Integrated Approach for LM PCI Using FFR and IVUS

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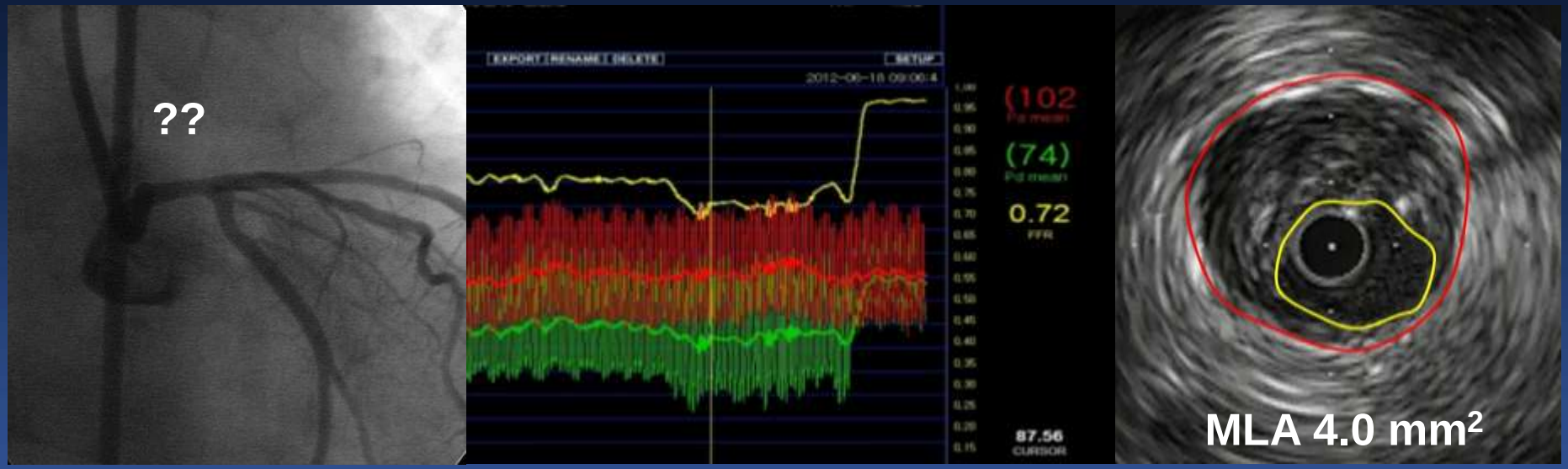
Q1,
Why FFR ?

Significant Stenosis Negative FFR

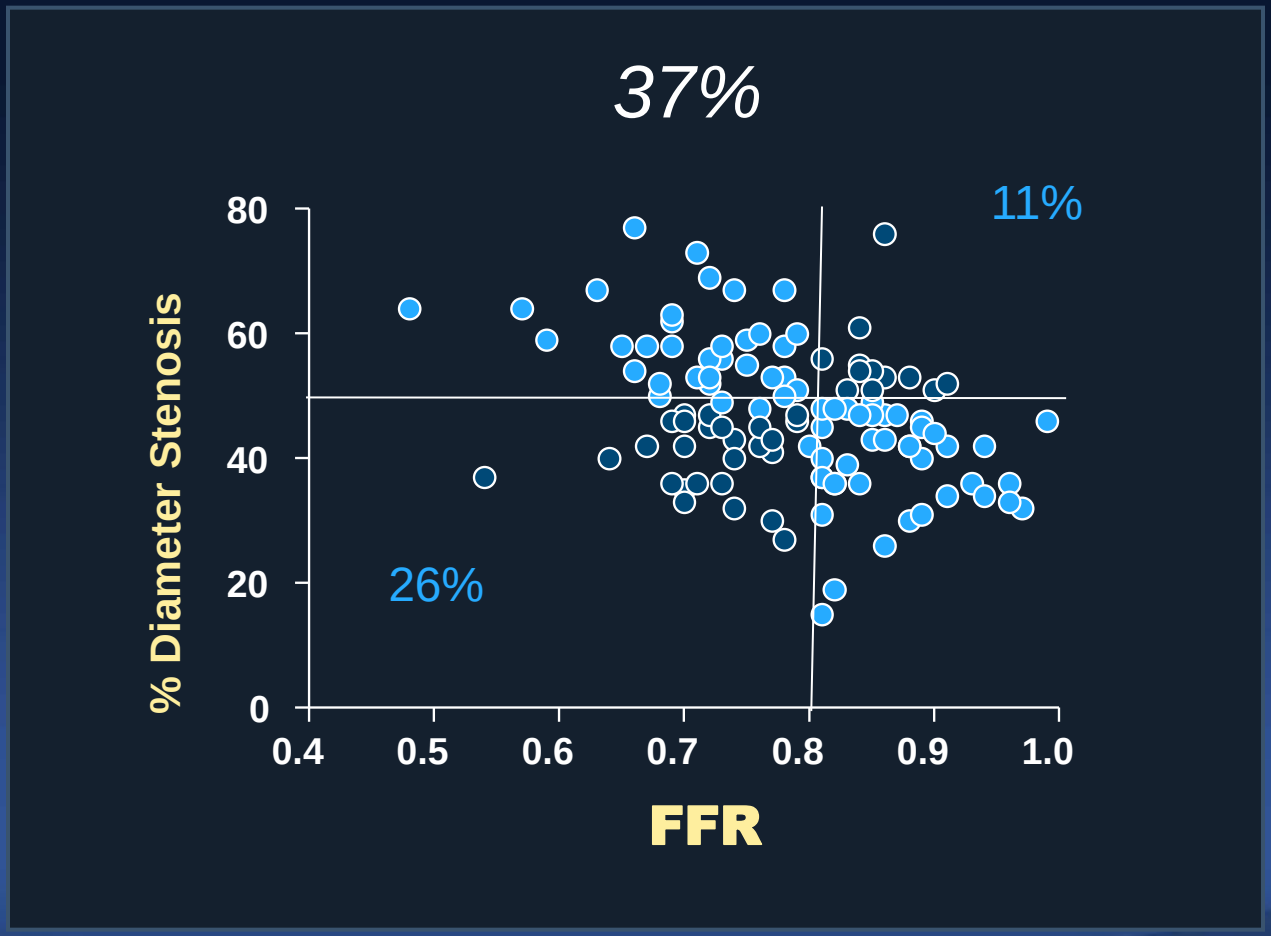
47/M Stable Angina

Insignificant Stenosis
Positive FFR
Mismatch

62/F Stable Angina



Many Mismatch
Intermediate LM Disease, Os/Shaft



Park SJ et al. *JACC Interv, 2014;7(8):868-874*

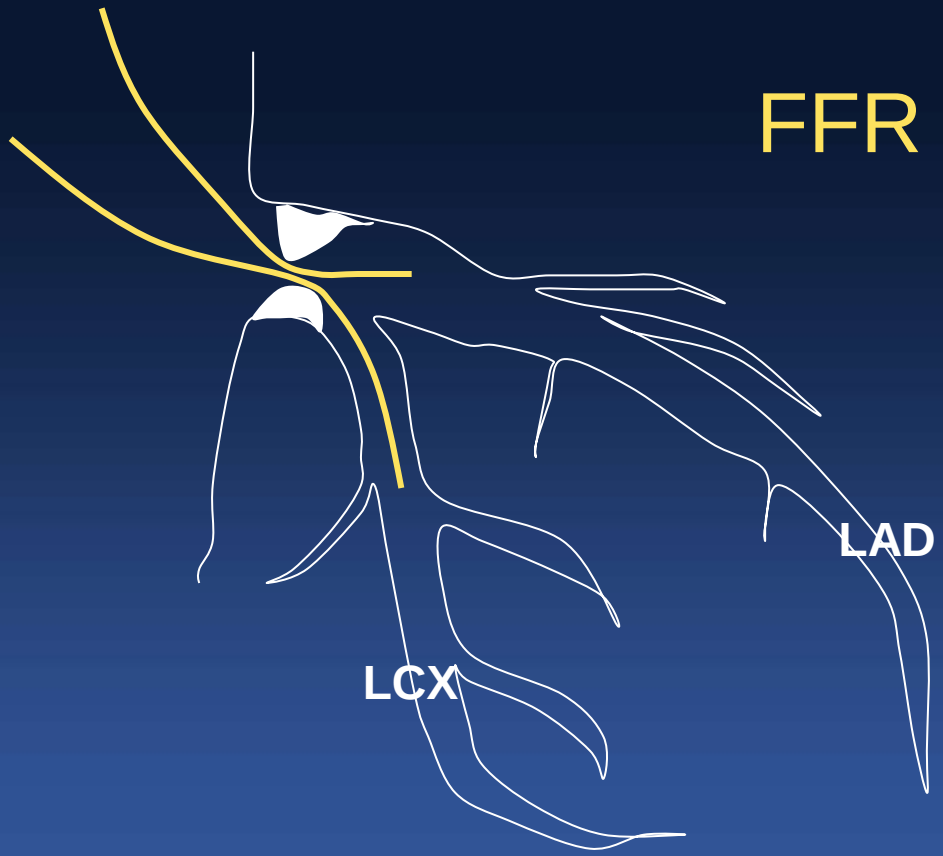
Predictors for FFR <0.80
Multivariable Analysis, LM (n=112)

Variables	OR	95%CI	p-value
Model 1			
MLA, mm^2	0.37	0.25-0.56	<0.001
Plaque rupture	4.51	1.36-14.9	0.014
Age, year	0.95	0.90-1.00	0.033
BMI, kg/m^2	1.19	1.00-1.40	0.05
Model 2			
MLA, mm^2	0.34	0.21-0.54	<0.001
Age, year	0.94	0.90-0.99	0.022
LV mass, g	1.01	1.00-1.03	0.03

Model 1 included clinical, QCA, and IVUS variables
Model 2 included Model 1 plus LV mass assessed by **Echocardiography**

How I Implement FFR in Real Practice ?

