

# **Integrated Use of FFR and IVUS**

## **Left Main PCI**

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# Why We Need FFR in LM Disease?

- Inaccuracy of CAG
- Insufficiency of Thallium or TMT
- Supporting Data for FFR Guided Decision

# Major Randomized Studies in LM

## ORIGINAL ARTICLE

### Outcomes in Patients With De Novo Left Main Disease Treated With Either Percutaneous Coronary Intervention Using

Journal of the American College of Cardiology  
© 2008 by the American College of Cardiology Foundation  
Published by Elsevier Inc.

Vol. 51, No. 5, 2008  
ISSN 0735-1097/08/\$34.00  
doi:10.1016/j.jacc.2007.09.054

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Vol. 57, No. 5, 2011  
ISSN 0735-1097/11/\$34.00  
doi:10.1016/j.jacc.2010.09.038

## CLINICAL RESEARCH

## Interventional Cardiology

### Randomized Comparison of Percutaneous Coronary Intervention With Sirolimus-Eluting Stents Versus Coronary Artery Bypass Grafting in Unprotected Left Main Stem Stenosis

Enno Boudriot, MD,\* Holger Thiele, MD,\* Thomas Walther, MD,† Christoph Liebetrau, MD,\*  
Peter Bode, MD,\* Thomas Bahl, MD,\* Reiner Bräse, MD,\* Hans-Joachim Meyer, MD,†

Patients age 18 to 80 years with stenosis ( $\geq 50\%$ ) of the ULM with or without additional multivessel coronary artery disease were included in this multicenter study. Patients had

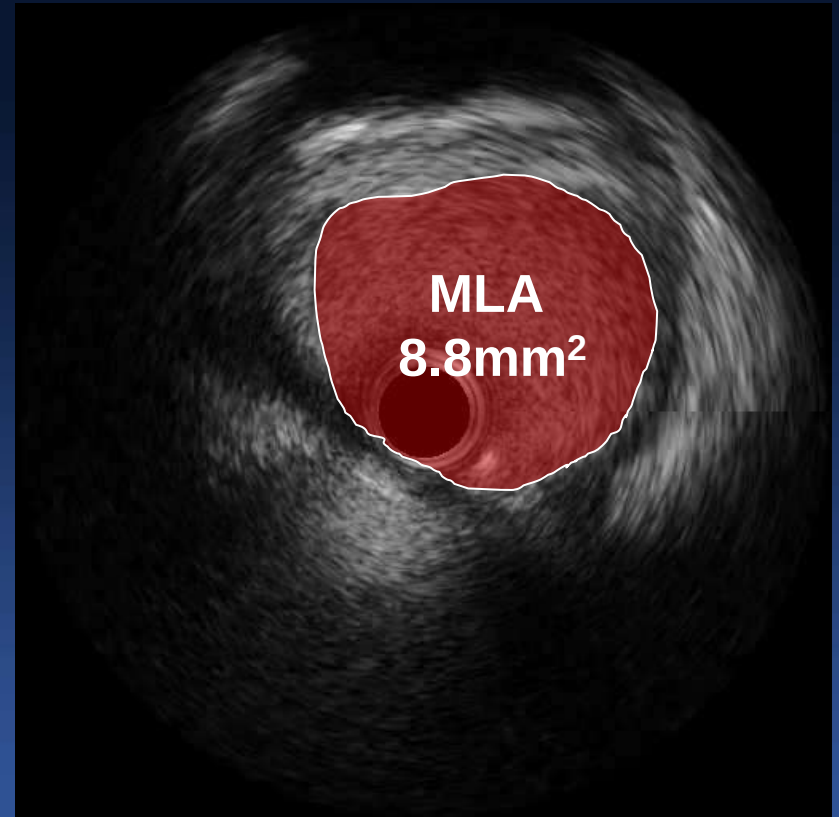
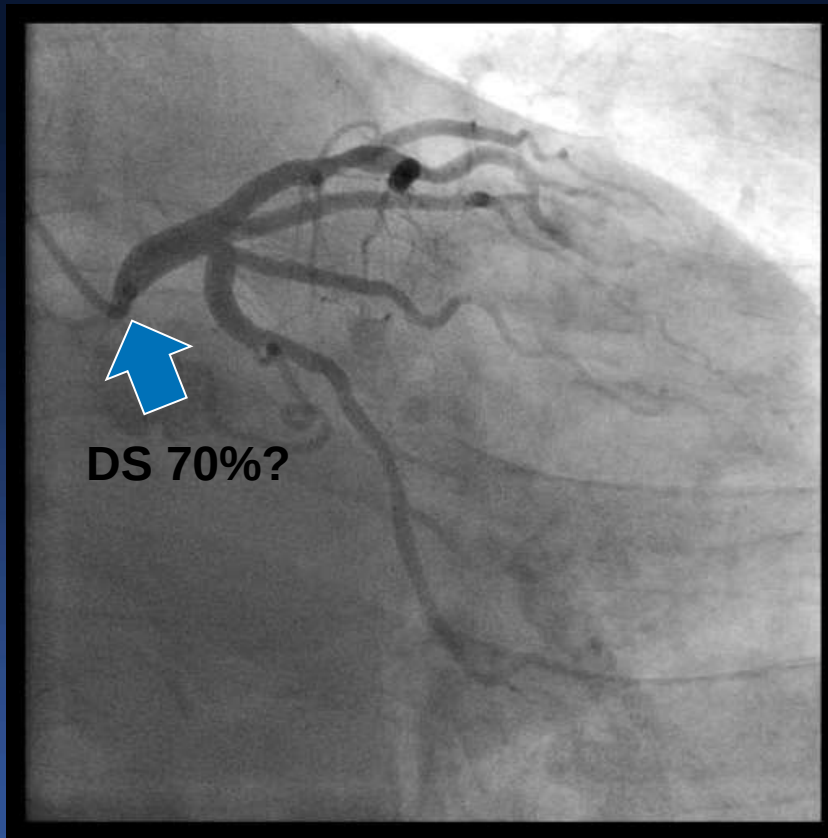
#### Background

CABG is considered the standard of care for treatment of ULM. Improvements in percutaneous coronary intervention (PCI) with use of drug-eluting stents might lead to similar results. The effectiveness of drug-eluting stenting versus surgery has not been established in a randomized trial.

#### Methods

In this prospective, multicenter, randomized trial, 201 patients with ULM disease were randomly assigned to

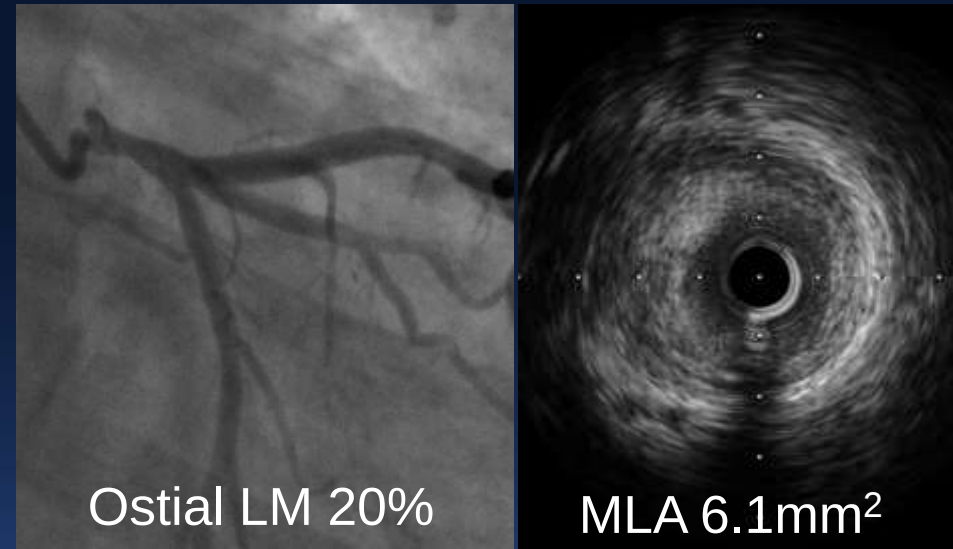
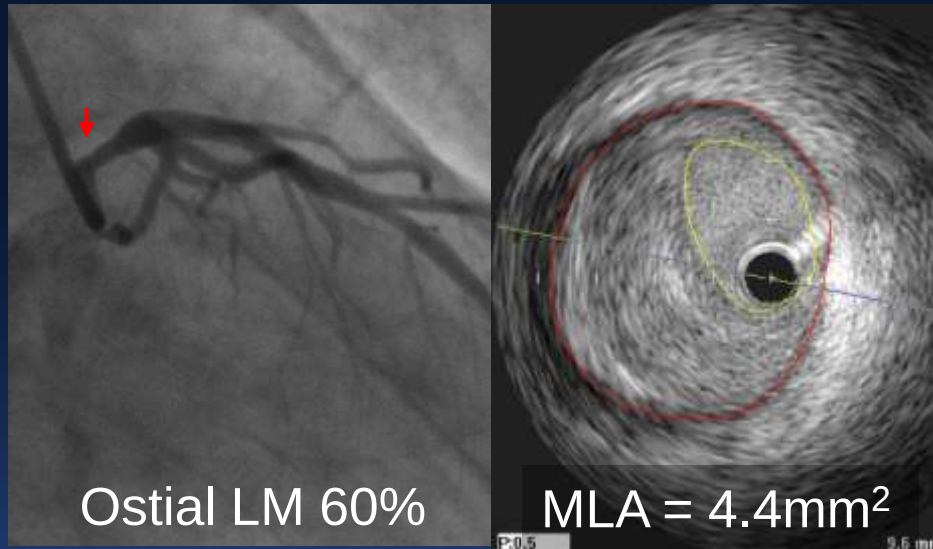
# Why We Need FFR?



