

Left Main PCI

Integrated Use of IVUS and FFR

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Efficacy of Left Main PCI

Major Studies

PCI vs CABG in Left Main Disease

- MAIN-COMPARE Registry, 3 year F/U
- SYNTAX RCT, subgroup LM, 4 year F/U
- MAIN-COMPARE Registry, 5 year F/U
- PRECOMBAT RCT, 2 year F/U
- META-ANAYLSIS of 4 RCTs

Seung KB, Park DW, Park SJ, NEJM 2008;358:1781-92
Parick W.Serruys, et al. TCT 2011 presentation
Park DW, et al. JACC 2010;56:117-24
Park SJ et al, NEJM 2011; May 5;364(18):1718-27
Capodanno D etal, JACC 2011;58;1426-1432

PCI vs. CABG for Left Main Disease

1-Year Outcomes

No Difference in Death or MI
TVR is Higher in PCI group.
Stroke is Higher in CABG group.

			(0.54-1.78)	
Stroke	0.1%	1.7%	0.15 (0.03-0.67)	0.013
TVR	11.4%	5.4%	2.25 (1.54-3.29)	< 0.001

Joint 2010 ESC-EACTS Guidelines for unprotected LMCA PCI

Subset of CAD by anatomy	CABG	PCI
Left Main (Isolated or 1 VD, ostium/shaft)	IA	Ila, B
Left Main (Isolated or 1 VD, distal bifurcation)	IA	Ilb, B
Left Main + 2VD or 3 VD, SYNTAX score ≤ 32	IA	Ilb, B
Left Main + 2VD or 3 VD, SYNTAX score ≥ 33	IA	III, B

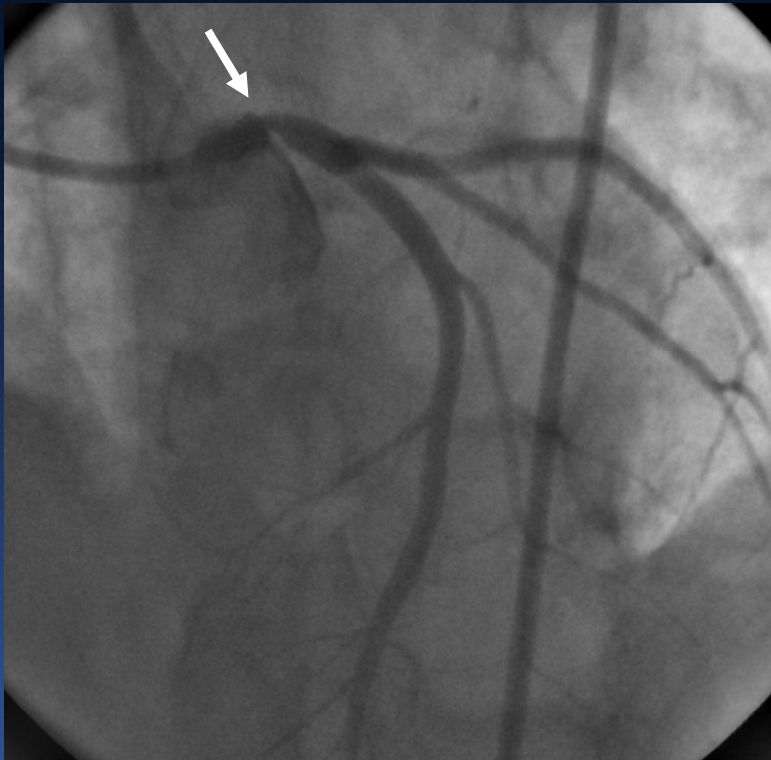
Current Issue is,

How To Do ?

Functional Angioplasty ;
Integrated Use of IVUS and FFR

Is Angiography Enough for Diagnosis of Clinical Ischemia ?

Visual Functional Mismatch



Visual : **80%**

IVUS MLA : **6.2mm²**

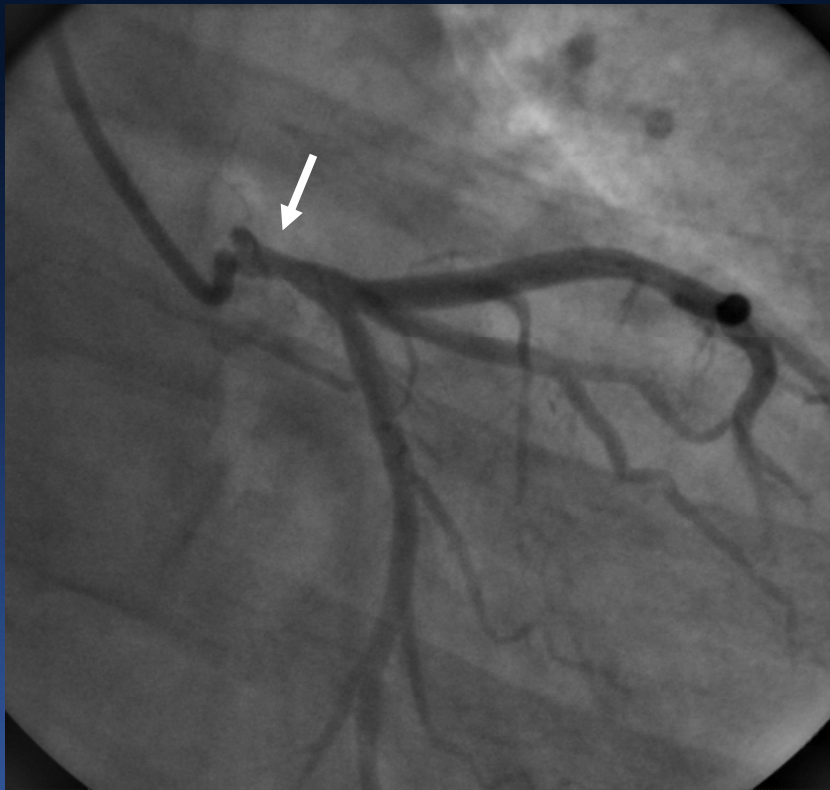
FFR : 0.82

Treadmill test : Negative

Thallium spect : Normal

Stress Echo : Negative

Reverse Mismatch



Visual Estimation : 30%

FFR : 0.70

IVUS MLA: 4.5 mm²

Treadmill test: + stage 2

Thallium spect : + large
LAD

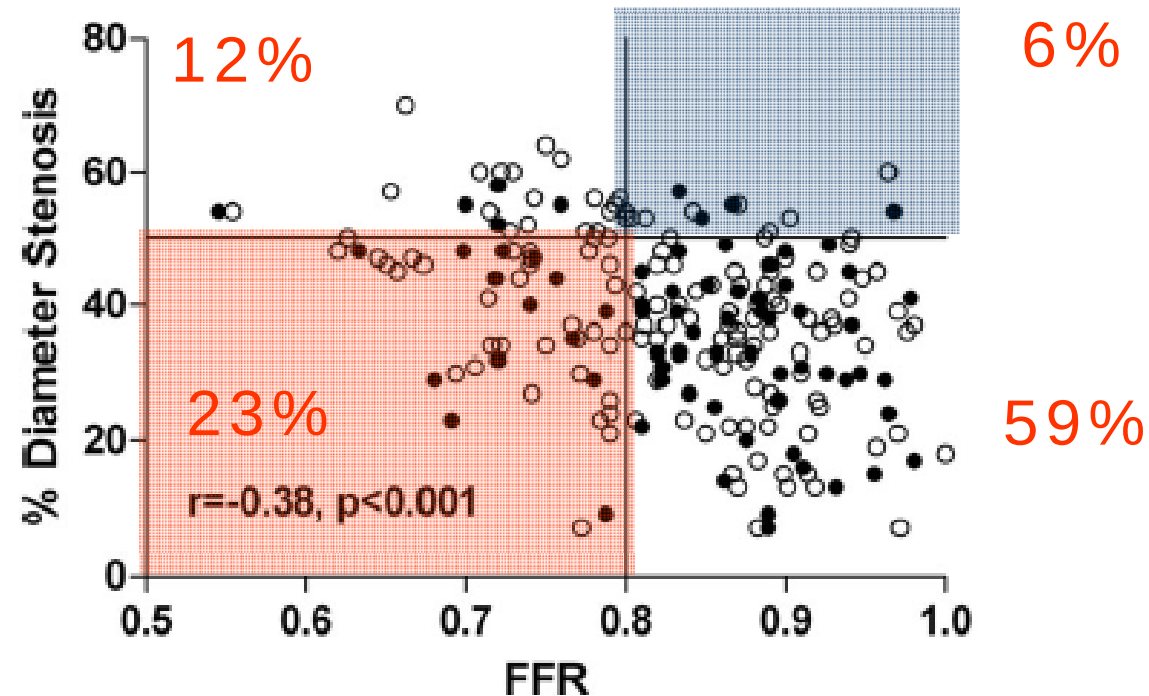
Mismatches ;
Significant Stenosis (>50%)
with Negative FFR

Reverse Mismatches ;
Insignificant Stenosis (<50%)
with Positive FFR

How Many Mismatches ?

Mismatch

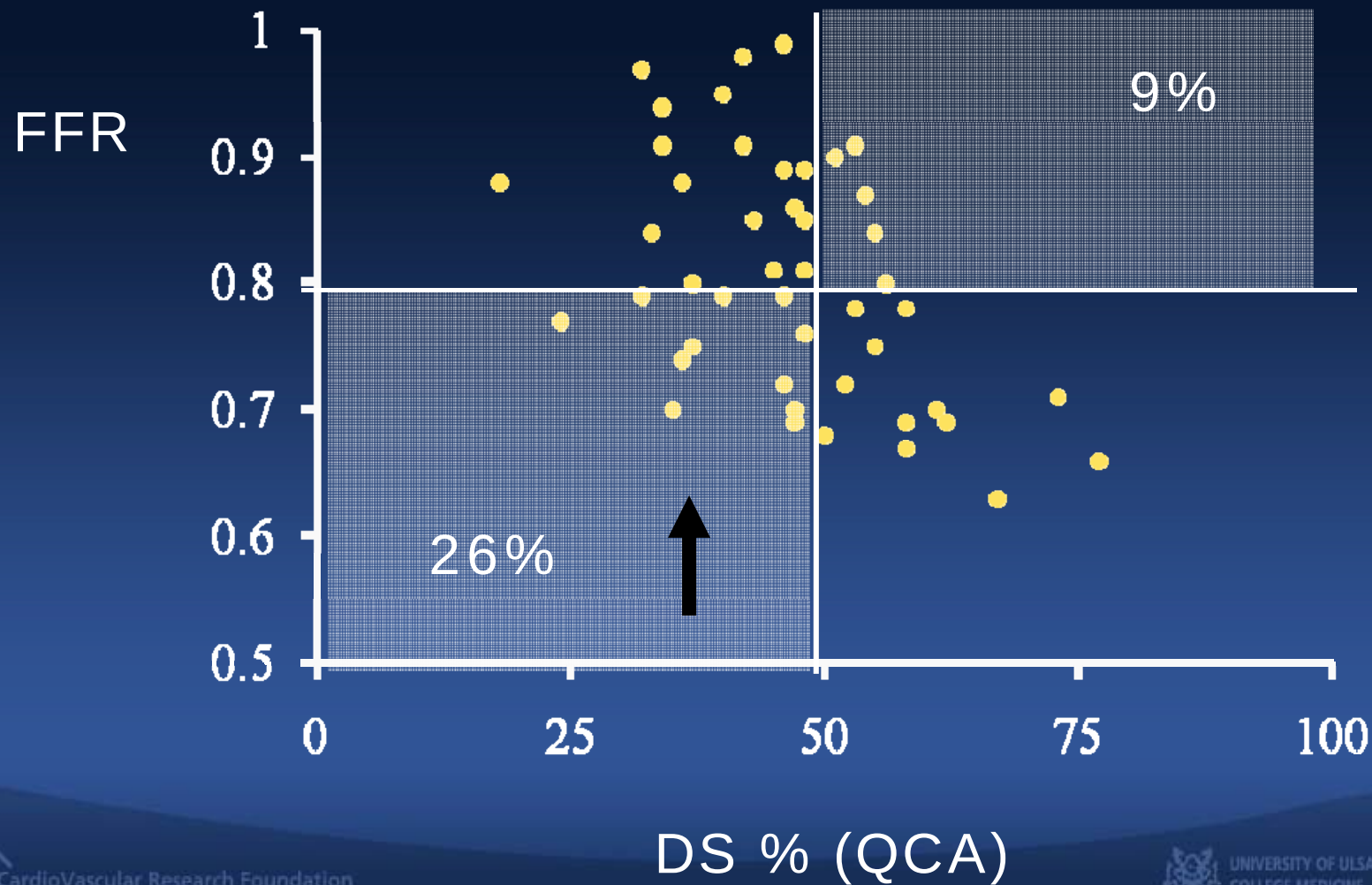
in intermediate LM Disease



Hamilos M, Circulation 2009; 120: 1505-1512

Mismatch

in Isolated intermediate LM Disease (n=55)



Why Relatively Higher Reverse Mismatches in LM disease?

