FFR-Guided Decision, IVUS-Guided Optimization of Left Main PCI

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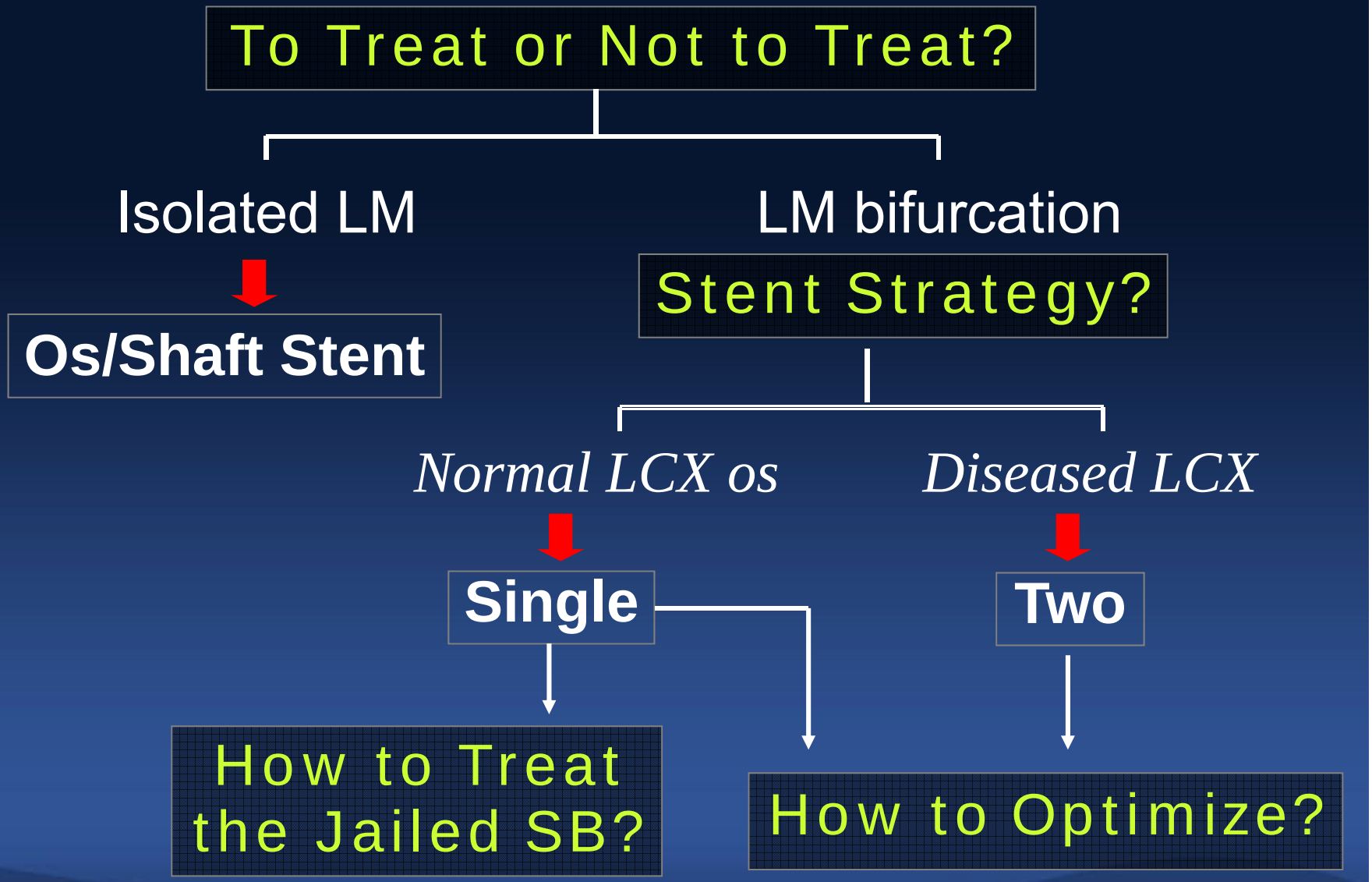
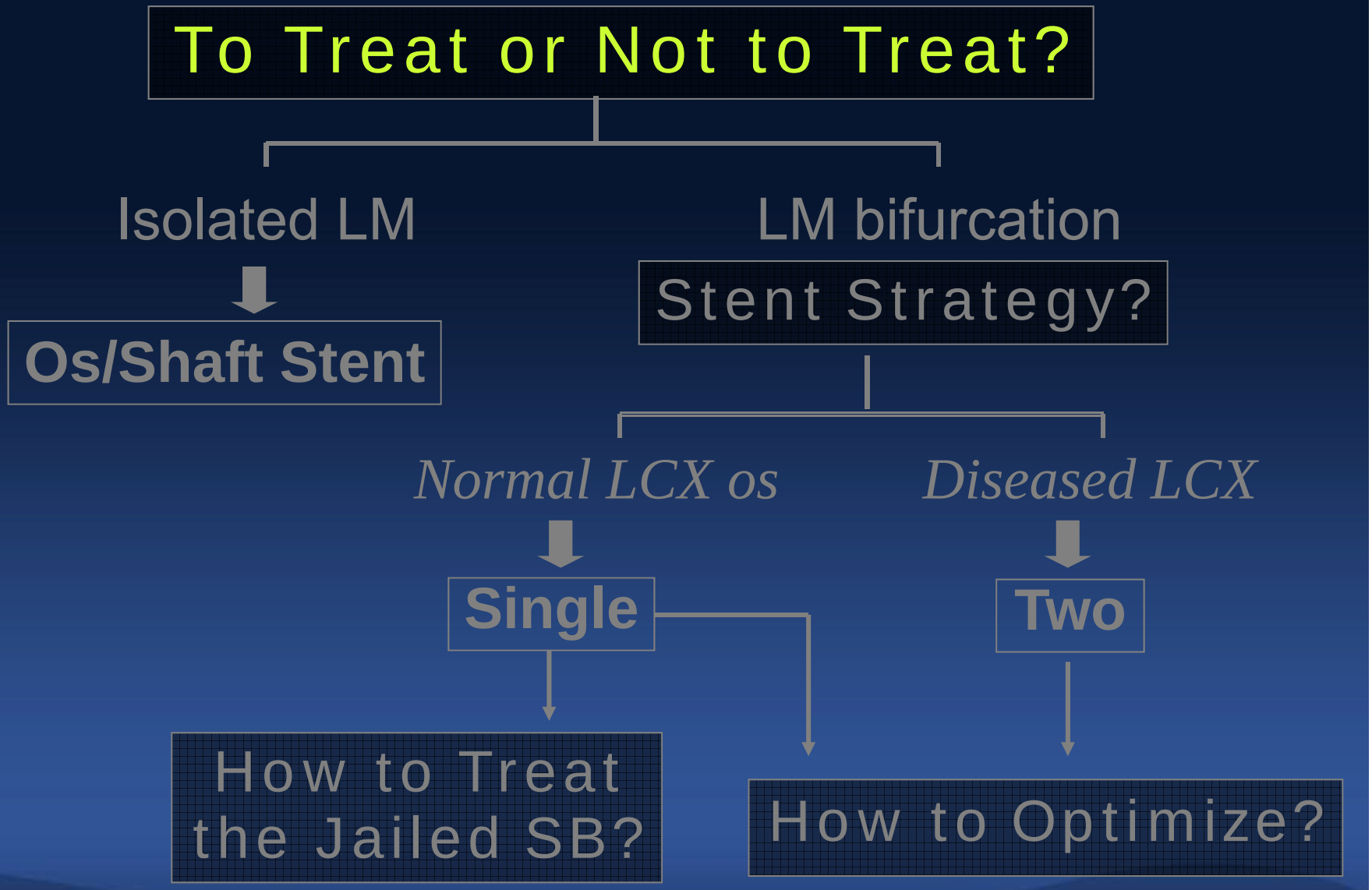
Disclosure

I have nothing to disclose

Issues of LM PCI



Issues of LM PCI

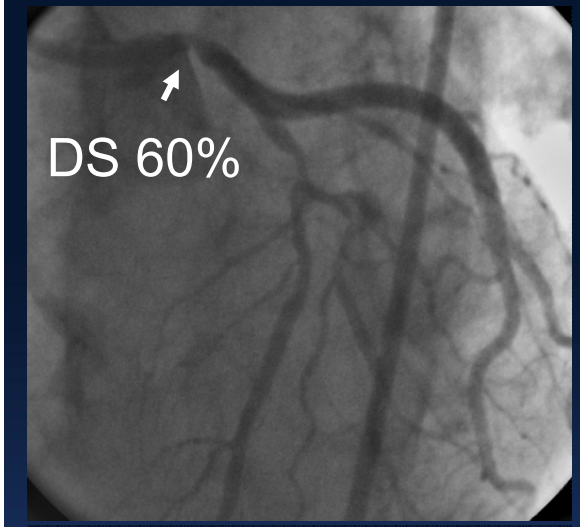


- Treatment strategy (deferral vs. revascularization) should be based on **"Functional significance"**

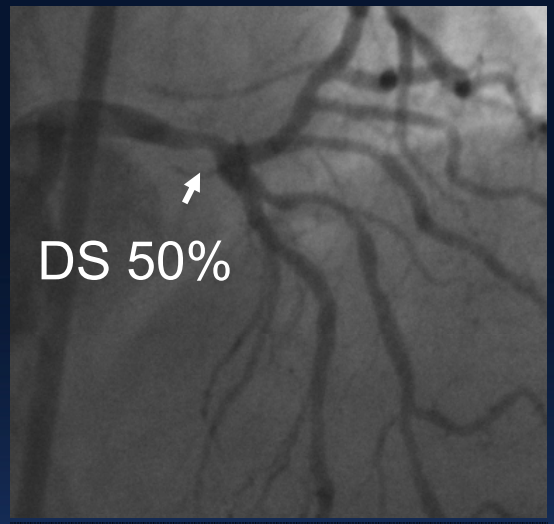
Author	Comparison	Results	p
Lindstaedt[1]	CABG (FFR<0.75) vs. Medical (≥0.80)	4-year Survival 81% vs. 100% MACE-free 66% vs. 69%	NS
Jasti[2]	CABG (FFR<0.75) vs. Medical (≥0.75)	38-month Survival 100% vs. 100% MACE-free 100% vs. 90%	NS
Courtis[3]	Revasc (FFR<0.75) vs. Medical (≥0.80)	14-month MACE 7% vs. 13%	NS
Bech[4]	Revasc (FFR<0.75) vs. Medical (≥0.75)	29-month Survival 100% vs. 97% MACE-free 83% vs.76%	NS
Hamilos[5]	CABG (FFR<0.80) vs. Medical (≥0.80)	5-year Survival 85% vs. 90% MACE-free 74% vs. 82%	NS

[1]Am Heart J 2006;152:156, [2]Circulation 2004;110:2831–6, [3]Am J Cardiol 2009;103:943-9
[4] Heart 2001;86:547-52, [5]Circulation 2009;120:1505-12

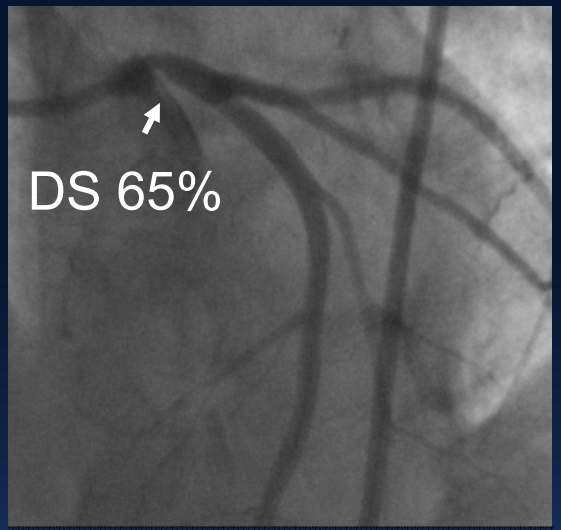
QCA DS Cannot Predict Neither Real Morphology Nor FFR