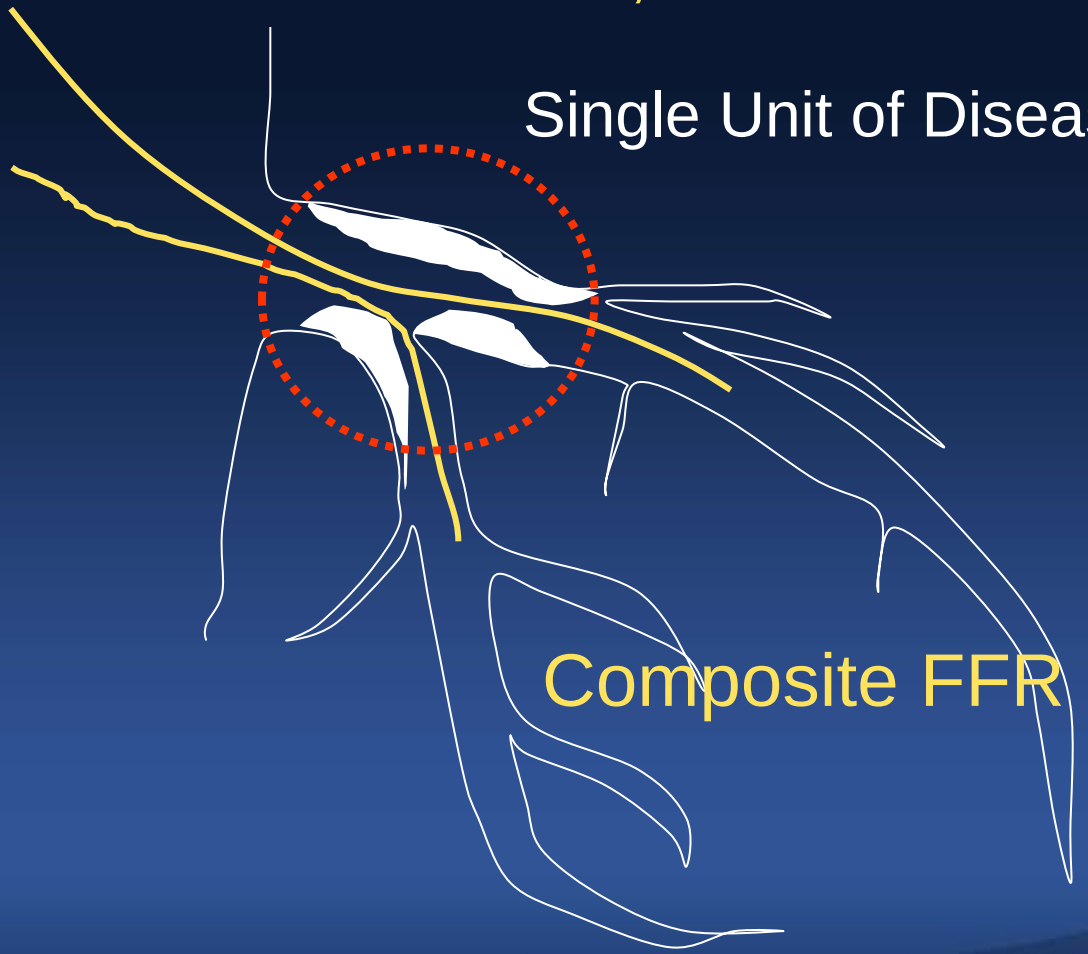
For the Undetermined, Intermediate Ostial and Shaft LM Lesion,



FFR is Crucial

For Intermediate Bifurcation LM Lesion,

If Transducer Placed Beyond Bifurcation
in both LAD and LCX,



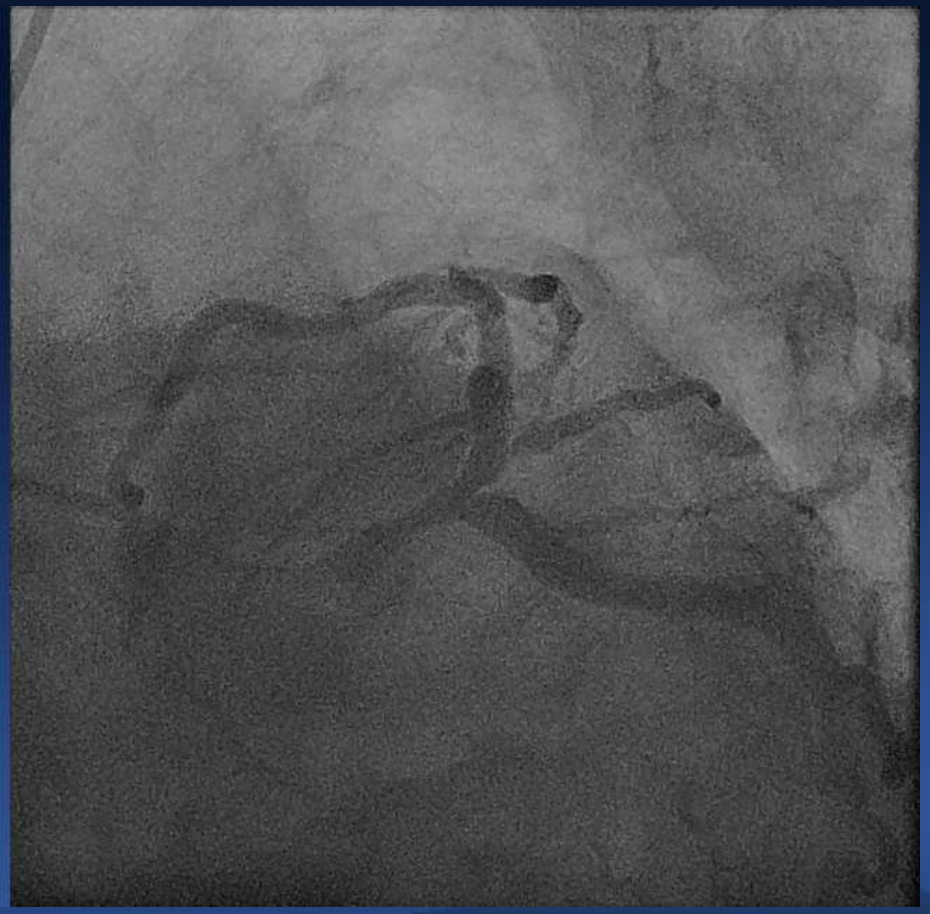
Single Unit of Disease

Composite FFR still Works.

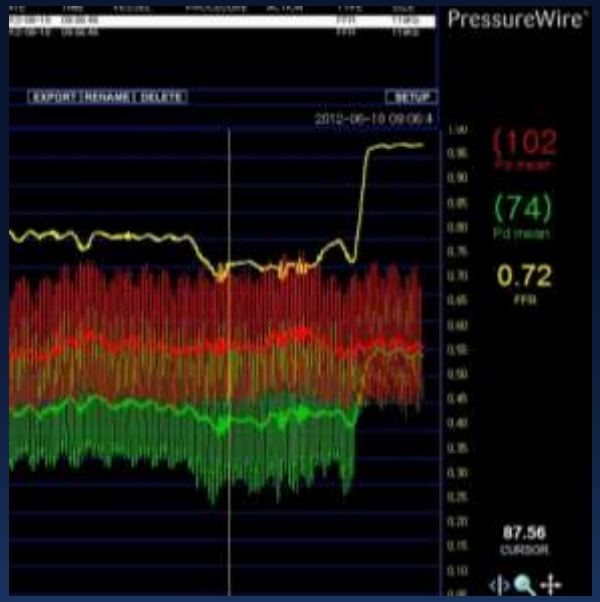
LM Bifurcation Disease

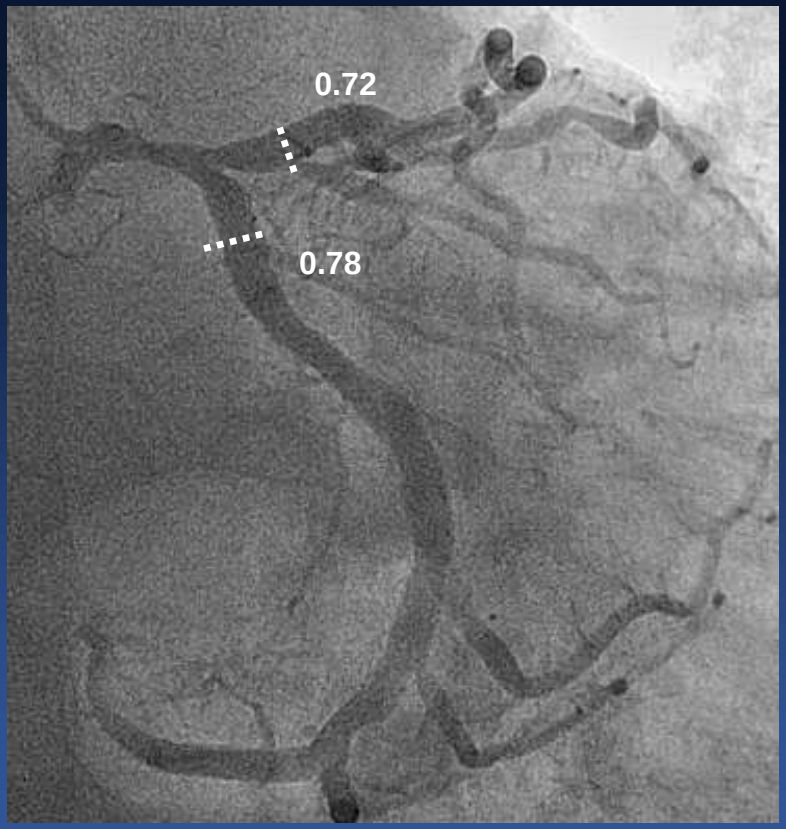
Medina (1,0,0)

55/M, Stable angina, TMT (+), Thallium scan (-)