LM supplied Large Myocardium

DS=50%



FFR=0.70

Large Myocardium

DS=85%



FFR=0.90

**Acute Injury and/or
Chronic Scar**

Small Myocardium

Univariable Analysis to Predict FFR <0.8

Variables	C-OR	95%CI	p-value
MLA within LM	0.312	0.164-0.593	<0.001
Plaque burden	1.095	1.031-1.164	0.003
Lesion length	1.192	1.038-1.368	0.013
Rupture	3.273	0.953-11.243	0.060
Angiographic DS	1.049	0.993 – 1.108	0.088
Lesion location	2.081	1.070 – 4.046	0.031
Male	0.511	0.127-2.057	0.345
Age	0.965	0.917-1.016	0.172
Diabetes melitus	1.062	0.304-3.710	0.924
Hypertension	1.3	0.412-4.101	0.654
Smoker	2.701	0.816-0.8945	0.104
Hyperlipidemia	1.167	0.324-4.200	0.814
Stable presentation	0.476	0.078-2.894	0.42

Multivariable Analysis to Predict FFR

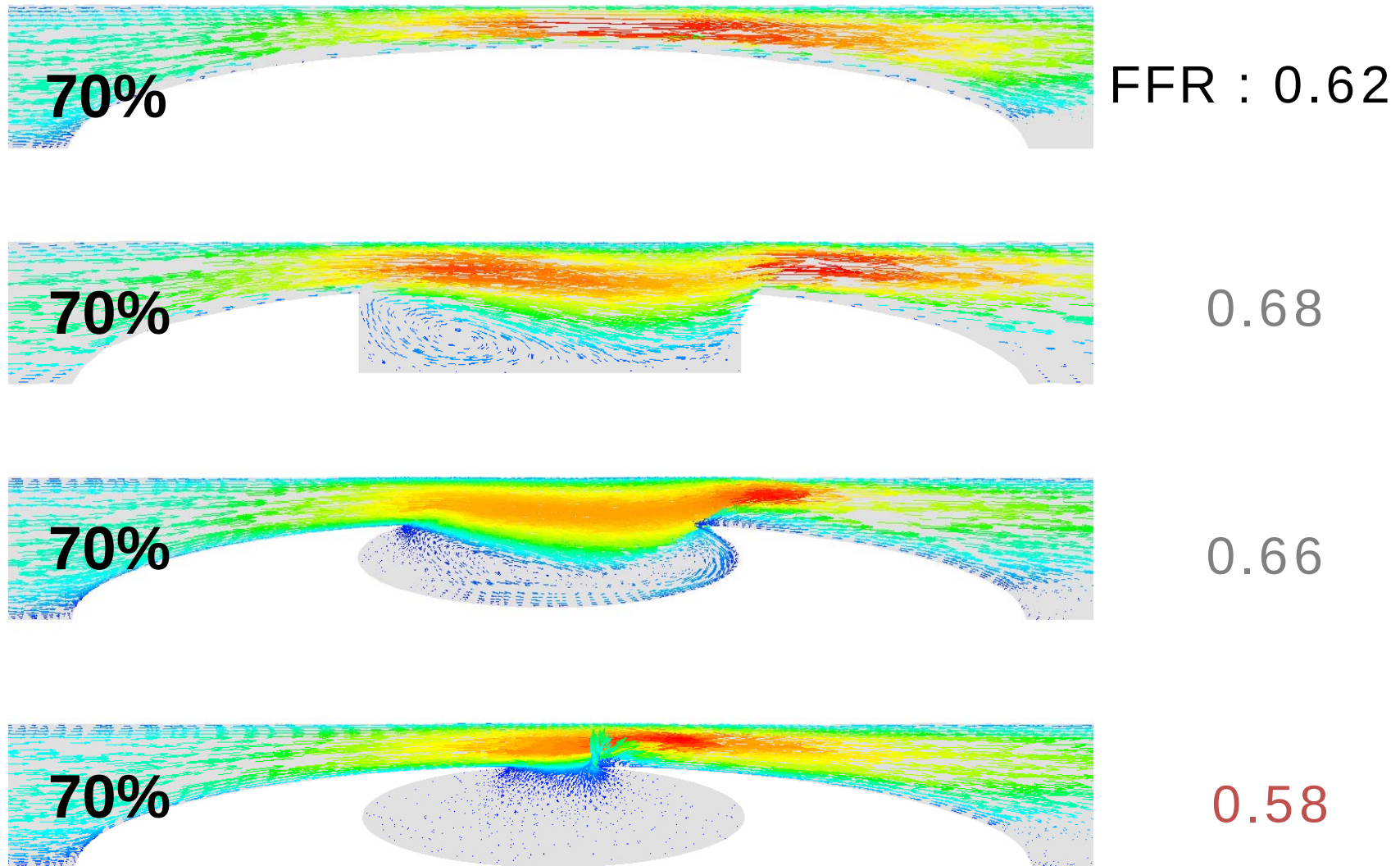
Independent predictors for FFR as continuous variable

MLA ($\beta=0.58$, 95% CI=0.02 - 0.04, $p<0.001$)

Plaque rupture ($\beta=-0.24$, 95%
CI= -0.09-0.01, $p=0.036$)

Kang SJ et al, JACC. Cardiovascular Interventions. 2011 Nov;4(11):1168-74.

Presence of Plaque Rupture



Steady-state 3D Computed Simulation under Hyperemic Condition, AMC data

FFR theory

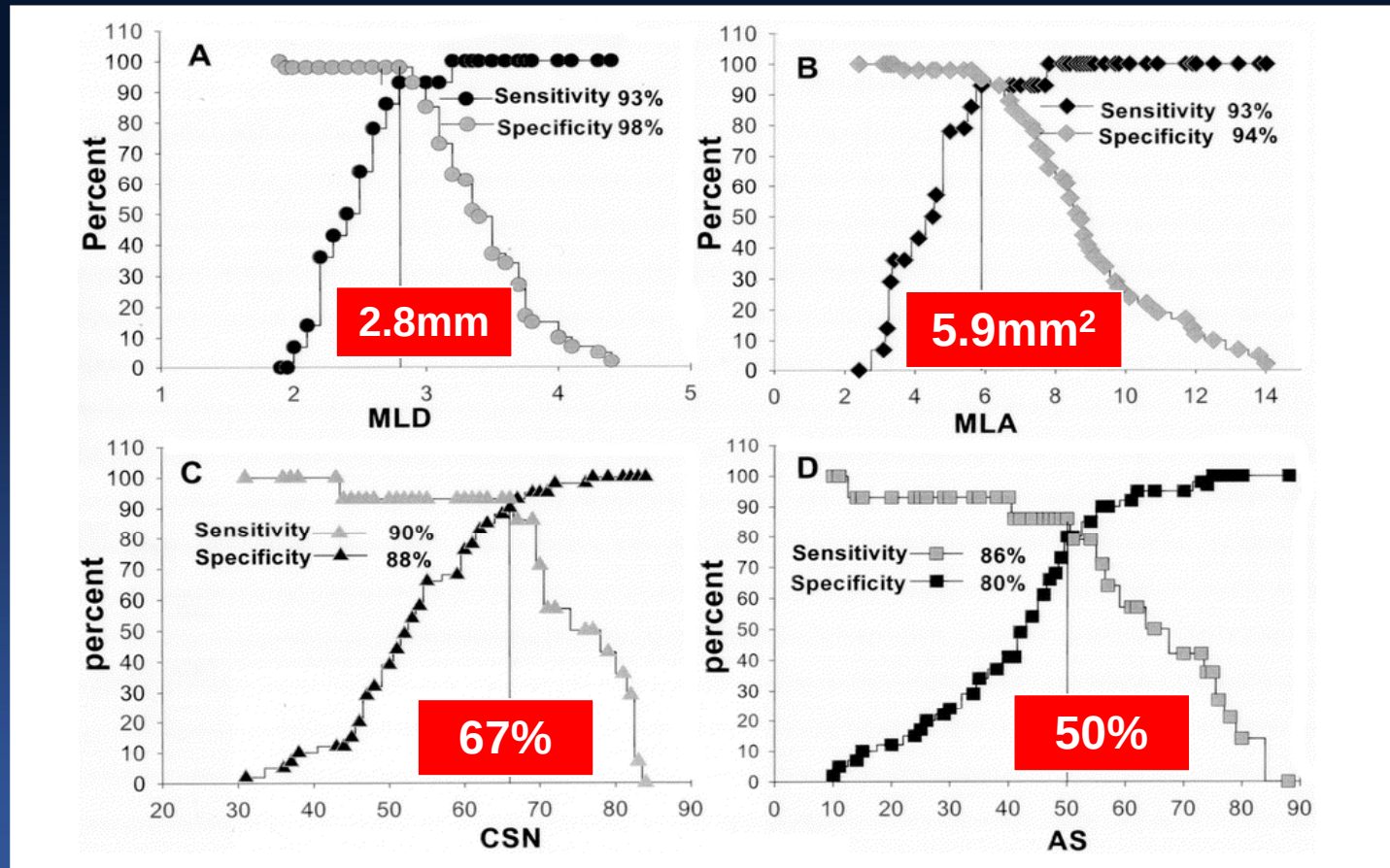
FFR is more **sensitive** and **integrated** summation of physiological and anatomical aspects (**total morphology**) of a stenosis rather than 2-dimensional angiographic diameter stenosis.

Why FFR ?

1. Angiography is not always enough !
2. FFR is **the only matched index** with objective ischemia even in the Left main disease.

IVUS MLA vs. FFR

IVUS MLA $< 6.0 \text{ mm}^2$ is matched with FFR < 0.75



New Comparison

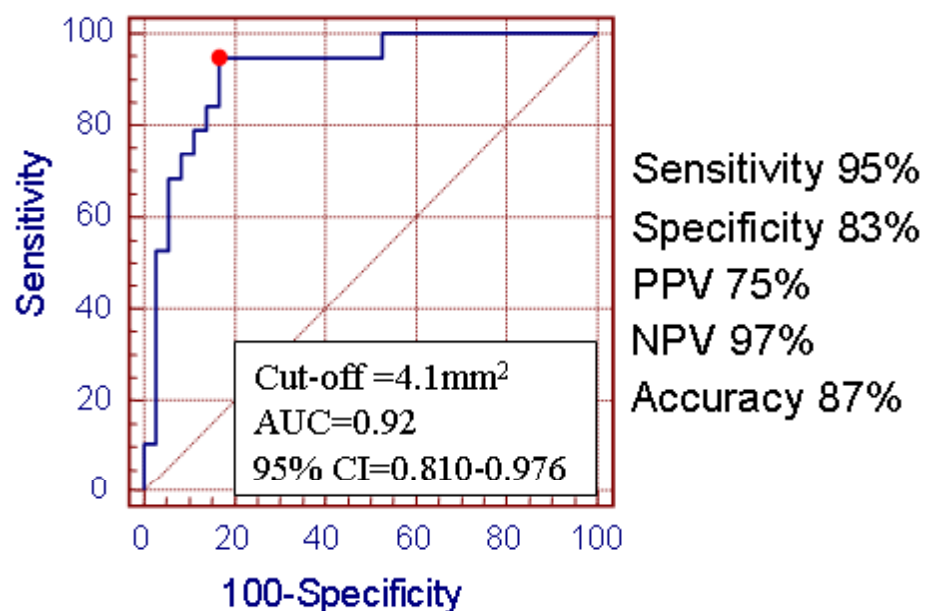
AMC prospective cohort registry
(n=55 lesions), 2011

