Integrated Use of FFR and IVUS for LM PCI

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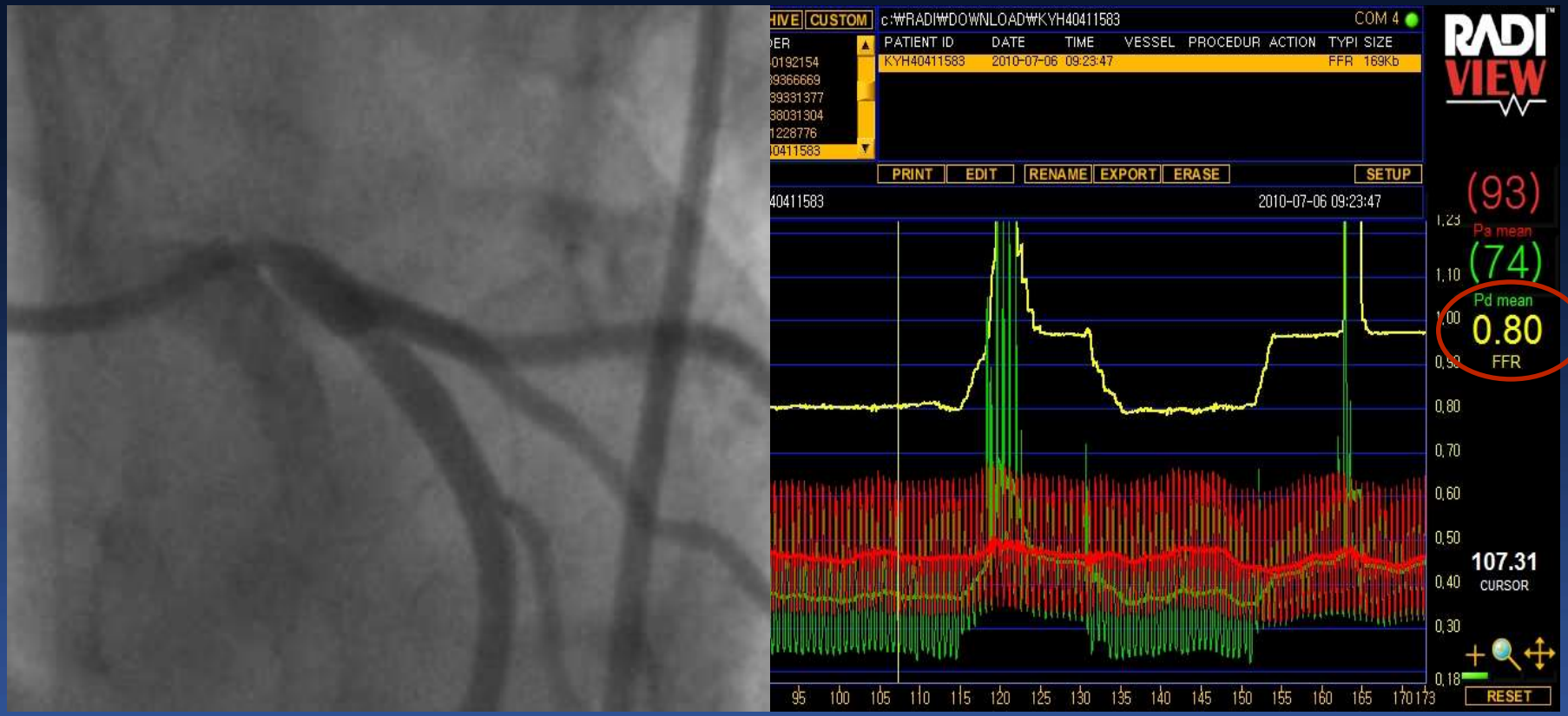
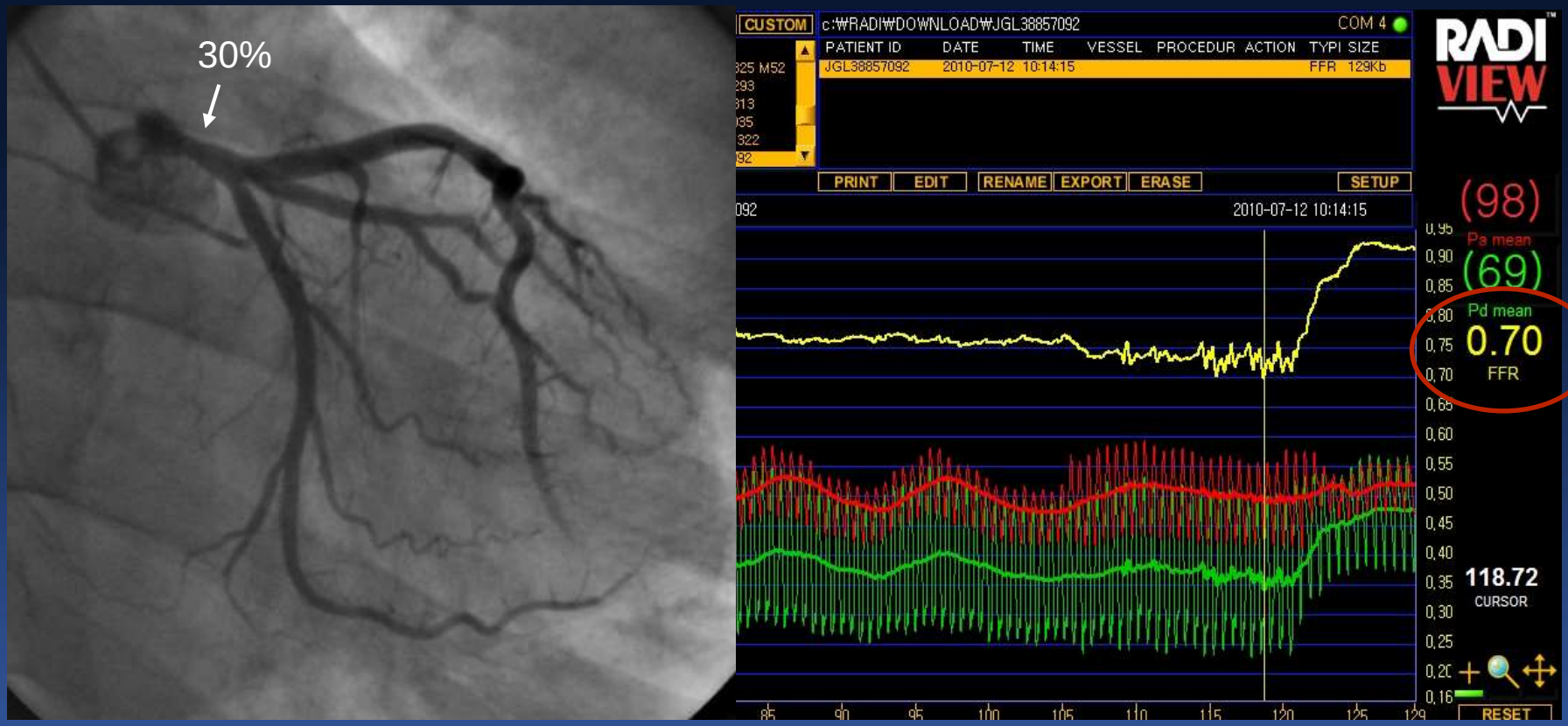
Q1, Why FFR ?

Significant Stenosis,
Negative FFR, 0.80

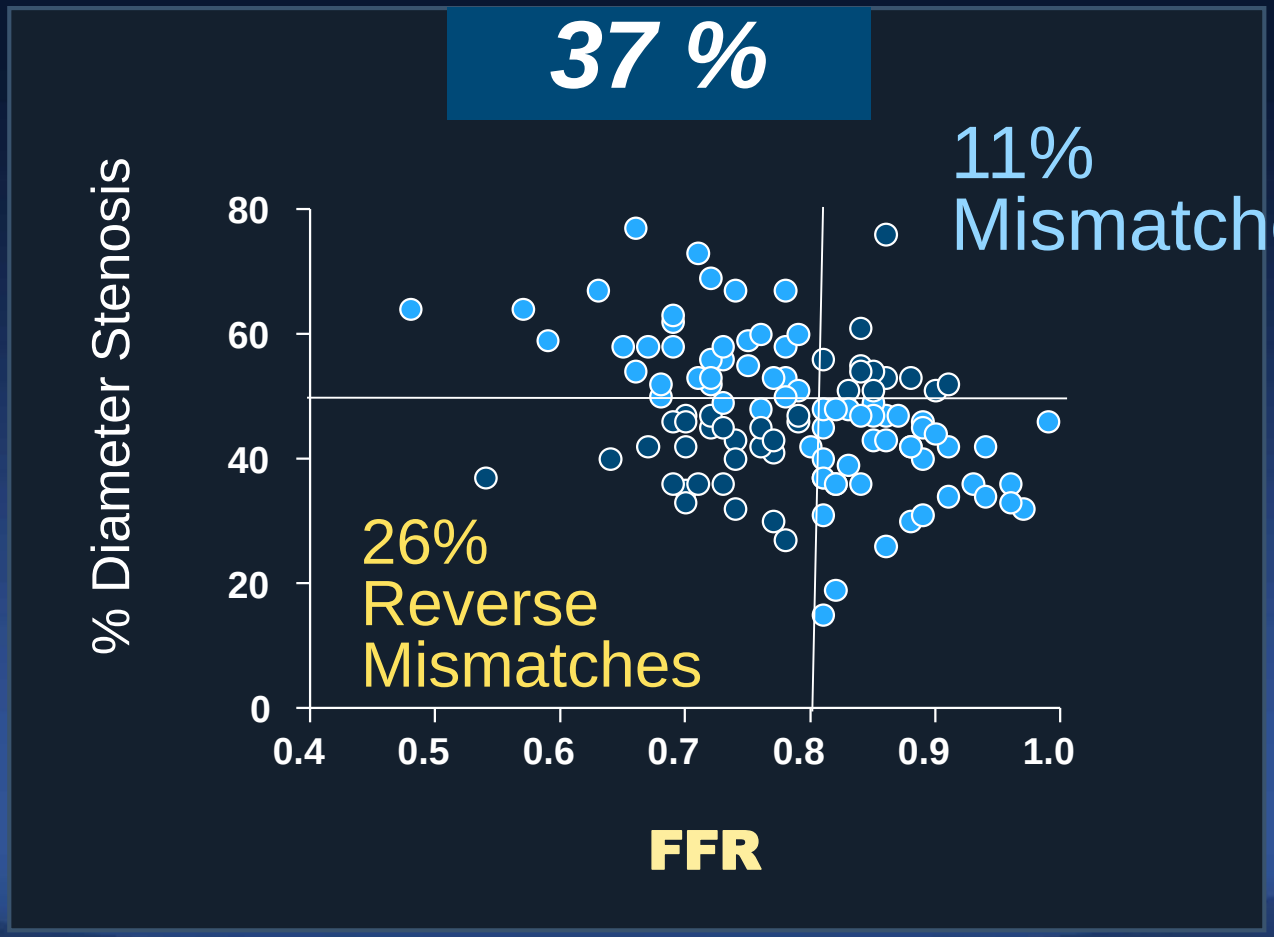


Insignificant Stenosis,
Positive FFR, 0.70



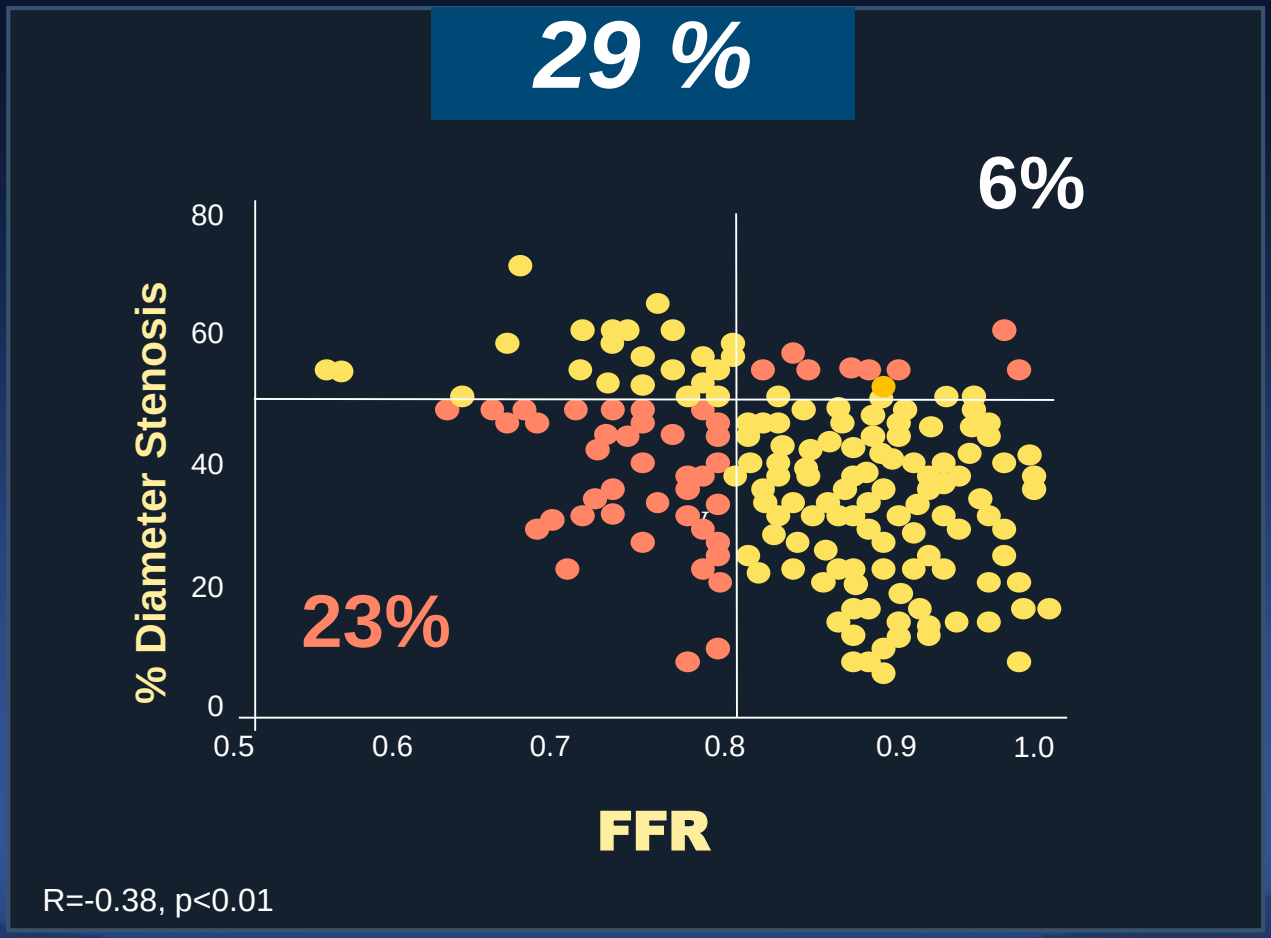
Intermediate LM Disease, Os/Shaft

Mismatches



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

Intermediate LM Disease with Downstream Disease *Mismatches*



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

FFR-Guided Means,
Ischemia Guided !

Angio-Guided Means,
No Ischemic threshold !
No Clinical Relevance !

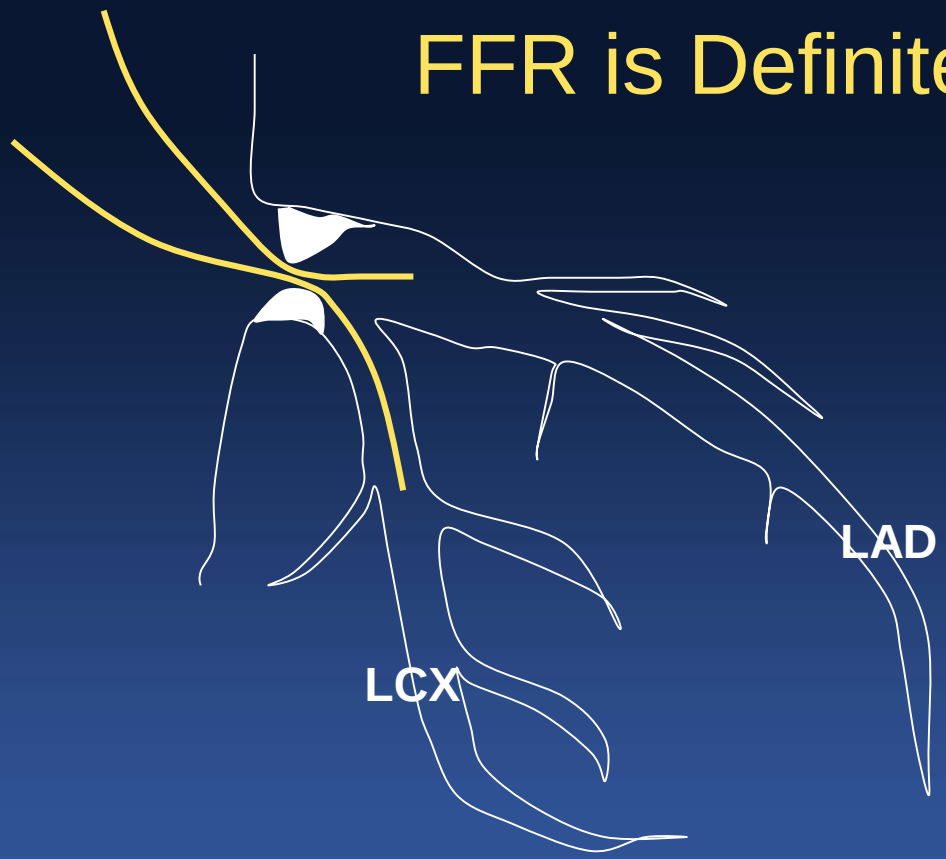
2018 ESC Guidelines for FFR

Recommendations	Class	Level
When evidence of ischemia is not available, FFR or iwFR are recommended to assess the hemodynamic relevance of intermediate-grade stenosis.	**I**	**A**
Revascularization of stenosis with FFR <0.80 is recommended in patients with angina symptoms or a positive stress test.	**I**	**B**
FFR-guided PCI shoud be considered in patients with multi-vessel disease undergoing PCI.	**IIa**	**B**
Revascularization of an angiographically intermediate stenosis without related ischemia or without FFR <0.80 is not recommended.	***III***	***B***

Q2, How do I Implement FFR for LM PCI ?