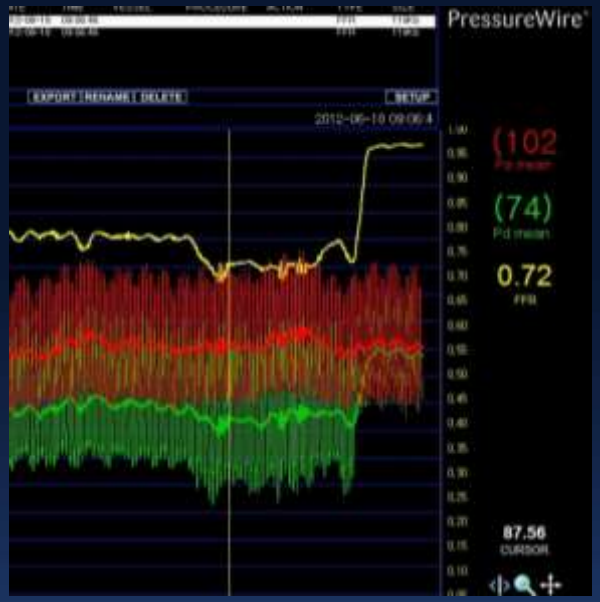


FFR in Both LAD and LCX,

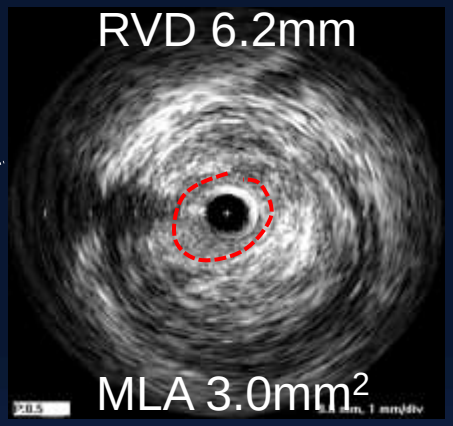


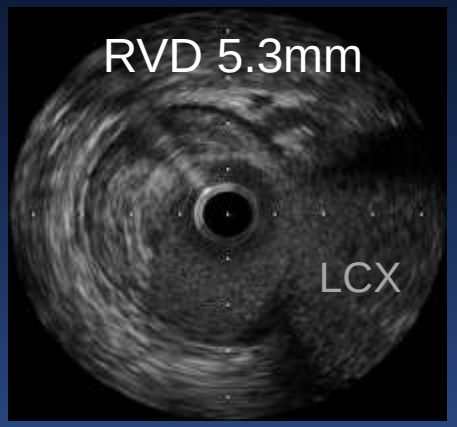


IVUS in Both LAD and LCX,

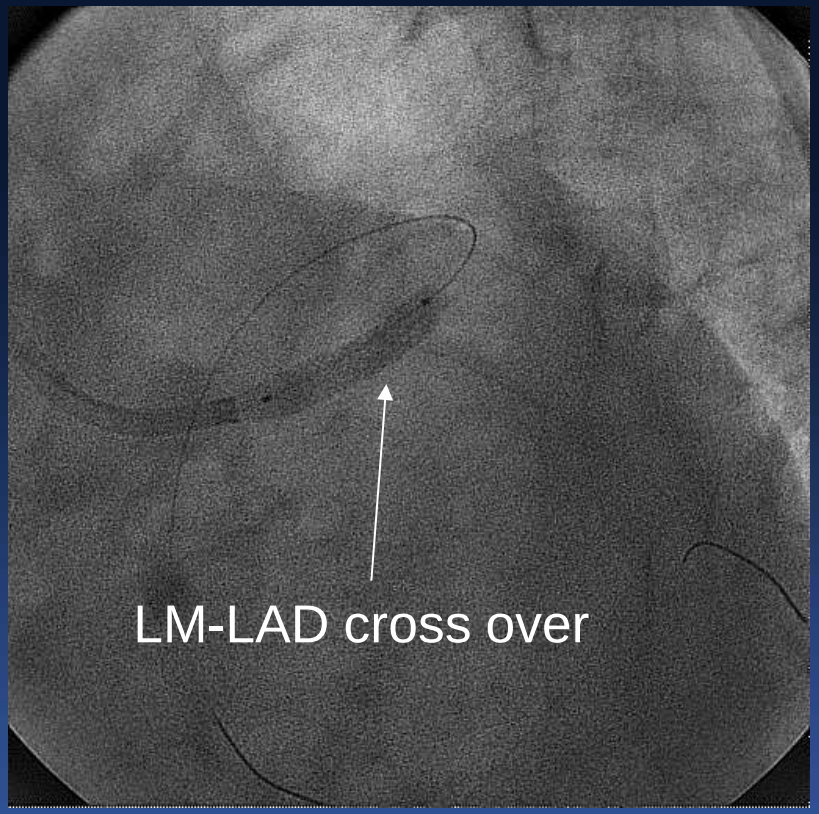


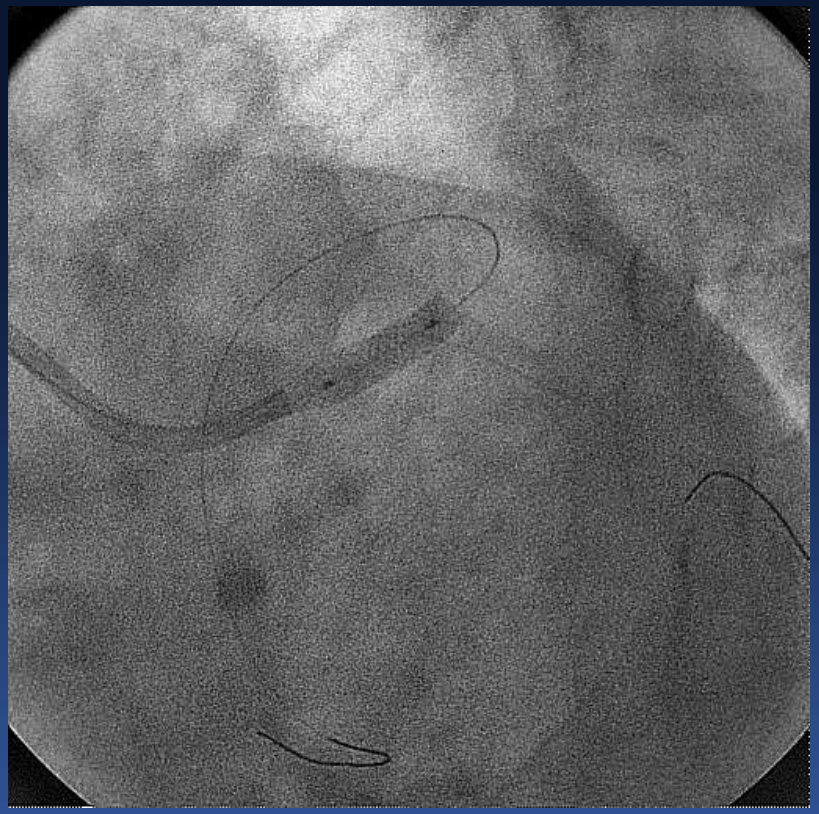
Distal LM,
RVD 6.2mm





Single Stent Cross-Over !

