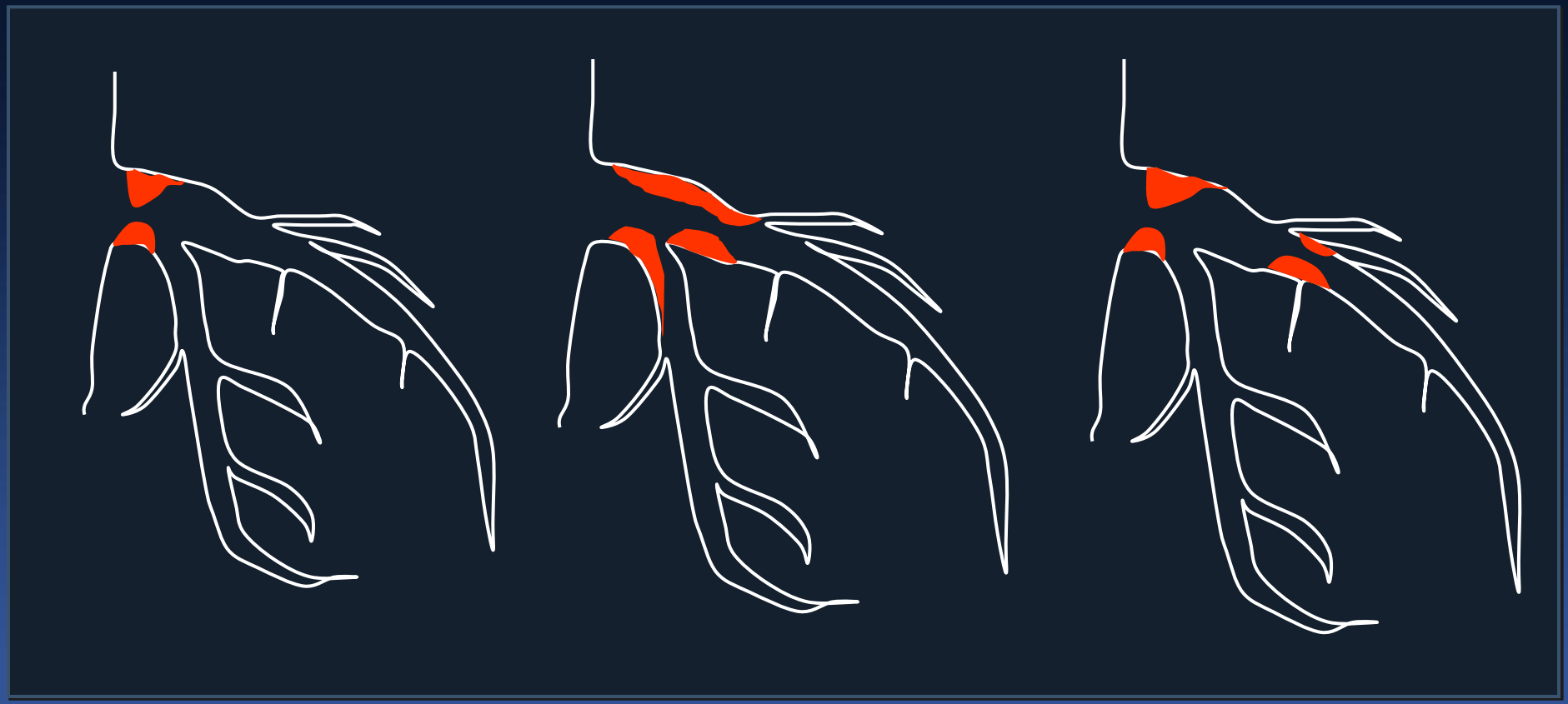
How Can We Implement FFR in LM stenosis?

LMCA Anatomy

(A) Ostial/Shaft

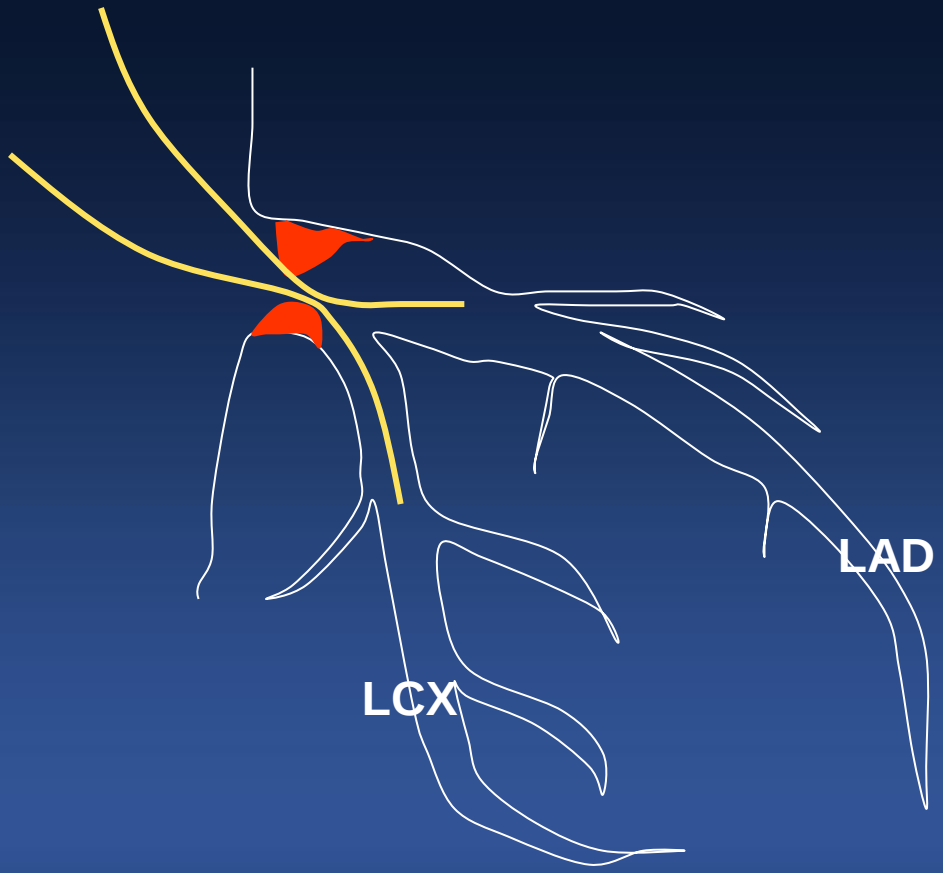
(B) Bifurcation

(C) LM with distal Dz



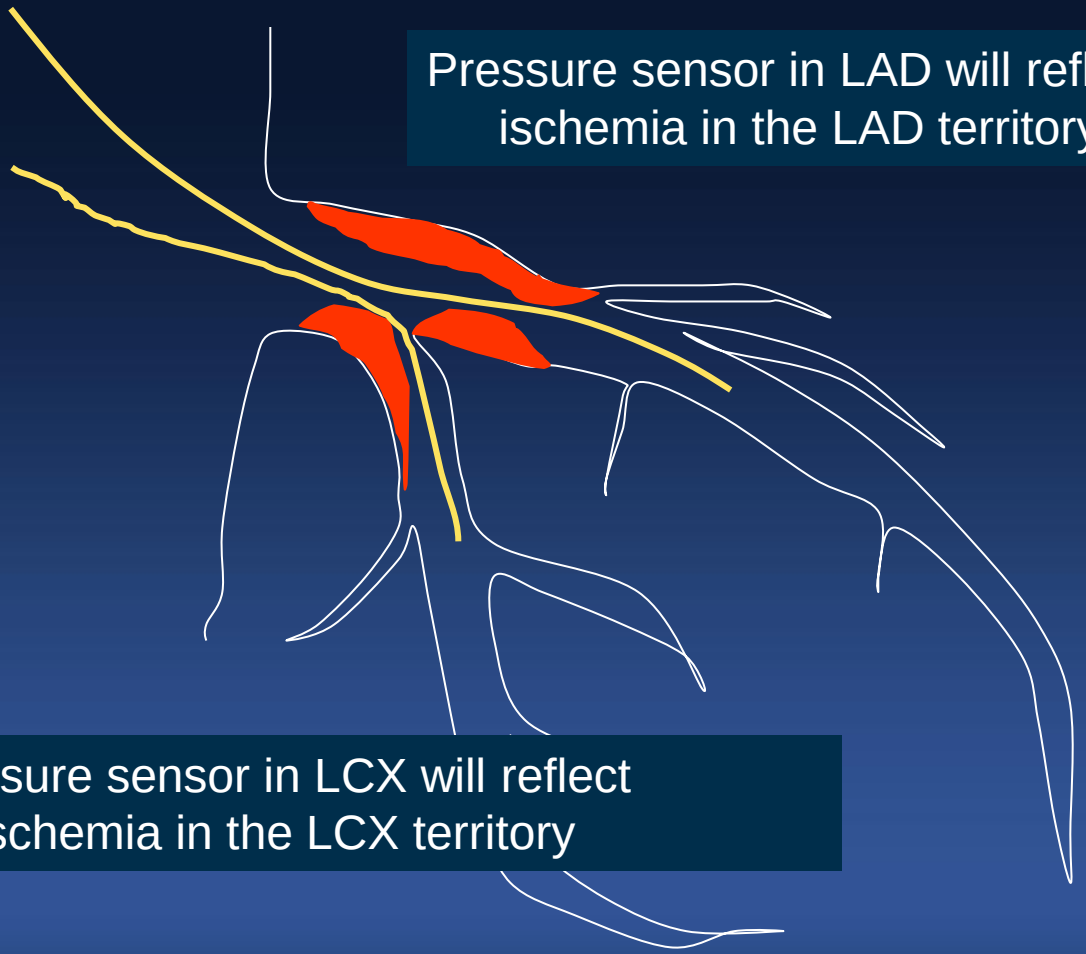
For the Undetermined, Intermediate Ostial and Shaft LM Lesion,