# Why We Need FFR in LM?

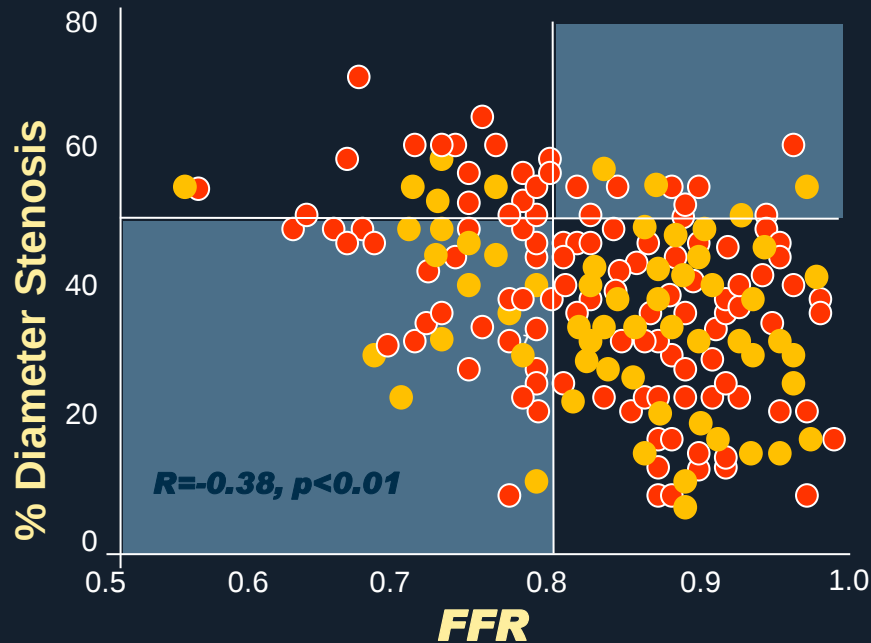
47/M Stable angina

50/M Stable angina



# FFR and %DS in **Equivocal LMCA**

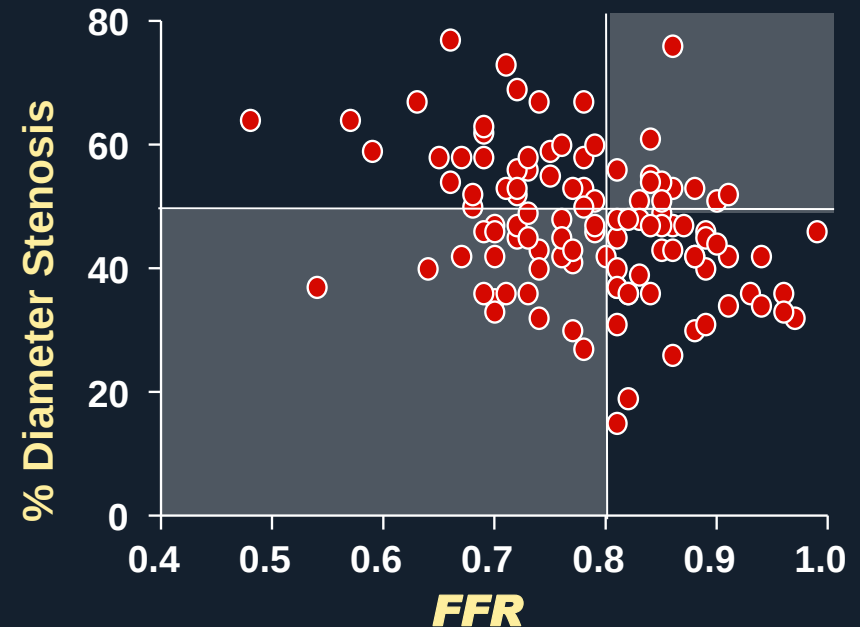
**“Mismatch” is 29% in equivocal LMCA**



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

● Isolated LMCA disease

**“Mismatch” is 37% in equivocal LMCA**



Park SJ, Ahn JM et al *JACC CI*. 2014;7(8):868-74

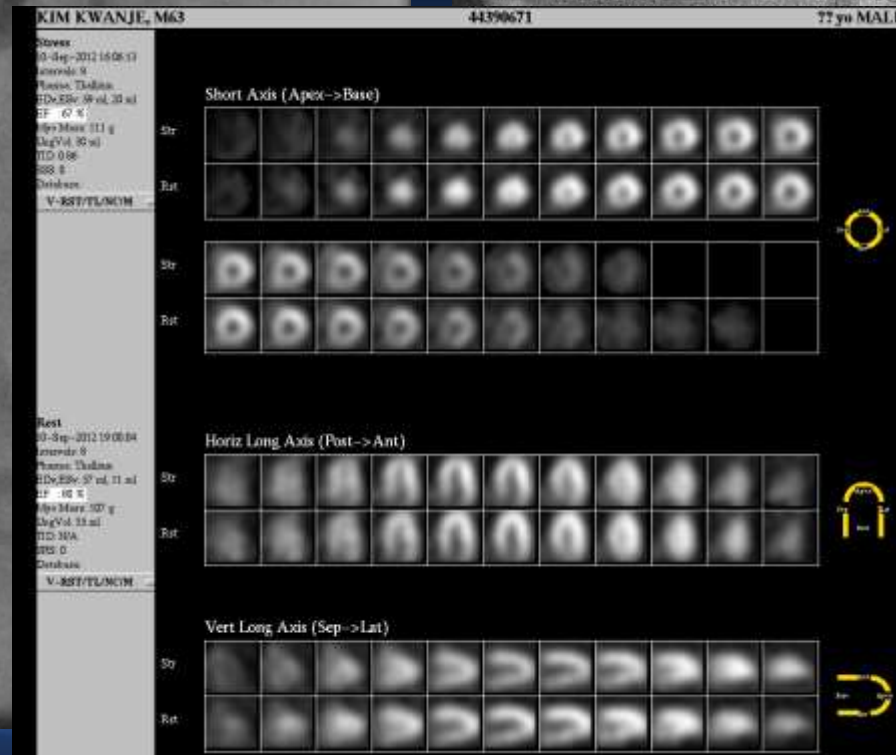
## LM with 3VD

# 65yrs/M, eCP

# RCA

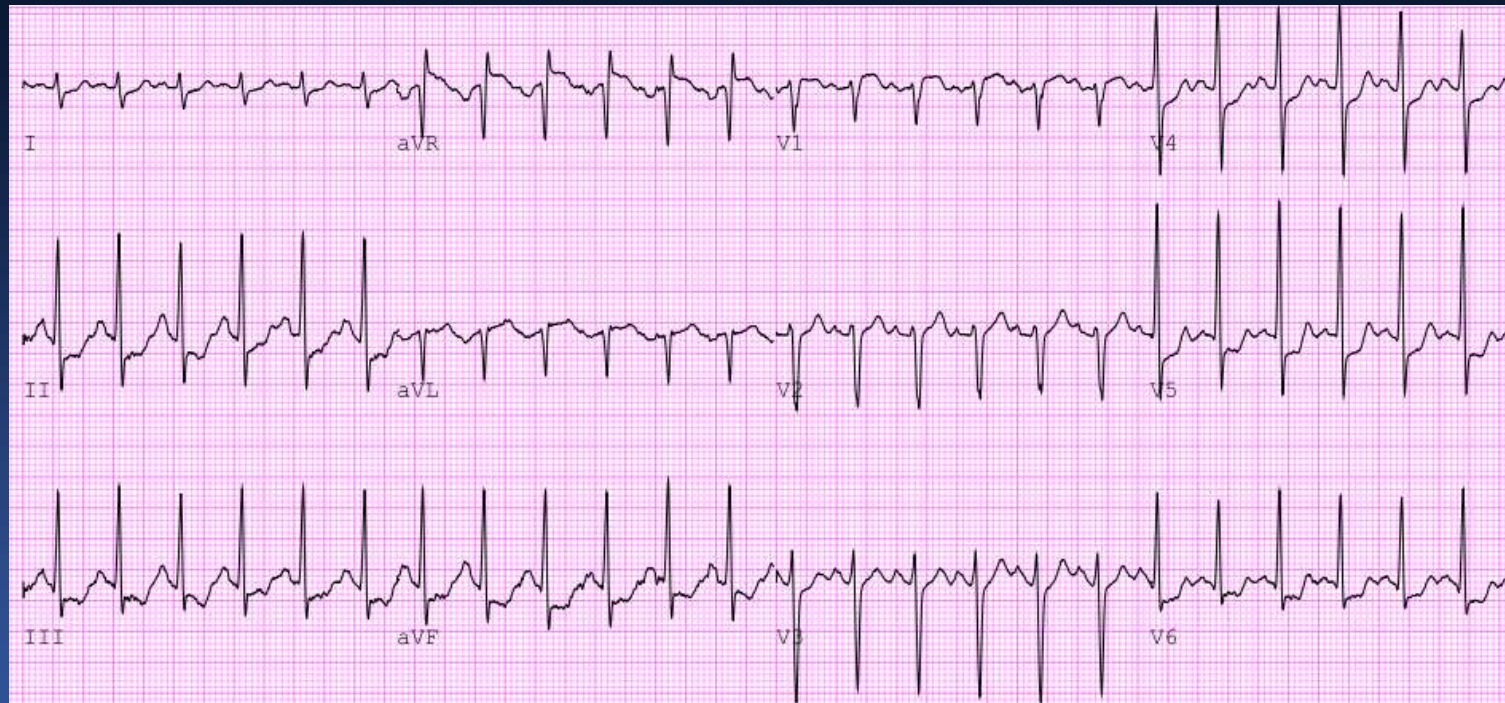
# LCA

## Normal Perfusion in Thallium SPECT



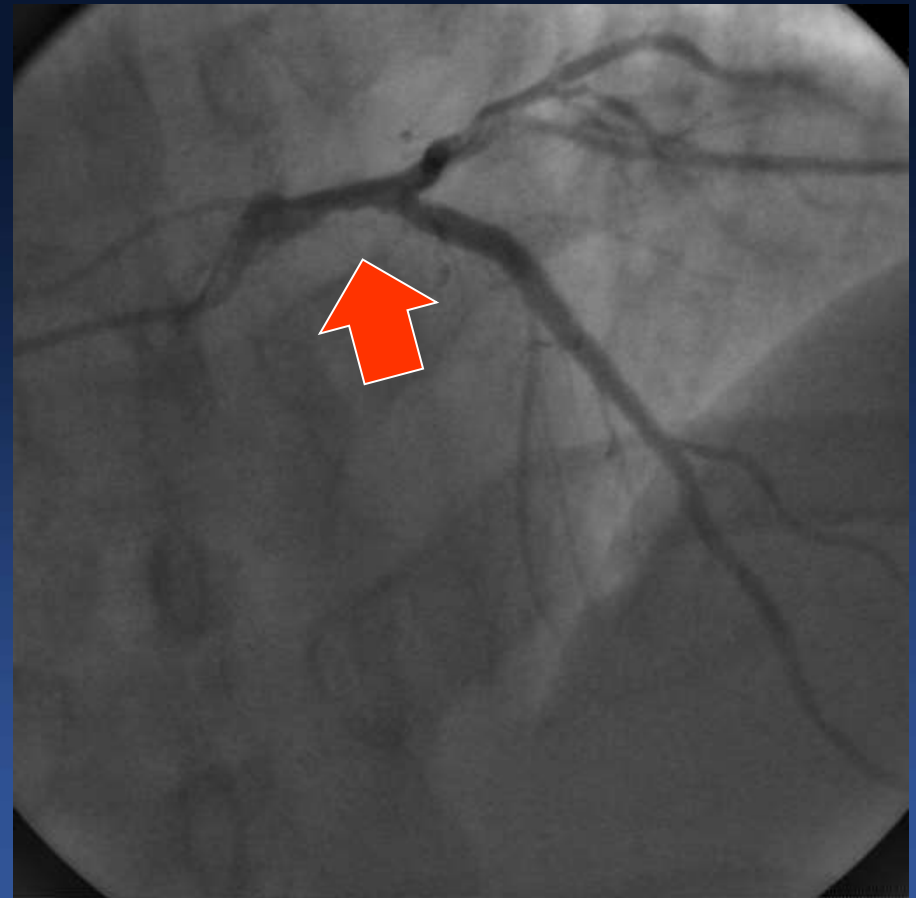
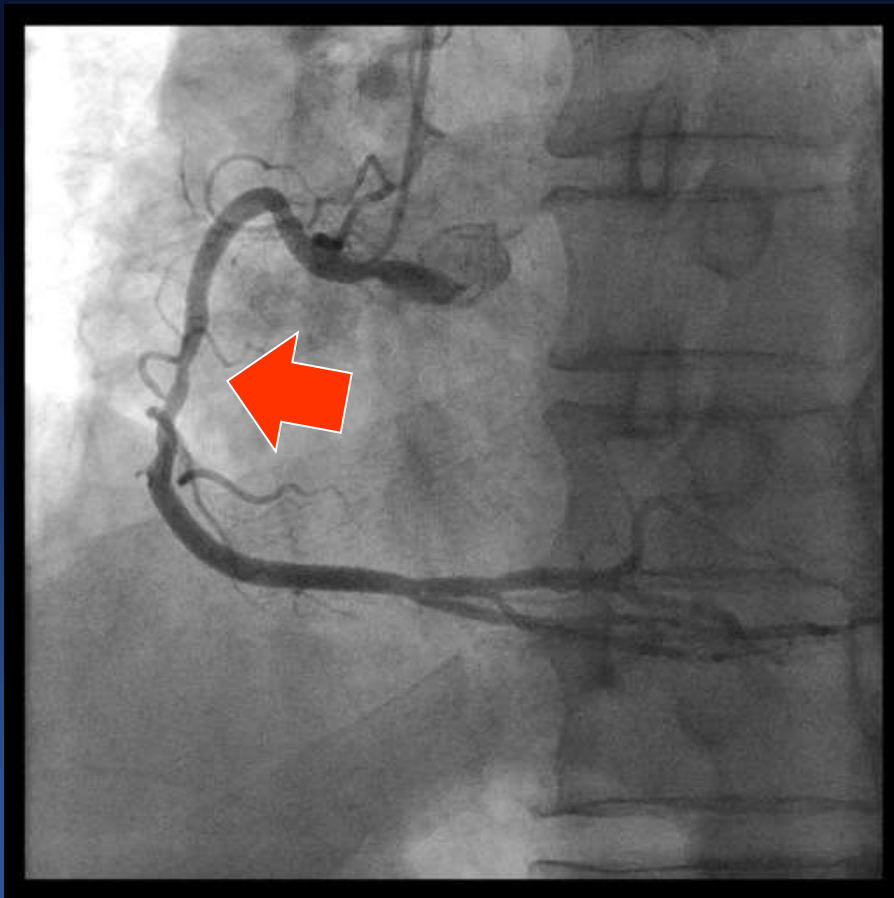
# M/76, eCP

