

Ischemia Mapping: FFR in Bifurcation Lesions

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Disclosure

I have nothing to disclose

Ischemia Mapping FFR in Bifurcation Lesions

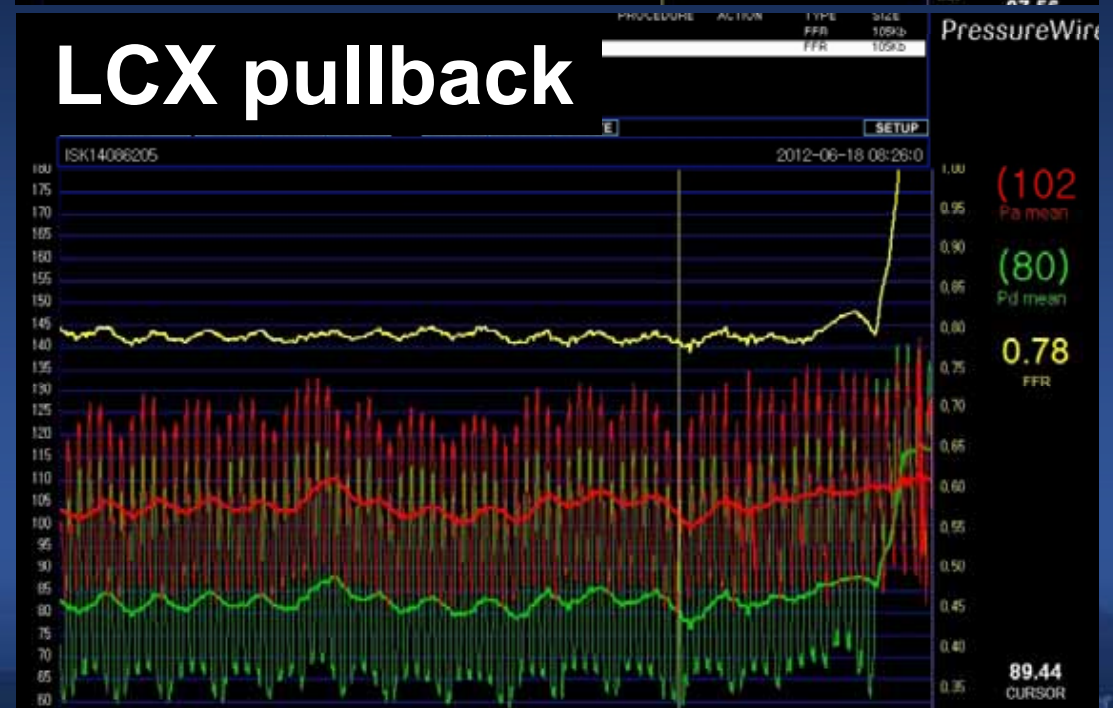
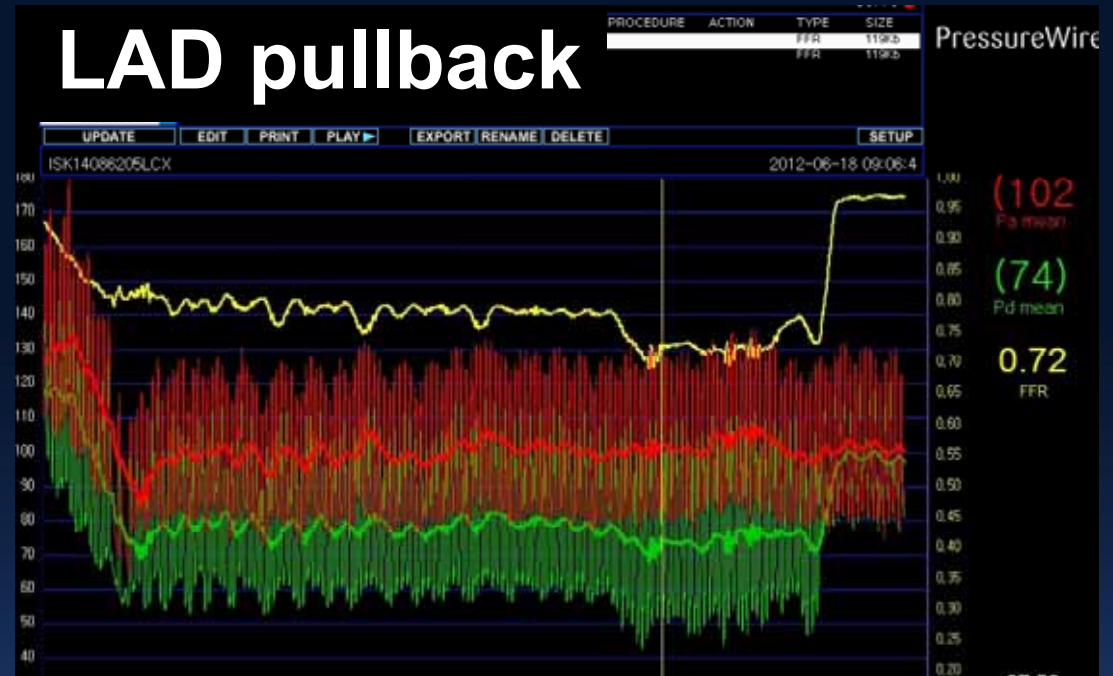
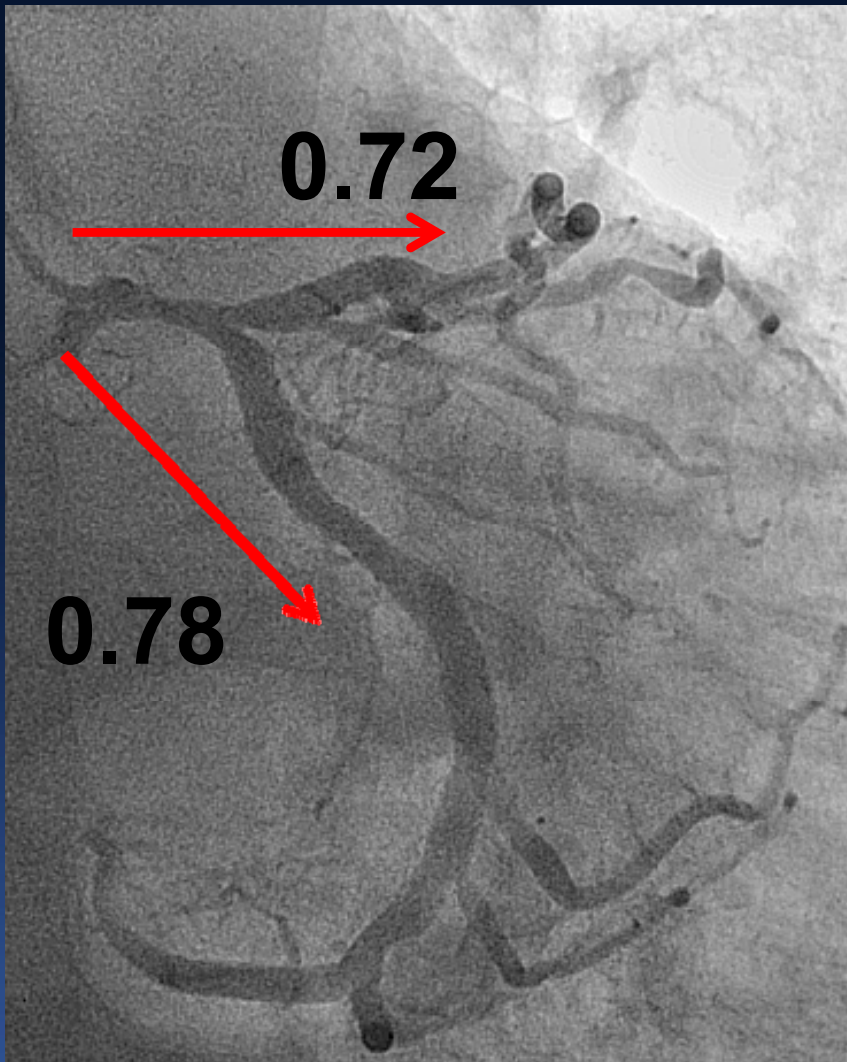
Issue 1: Treat or Not Treat?

Issue 2: Initial Stent Strategy

Issue 3: Treatment of SB Jailing

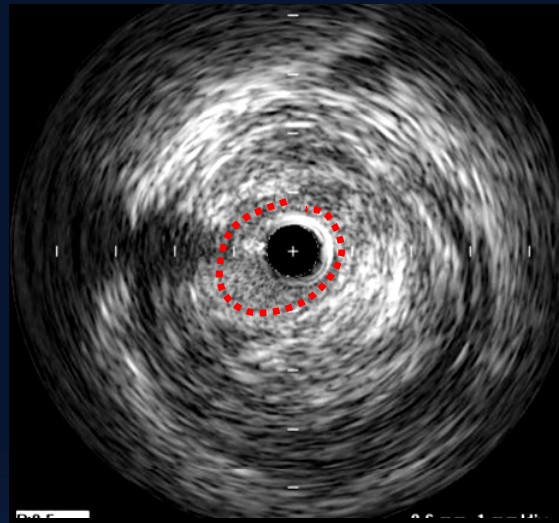
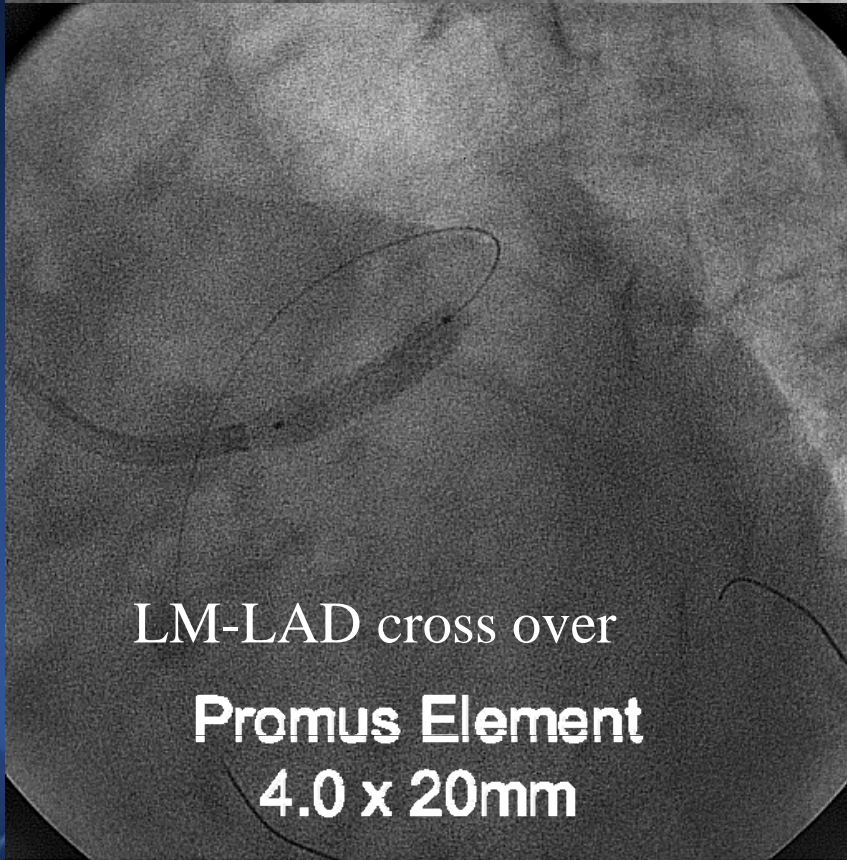
Issue 4: Mechanism of SB Jailing

Treat or Not Treat?