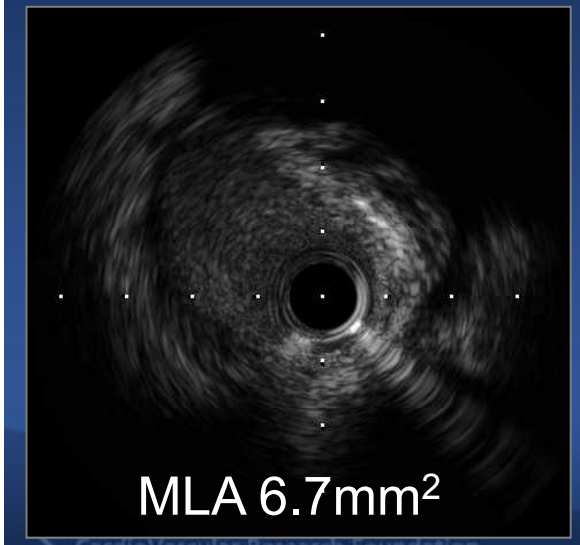
FFR=0.84

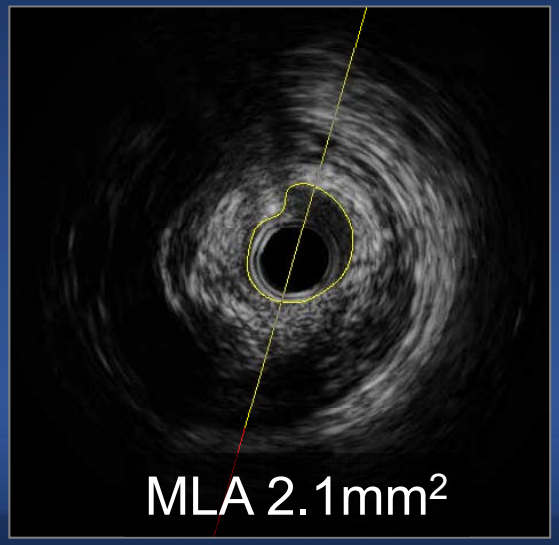


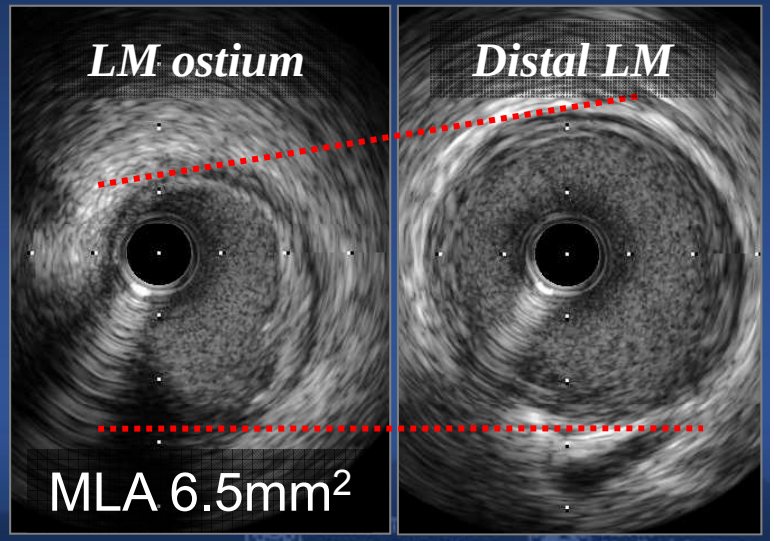
FFR=0.70



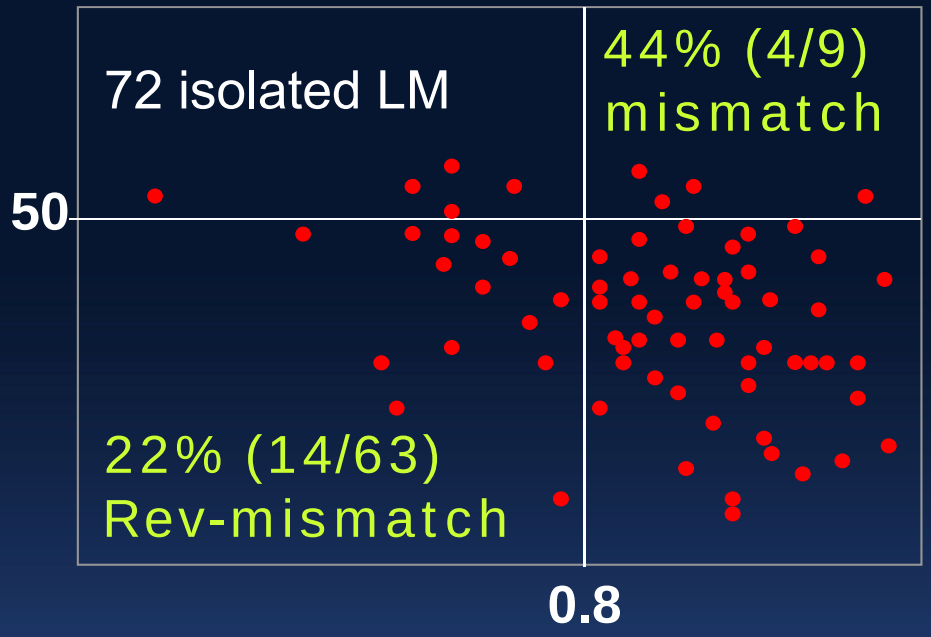
FFR=0.80

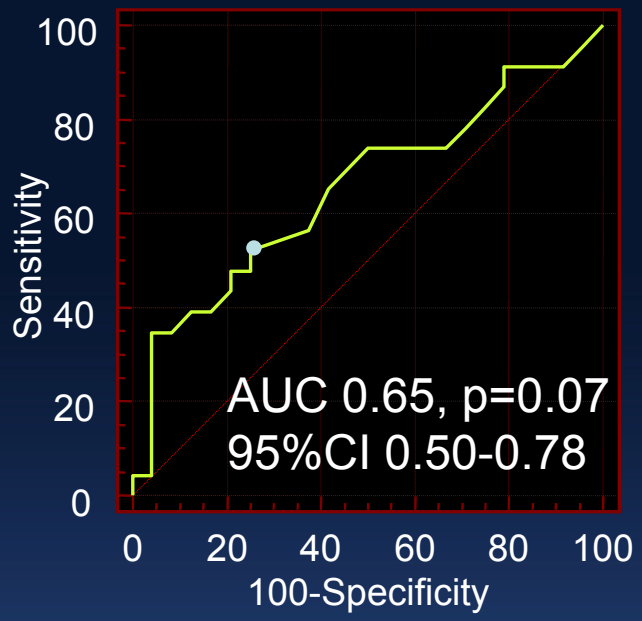






QCA DS Poorly Predicts LM FFR





DS 50%

Sensitivity 26%
Specificity 92%
Accuracy 75%

DS 48%

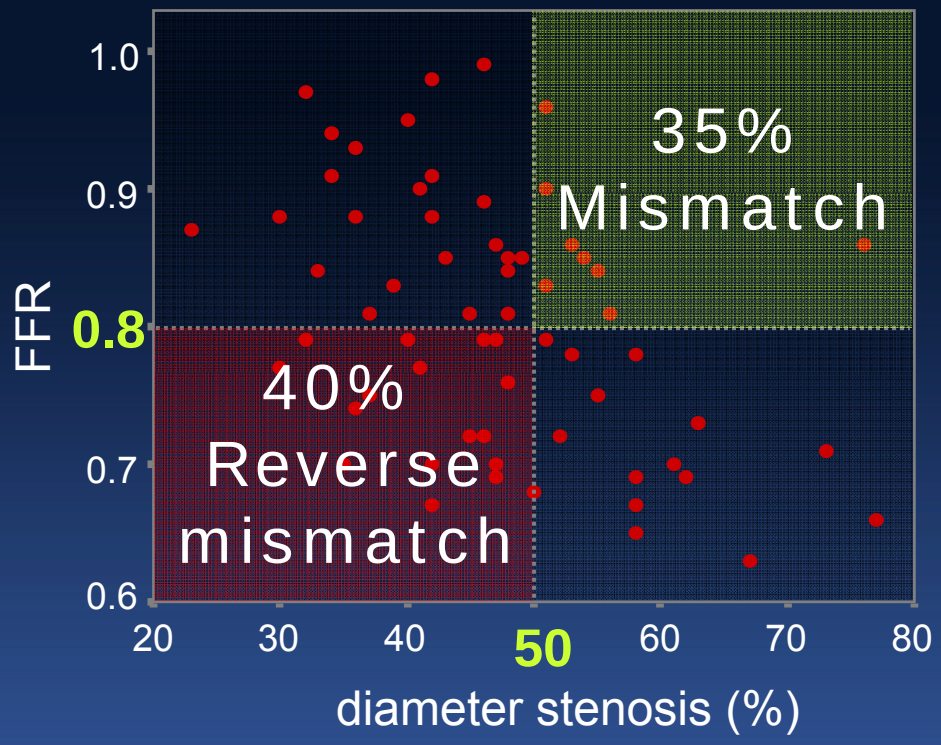
Sensitivity 51%
Specificity 75%
Accuracy 65%

Hamilos et al. Circulation 2009;120:1505-12

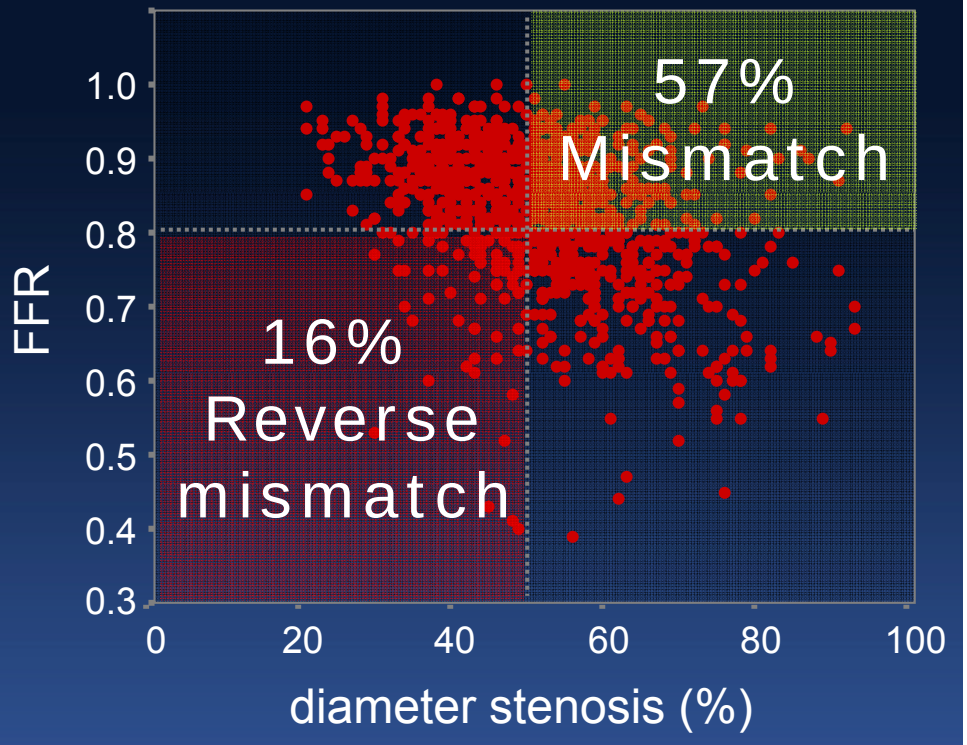
AMC data

QCA-FFR Discordance: LM vs. Non-LM

63 LM lesions



1066 Non-LM lesions



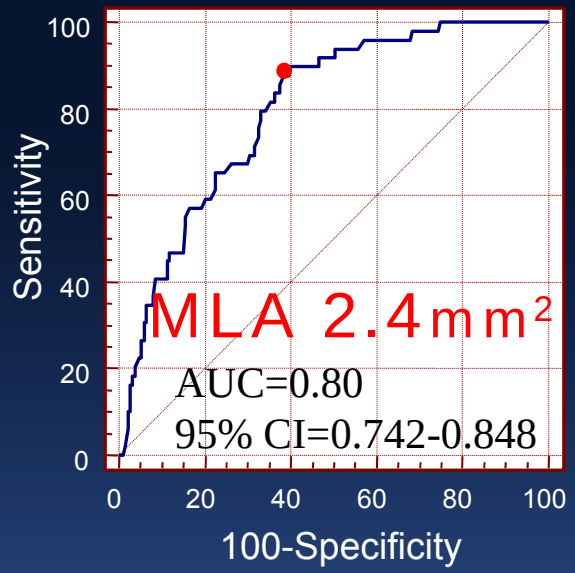
Angiographic underestimation of stenosis degree
Relatively large myocardial territory of LM

AMC data

IVUS-MLA Predicting LM FFR< 0.80

Pure LM lesion of DS 30-80%, exclude distal stream disease

Non-LM

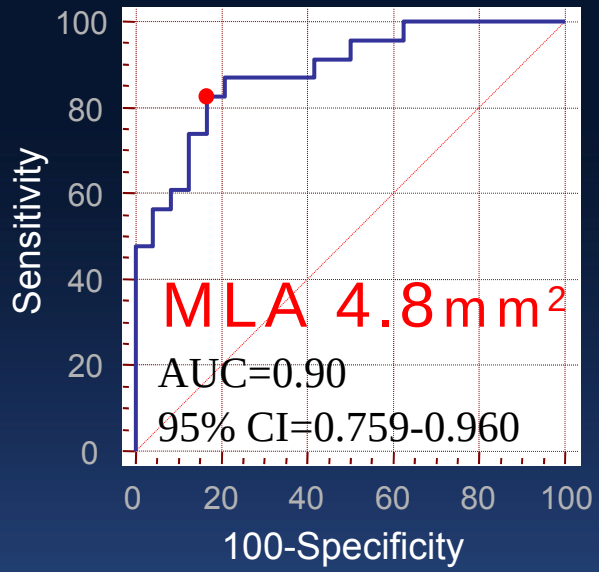


Sensitivity=90%

Specificity=60%

Accuracy=68%

Pure LM Disease



Sensitivity 89%

Specificity 83%

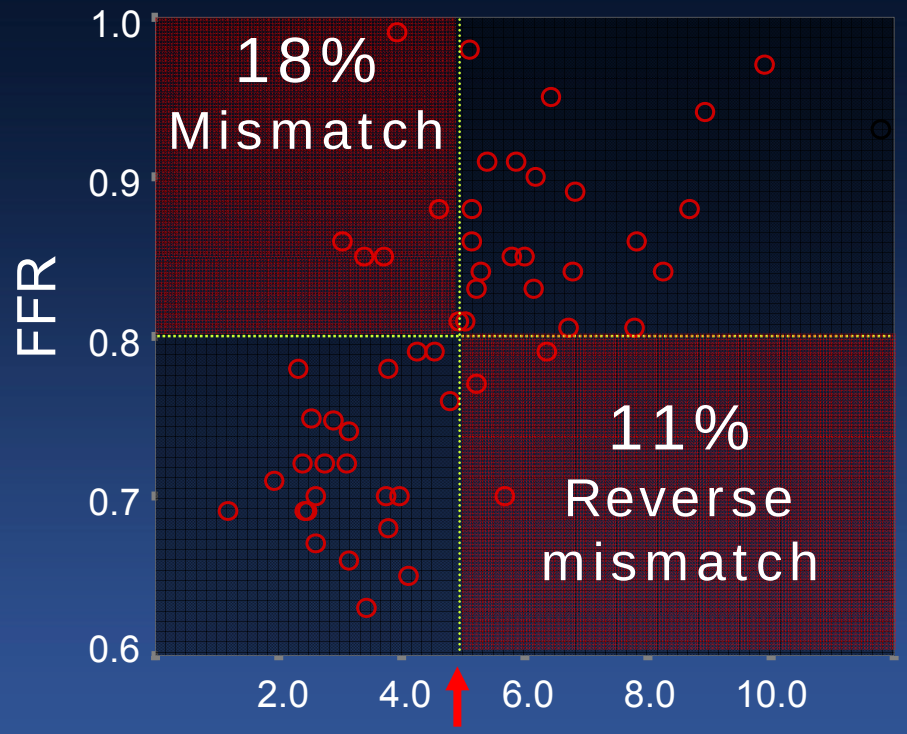
Accuracy 86%

Morphologic Simplicity of Pure LM Lesion

uniformly large vessel, short lesion length, lack of sidebranch

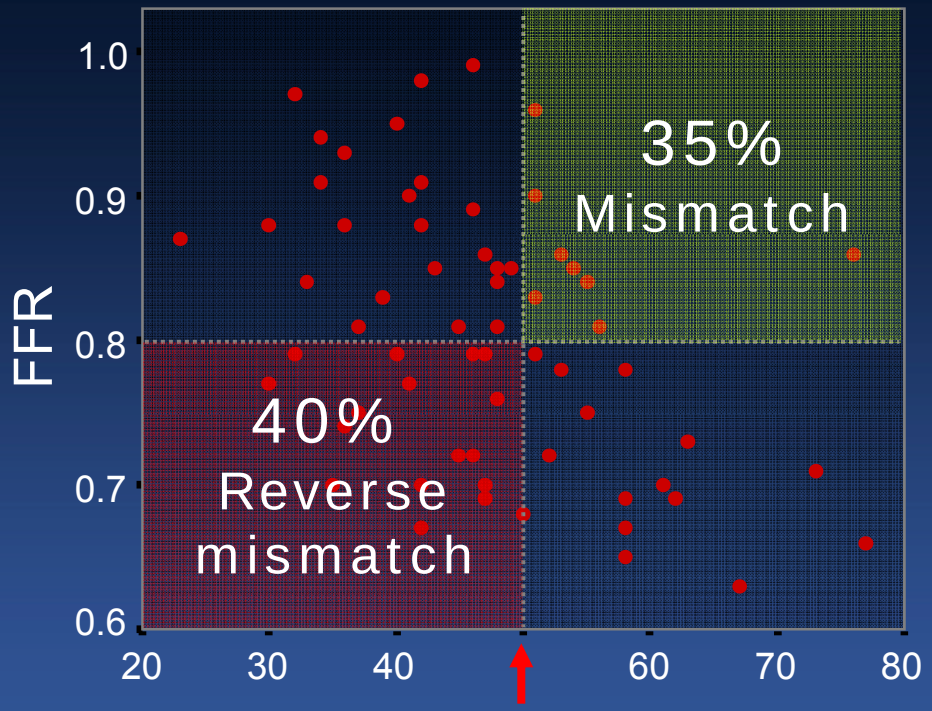
Visual-Functional Discordance
in LM Disease