FFR vs.
IVUS MLA

JACC Cardiovasc Interv, 2011 (in press)

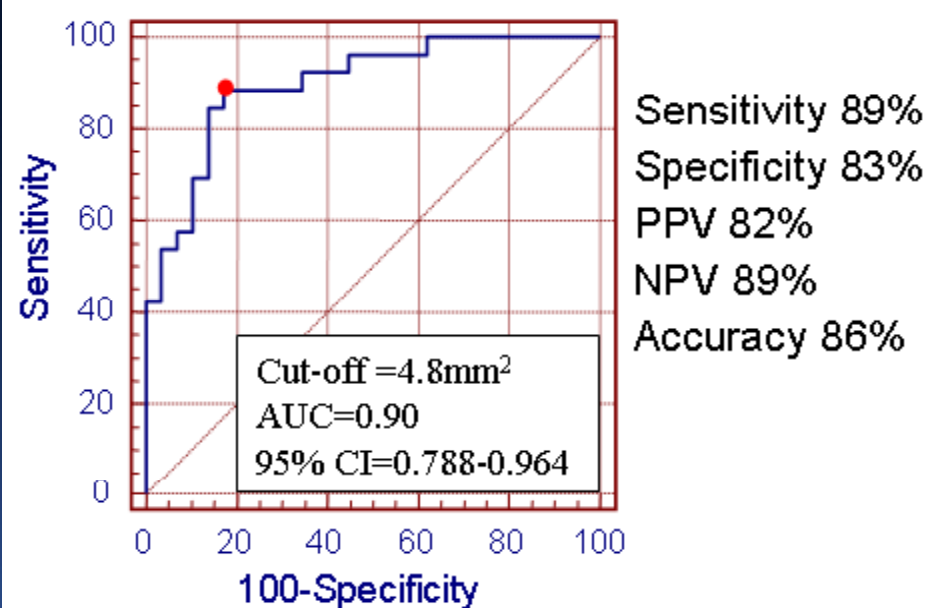
New IVUS MLA

C. MLA predicting FFR<0.75



4.1 mm²

A. MLA predicting FFR<0.80



4.8 mm²

Kang SJ, Park SJ et al, JACC. Cardiovascular Interventions. 2011 Nov;4(11):1168-74.

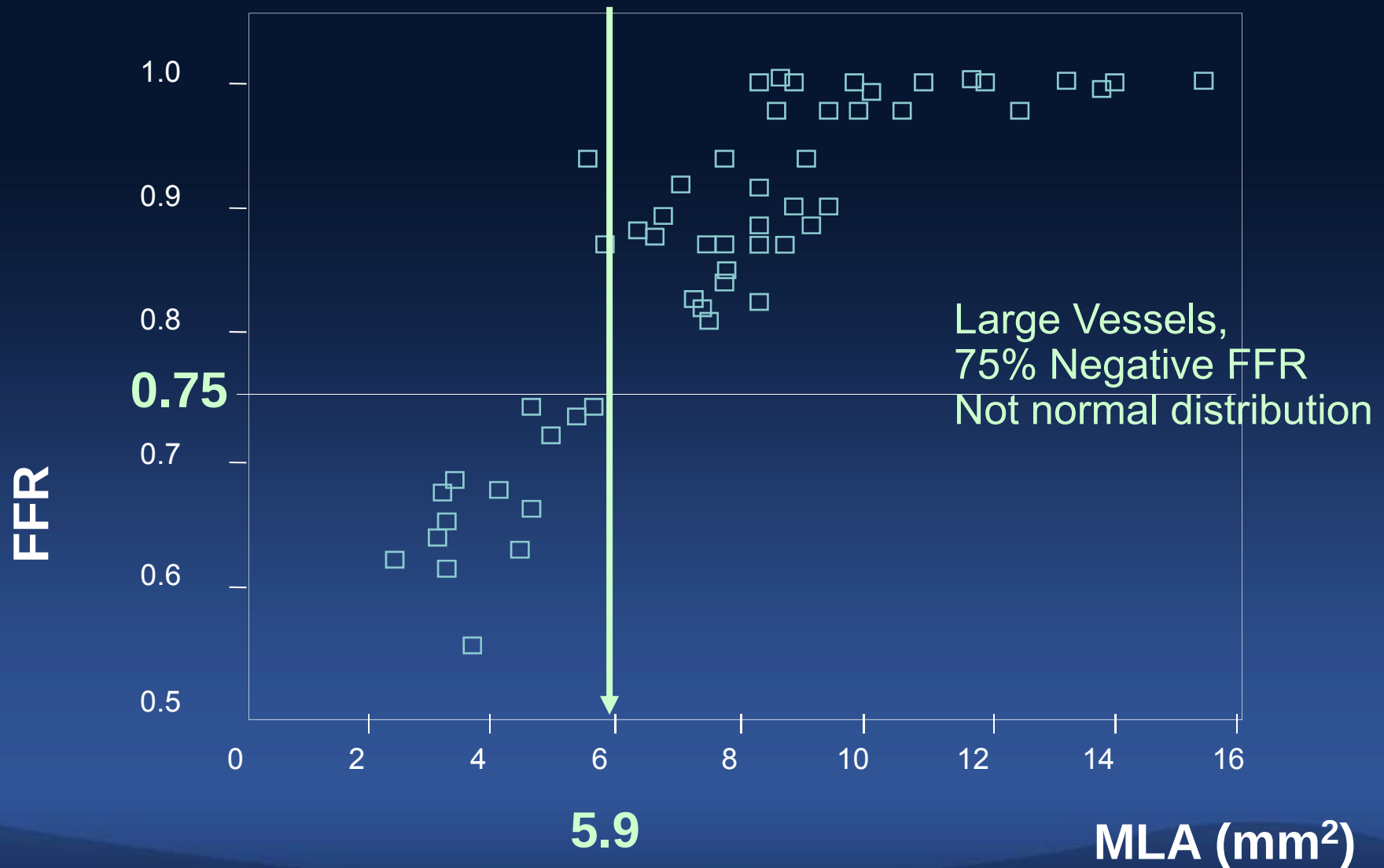
New IVUS MLA

Matched with FFR <0.80 in LM Disease

4.8 mm²

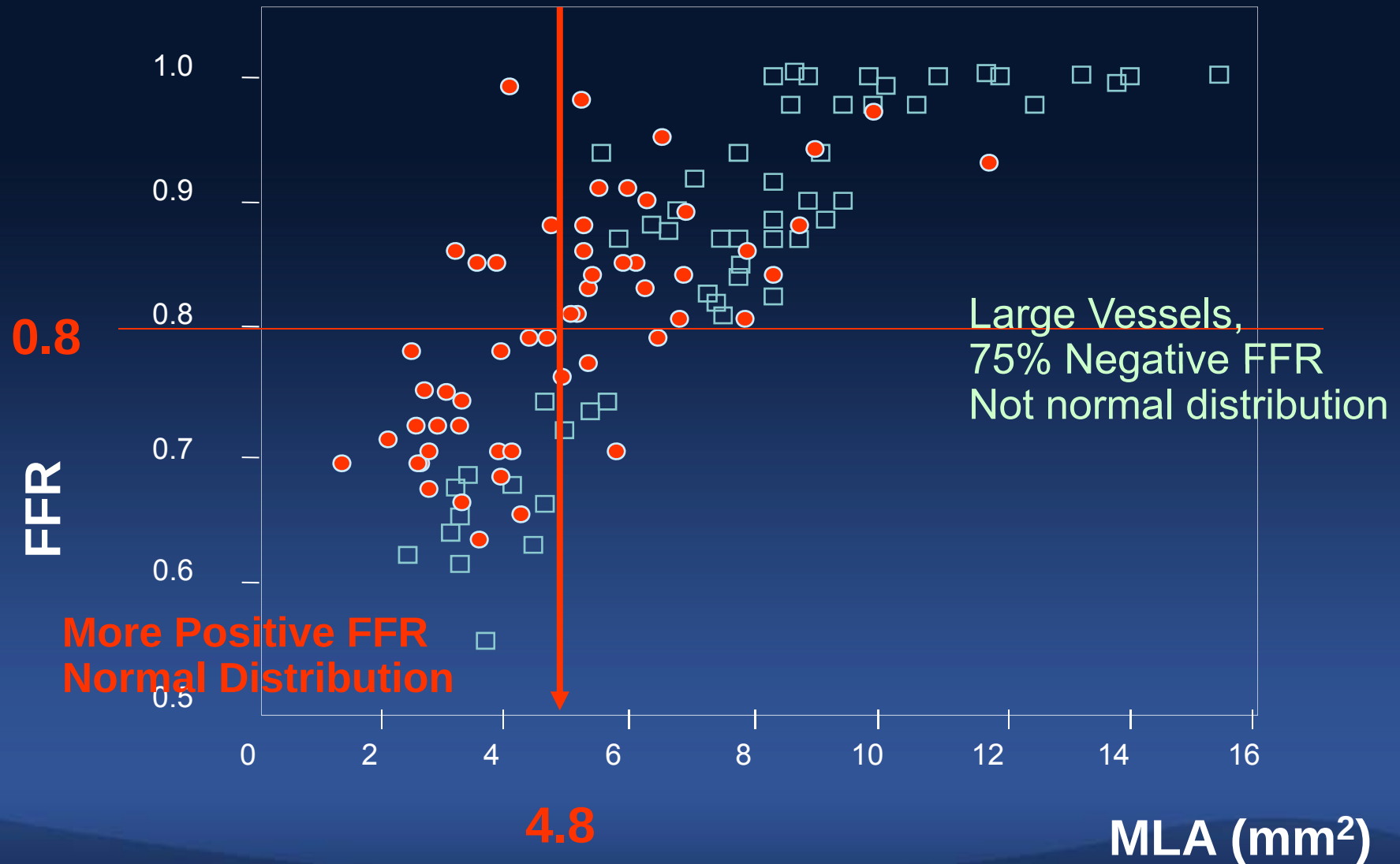
Kang SJ, Park SJ et al, JACC. Cardiovascular Interventions. 2011 Nov;4(11):1168-74.

Jasti's data



Kang's data, AMC

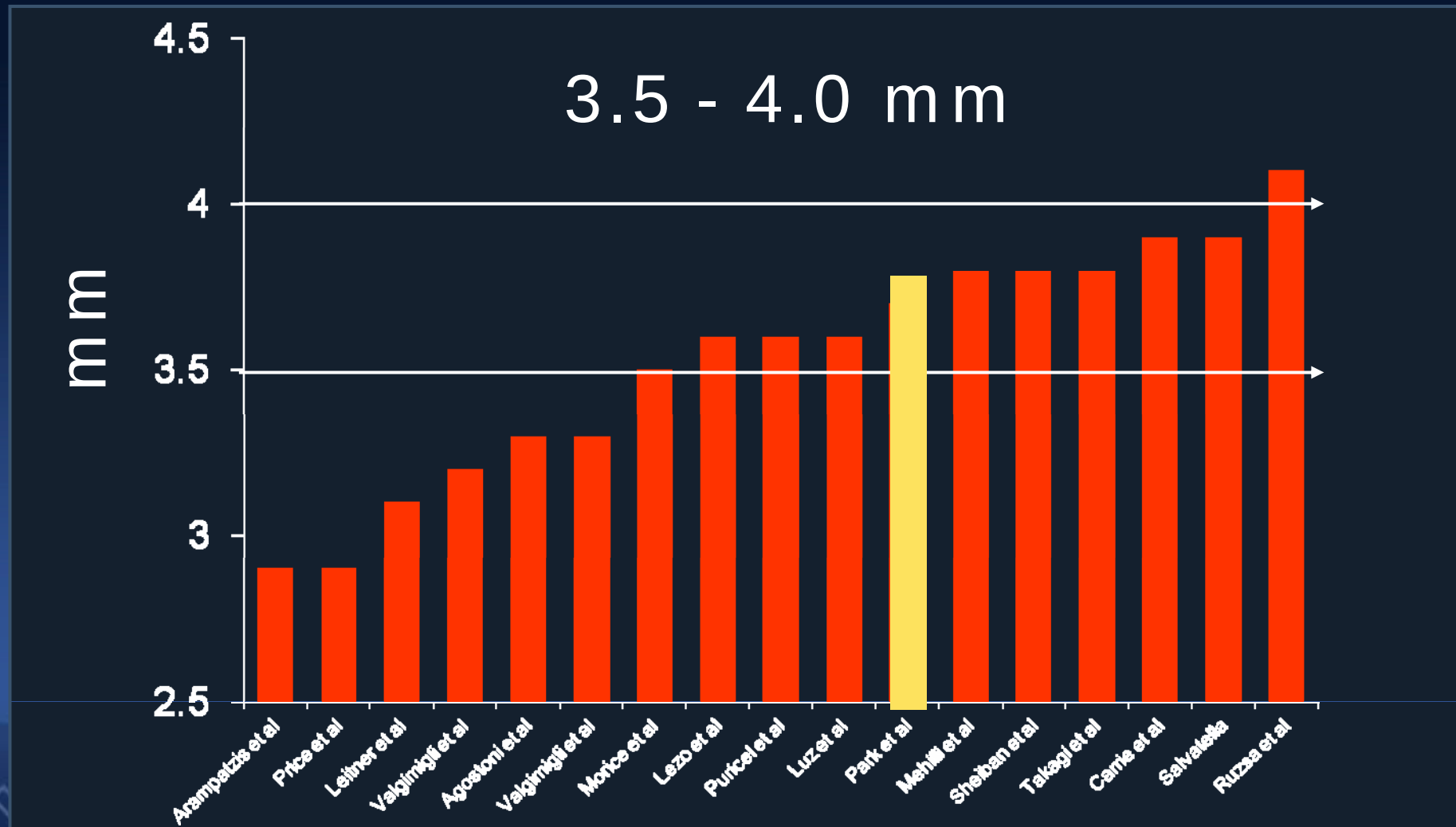
Jasti's data



Ethnic Difference ?