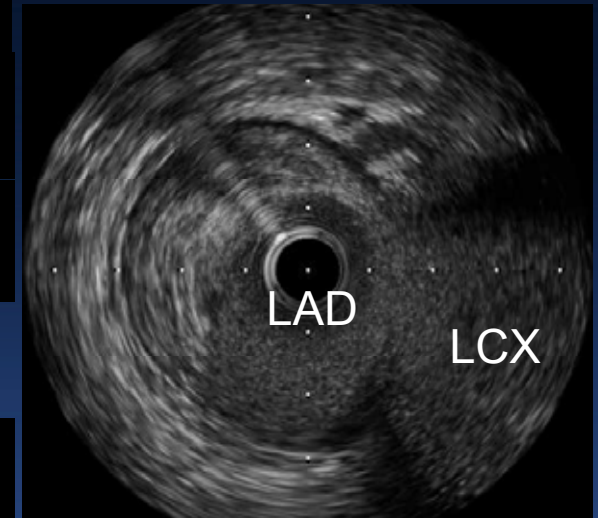


Next, what is stent strategy?

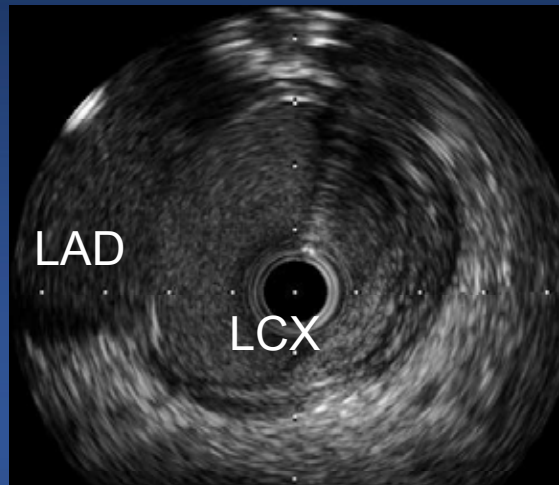
IVUS



EEM ϕ 6.2mm
MLA 3.0mm²



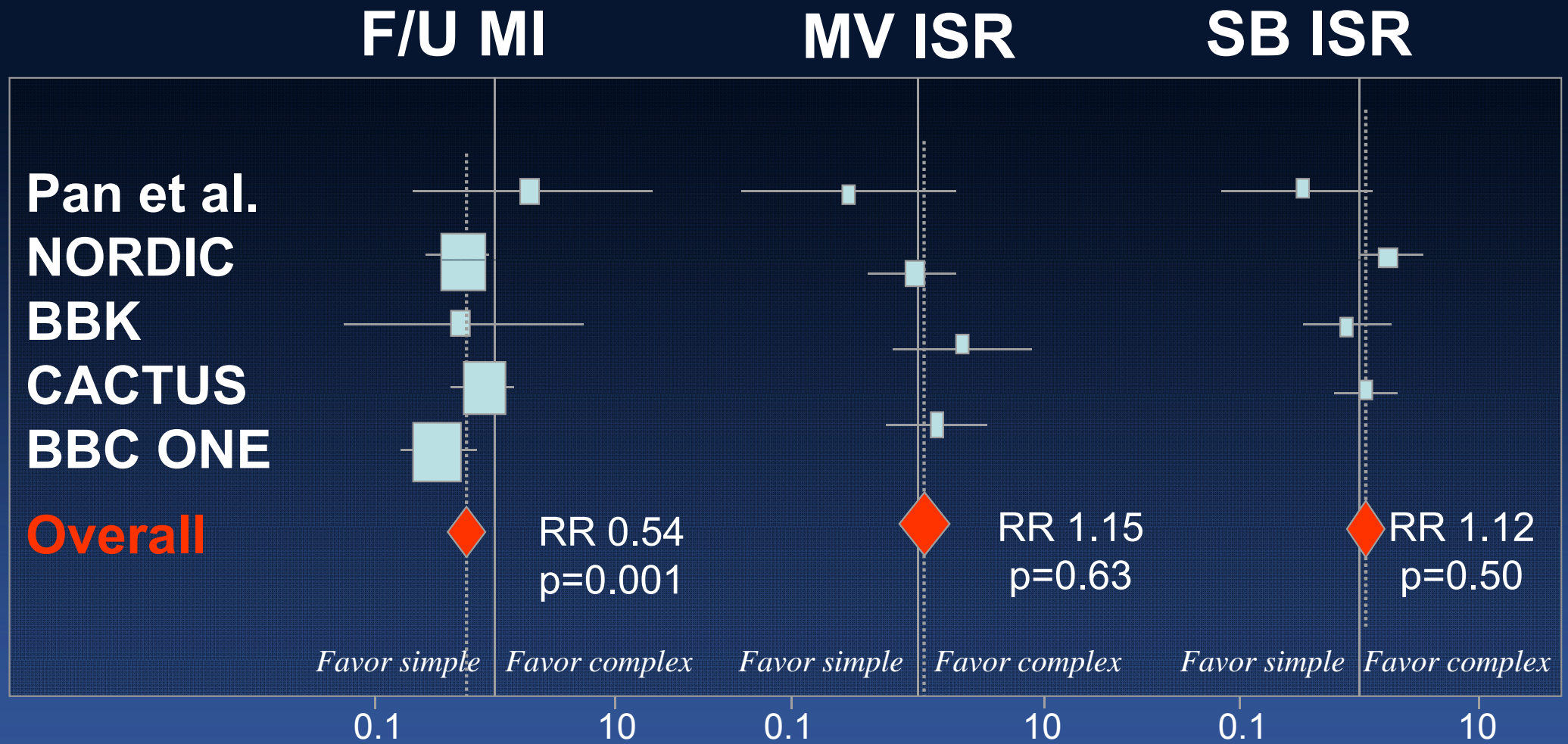
LAD os
EEM ϕ 5.2mm
MLA 6.0mm²



LCX os minimal

Initial Stent Strategy

Simple vs. Complex



46% ↓ RR

Zhang et al. Heart 2009;95:1676-81

“High Risk” Population

DKCRUSH-II in unselected population

DK-Crush (185 pts.) vs. Provisional (185 pts.)

Medina (1,1,1) in 81%
(0,1,1) in 19%

	DK-Crush	Provisional	p
Acute SB occlusion	0%	1.6%	0.248
Cardiac death, 1-year	1.1%	1.1%	1.000
MI, 1-year	3.2%	2.2%	0.751
TLR, 1-year	4.3%	13.0%	0.005
MACE, 1-year	10.3%	17.3%	0.070
Stent thrombosis, 1-year	2.7%	1.1%	0.449

Chen SL, et al. J Am Coll Cardiol 2011;57:914–20.

How Often is Provisional Stent Needed?

Crossover rate from single to two stents

Trial	Crossover	Criteria for stenting
CACTUS	31%	Residual SB DS >50% or dissec (B) or TIMI 0-1
BBK	18.8%	Residual SB DS >75% or flow limiting dissec
NORDIC	4.3%	TIMI 0
BBC ONE	3.0%	Residual DS>70% or TIMI 0-2 or dissec (A)

Colombo et al. Circulation 2009;119:71-8

Ferenc et al EHJ 2008;29:2859-67

Steigen et al Circulation 2006;114:1955-61

Hildick-Smith et al Circulation 2010;121:1235-43

Current Guideline

2011 ACCF/AHA/SCAI Guideline for PCI

Indication of Single-Stent

CLASS I

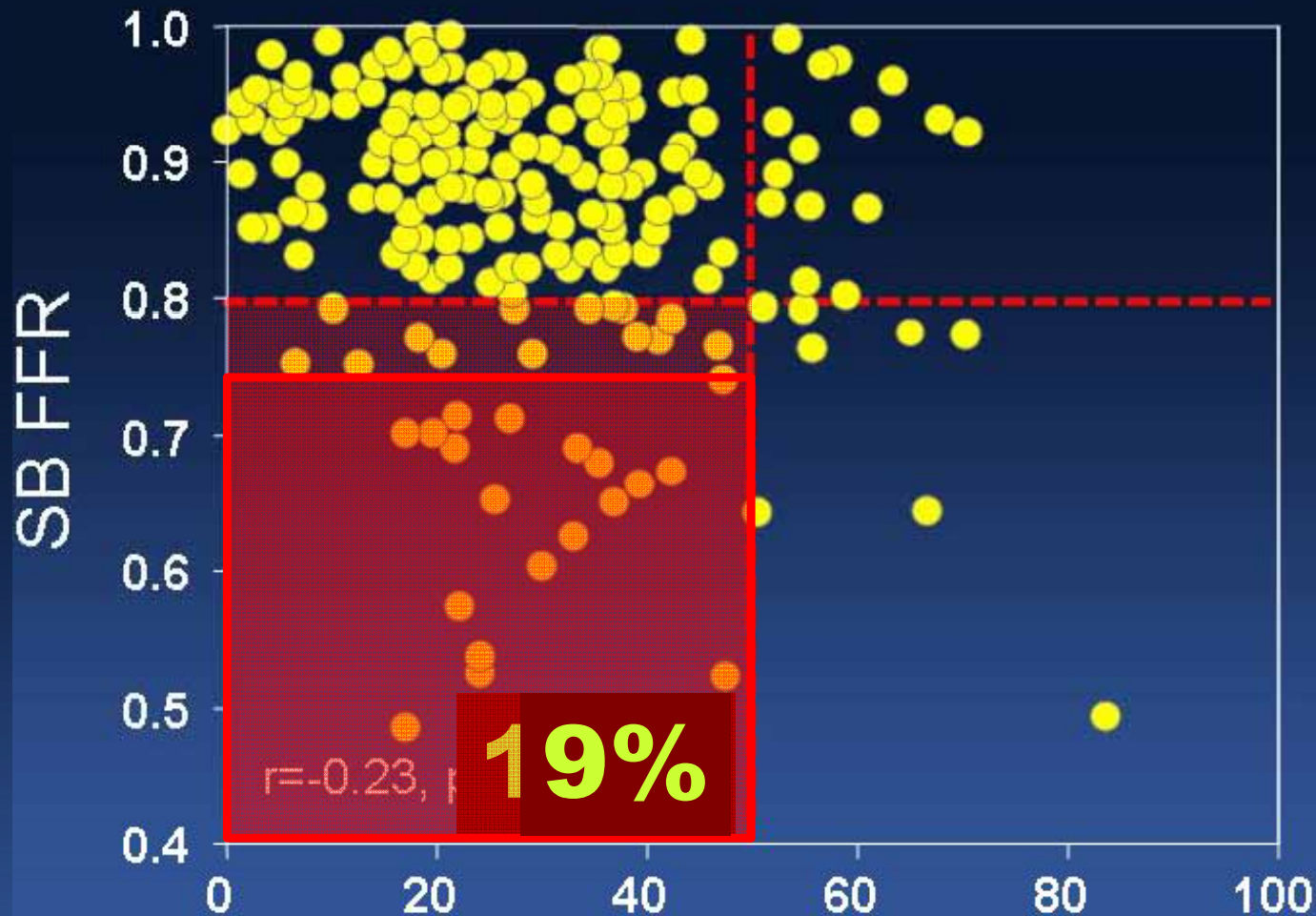
1. Provisional side-branch stenting should be the initial approach in patients with bifurcation lesions when the side branch is not large and has only mild or moderate focal disease at the ostium (726-729).
(Level of Evidence: A)



- SB ostial stenosis (**DS<50%**)
 - Focal (**length<5-6mm**)
- *Low risk for SB occlusion*

JACC 2011;58:e44-122

SB Ischemia, How Often?




