Functional Angioplasty

Insight from FFR and IVUS

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New Insight
for FFR vs. IVUS

Epicardial Artery

FFR and IVUS MLA
IVUS guided optimization

In Epicardial Artery

Published IVUS MLA Cut-off Value

	Nishioka T, JACC 1999	Briguori et al AJC 2001	Takaki et al Cir. 1999	Abizaid et al AJC 1998
	70 lesions	53 lesions	42 pts	86 pts
Cut-off of MLA (mm^2)	<4.0 (Thallium +)	< 4.0 (FFR<0.75)	<3.0 (FFR<0.75)	> 4.0 (CFR >2.0)
Sensitivity Specificity	80% 90%	92% 54%	83 % 92.3 %	Accuracy 92%
QCA VD (mm) DS (%)		3.08±0.3 52±11		
MLA (mm^2)	3.3±2.3	3.9±2.5	3.9±2.0	4.4±2.0
MVA (mm^2)		12.0±4.6		13.2±4.4
Area stenosis%		65±18	55±24	43±24

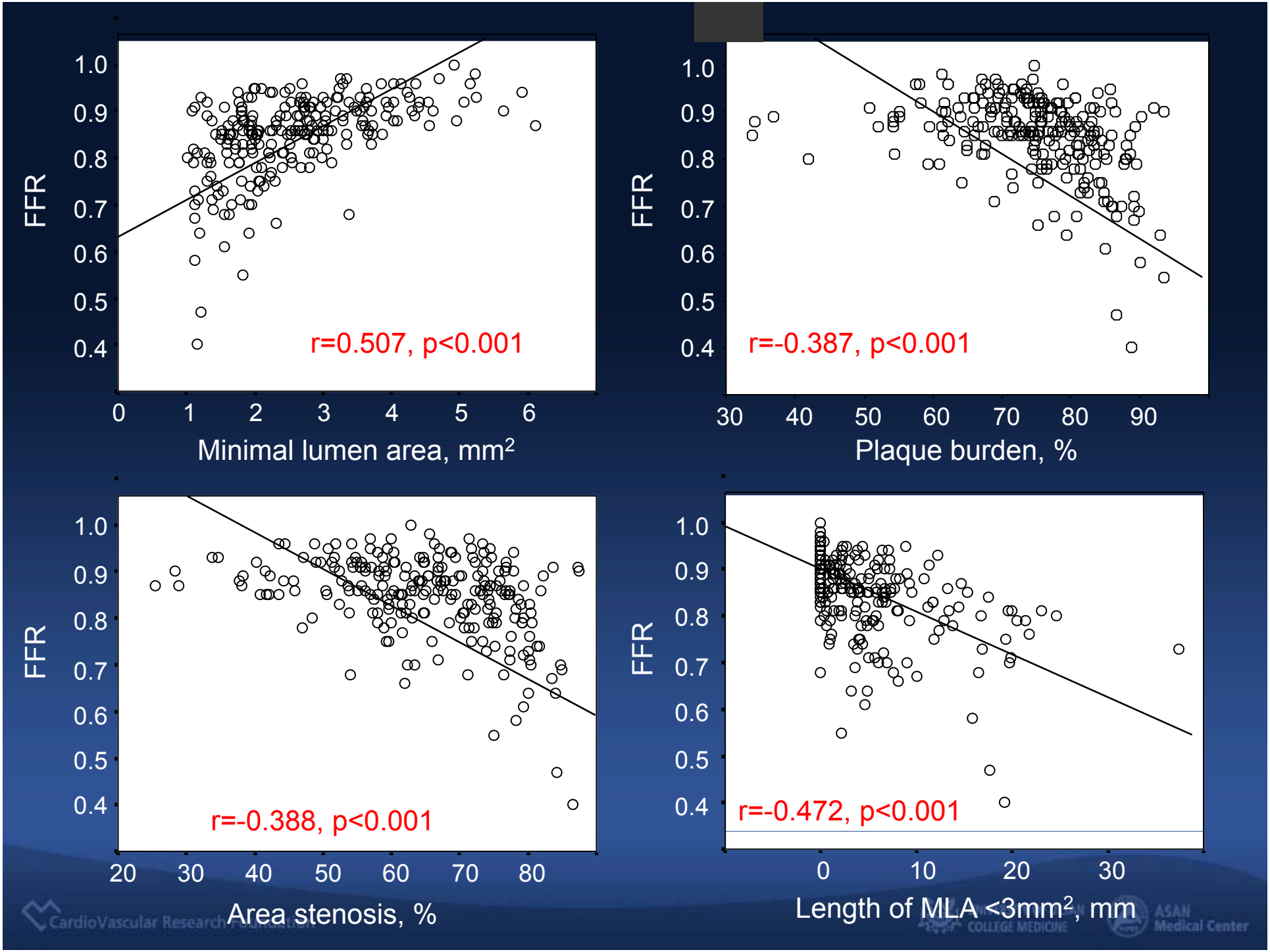
Published Data Review

New Comparison

AMC prospective cohort registry, (n=236 lesions)

FFR vs. IVUS MLA

Kang SJ, et al, Circ Cardiovasc Interv. 2011;4: 65-71


FFR
1.0
0.9
0.8
0.7
0.6
0.5
0.4
r=0.507, p<0.001
0
1
2
3
4
5
6
Minimal lumen area, mm2
FFR
1.0
0.9
0.8
0.7
0.6
0.5
0.4
r=-0.387, p<0.001
30
40
50
60
70
80
90
Plaque burden, %
FFR
1.0
0.9
0.8
0.7
0.6
0.5
0.4
r=-0.388, p<0.001
20
30
40
50
60
70
80
Area stenosis, %
FFR
1.0
0.9
0.8
0.7
0.6
0.5
0.4
r=-0.472, p<0.001
0
10
20
30
Length of MLA <3mm2, mm
CardioVascular Research Foundation
COLLEGE MEDICINE
ASAN
Medical Center

Multivariable Analysis to Predict FFR

Independent predictors for FFR <0.08

Age (OR=0.238, 95% CI=0.090-0.629, p=0.003),

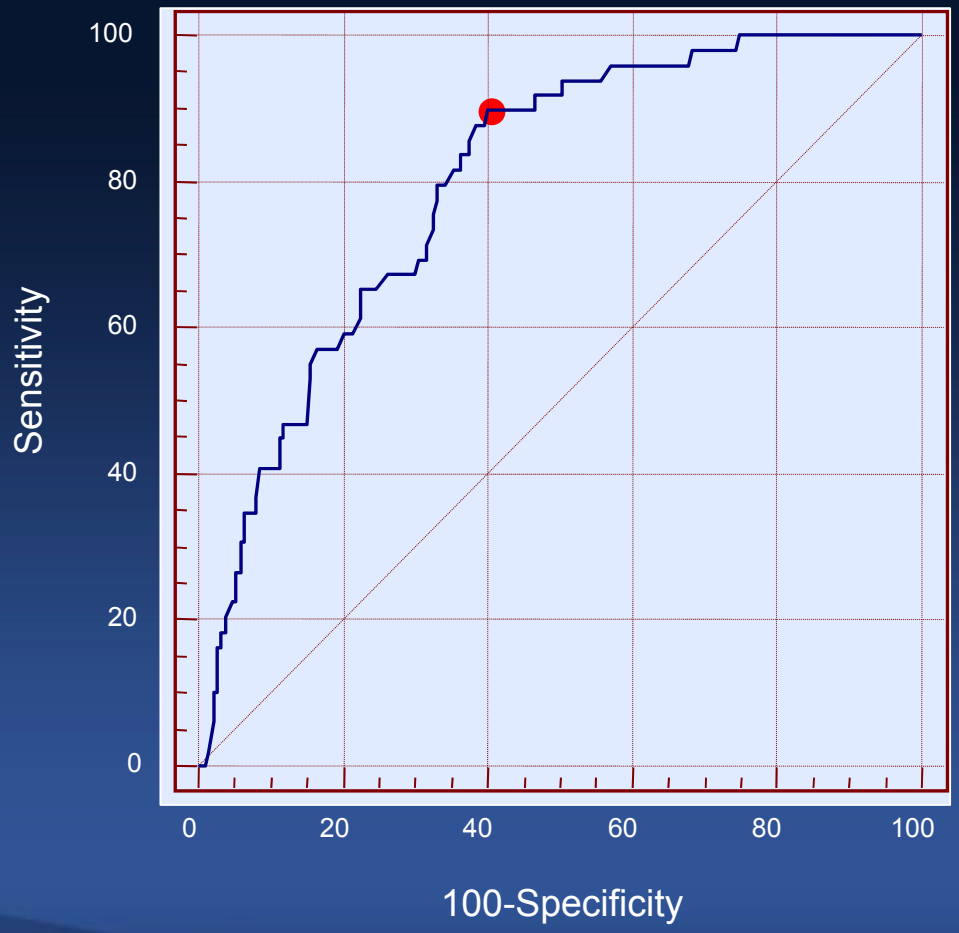
MLA (OR=0.206, 95% CI=0.100-0.424, p<0.001),

Plaque burden (OR=1.062, 95% CI=1.014-1.111, p=0.010),

LAD location (OR=4.371, 95% CI=0.755-10.885, p=0.002).

Kang SJ, et al, Circ Cardiovasc Interv. 2011;4: 65-71

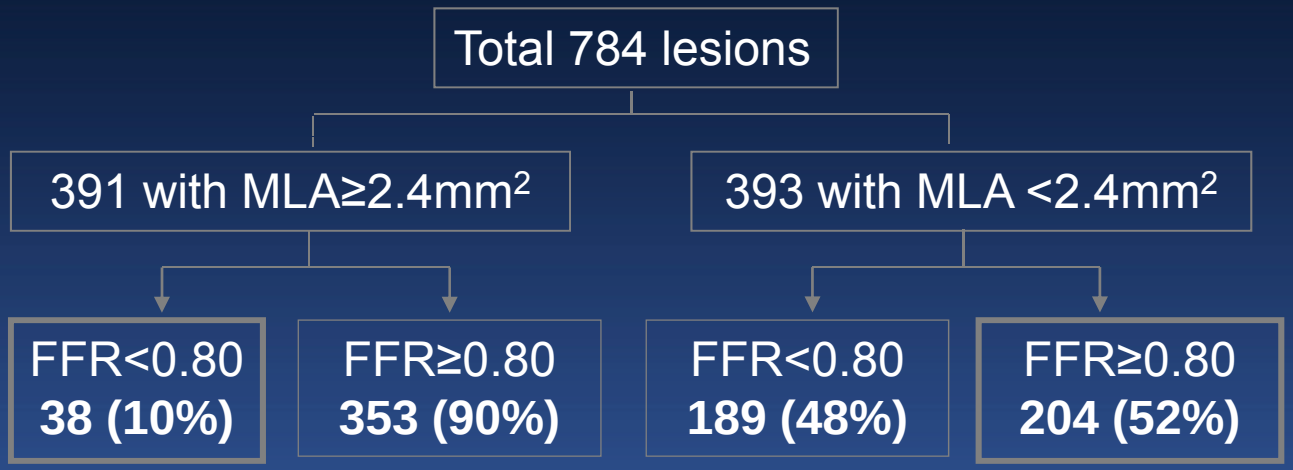
New IVUS MLA
matched with FFR <0.80 (n=236)