Reference Vessel Size of Left Main Coronary Artery by QCA

2309 USA/EU Patients in 17 Studies



1.0

Sensitivity 89%
Specificity 83%

Don't Use Anymore
the IVUS MLA of 6 mm²
for LM PCI. **It's too Big !**

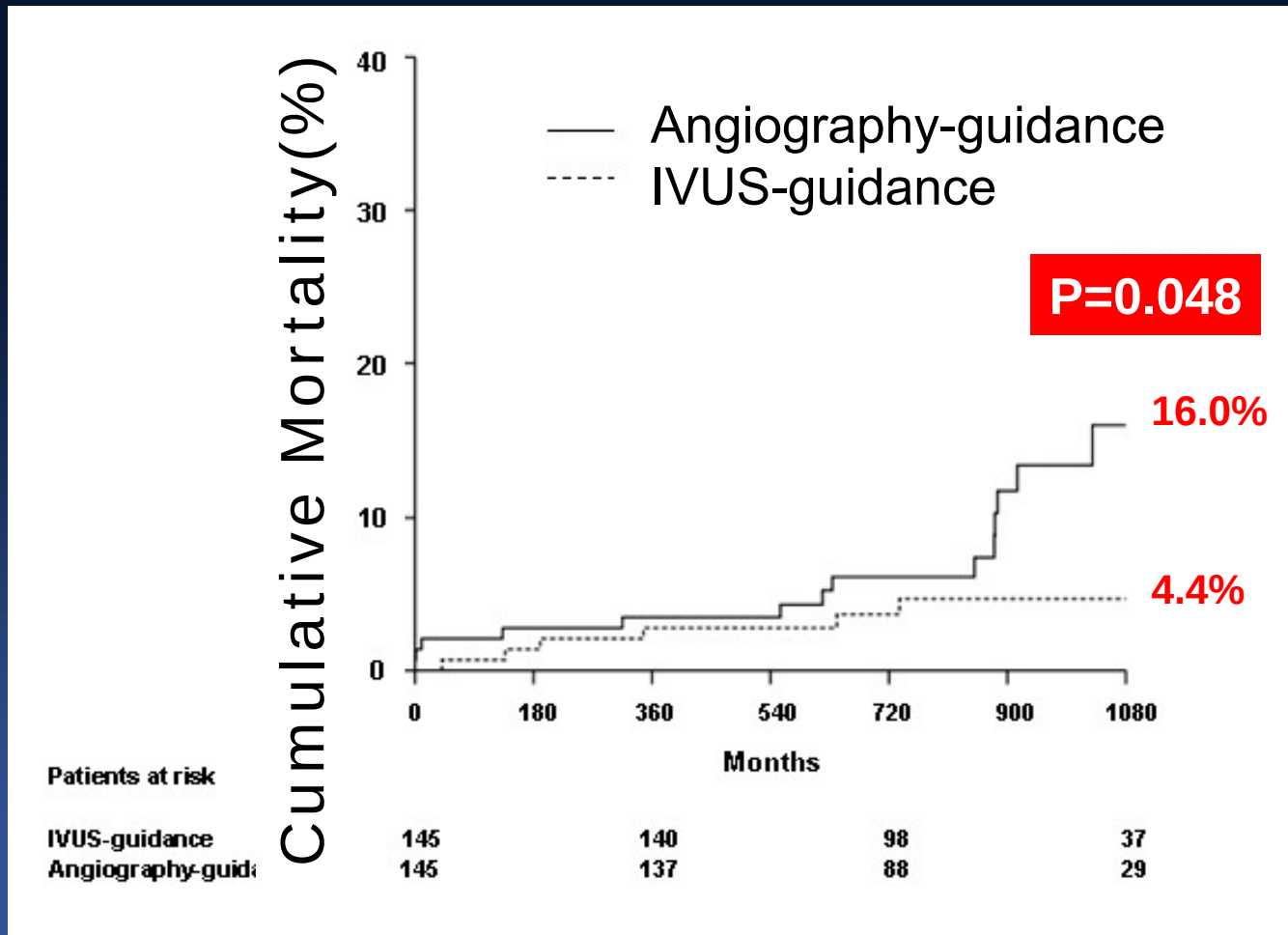
0 2.0 4.0 6.0 8.0 10.0

MLA 6.0 mm²

MLA 4.8 mm²

Why IVUS ?

IVUS guidance saves lives in LM PCI



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

Why IVUS guidance

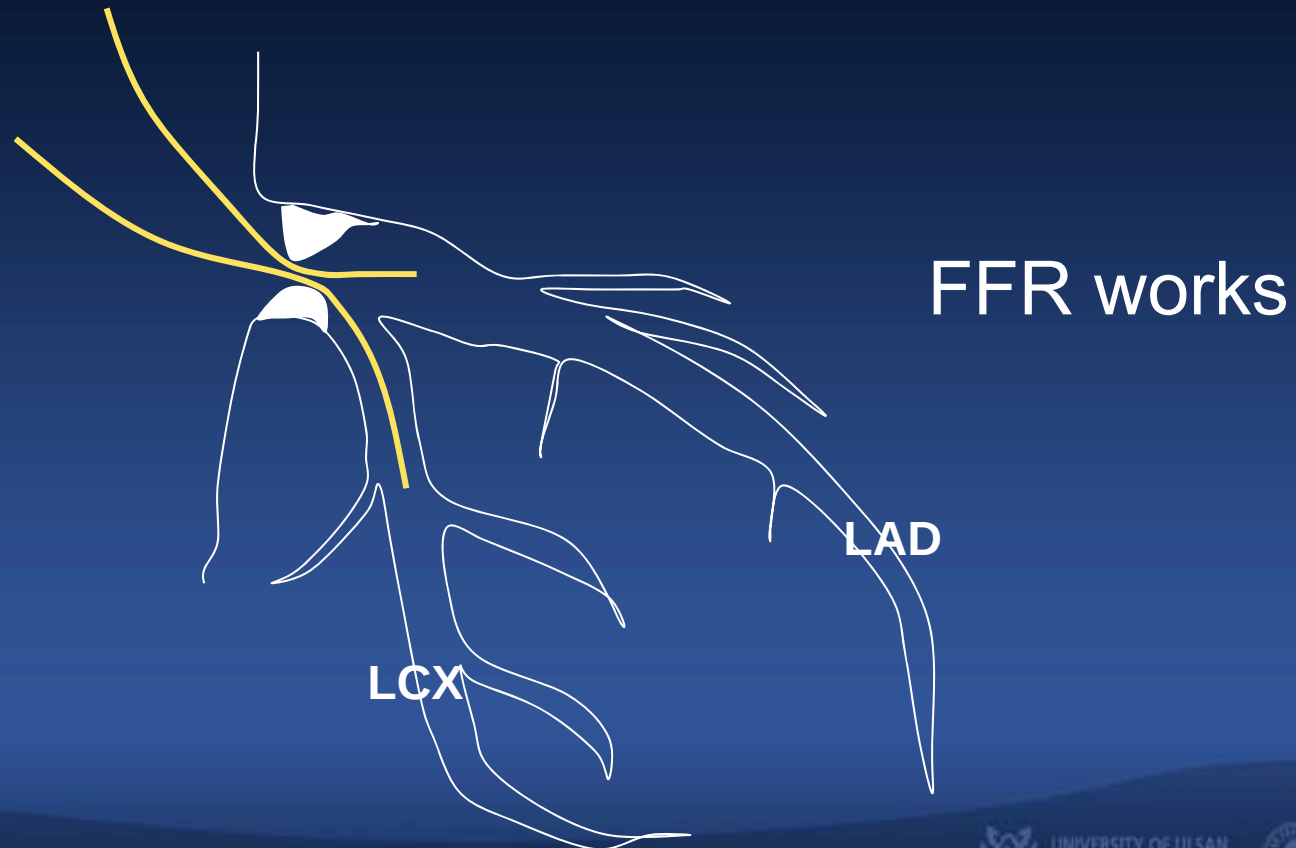
- The IVUS-guidance will reduce 3-year mortality from MAIN COMPARE registry data.
(Park SJ, et al. Circulation Cardiovasc Interv. 2009 Jun;2(3):167-77)
- Treat or not treat decision could be made by IVUS MLA 4.8 mm² (PPV:82%).
- IVUS guidance have more understanding about the inside of the vessel (negative remodeling, true reference vessel size and ostial lesion assessment). We can **decide the treatment strategy** based on IVUS guidance.

Ostial and Shaft LM PCI

How to Do ?

Ostial and Shaft LM PCI

- Functional Assessment (FFR) is Crucial.



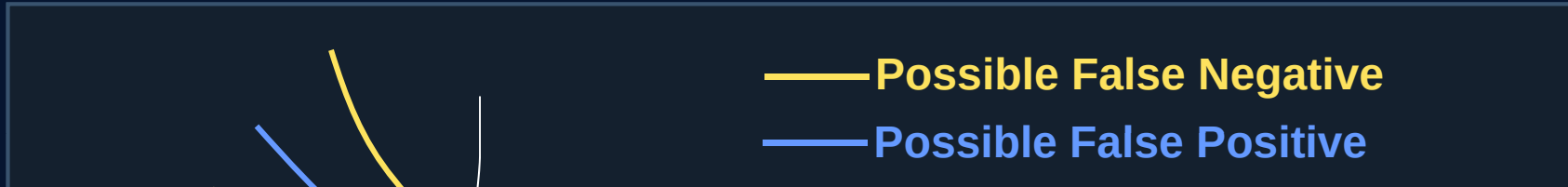
Ostial and Shaft LM PCI

- **Functional Assessment (FFR)** is Crucial.
- IVUS MLA (4.8 mm²) **can predict** functional significance of stenosis of LM disease.
- **Just Stent it !** It takes just 5 minutes !
- We have more than 5 -10 year long-term data.
- No difference of death and MI compared with surgery (even better).
- Long-term clinical outcomes should be comparable to 100% of arterial grafts.