IVUS-MLA vs. FFR



MLA 4.8mm²

QCA DS vs. FFR



DS 50%

More accurate morphologic information by IVUS

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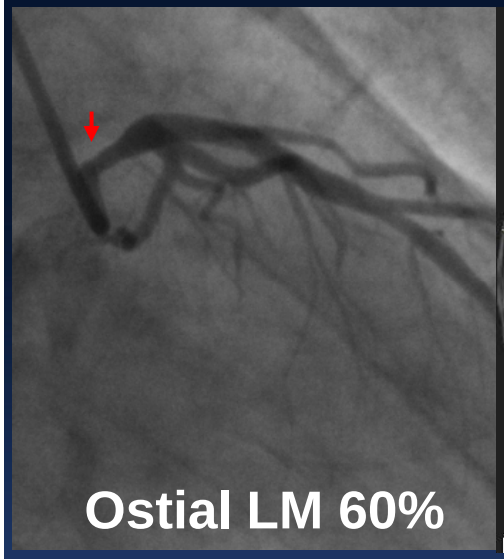
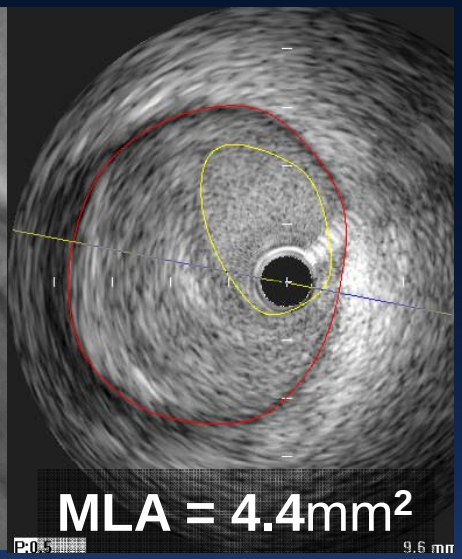
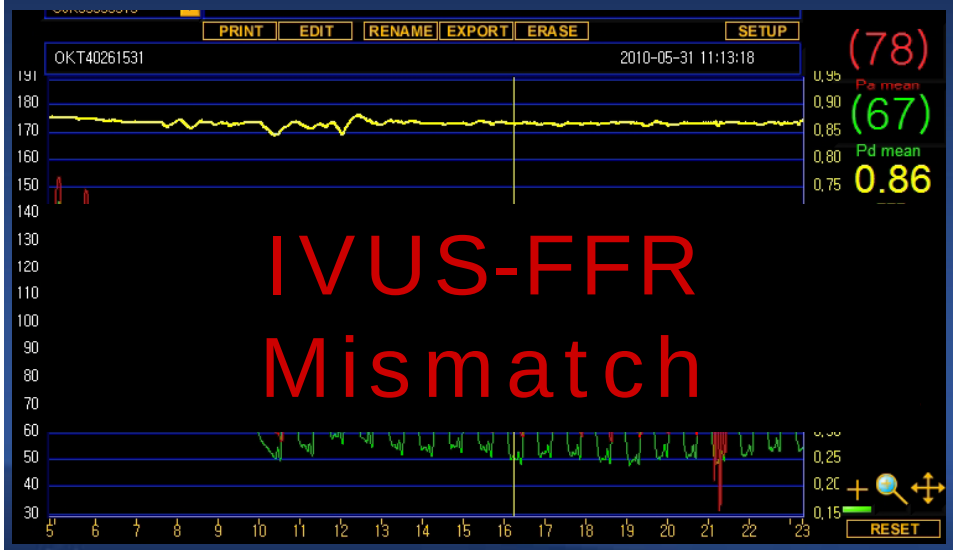
14% are still misclassified with MLA Cut-off

47/M Stable angina



Ostial LM 60%

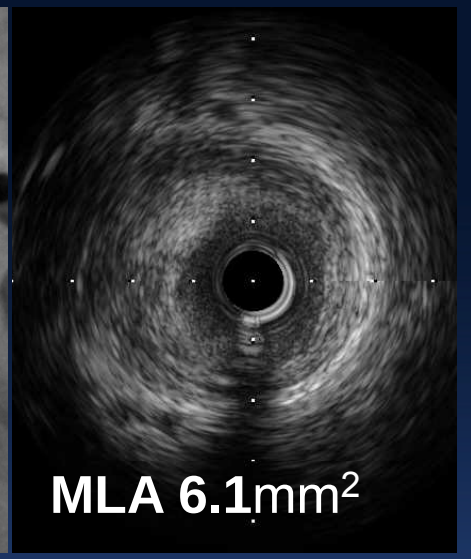


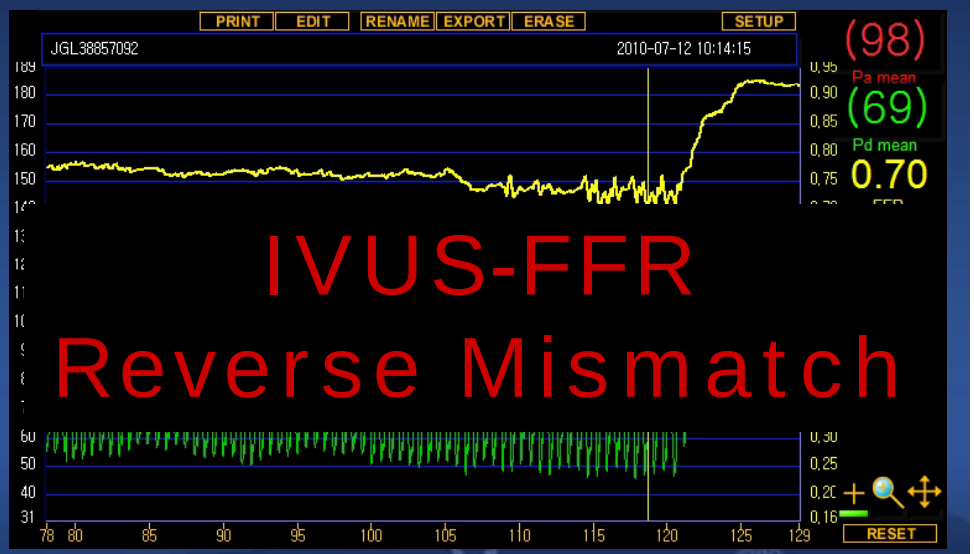


IVUS-FFR Mismatch

50/M Stable angina

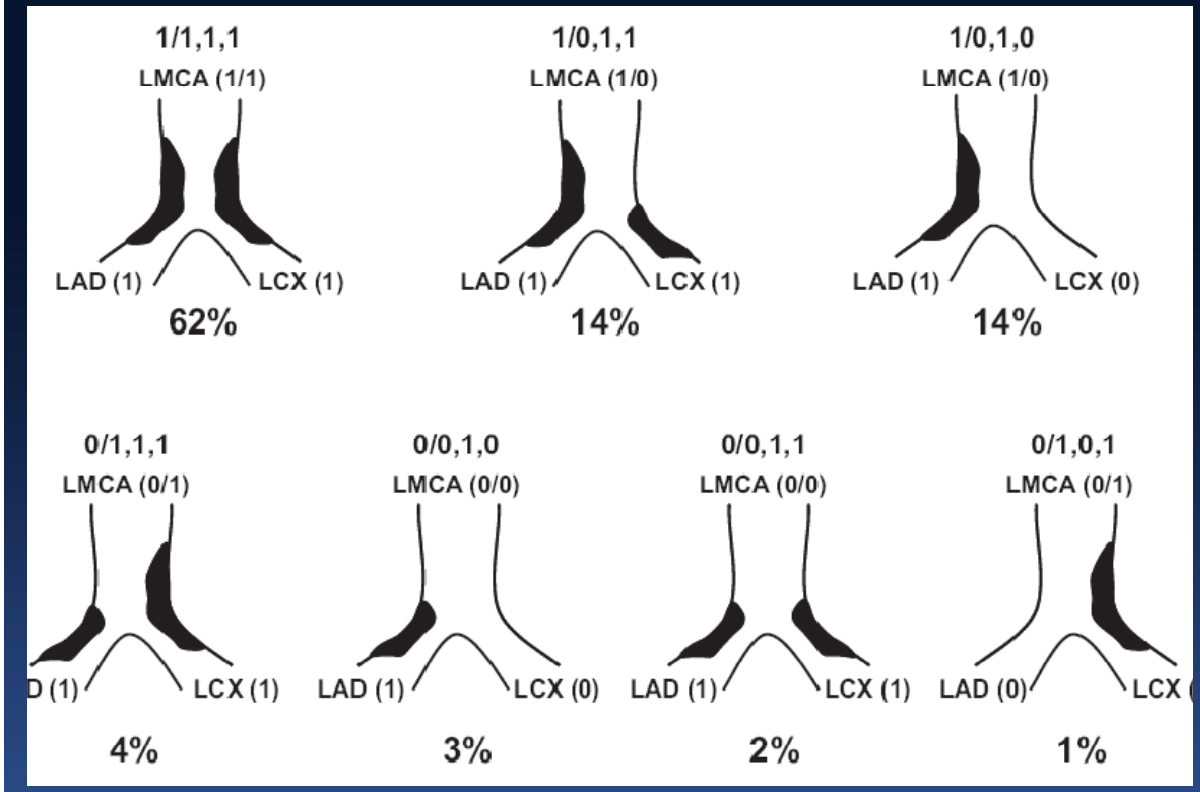
Ostial LM 20%

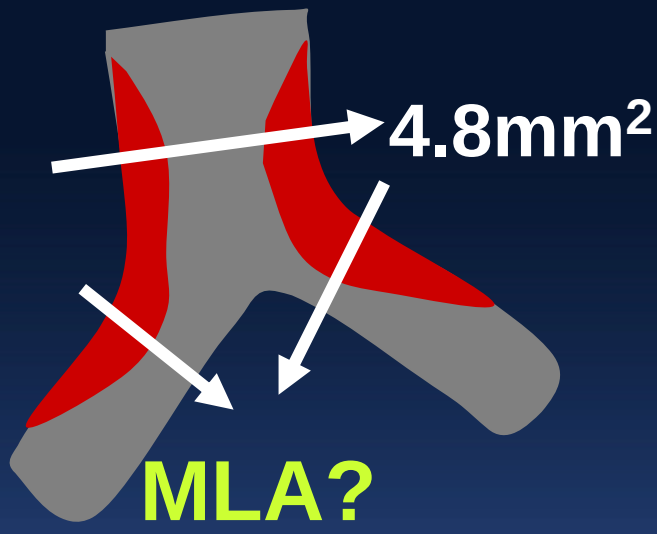




IVUS-FFR Reverse Mismatch

Bifurcation Lesions in Majority…

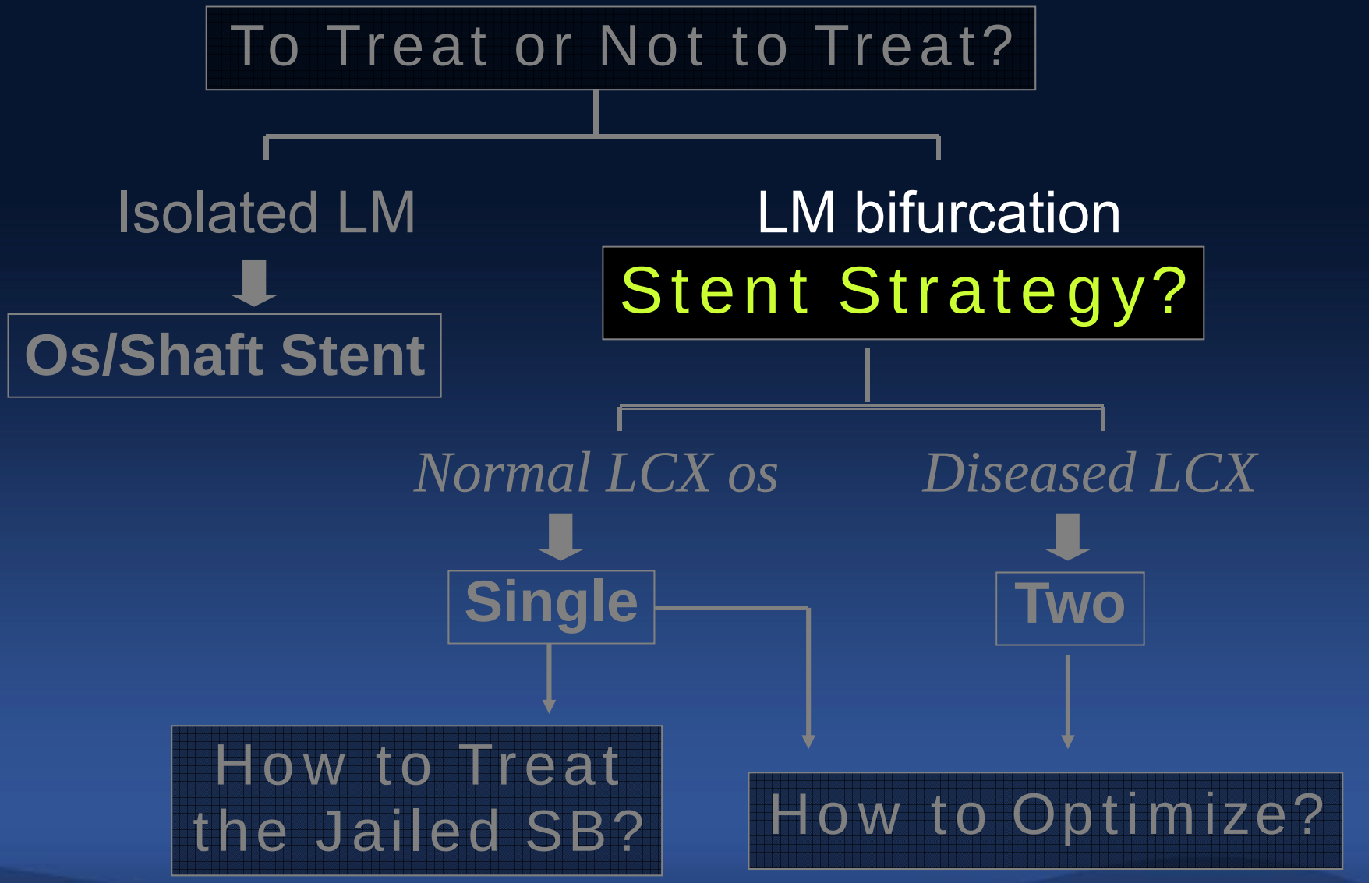




Oviedo et al. Circ Cardiovasc Interv 2010;3:105-12

FFR measurement is necessary to decide to treat or not to treat for LM bifurcation

Issues of LM PCI

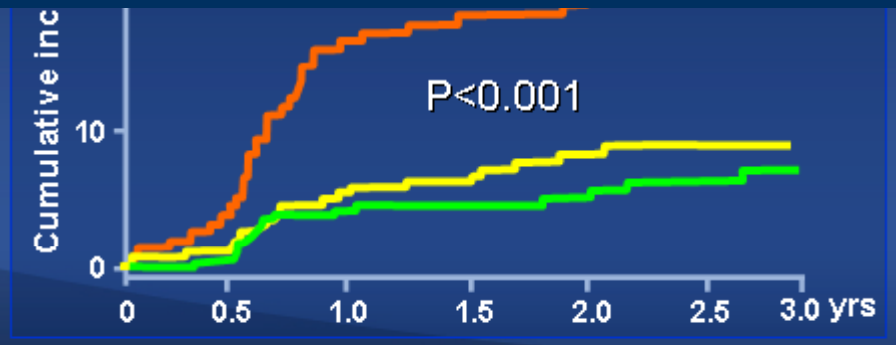


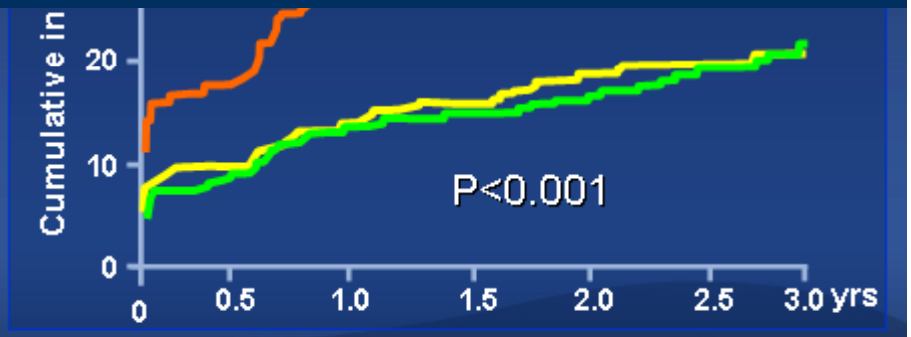
Complex 2 stents

Non-distal (Ostial and Shaft)

Simple (single stent cross over) In LM bifurcation lesions

Single Stent Cross Over is Clearly better !