Theoretically, LAD FFR = LCX FFR = LM FFR



For the Intermediate LM Bifurcation Lesion,

LAD FFR ≠ LCX FFR ≠ LM FFR



For the Intermediate LM Bifurcation Lesion,

If any of FFR in LAD or LCX<0.80

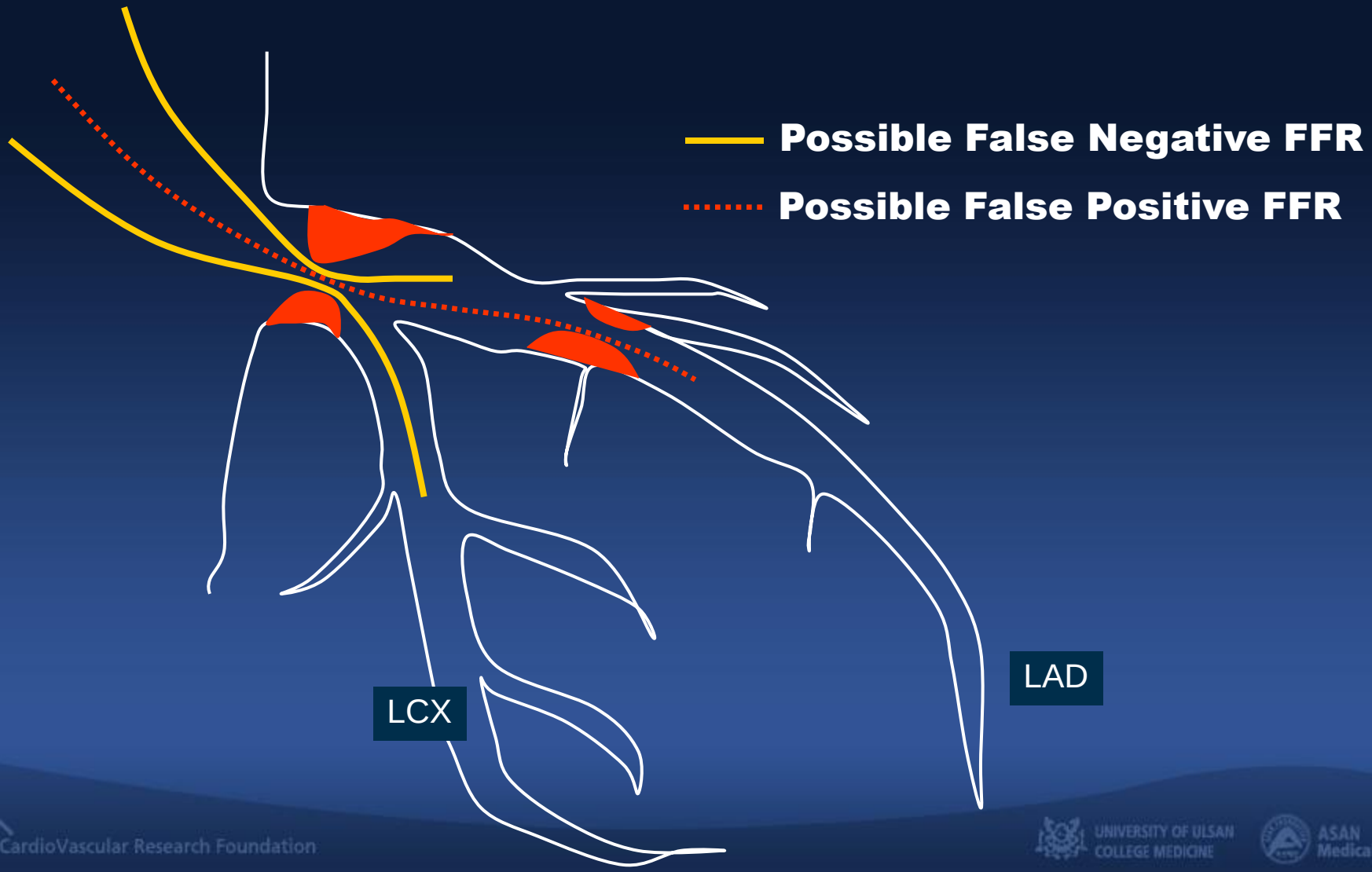
Main Concern is Just to Determine

Single Stent Cross Over or 2 Stents Technique.

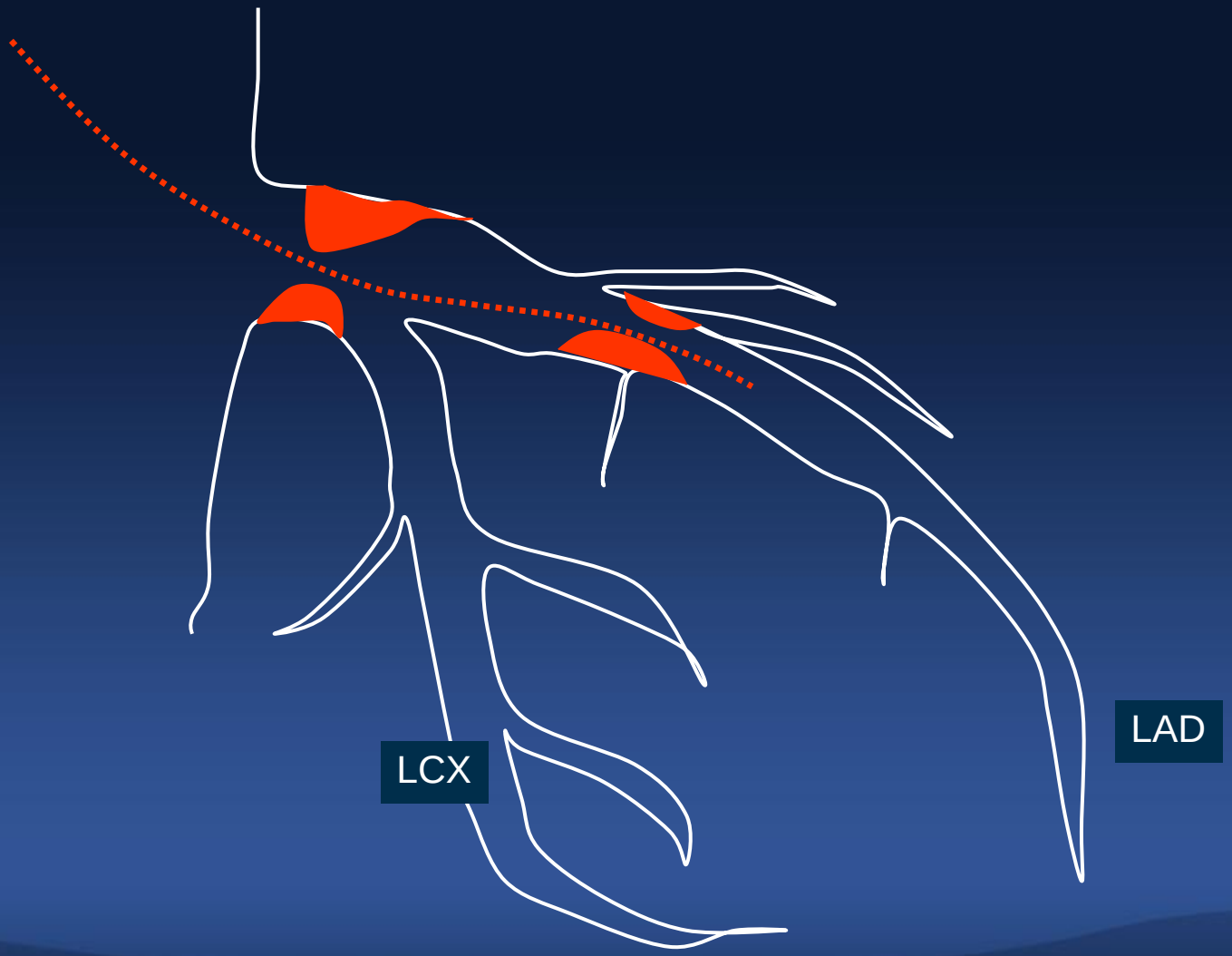
Practically, We Can Not Separately Treat