2.42 mm²
AUC=0.800,
95% CI=0.742-0.848

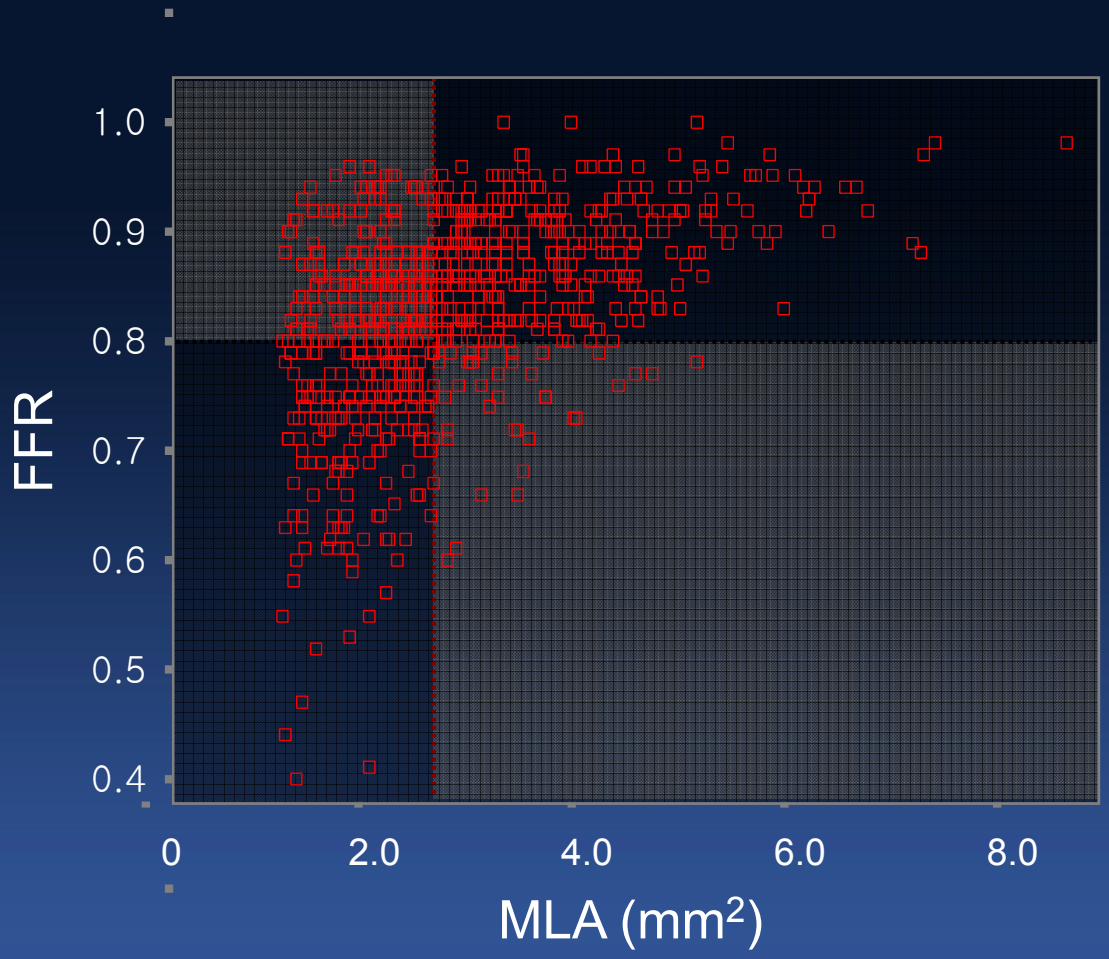
Sensitivity=90%
Specificity=60%
PPV=37%
NPV=96%
Accuracy=68%

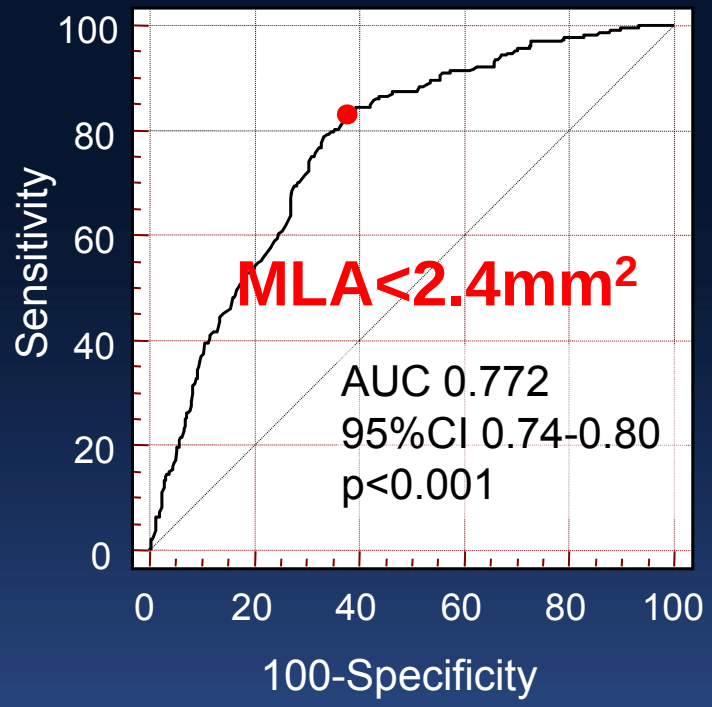
In total 692 consecutive patients with 784 coronary lesions were assessed by IVUS and FFR before intervention



Kang et al. Am J Cardiol 2012 in press

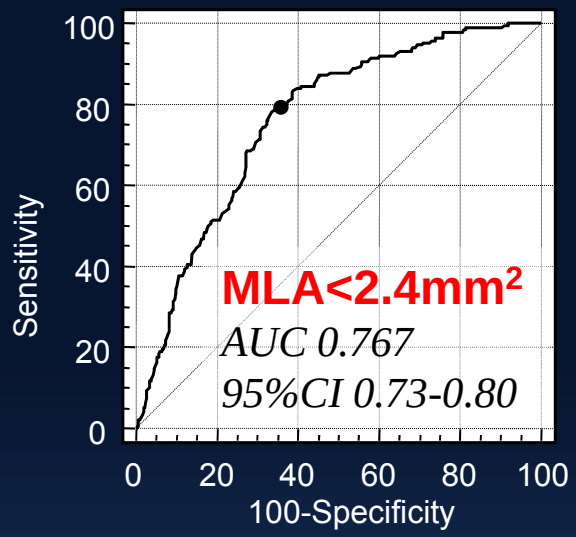
MLA Criteria to Predict FFR<0.80





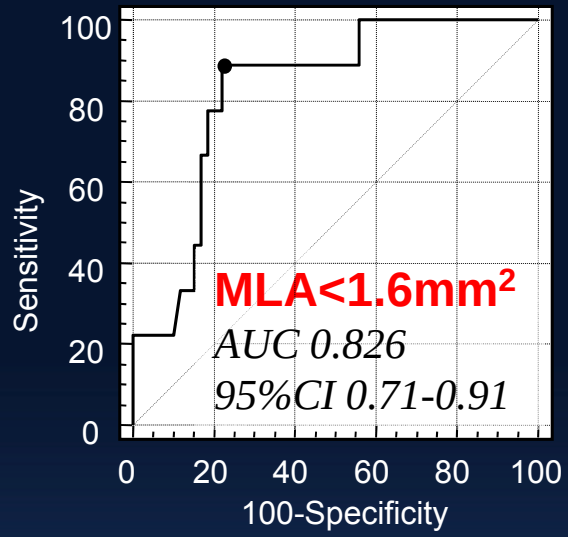
Sensitivity 84%
Specificity 63%
PPV 48%
NPV 90%

LAD (n=528)



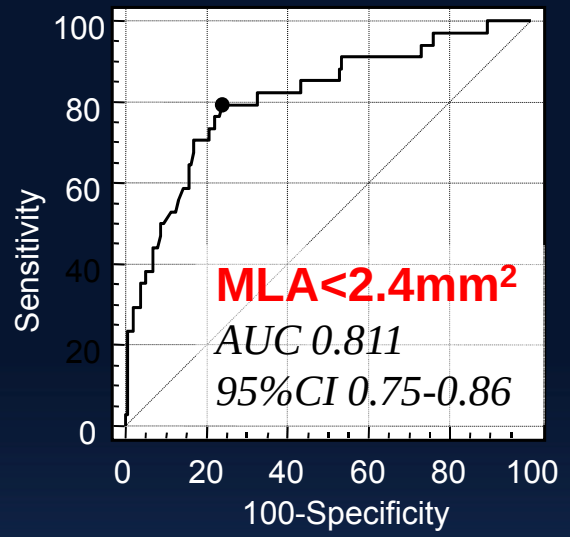
Sensitivity 80%, Specificity 64%

LCX (n=68)



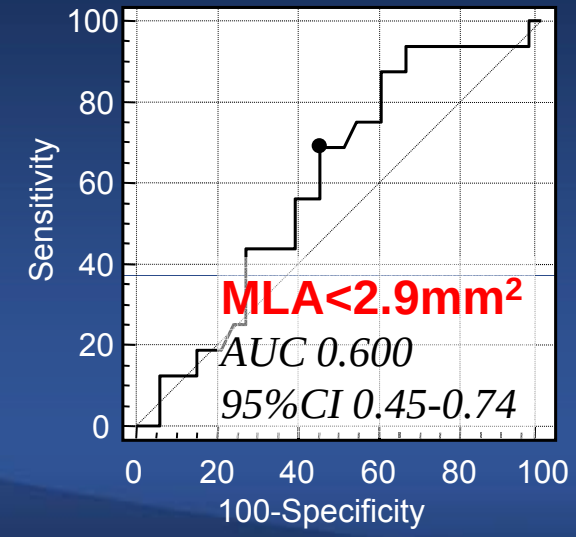
Sensitivity 89%, Specificity 77%

RCA (n=188)



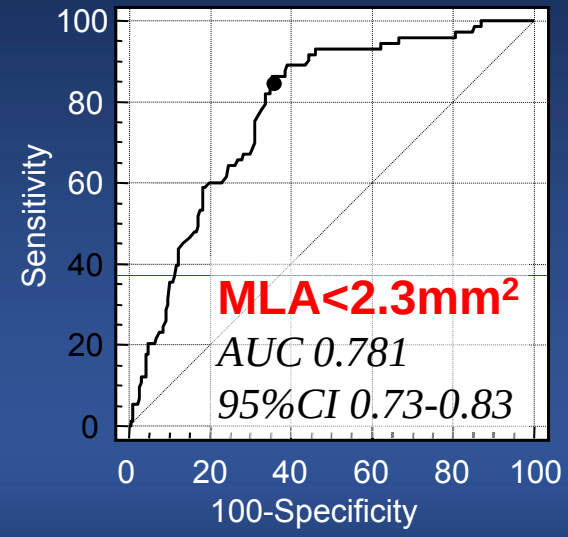
Sensitivity 79%, Specificity 77%

Plaque rupture (n=51)