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Kim WJ, et al. Catheter Cardiovasc Interv. 2011 May 1;77(6):775-82

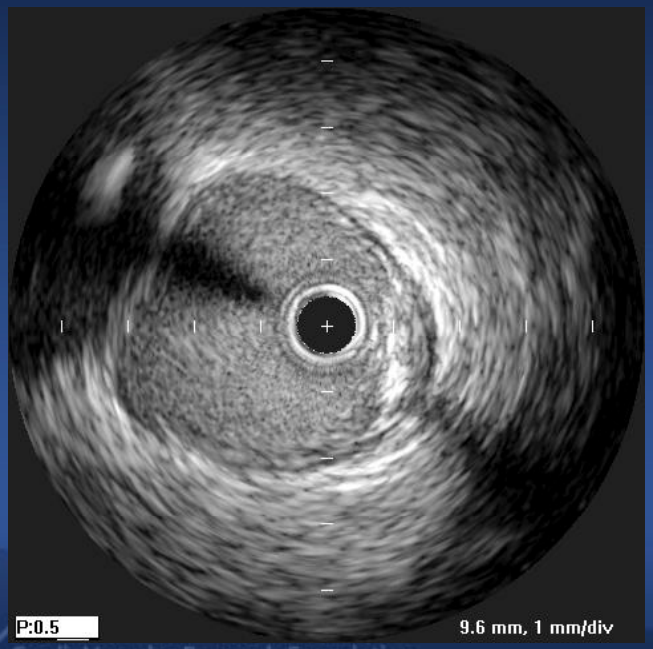
Stent Strategy for LM Bifurcation

Single	▪ Normal ostial LCX (Medina 1.1.0., 1.0.0…) ▪ Small LCX with < 2.5 mm in diameter ▪ Diminutive LCX ▪ Normal or focal disease in distal LCX
Two	▪ Diseased LCX (Medina 1.1.1., 1.0.1…) ▪ Large LCX with ≥ 2.5 mm in diameter ▪ Diseased left dominant coronary system ▪ Concomitant diffuse disease in distal LCX

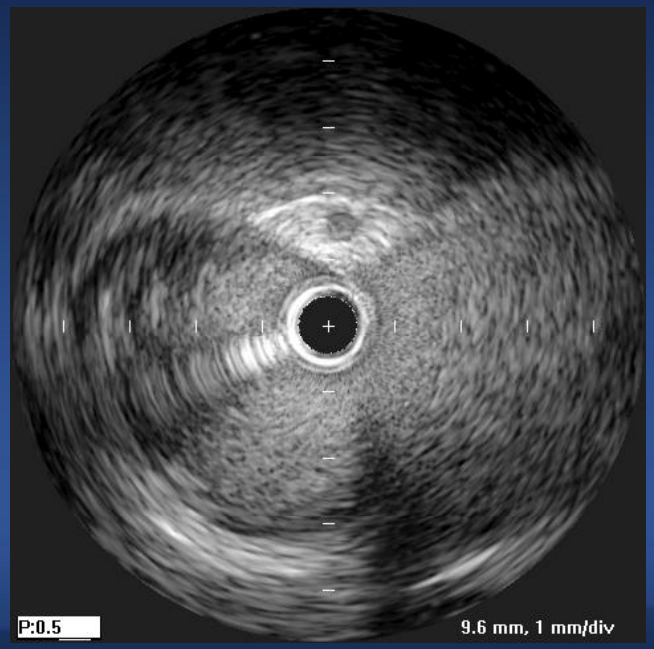
Park SJ, Kim YH. Colombo A, Issam D. Moussa et al. Textbook of Bifurcation Stenting

Single stent
Cross-over

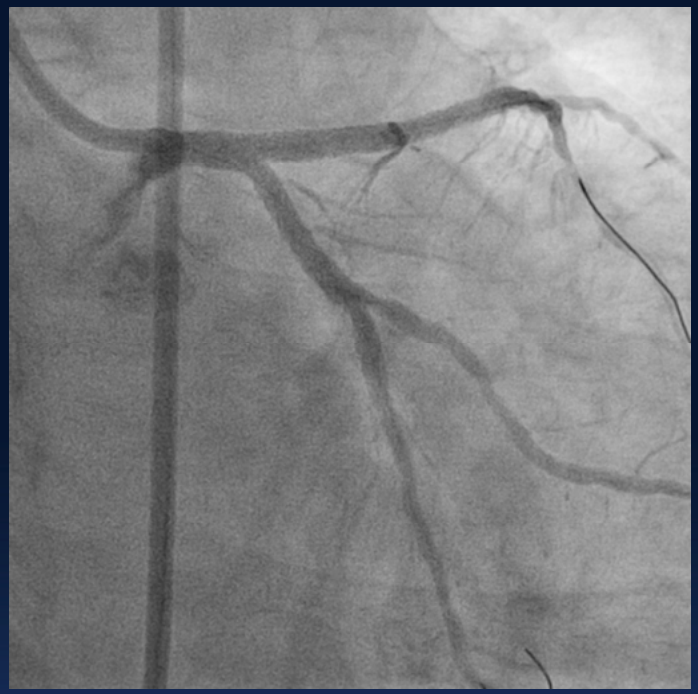
LCX pullback



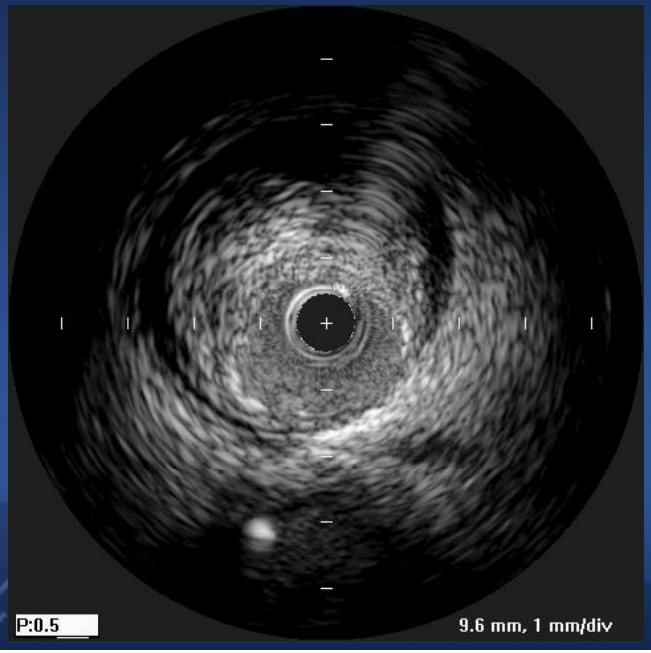
LAD pullback



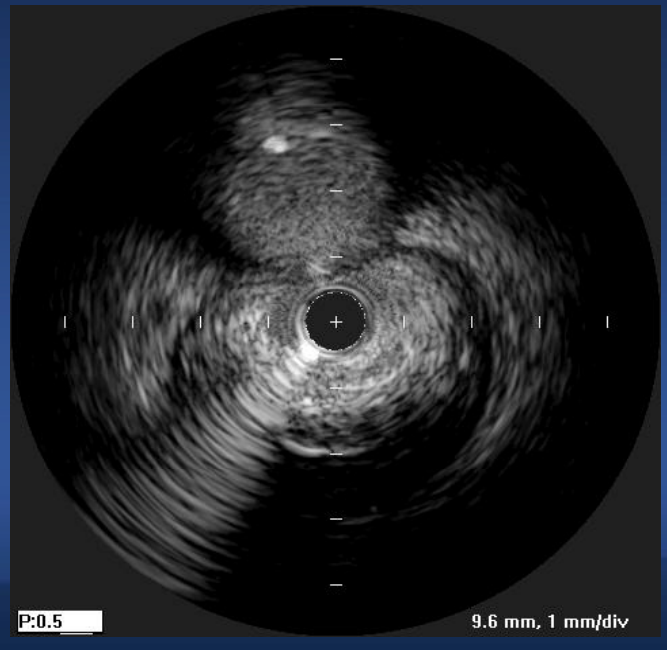
Two Xience
Mini-Crush



LCX pullback



LAD pullback



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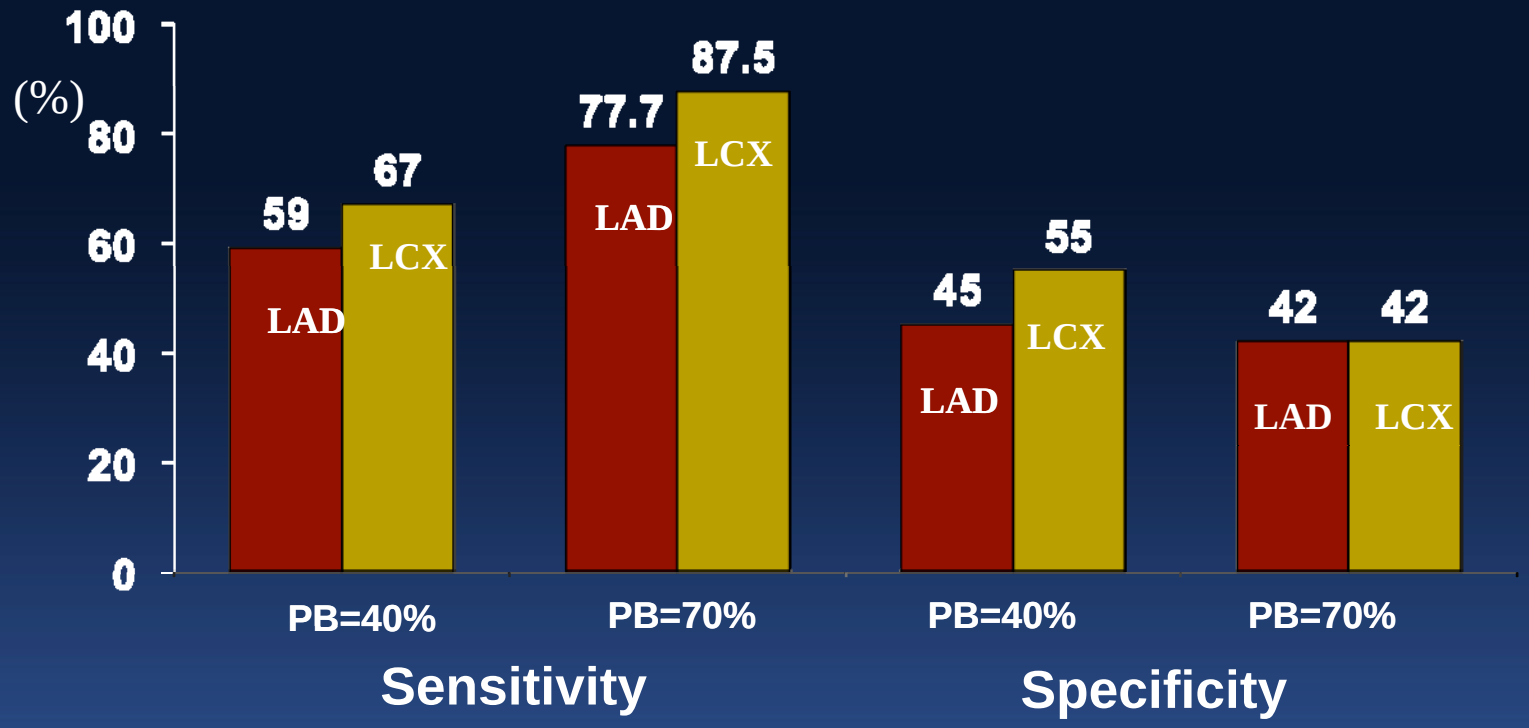
Plaque Burden of SB Ostium Measured by MB-Pullback is Only Moderately Reliable

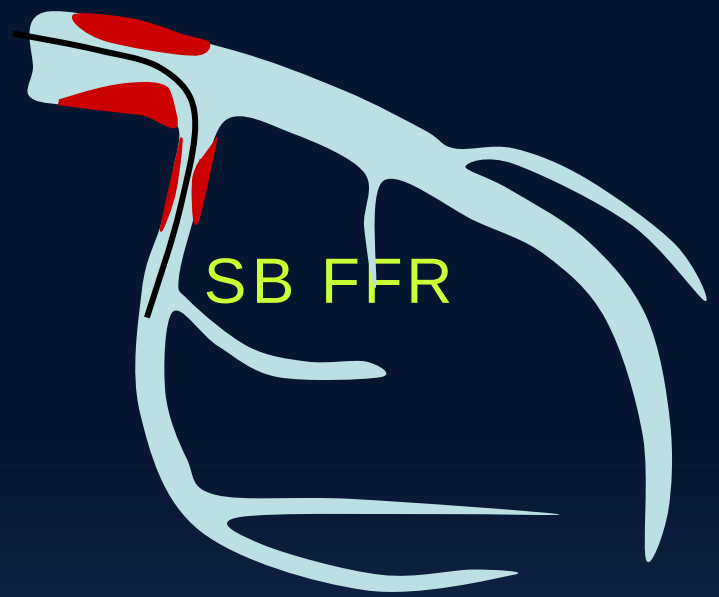


Direct LCX pullback is necessary for the accurate assessment of side branch ostium