For LMCA stenosis with distal LAD/LCX stenosis

Tandem Lesions with Interposing side branch



Pressure Wire Pull-Back Help To Decide the Treatment Sequence



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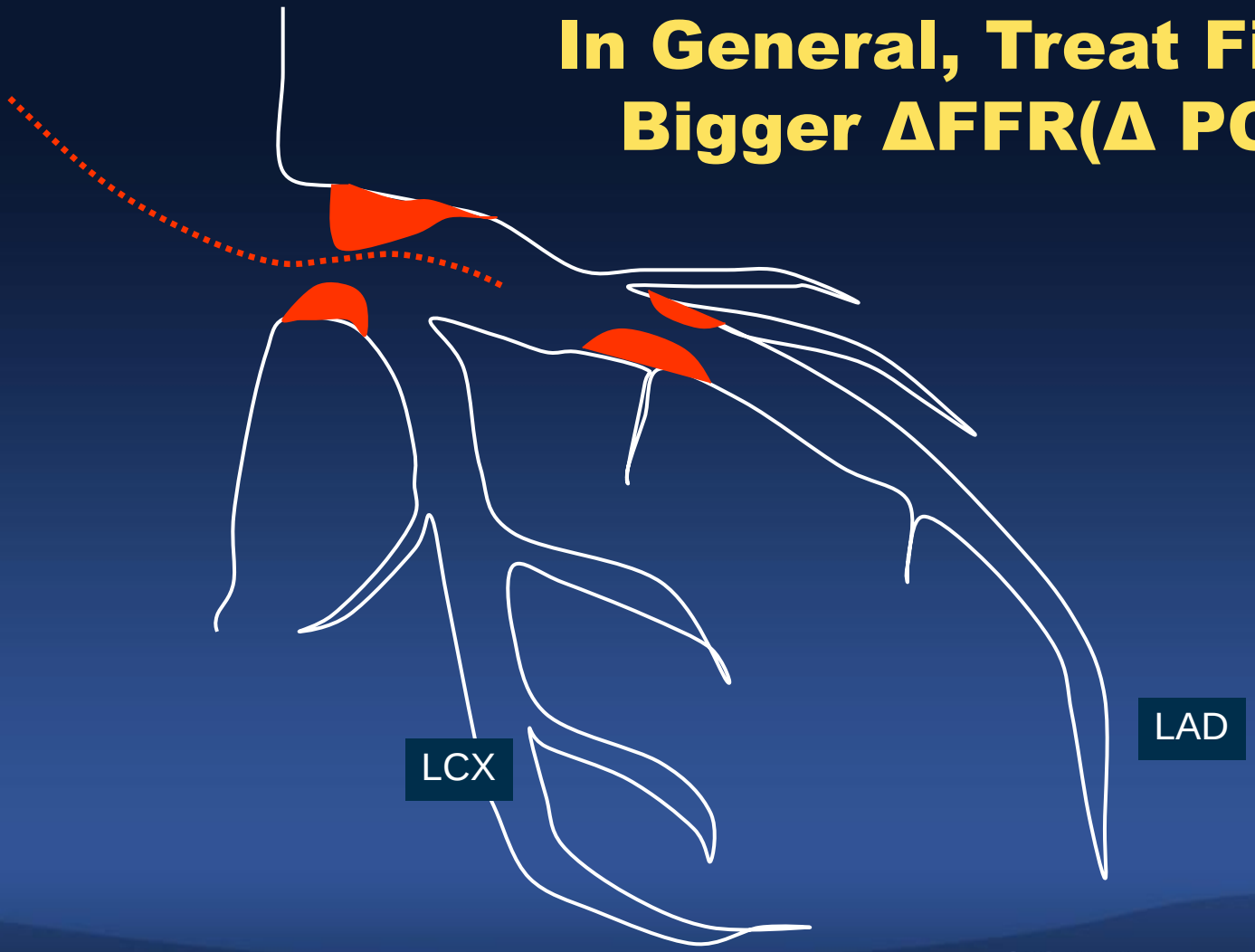
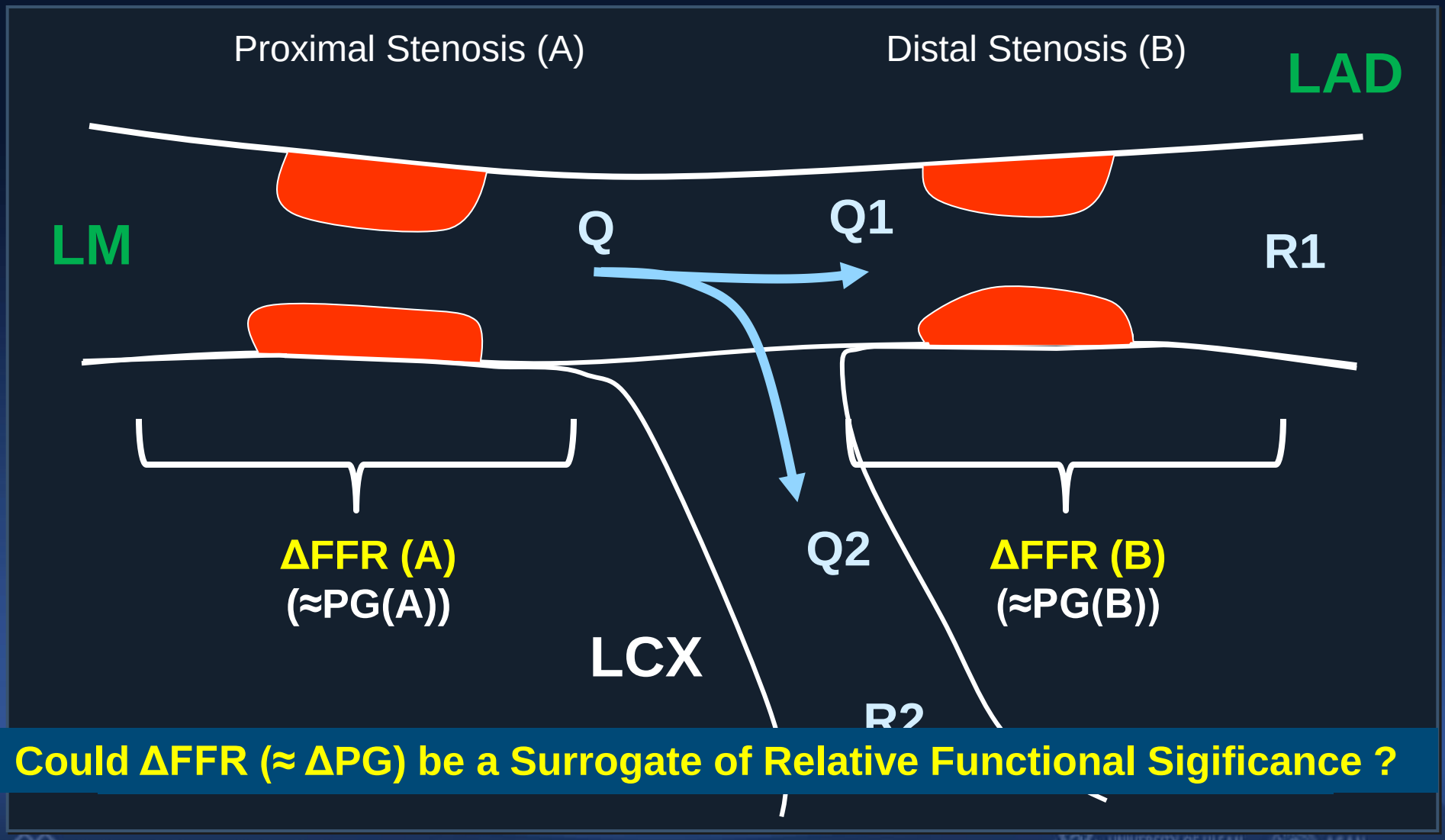
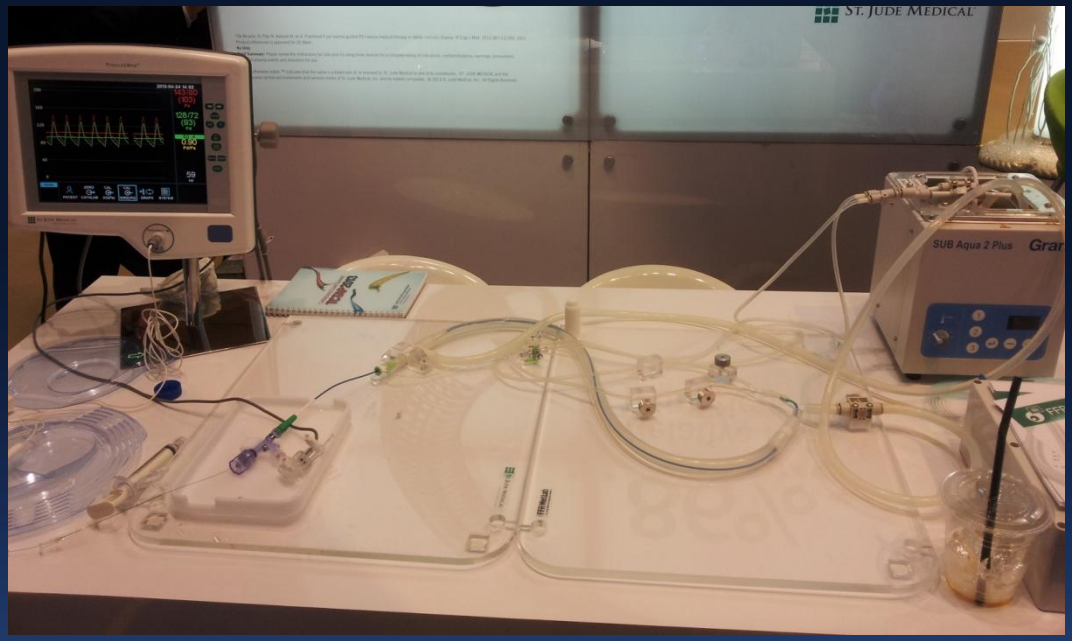