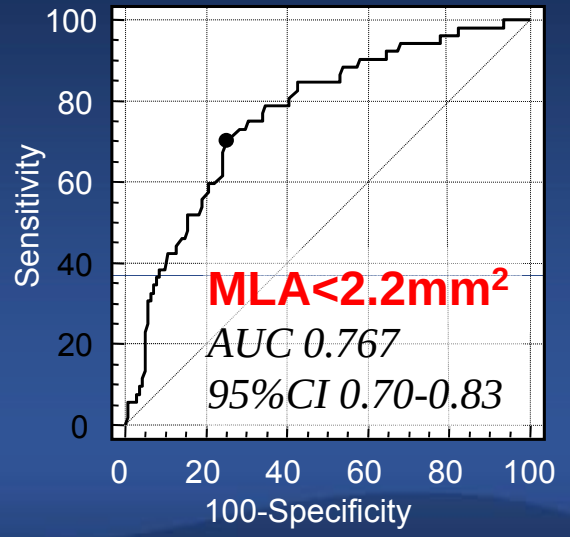
Sensitivity 69%, Specificity 55%

Diabetes (n=249)



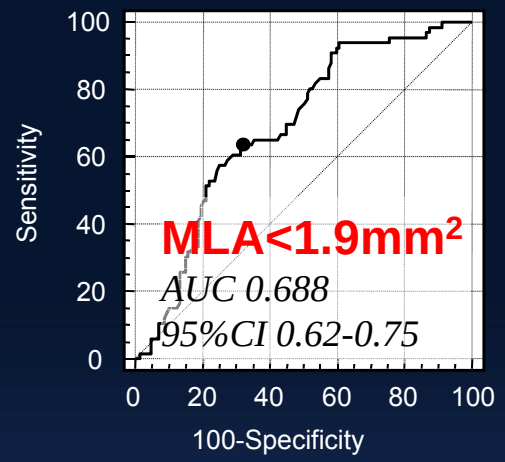
Sensitivity 86%, Specificity 65%

ACS (n=193)



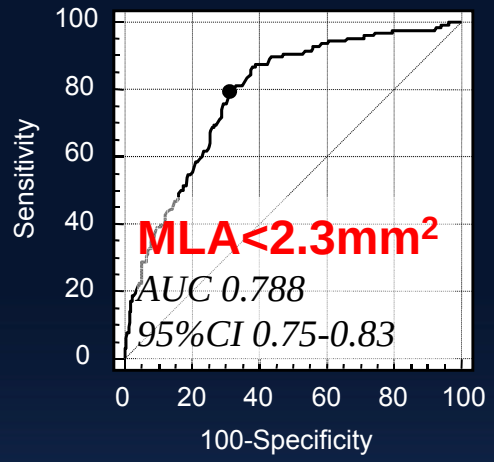
Sensitivity 71%, Specificity 75%

RLD <2.75mm (n=184)



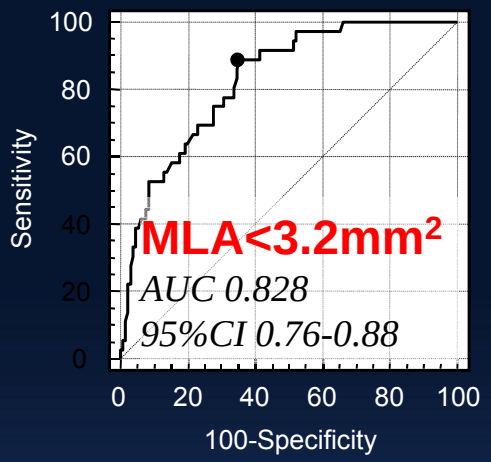
Sensitivity 64% Specificity 69%

RLD 2.75–3.5mm (n=439)



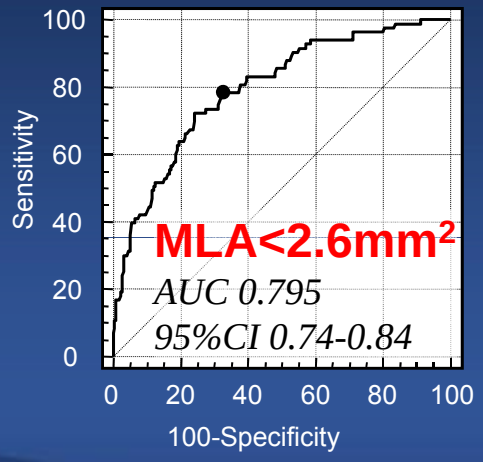
Sensitivity 80% Specificity 68%

RLD>3.5mm (n=161)



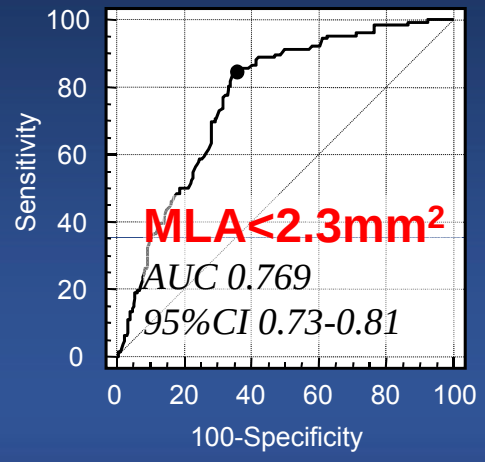
Sensitivity 89% Specificity 65%

Proximal (n=285)



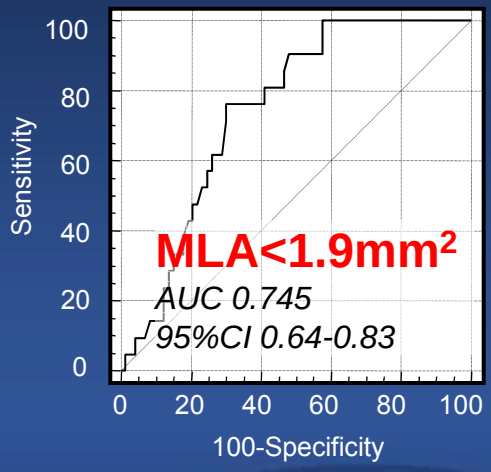
Sensitivity 78% Specificity 68%

Mid (n=405)



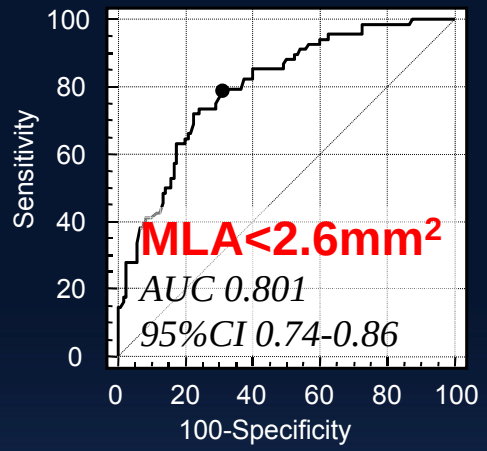
Sensitivity 84% Specificity 65%

Distal (n=94)



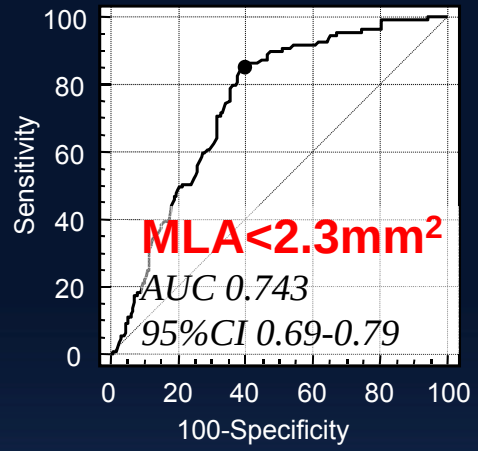
Sensitivity 76% Specificity 70%

Proximal LAD (n=180)



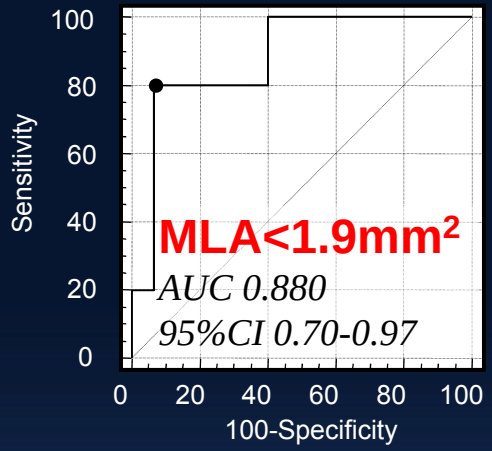
Sensitivity 79% Specificity 70%

Mid-LAD (n=323)



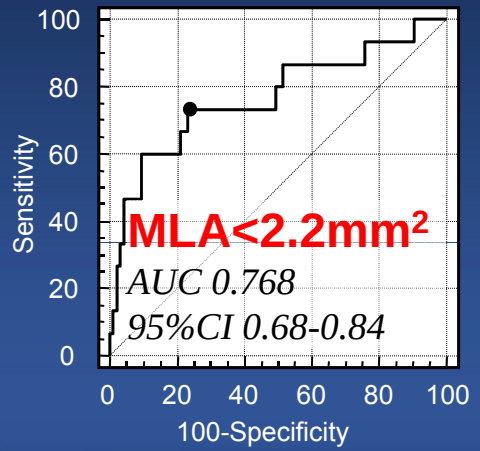
Sensitivity 85% Specificity 61%

Distal LAD (n=25)



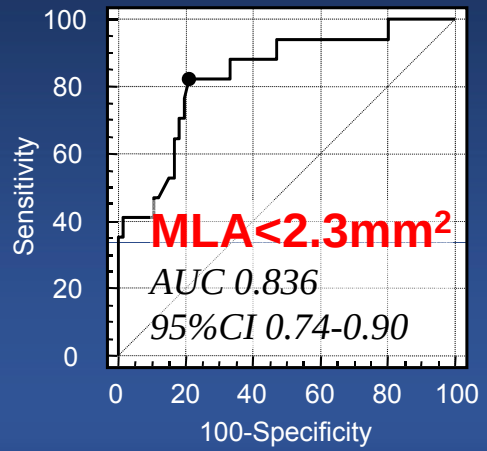
Sensitivity 80% Specificity 93%

Proximal, non-LAD (n=105)



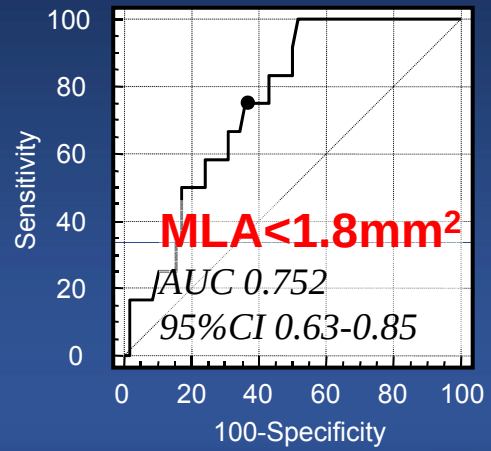
Sensitivity 73% Specificity 77%

Mid, non-LAD (n=82)



Sensitivity 82% Specificity 79%

Distal, non-LAD (n=69)



Sensitivity 75% Specificity 64%

New IVUS MLA
matched with FFR <0.80

2.4 mm^2

Kang SJ, Park SJ, Circ Cardiovasc Interv. 2011;4: 65-71

In My Practice

32%

Decision making (treat or not treat) should be done by FFR not by IVUS MLA.