Oviedo et al. Am J Cardiol 2010;105:948-54

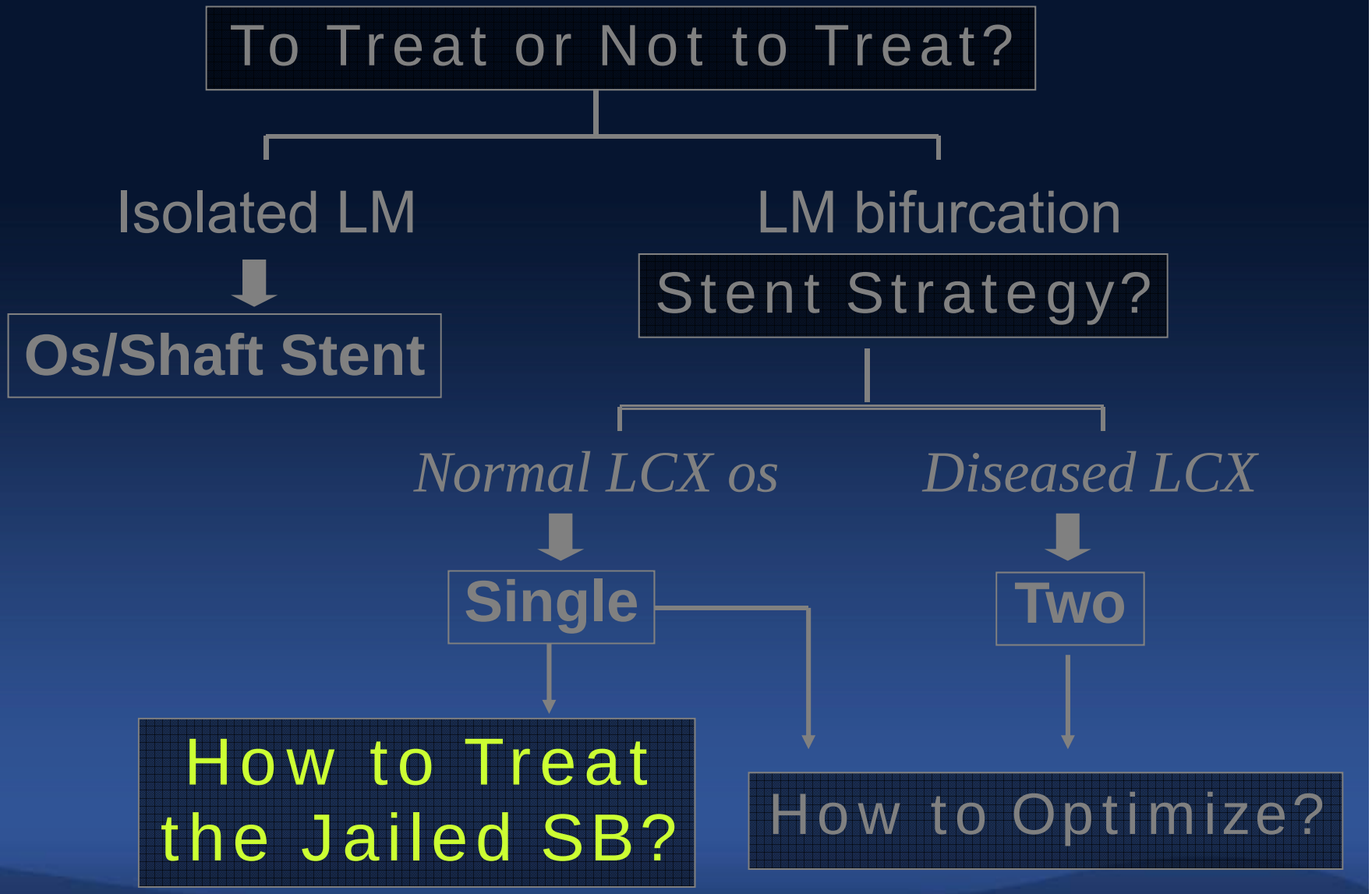
Pre-PCI
LCX IVUS vs. FFR

Most have proximal LM disease



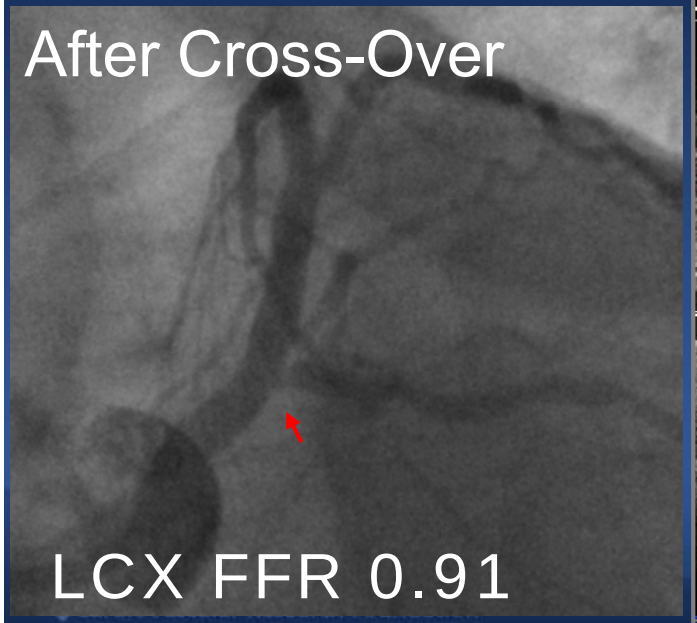
	LCX-IVUS	LCX-FFR
Advantage	▪ clearly demonstrate LCX ostial disease- MLA, PB, remodeling	▪ functional significance only in isolated SB stenosis
Pitfalls	▪ MLA-FFR mismatch ▪ No MLA criteria of SB ▪ Low feasibility	▪ cannot predict geometric change of SB post-stenting