**When Pre-PCI SB Ostial DS <50%,
Just Do Single Stent!**

Current Guideline

2011 ACCF/AHA/SCAI Guideline for PCI

Indication of Two-Stents

CLASS IIa

1. It is reasonable to use elective double stenting in patients with complex bifurcation morphology involving a large side branch where the risk of side-branch occlusion is high and the likelihood of successful side-branch reaccess is low (730–733). (*Level of Evidence: B*)
- 

What is 'complex morphology'?

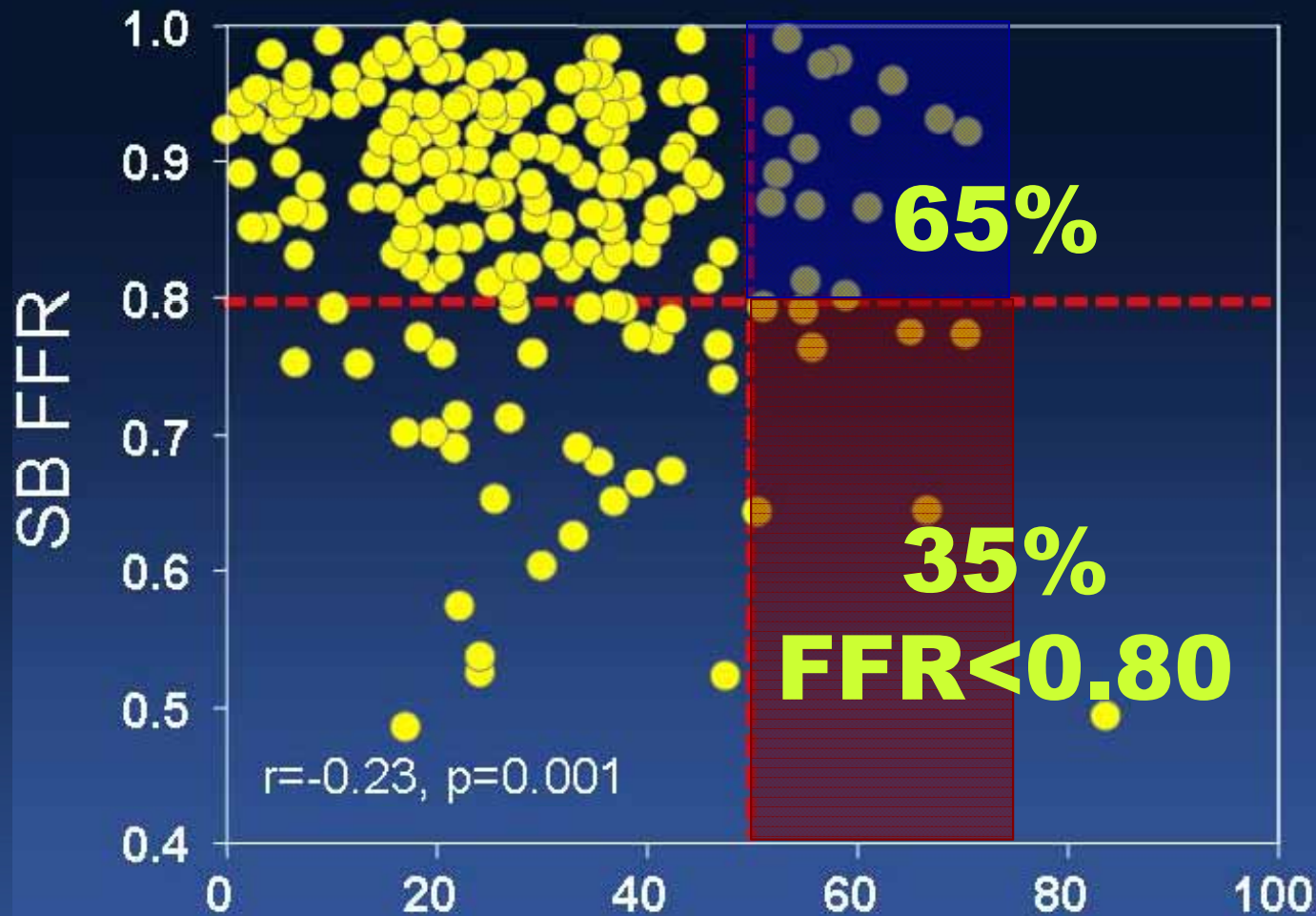
JACC 2011;58:e44-122

What is 'Complex Morphology'?

- Medina 1,1,1
- Severity of SB ostial stenosis (DS>70%)
- Large plaque at the SB ostium
- SB stenosis length >5mm
- Severity of MB disease
- Large SB angle (>70°)
- Technical difficulty in SB re-access

More likely to have functional SB compromise during provisional approach

SB Ischemia, How Often?



**When Pre-PCI SB Ostial DS >50%,
We Need More Information!**

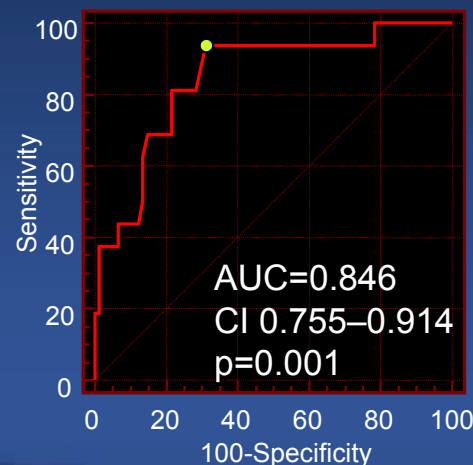
Preintervention Angiographic and Intravascular Ultrasound Predictors for Side Branch Compromise After a Single-Stent Crossover Technique

Soo-Jin Kang, MD, PhD^a, Gary S. Mintz, MD^b, Won-Jang Kim, MD^a, Jong-Young Lee, MD^a, Duk-Woo Park, MD, PhD^a, Seung-Whan Lee, MD, PhD^a, Young-Hak Kim, MD, PhD^a, Cheol Whan Lee, MD, PhD^a, Seong-Wook Park, MD, PhD^a, and Seung-Jung Park, MD, PhD^{a,*}

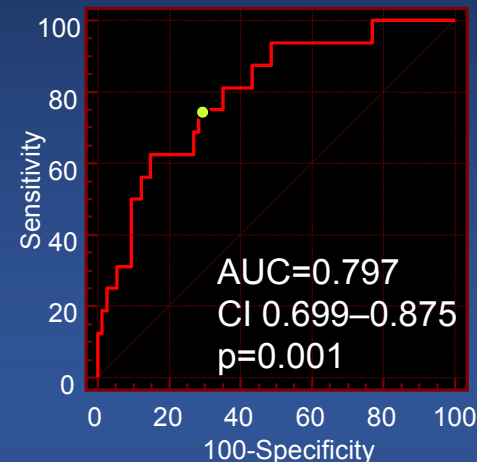
In 90 non-LM bifurcation lesions with SB ostial DS <75%