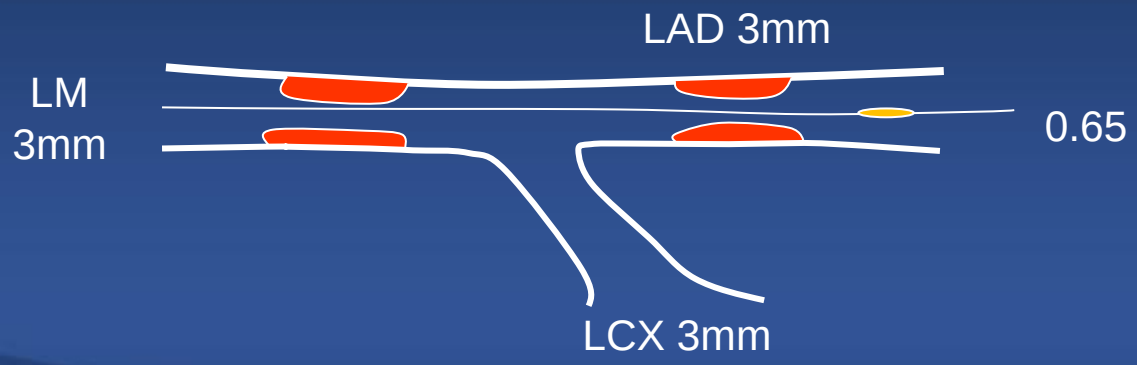
Tandem Lesion

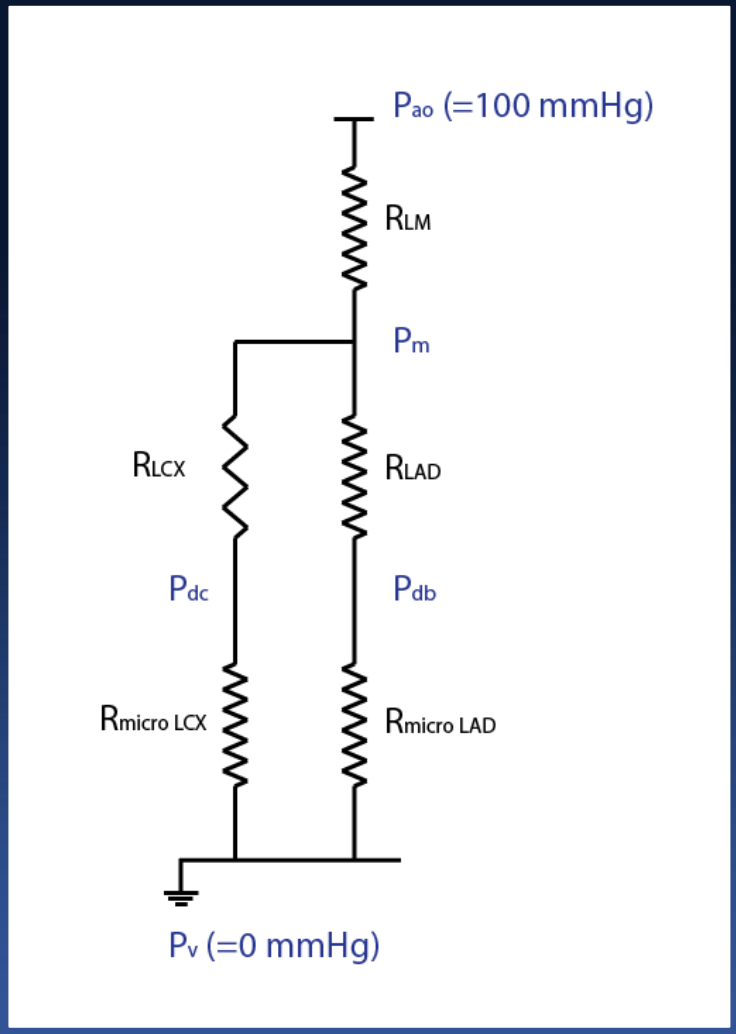


Could ΔFFR (≈ ΔPG) be a Surrogate of Relative Functional Sigificance ?

In Vitro Simulation

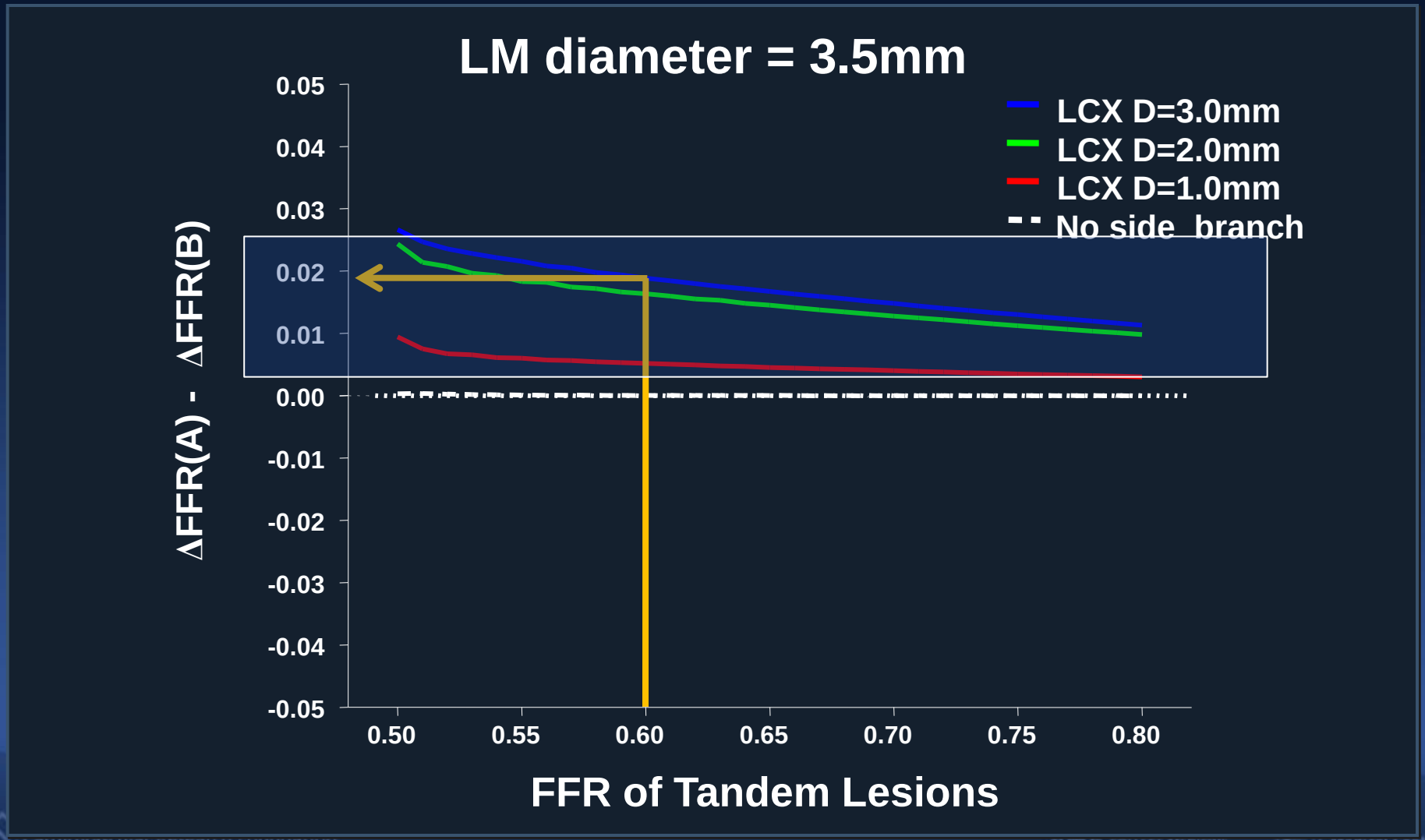






When Two Lesions Are Functionally Equal,

$(FFR(A)_{true} = FFR(B)_{true})$



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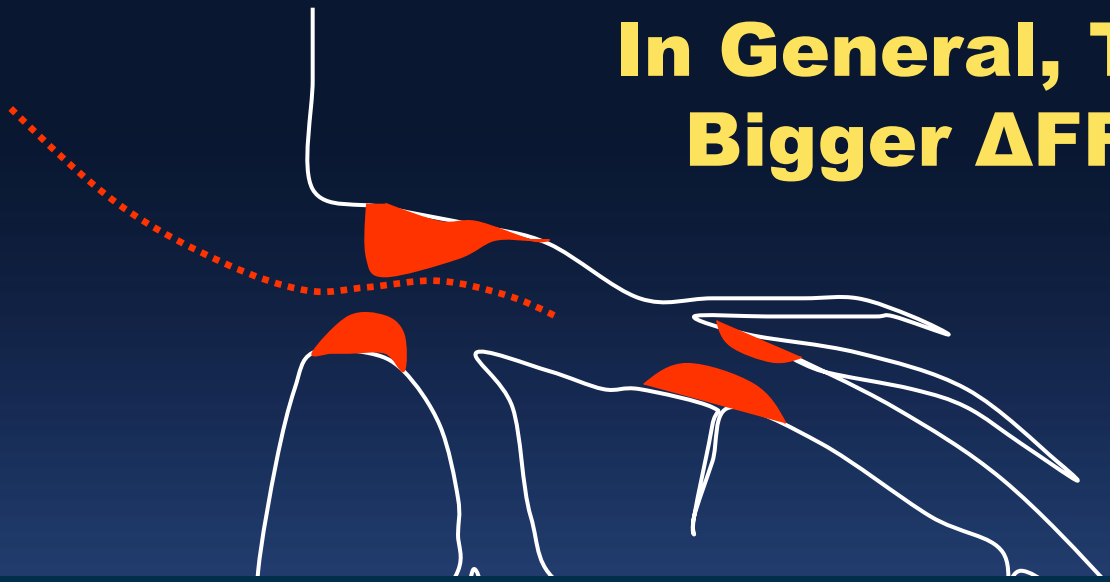