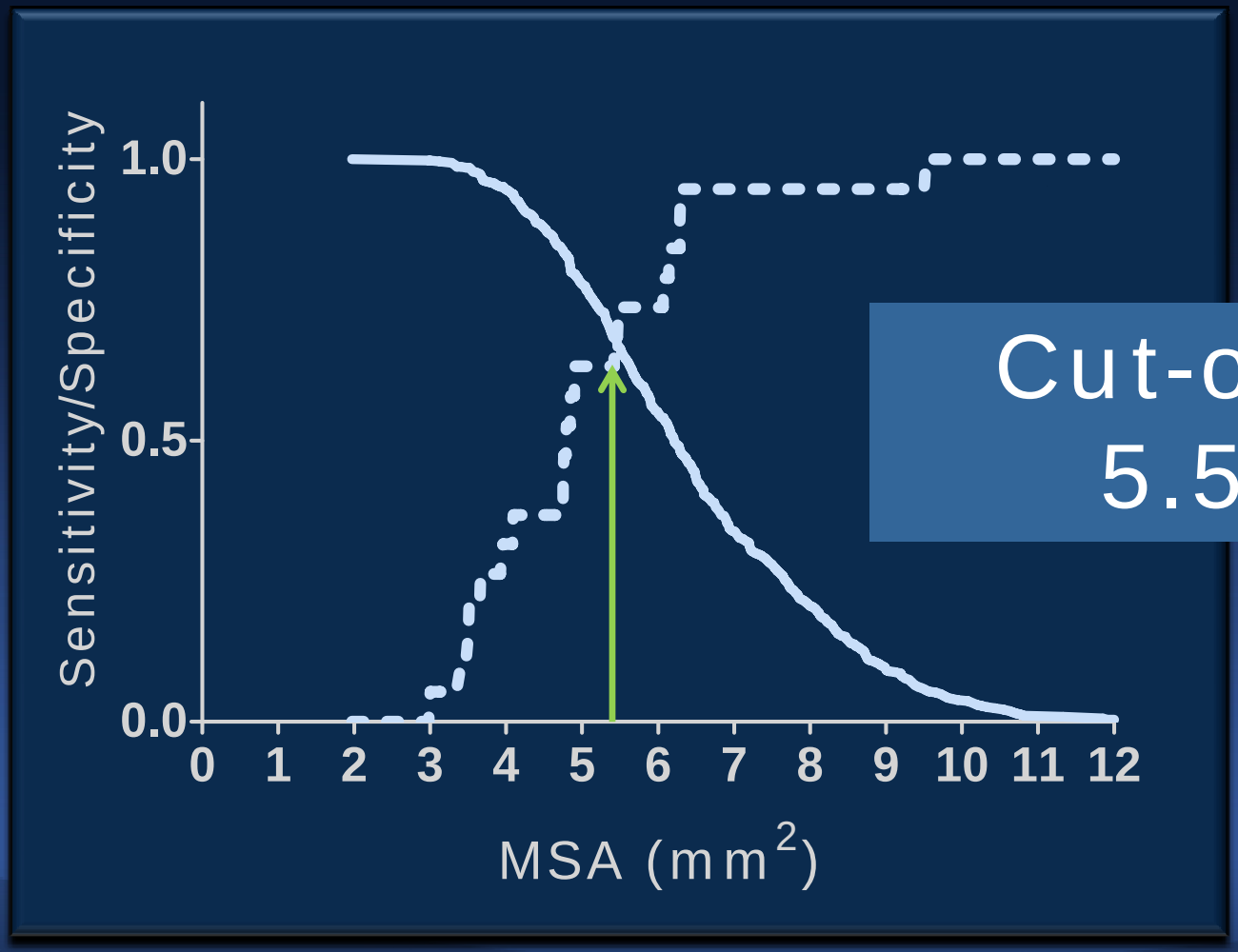
IVUS guided Stent Optimization

IVUS Predictors for Clinical Outcomes

IVUS stent CSA and total stent length, are independent predictors for restenosis and stent thrombosis.

Park, DW. AJC 2006;98:353-356, AMC data
Hong MK, Eur Heart J, 2006:27:1305,AMC data
Suh J, JACC Intv, 2010;3:383-9

Optimal IVUS Stent CSA to Predict Restenosis (n=541, SES)



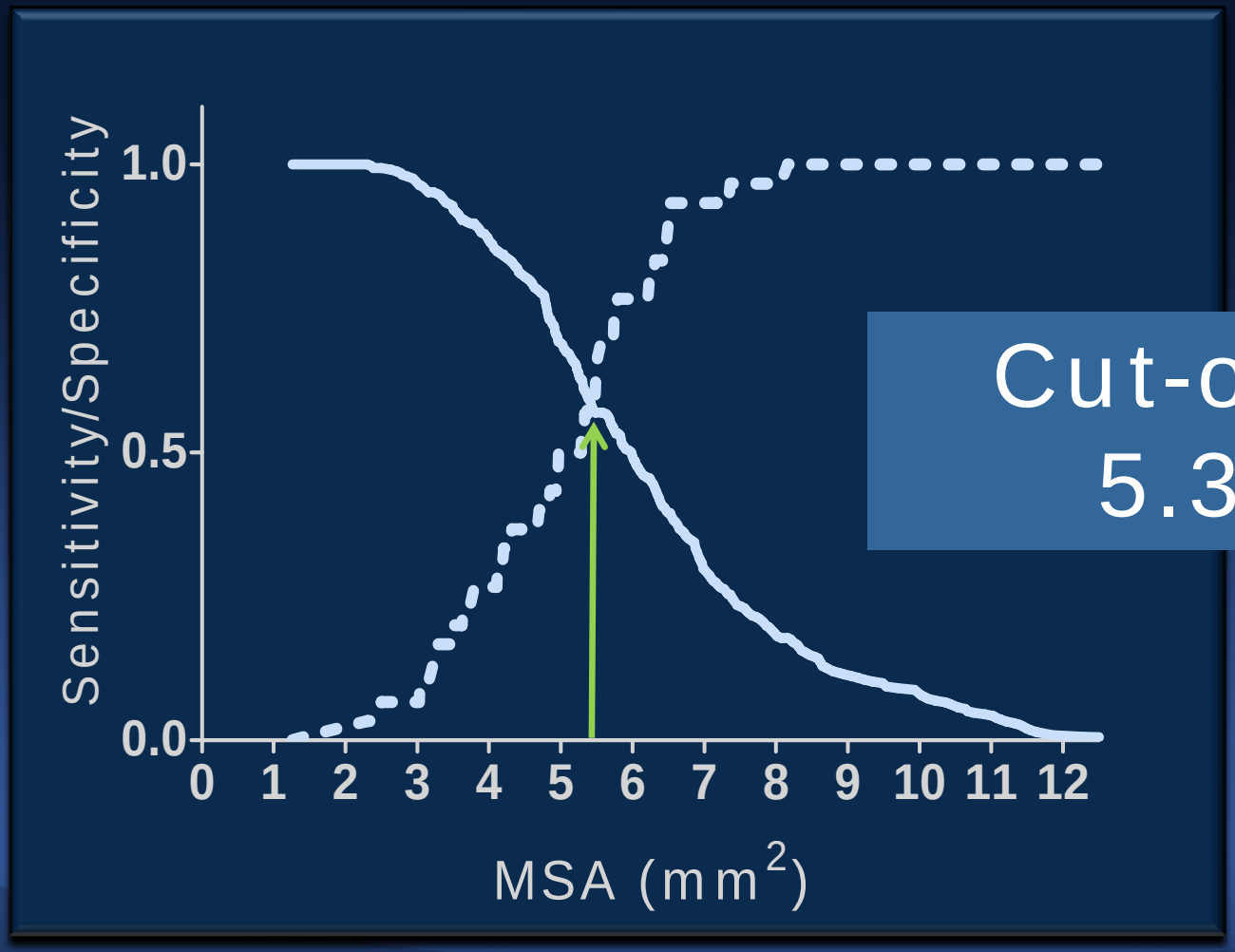
Cut-off value
5.5 mm²

Sensitivity 72.2%

Specificity 66.3%

(AUC 0.74)

Optimal IVUS Stent CSA to Predict Restenosis (n=220, ZES)