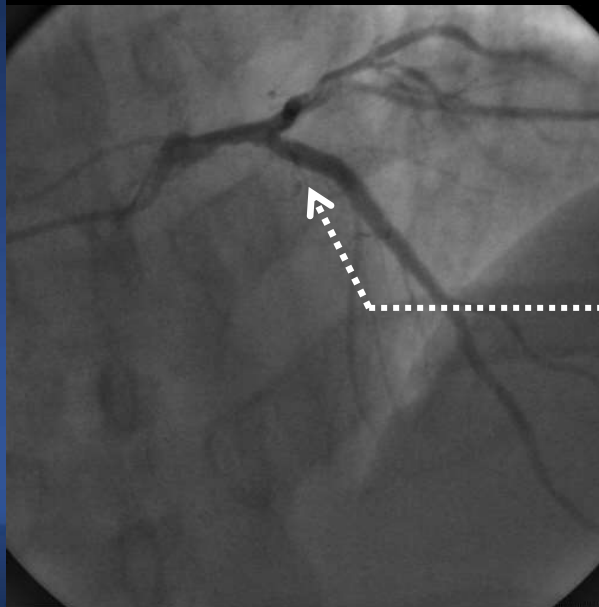
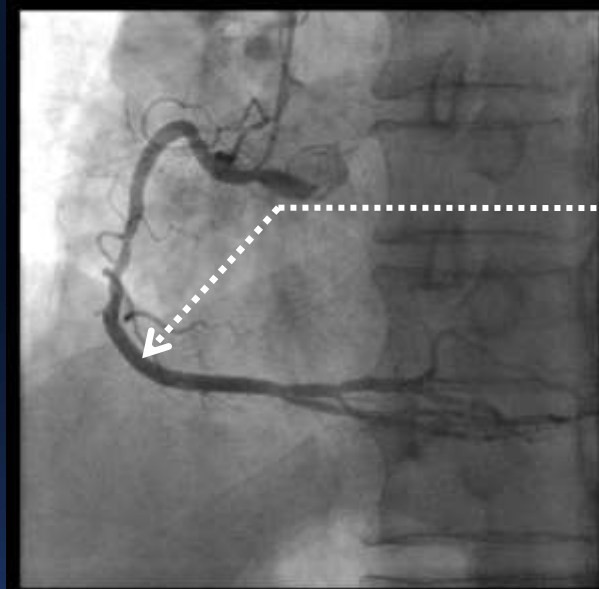
## Treadmill Test



Positive at Stage 4

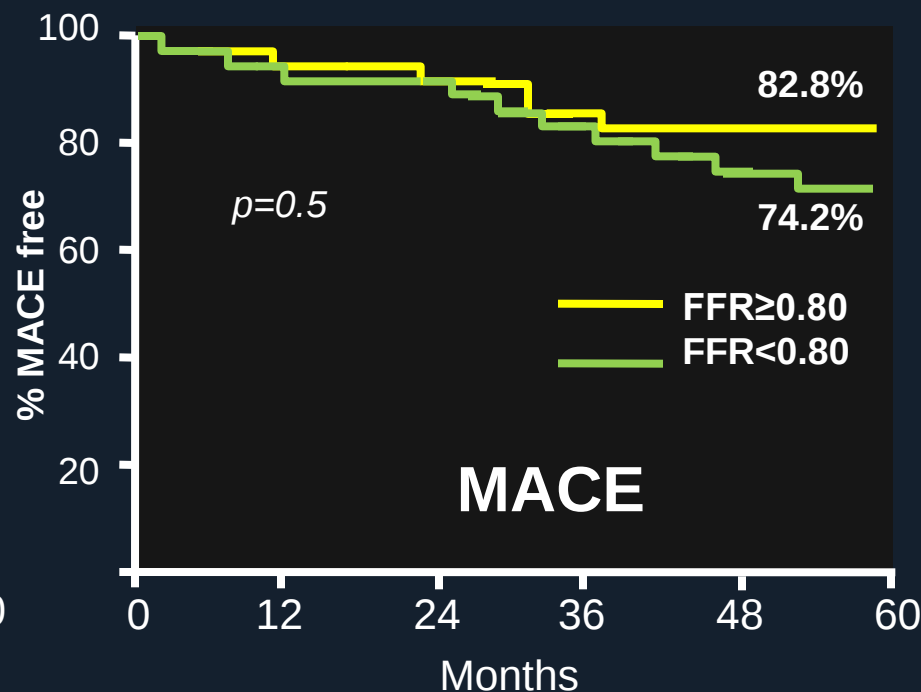
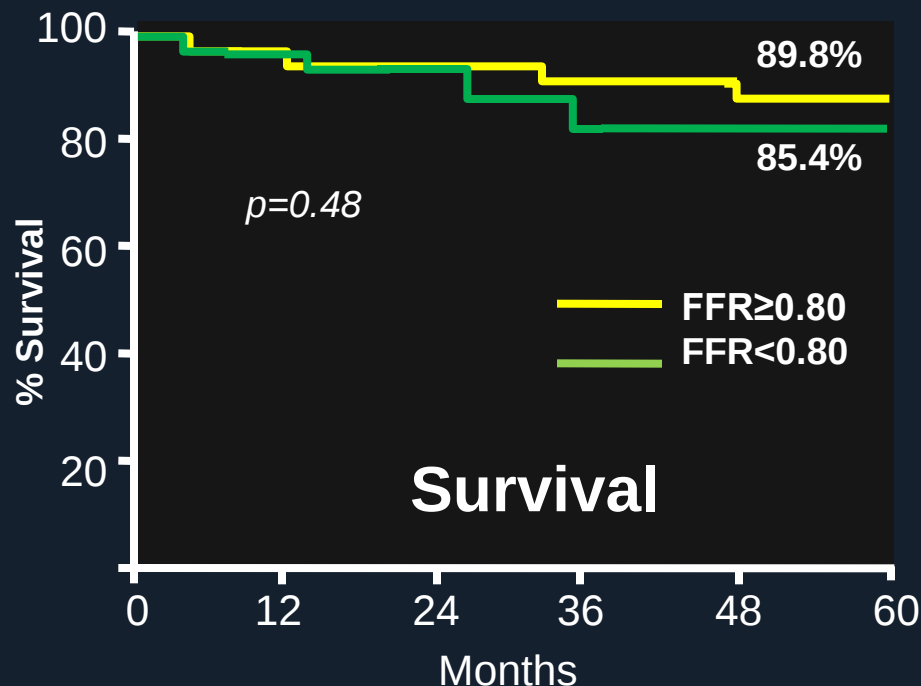
# ***Coronary Angiography***



**FFR**

# **FFR Guided PCI in Equivocal LMCA**

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



**An FFR-guided strategy showed the favorable outcome.**

# FFR Guided Decision Making in LM Disease

|                     | Hamilos et al <sup>1</sup> |           | Bech et al <sup>2</sup> |        | Courtis et al <sup>3</sup> |         | Lindstaedt et al <sup>4</sup> |         | Jasti et al <sup>5</sup> |       |
|---------------------|----------------------------|-----------|-------------------------|--------|----------------------------|---------|-------------------------------|---------|--------------------------|-------|
| 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     |

<sup>1</sup>Circulation 2009;120:1505-1512;<sup>2</sup>Heart 2001;86:547-552;<sup>3</sup>Am J Cardiol 2009;103:943-949;

<sup>4</sup>Am Heart J 2006;152:156.e151-156;<sup>5</sup>Circulation 2004;110:2831-2836

# **Clinical Outcomes After Deferral of LM Disease**

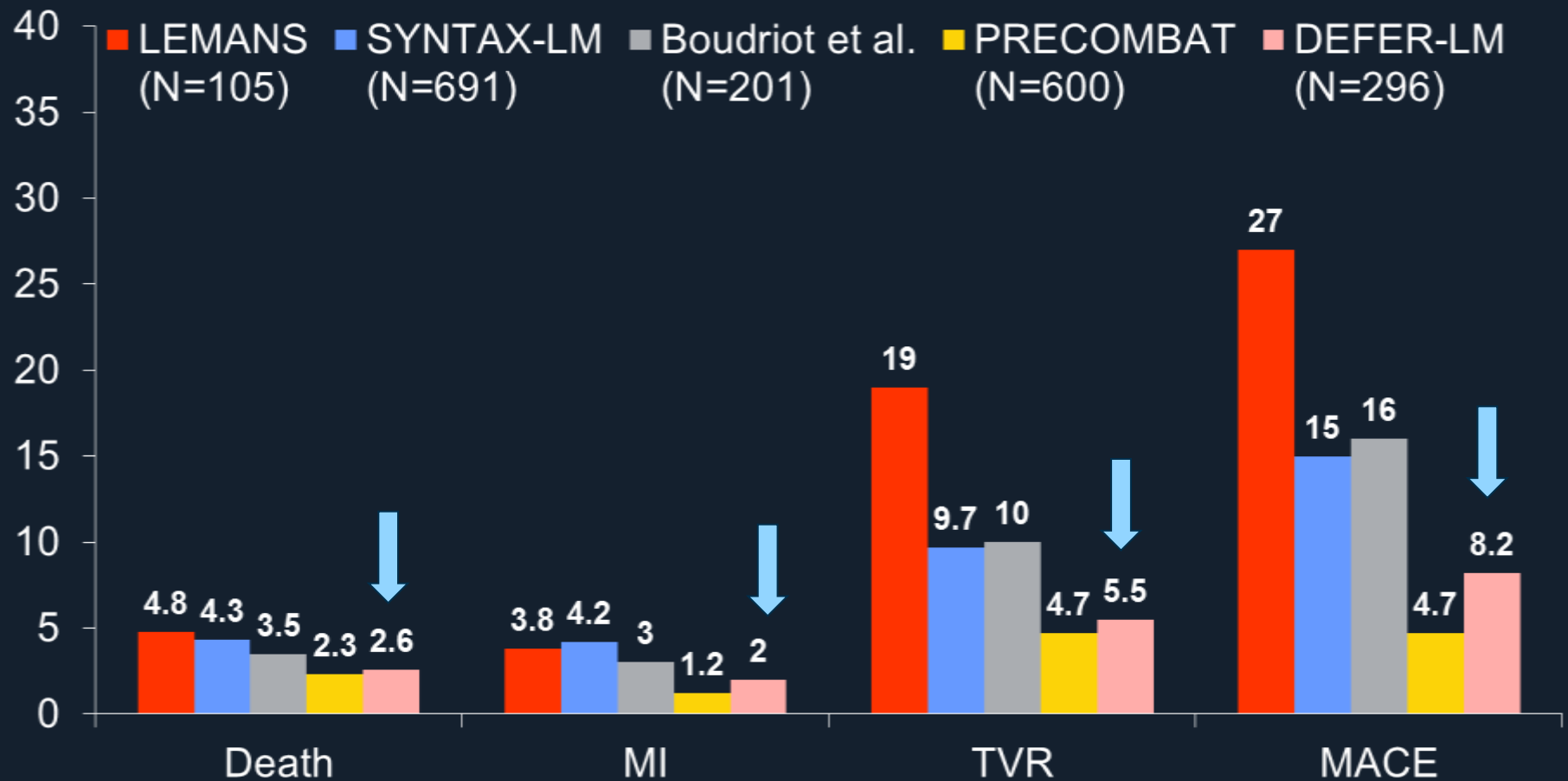
**(6 studies, 296 patients)**

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

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 (6 studies, 296 patients)



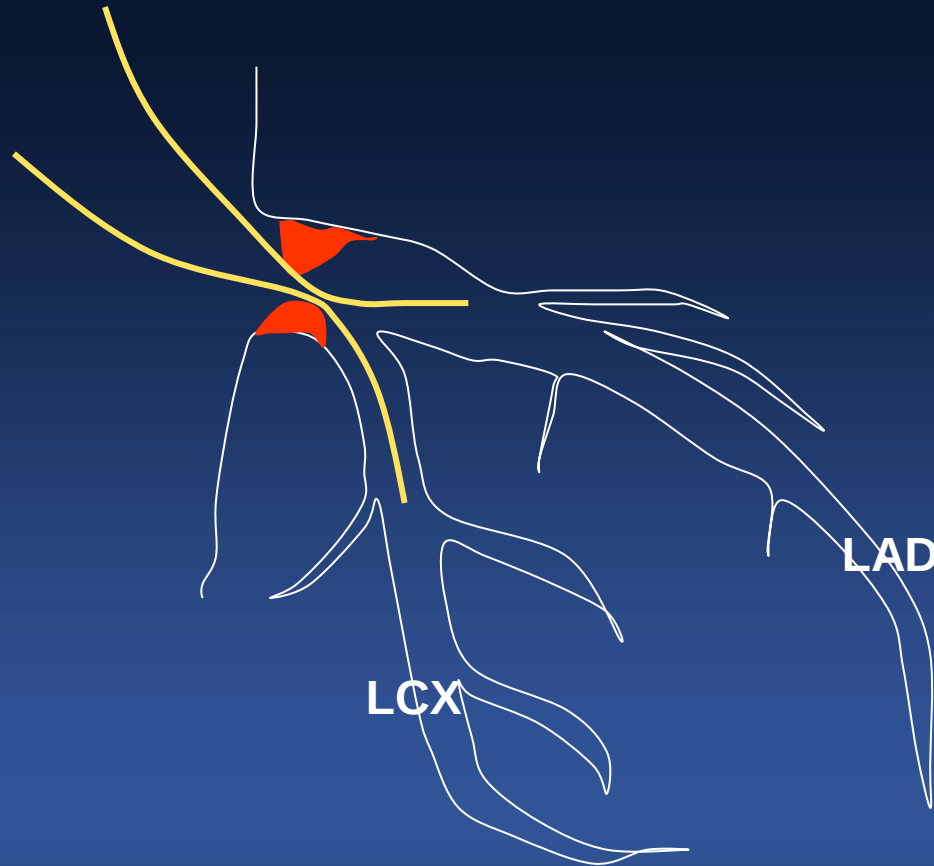
# Why We Need FFR in LM Disease?