In General, Treat First Bigger ΔFFR(Δ PG)

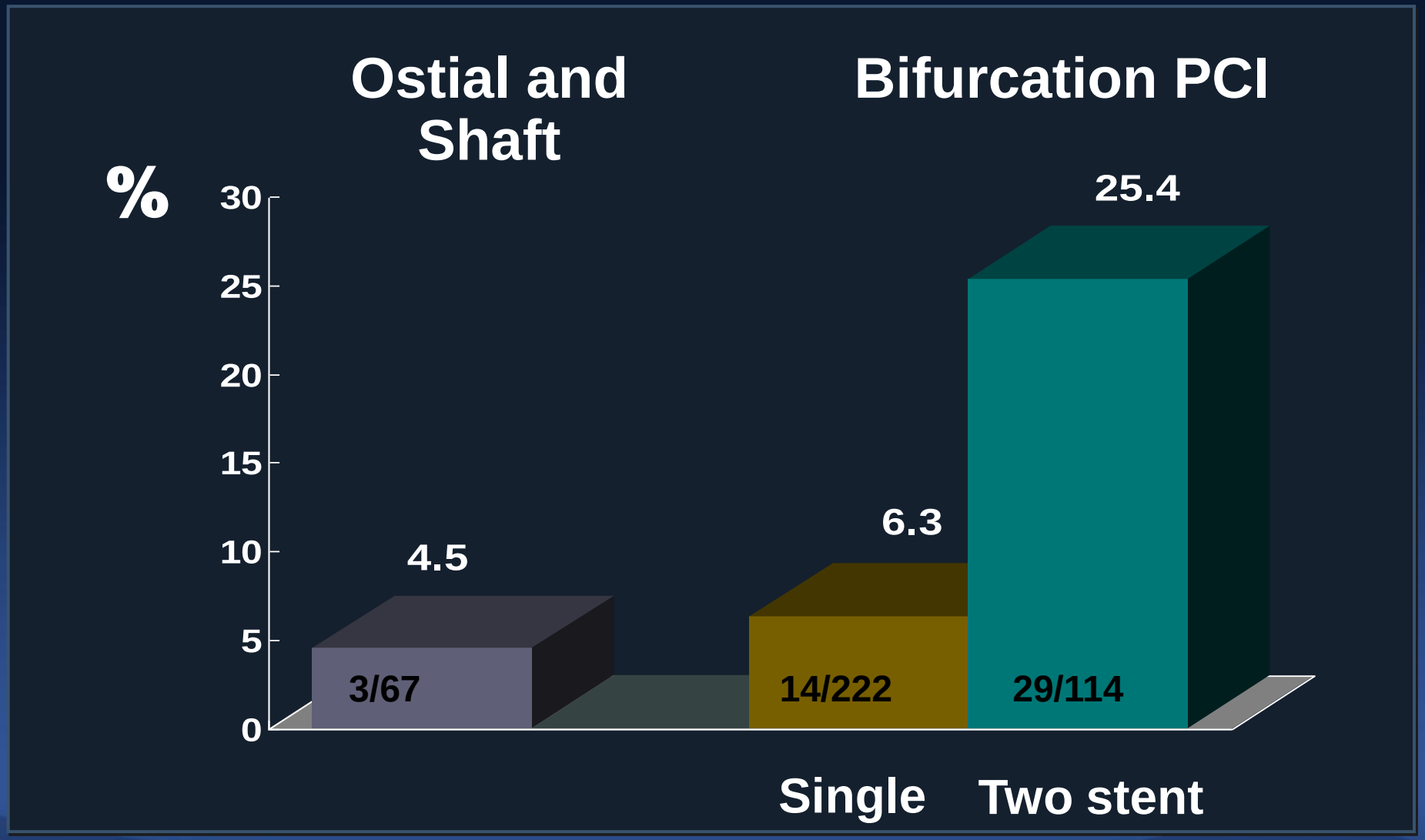
The impact of side branch (≈ 0.02) should be considered,
But this number may be below the clinical significance.

Why We Need IVUS in LM Stenting?

- Selection of Treatment strategies: 1 stent or 2 stents
- Post-Stent Optimization (5,6,7,8) Reduced ISR
- IVUS guided PCI in LMCA Improved the Survival
- Assist the Functional evaluation of Complex LM disease

Restenosis at 2 year

Pooled Analysis in 403 Patients with LM PCI Using SES

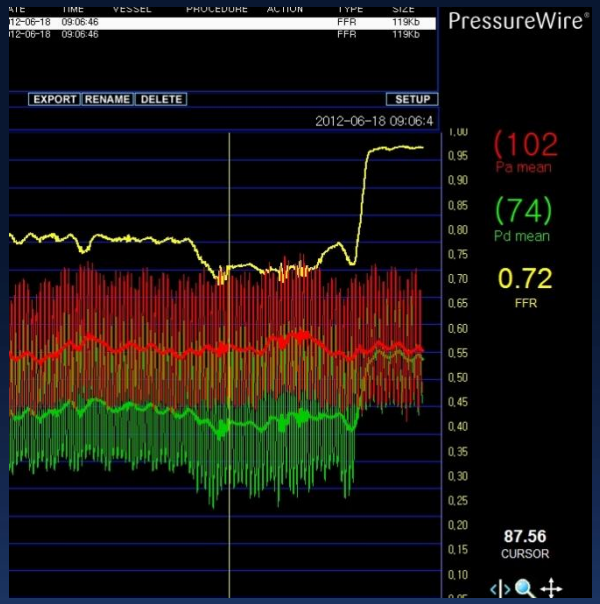


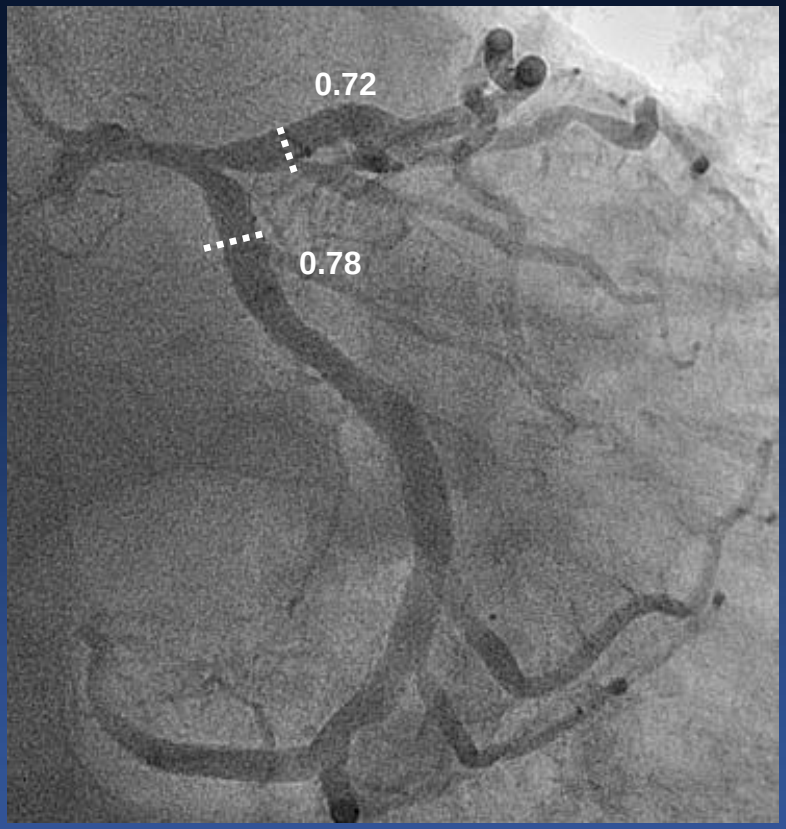
Kang et al. Circ Cardiovasc Interv 2011 2011;4:1168-74