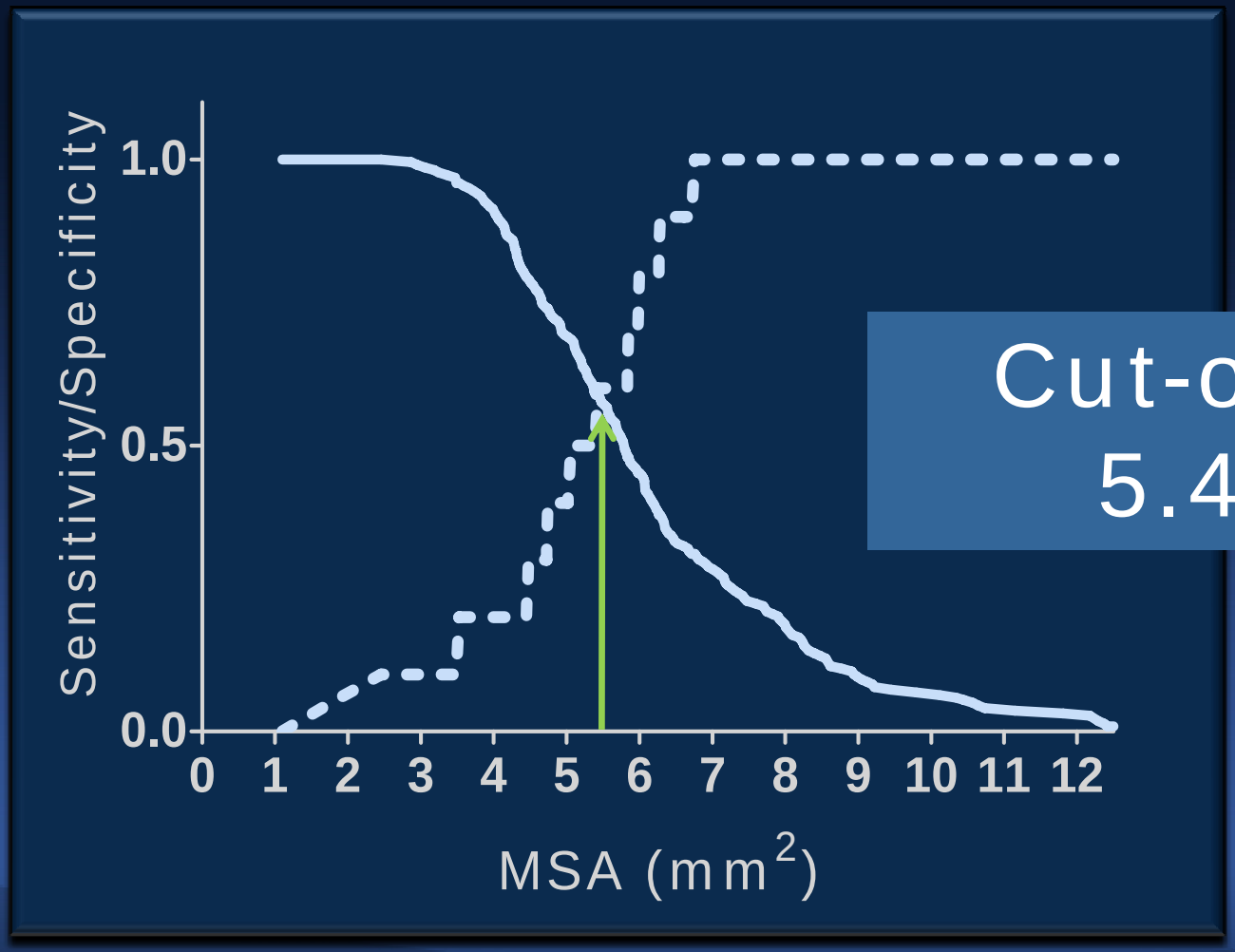
Cut-off value
5.3 mm²

Sensitivity 56.7%

Specificity 61.8%

(AUC 0.67)

Optimal IVUS Stent CSA to Predict Restenosis (n=229, EES)



Cut-off value
5.4 mm²

Sensitivity 60.0%

Specificity 59.9%

(AUC 0.64)

IVUS Guided Stent Optimization (Rule of 5)

Stent CSA : > 5.5 mm^2

Stented length : < 50 mm

< 2 % TVR

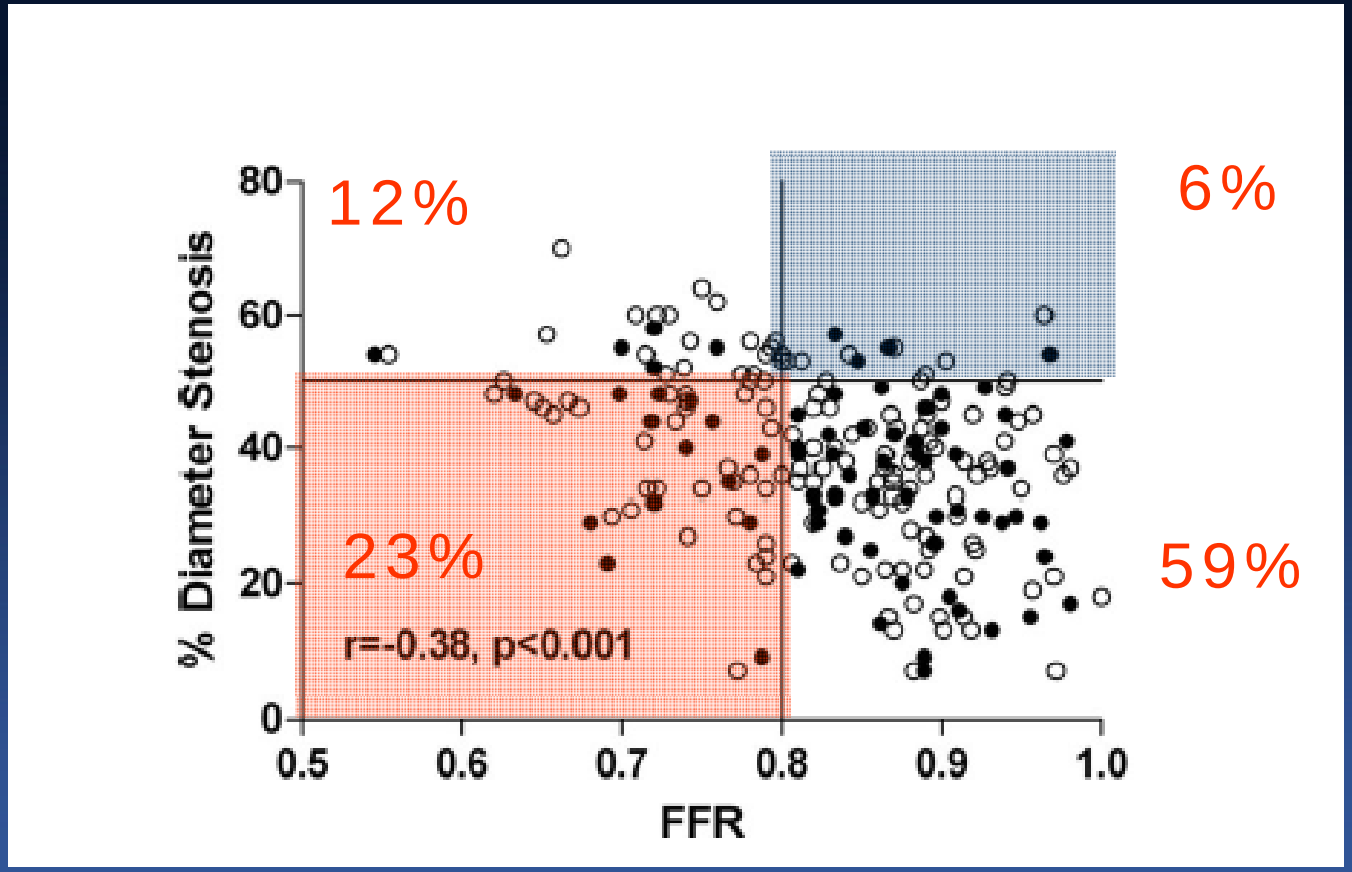
Park, DW. AJC 2006;98:353-356,
Hong MK, Eur Heart J, 2006:27:1305,AMC data