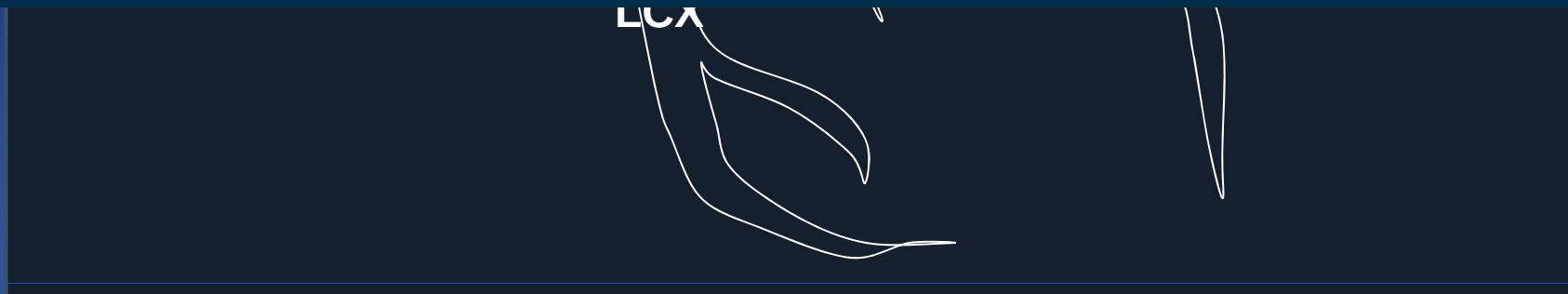
Distal Bifurcation LM PCI

How to Do ?

Problem of FFR for LMCA Lesions

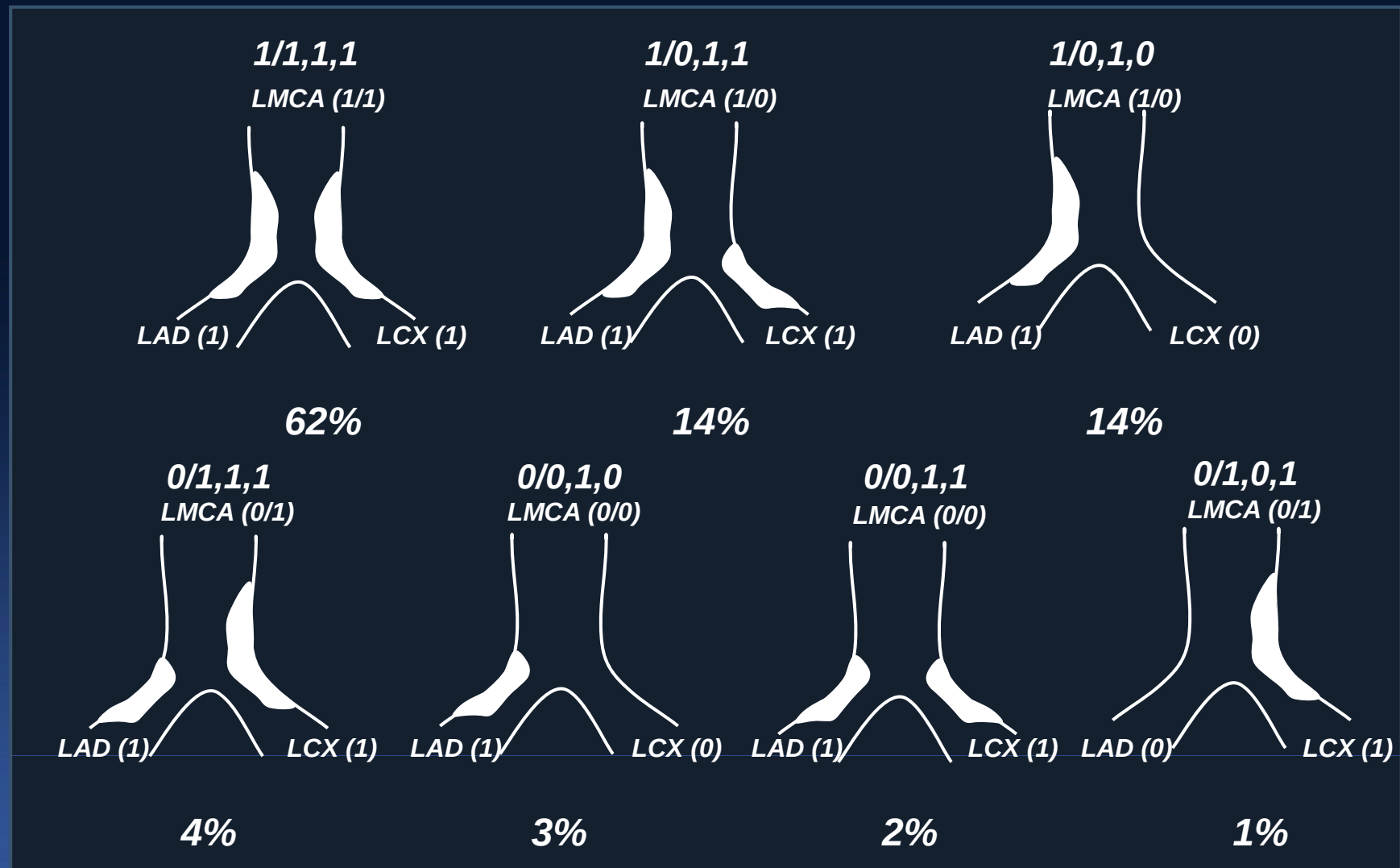


Conceptual Problem !



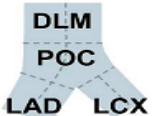
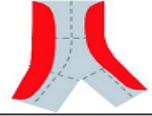
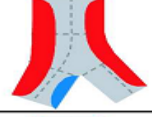
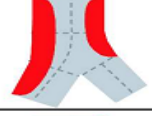
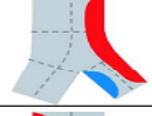
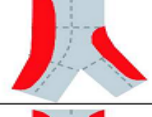
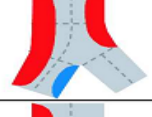
In Reality,

Plaque Distribution by IVUS (n=140)



In 90% plaque extends from LMCA-LAD

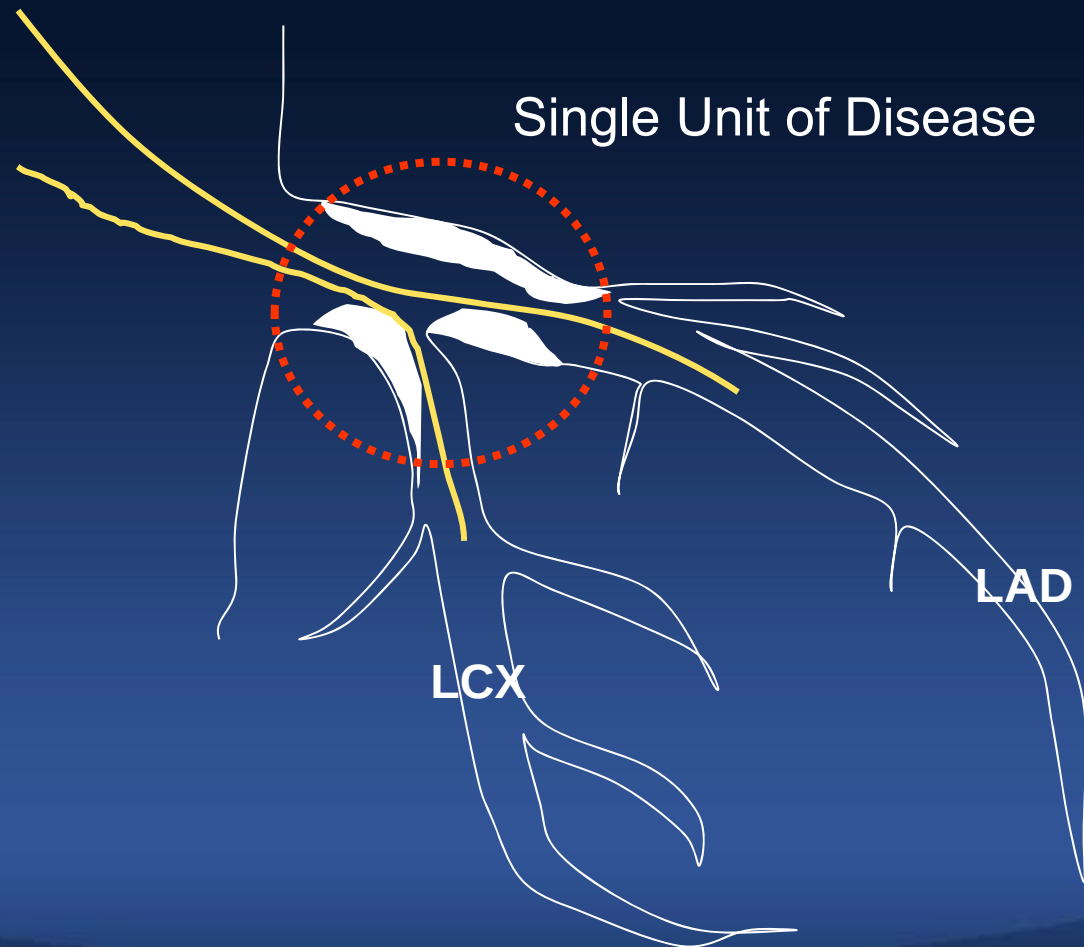
Plaque Distribution by IVUS (n=82)

	N. (%)	LAD ostium, MLA (mm ²)	POC, MLA (mm ²)	DLM, MLA (mm ²)	LCX ostium, MLA (mm ²)
	5 (6%)	4.4±2.0	9.6±4.4	8.1±4.7	3.4±1.6
	26 (32%)	4.2±2.8	5.3±2.6	4.6±1.5	3.9±2.1
	12 (15%)	2.6±1.3	4.5±1.6	4.5±2.1	3.3±2.0
	9 (11%)	4.3±2.5	5.6±3.3	5.7±3.8	7.6±3.6
	9 (11%)	3.2±1.4	6.1±2.0	4.8±2.5	3.9±1.4
	4 (5%)	3.4±1.9	5.2±1.9	5.8±4.7	3.9±2.0
	4 (5%)	2.8±0.7	5.1±2.1	5.1±2.2	6.6±1.7
	5 (6%)	3.4±1.9	5.2±2.6	5.1±3.8	4.6±2.1

**In all cases,
the LM disease
extended into
LAD and LCX
continuously.**

Placed Transducer Beyond Bifurcation in both LAD and LCX

FFR still works.



Distal LM Bifurcation PCI

- Single Stent Cross Over
- 2 Stents Procedures

When, 1 vs. 2 stents

Single stent

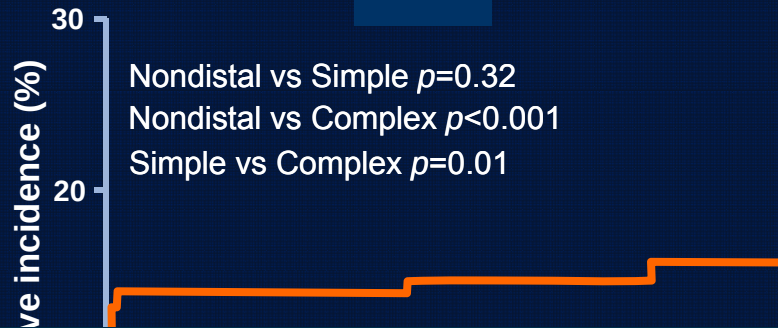
- Normal ostial LCX with MEDINA 1.1.0. or 1.0.0.
- Small LCX with < 2.5 mm in diameter
- Diminutive LCX
- Normal or focal disease in distal LCX

Two stent

- Diseased LCX with MEDINA 1.1.1., 1.0.1., or 0.1.1
- Large LCX with ≥ 2.5 mm in diameter
- Diseased left dominant coronary system
- Concomitant diffuse disease in distal LCX

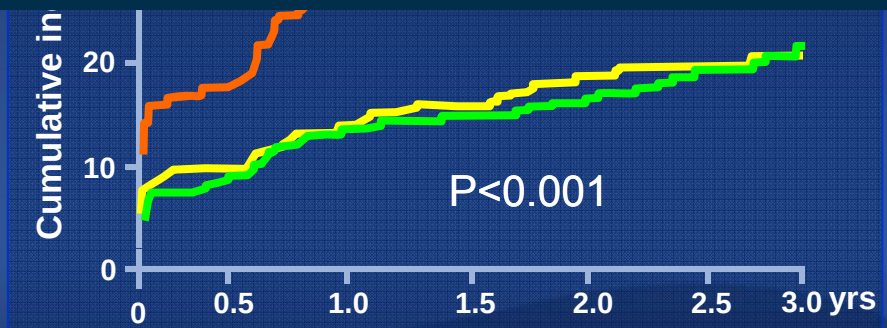
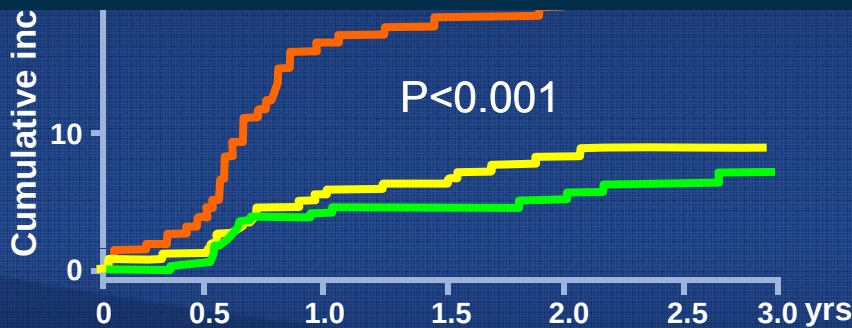
Park SJ, Kim YH. Colombo A, Issam D. Moussa et al. Textbook of Bifurcation Stenting