LM Bifurcation Lesion (Medina 1,0,0) with Minimal LCX Disease

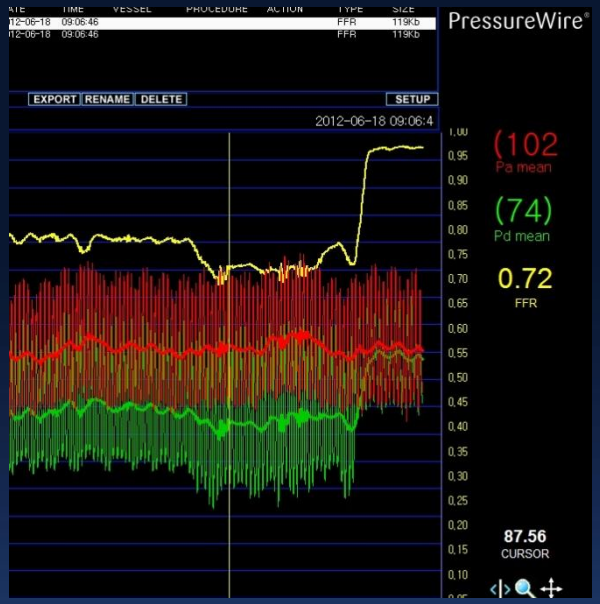
55/M, Stable angina,

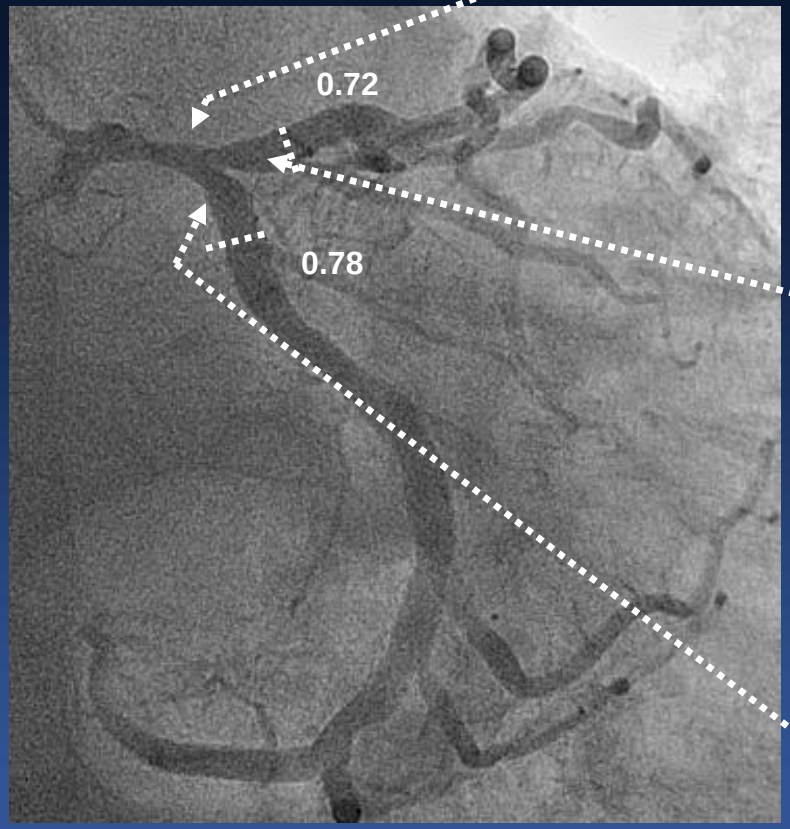
FFR in Both LAD and LCX,





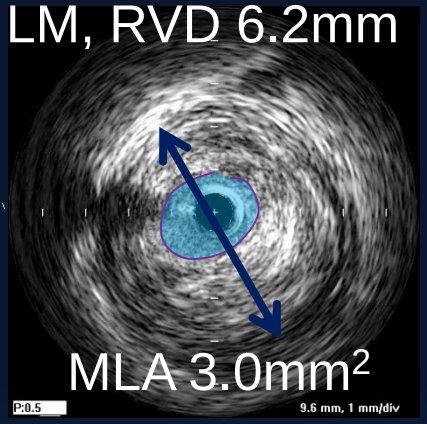
IVUS in Both LAD and LCX,

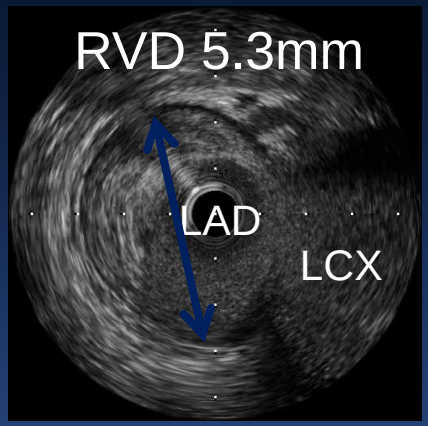


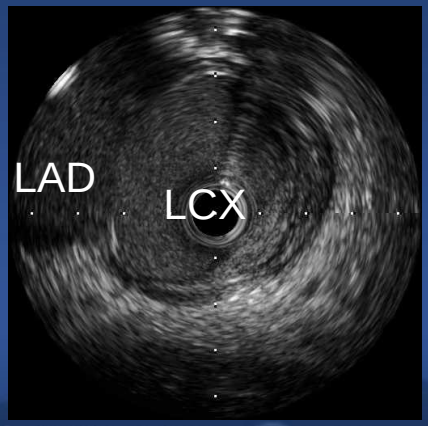


Minimal disease at LCX ostium

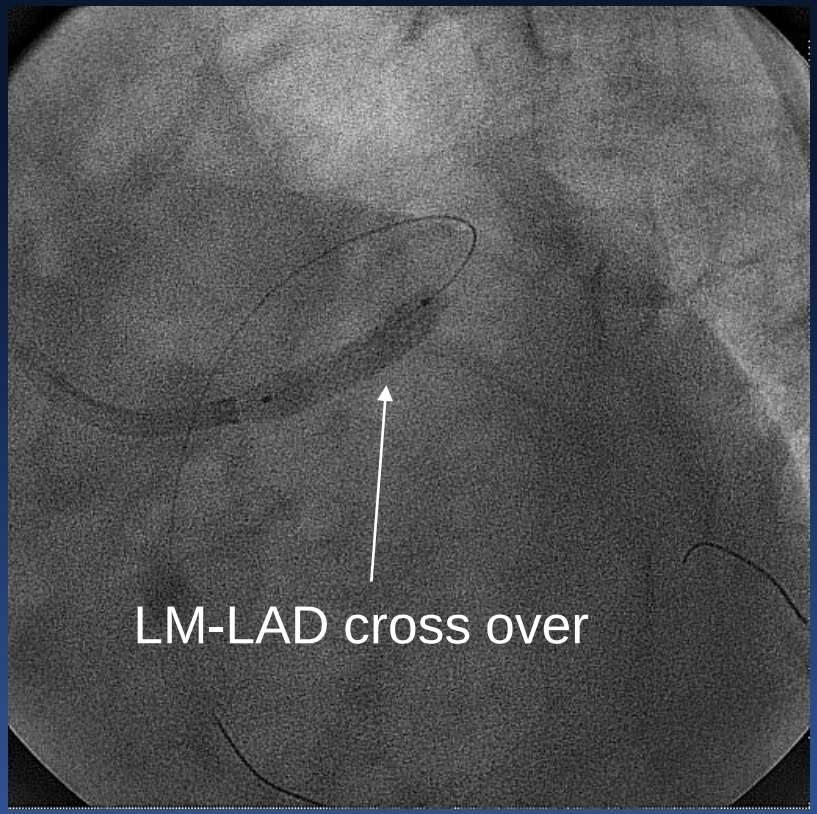
Distal LM, RVD 6.2mm



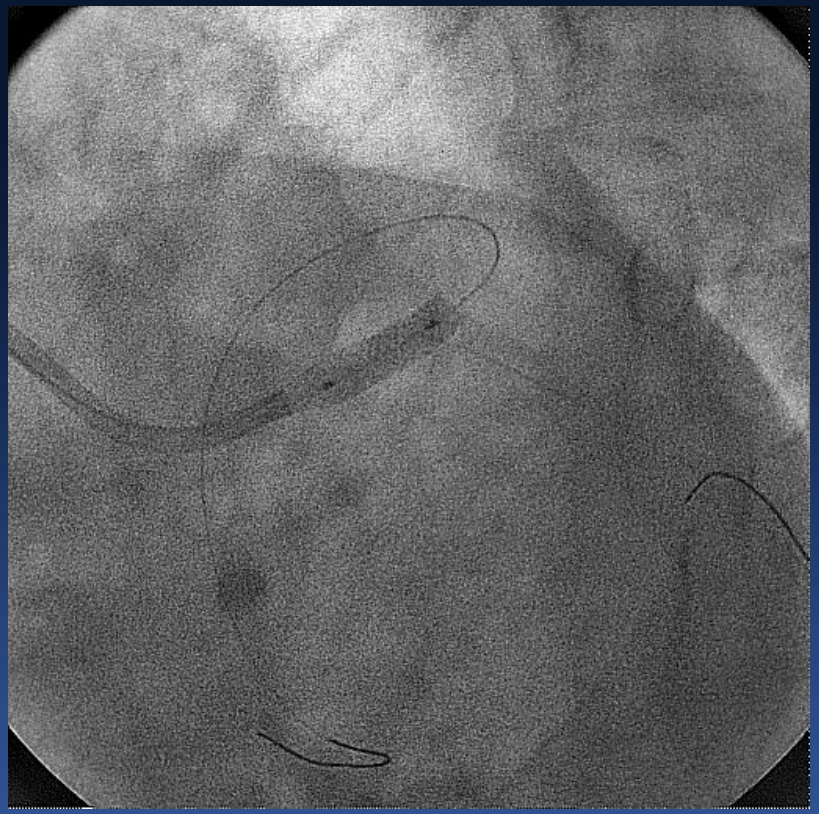




Single Stent Cross-Over
with minimal-disease at LCX OS