Ostial / Shaft LM Disease

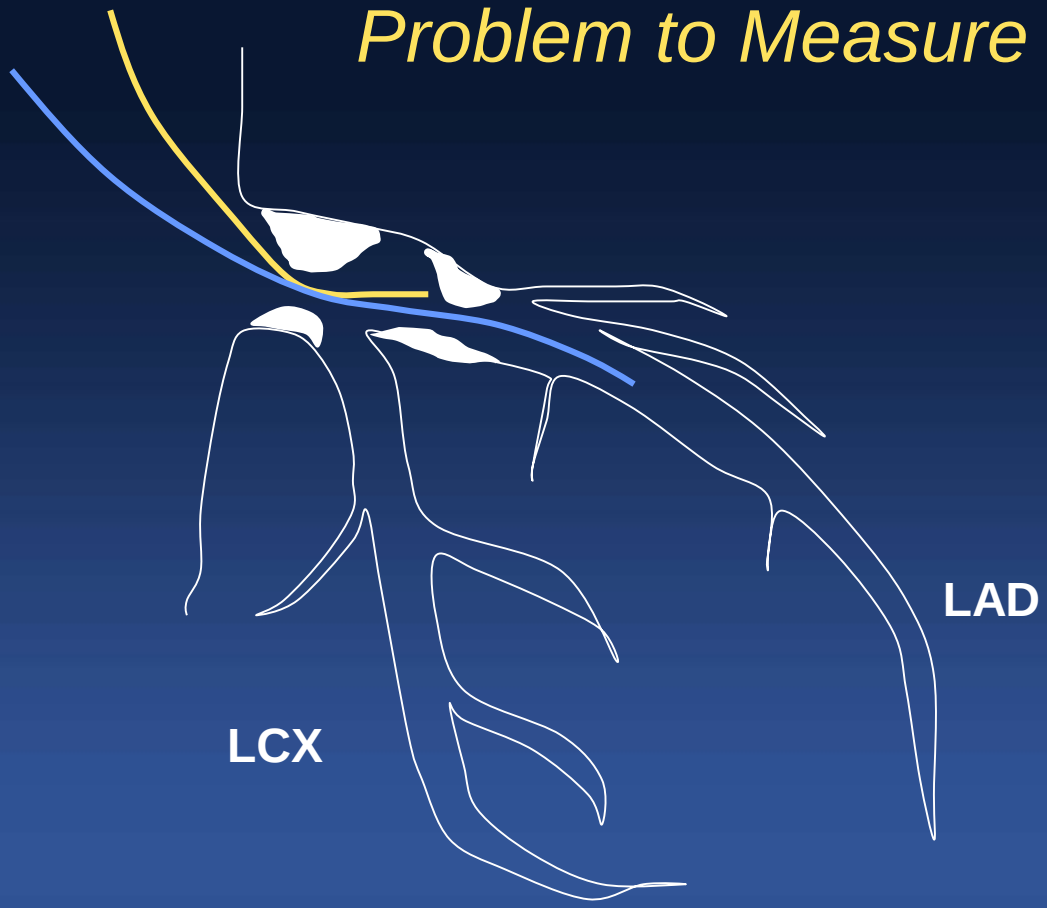
FFR is Definitely Helpful.



Courtesy of Akiko Maehara, MD

Bifurcation LM Disease

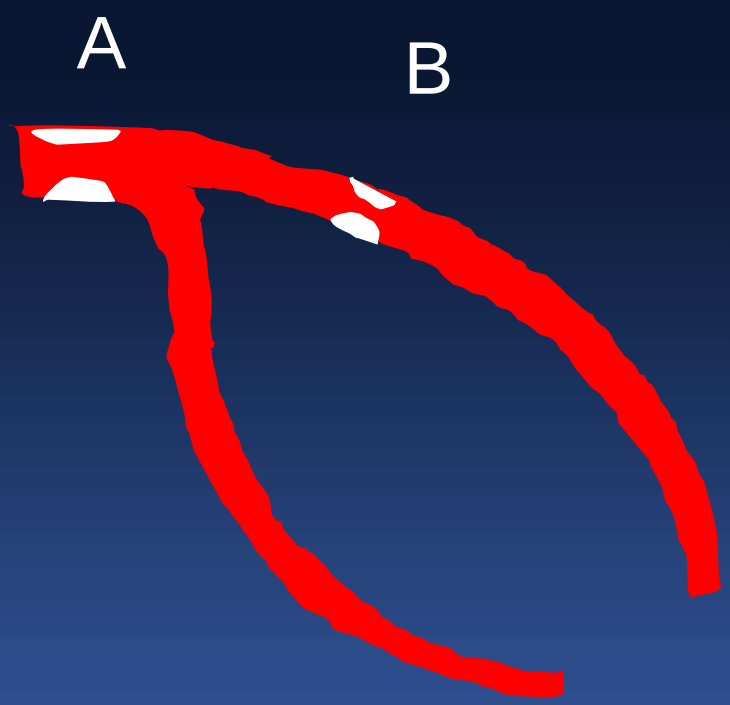
Problem to Measure FFR ?



Presence of
Large LCX Side Branch,

Does It Really Matter ?

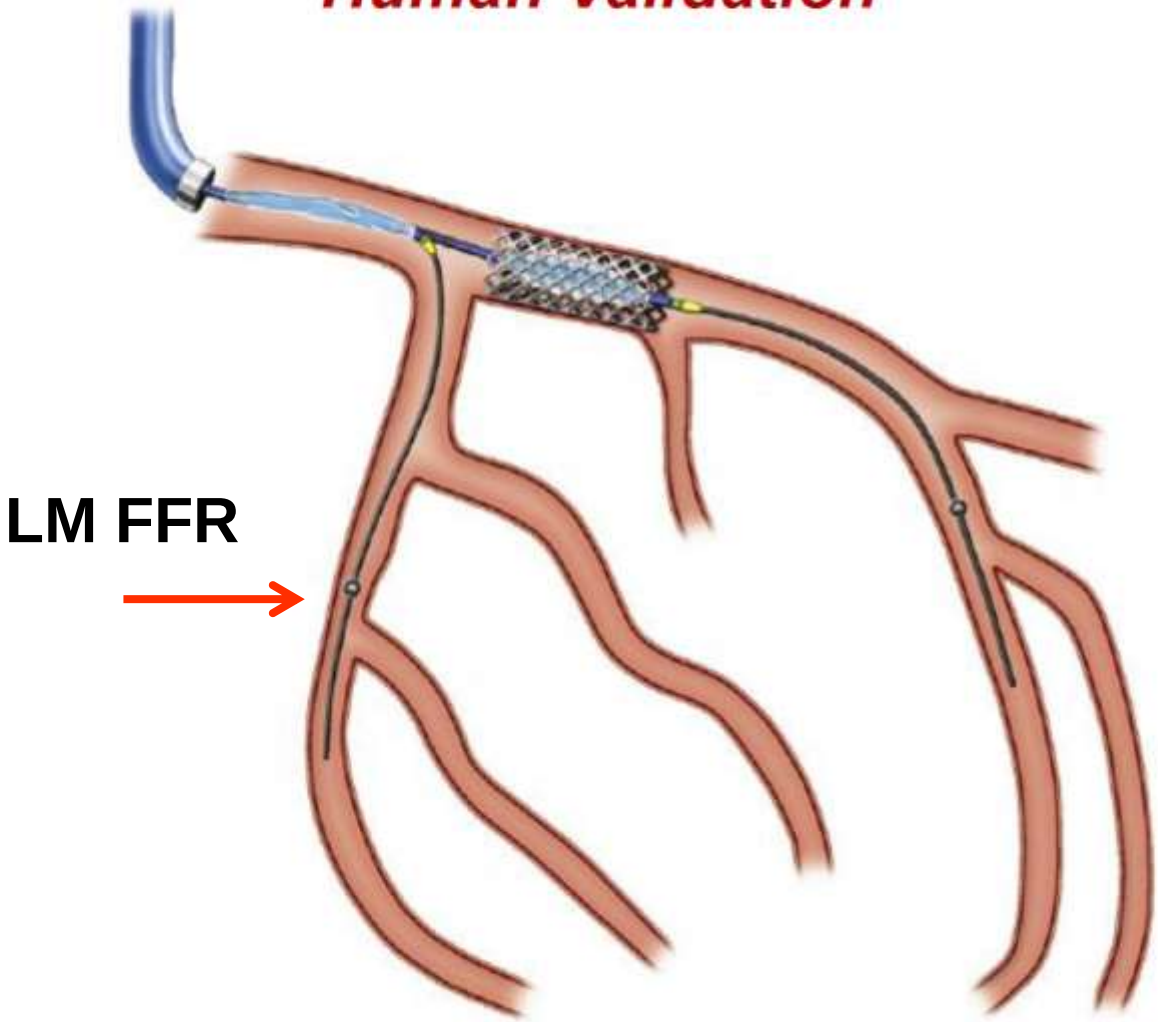
LM
with Downstream Stenosis



How Do I Implement the FFR ?

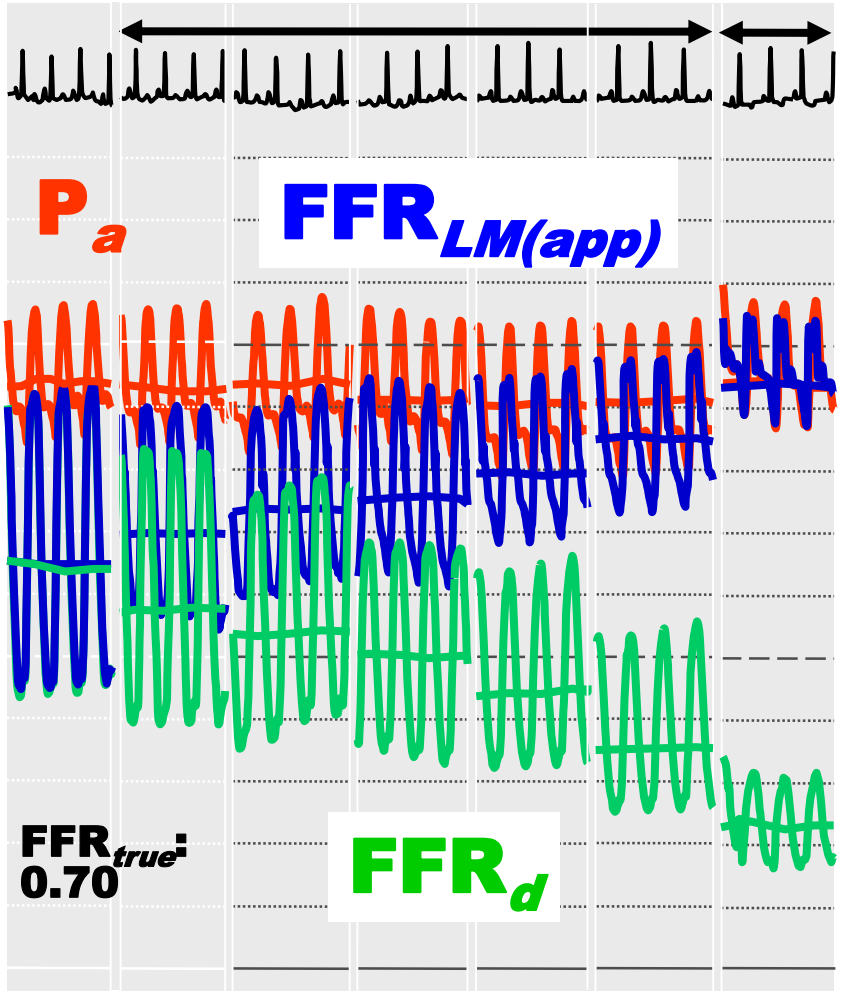
Effect of Downstream Stenosis on LM FFR:

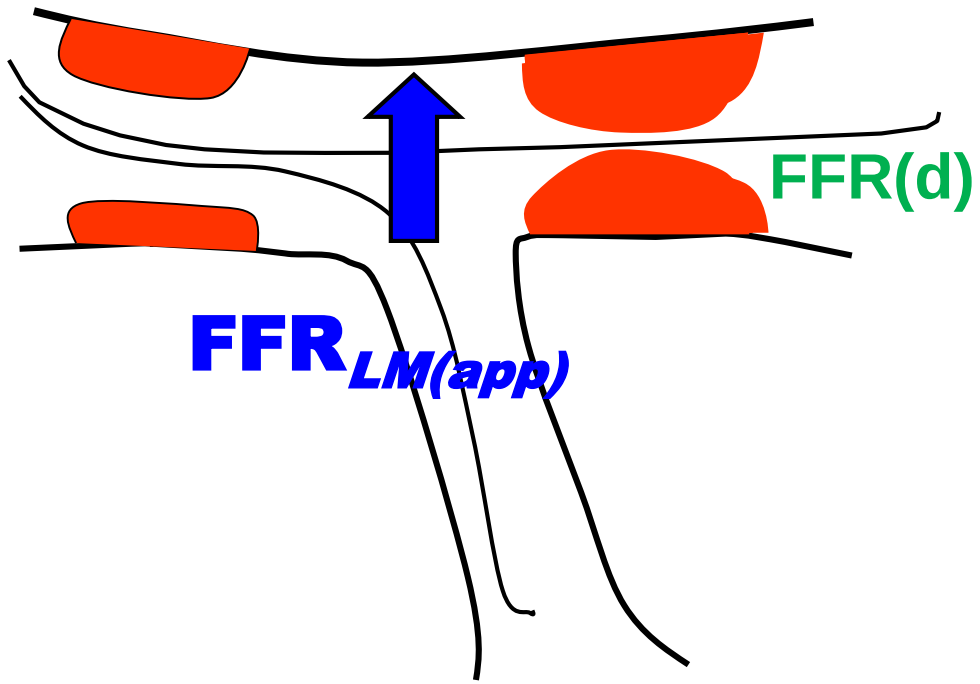
Human Validation



JACC CV Intervent 2015;8:398-403.

$FFR_{LM(app)}$ *Would Be Overestimated*



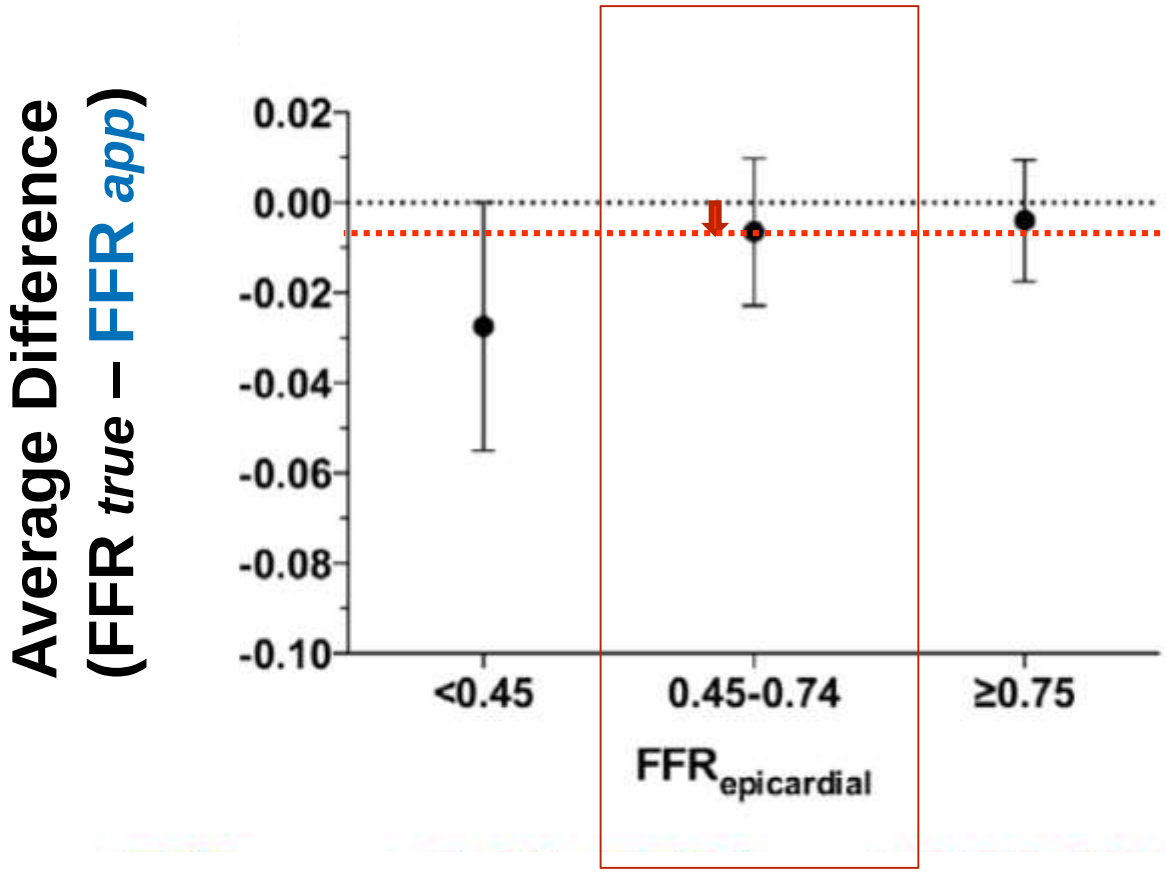


Courtesy of Bernard De Bruyne, MD, PhD

Effect of Downstream Stenosis on LM FFR:

Human Validation

91 paired measurements obtained in 24 patients

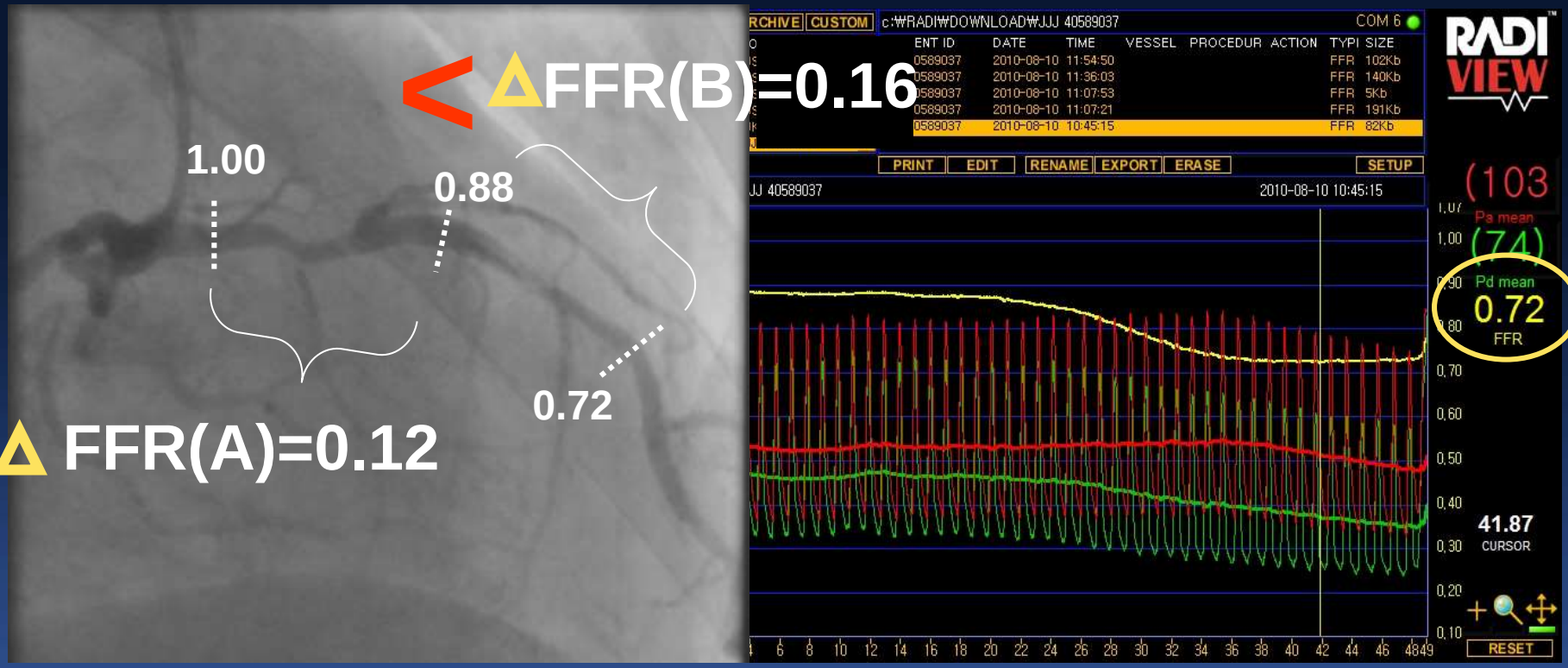


JACC CV Intervent 2015;8:398-403.

The Bigger ΔFFR Is The Tighter Stenosis !

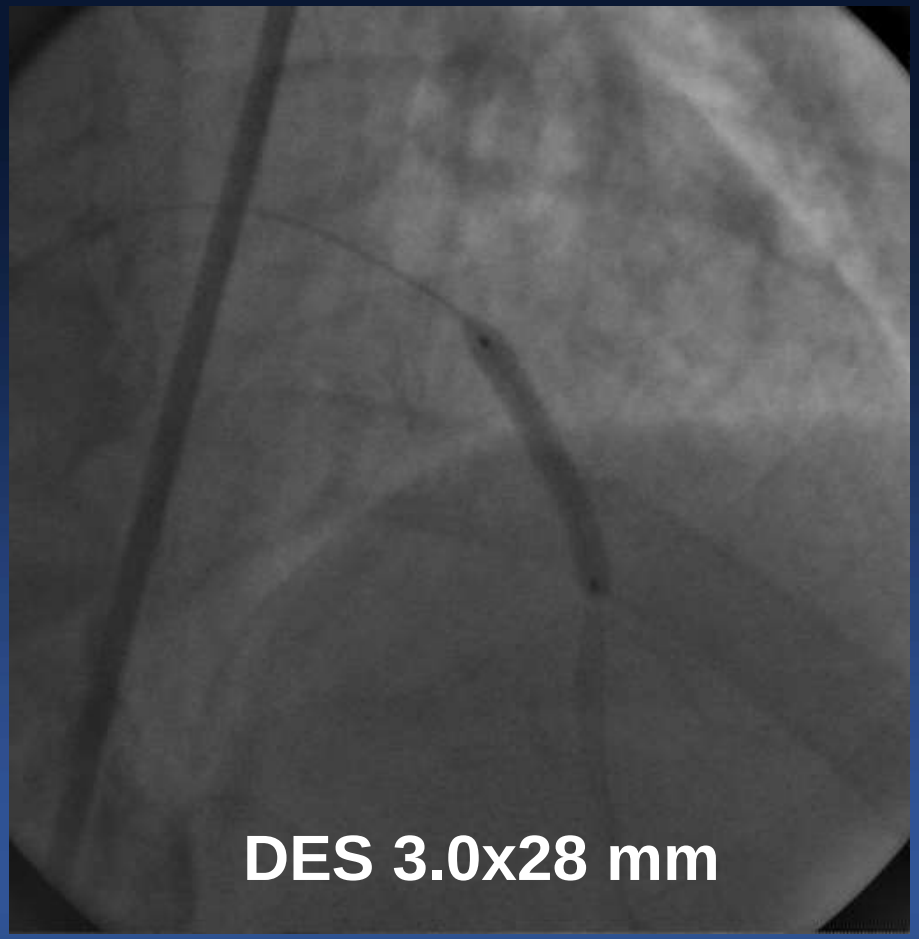
Park SJ et al, Am J Cardiol 2012 1;110(11):1578-84.

Tandem lesion PCI

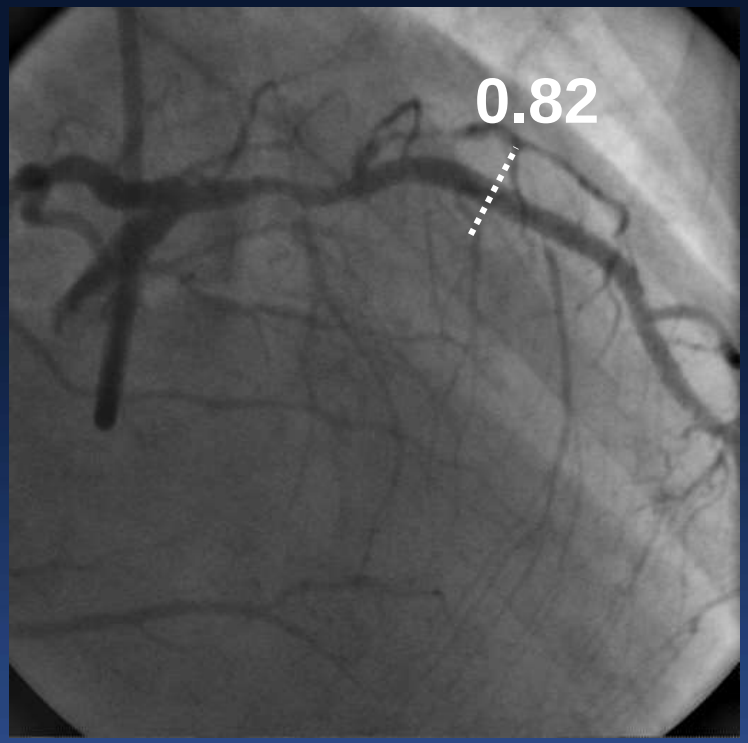


Distal lesion Should be Tighter !

Treat
Distal Tighter Stenosis First !

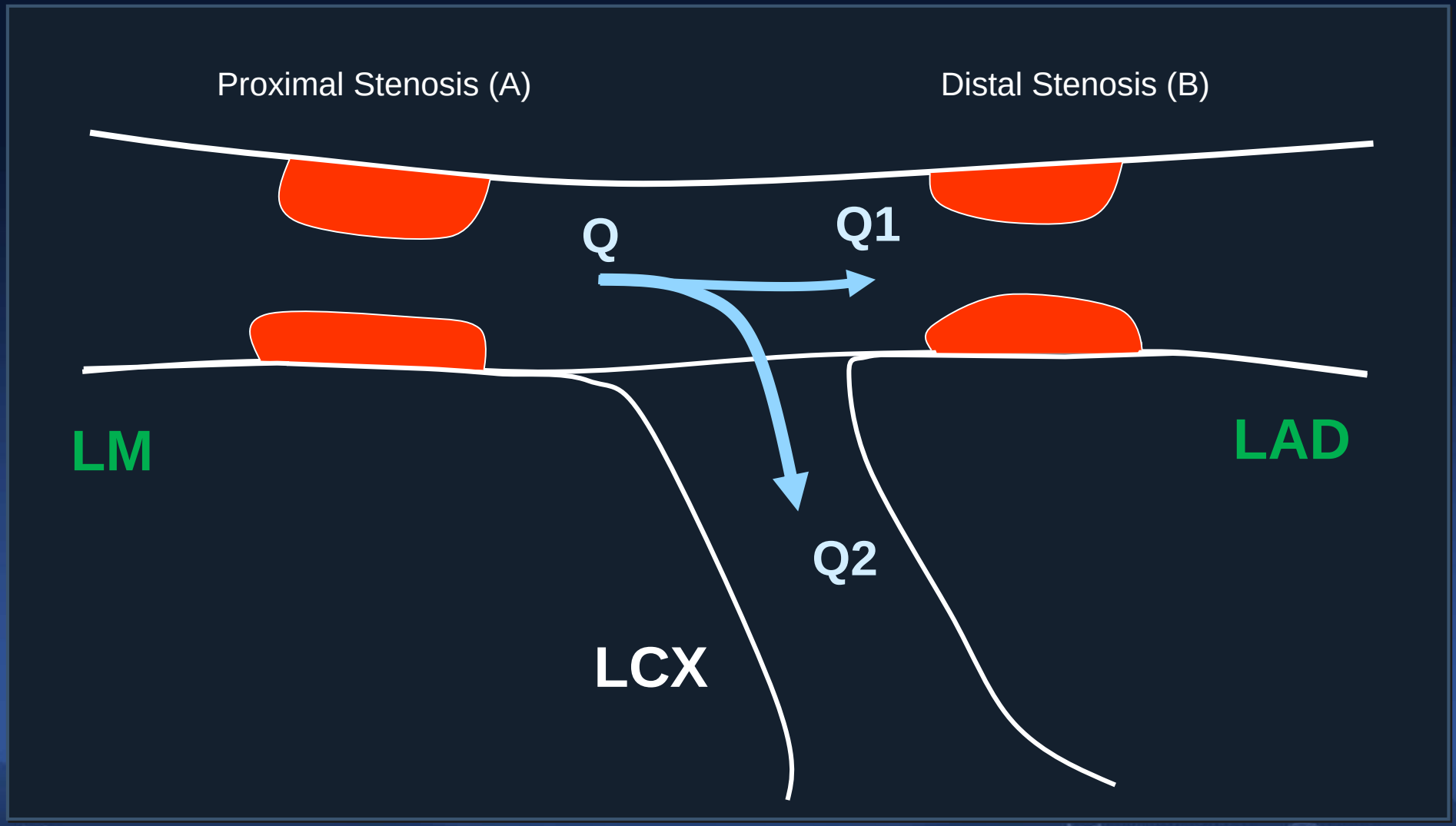


FFR again : 0.82

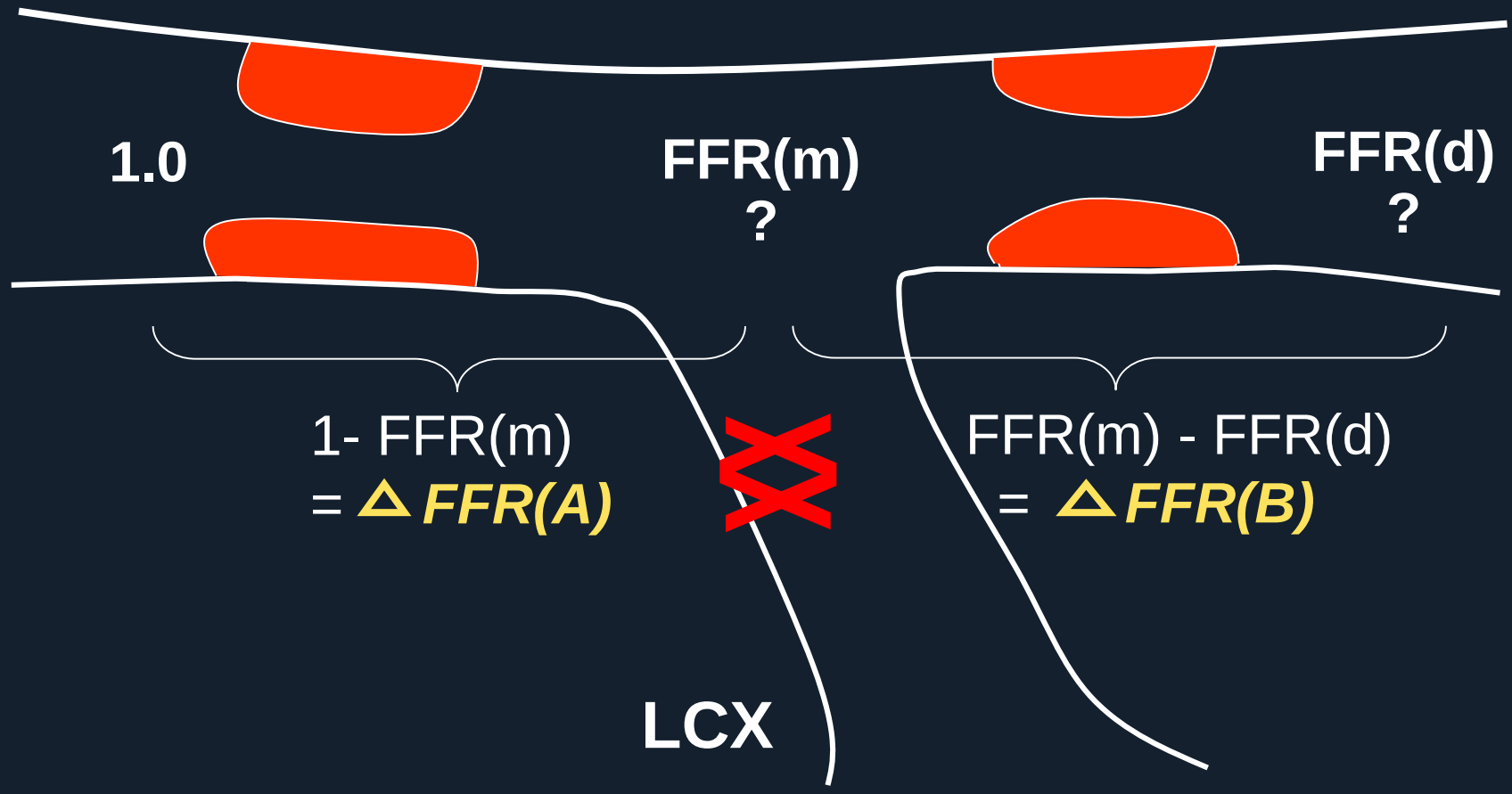


Avoid Unnecessary Stent !