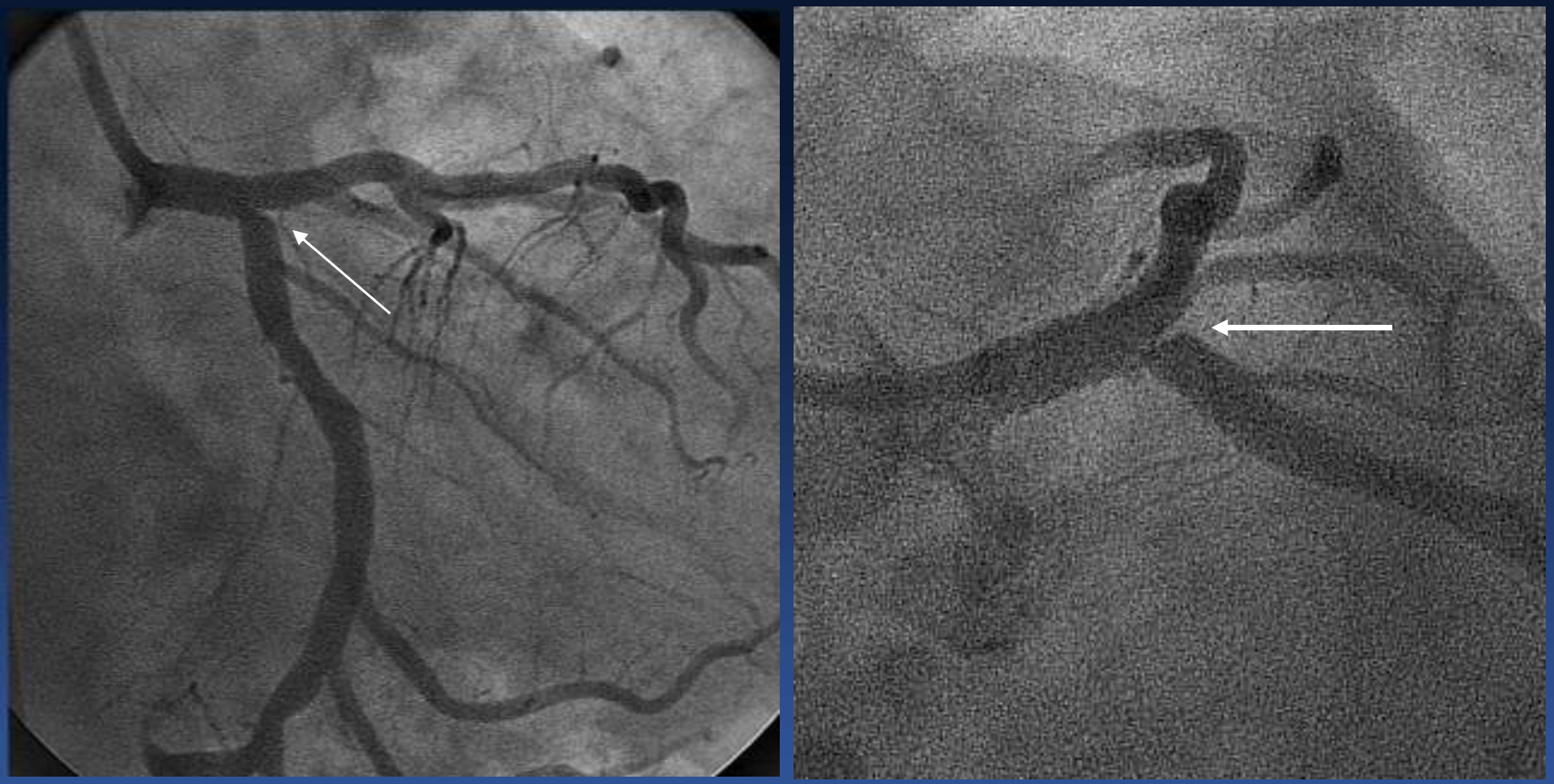




Promus Element 4.0x20

Additional high pressure Inflation with 4.0 mm non-compliant balloon

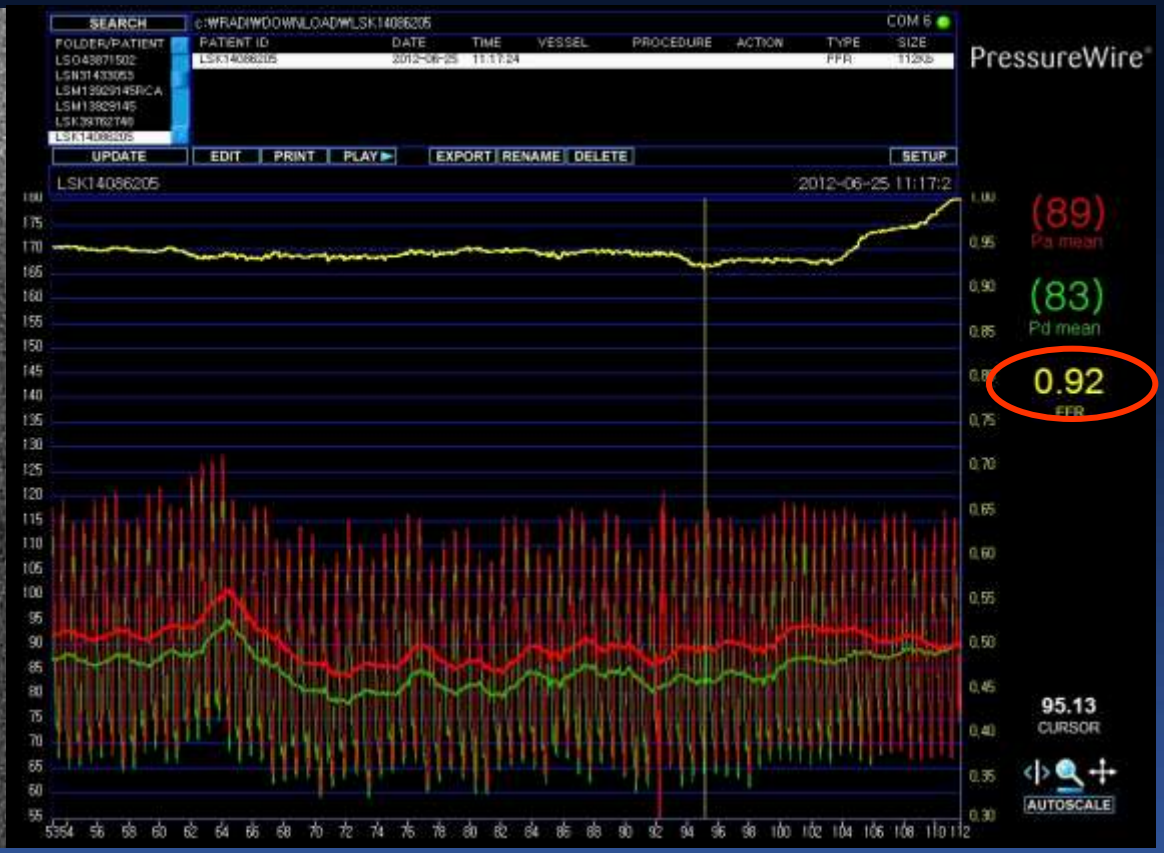
After Stent Crossover, LCX Ostium Was Jailed !



What Would You Do ?

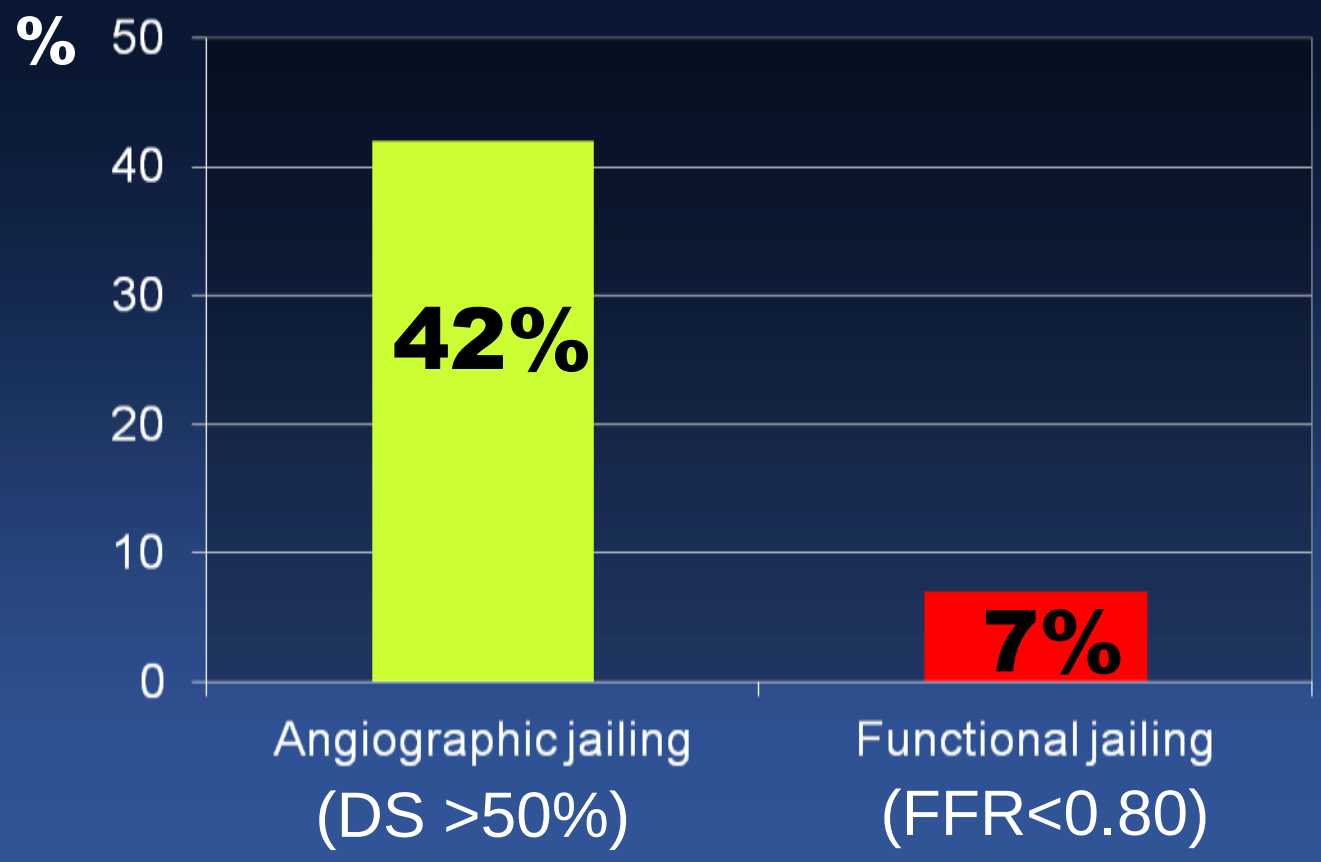
Do You Want to Treat Jailed Side Branch ?

Consider FFR, First !



Just Defer !

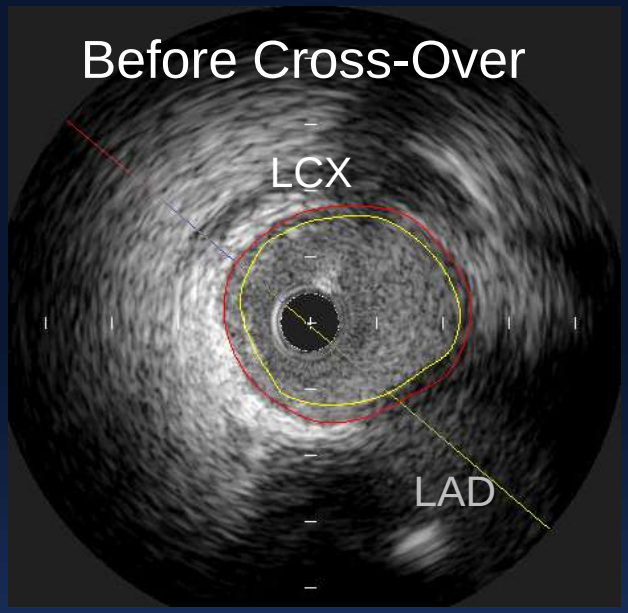
Functionally Significant LCX Jailing
After Stent Crossover (LCX ostial DS<50%)

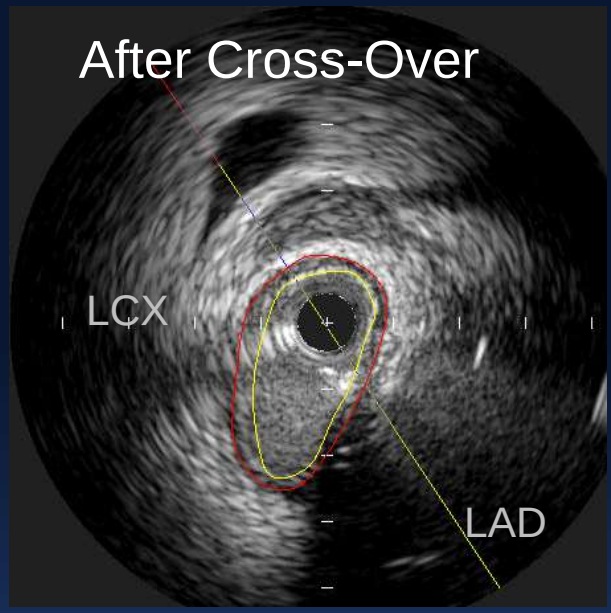


Kang SJ, Catheterization and Cardiovascular Interventions. 2014;83(4):545-52.