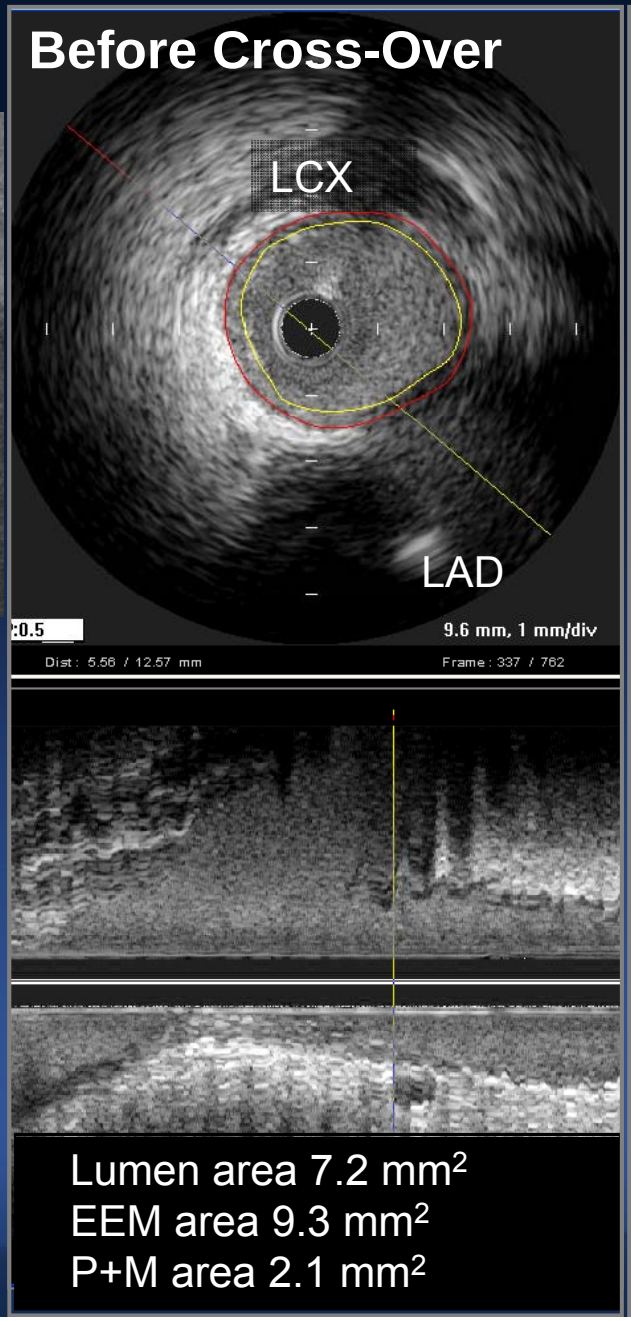
Issues of LM PCI

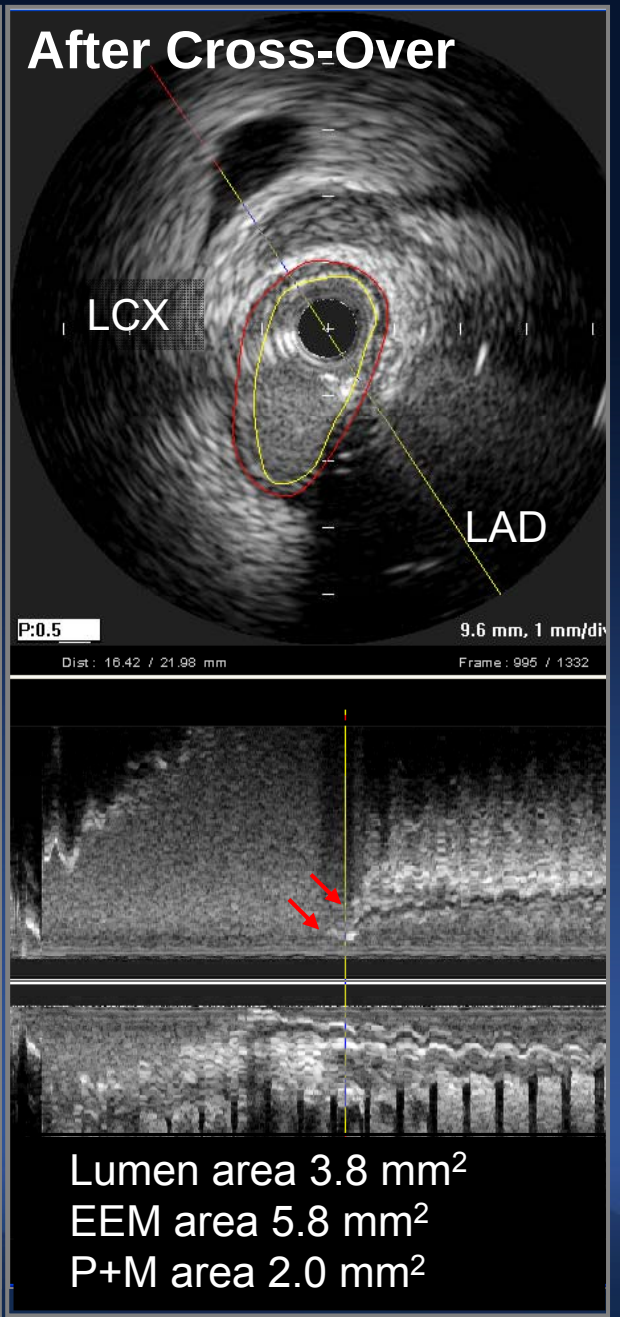


Mechanism of Angiographic Jailing of SB

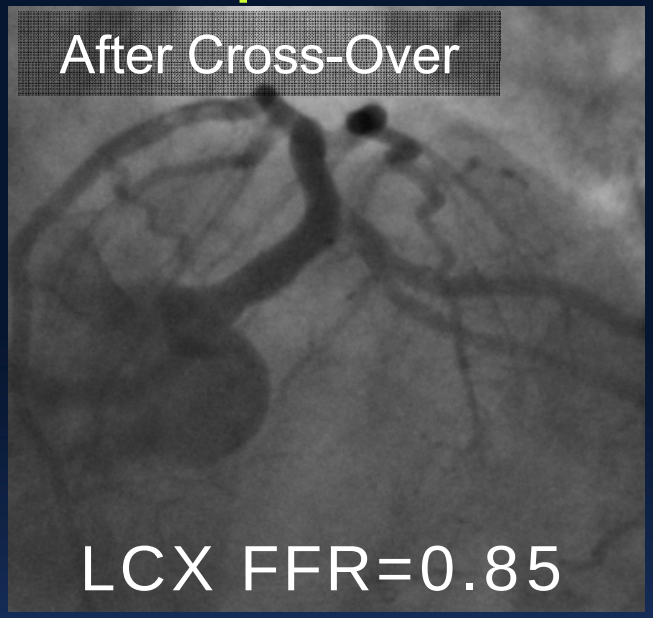
Carina Shift

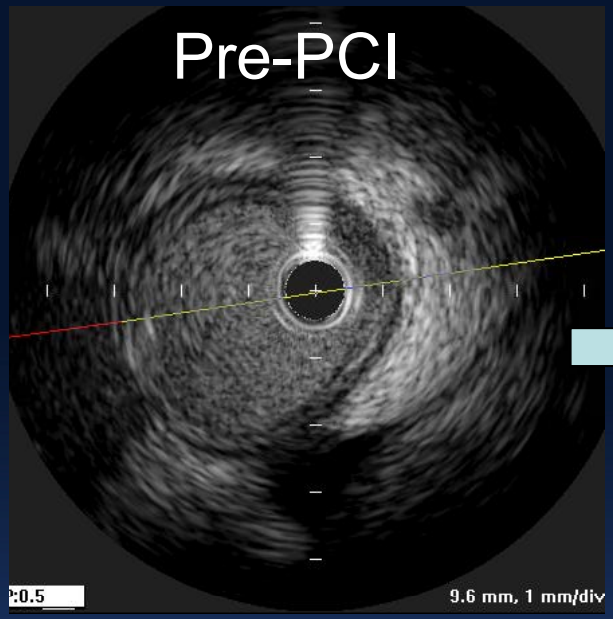


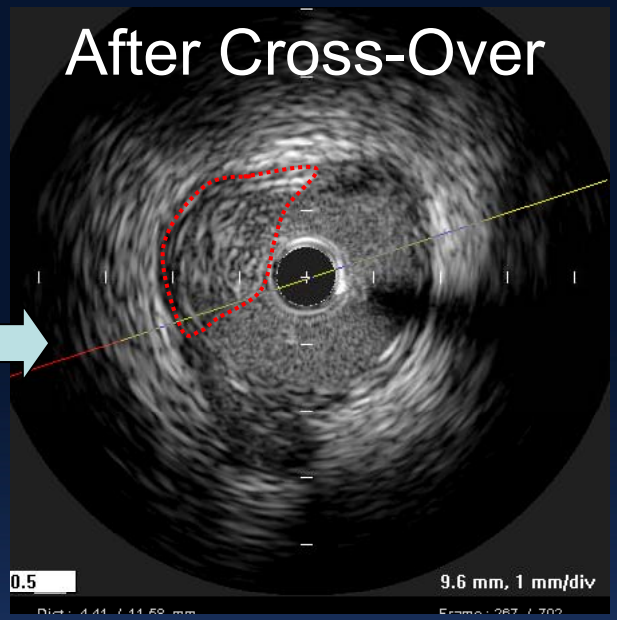




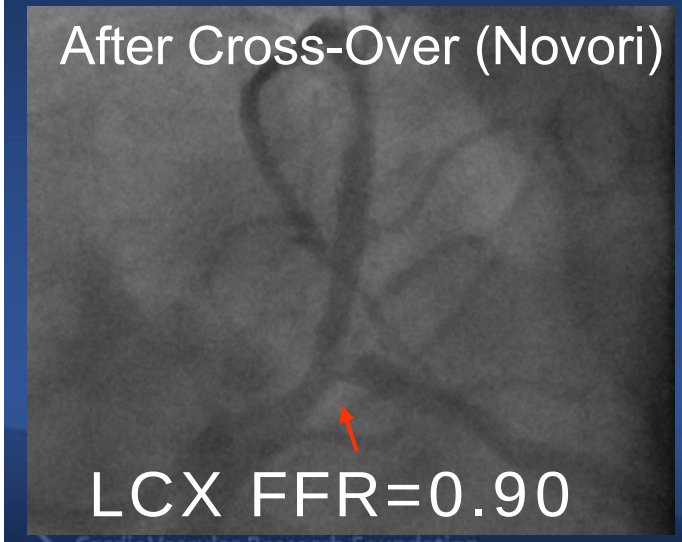
Plaque Redistribution

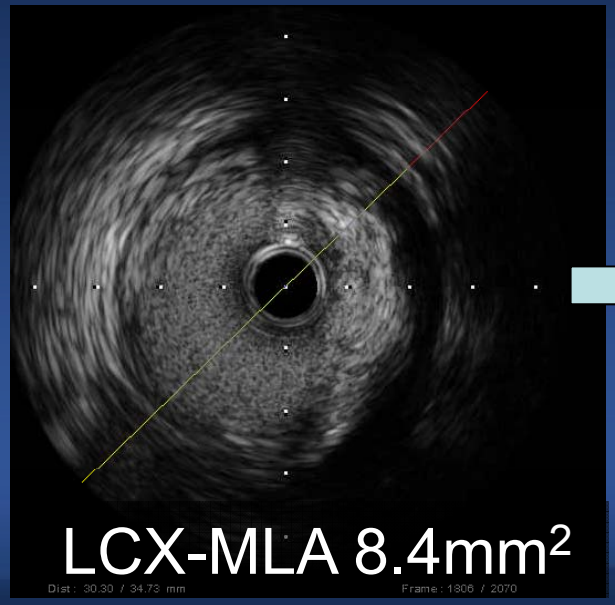


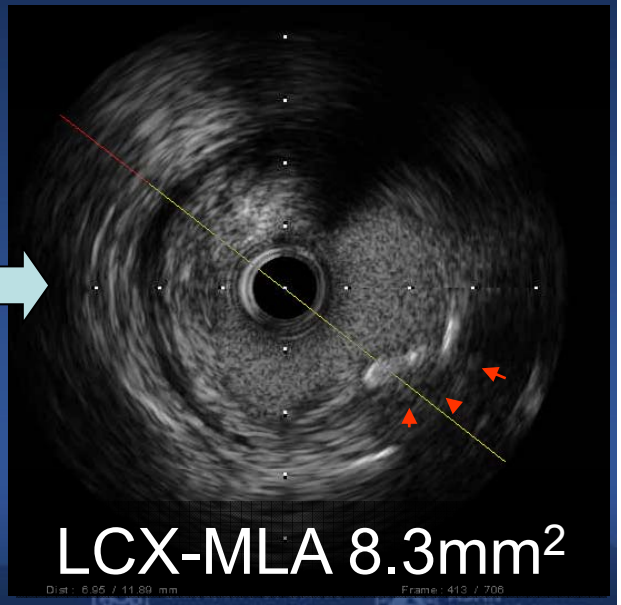




Strut Artifact

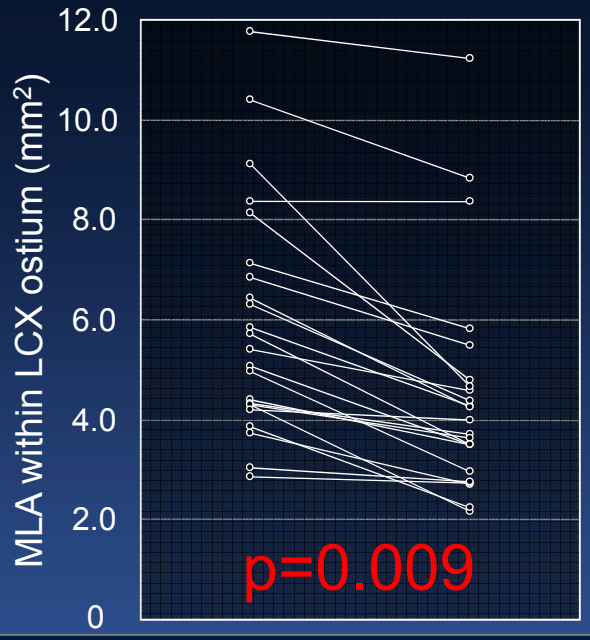




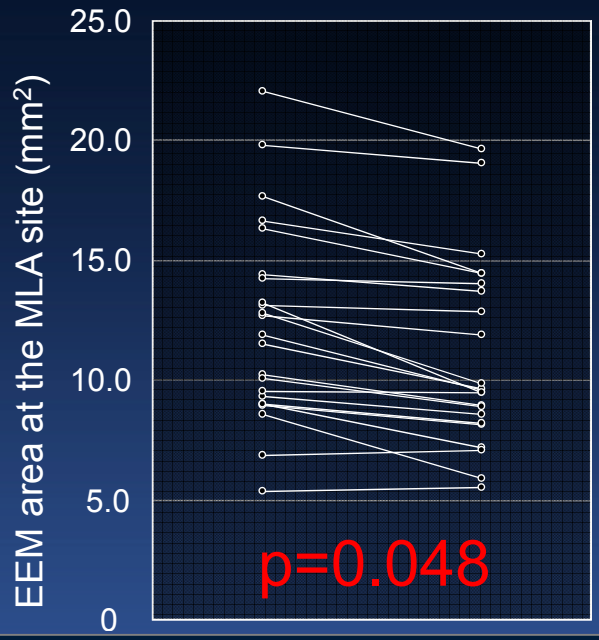


Changes in LCX Ostial Geometry
After a Single Stent Cross-over

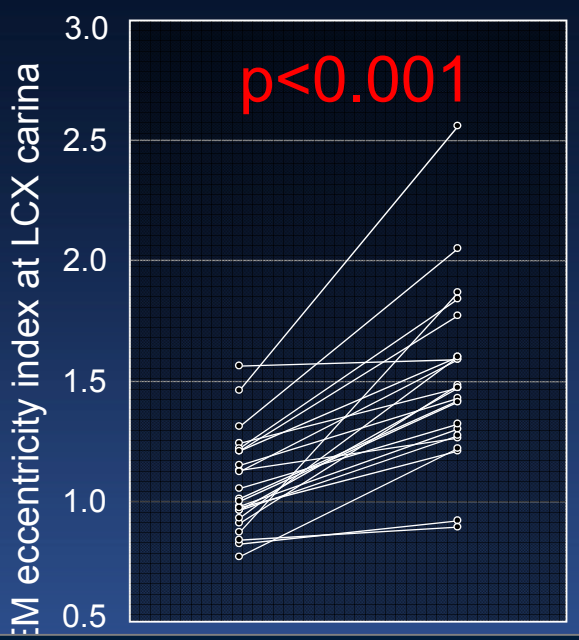
MLA within LCX ostium
5.4mm²→4.0mm²



EEM area at MLA
11.8mm²→9.6mm²



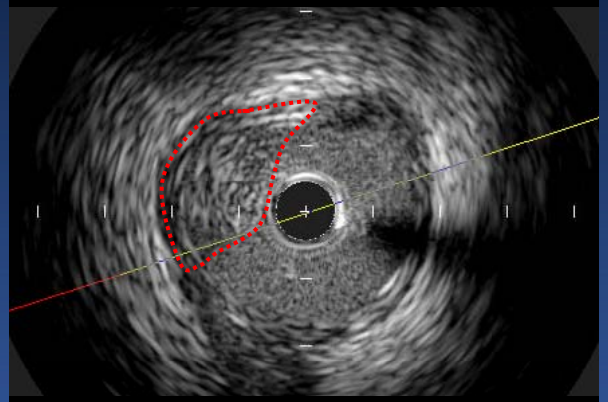
EEM eccentricity
1.22→1.47



In a minority, plaque redistribution may be superimposed on carina shift to contribute to the further lumen loss at the ostial LCX

IVUS Cannot Predict LCX FFR

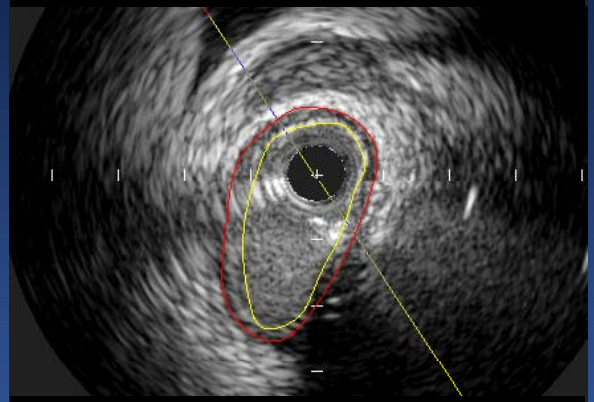
Plaque shift



MLA 4.5 mm²

FFR 0.85

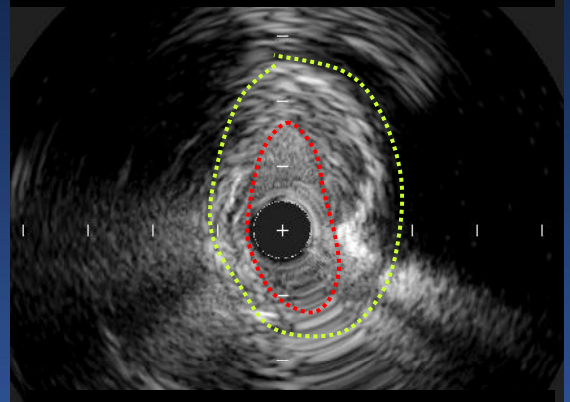
Carina shift



MLA 3.8 mm²

FFR 0.91

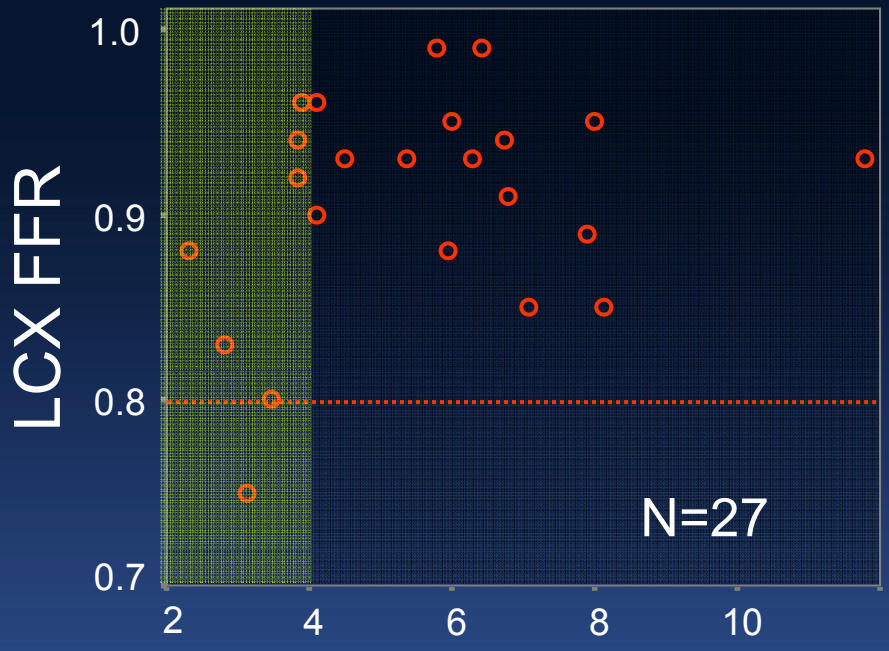
Carina shift

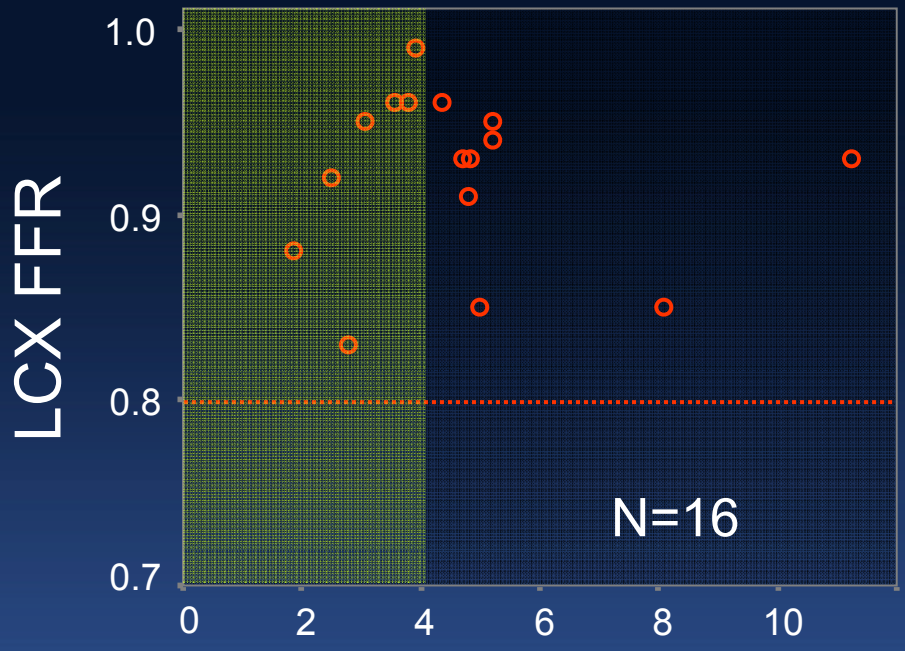


MLA 2.5mm²

FFR 0.81

Correlation between
IVUS-MLA vs. Post-stenting FFR

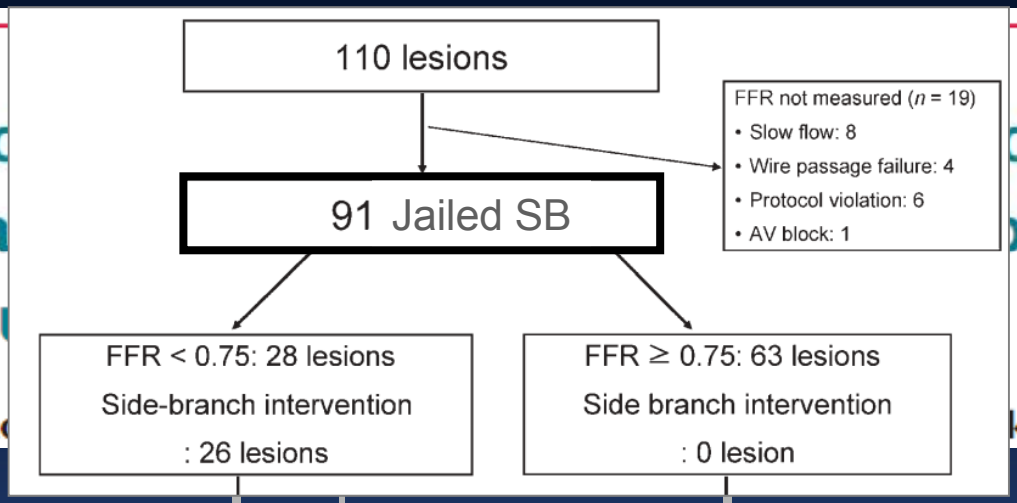




AMC data, preliminary

Treatment for Angiographically Jailed SB

FFR >0.75 is safe for deferral in non-LM disease



SB intervention
26 lesions

2 lesions

No SB intervention
65 lesions

6 Mo f/u

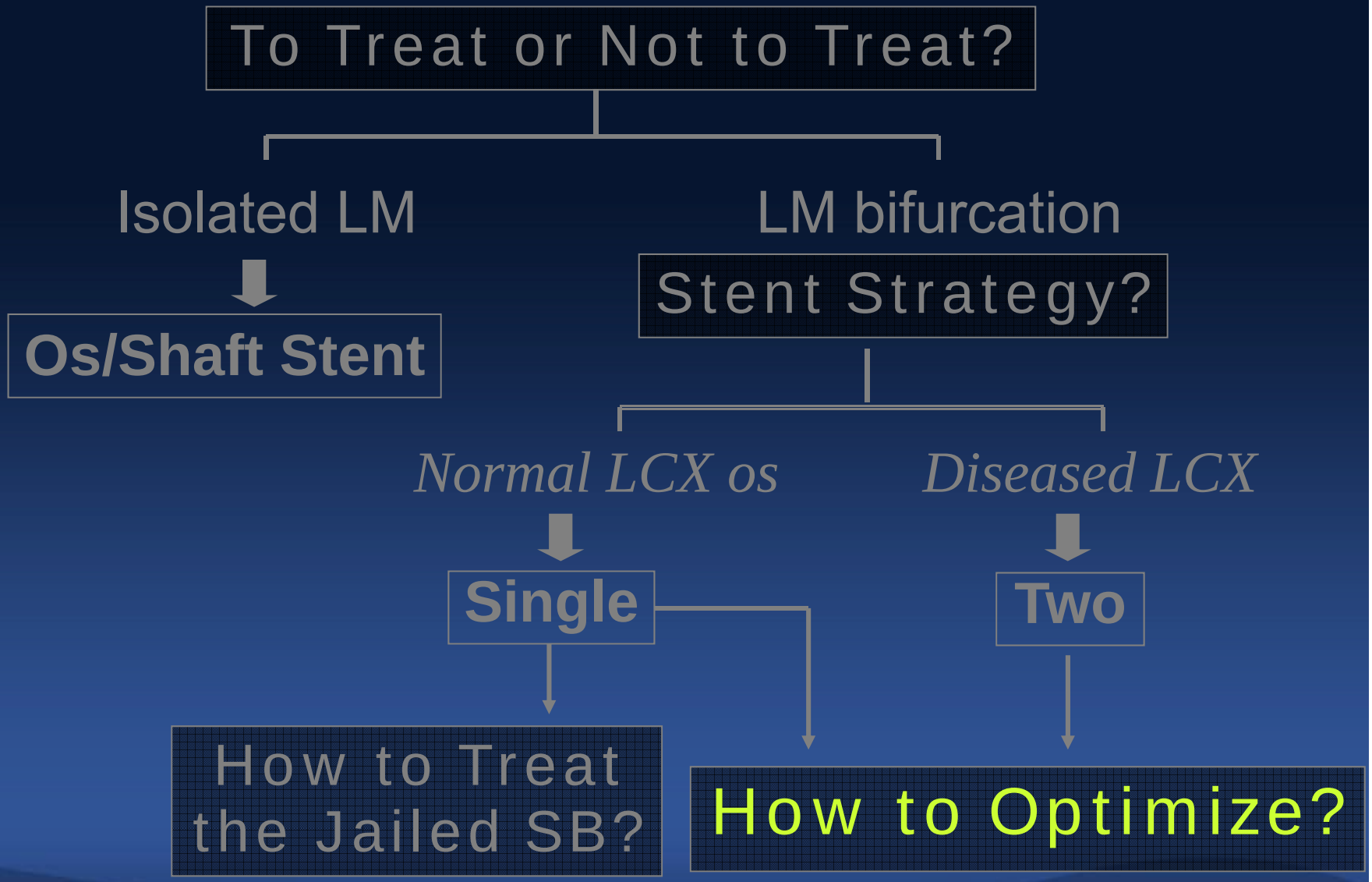
No change in SB FFR (0.87±0.06→0.89±0.07)
Functional restenosis in only 8% (FFR<0.75)