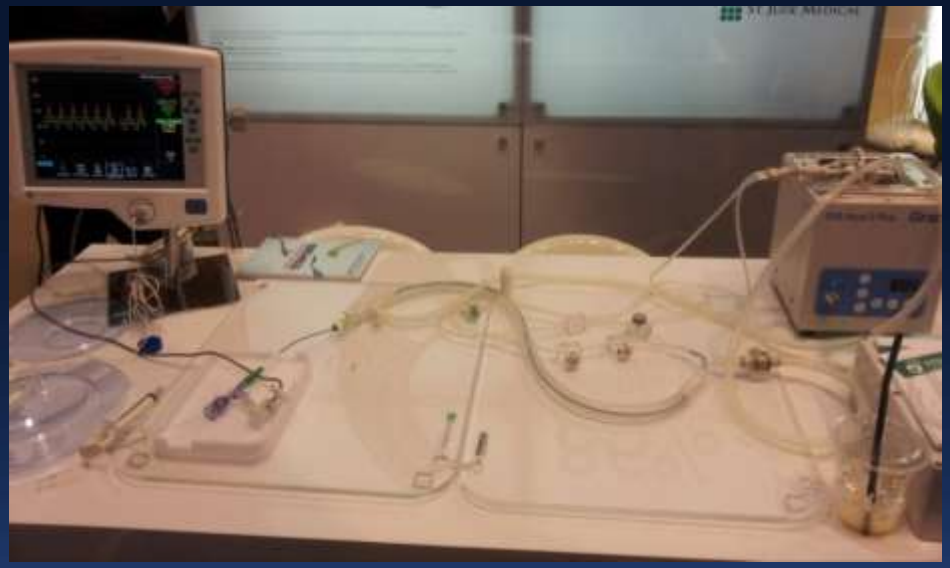
In the Presence of Side Branch,

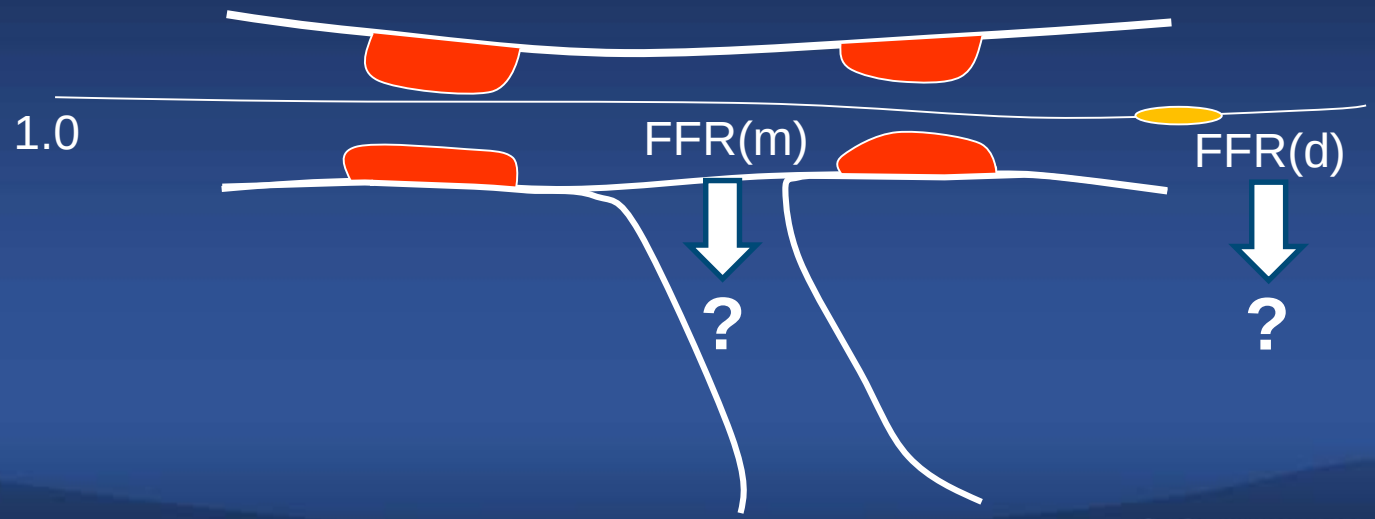


In the Presence of Side Branch, Does the "Rule of Big Delta" Still Work ?



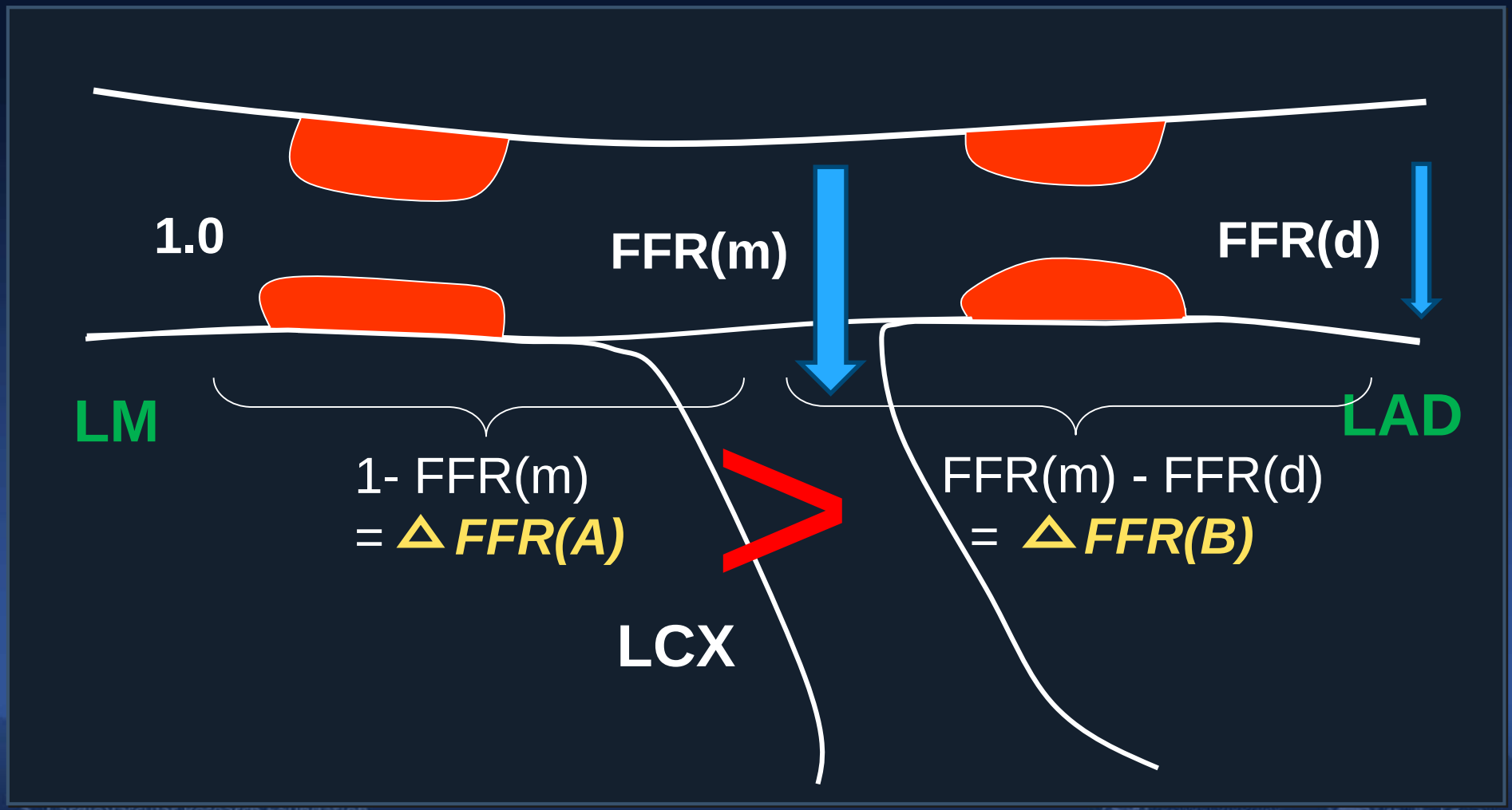
In Vitro Simulation (1)
If Two Lesions Are Functionally Same,





In Vitro Simulation (1)

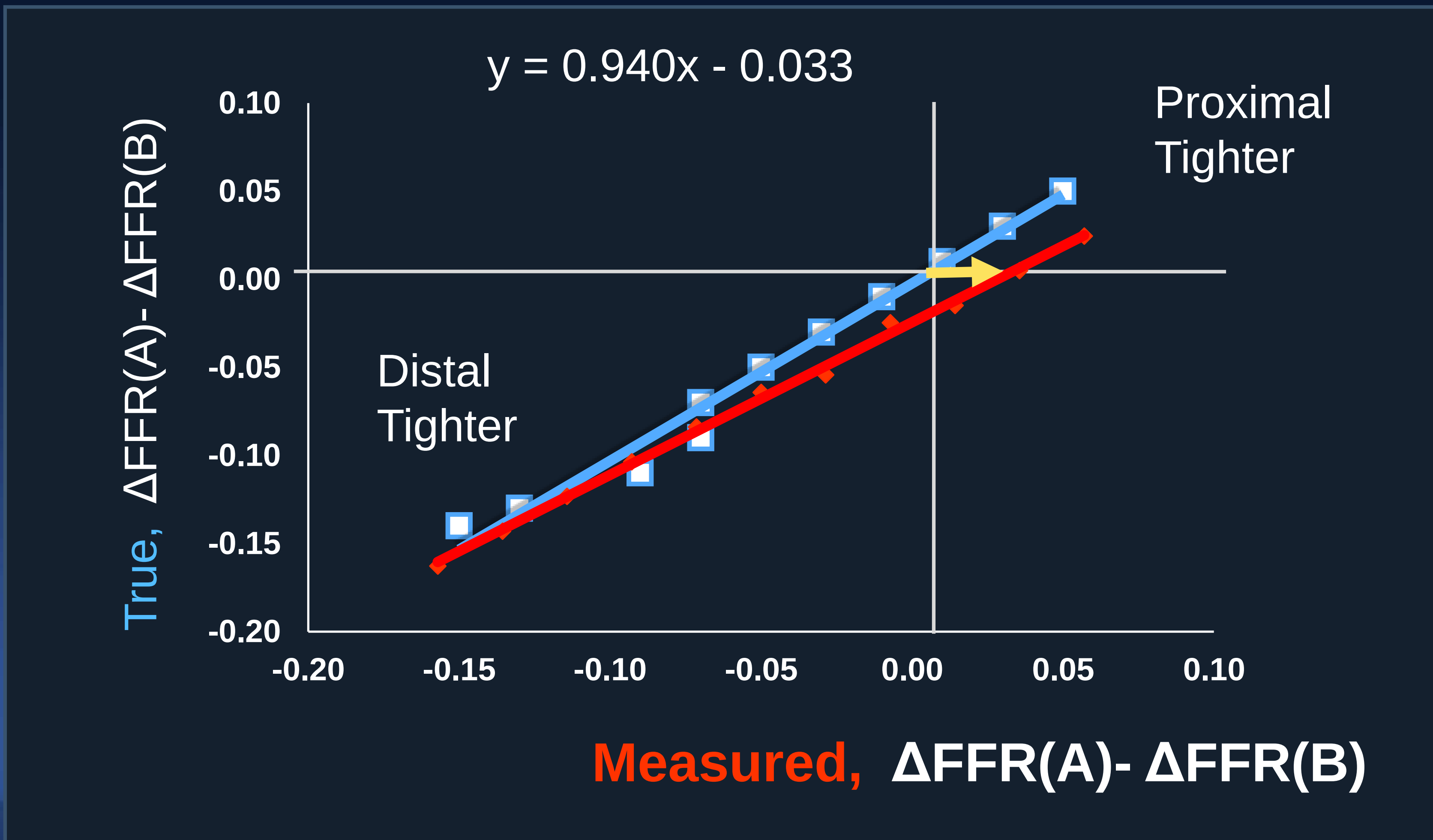
Measured ΔFFR Difference, (ΔFFR(A)- ΔFFR(B)) Is Getting Bigger (Overestimated) !



In Vitro Simulation (1)

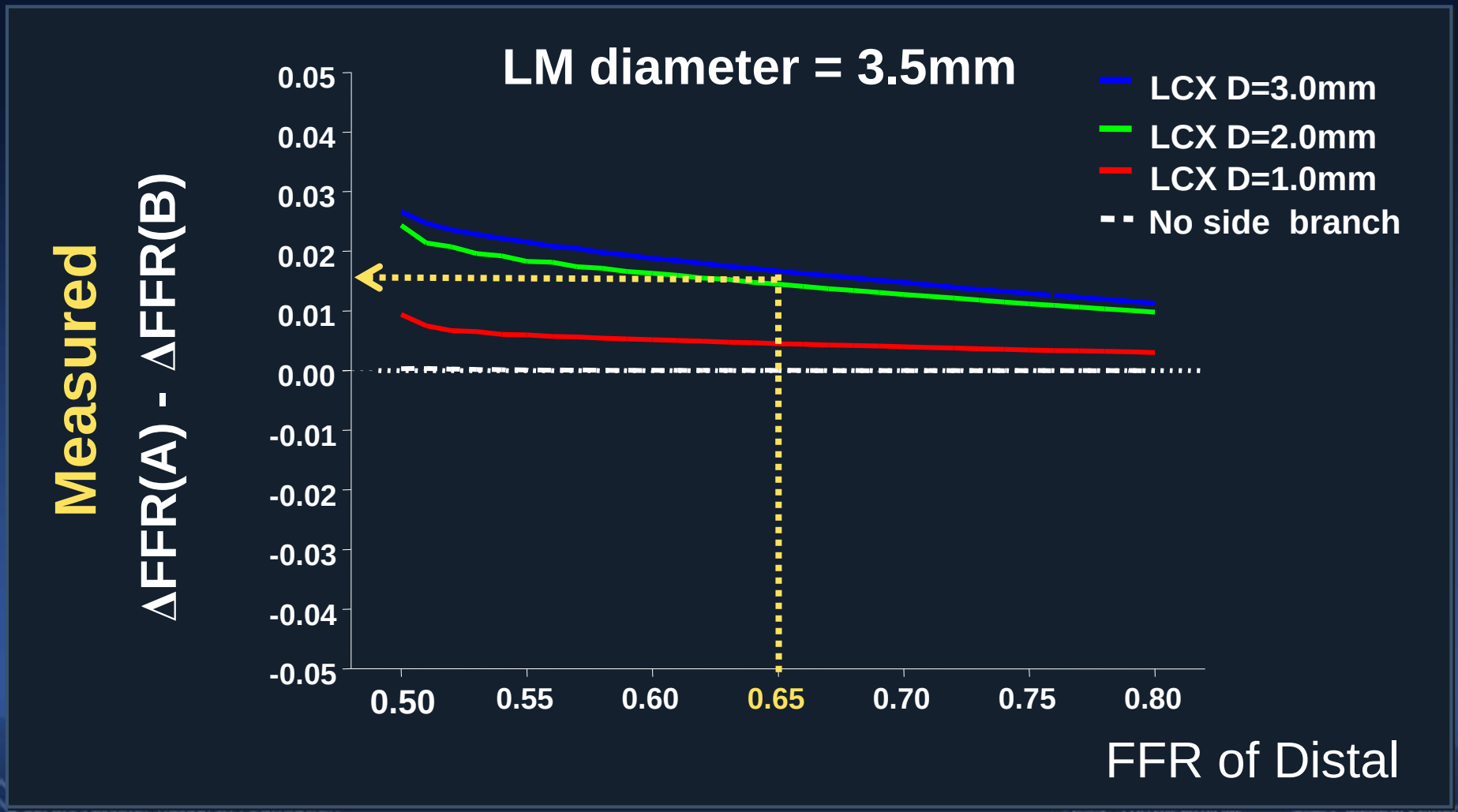
If Two Lesions Are Functionally Same,

In … ΔFFR Difference (A-B) Is Usually Overestimated



3-D Computed Simulation (2)

In Presence of Side Branch, Measured ΔFFR Difference (A-B) Is Usually Overestimated



Effect of Large Side Branch on LM FFR

1. In the Presence of Large Side Branch of LM disease, Measured ΔFFR(A)- ΔFFR(B) is Usually Overestimated. ***However, the Difference is Very Small (0.01-0.02).*** *(Human Validation Study, In Vitro and 3D Computed Simulation Studies Showed Consistent Findings)*

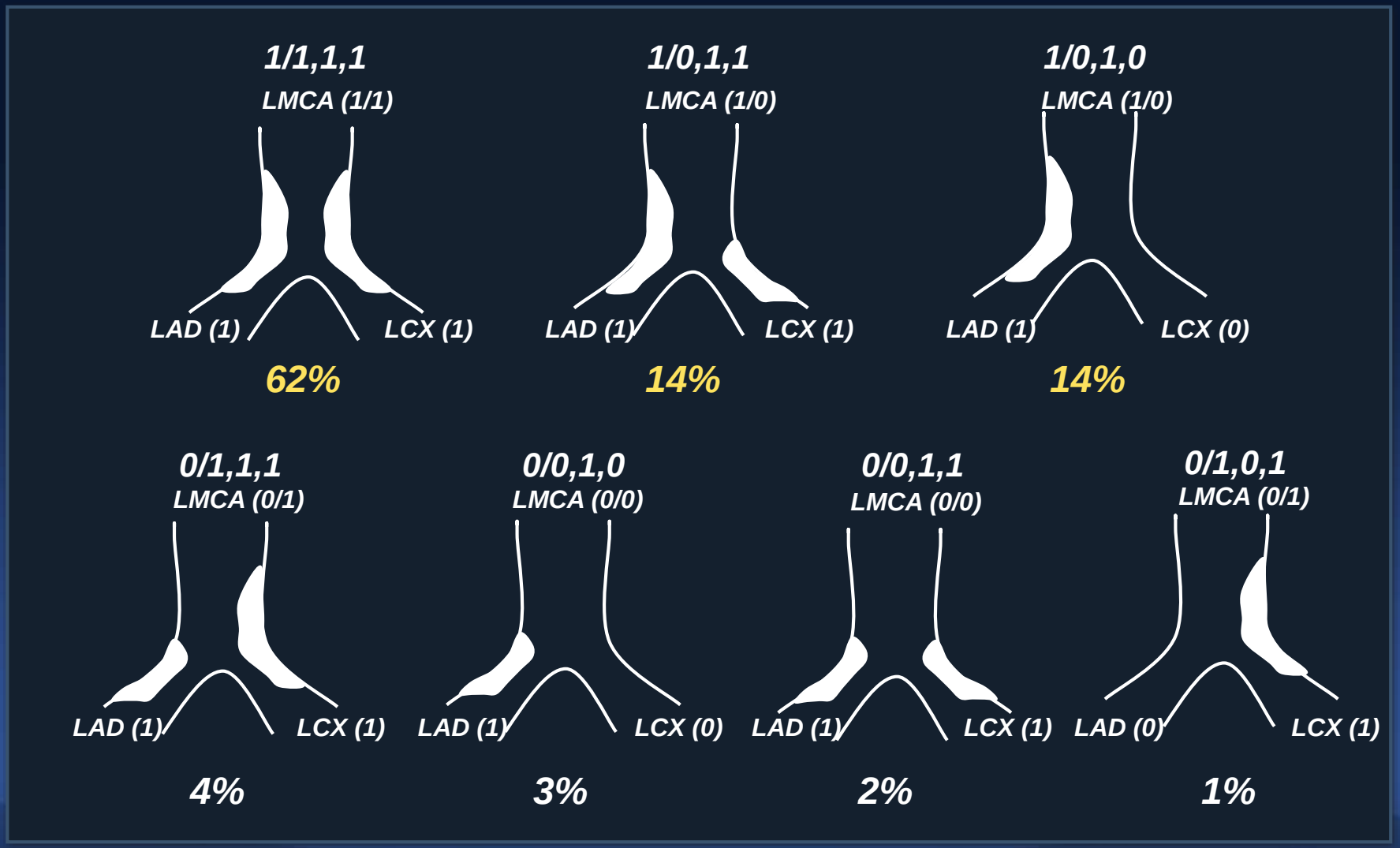
2. ***Therefore, the "Rule of Big Delta" Still Work in Real Practice.***

Presence of
Large LCX Side Branch,
Does It Really Matter ?