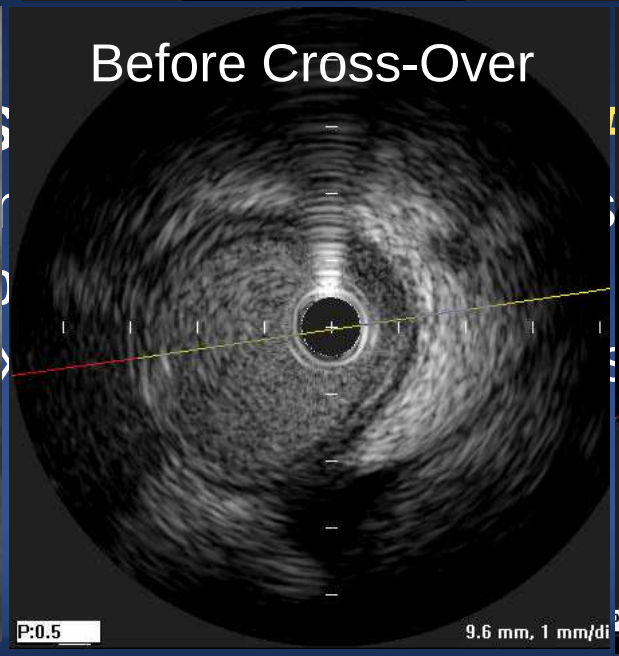
Mechanism of LCX Jailing

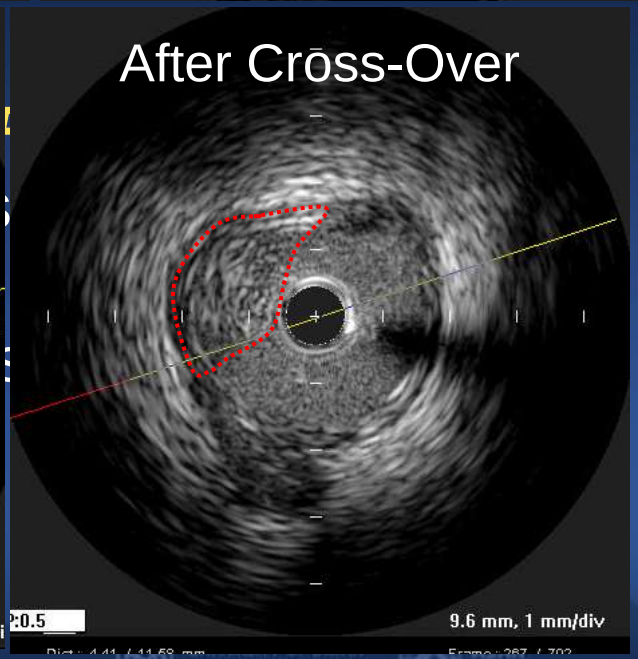
Mainly,
Carina Shift





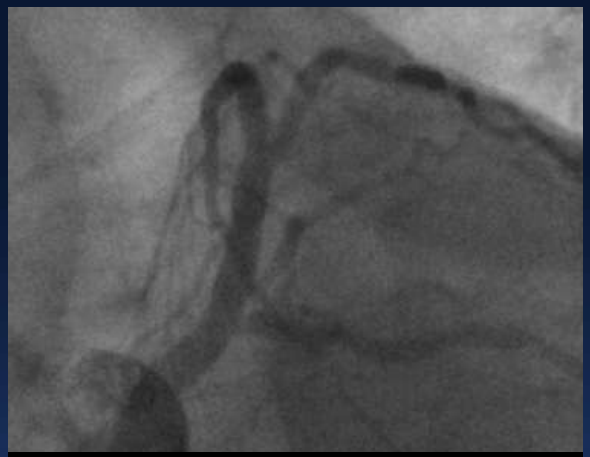
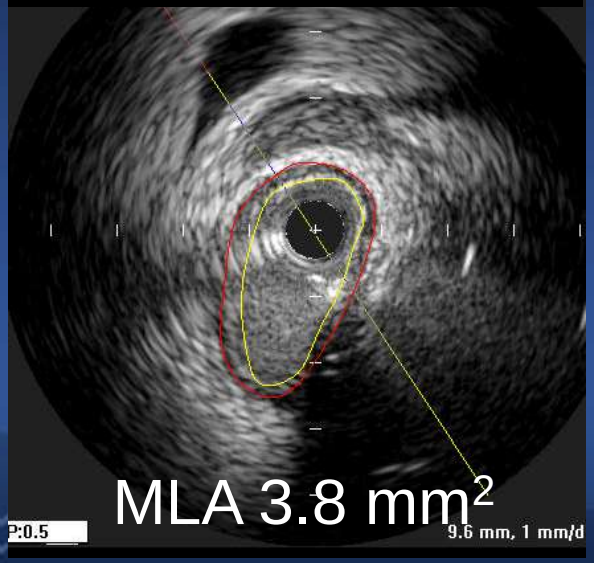
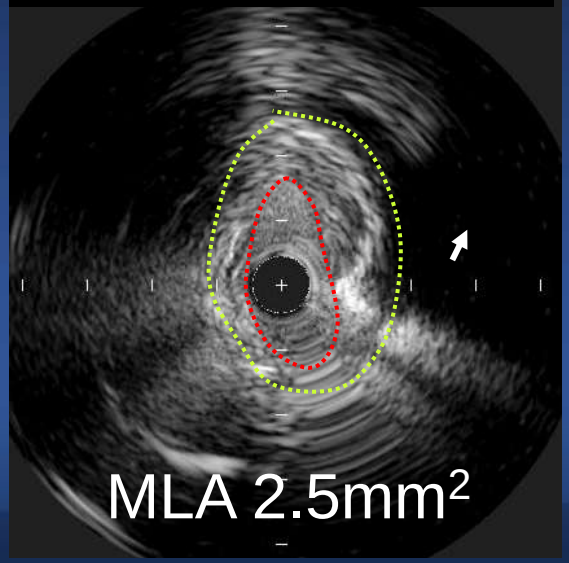
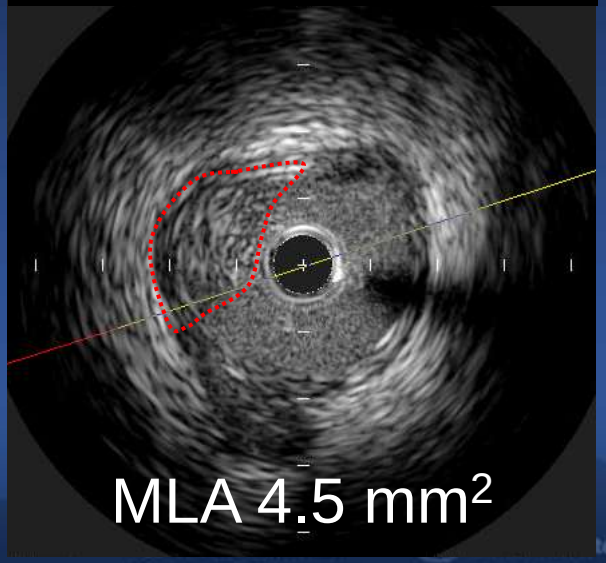
Plaque Redistribution