- Inaccuracy of CAG
- Insufficiency of Thallium or TMT
- Supporting Data for FFR Guided Decision

# How Can We **Implement FFR** in Real Practice ?

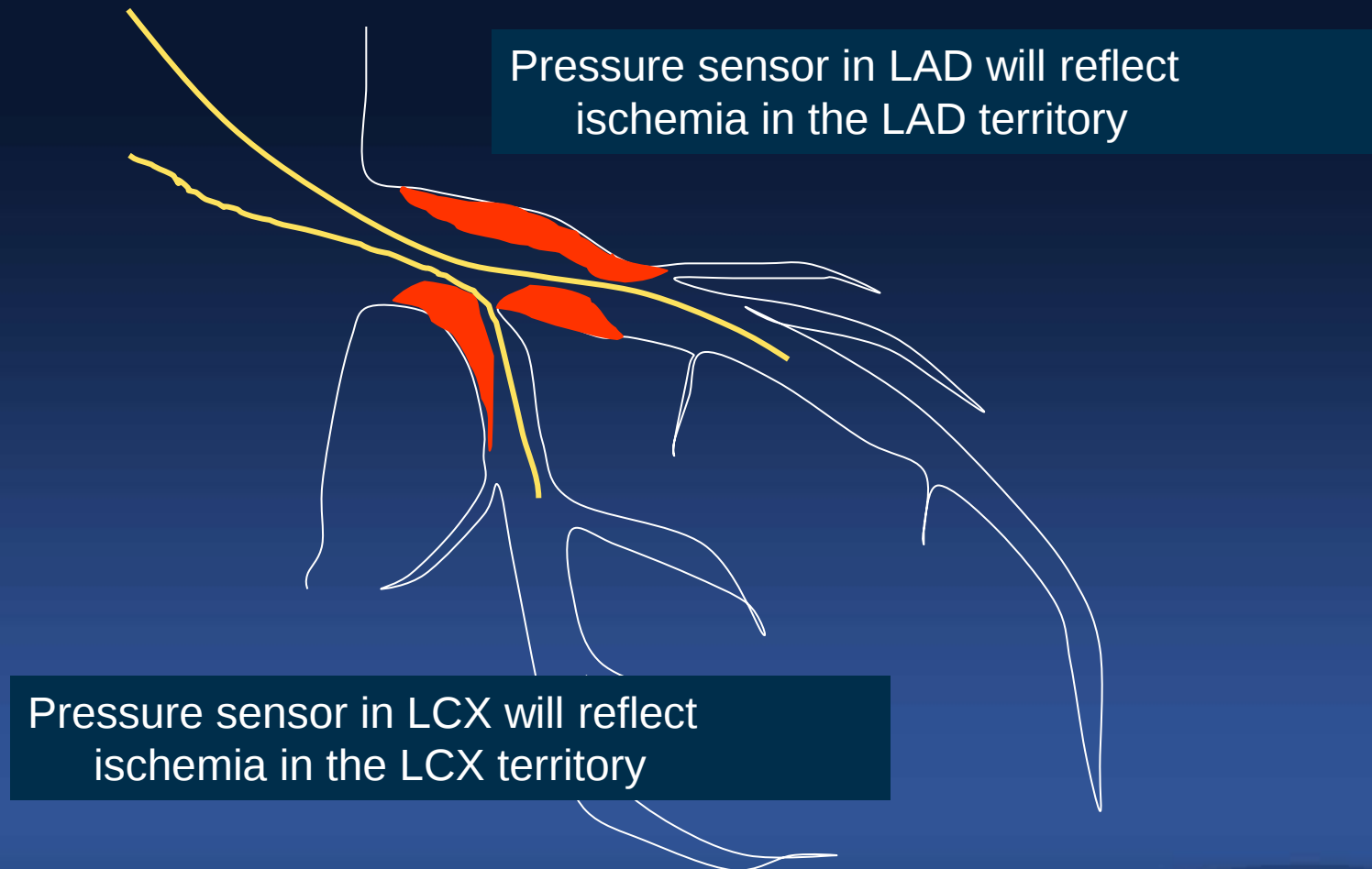
# For the Undetermined, Intermediate **Ostial and Shaft** LM Lesion,

**Theoretically, LAD FFR = LCX FFR**



# For the Intermediate **LM Bifurcation** Lesion,

**LAD FFR = or  $\neq$  LCX FFR**



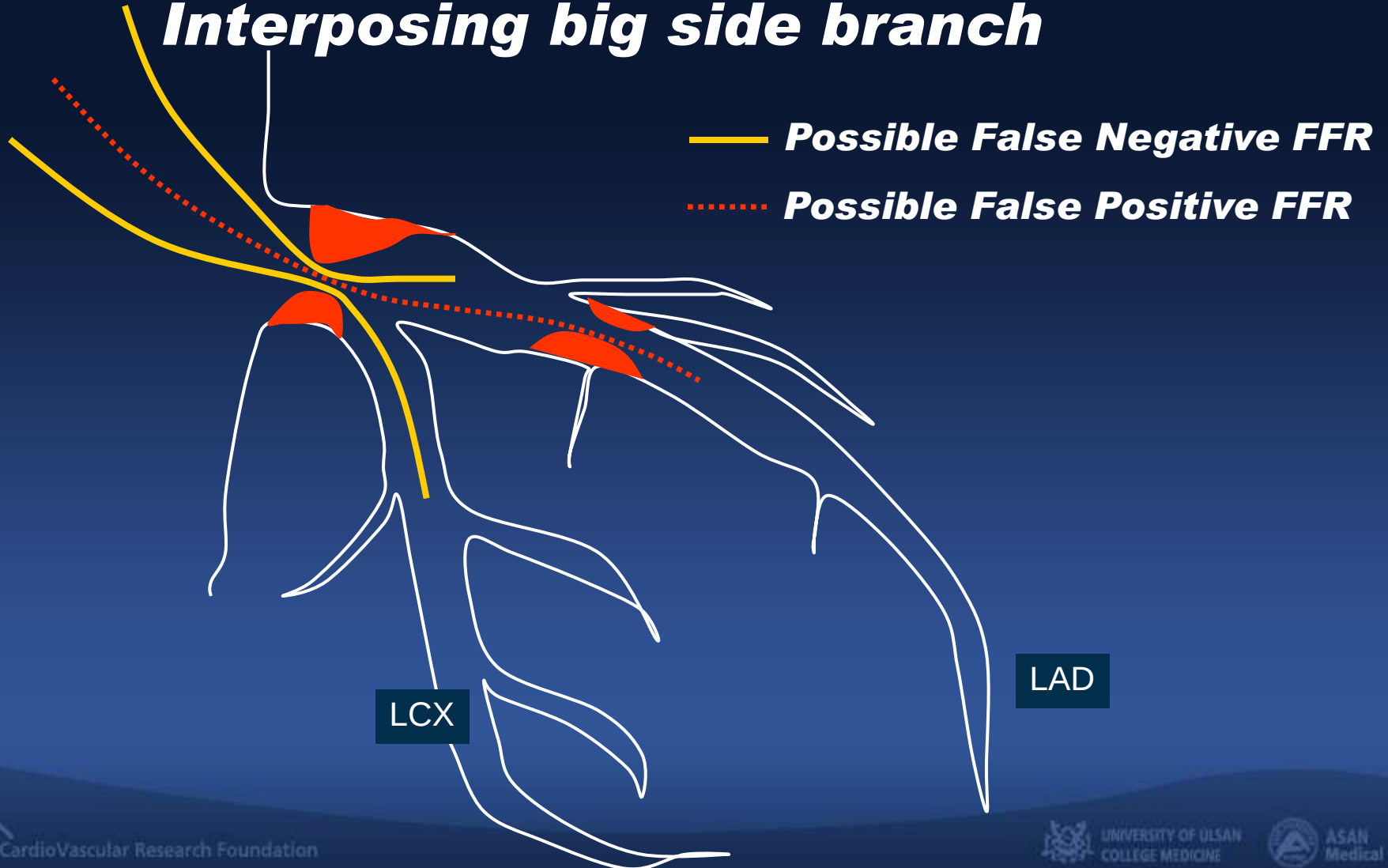
For the Intermediate **LM Bifurcation Lesion**,  
**Main Concern is to Determine**  
Single Stent Cross Over or 2 Stents Technique.



**We Can Not Treat Separately**

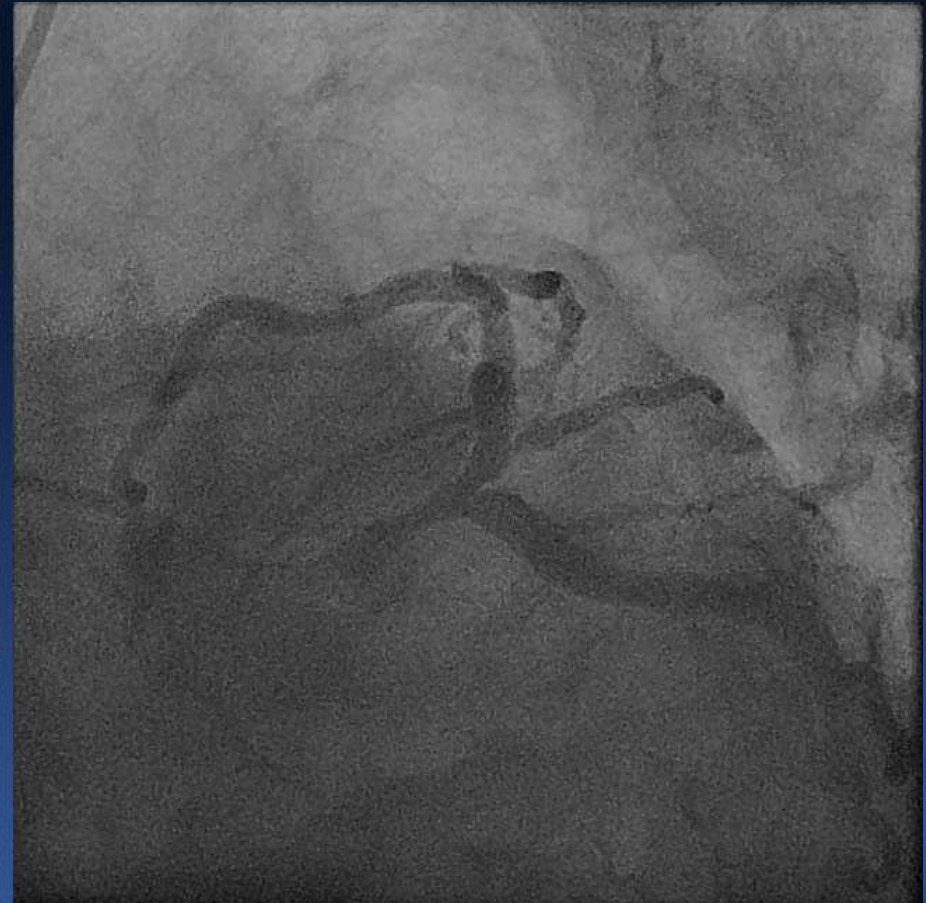
# For LMCA stenosis with distal LAD/LCX stenosis