MLA <2.4mm²

Plaque burden >50%

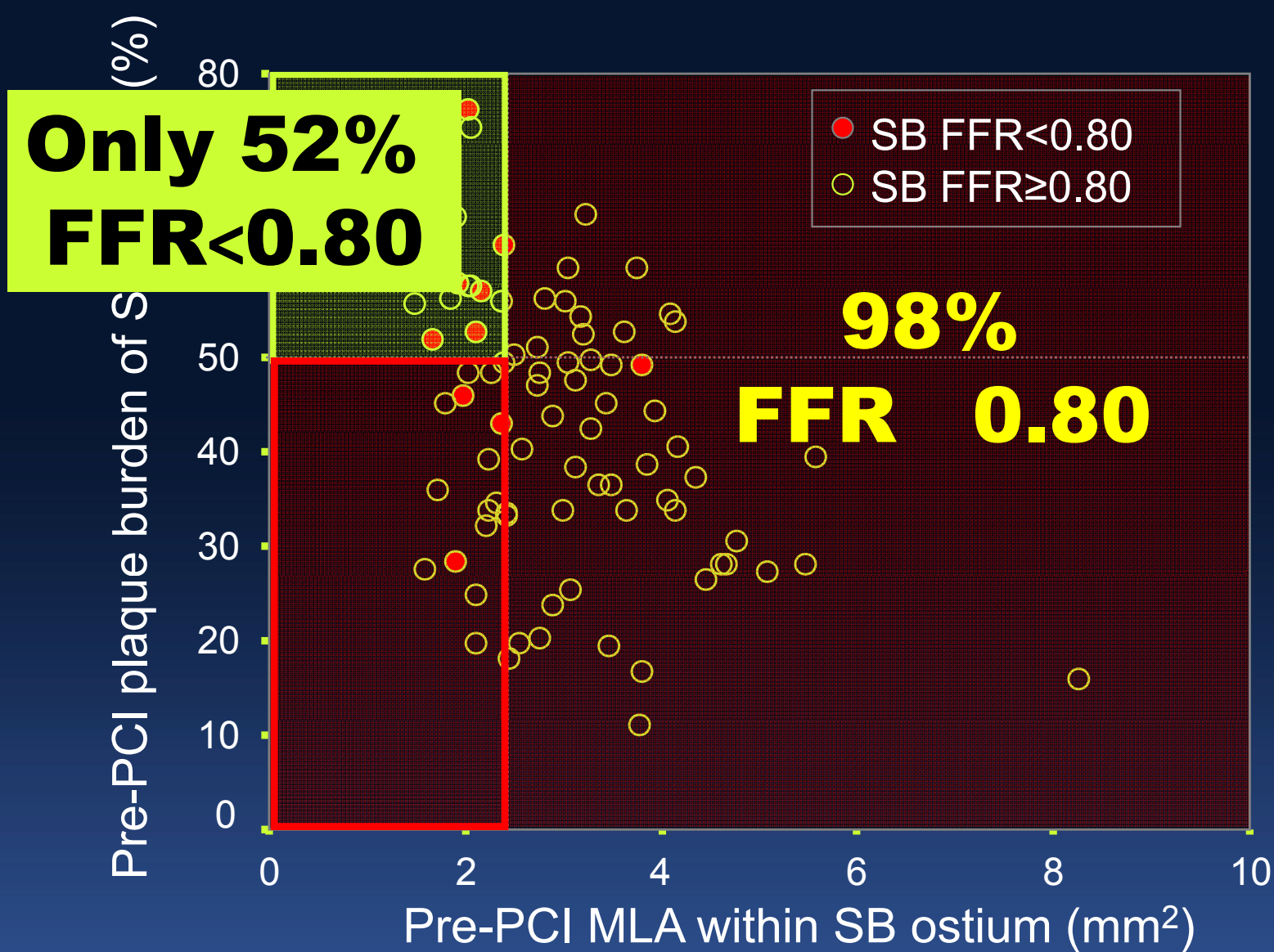


Sensitivity=94%
Specificity=68%
PPV=40%
NPV=98%



Sensitivity=75%
Specificity=71%
PPV=36%
NPV=93%

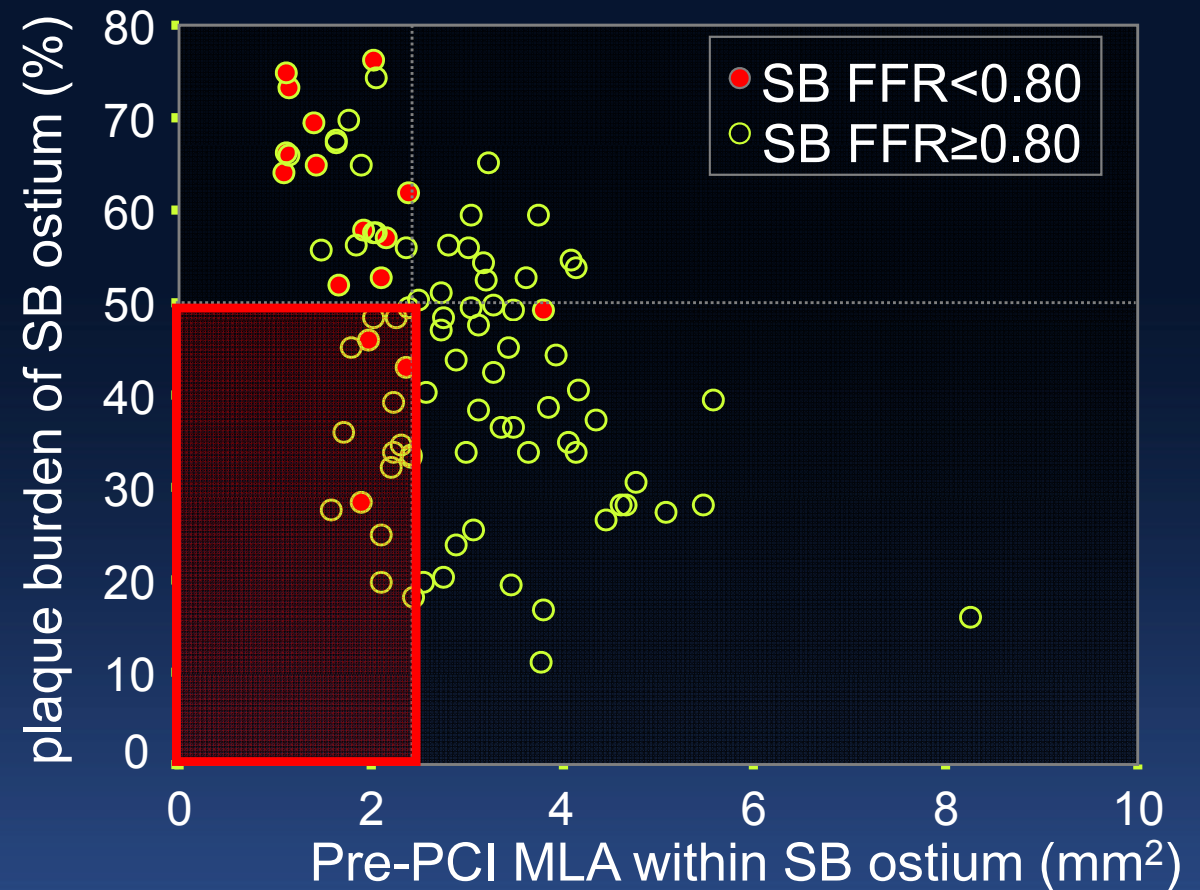
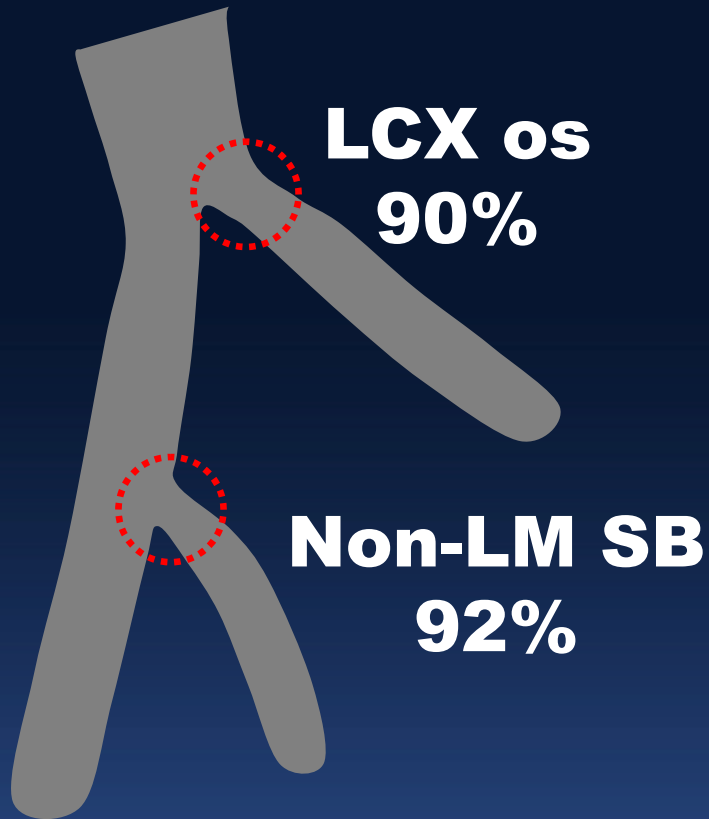
Kang et al. Am J Cardiol 2011;107:1787-93



Small pre-procedural MLA poorly predicted functional SB compromise

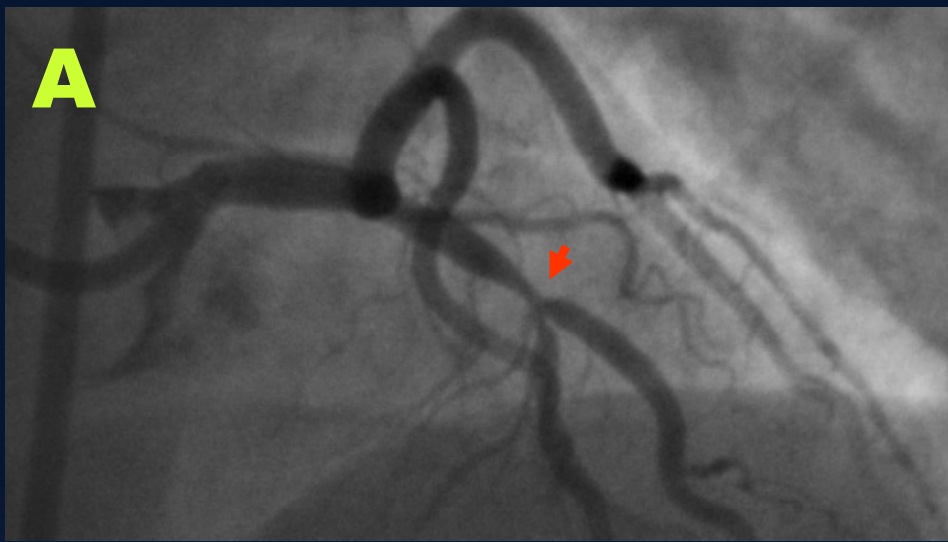
Kang et al. Am J Cardiol 2011;107:1787-93

Negative Remodeling at SB Ostium

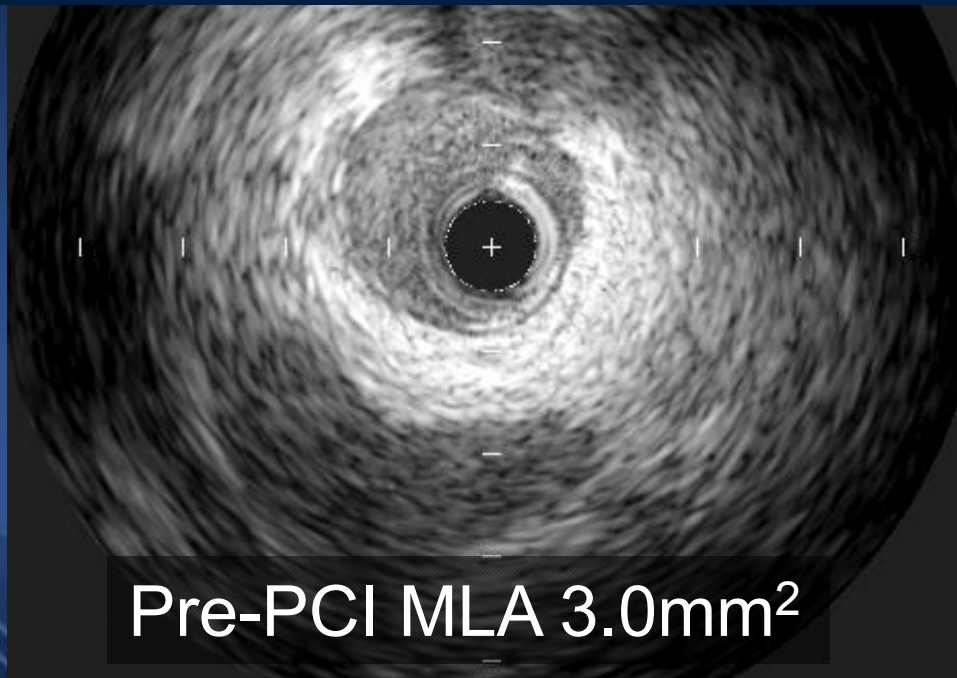


If small MLA is not caused by significant plaque, but by negative remodeling, **80%** show **normal FFR**