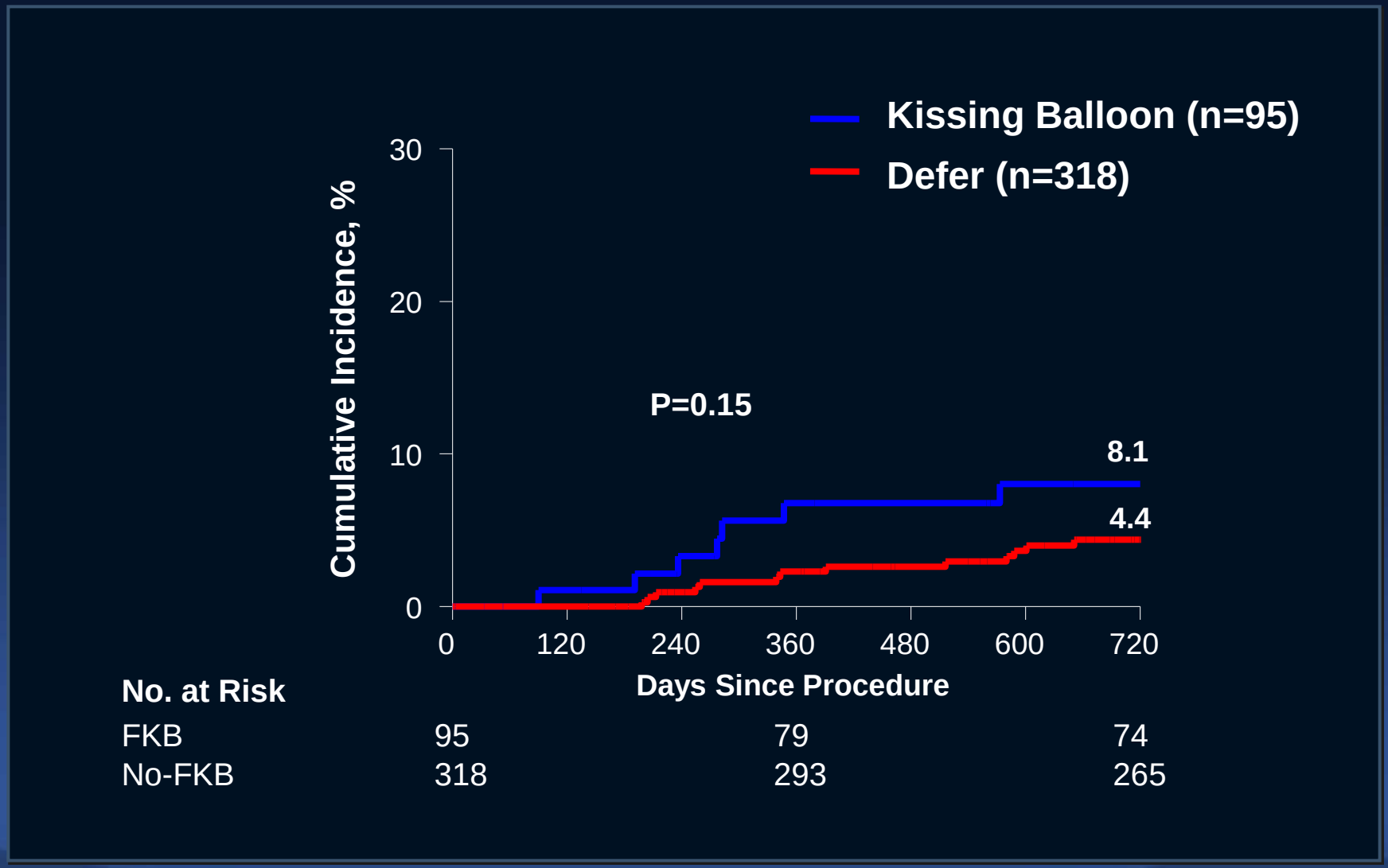


Kang et al. Circ Cardiovasc Interv 2011;4:355-61

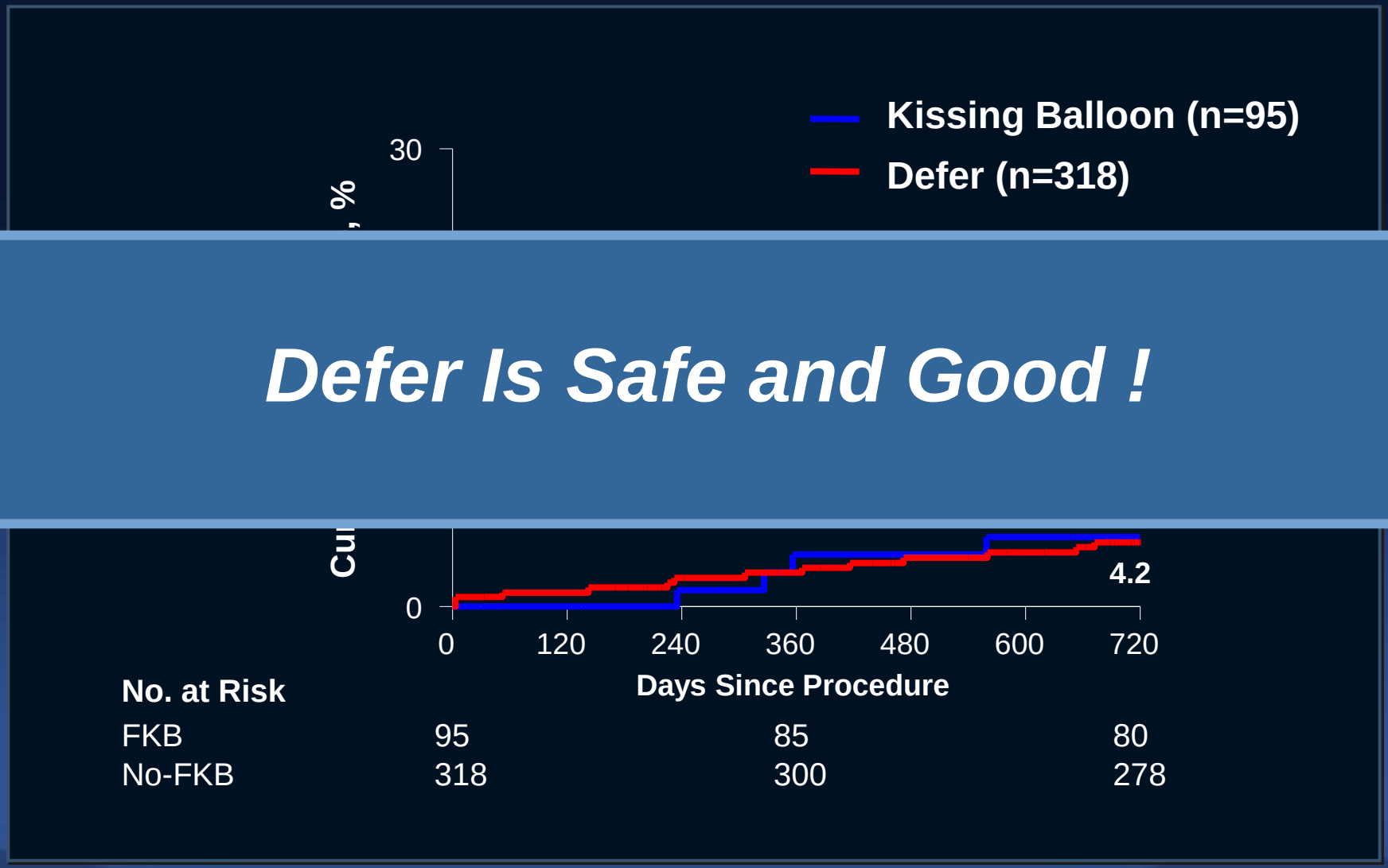
Morphology Cannot Predict LCX FFR

FFR 0.91	FFR 0.81	FFR 0.85
		
Carina shift	*Carina shift*	*Plaque shift*
		
MLA 3.8 mm^2	MLA 2.5mm^2	MLA 4.5 mm^2

Left Main-TLR *at 2 Years*



Death or MI *at 2 Years*



Defer Is Safe and Good !

AMC New Data, 2015

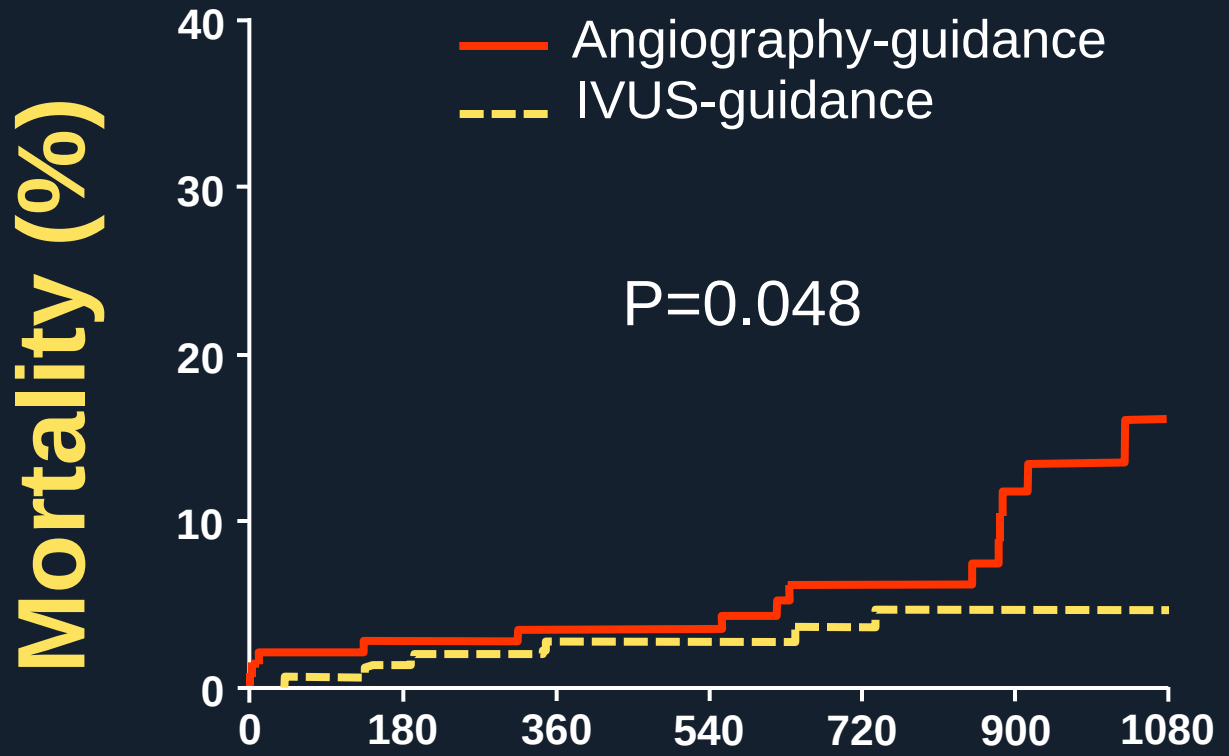
Q1, Why FFR ?

1. Angiographic Assessment is *Not Always Enough !* Decision Making To Treat or Not To Treat for Intermediate LM Stenosis, *FFR is Crucial !*

2. Decision Making To Treat or Not To Treat for Side Brach Jailing after Main Stent Crossover, *FFR Should Be Considered First !* Routine Kissing Balloon Inflation is Not Always Good.

Q2,
Why IVUS too ?

IVUS Guidance Saved Lives !