No, It Does Not Matter !

In Reality,
Left Main Stem Stenoses are Rarely Isolated !

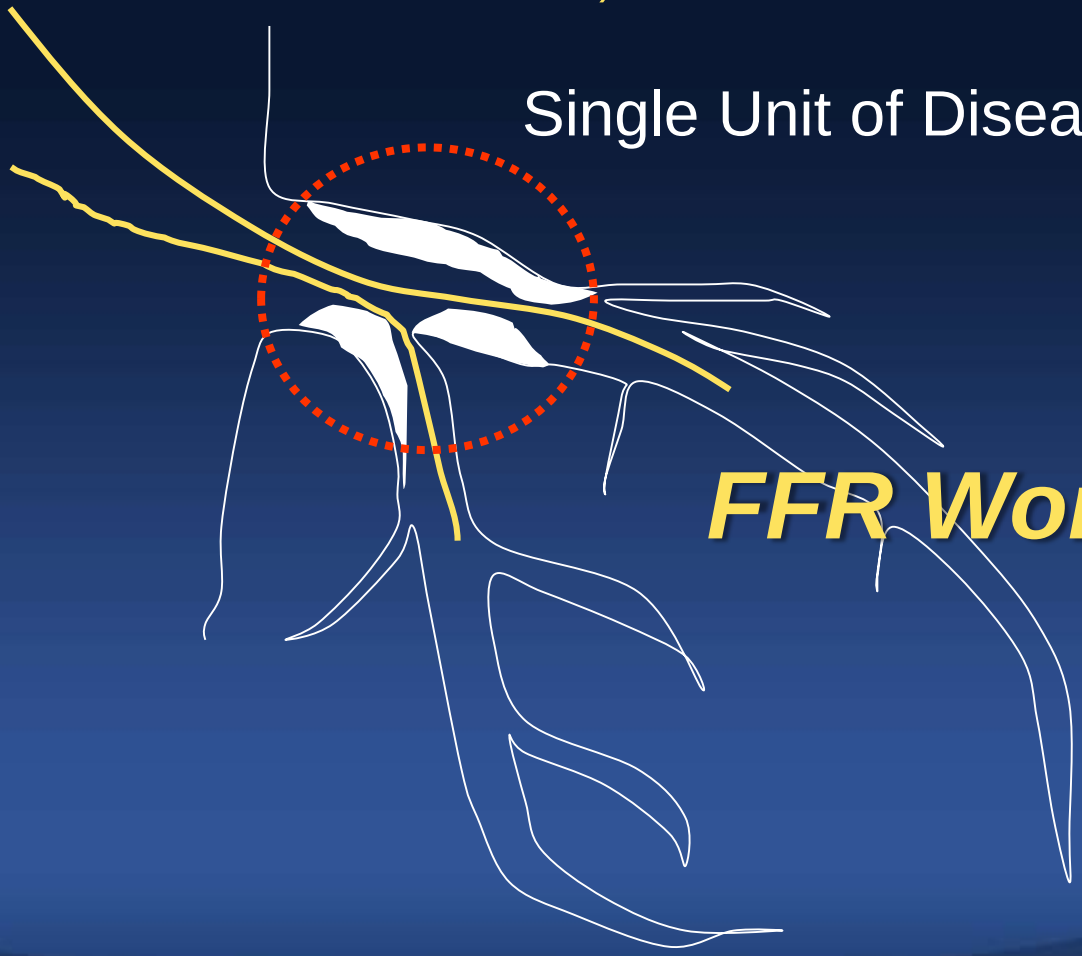
90% of Plaque, Extends from LM to LAD
In LM Bifurcation Disease



Oviedo C et al. Circ Cardiovasc Interv 2010;3:105-12. (IVUS Study, n=140)

FFR for LM Bifurcation

If Transducer Placed Beyond Bifurcation in both LAD and LCX,



Single Unit of Disease

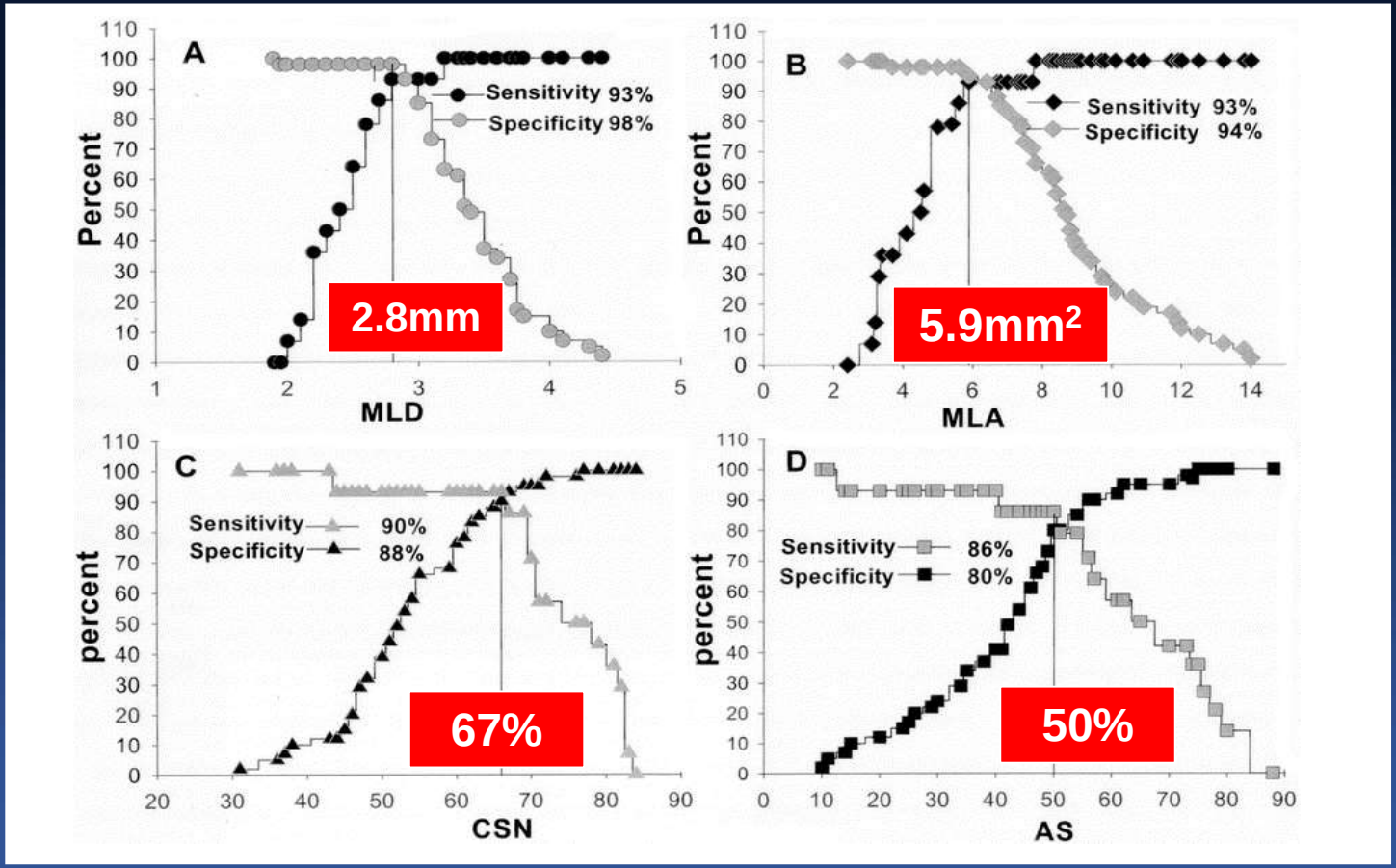
FFR Works !

Q3, Strongly Recommended IVUS Guided LM PCI (Class IIA)

IVUS MLA Issue

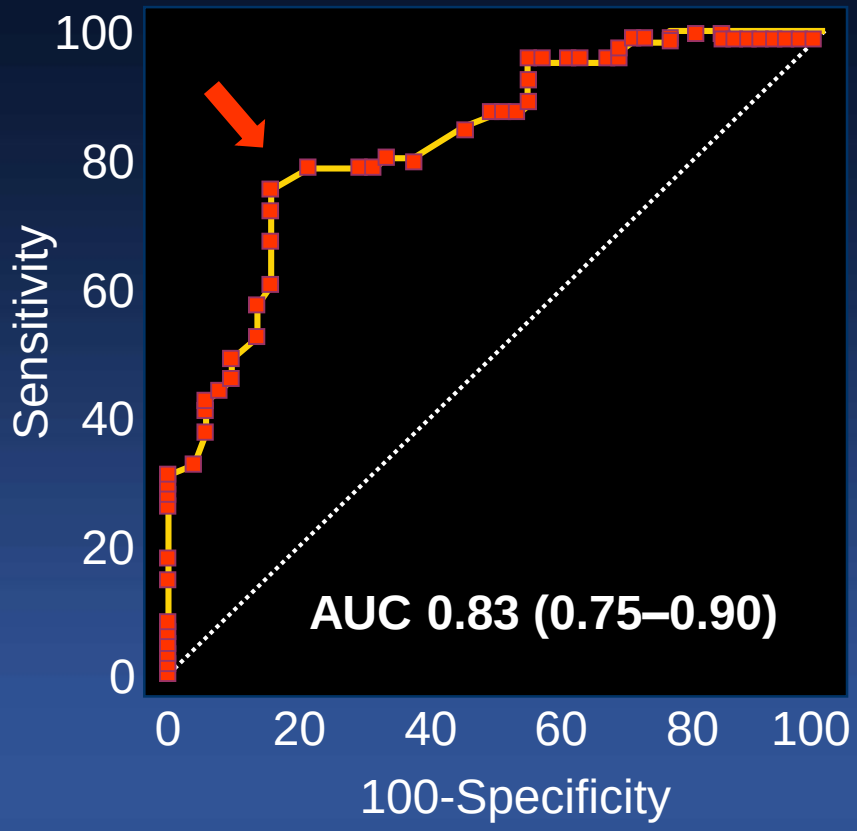
Can IVUS MLA Predict
Functional Significance of LM Stenosis ?

MLA < 6.0 mm² matched FFR <0.75 (n=55, LM disease)



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

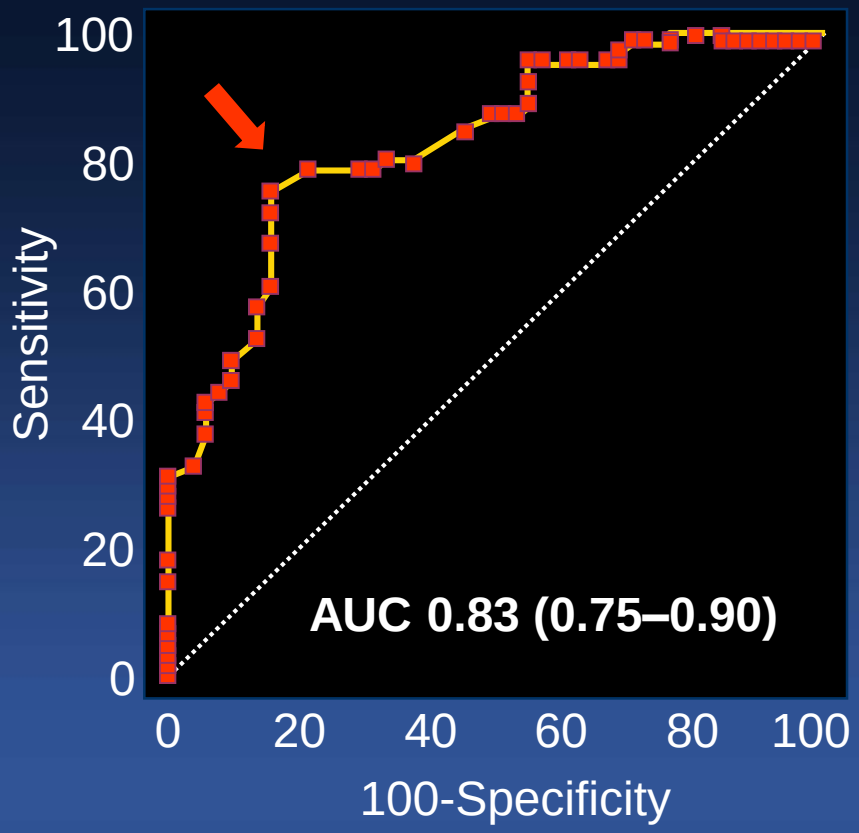
MLA < 4.5 mm² matched FFR <0.80 (n=112, Os and Shaft LM disease)



Cut-off = 4.5 mm²

Sensitivity	79%
Specificity	80%
PPV	83%
NPV	76%
Accuracy	80%

Can IVUS MLA (4.5 mm^2) Predict Functional Significance of LM Stenosis ?



Yes !

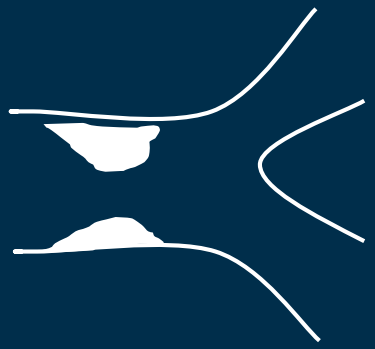
Cut-off = 4.5 mm^2

Sensitivity	79%
Specificity	80%
PPV	83%
NPV	76%
Accuracy	80%

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

How do I Implement ?

Ostial and Shaft
LM Disease



< 4.5 mm²
Positive FFR

Bifurcation with
Down Stream Disease

4.5~6.0 mm²
Consider FFR !

> 6.0 mm²
Negative FFR

Q4, 1 or 2 Stents for LM Bifurcation Lesions ?