Kang et al. Catheter Cardiovasc Interv 2013 in press



If SB disease looks significant, we need IVUS to avoid unnecessary two-stent

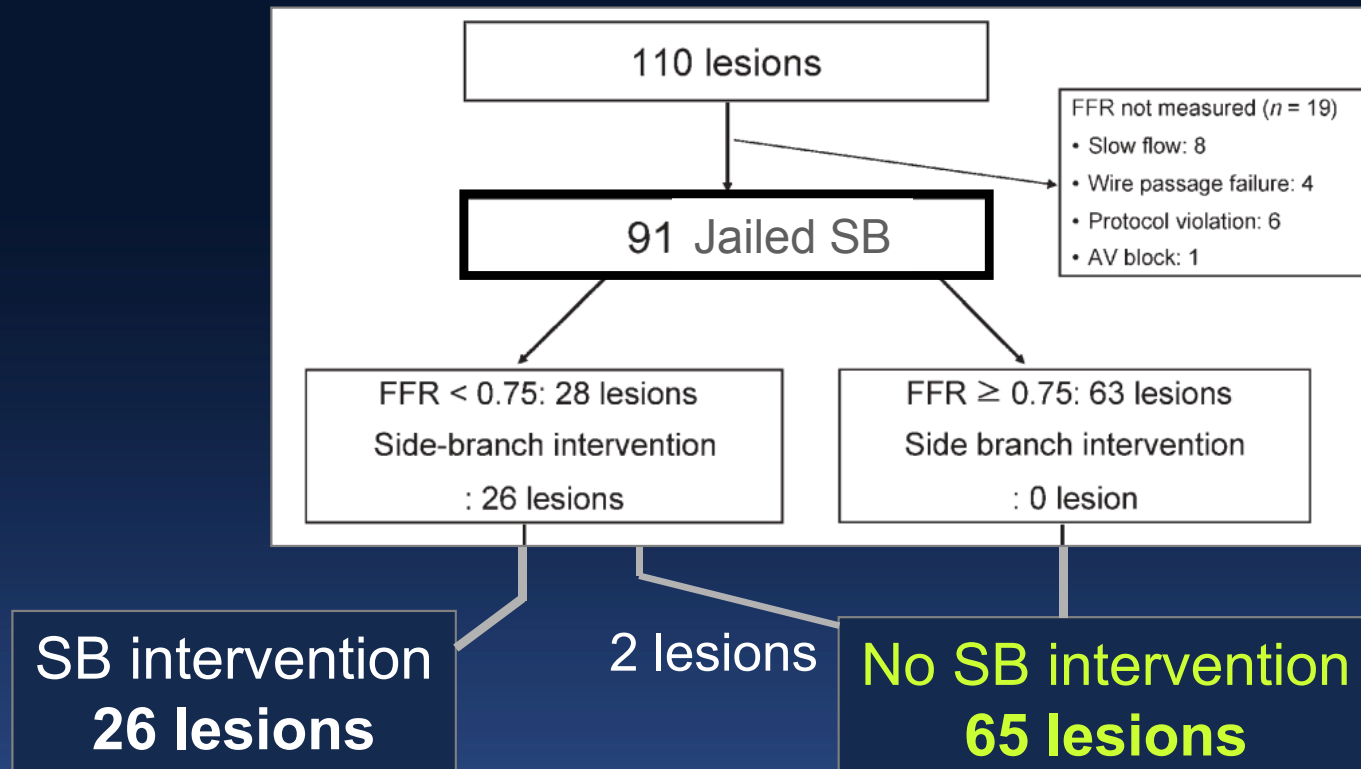


Pre-PCI MLA 3.0mm^2



Pre-PCI MLA 2.0mm^2

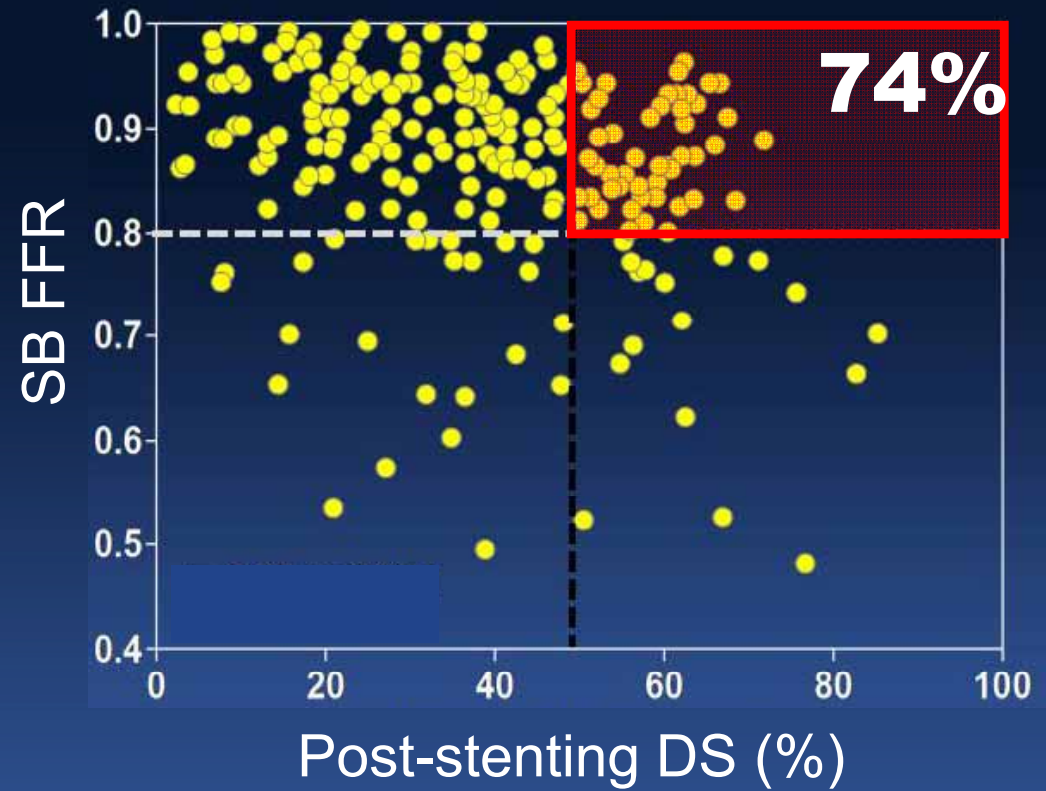
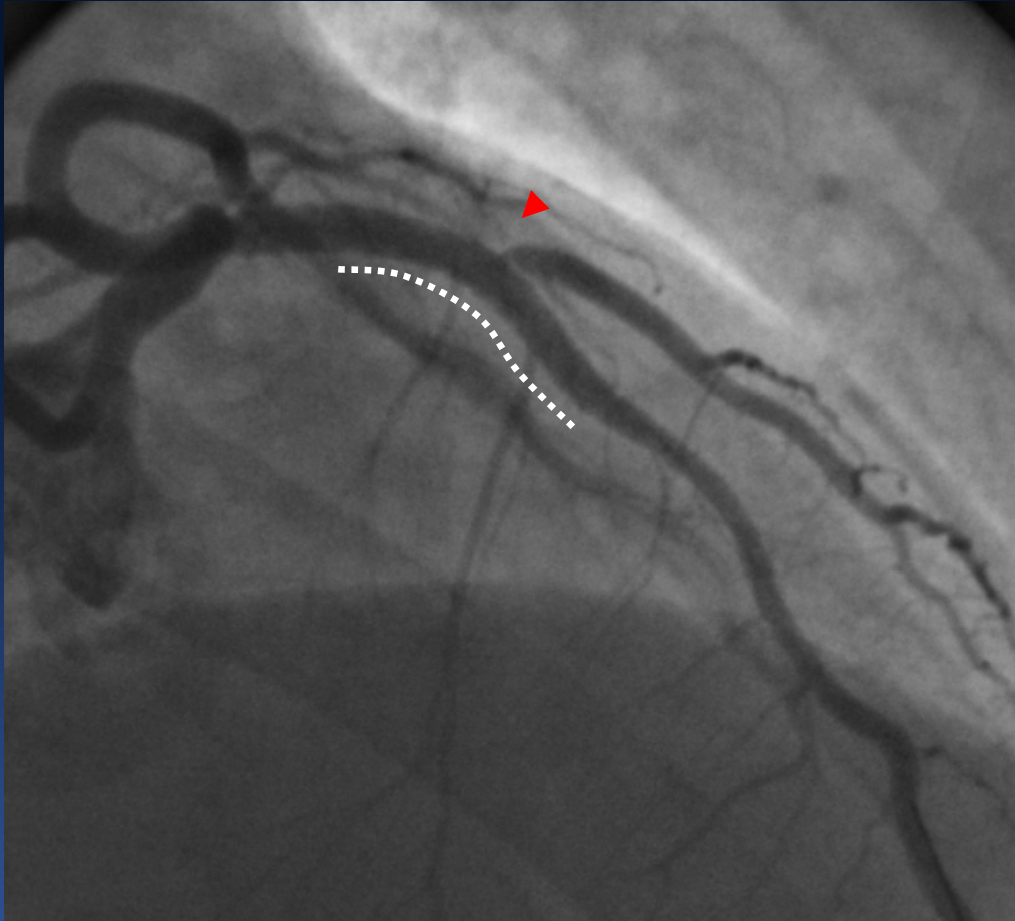
How to Treat the SB Stenosis?



FFR > 0.75 is safe for deferral of jailed SB

FFR-guided provisional SB intervention resulted in a low rate of 9-month MACE

Discordance Between Post-stenting QCA vs. SB FFR

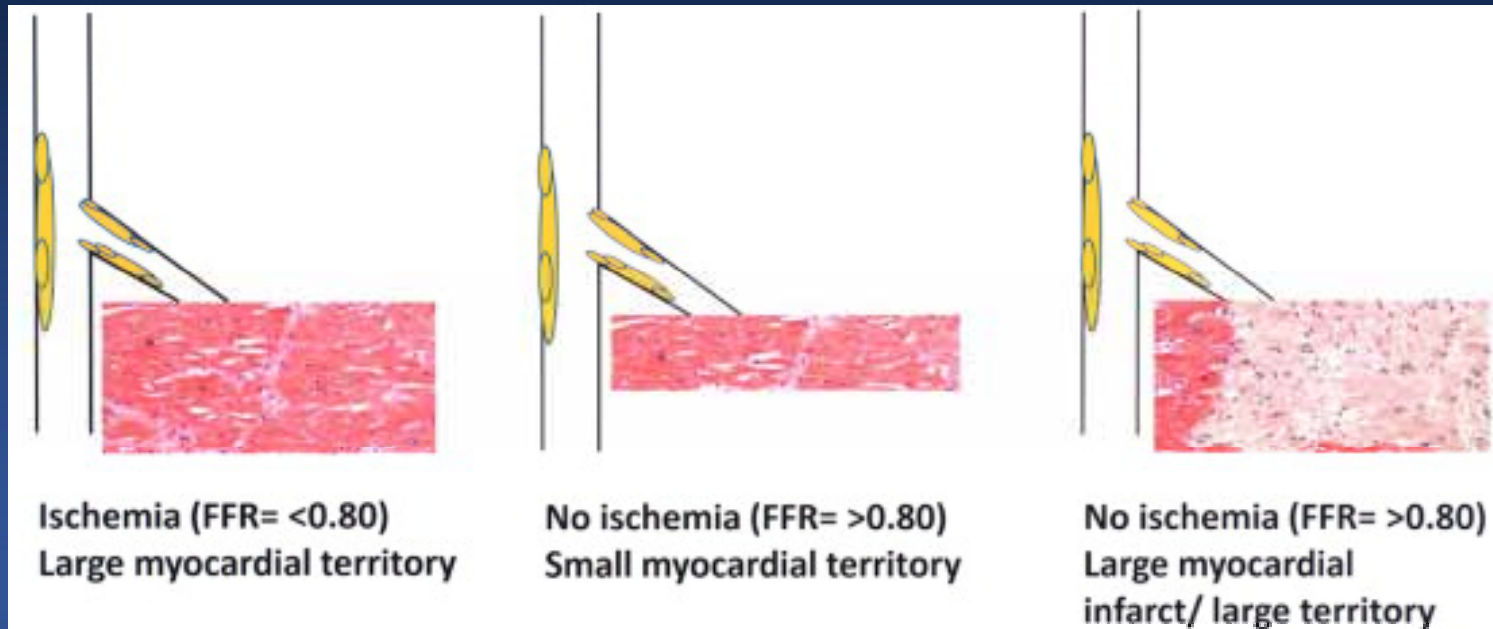


Post-stenting DS **80%**
SB FFR **0.88**

Ahn et al. JACC Interv in Press

Why Mismatch?