MI



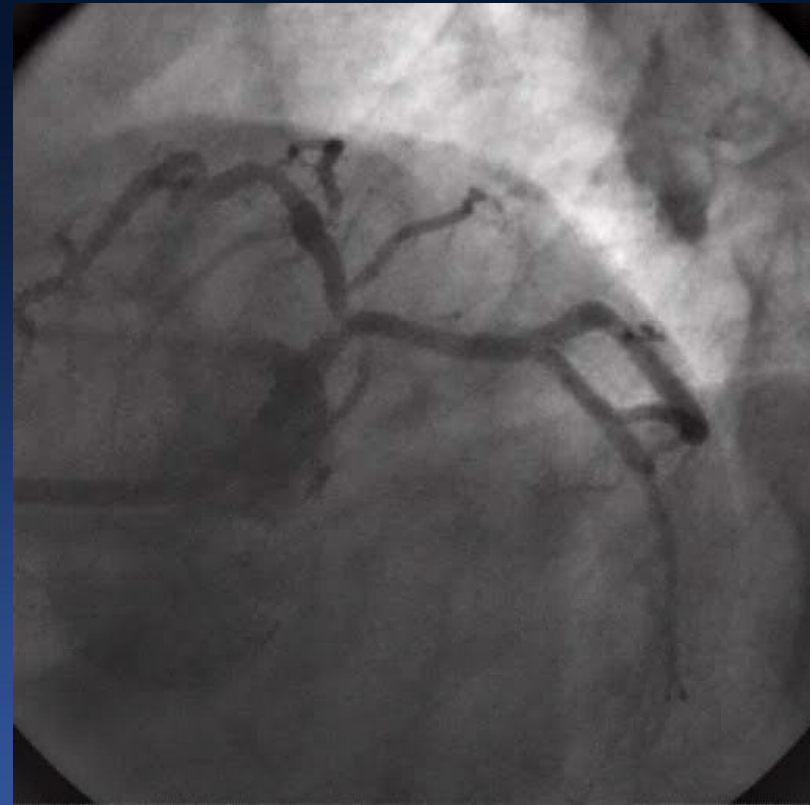
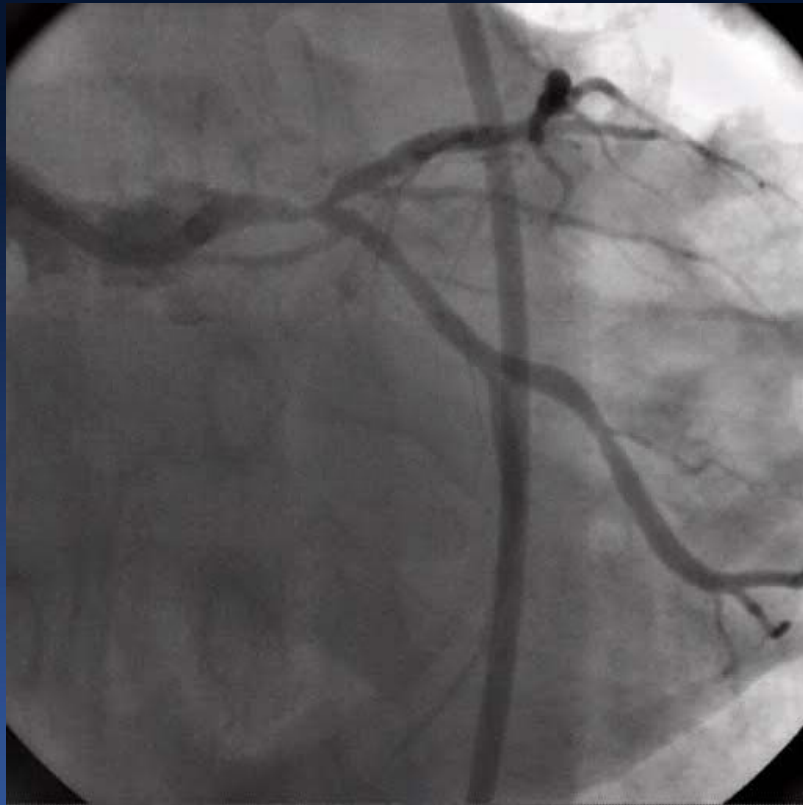
- Complex 2 stents
- Non-distal (Ostial and Shaft)
- Simple (single stent cross over)**
In LM bifurcation lesions

Single Stent Cross Over is **Clearly better** !



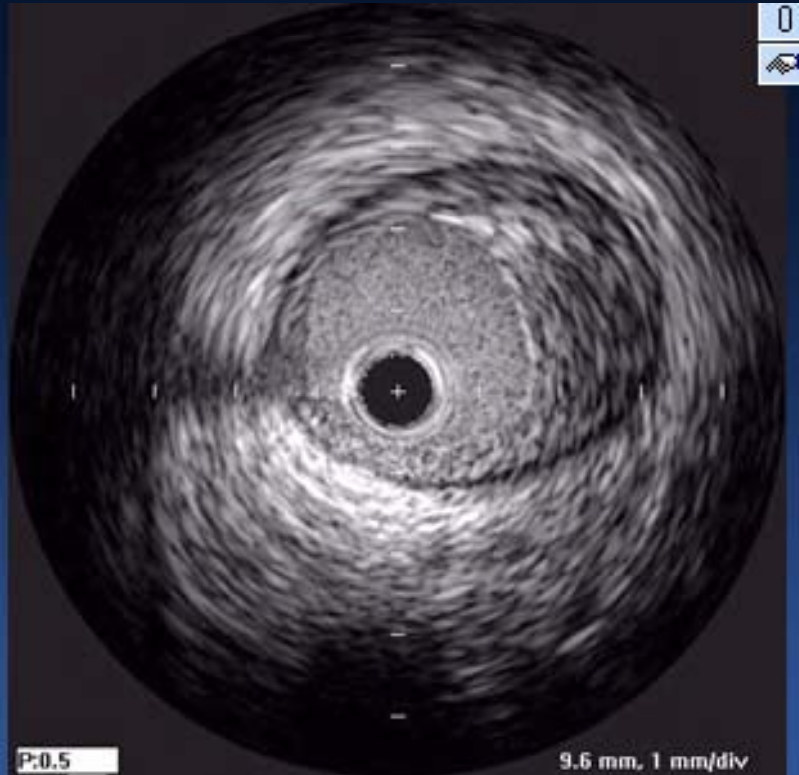
Stent Cross Over for LM Bifurcation Lesions