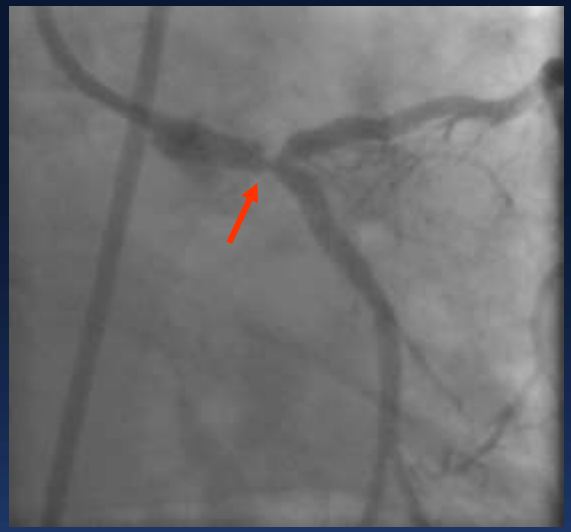
LM Bifurcation PCI

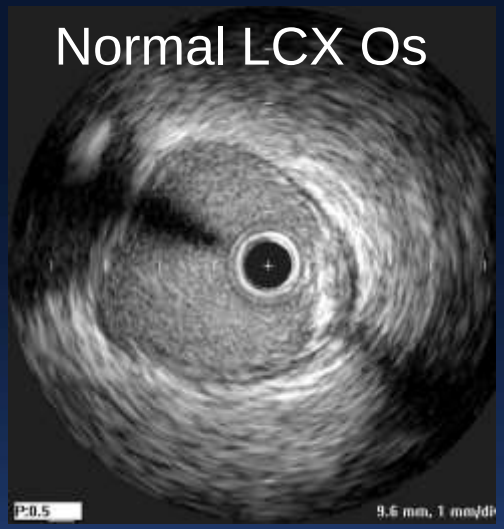
1 Stent	***Normal or Diminutive LCX, (Medina 1.1.0., 1.0.0)*** Small LCX with < 2.5 mm in diameter, Focal disease in distal LCX
2 Stent	***Diseased LCX, (Medina 1.1.1., 1.0.1)*** Large LCX with ≥ 2.5 mm in diameter Diseased left dominant coronary system Diffuse disease in distal LCX

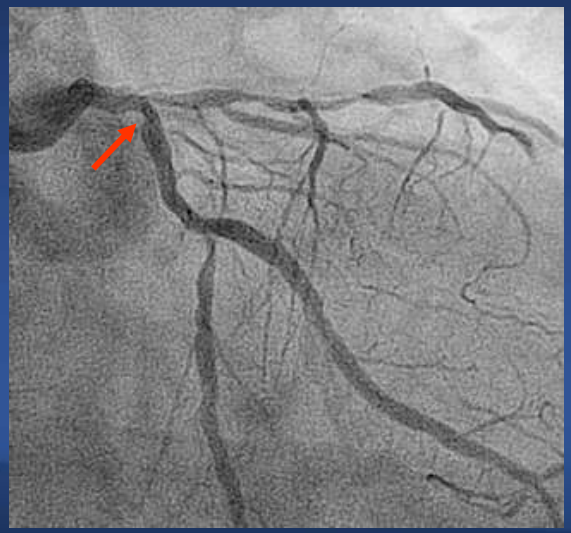
Park SJ, Textbook of Bifurcation Stenting 2007