## ***Tandem Lesions with Interposing big side branch***

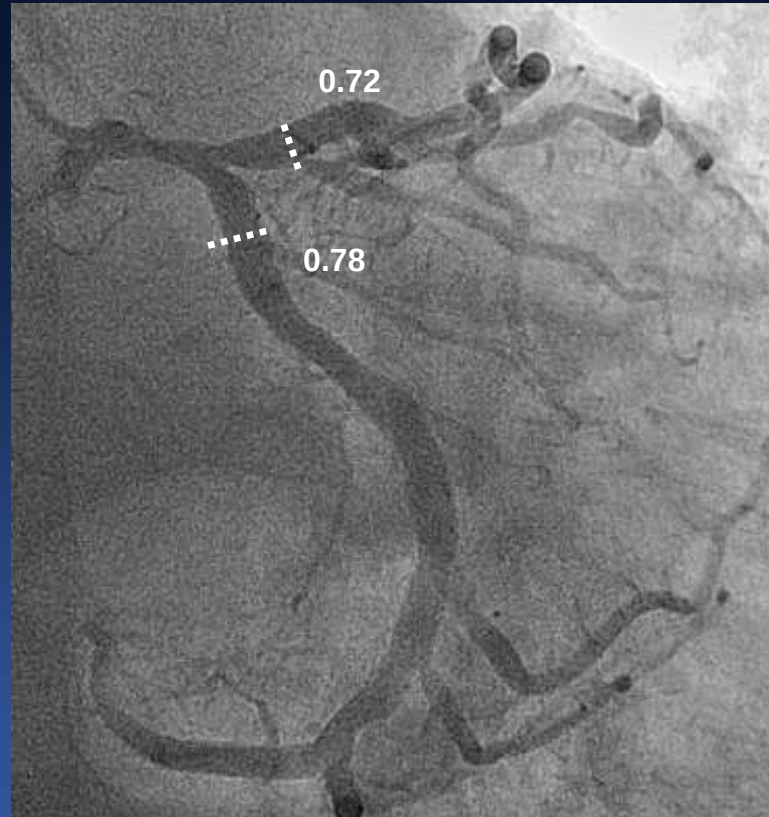


# LM Bifurcation Lesion (Medina 1,0,0) with Minimal LCX Disease

55/M, Stable angina,

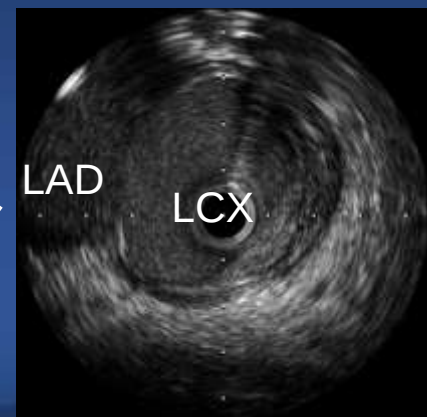
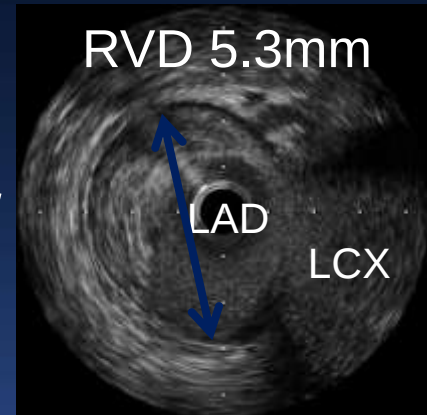
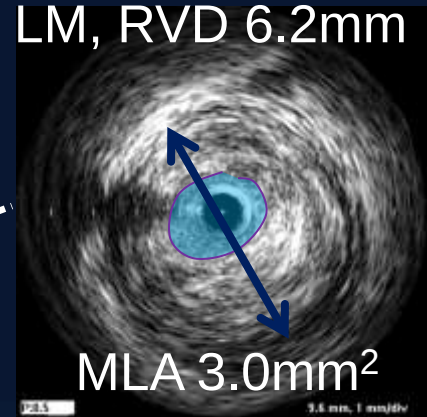
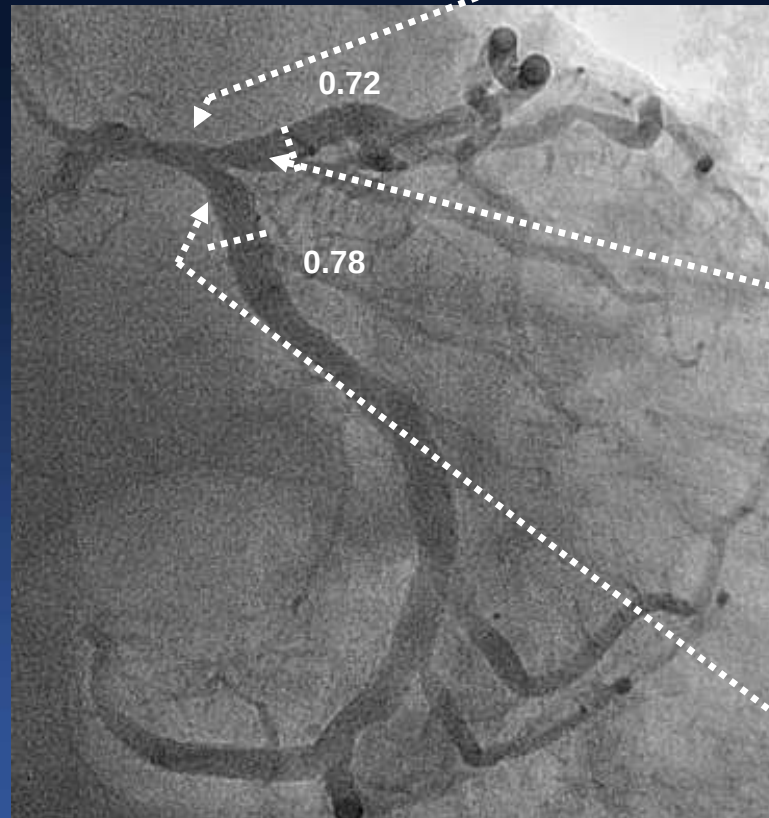