Koo et al. Eur Heart J 2008;29:726–32

Use of LCX-IVUS vs. FFR
After LM Cross-over

	LCX-pullback IVUS	LCX FFR
Advantage	▪ support the anatomical change, MLA loss ▪ Mechanism of SB jailing	▪ Confirm the functional SB compromise
Pitfalls	▪ MLA-FFR mismatch ▪ No MLA criteria for FFR ▪ Low feasibility	▪ Minority - not feasible ▪ Impact on outcomes is not clear in LM disease

Issues of LM PCI



LM Stent Optimization

Between Mar 2003 - May 2009, 450 patients with LM disease underwent SES implantation and 9-mo angio surveillance

- 22 kissing
- 3 LM-LCX cross-over
- 22 without IVUS data

403 patients treated with SES implantation for LM

All had post-stenting IVUS and 9-mo angiography

Single-stent (n=289)

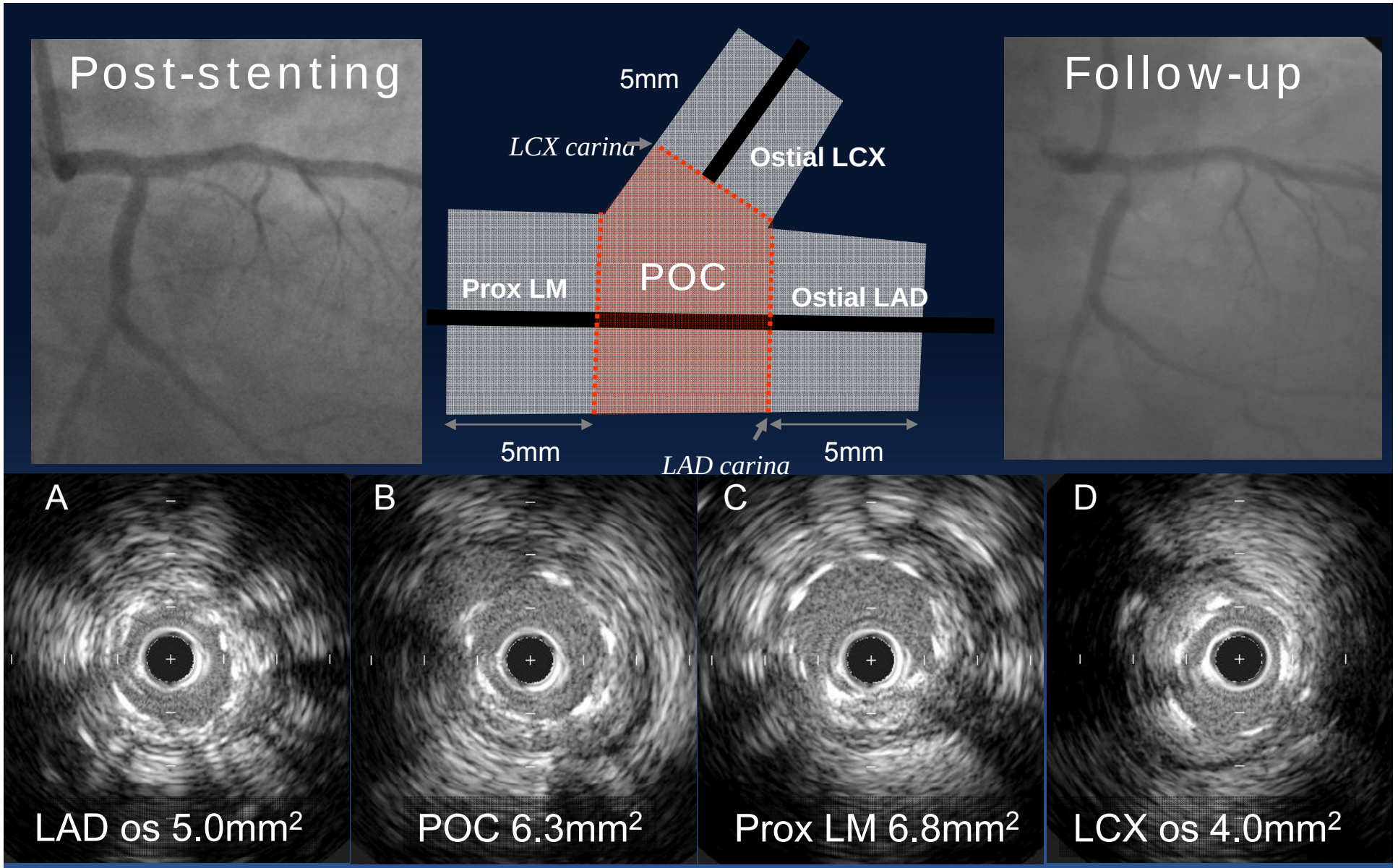
Non-bifurcation (n=67)

Bifurcation with Single-stent (n=222)

Two-stent (n=114)

Bifurcation with Two-stent (*including 99 crushing, 15 T-stent)*

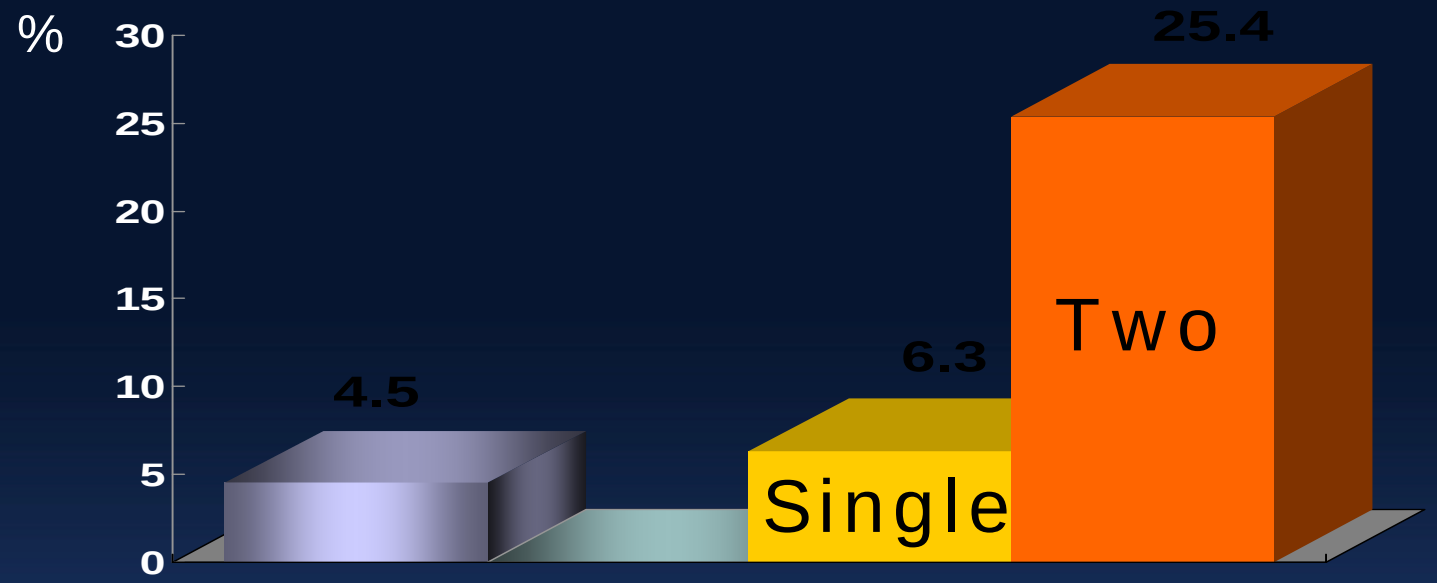
Kang et al. Circ Cardiovasc Interv 2011;4:1168-74



Using both pullback, MSA in each of 4 segments were measured. The MSA that predicts 9 mo ISR at each of the corresponding segments was assessed

Kang et al. Am J Cardiol 2011;107:367-73

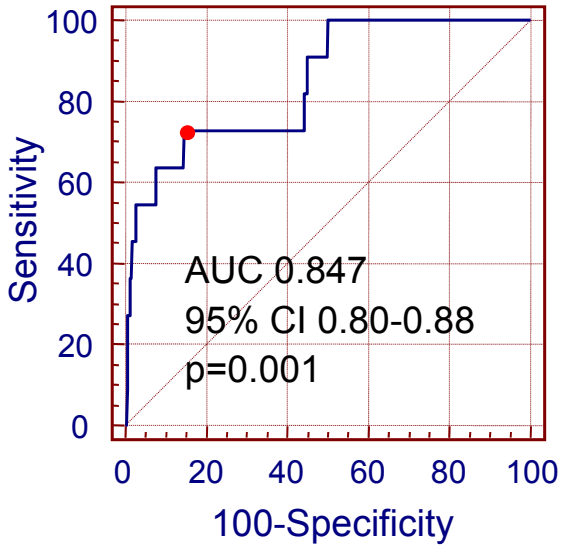
9-Month Angiographic Restenosis



4.5% (3/67)	6.3% (14/222)	25.4% (29/114)
LM ostium: 3 (4.5%)	*LM (above POC): 2 (1.0%)* *POC: 1 (0.5%)* *LAD ostium: 3 (1.4%)* *non-stented LCX os: 9 (4.1%)*	*LM (above POC): 5 (4.4%)* *POC: 6 (5.3%)* *LAD ostium: 8 (7.0%)* *LCX ostium: 27 (23.7%)*