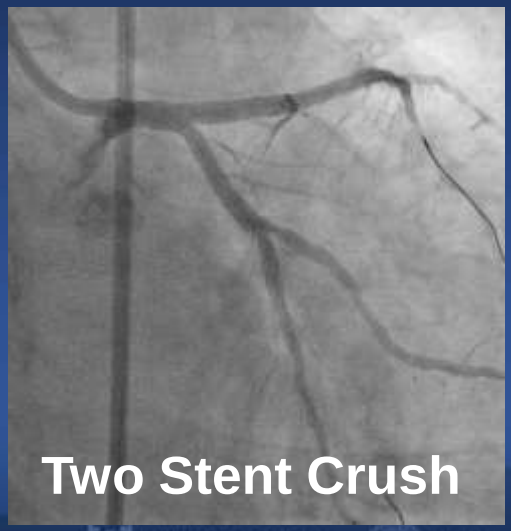
IVUS Guided LM PCI

1 or 2 Stents
According to LCX Disease by IVUS



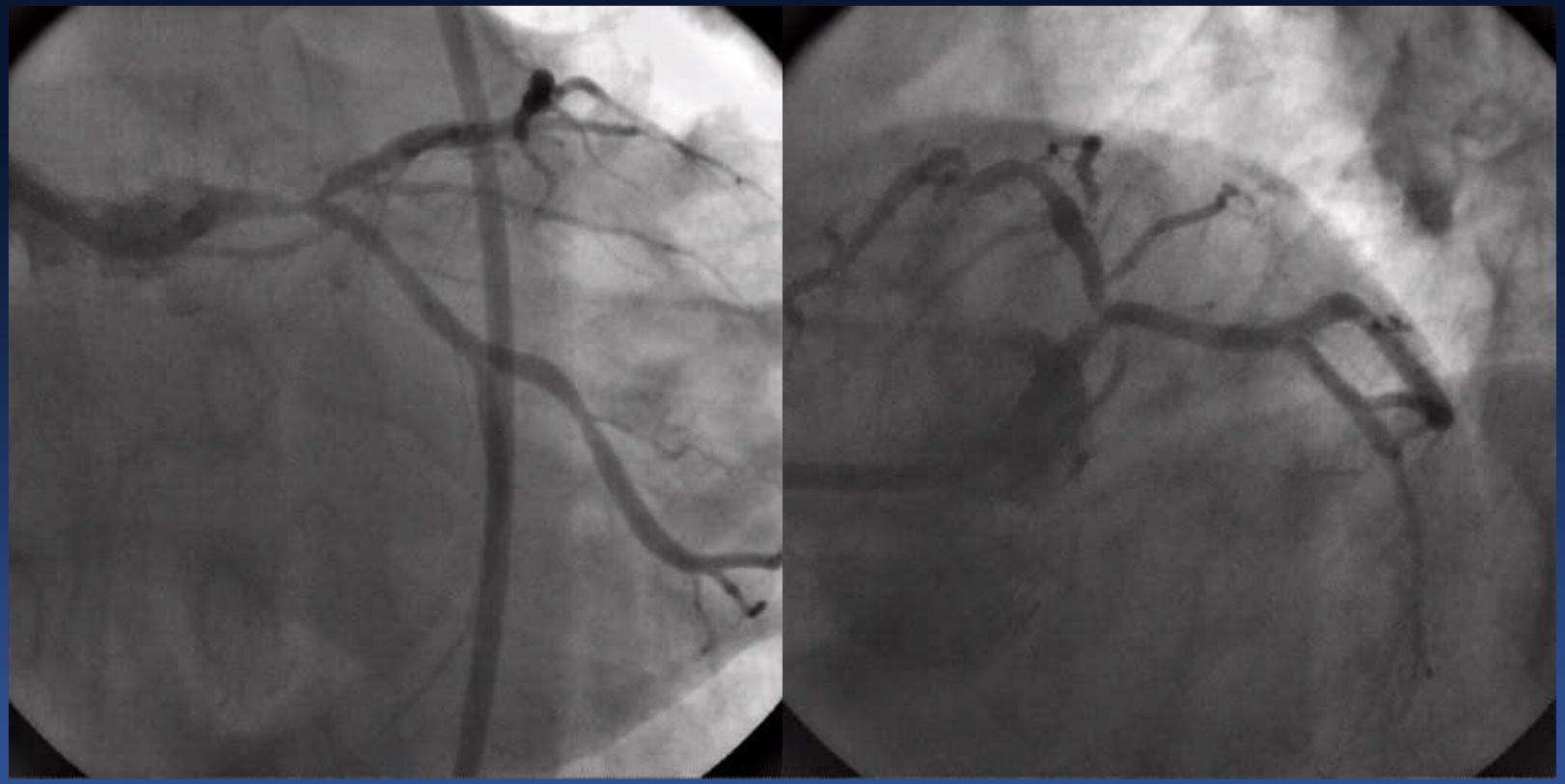




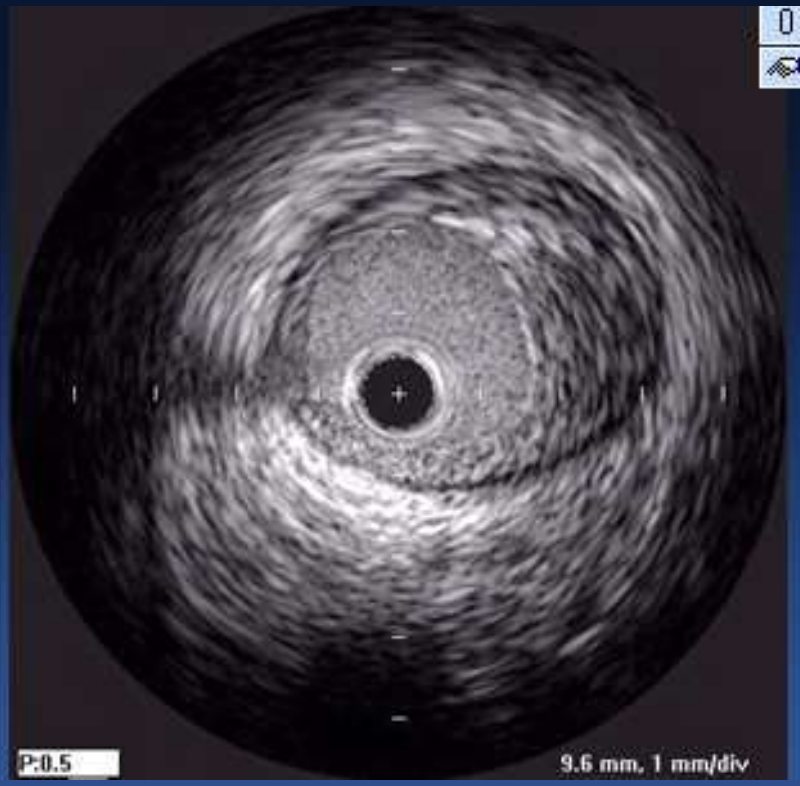


1 Stent
for Normal LCX

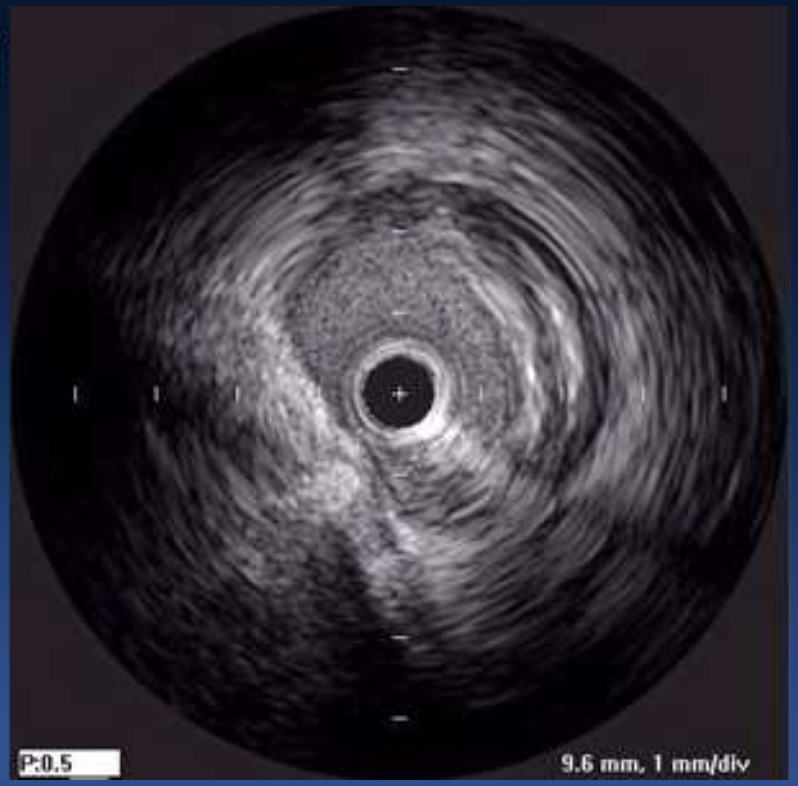
72/M, Unstable angina,



IVUS

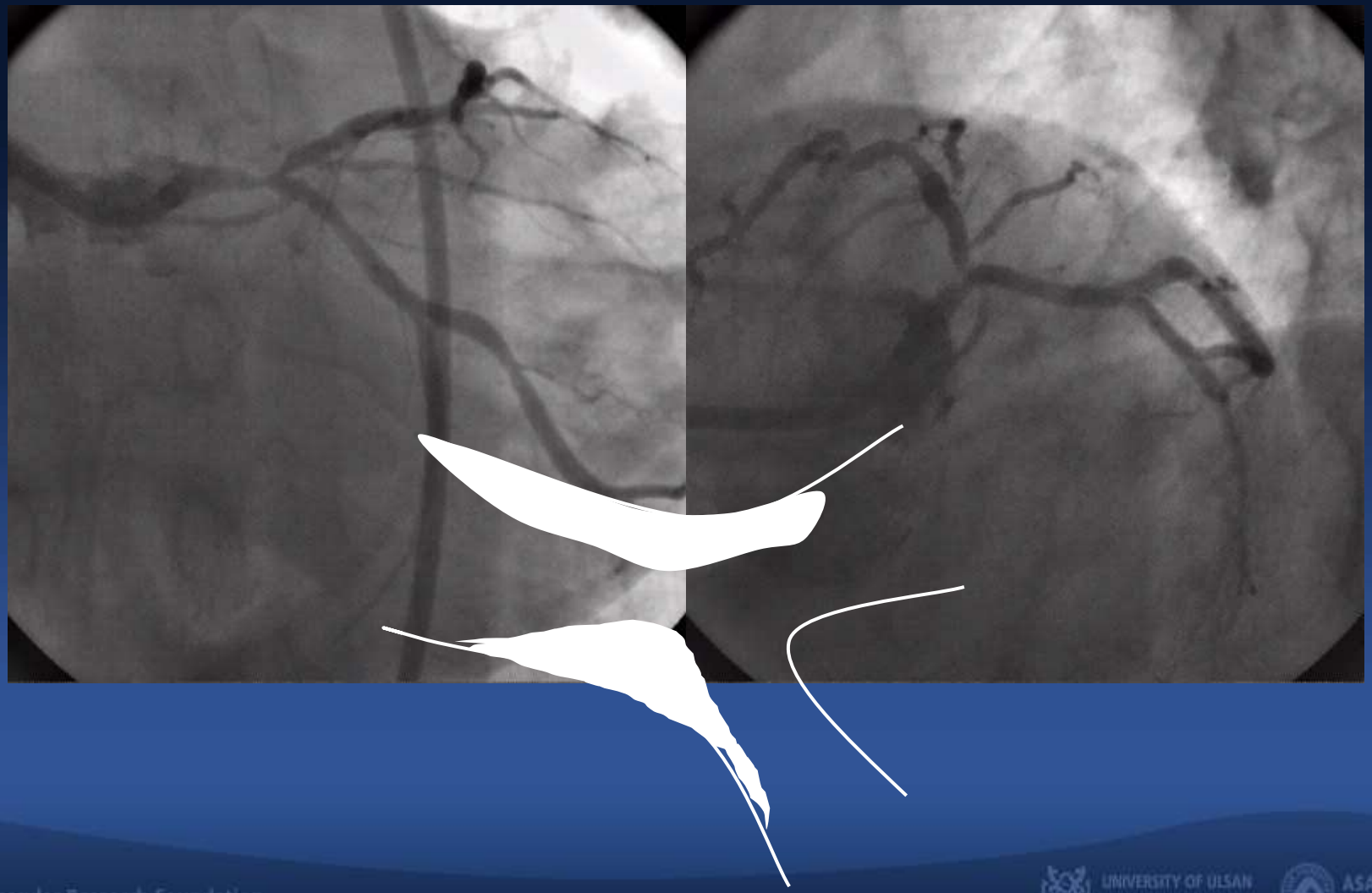


LAD Ostium

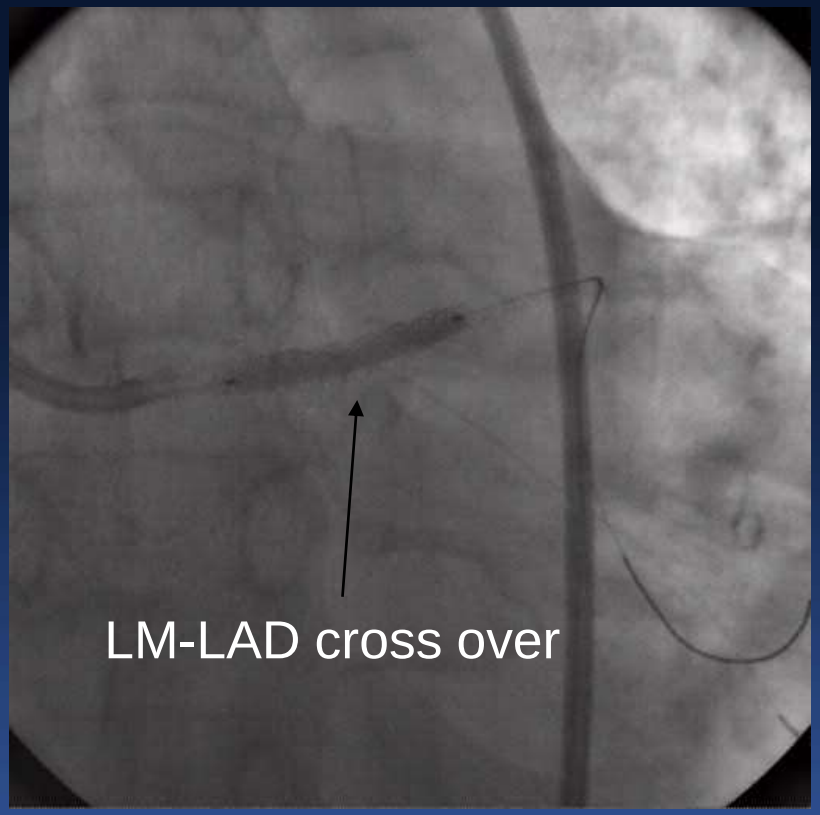


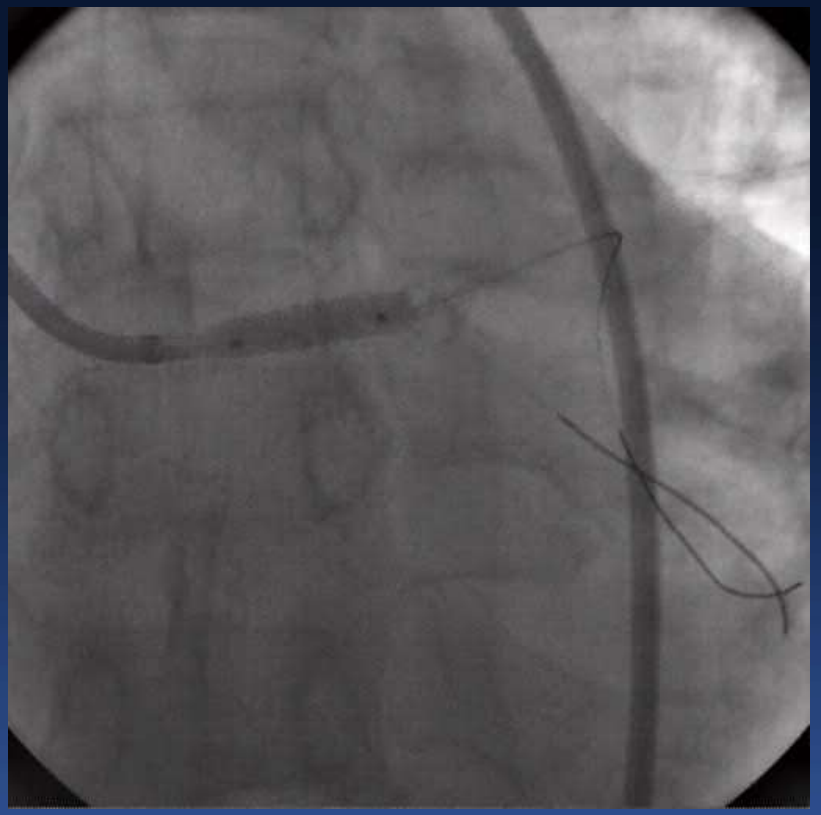
LCX Ostium
Minimal-disease

72/M, Unstable angina,



1 Stent

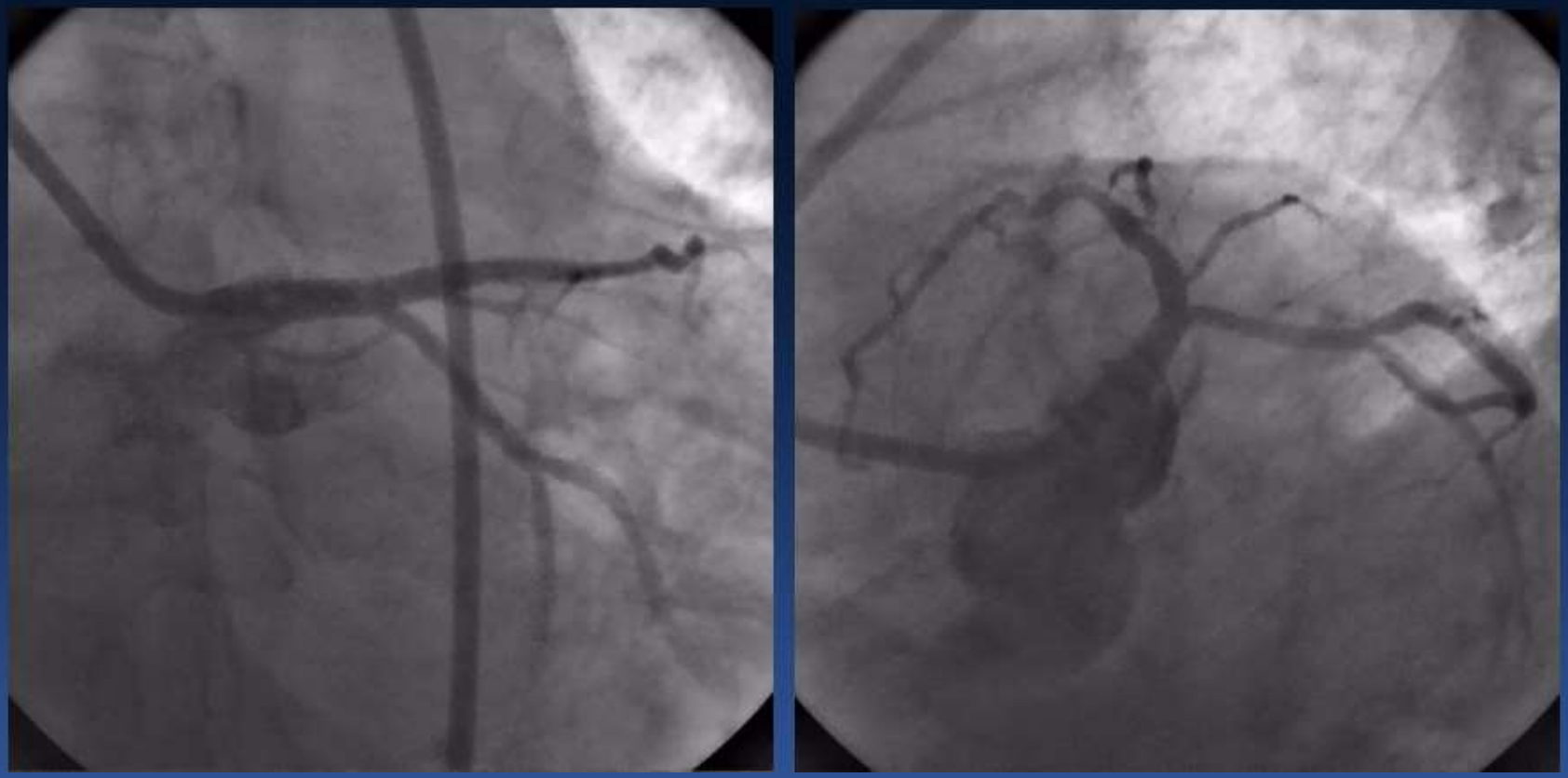




DES 3.5 × 23 mm

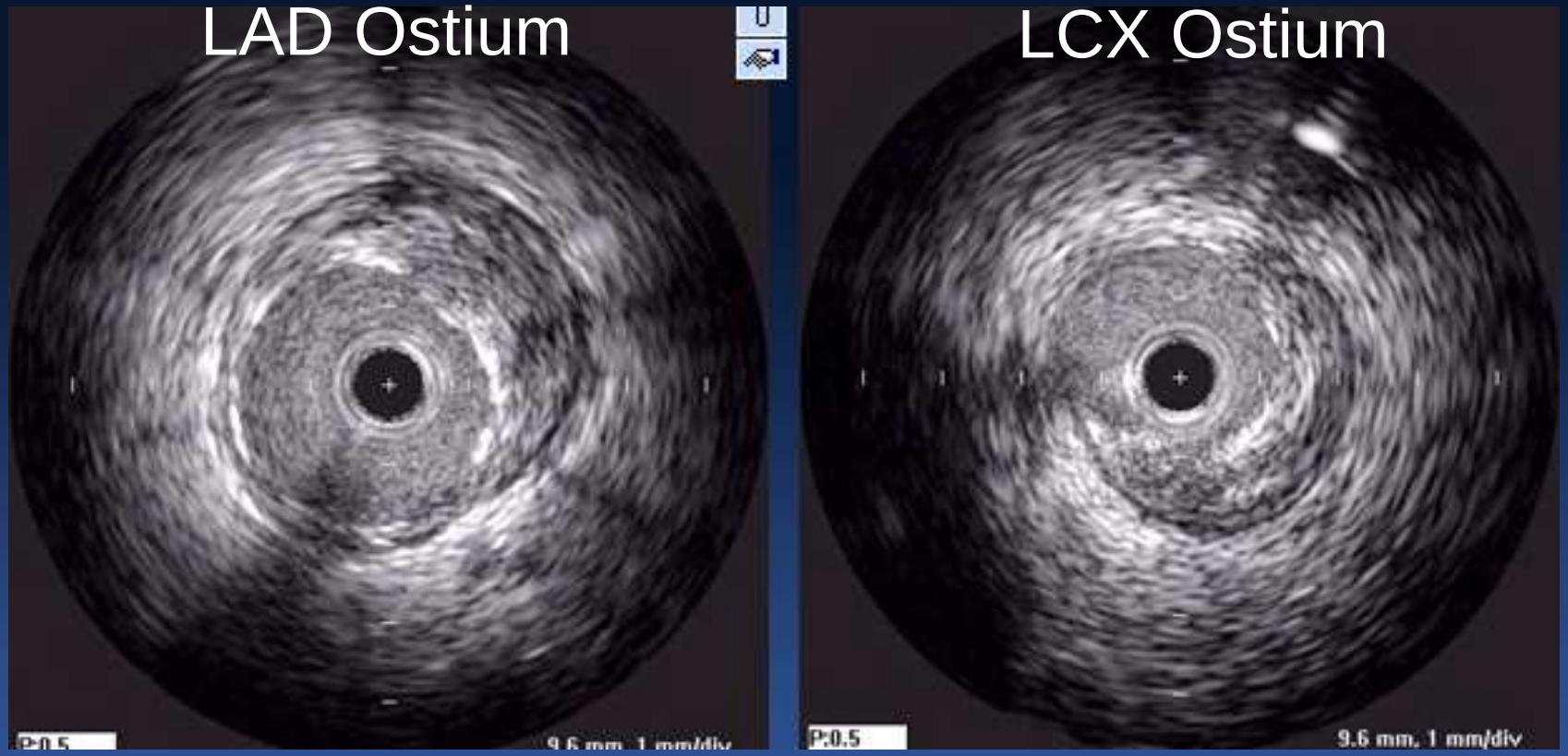
Additional high pressure Inflation with 4.0 mm non-compliant balloon

Angiographic Result Is Perfect !



No significant compromise of LCX ostium.

Post stent-IVUS

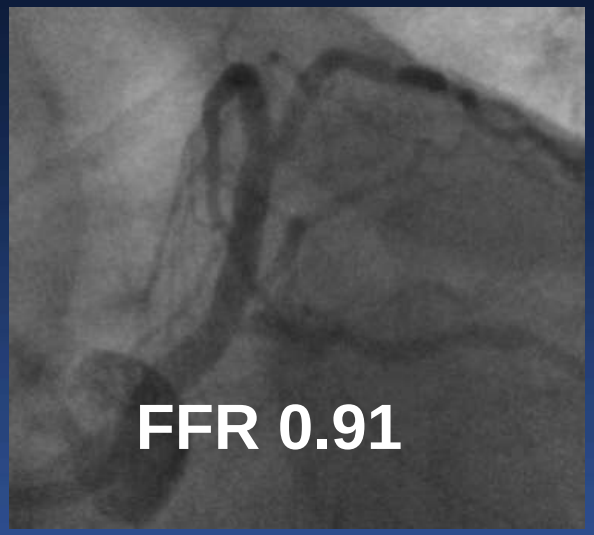


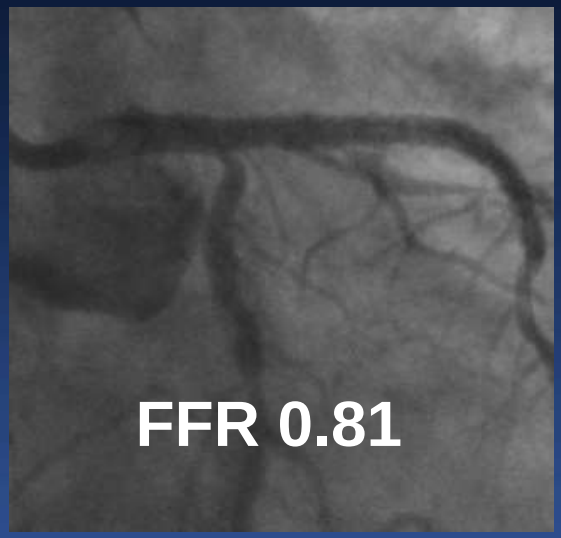
Good Stent Expansion
Stent Area 6.2 mm^2