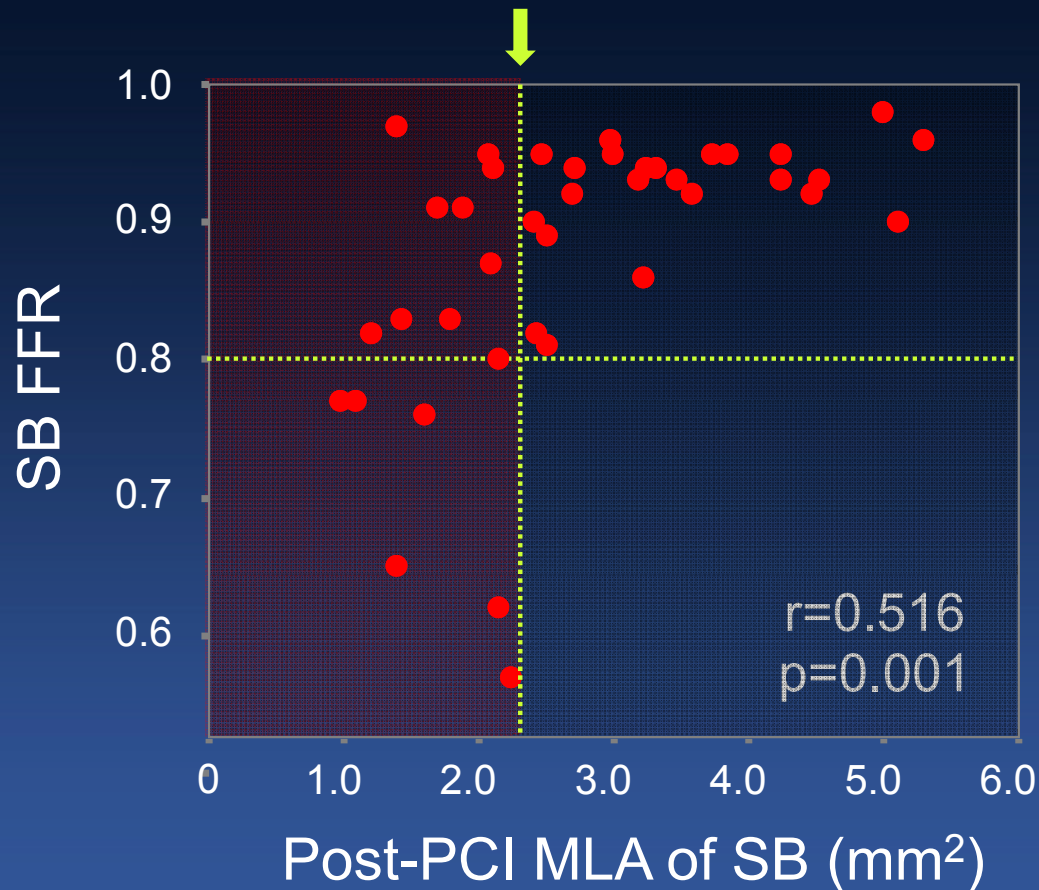
- Lesion eccentricity of SB
- Negative remodeling of ostium
- Various size of myocardium
- Strut artifacts



Sachdeva et al. Am J Cardiol 2011;107:1794-5

Discordance Between Post-stenting MLA vs. SB FFR

SB MLA < 2.25mm²



To Predict FFR < 0.80

Sensitivity 100%

Specificity 71%

PPV 38%

NPV 100%

Kang et al. Catheter Cardiovasc Interv 2013 in press

Why Mismatch?



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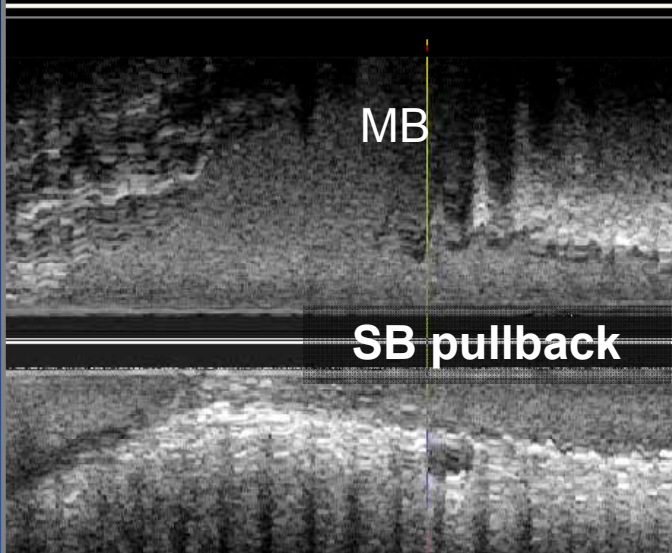
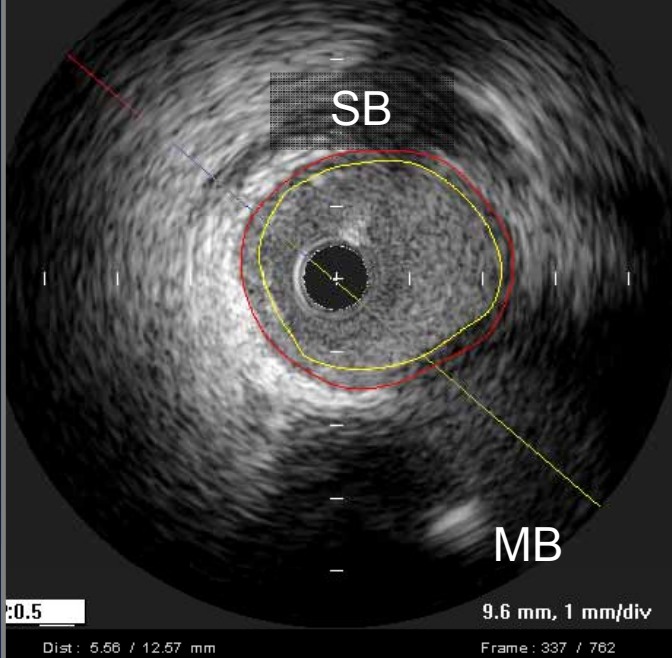


≠

FFR 0.83

- Small myocardial territory
- The general mechanism of SB jailing is **focal carina shift** rarely causing functional stenosis

Pre-procedure



SB MLA 7.2 mm²
 EEM area 9.3 mm²
 P+M area 2.1 mm²

Mechanism **Carina Shift**

$$\Delta V / \Delta L > 1$$

$$\Delta P < 0$$

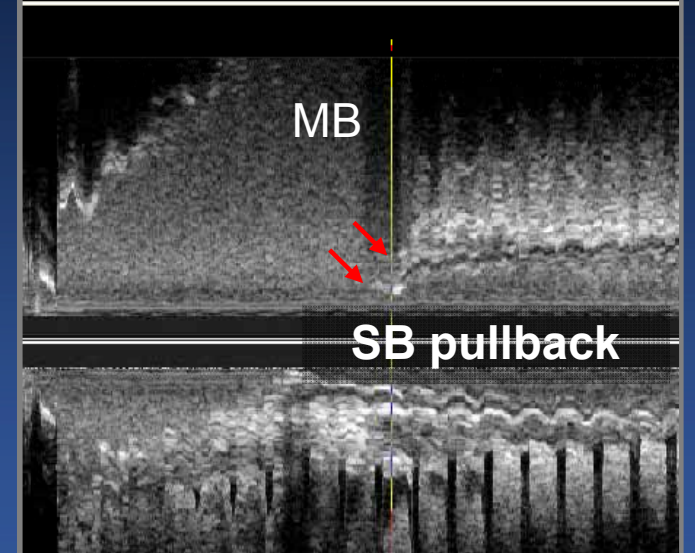
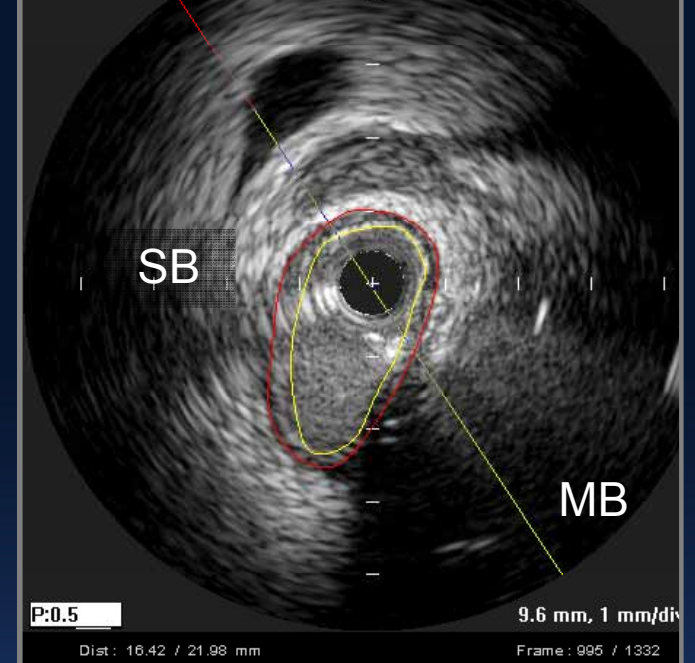
Area Change

ΔL	-3.4 mm ²
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ΔV	-3.5 mm ²
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ΔP	-0.1 mm ²
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After Cross-Over