# FFR in Both LAD and LCX,



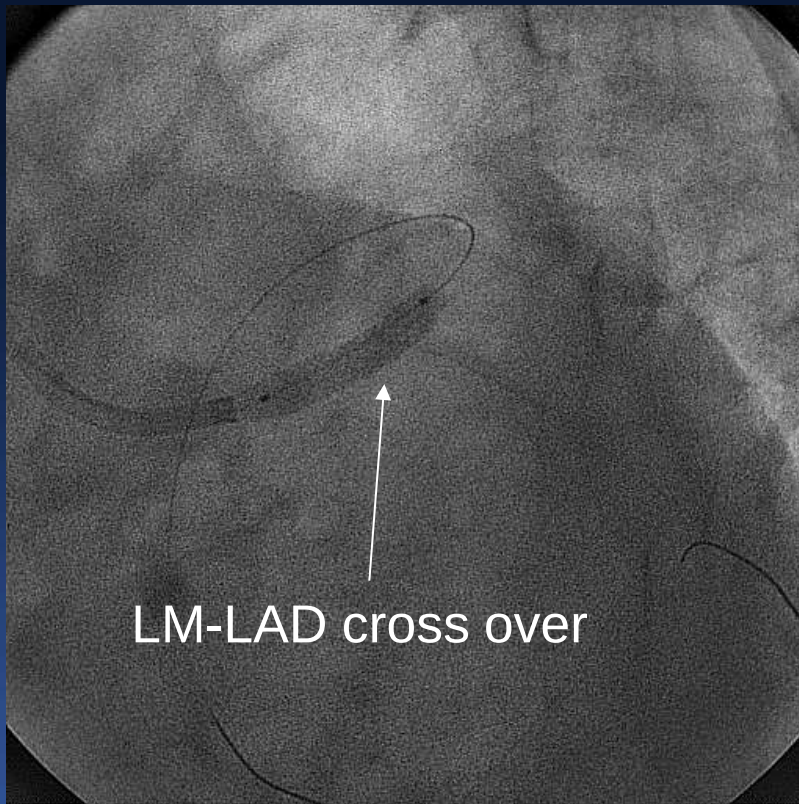
# IVUS in Both LAD and LCX,

Distal LM, RVD 6.2mm

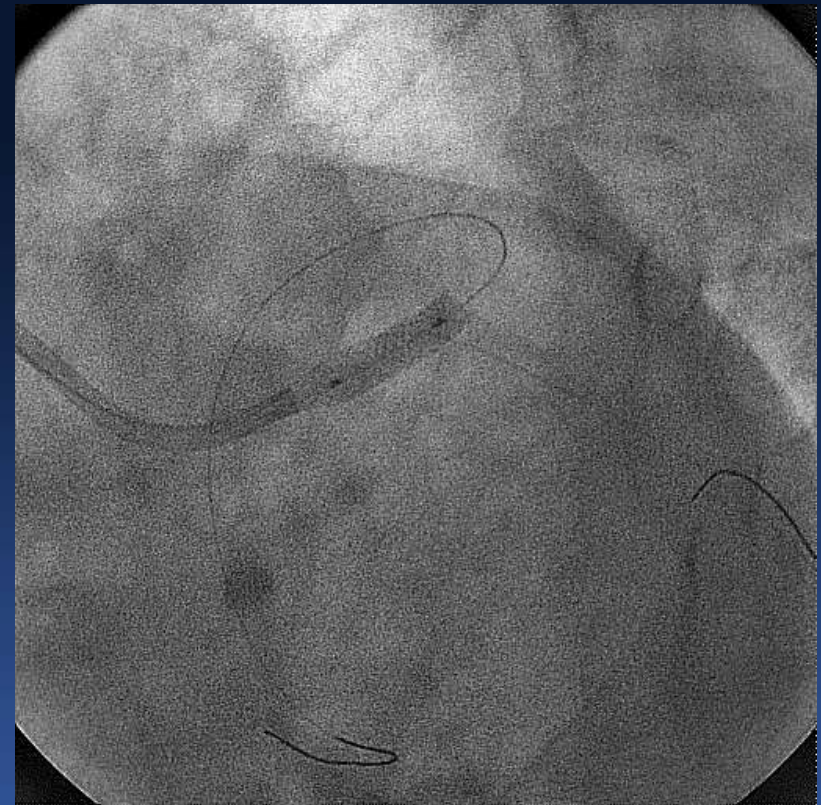


Minimal disease at LCX ostium

# 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***

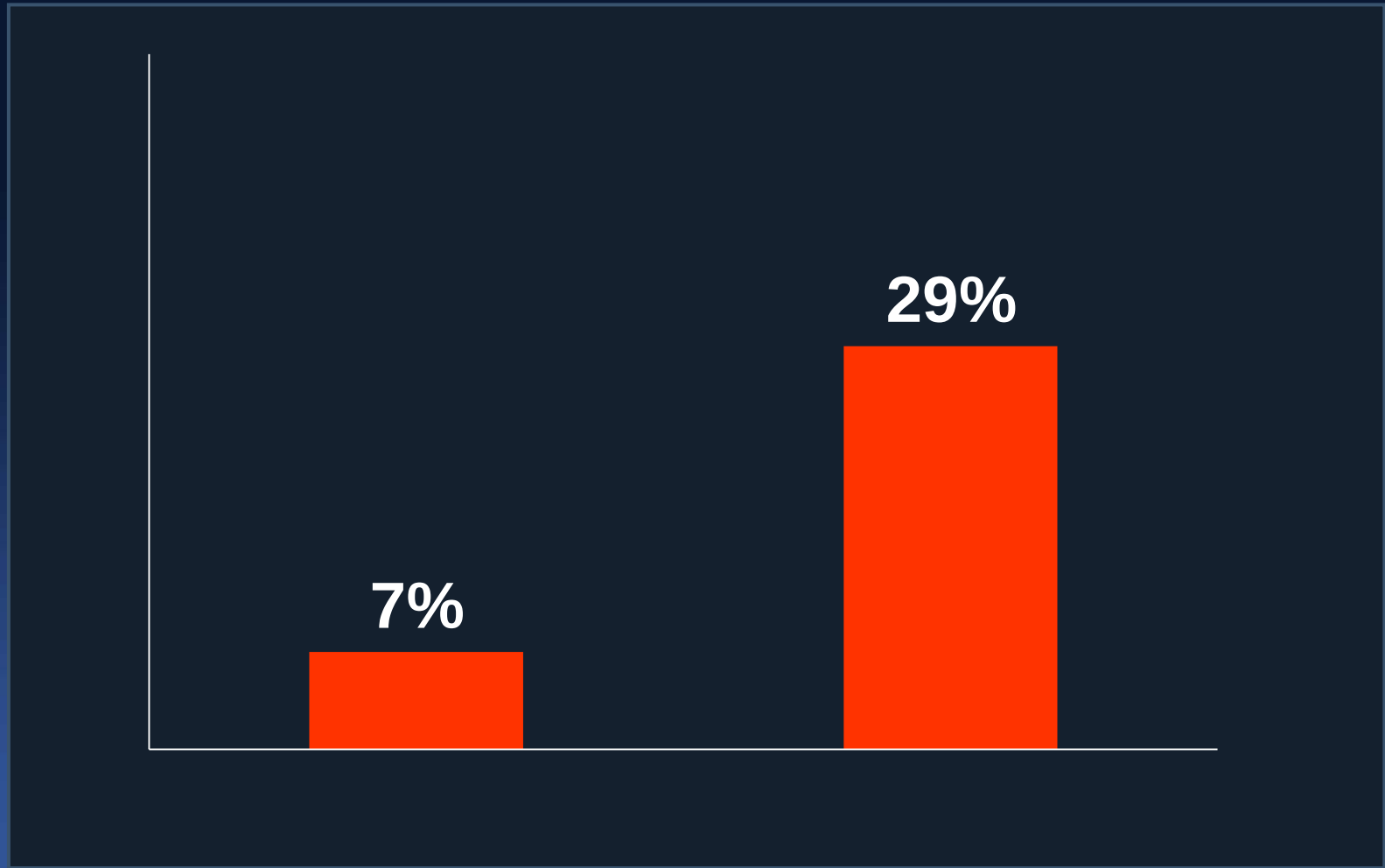


# Consider FFR, First !

## FFR is 0.92



# LCX FFR after Cross-Over Stenting



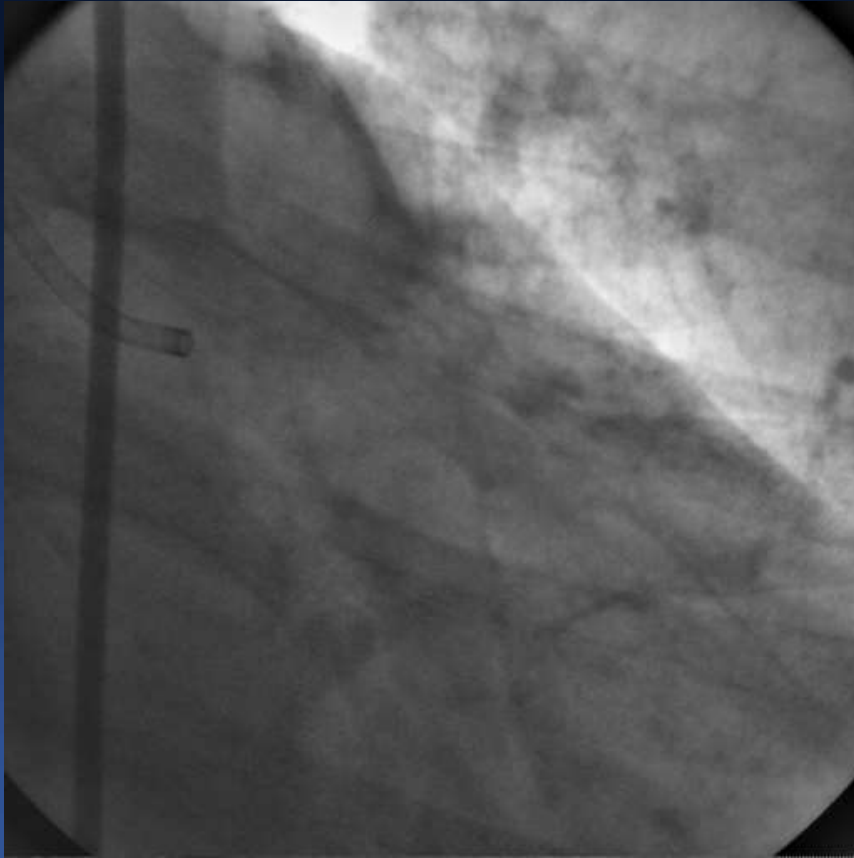
Kang et al. Catheter Cardiovasc Interv. 2014;83(4):545-52

Nam et al, Korean Circ J 2011;41(6):304-7

# Why We Need IVUS in LM Disease?

- **Decision in Treatment Strategy**
- **Detection of Procedure Complication: Safety**
- **Long-Term Outcome: Efficacy**
- **Prediction of Functional Severity**

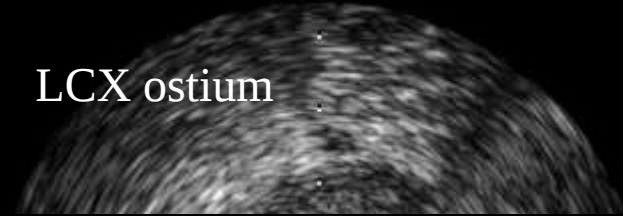
# LM shaft stenosis with minimal disease of LCX