Left Main Disease

FFR and IVUS MLA
IVUS guided optimization

FFR vs. Angiography

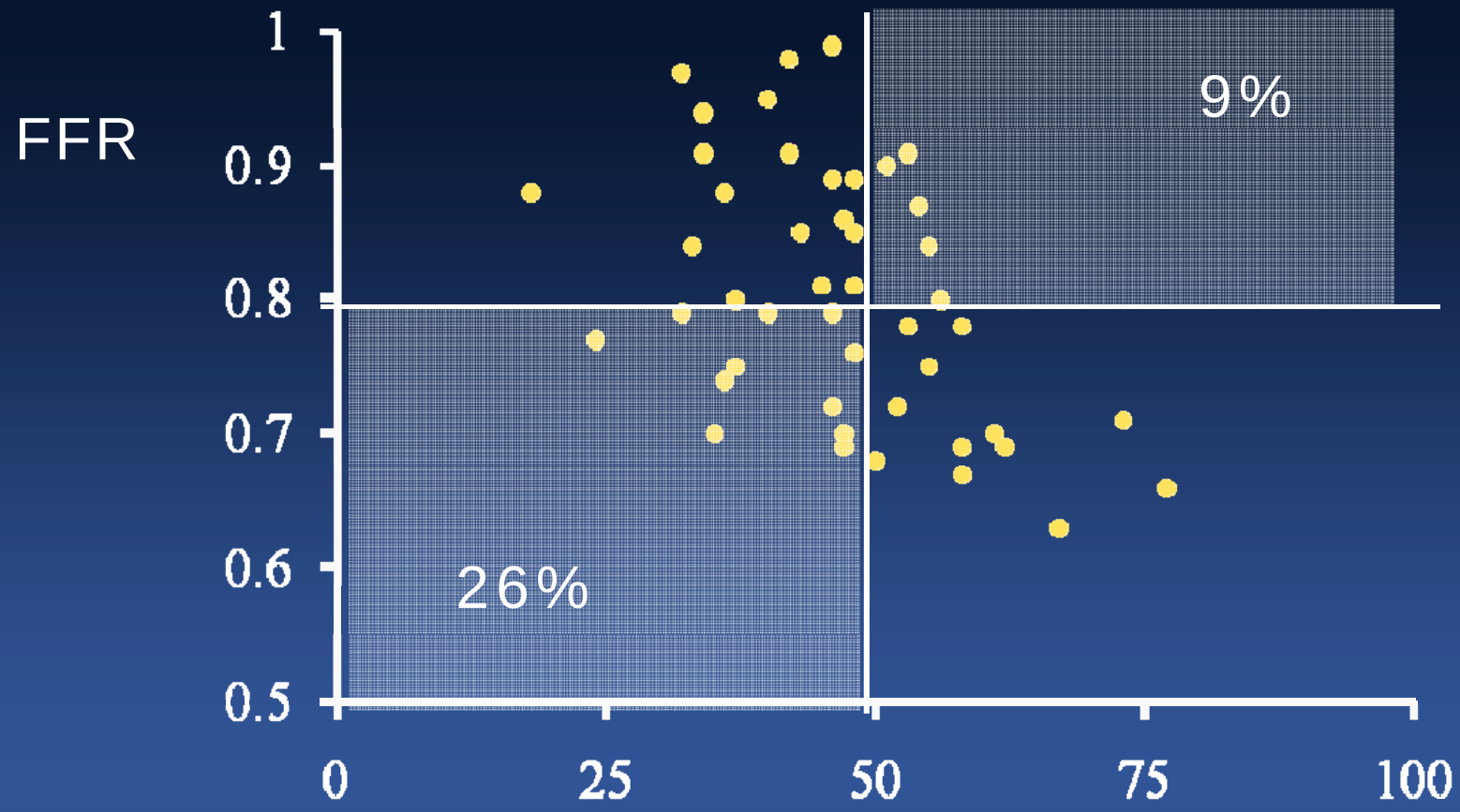
Mismatch
in intermediate LM Disease



Hamilos M, Circulation 2009; 120: 1505-1512

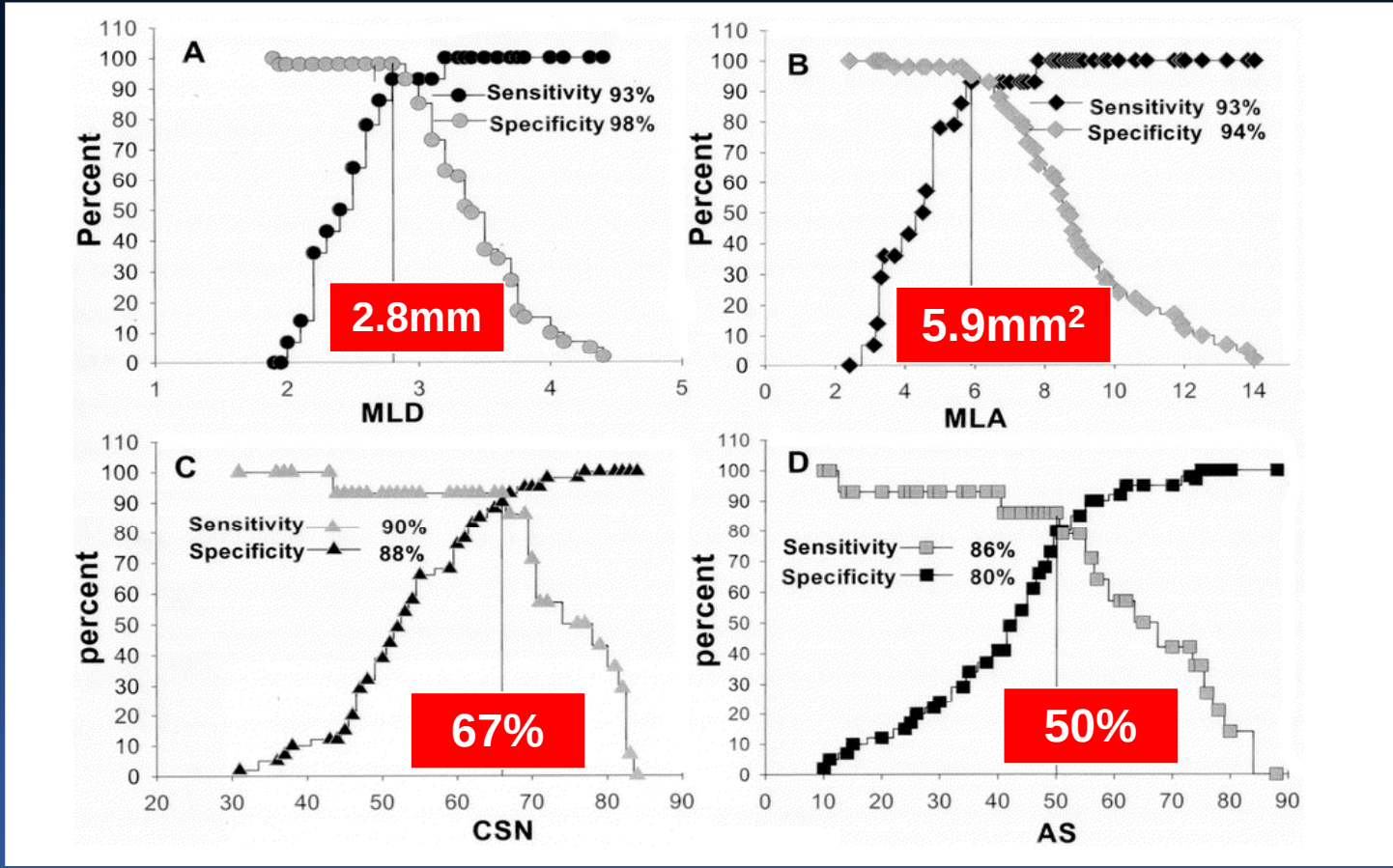
Mismatch

in Isolated intermediate LM Disease (n=55)



Different Insight
for FFR vs. IVUS
in Left Main Disease

IVUS MLA < 6.0 mm^2 is matched with FFR <0.75



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

New Comparison

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

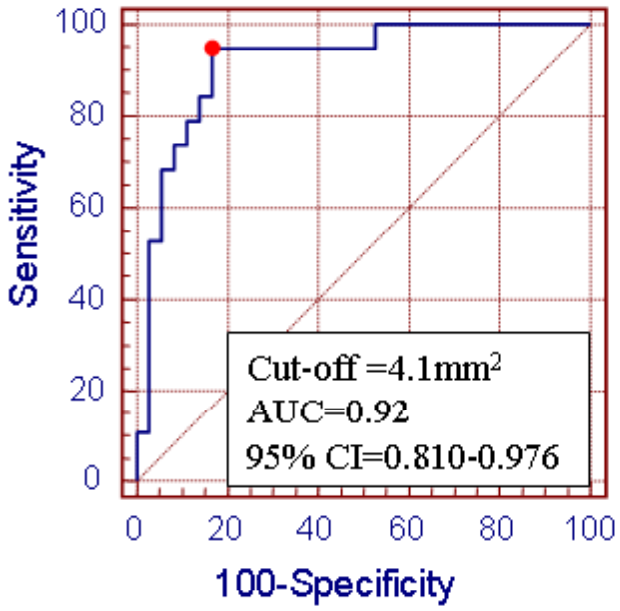
FFR vs. IVUS MLA

Preliminary Data, 2011

New IVUS MLA

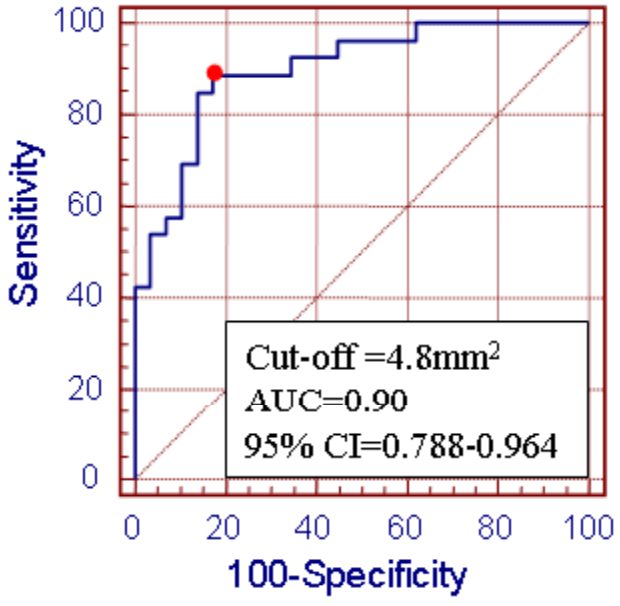
AMC prospective cohort registry (n=55 lesions)