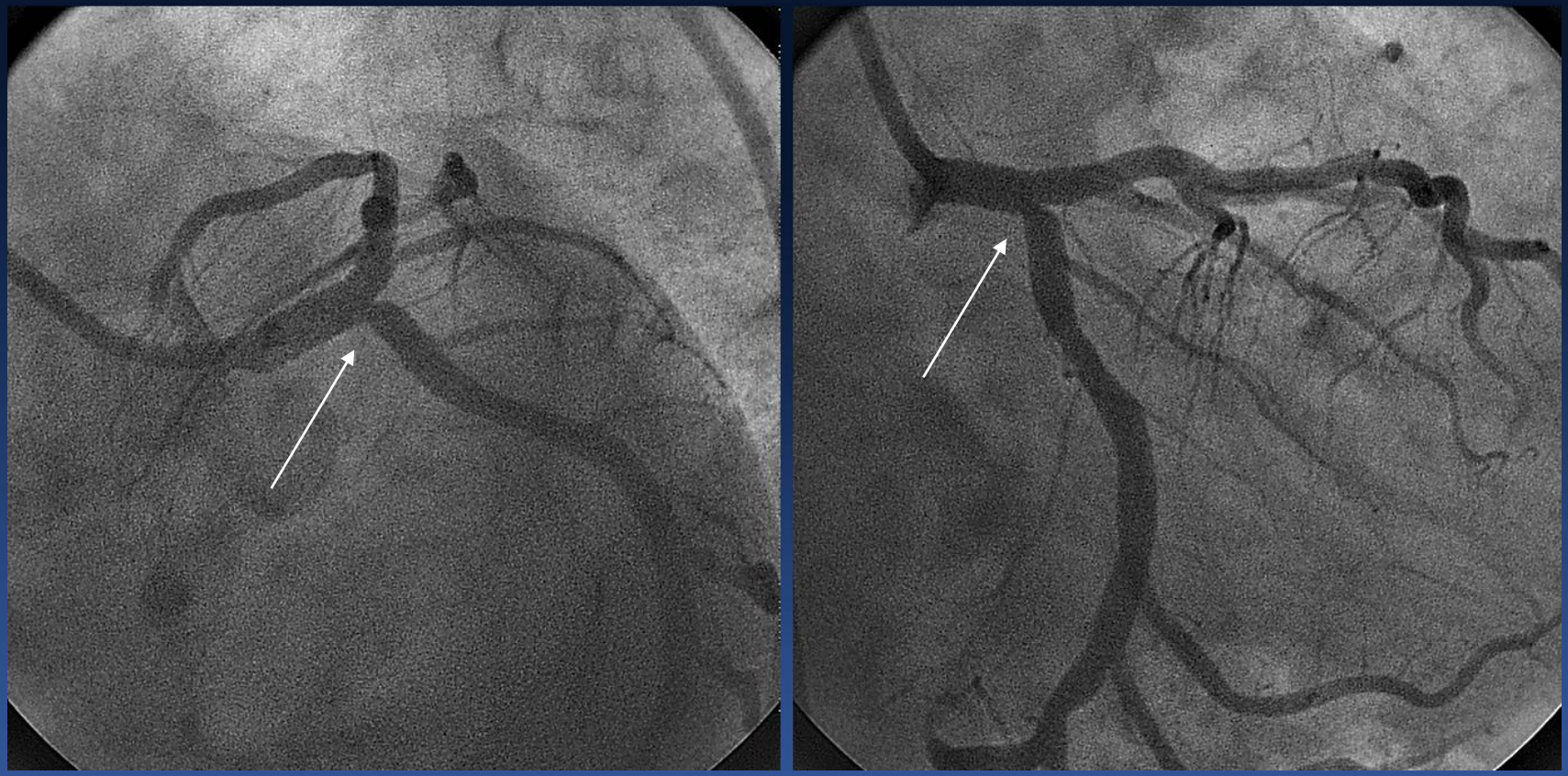


Promus Element
4.0x20



Additional high pressure
Inflation with 4.0 mm
non-compliant balloon

After Single Stent Cross-Over,
Angiographic Compromise of LCX Ostium.



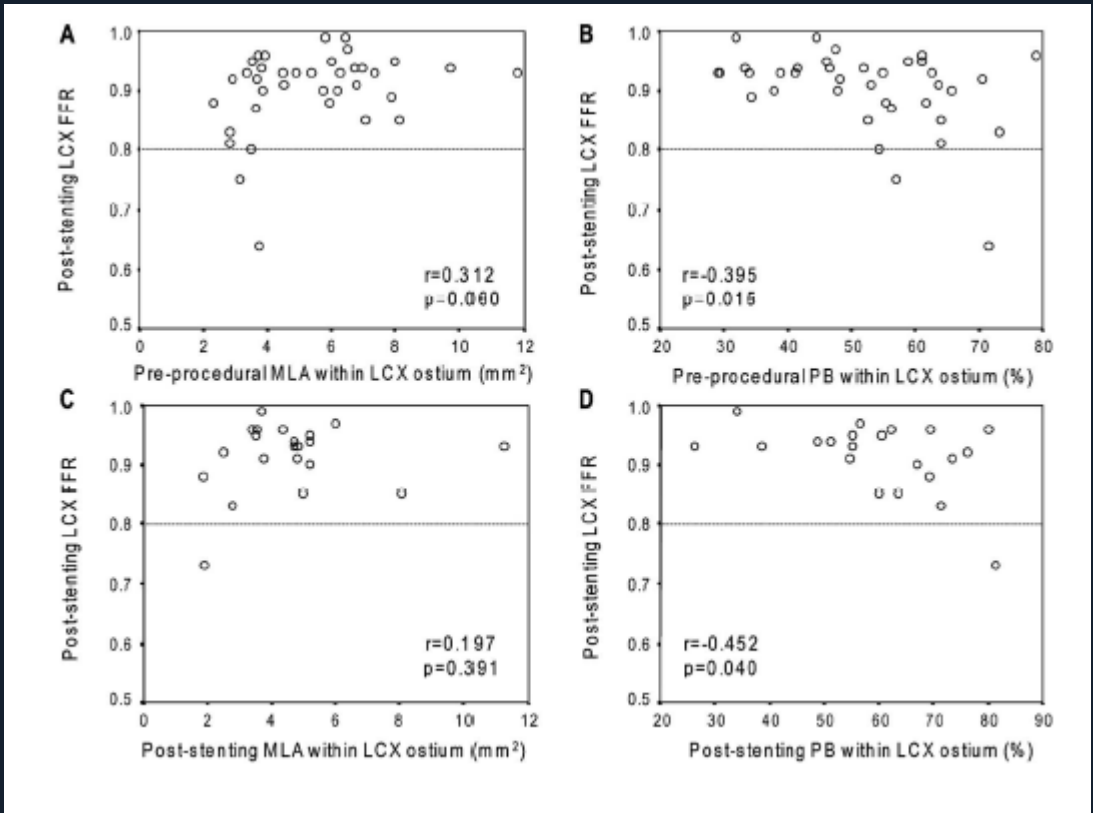
What Would You Do ?
To Treat or Not To Treat

Consider FFR, First !

FFR is 0.92

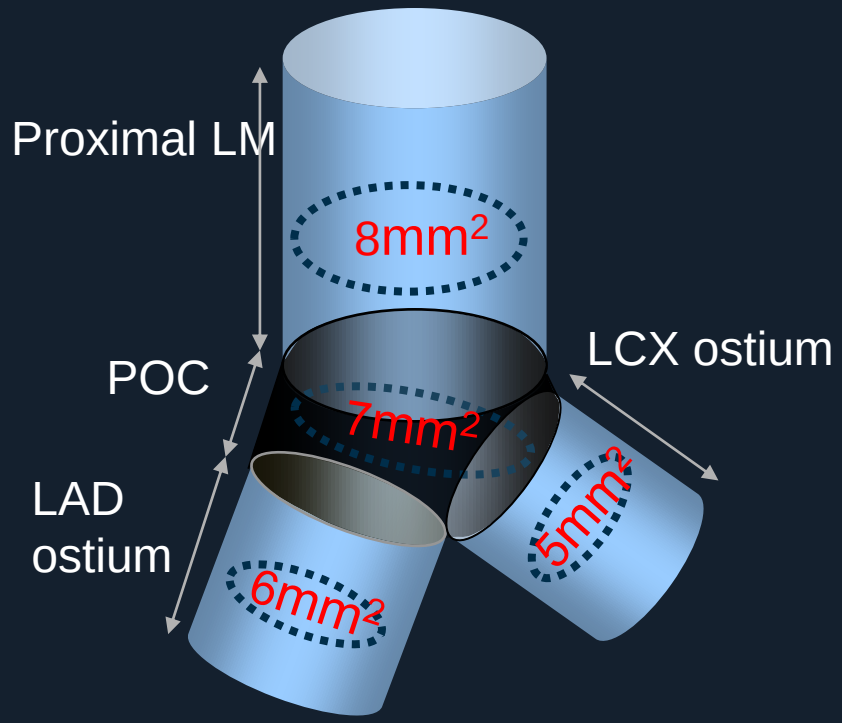
LCX FFR after Cross Over Stenting

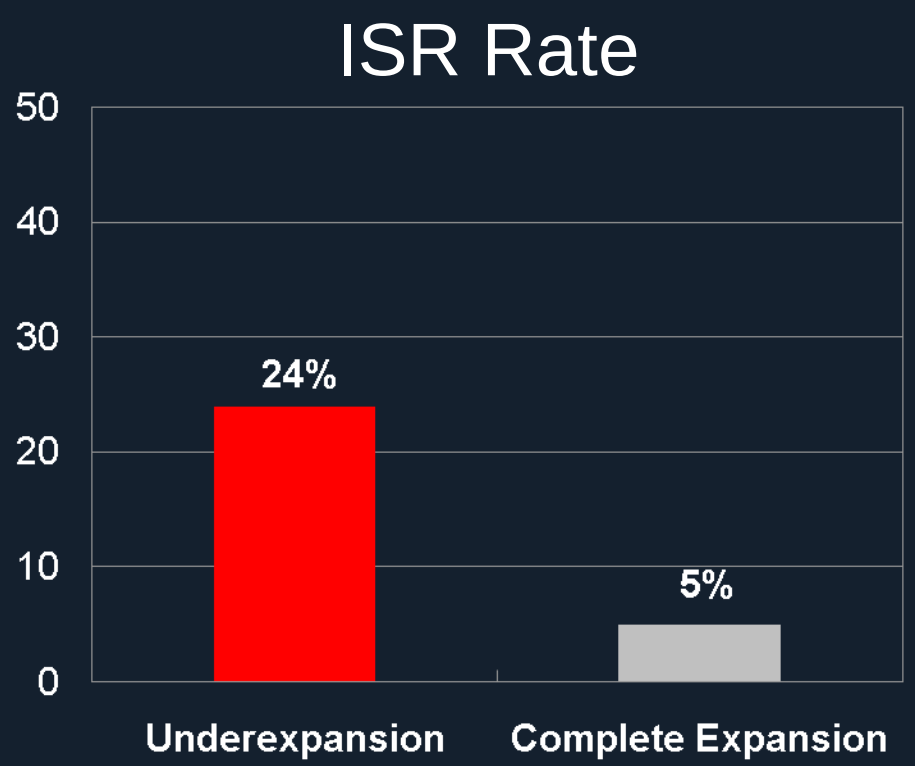
- 43 Patients with LM Bifurcation Lesions
- Only in 3 Patients, FFR of LCX ostium after LM Stenting <0.80