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

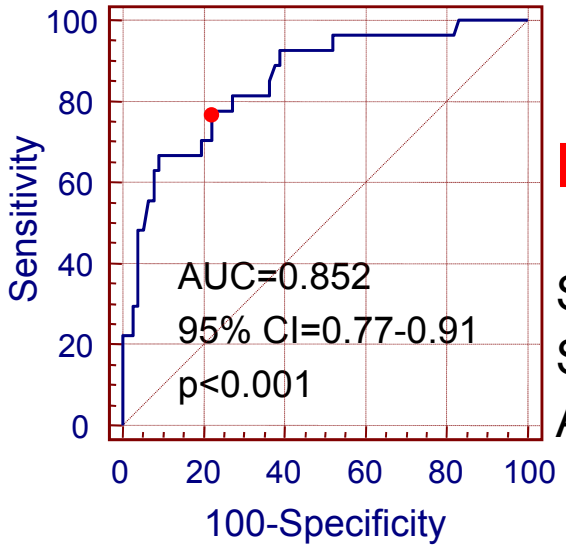
LAD ostium



MSA 6.3mm^2

Sensitivity 73%
Specificity 85%
Accuracy 84%

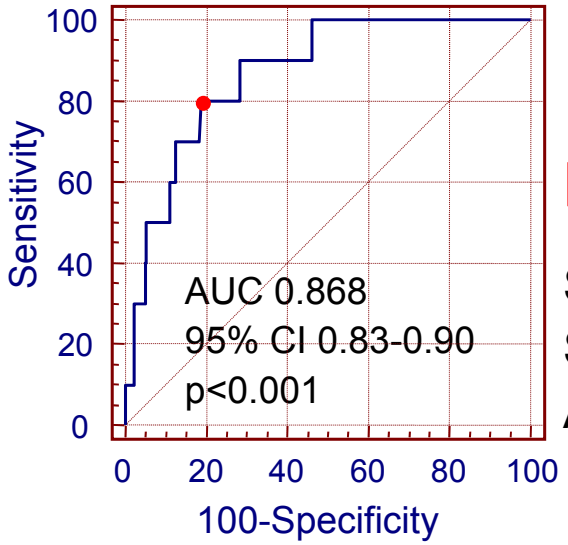
LCX ostium



MSA 5.0mm^2

Sensitivity 78%
Specificity 78%
Accuracy 78%

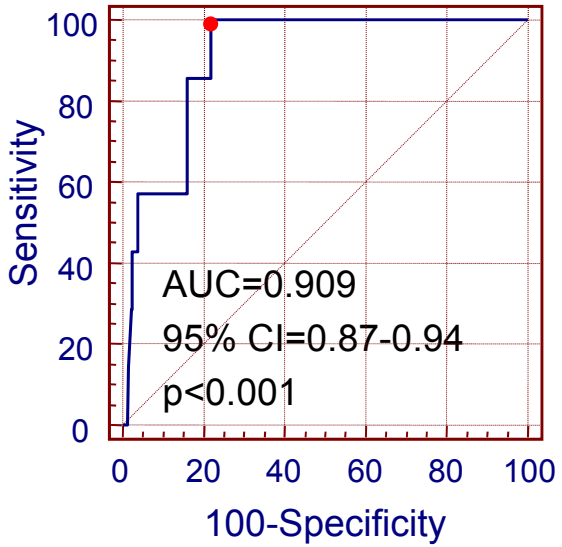
Proximal LM



MSA 8.2mm^2

Sensitivity 80%
Specificity 81%
Accuracy 81%

POC



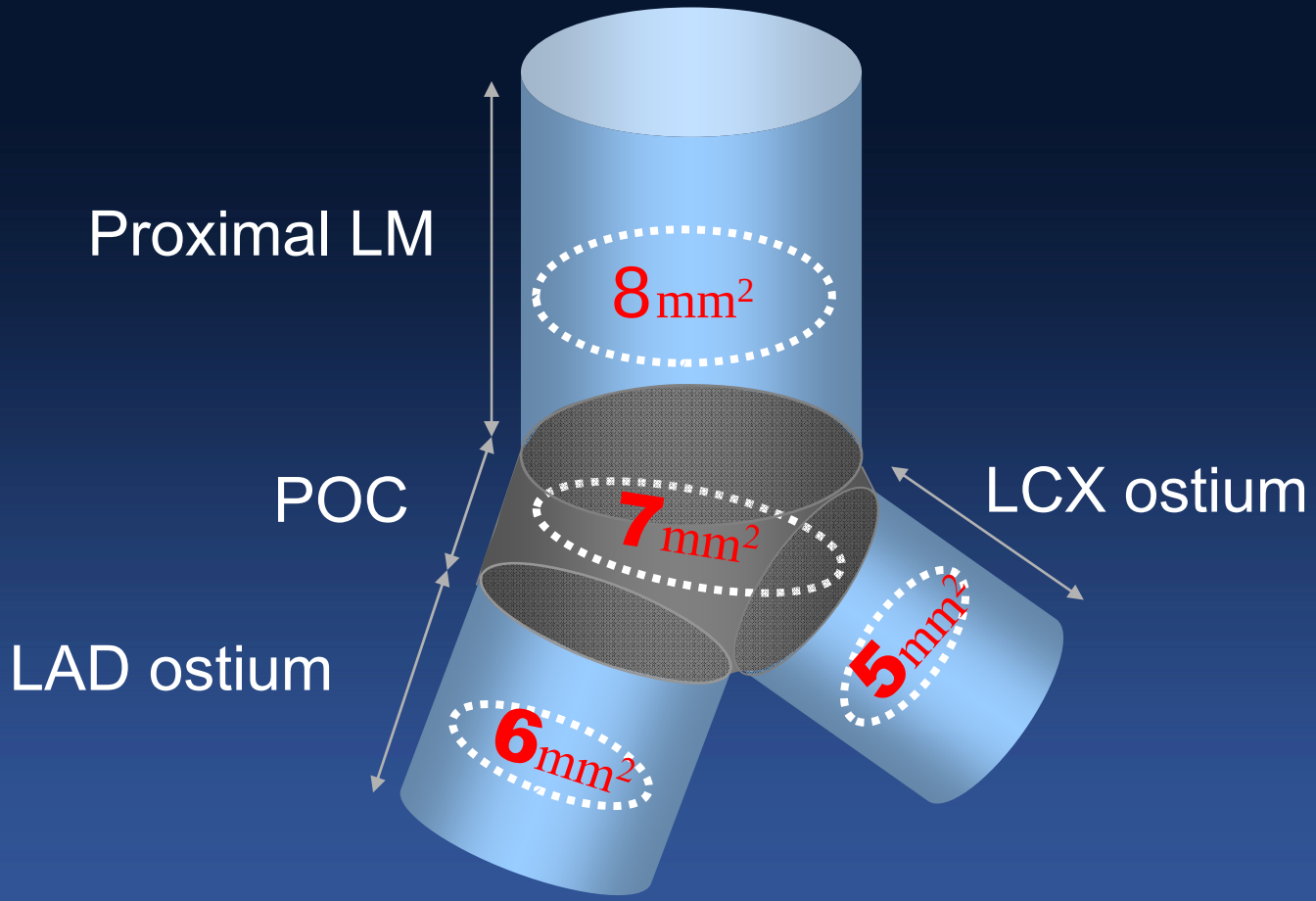
MSA 7.2mm^2

Sensitivity 100%
Specificity 78%
Accuracy 80%

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

Stent Optimization

on a segmental basis

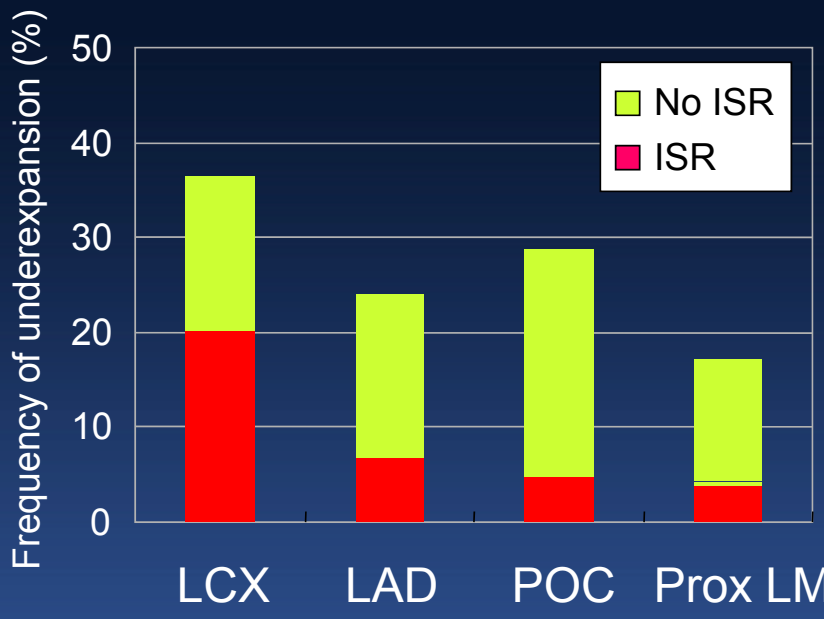


Kang et al. Circ Cardiovasc Interv 2011 2011;4:1168-74

Frequency of Underexpansion and ISR

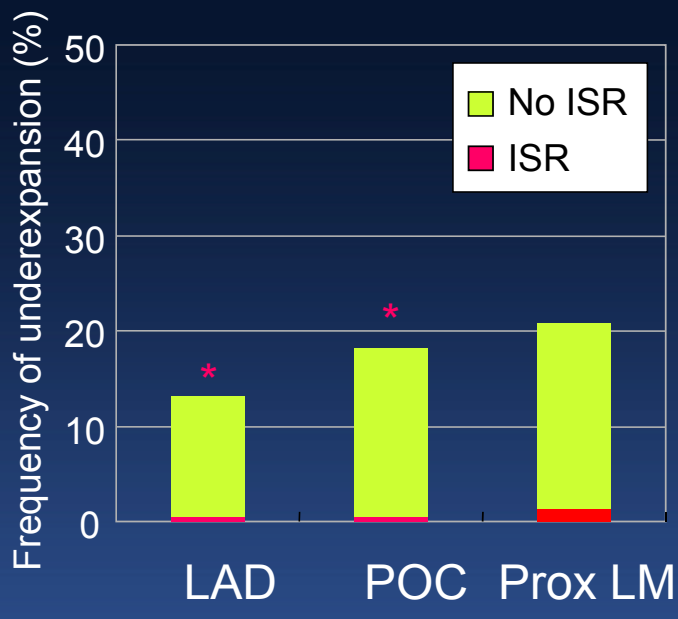
33.8% *had underexpansion of at least one stented segment*

Two-stent



54% had underexpansion in at least one of the 4 stented segments

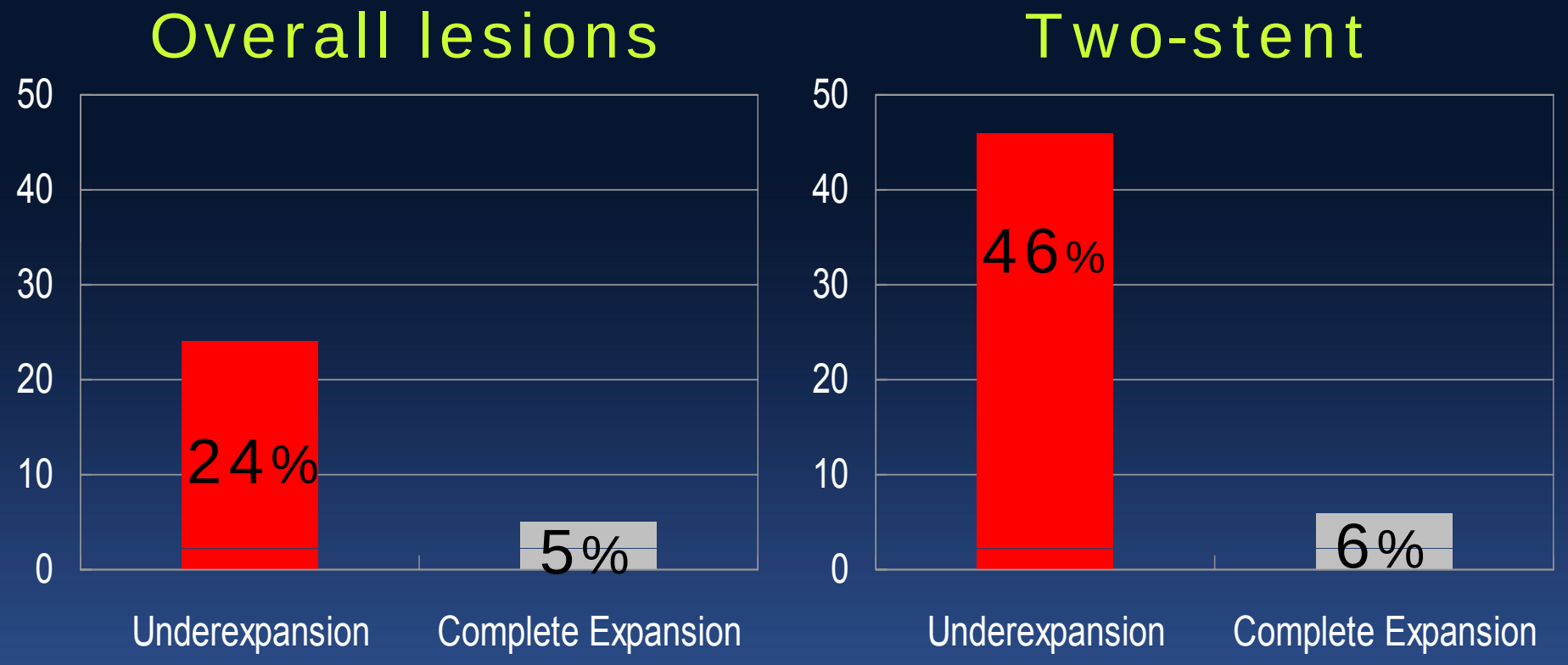
Single-stent



* *single-stent vs. two-stent, p<0.05*

27% had underexpansion in at least one of the 3 stented segments

Frequency of ISR in LM Lesions
with vs. without Underexpansion



Underexpansion of at least 1 segment

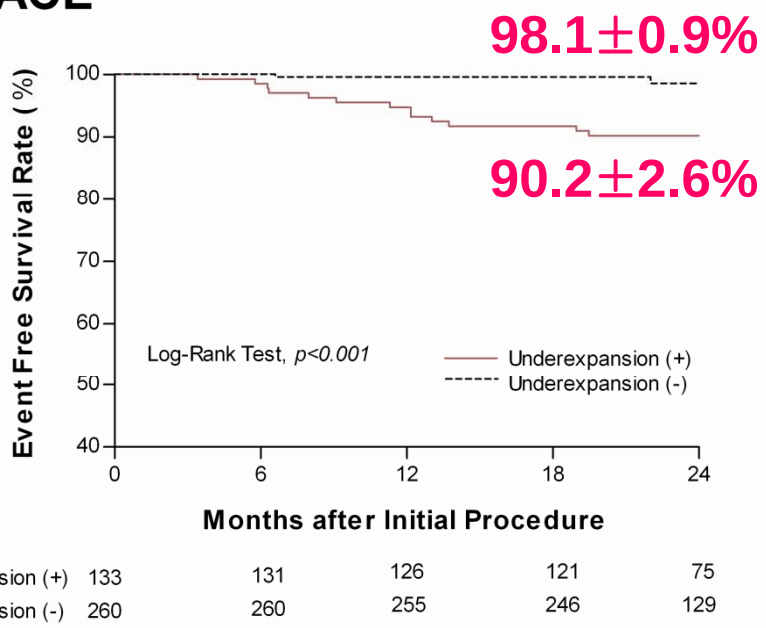
Adequate expansion at all sites

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

Kaplan-Meier for MACE-free Survival

2-year MACE 4.8% at 23.8±3.2 months (median 24 months)

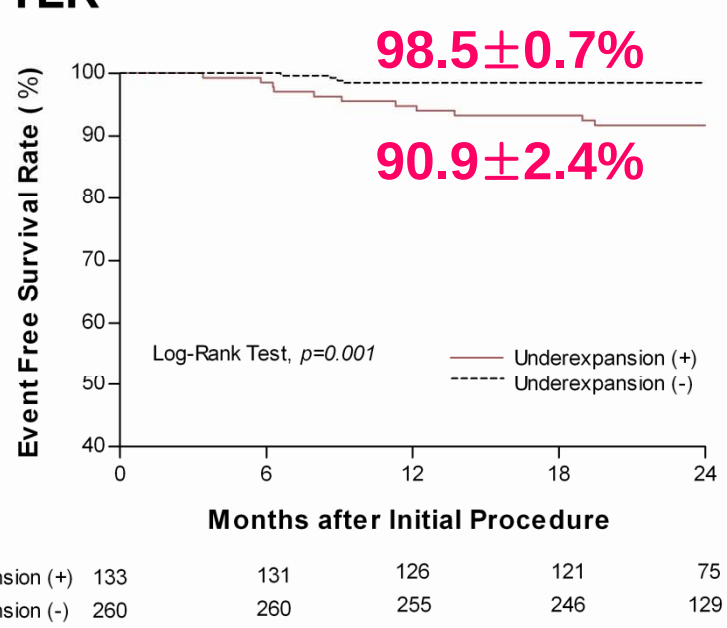
A MACE



No. at risk

Underexpansion (+)	133	131	126	121	75
Underexpansion (-)	260	260	255	246	129

B TLR

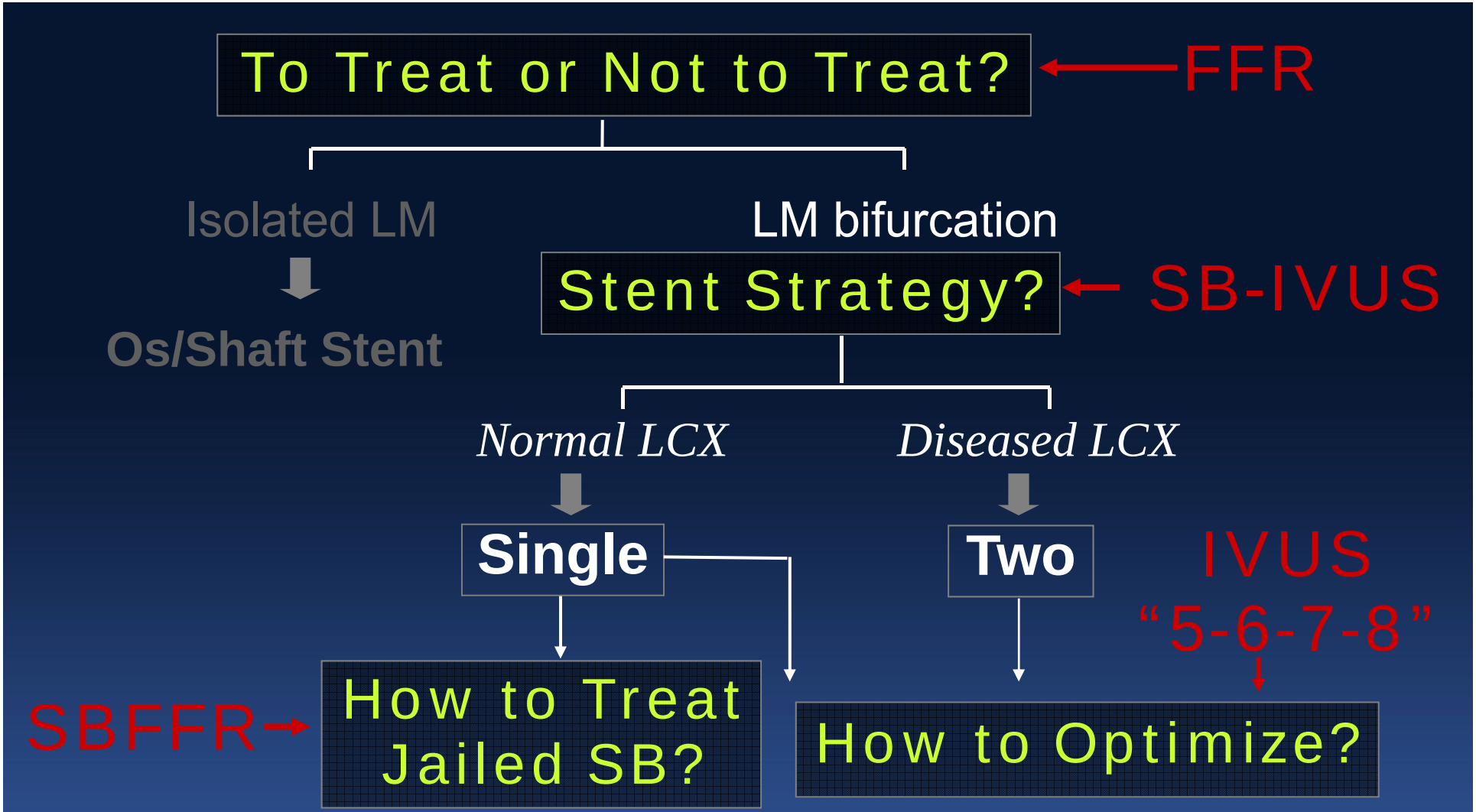


No. at risk

Underexpansion (+)	133	131	126	121	75
Underexpansion (-)	260	260	255	246	129

TLR 4.1%, Cardiac death 1%, AMI (VLST) 0.5%

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



- IVUS optimization with the MSA criteria may improve the long-term clinical outcomes