Patients after risk				
IVUS-guidance	145	140	98	37
Angiography-guidance	145	137	88	29

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

Impact Of IVUS

① *Decision Making ;*

1 Stent or 2 Stents ?

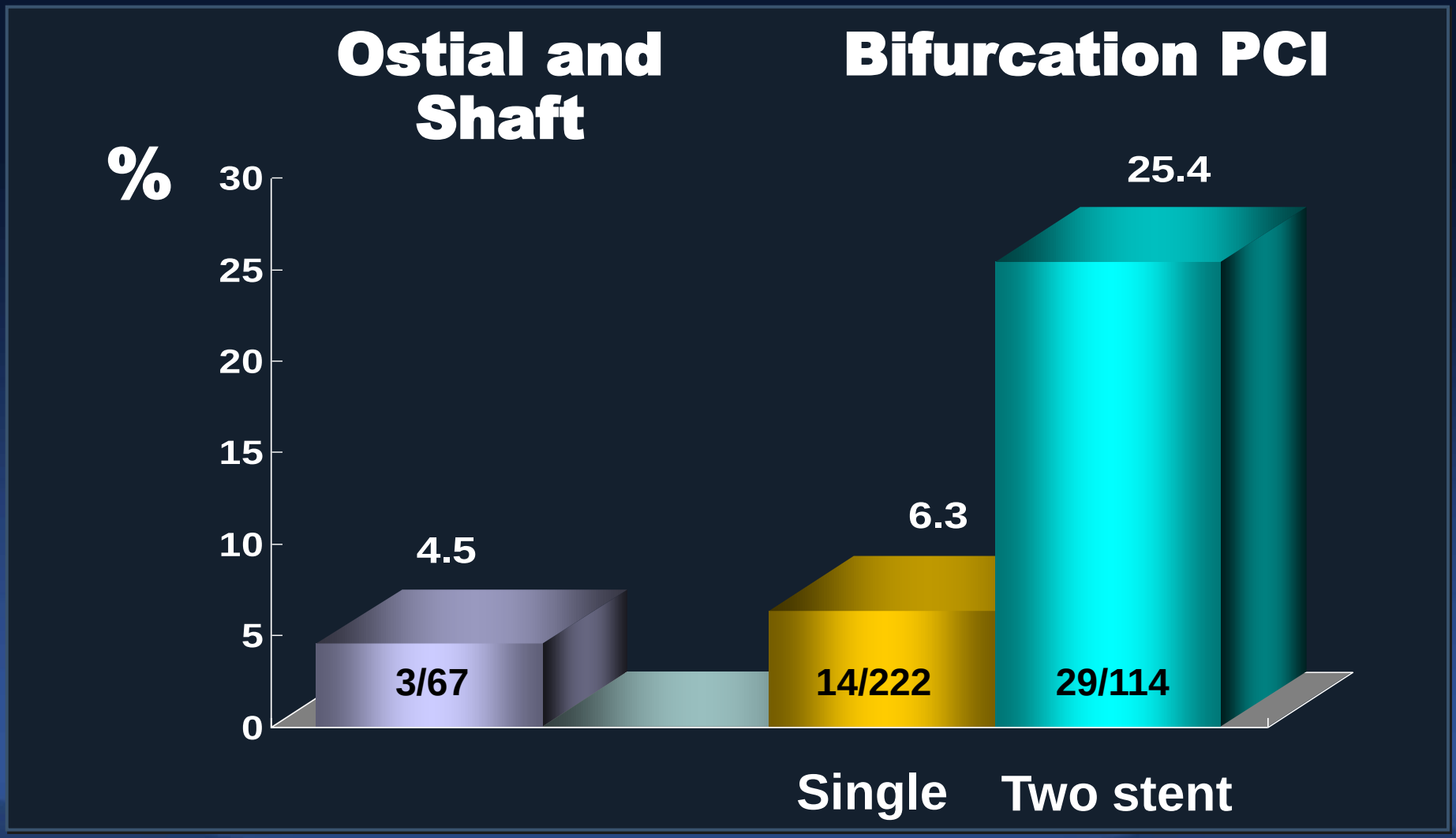
Stent Strategy for Distal LM Bifurcation

Stent Cross Over	***Normal Ostial LCX (Medina 1.1.0., 1.0.0)*** Normal or Diminutive LCX Small LCX with < 2.5 mm in diameter Focal disease in distal LCX
Two Stent	***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 2007

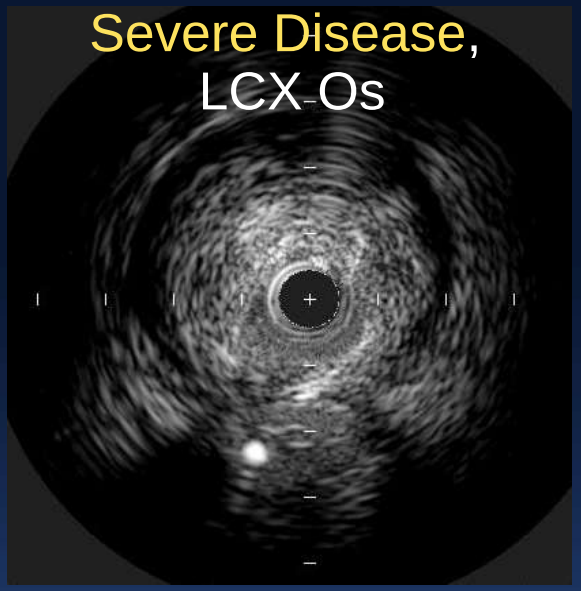
Restenosis at 2 year

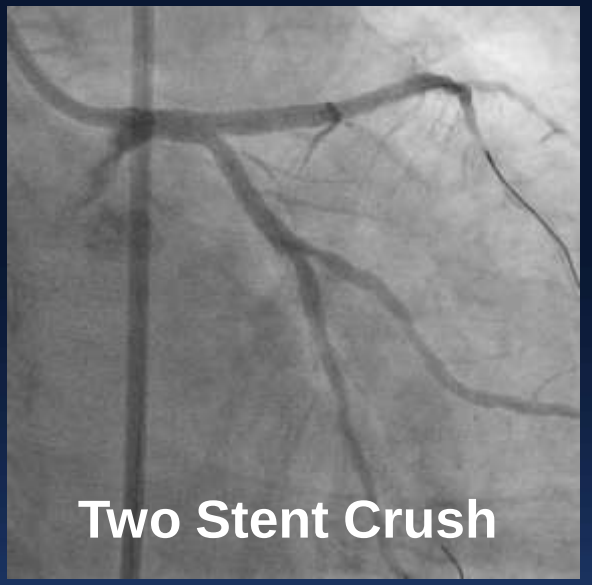
Pooled Analysis in 403 Patients with LM PCI Using SES

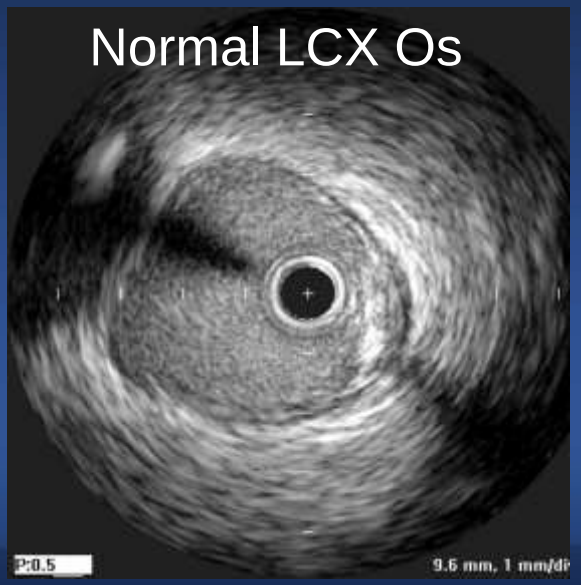


Kang et al. Circ Cardiovasc Interv 2011;4:1168-74

Depending on Whether or LCX Disease,







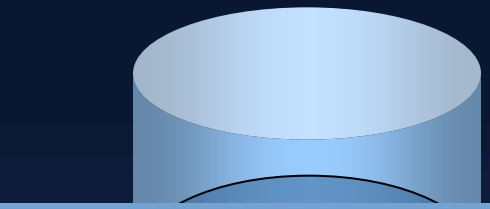
Impact Of IVUS

② *Stent Optimization ;*
After 2 DES Stents

2 Stent Techniques

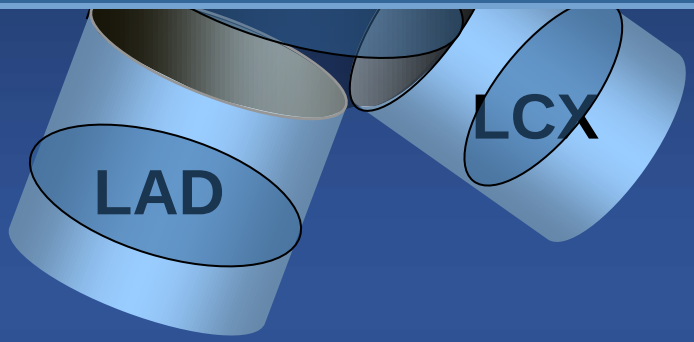
- T-stent, modified T-stent or TAP
- Mini-crush (or step crush)
- Culotte
- V-stent
- Y-stent (SKS-simultaneous kissing stents)