LM Bifurcation Lesion with minimal-disease of LCX

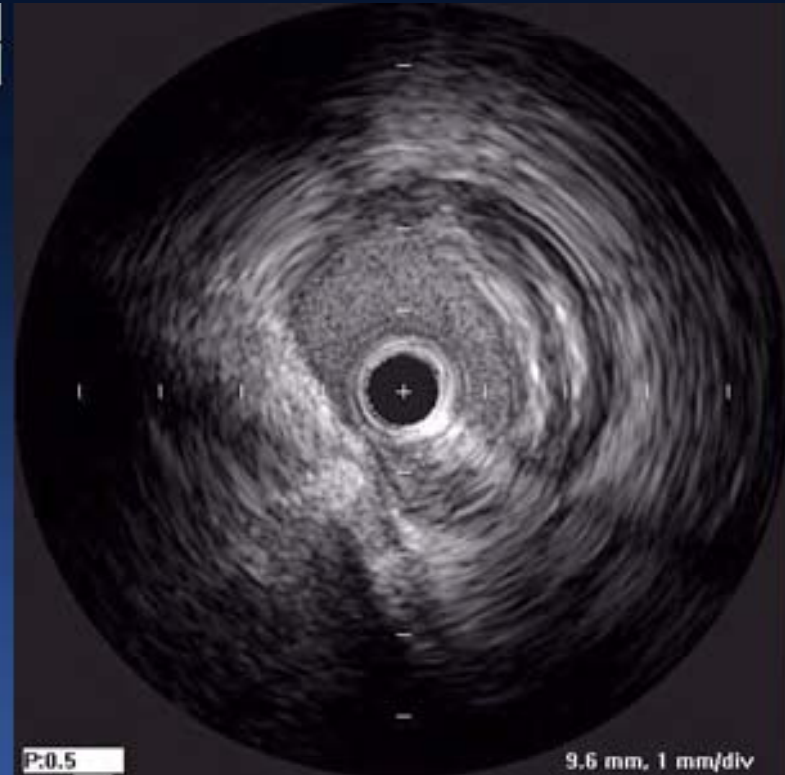


72/M, Unstable angina,

IVUS

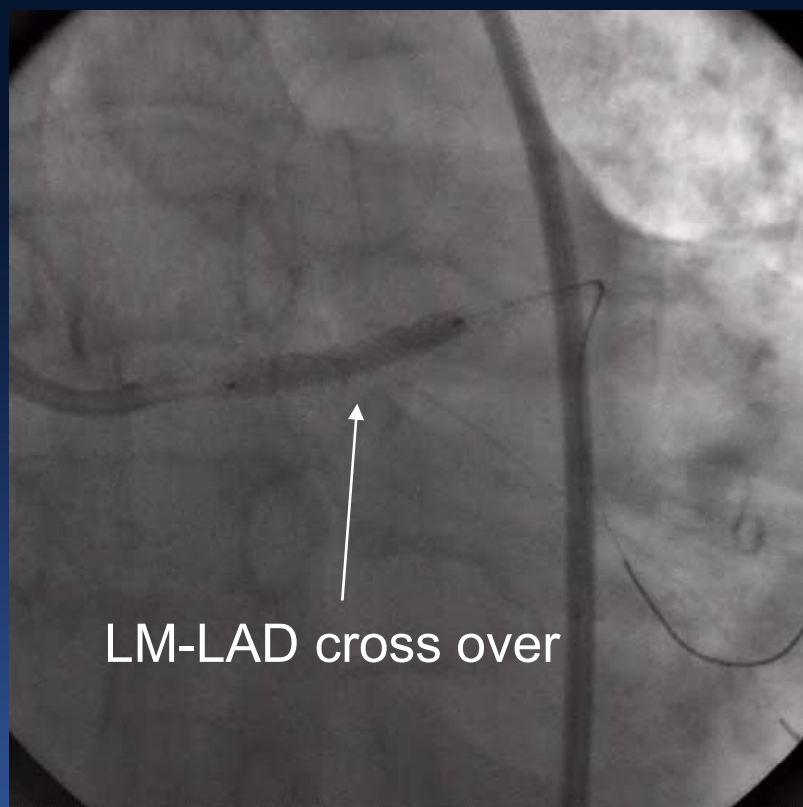


LAD Ostium

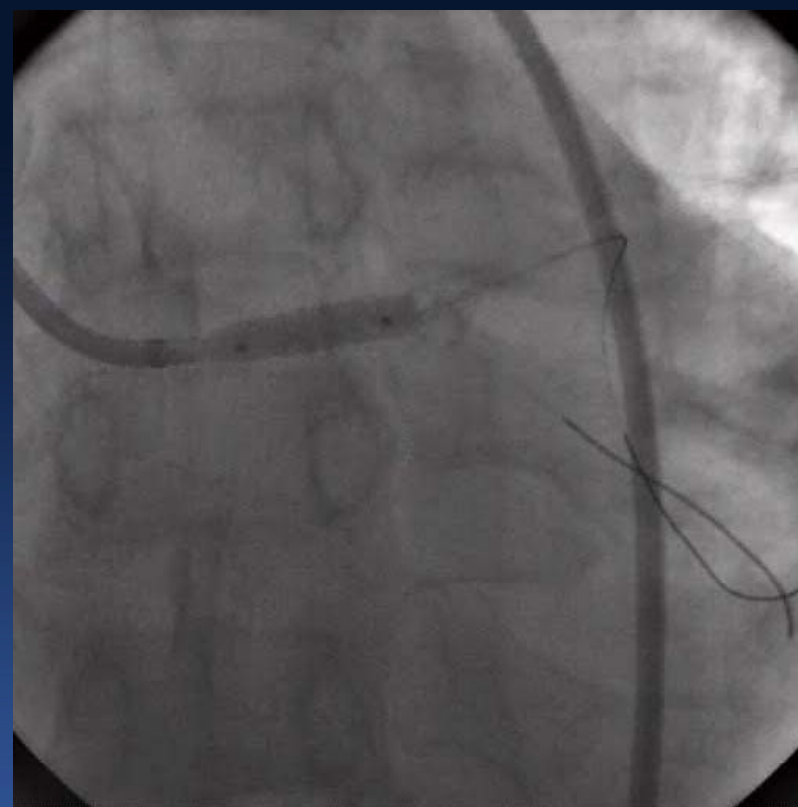


LCX Ostium
Minimal-disease
MLA 5.4 mm²

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

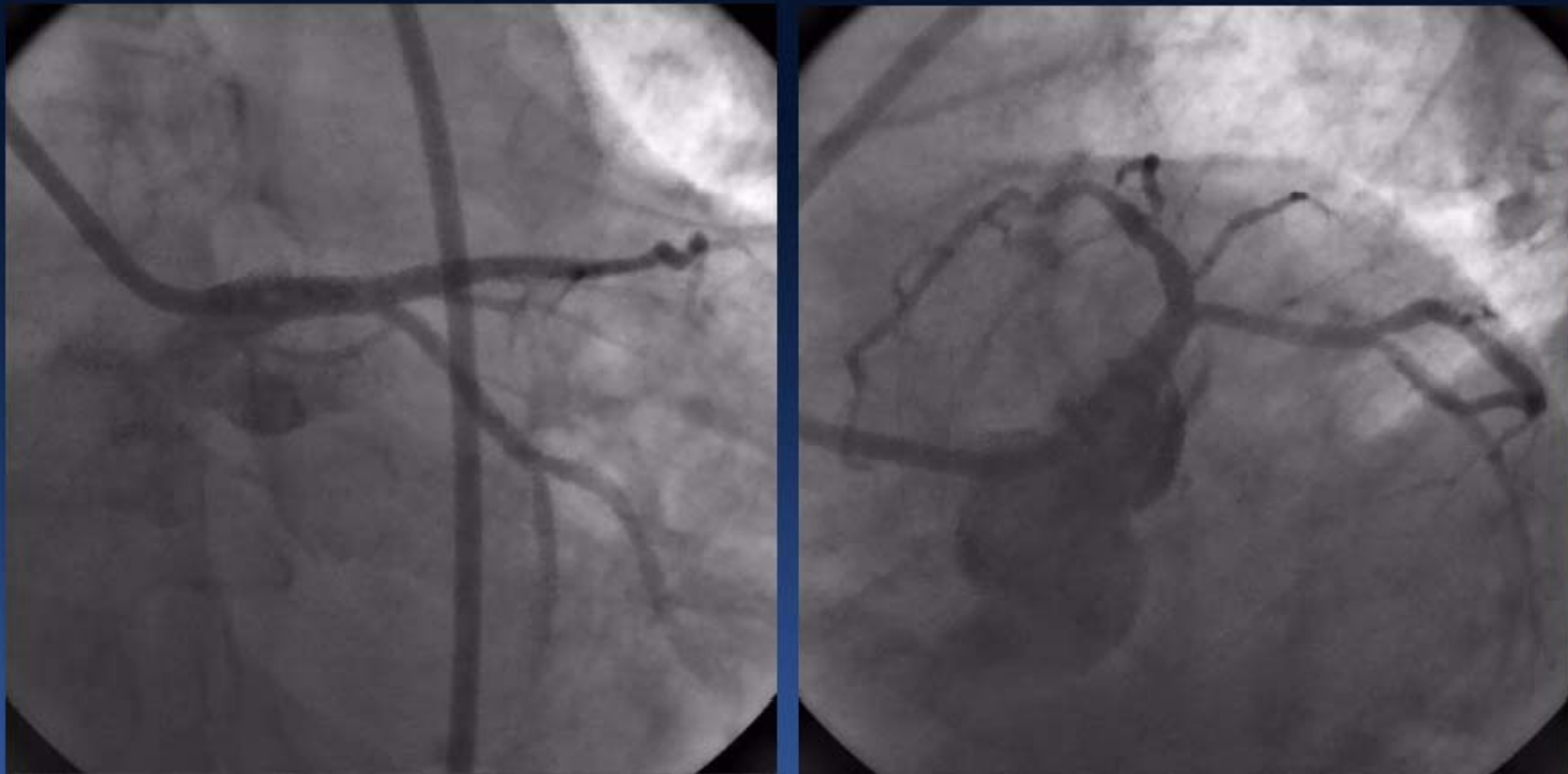


Cypher 3.5 × 23 mm



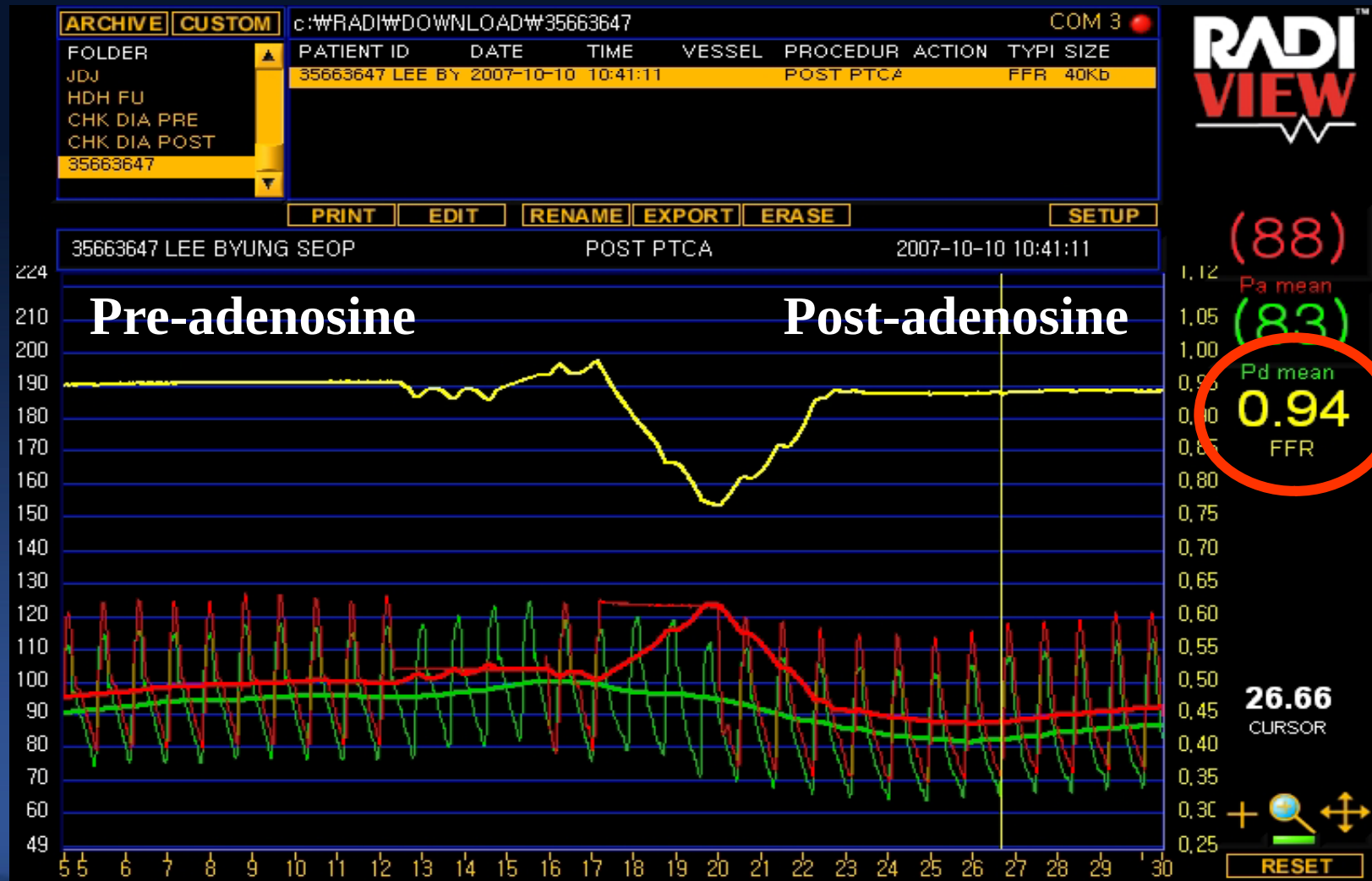
Additional high pressure
Inflation with 4.0 mm
non-compliant balloon

Final Results after Single Stent Cross-Over



Immediate after the procedure, there was no significant compromise of LCX ostium.

FFR of LCX is 0.94



Single Stent Cross-Over

IVUS Guided Stent Cross over depending on LCX disease status by IVUS, stent size selection, stent optimization.

FFR Guided decision making for further treatment about the compromised side branch (LCX).

2 stent techniques in LM true bifurcation lesions

2 stent Techniques

- T-stent, modified T-stent or TAP
- Mini-crush (or step crush)
- Culotte
- V-stent
- Y-stent (SKS-simultaneous kissing stents)

When to Choose Different 2 stent Techniques

Technique

When to choose

- T, modified T, TAP: 75-90' angled LCX
- Culotte: Y bif with matched LAD/LCX dia.
- Mini-crush (or step crush): Y bif with LAD/LCX dia mismatch.
- V-stent: Medina 0,1,1 (true LMEQ ds)
- SKS: Short LM, unstable pt