# LCX Ostium is OK: Simple Cross-Over



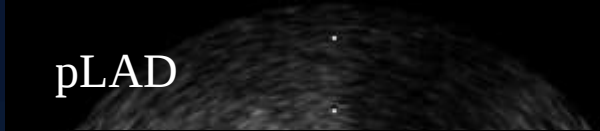
LCX ostium



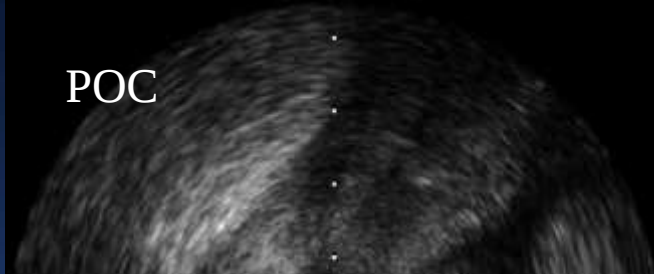
pLAD Reference Vessel



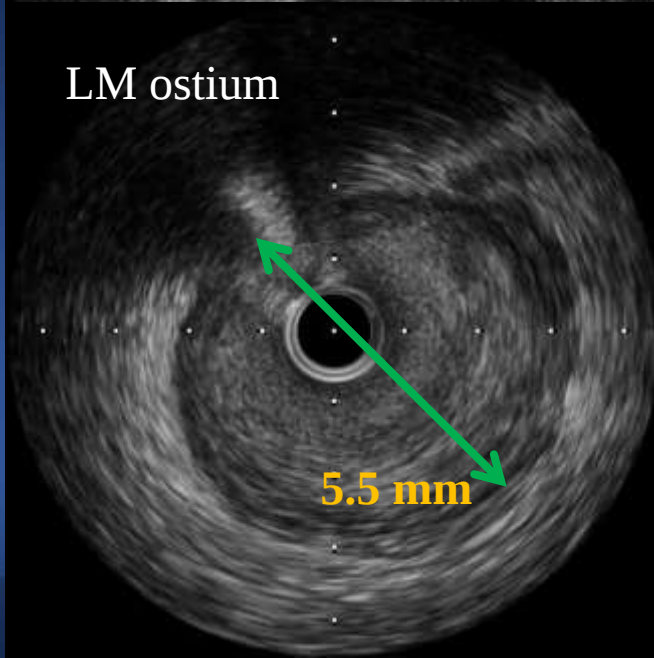
pLAD



POC

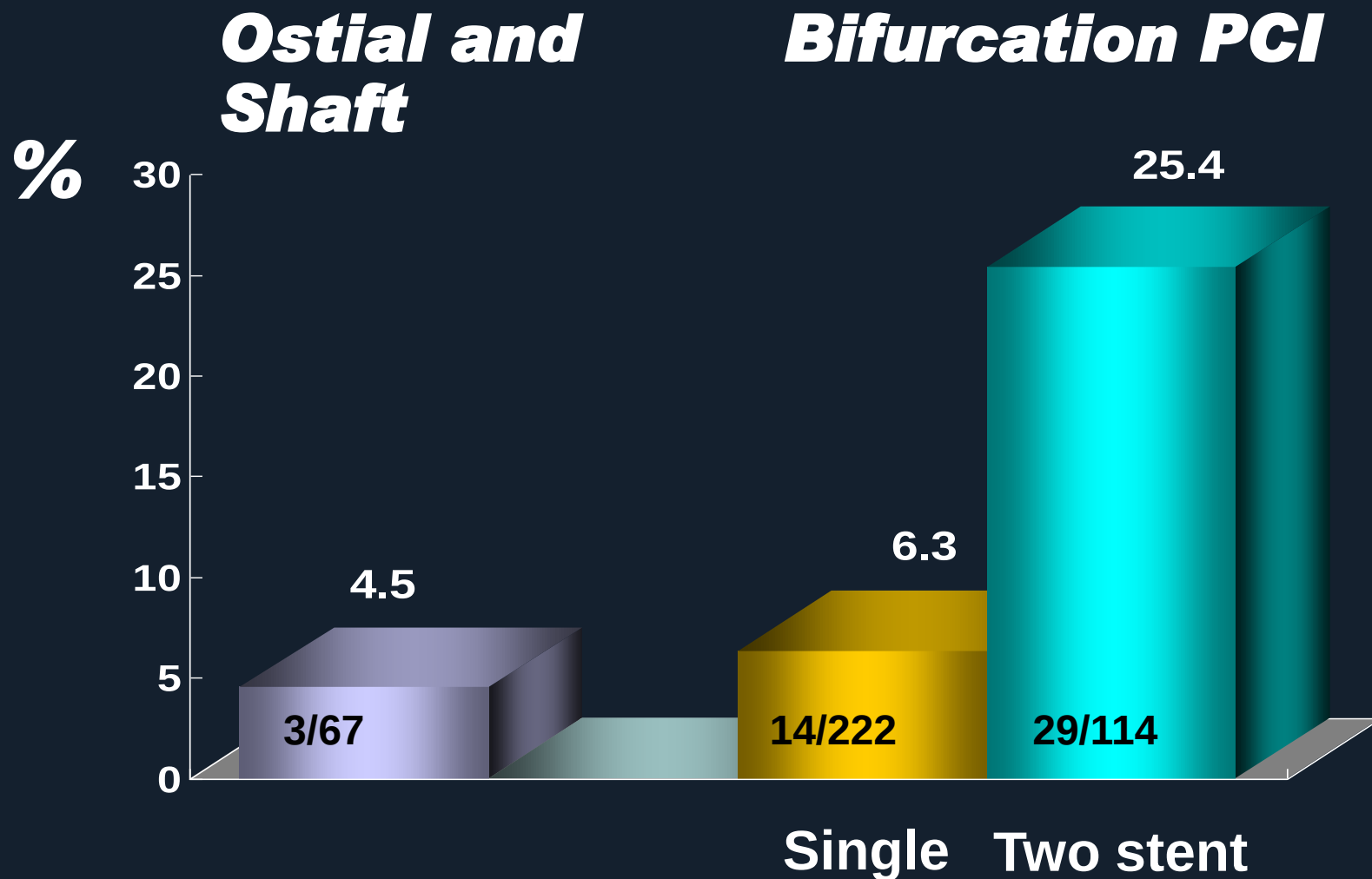


LM ostium

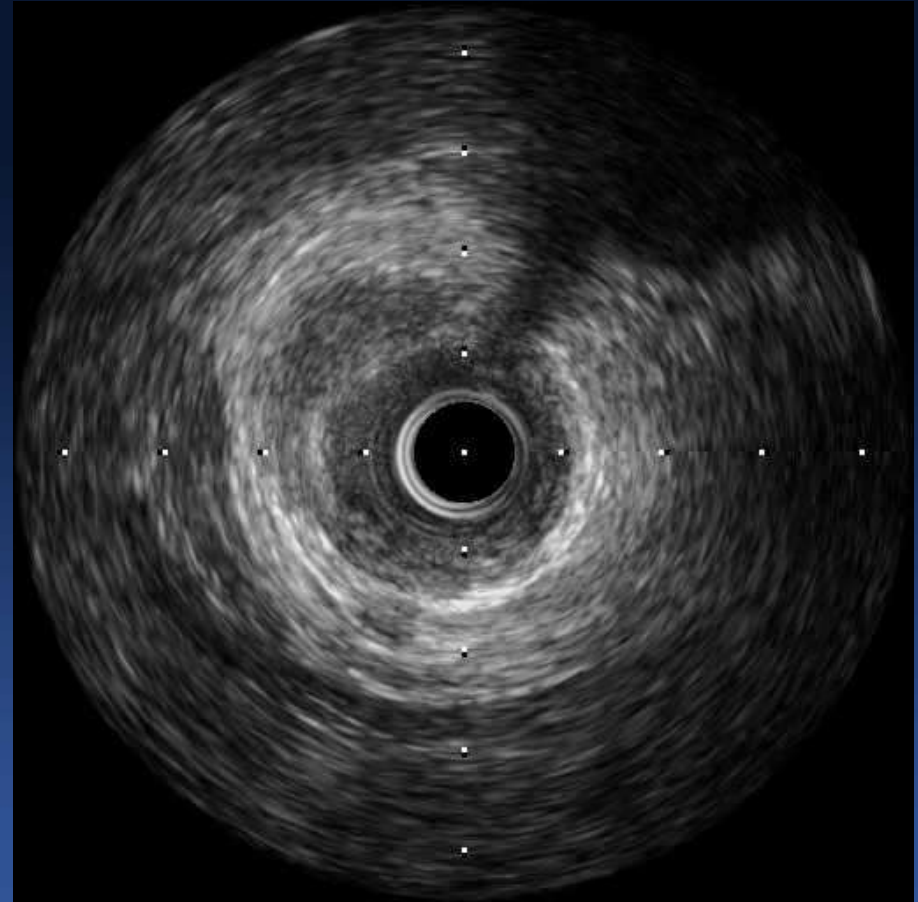
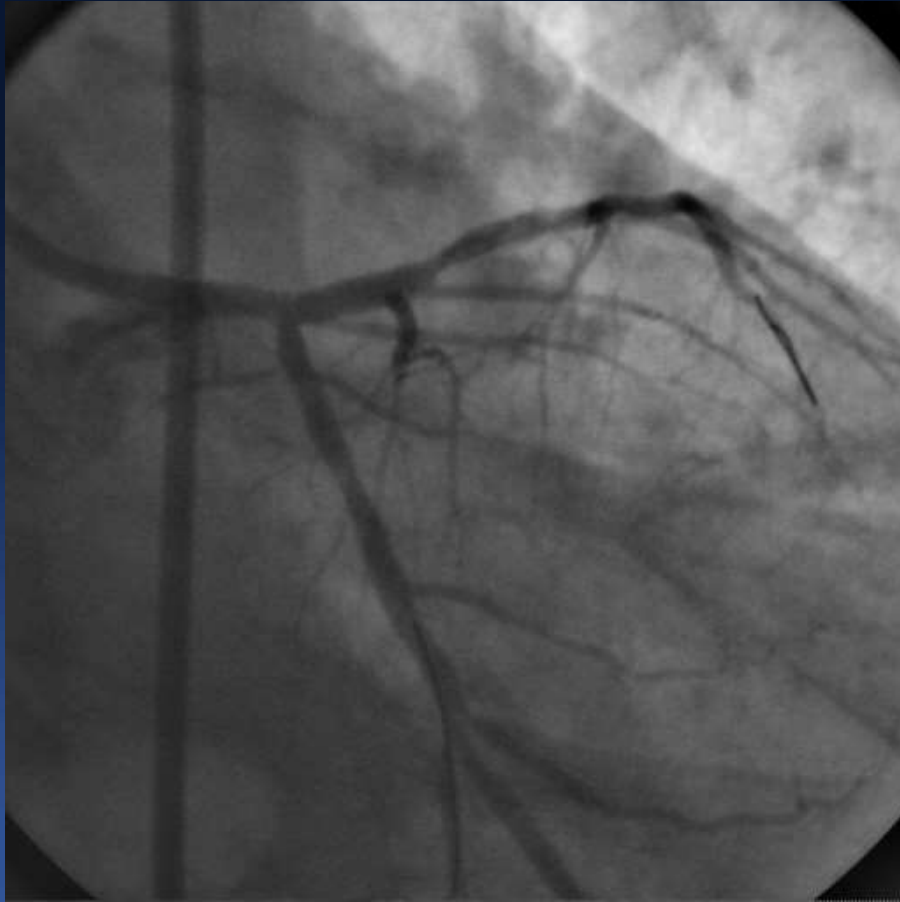


# ***Restenosis at 2 year***

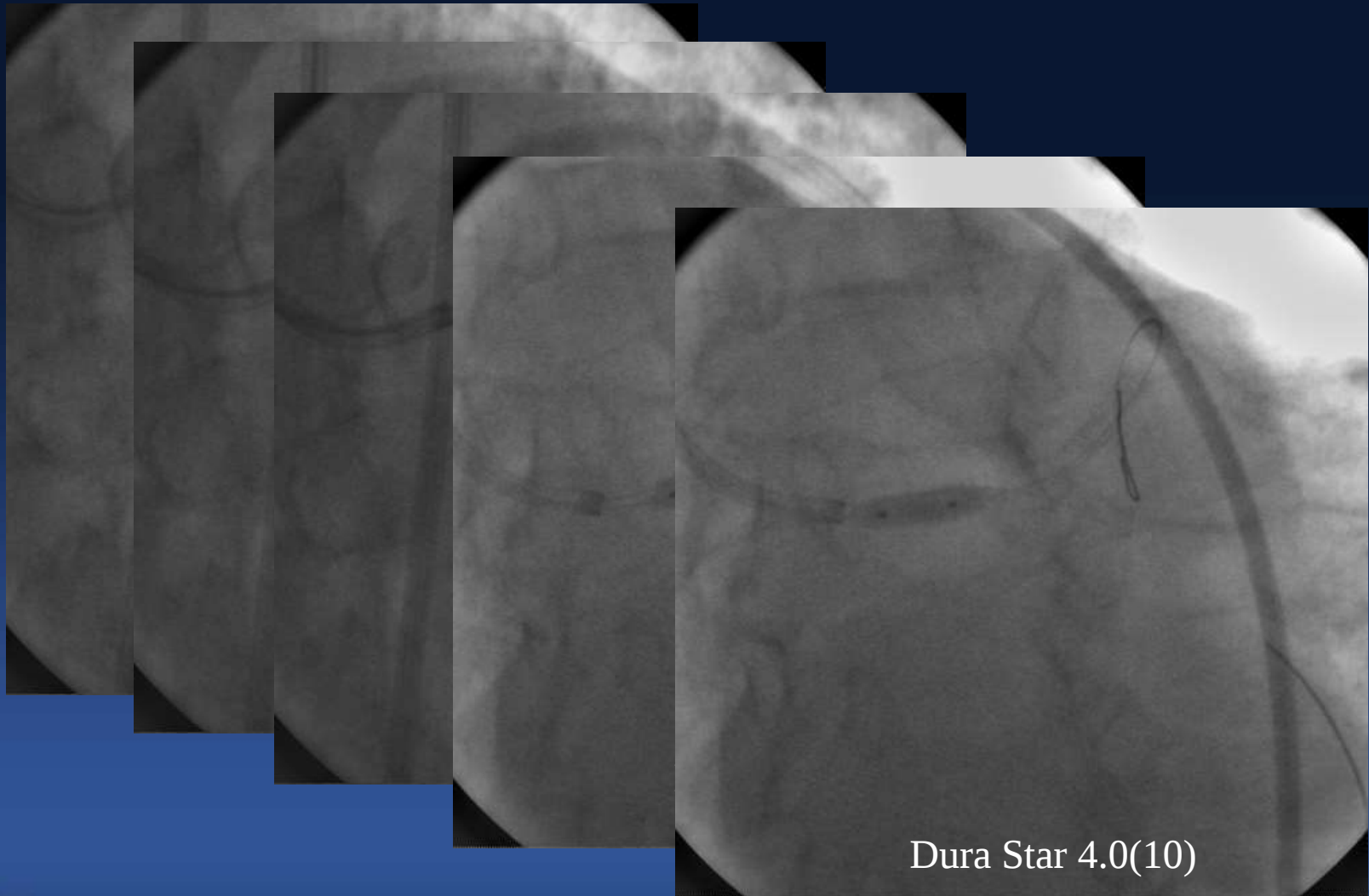
Pooled Analysis in 403 Patients with LM PCI Using SES