C. MLA predicting FFR<0.75



Sensitivity 95%
Specificity 83%
PPV 75%
NPV 97%
Accuracy 87%

A. MLA predicting FFR<0.80



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

4.1 mm²

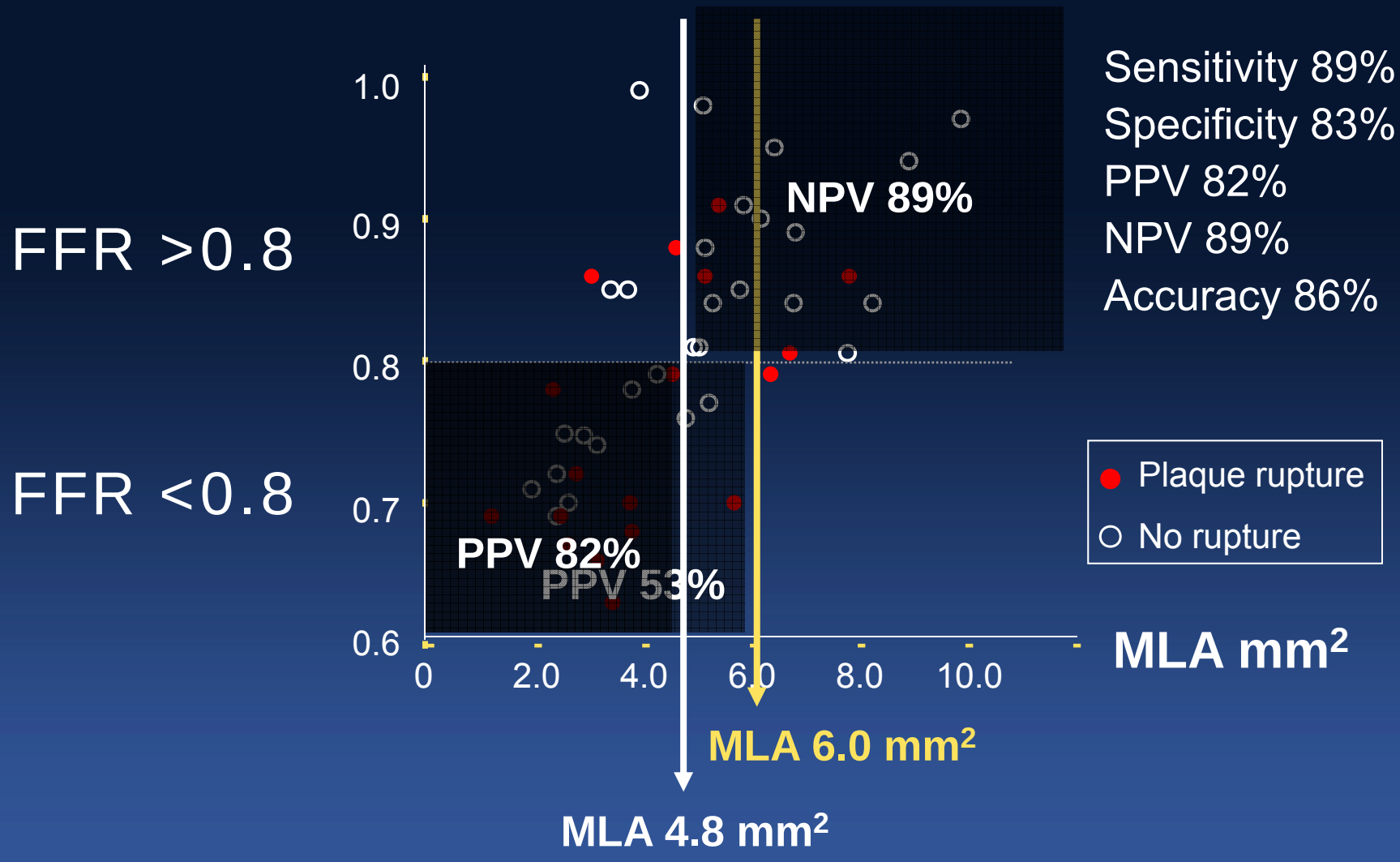
4.8 mm²

New IVUS MLA

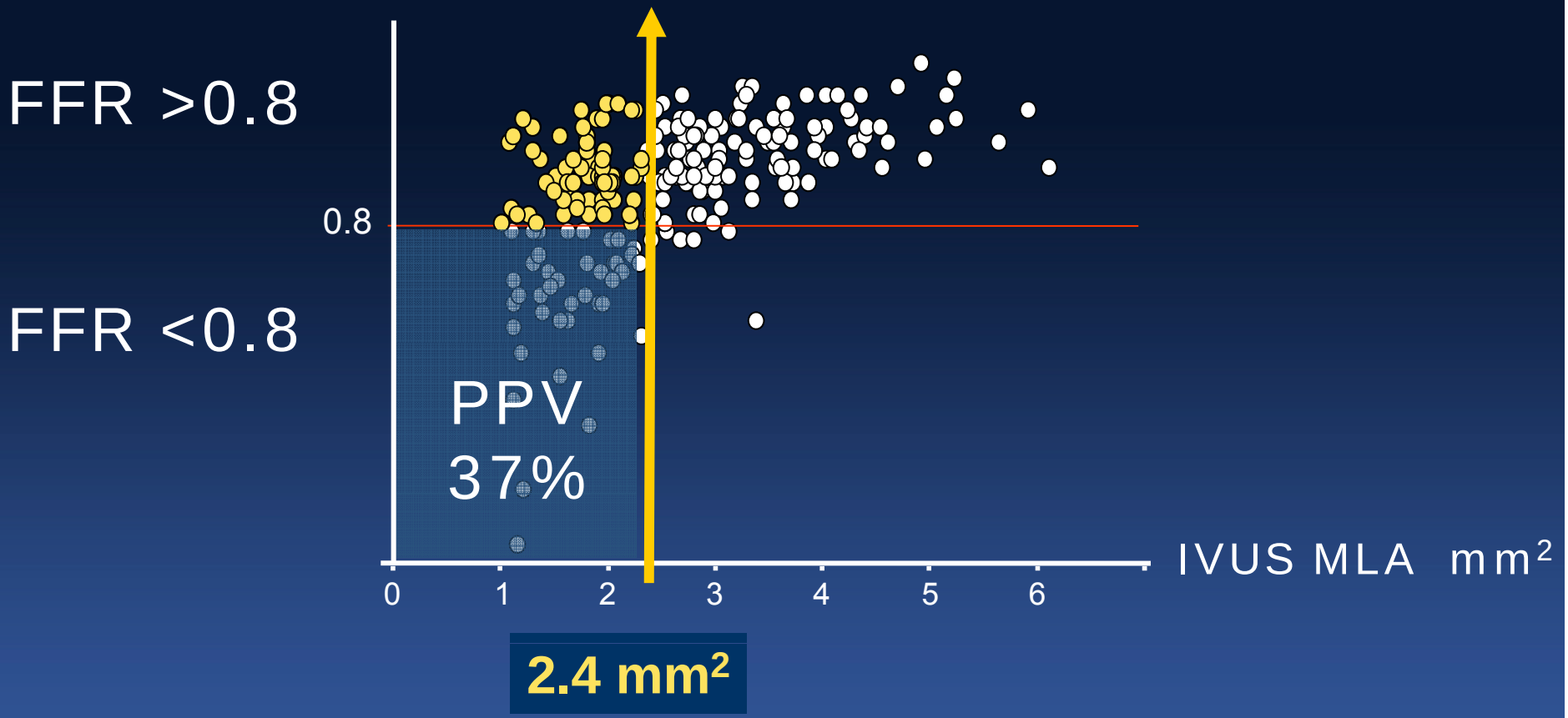
Matched with FFR <0.80 in LM Disease

4.8 mm^2

Preliminary AMC data


FFR >0.8
FFR <0.8
1.0
0.9
0.8
0.7
0.6
0
2.0
4.0
6.0
8.0
10.0
NPV 89%
PPV 82%
PPV 53%
MLA mm²
MLA 6.0 mm²
MLA 4.8 mm²
Plaque rupture
No rupture
Sensitivity 89%
Specificity 83%
PPV 82%
NPV 89%
Accuracy 86%

In Epicardial artery



New IVUS MLA (4.8 mm^2) can predict functional significance of stenosis of LM disease. (PPV : 82%)

In Real Practice

Ostial and Shaft LM PCI

- Functional Assessment (FFR) is Crucial.
- 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 LM Bifurcation Treatment

Still FFR-guided decision making for intermediate lesion, IVUS-guided lesion specific approach, and IVUS-guided optimization.

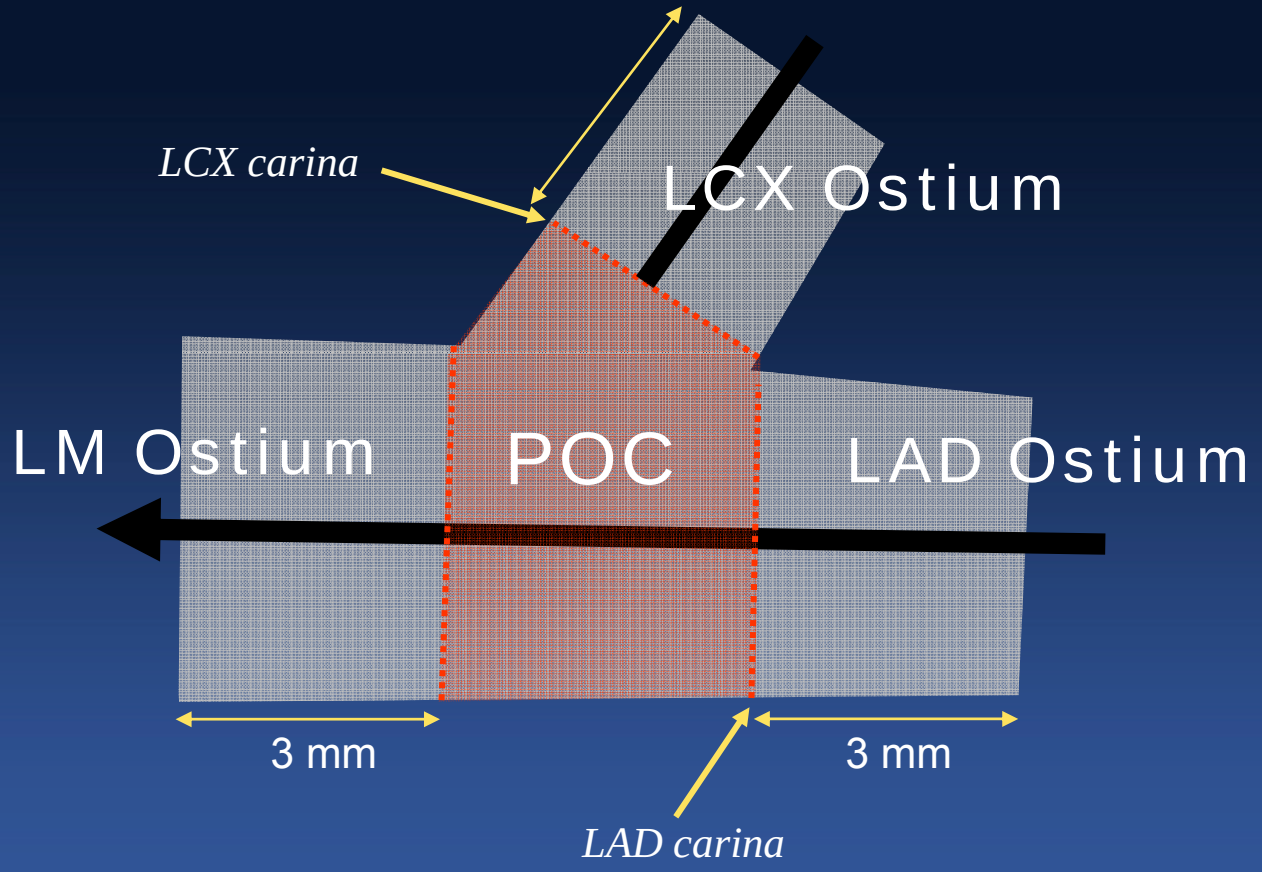
IVUS guided Stent Optimization

IVUS Stent Area and its Impact for restenosis

in 403 Patients with Unprotected Left Main Disease

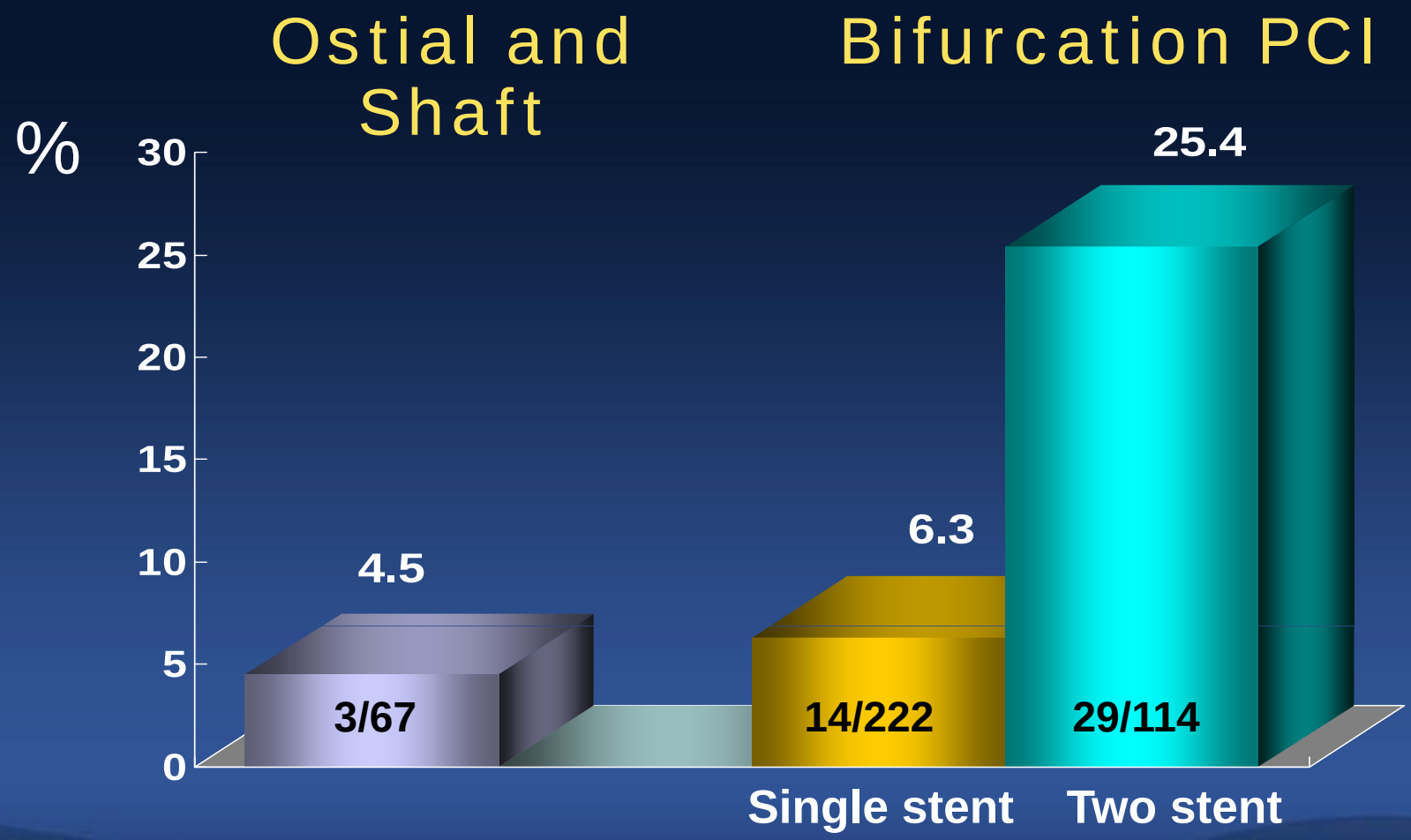
All patients treated with SES
100% Post-stent IVUS,
100% Angiography F/U at 9 months and
2 years clinical F/U