SB MLA 3.8 mm²
 EEM area 5.8 mm²
 P+M area 2.0 mm²

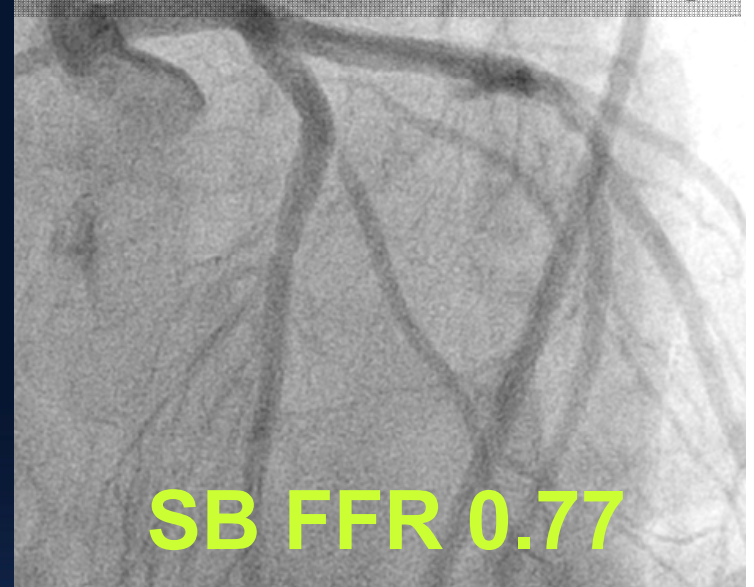
Pre-procedure



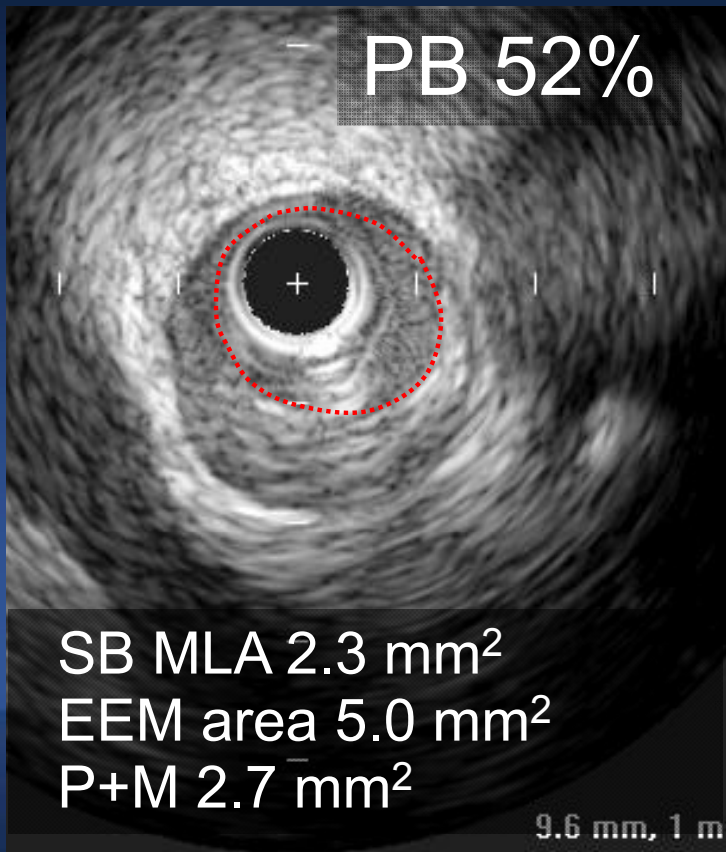
Mechanism Plaque Shift

$$\Delta V / \Delta L < 1$$
$$\Delta P > 0$$

After MB stenting



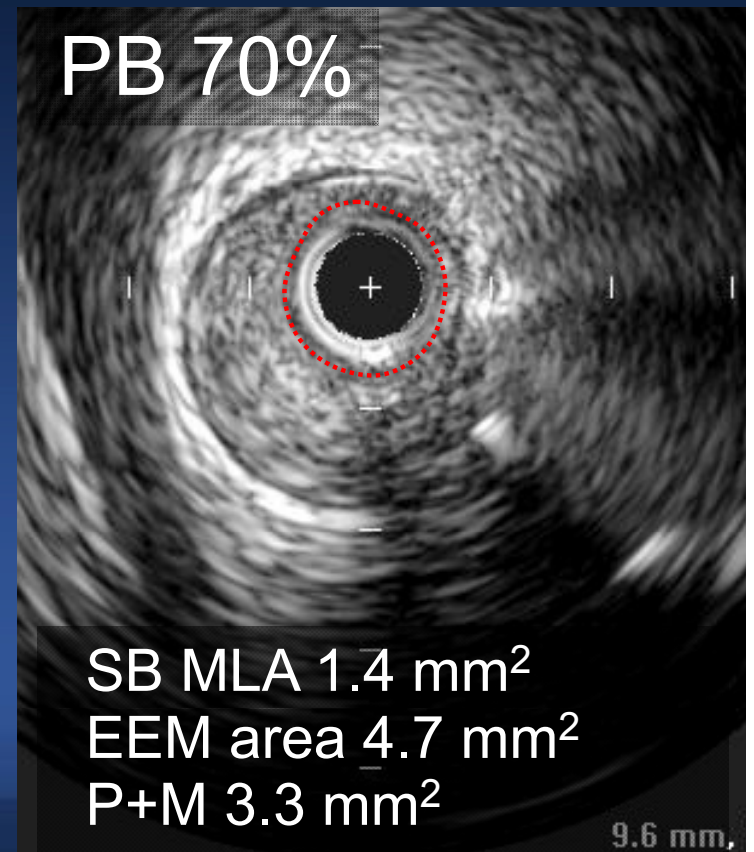
PB 52%



Area Change

ΔL	-1.0mm ²
ΔV	-0.3mm ²
ΔP	+0.7mm ²

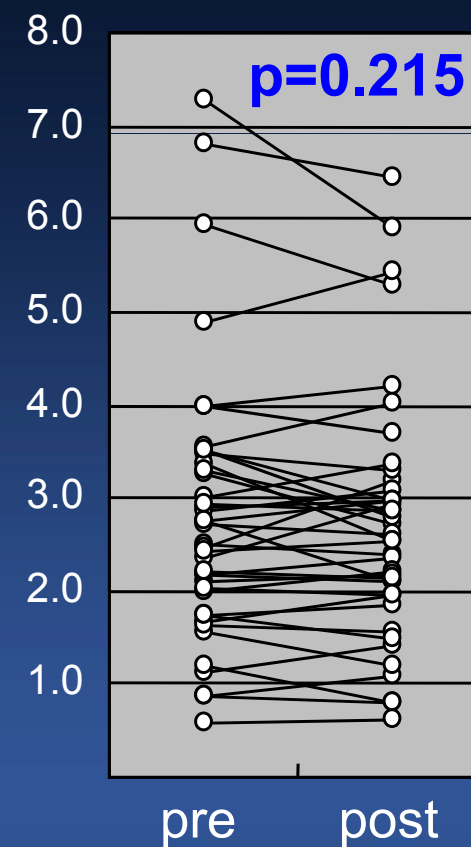
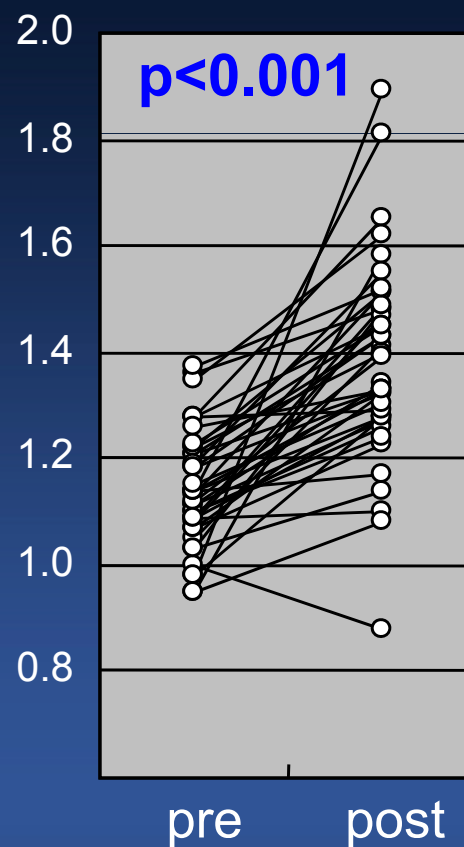
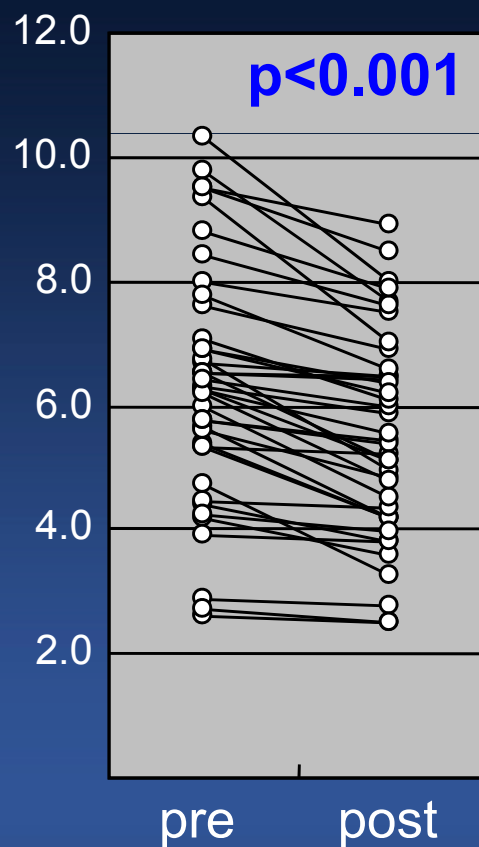
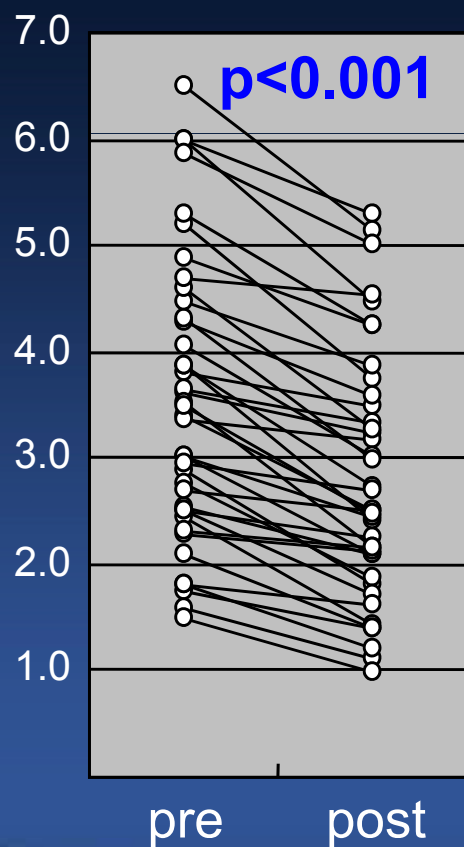
PB 70%



Mechanisms of SB Jailing

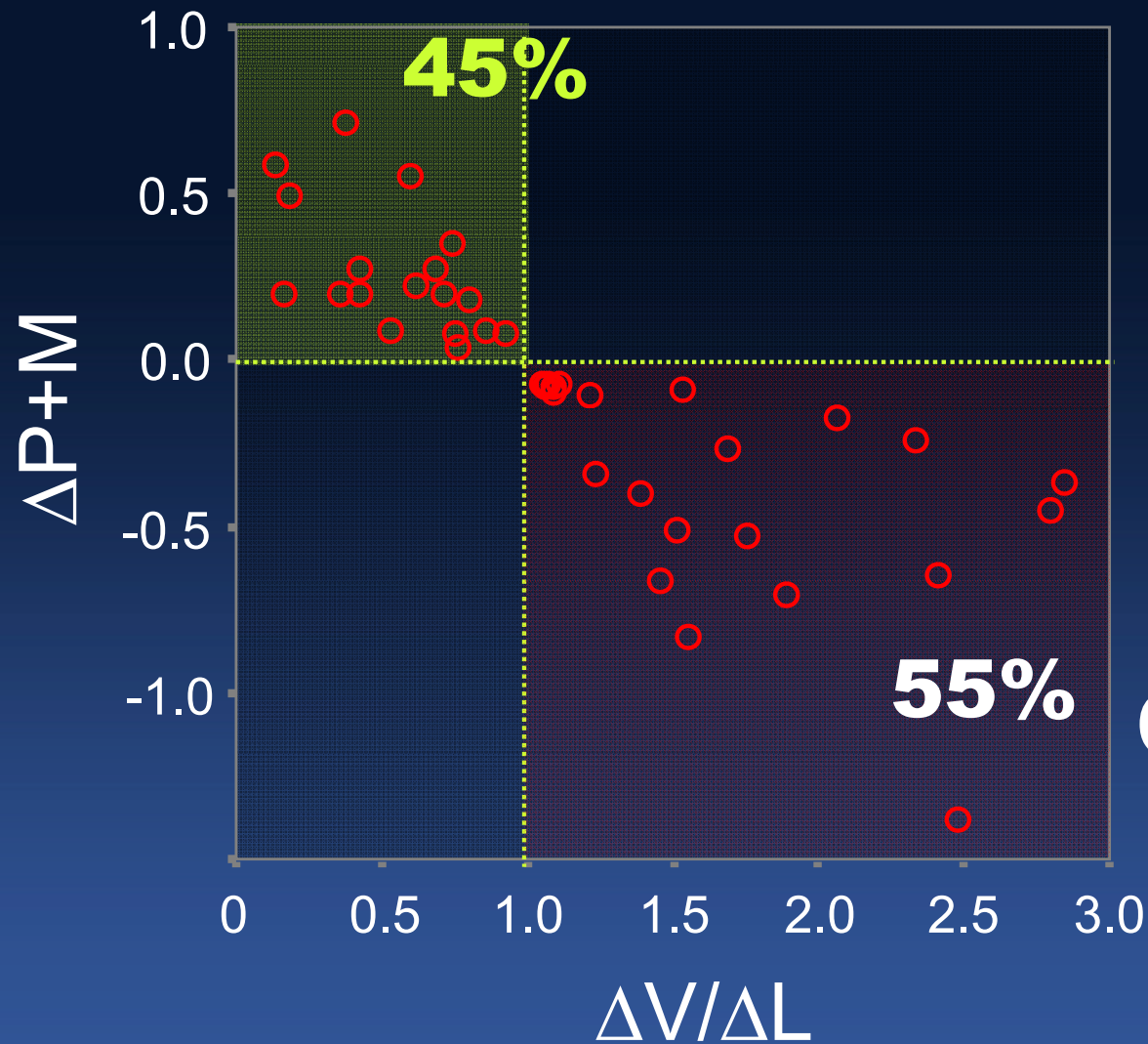
Changes in Geometry of Non-LM Bifurcation