Kang et al. Catheter Cardiovasc Interv. 2013 Jun 13

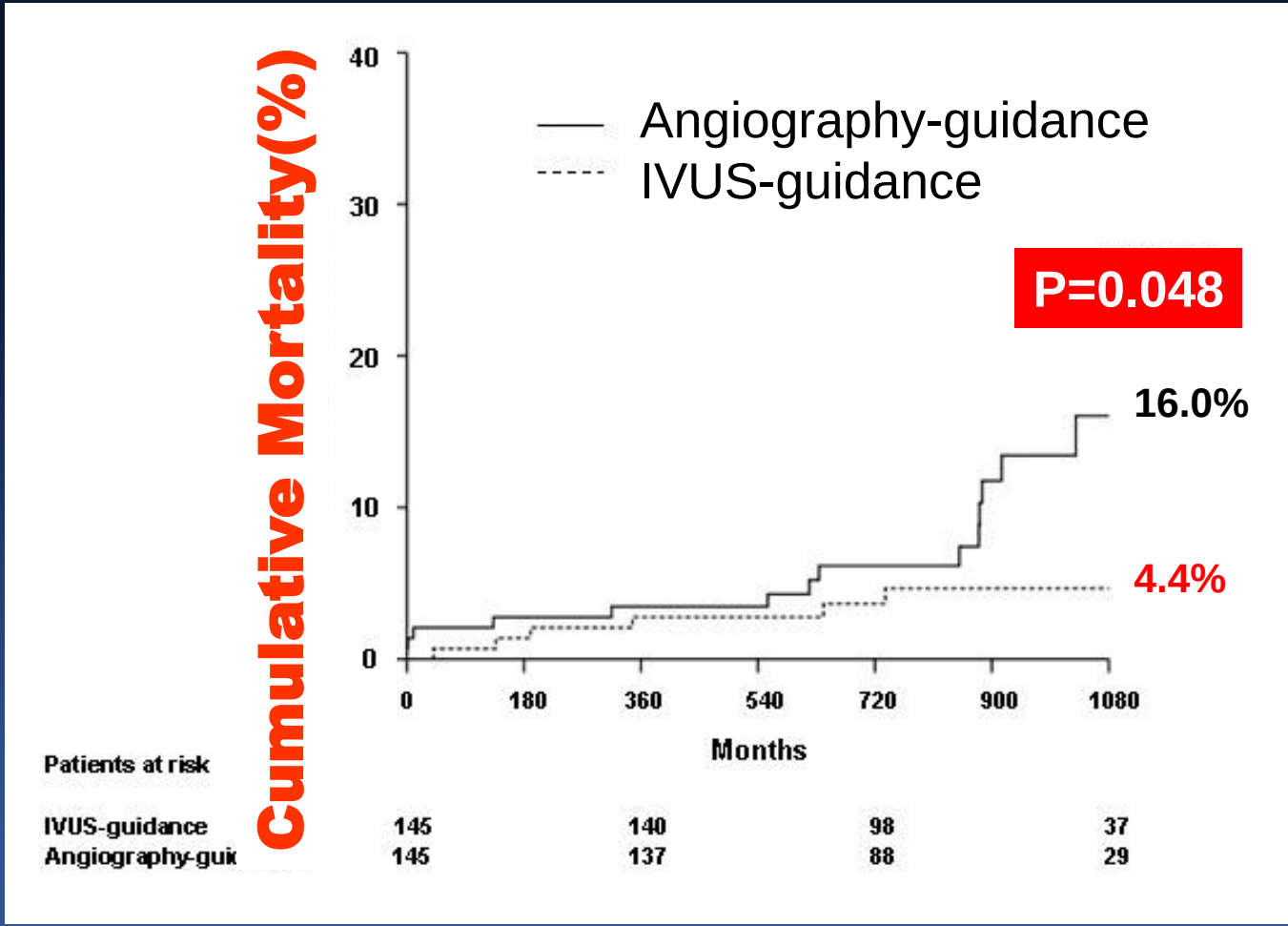
Optimal Stent Cross Sectional Area After LM Stenting





Kang et al. Circ Cardiovasc Interv 2011 2011;4:1168-74

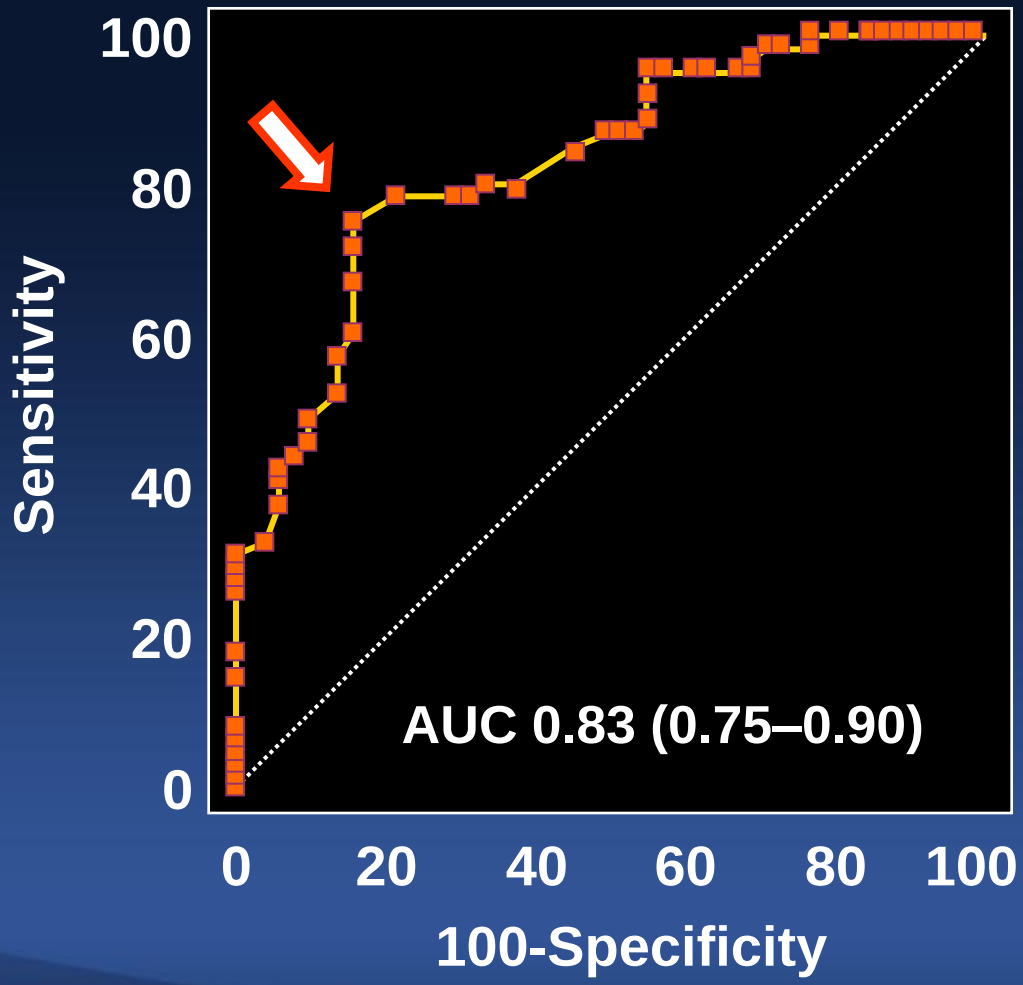
IVUS Guidance reduced the rate of mortality In LM DES stenting



Park SJ et al, Circulation. Cardiovasc Interv. 2009 Jun;2(3):167-77.

New LM IVUS MLA

Matched with FFR <0.80,
Ostial and Shaft LM Disease (N=112)



Cut-off = 4.5 mm²

Sensitivity	79%
Specificity	80%
PPV	83%
NPV	76%
Accuracy	80%

Park SJ et al. *JACC-CI (In Press)*

Integrated Use of FFR and IVUS in LM stenting

Ostial or Shaft Stenosis

Whether to Treat or Not: FFR guidance

How to Treat: IVUS guidance

- Preintervention IVUS evaluation
  MLA, RVD, LL, Plaque burden etc.
- Postintervention IVUS optimization
  MSA>8mm^2

Bifurcation Stenosis

Whether to Treat or Not: FFR guidance

- FFR measurement is important
  Consider a bifurcation stenosis as a single unit of disease
- IVUS can assist the functional evaluation of complex LM disease
  MLA < 4.5mm^2

How to Treat: IVUS guidance

- Preintervention IVUS evaluation
  MLA, RVD, LL, Plaque burden etc.
- Postintervention IVUS optimization
  Evaluate MSA in every segment (5,6,7,8)