IVUS Measurement

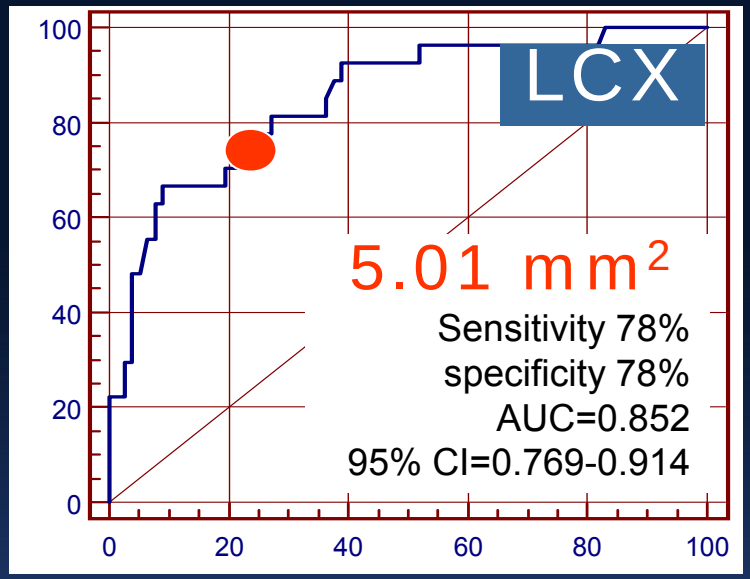


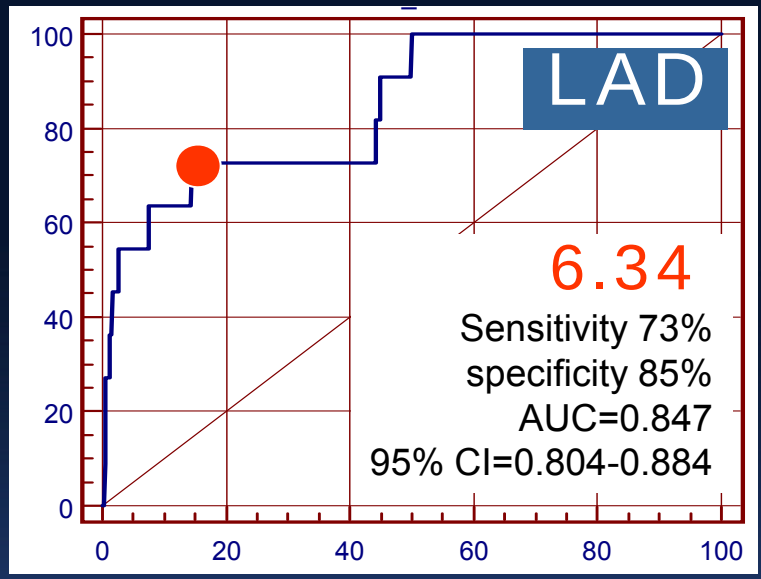
POC : Polygon Of Confluence

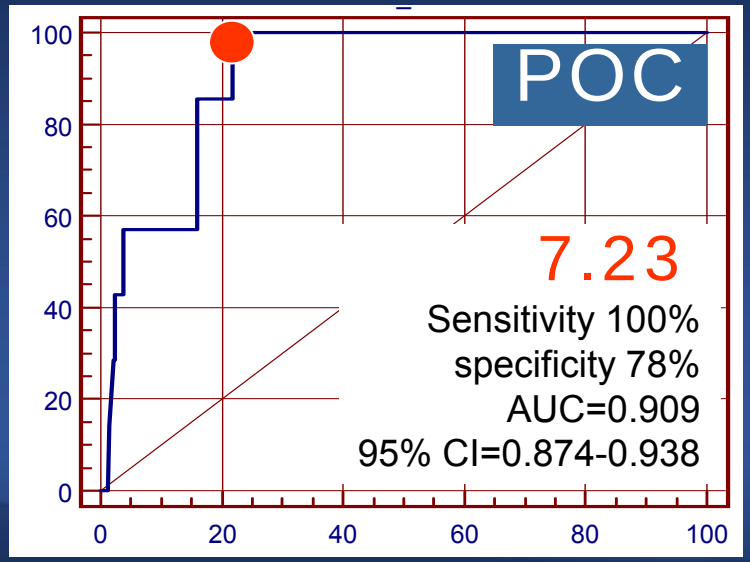
Restenosis at 2 year

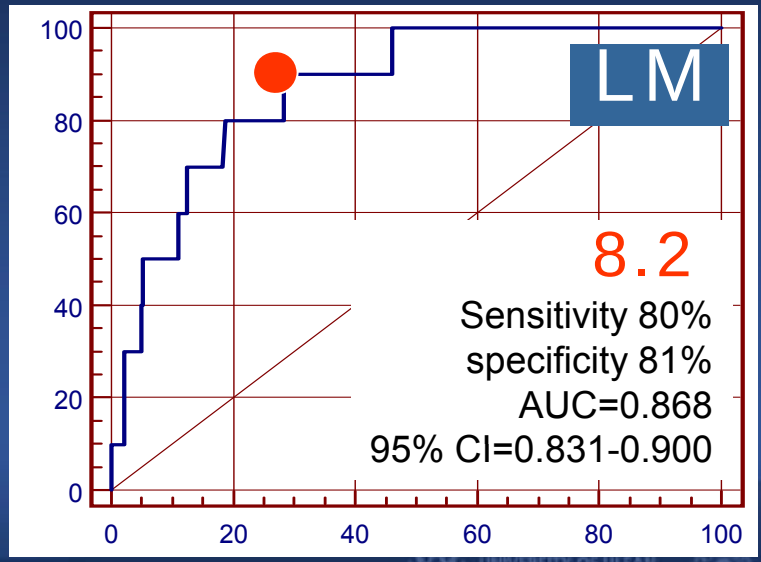


Minimal Stent Area (mm^2)
to predict ISR





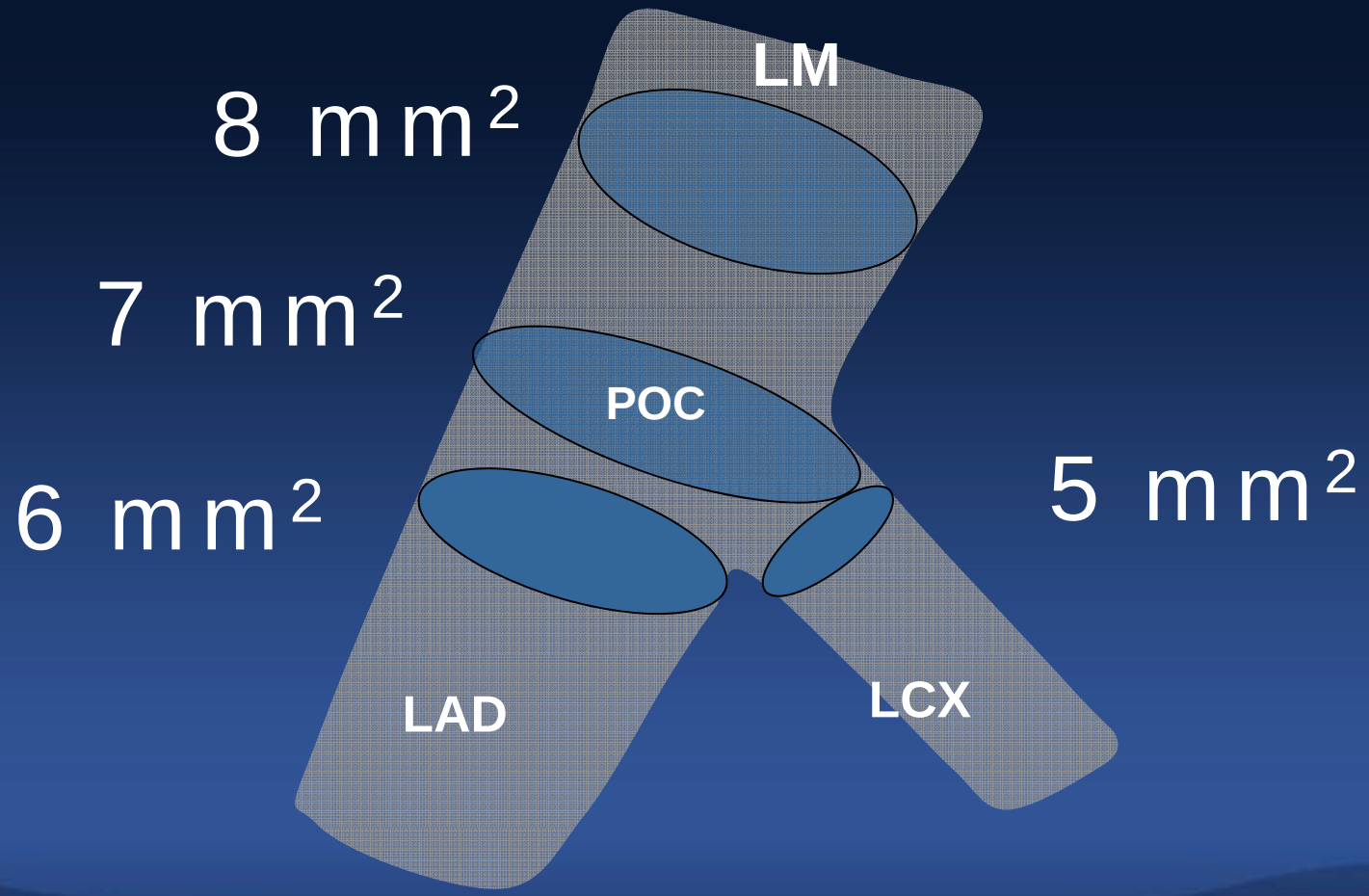




Sensitivity

Specificity

IVUS Stent Optimization
(Stent Cross-sectional Area)



Take Home Message

FFR and IVUS MLA ,
they are totally different.

FFR, When ?

If the patient have no data about the non-invasive stress tests,

Please consider FFR in the cath. Lab !

FFR, When ?

Angiographic (visual) DS <80% (60% of your procedures) should be considered FFR.

60% out of them would be negative FFR.

IVUS, When ?

IVUS guidance have more understanding about inside of the vessel (ostial lesion assessment, negative remodeling, plaque characterization and true reference vessel size).

IVUS, When ?

Absolute lumen CSA >2.4 mm^2 in epicardial artery is well matched with negative FFR (NPV 90%) and we also have IVUS criteria (IVUS MLA >5 mm^2) to minimize TLR .

Absolute lumen CSA <4.8 mm^2 is the suggested criterion for intervention and we also have IVUS criteria (IVUS MLA 5,6,7,8 mm2) to minimize TLR for LM disease PCI.

Issue is,

Do you want to treat the Lesion ?
based on angiography or IVUS MLA

Do you want to treat the Patient ?
based on FFR
and/or non-invasive stress test