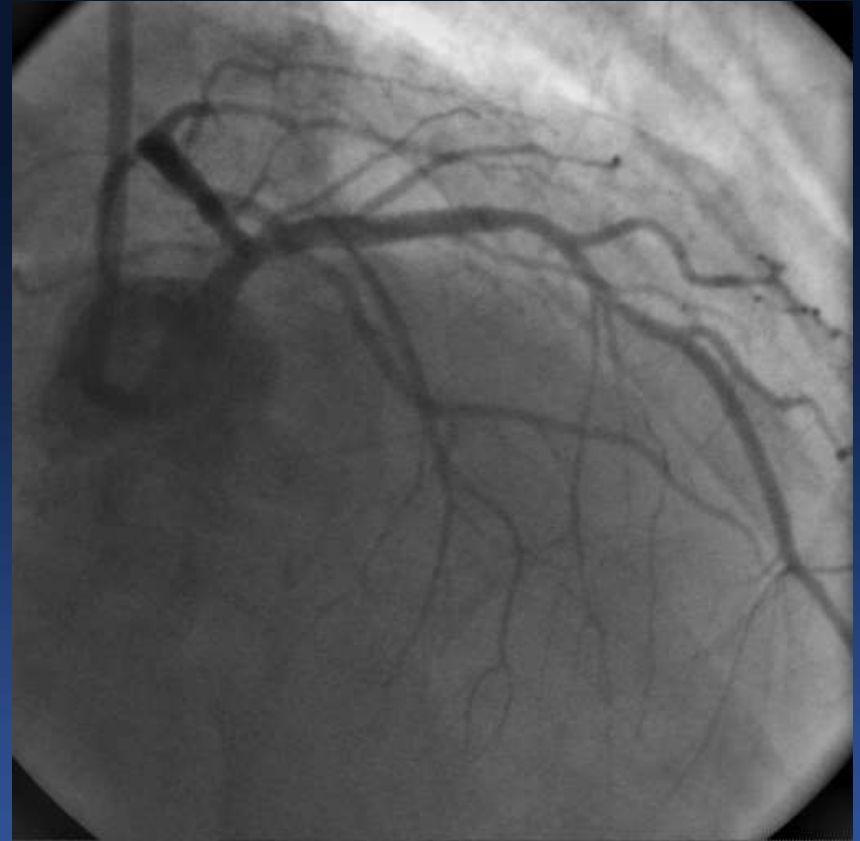
# Post Stenting



# Xience Prime 3.0(12)

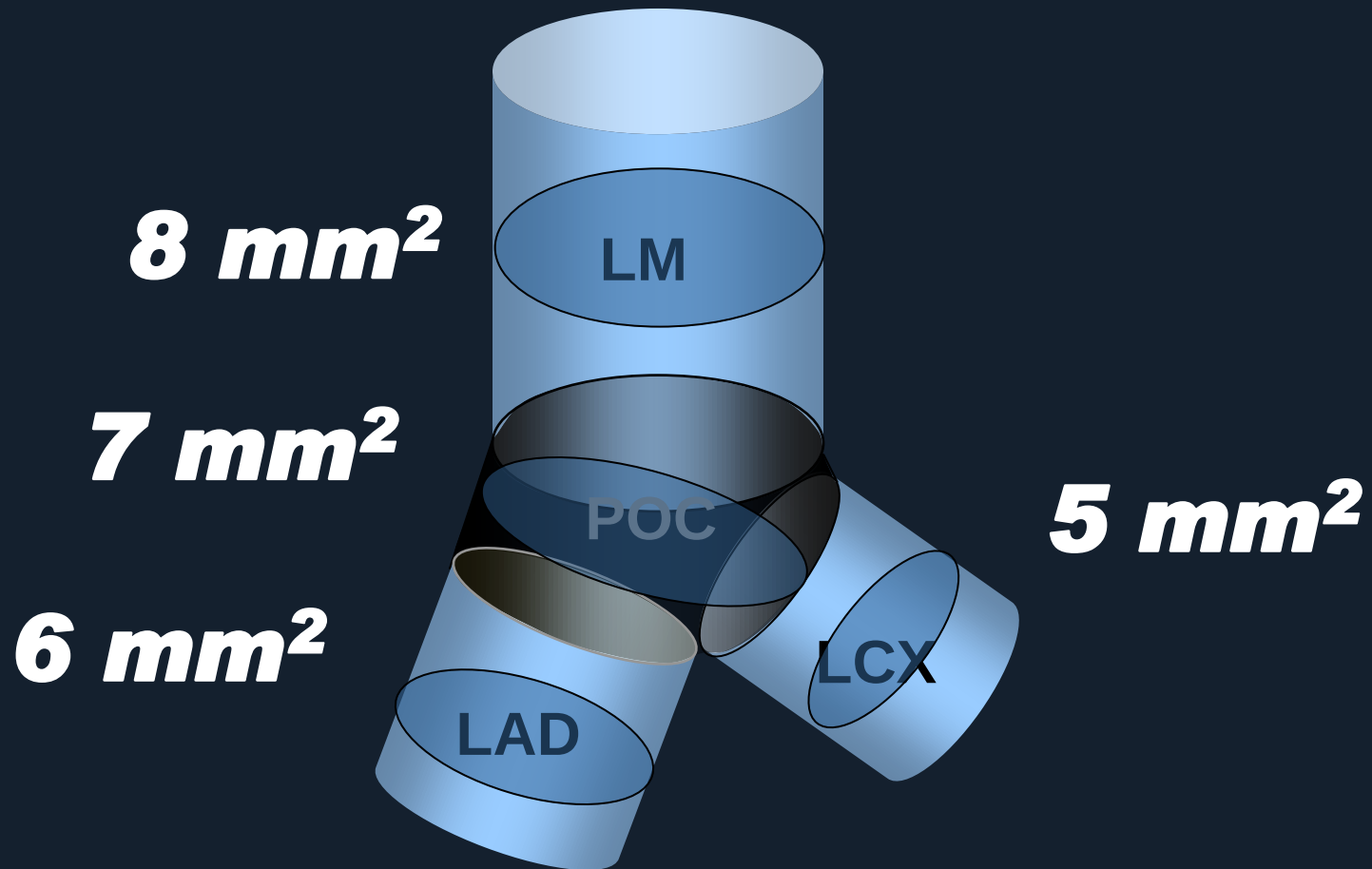


# Final Angiography

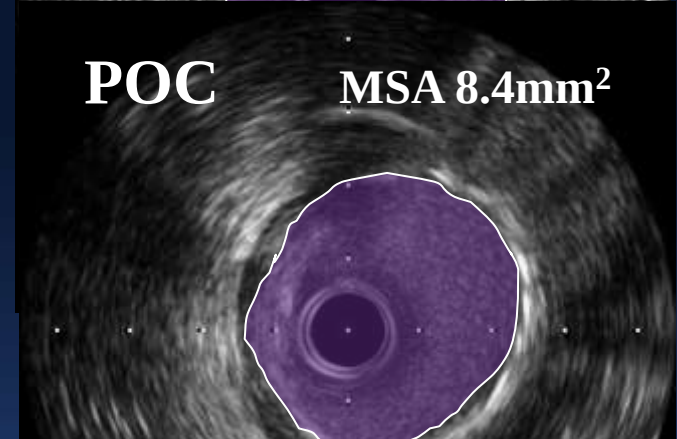
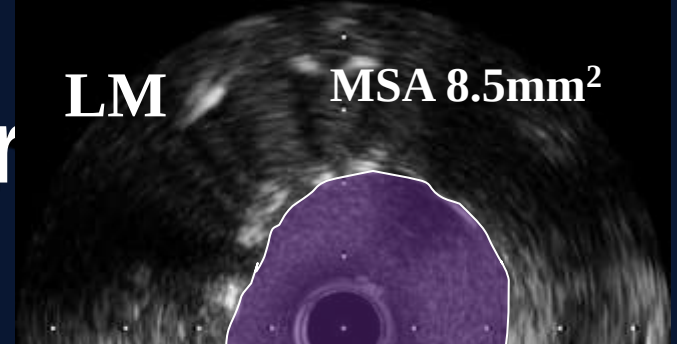
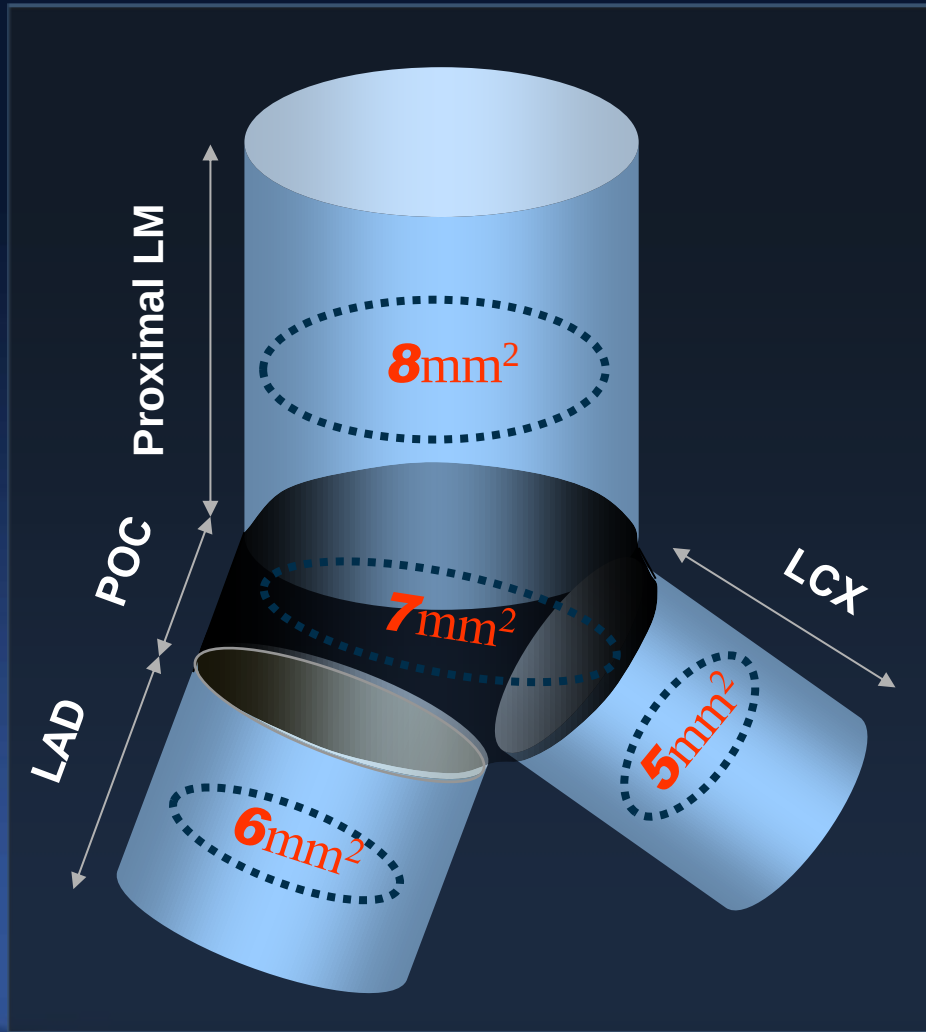


# IVUS Stent Area to Reduce Restenosis (*Rule of 5,6,7,8*)

***TLR at 2 Years < 2%***

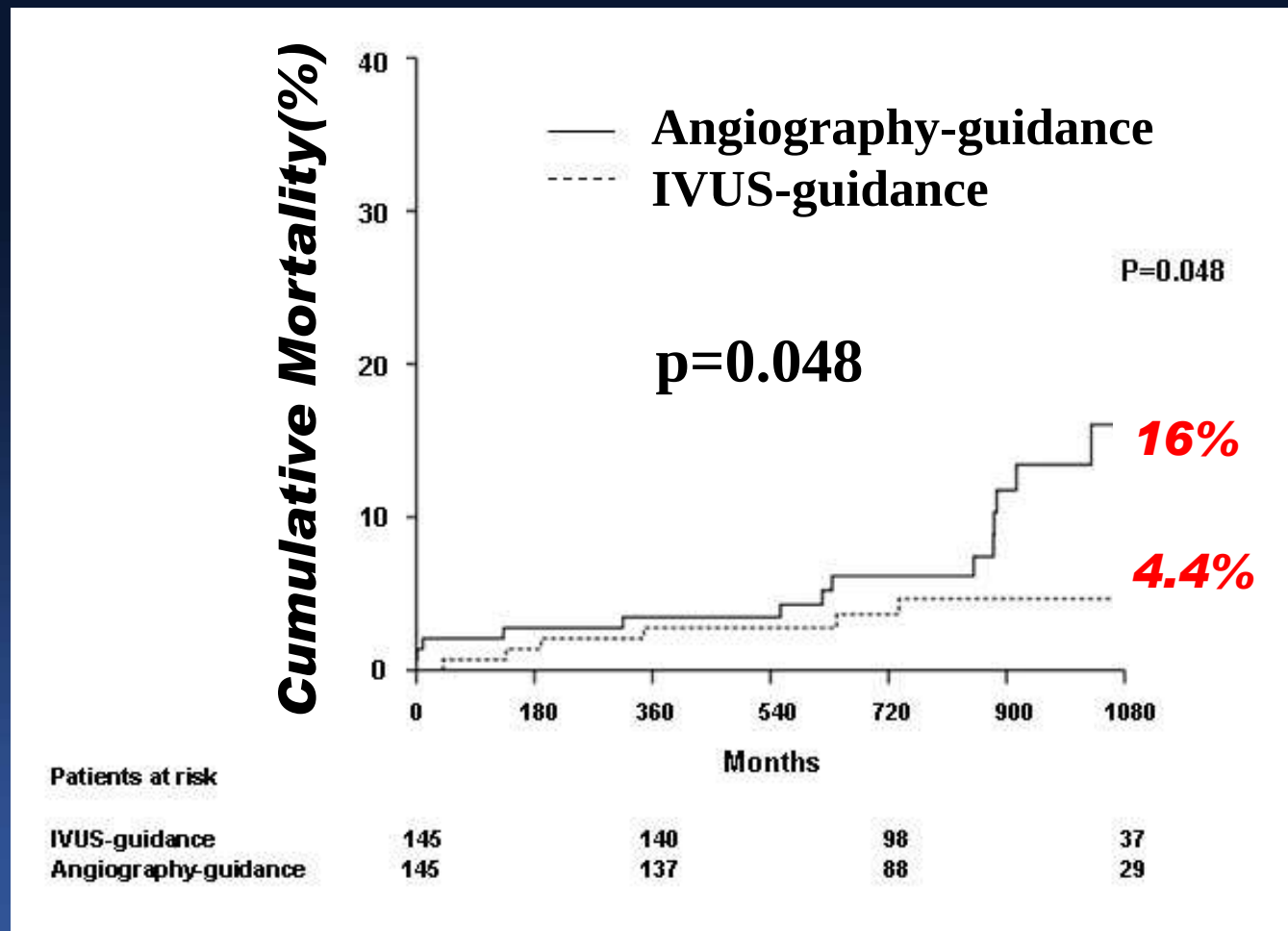


# IVUS Criteria



Park SJ et al. JACC Cardiovasc Interv 2011;4:1168-1174.

# IVUS-Guidance Saves Lives in LM PCI



*Park SJ et al Circ Cardiovasc Interv 2009;2:167-77*

# Why We Need IVUS in LM Disease?

## IVUS-Guidance Saves Lives in LM PCI

- **Decision in Treatment Strategy**

Based on LCX IVUS finding: One vs Two stent

- **Detection of Procedure Complication: Safety**

- **Long-Term Outcome: Efficacy**

According to the IVUS MLA criteria: 5,6,7,8

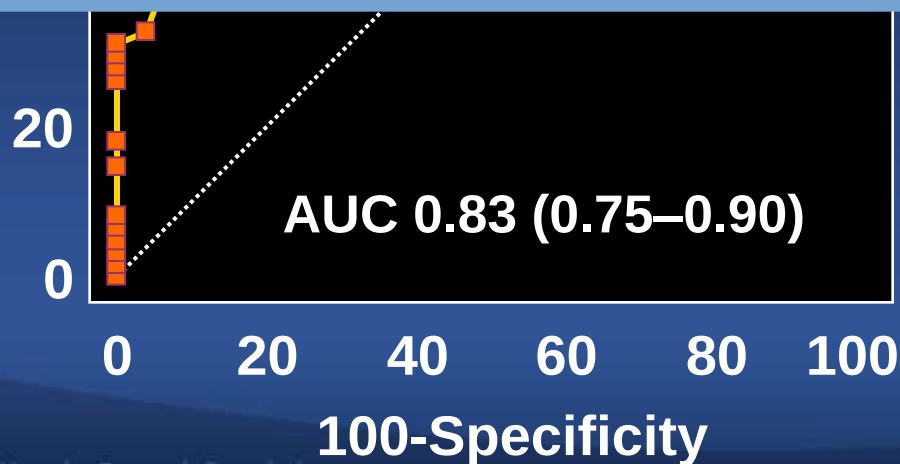
# New LM IVUS MLA

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



Cut-off = 4.5 mm<sup>2</sup>

Smaller LM IVUS MLA of 4.5 mm<sup>2</sup> Can Predict  
Functional Significance of Stenosis (PPV 83%).



|          |     |
|----------|-----|
| PPV      | 83% |
| NPV      | 76% |
| Accuracy | 80% |

# Summary

1. LM Disease has the greatest angiographic variability. Angiographic assessment is **Not Always Enough**. Direct FFR should be measured when the ischemic potential was not defined.
2. FFR Guided Decision Making Can Avoid Unnecessary PCI (Unnecessary LCX Treatment).
3. IVUS Guided Stent Optimization Can Maximize Clinical Outcomes and Minimize Adverse Complications.
4. FFR and IVUS are Very Complementary for the Good Clinical Outcomes.