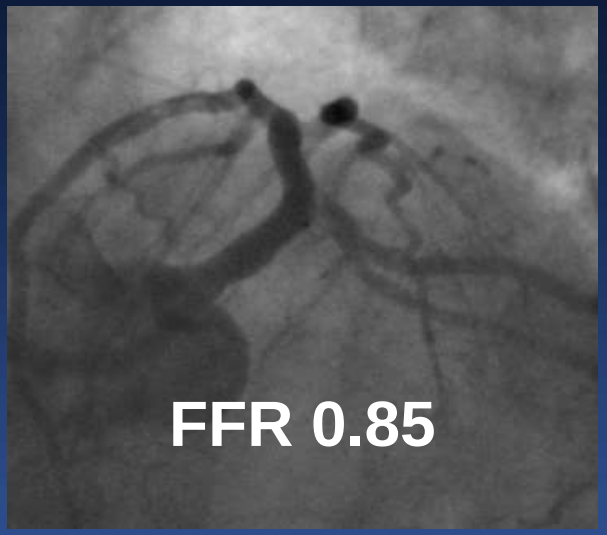
No Carina Shift
MLA 4.7 mm^2

Any Jailing Morphology Cannot Predict Functional Significance of Jailed LCX

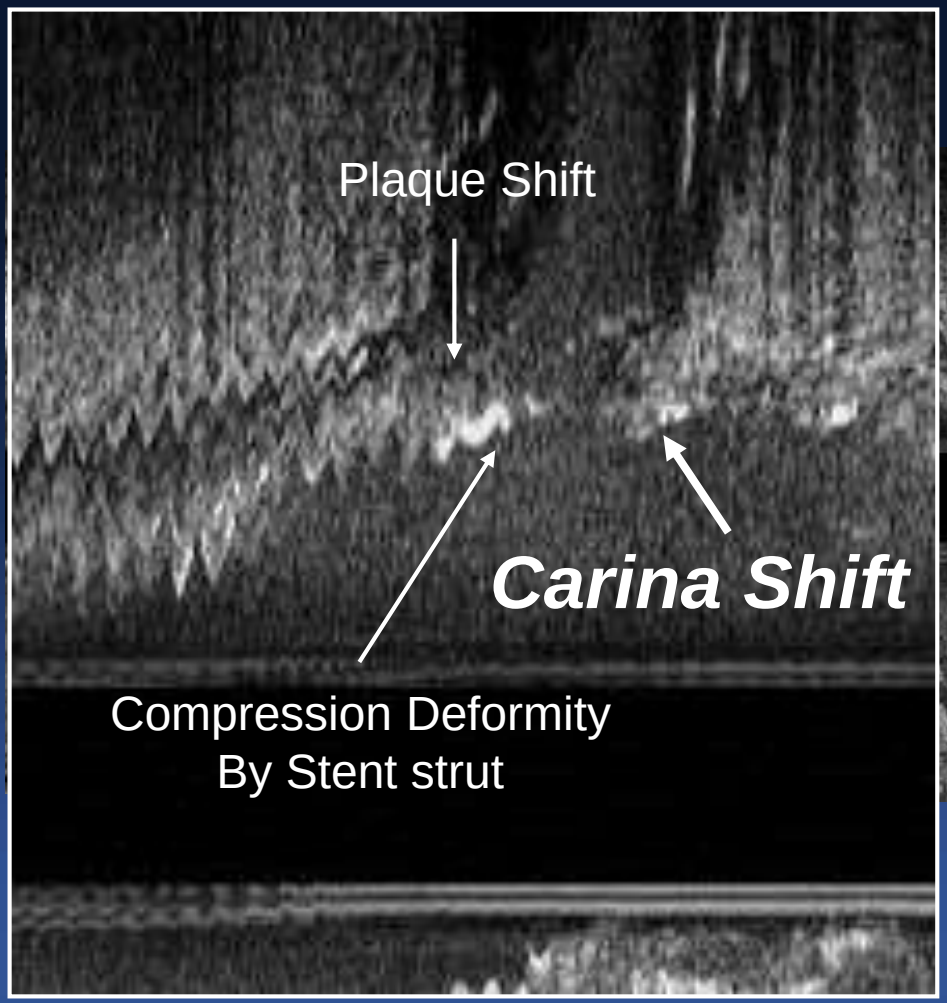
Jailing LCX After Stent Cross-Over

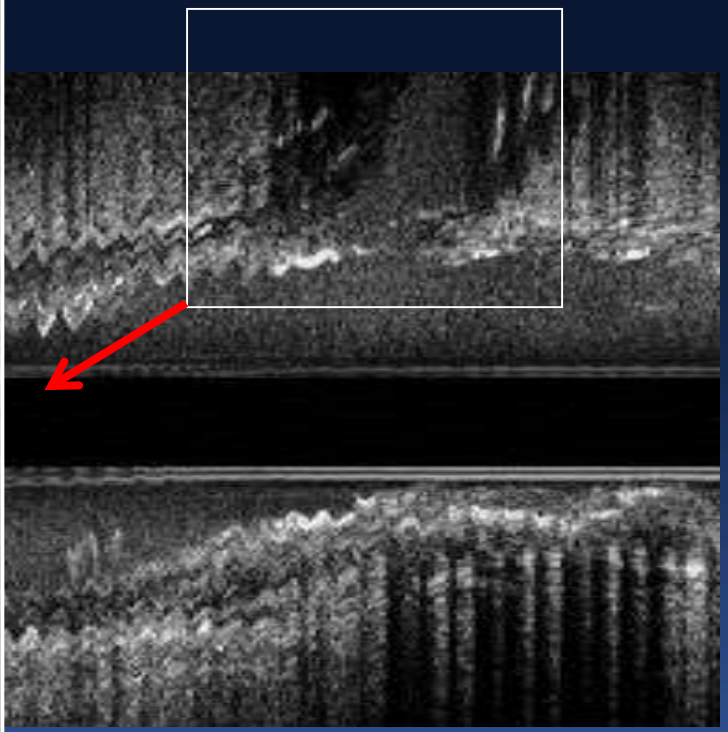






Mechanism of LCX Jailing
After Stent Cross-Over

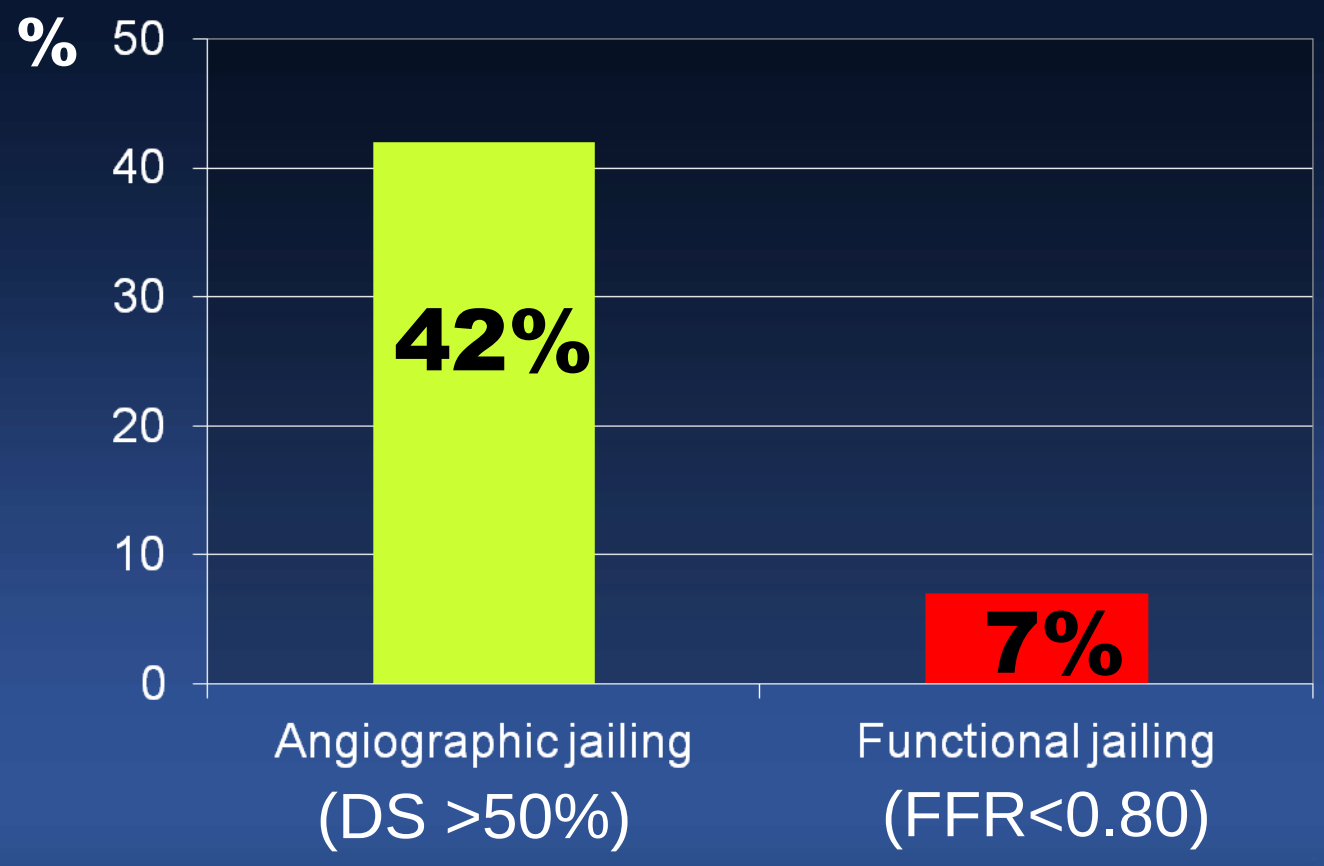




After Stent Cross Over

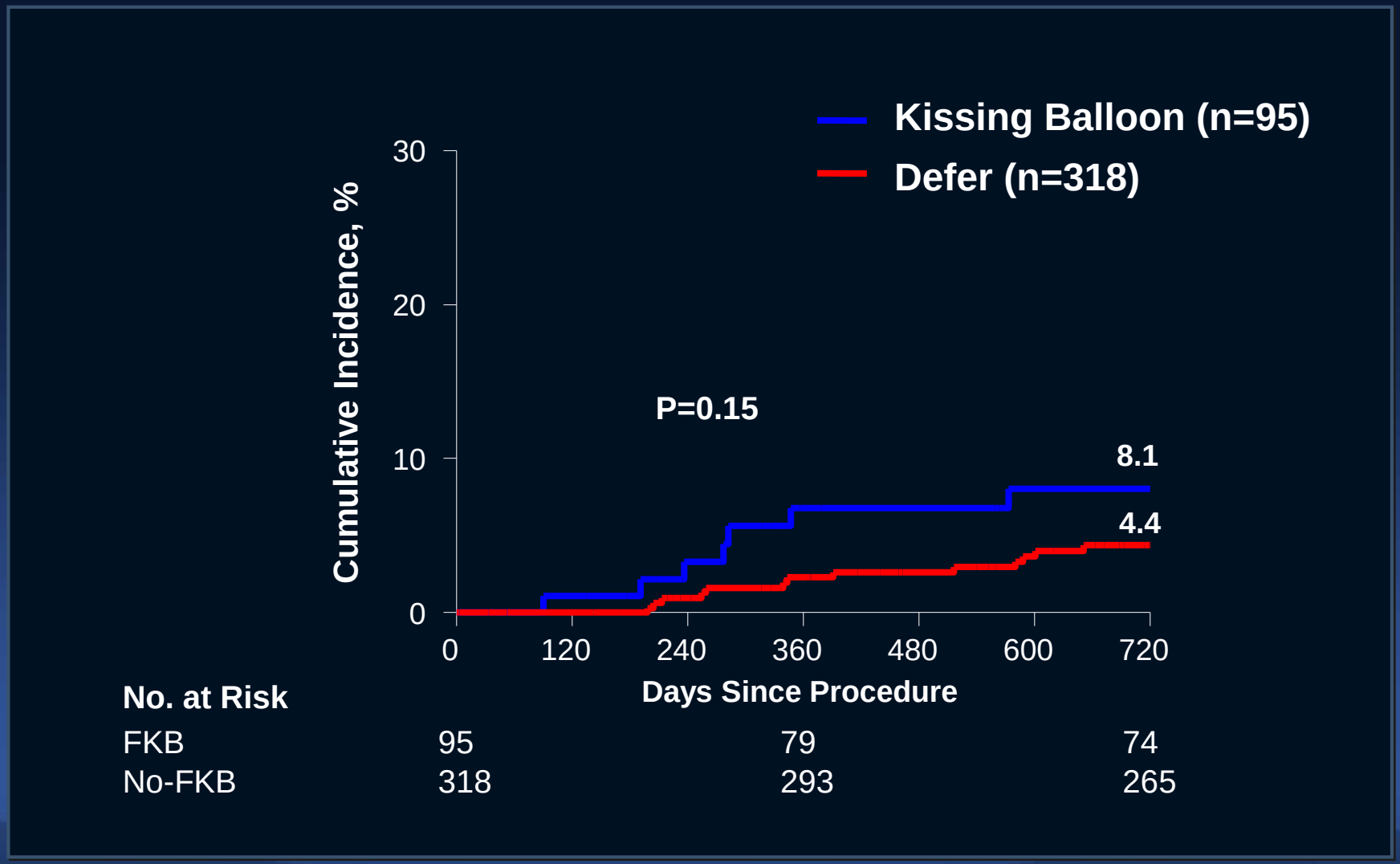
Courtesy of Koo BK

After Stent Crossover Normal Looking LCX, Functionally Significant LCX Jailing Is Only 7%



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

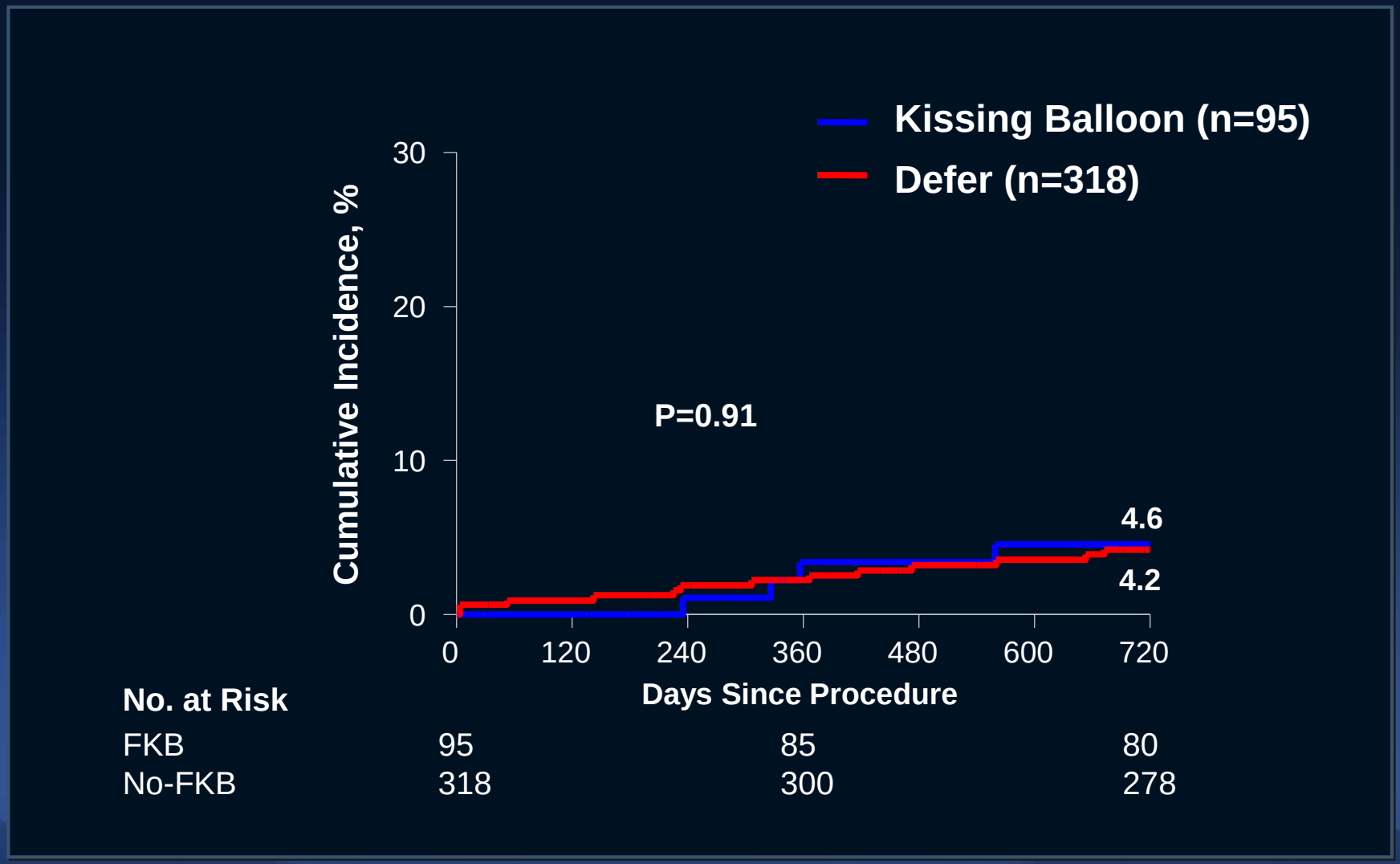
Left Main-TLR *at 2 Years*



Ahn JM et al, AJC 2017 15;119(4):528-534.

Death or MI at 2 Years

Jailing LCX Defer Is Safe and Good !



Ahn JM et al, AJC 2017 15;119(4):528-534.

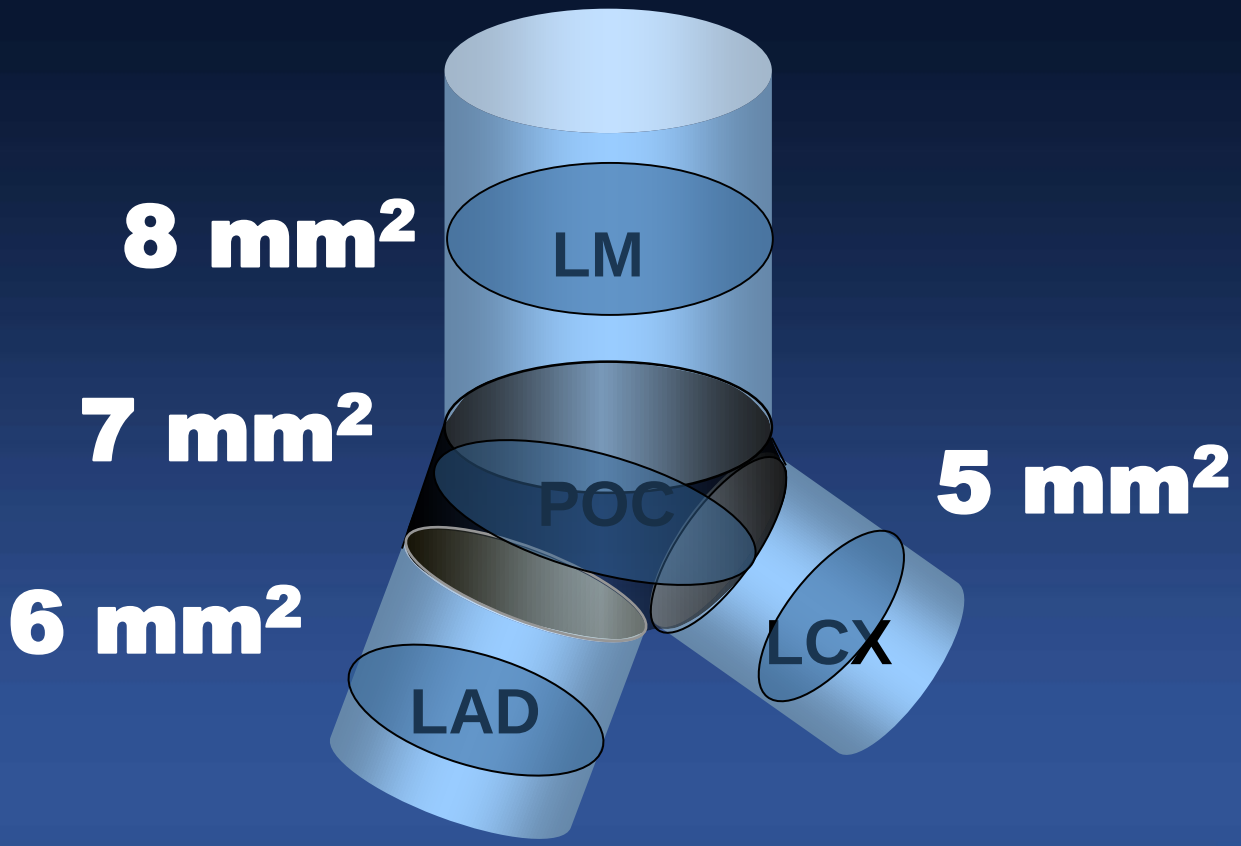
2 Stents for True Bifurcation

Whatever,
Any 2 Stent Techniques

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

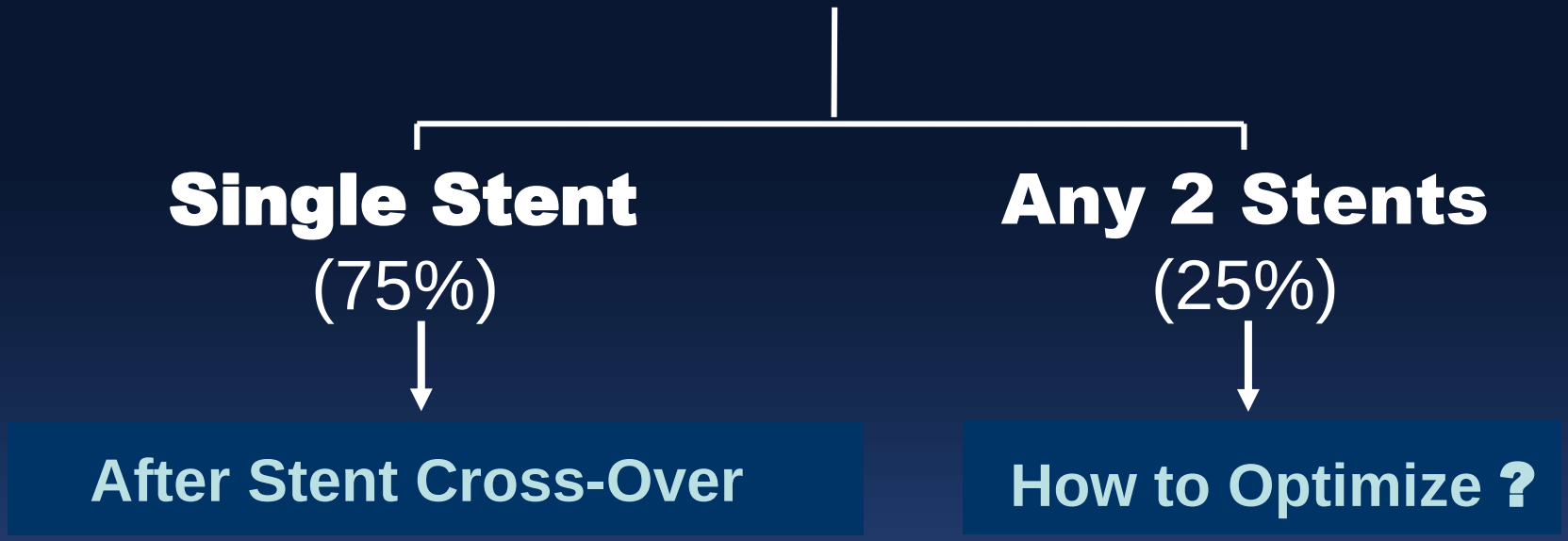
Effective Stent Area (5,6,7,8 mm^2) Can Make A Good Clinical Outcomes

Restenosis < 5%, TLR < 2%



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

Practical Guideline
LM Bifurcation PCI



- Do You Want to Treat the Jailed Side Branch ?
- How to Treat ?

IVUS Minimal Stent CSA Criteria 5-6-7-8 mm^2
May Improve Long-term Clinical Outcomes.

Left Main PCI;
Concept to Practice

1. FFR Guided Decision Making
2. IVUS Guided Optimization

Thank You !!

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