2 Stents Technique, *Effective IVUS Stent Area* (Rule of 5,6,7,8) Can Reduce Restenosis Rate



Overall Restenosis Rate < 5%,
TLR < 2%

6 mm²

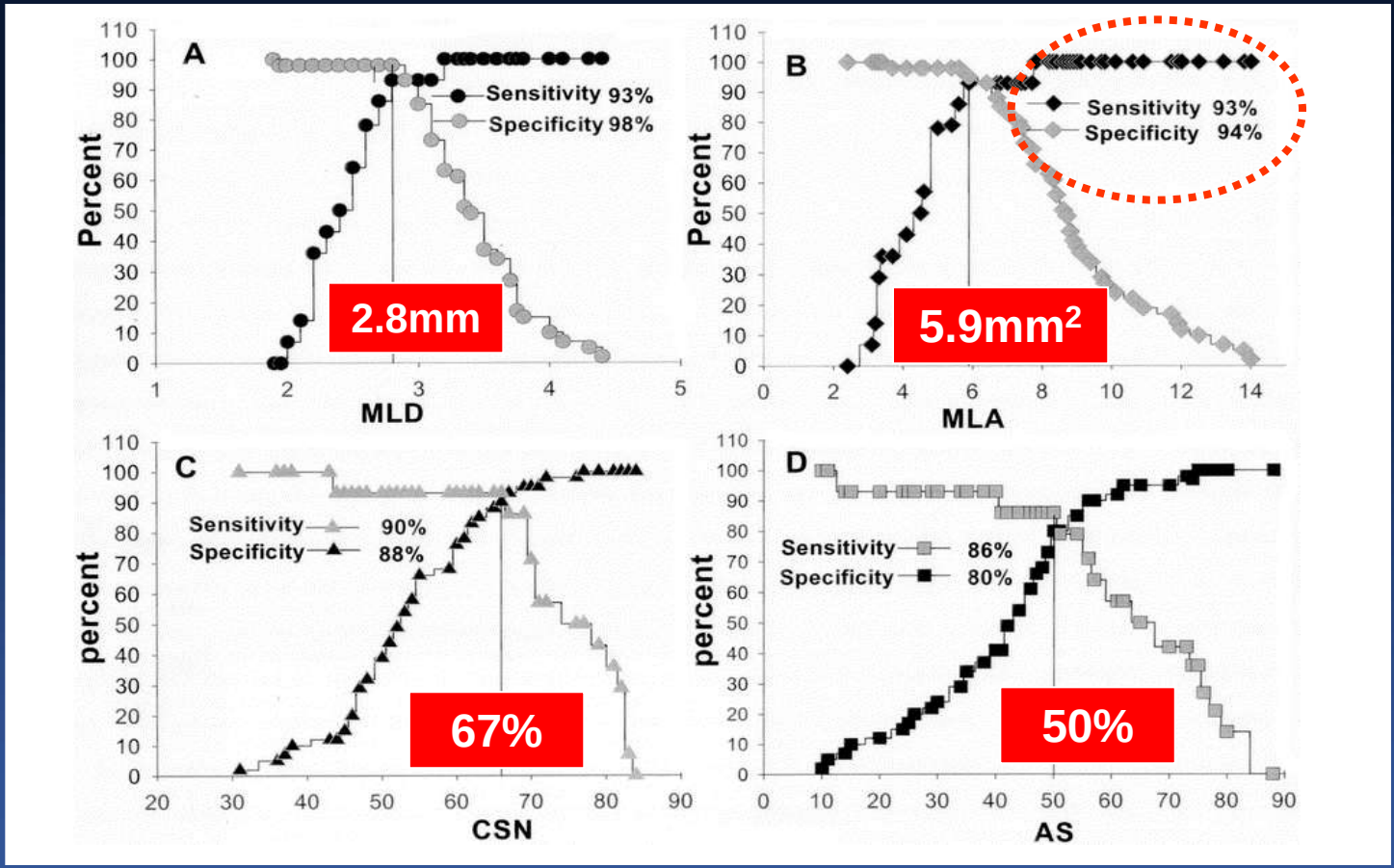


Kang et al. Circ Cardiovasc Interv 2011;4:1168-74

Issue of *LM IVUS MLA*
(Ischemic Threshold)

LM, IVUS MLA < 6.0 mm²

Matched with FFR <0.75



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

Non-LM, IVUS MLA Matched with FFR

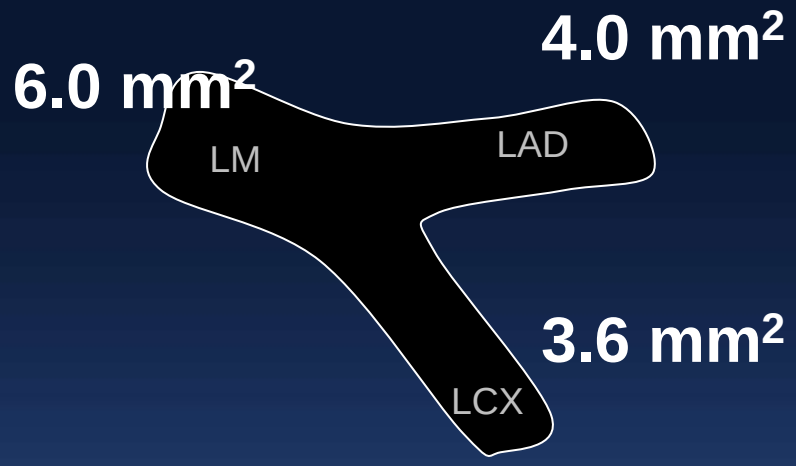
	N	FFR	RLA	MLA mm^2	AUC	Sens	Spec	PPV	NPV	Accu
Abizaid (1998, AJC)	112	CFR	8.3	***4.0***						
Nishioka (1999, JACC)	70	SPECT	10.6	***4.0***						
Briguori (2001, AJC)	53	0.75	7.8	***4.0***	–	92%	56%	38%	96%	64%
Waksman (2013, JACC)	350	0.80	8.6	***3.07***	0.65	64%	65%	–	–	65%
Kang (2012, AJC)	784	0.80	8.2	***2.4***	0.77	84%	63%	48%	90%	69%
Kang (2011, Circ int)	236	0.80	7.6	***2.4***	0.80	90%	60%	37%	96%	68%
Koo (2011, JACC int)	267	0.80	6.8	***2.75***	0.81	69%	65%	27%	81%	67%
Lee (2010, AJC)	94	0.75	5.9	***2.0***	0.80	82%	81%	–	–	81%
Gonzalo (2012, JACC)	47	0.80	7.1	***2.36***	0.63	67%	65%	67%	65%	66%
Stone (2012, VERDICT – FIRST)	554	0.80		***2.9***				47%	81%	66

Background

Geometric Abstraction By Murray's Law

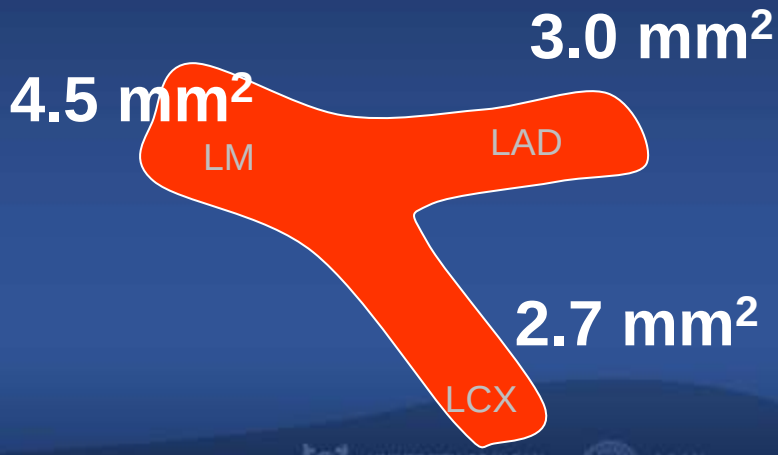
Old Data

		Murray's	Finet's
LAD	LCX	LM	LM
4.0	4.0	6.35	7.35
4.0	3.9	6.27	7.26
4.0	3.8	6.19	7.17
4.0	3.7	6.11	7.08
4.0	3.6	6.04	6.98
4.0	3.5	5.96	6.89



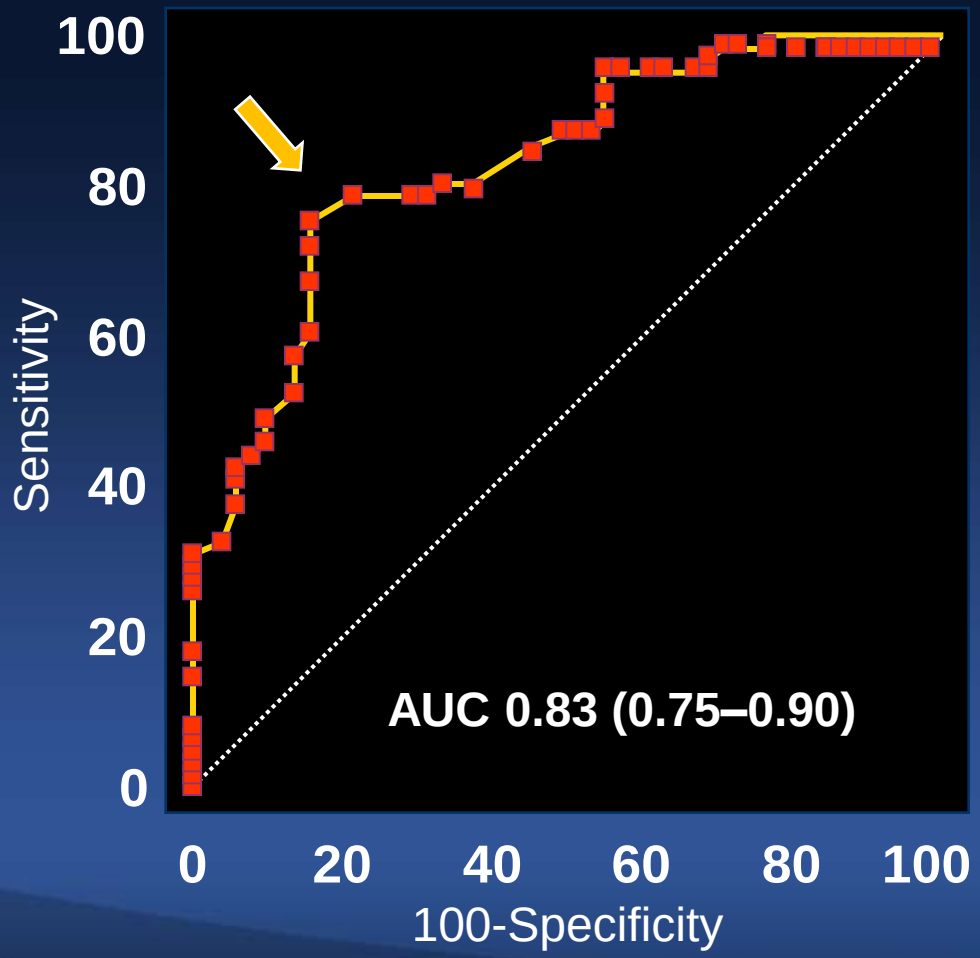
New Data

		Murray's	Finet's
LAD	LCX	LM	LM
3.0	3.0	4.76	5.52
3.0	2.9	4.68	5.42
3.0	2.8	4.60	5.33
3.0	2.7	4.53	5.24
3.0	2.6	4.45	5.14
3.0	2.5	4.37	5.05



New 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 Interv, 2014;7(8):868-874*

Q2, Why IVUS Too ?

1. IVUS Guidance Saves Lives.
2. Assessment of LM Ostium, Reference Vessel Diameter, Pattern of Remodeling, and Vulnerability of Plaque.
3. Treatment Strategy Would be Simplified as Single Stent Cross-Over Depending on the Disease Status of LCX Ostium by Separate IVUS Run.
4. IVUS Guided Stent Optimization and Effective Stent CSA (Rule of 5,6,7,8 mm^2) Can Make a Good Clinical Outcomes.
5. Smaller IVUS MLA 4.5 mm^2 Can Predict Functional Significance of LM Stenosis.

Integrated Use of FFR and IVUS

Less DES,
Less Surgery,
Simplified Procedure, and
Improved Clinical Outcomes !