End with a FKB inflation with all 2-stent techniques

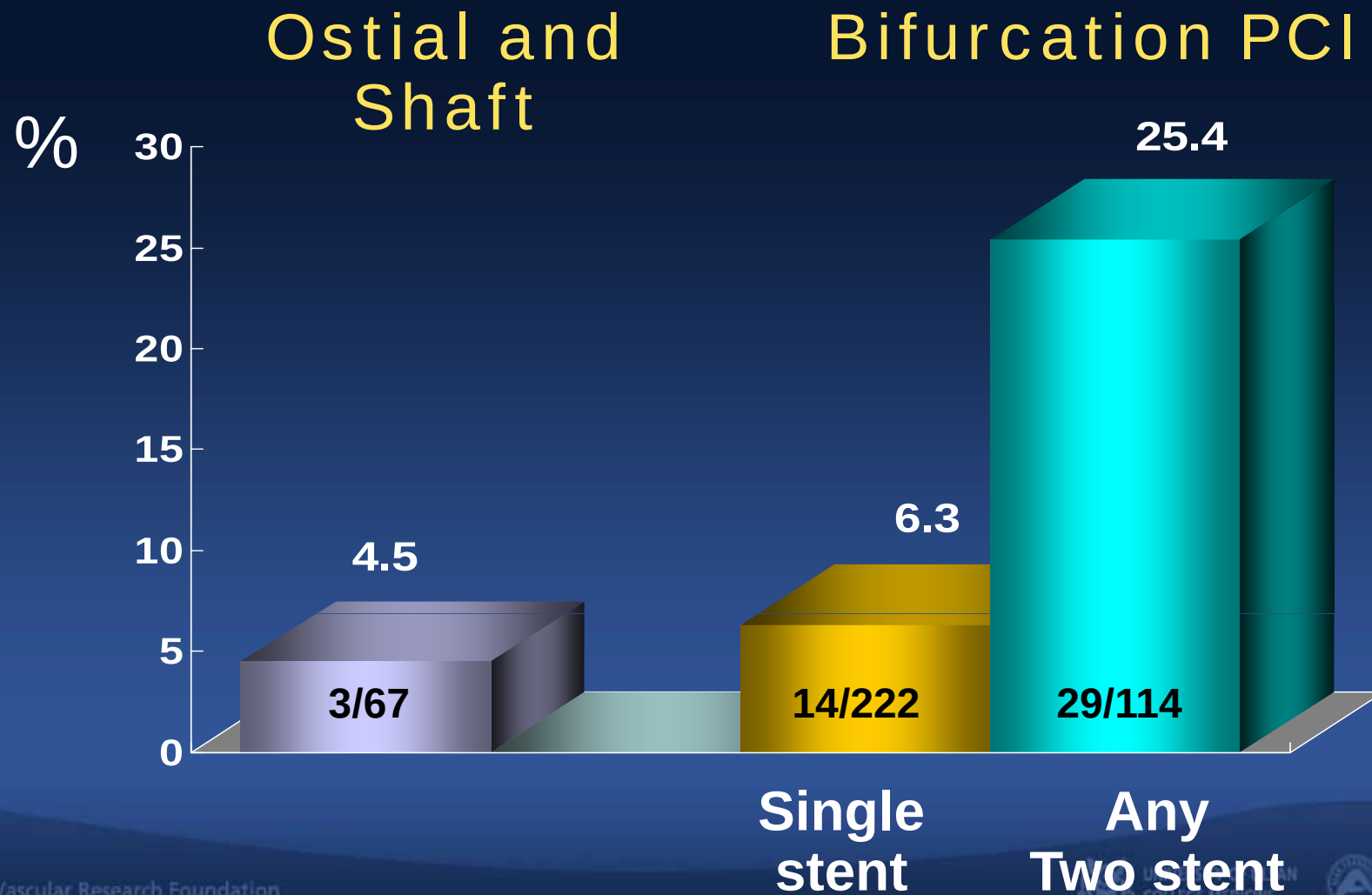
Whatever
you choose 2 stent techniques,

You have to consider **IVUS guided
Stent Optimization !**

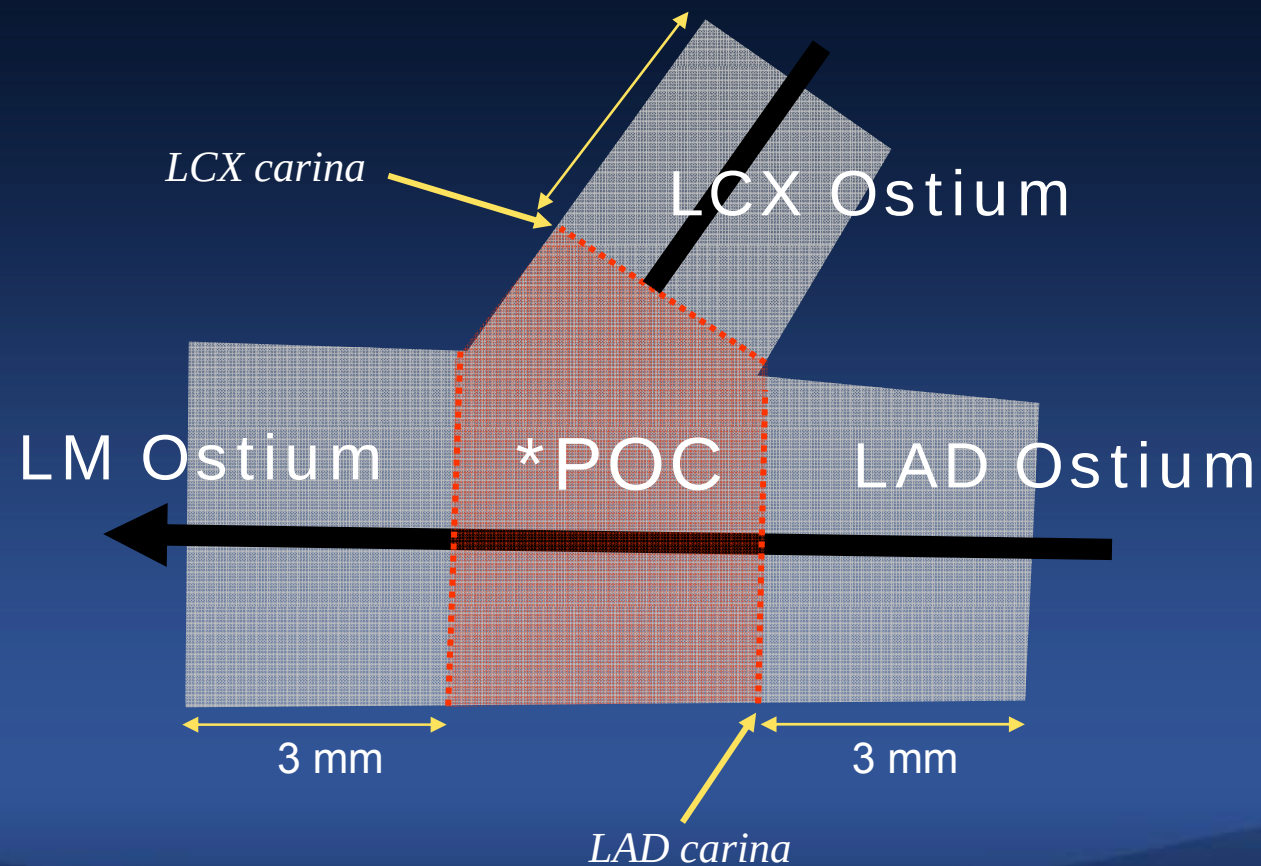
IVUS **Stent Area** and its Impact for restenosis in 403 Patients with Unprotected Left Main Disease

All patients treated with SES
100% Post-stent IVUS,
100% Angiography F/U at 9 months and
2 years clinical F/U

Restenosis at 2 year



IVUS Measurement for LM Bifurcation Stents



*POC : Polygon Of Confluence



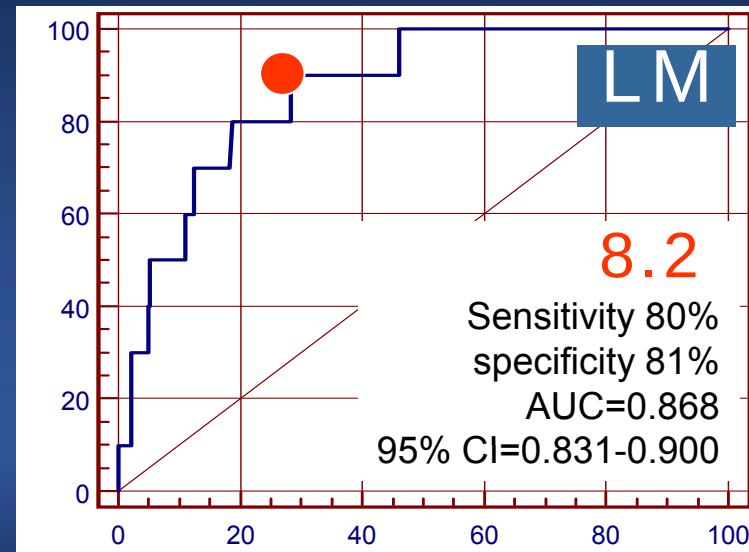
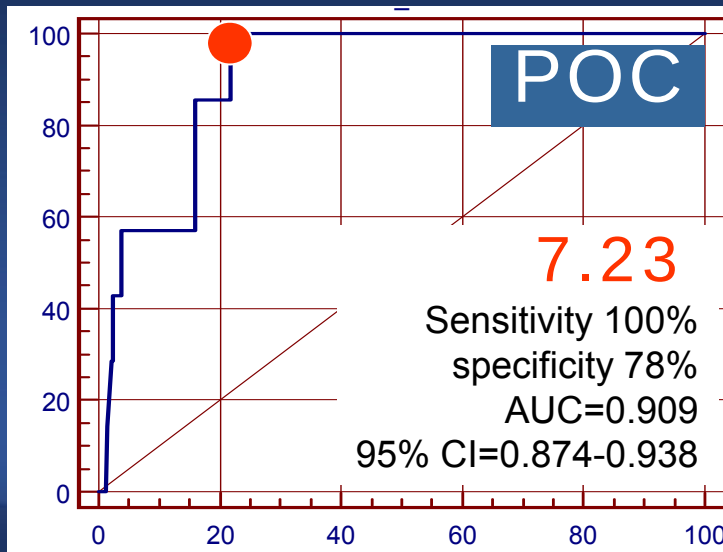
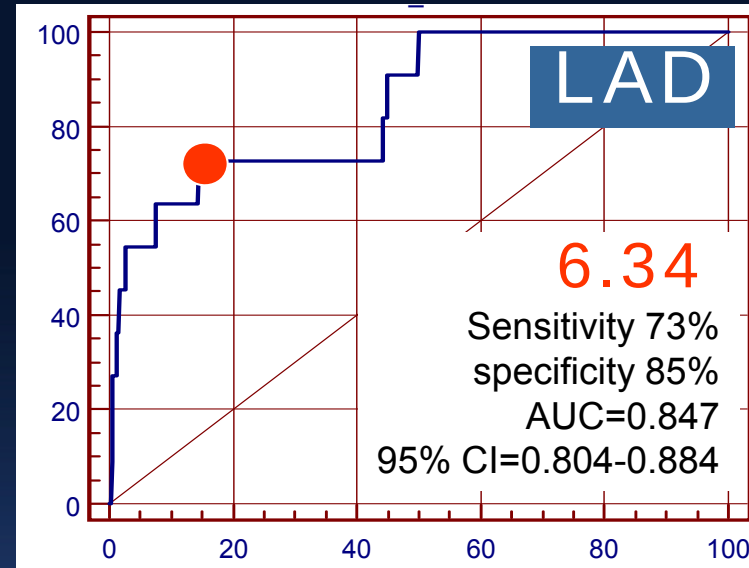
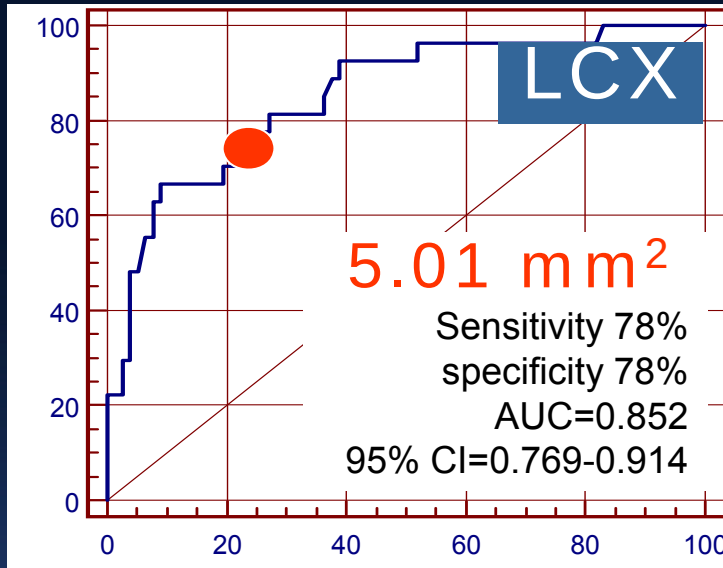
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Medical Center

Minimal Stent Area (mm²) to predict ISR

Sensitivity



Specificity

IVUS Stent Optimization (Stent Cross-sectional Area)

**5,6,7,8 mm² of Stent CSA Can Make a
Good Clinical Outcomes in 2 stents
technique in LM bifurcation PCI.
(Restenosis Rate < 5% and TLR < 2%)**

Whatever
you choose 2 stent techniques,

**IVUS Final stent CSA (5,6,7,8
mm²) is the most important criteria
for the good clinical outcomes !**

Distal LM Bifurcation Treatment

- For the intermediate LM bifurcation disease, **FFR still works**. IVUS guidance give us more understanding about the inside of vessel. And also **MLA of LM $<4.8 \text{ mm}^2$** can predict functional significance of stenosis (PPV 83%).
- When we used single stent cross over, **FFR guided side branch optimization** is reasonable approach.
- When we used 2 stents technique, IVUS guided optimization of stent (**IVUS stent CSA 5,6,7,8 mm^2**) can make a good clinical outcomes.

Functional Angioplasty

Integrated Use of FFR and IVUS

- Avoid unnecessary PCI
- Avoid unnecessary Surgery
- Minimize MACE
- Maximize clinical outcomes
- Save money
- Save lives