SB MLA (mm²) **EEM (mm²)** **Eccentricity** **P+M (mm²)**
3.5 ± 1.3 → 2.8 ± 1.2 6.3 ± 1.9 → 5.5 ± 1.7 1.1 ± 1.1 → 1.4 ± 0.2 2.8 ± 1.5 → 2.7 ± 1.3



Kang et al. Catheter Cardiovasc Interv 2013 in press

Plaque Shift + Carina Shift

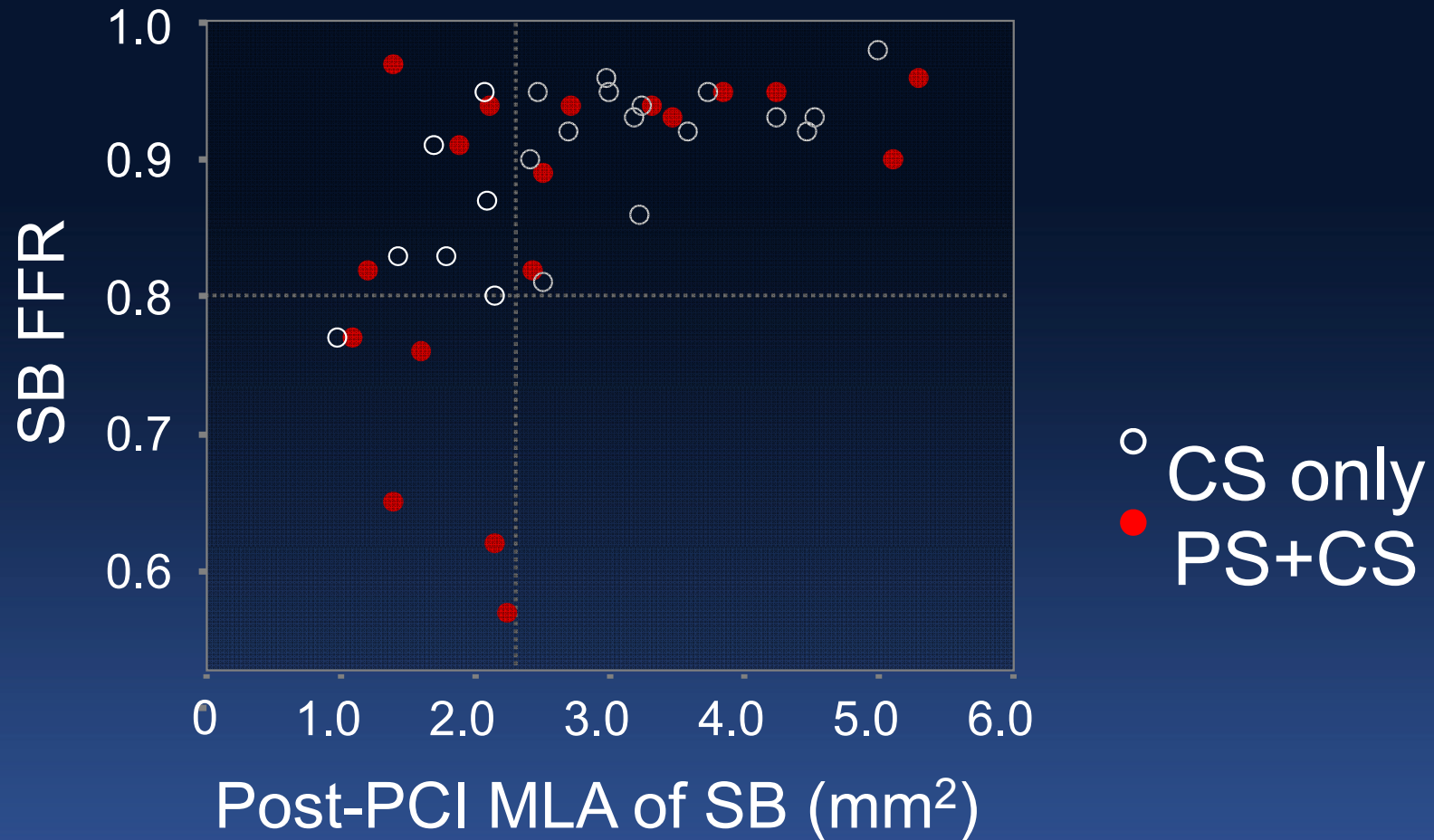


**Isolated
Carina Shift**

Kang et al. Catheter Cardiovasc Interv 2013 in press

Hemodynamic Impact

Carina Shift vs. Plaque Shift

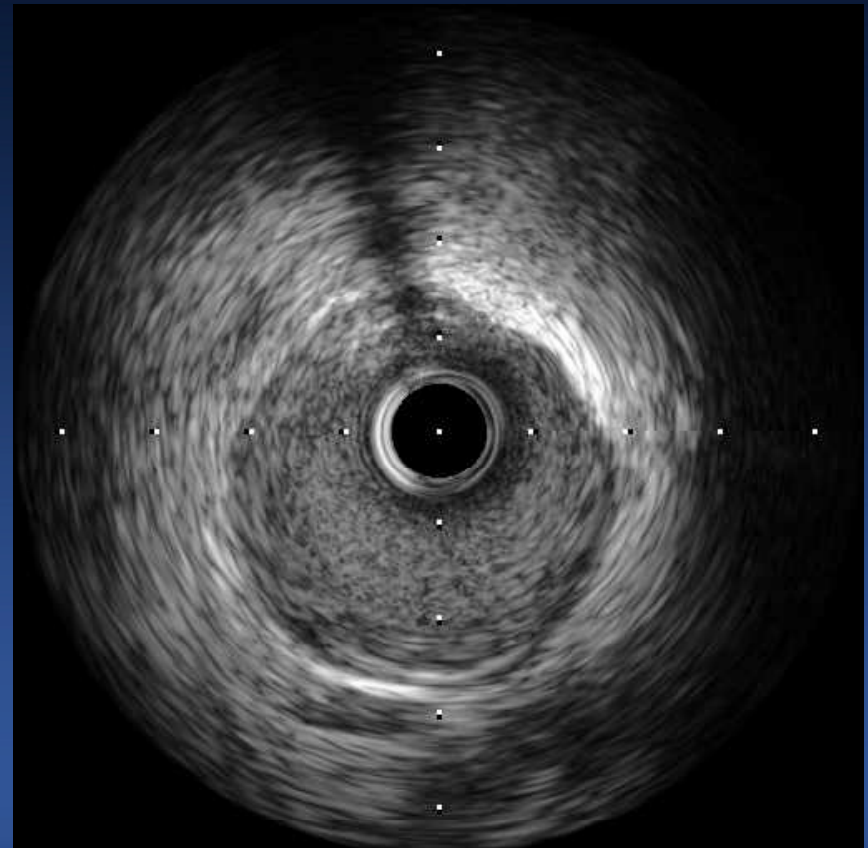


Plaque shift may be a prerequisite to the hemodynamically significant SB stenosis

Kang et al. Catheter Cardiovasc Interv 2013 in press

Why Does the Isolated Carina Shift Rarely Reduce FFR?

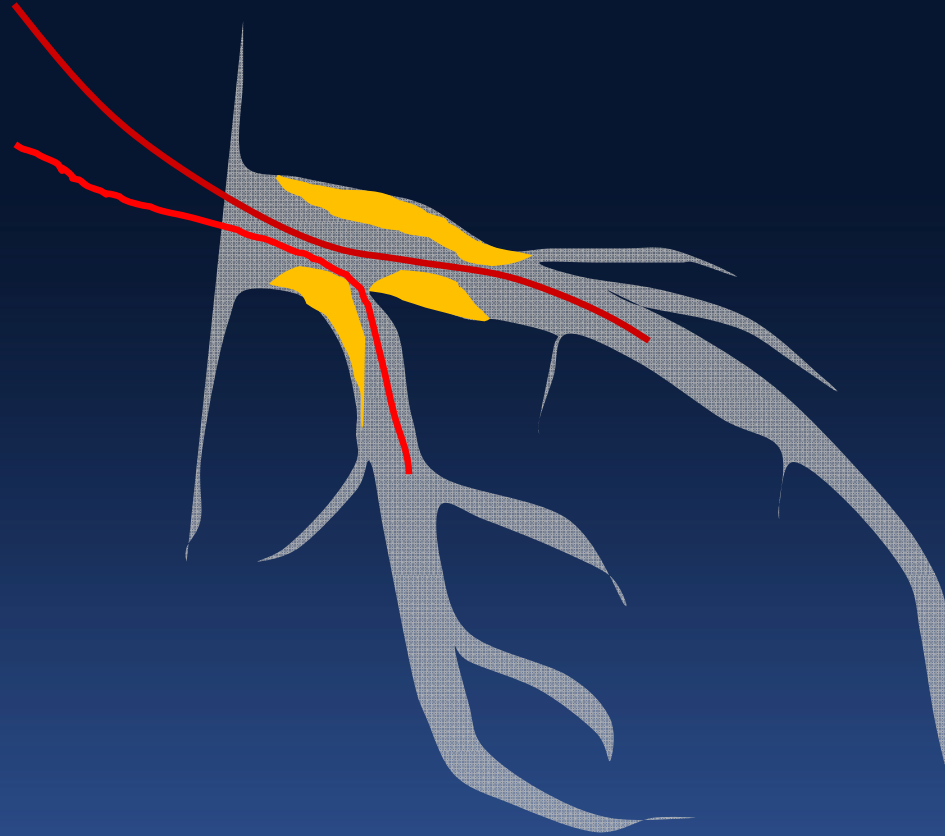
- Not by plaque gain, but by vessel deformation
- The luminal change is extremely focal



Kang et al. Catheter Cardiovasc Interv 2013 in press

Step-by-step Approach for Bifurcation

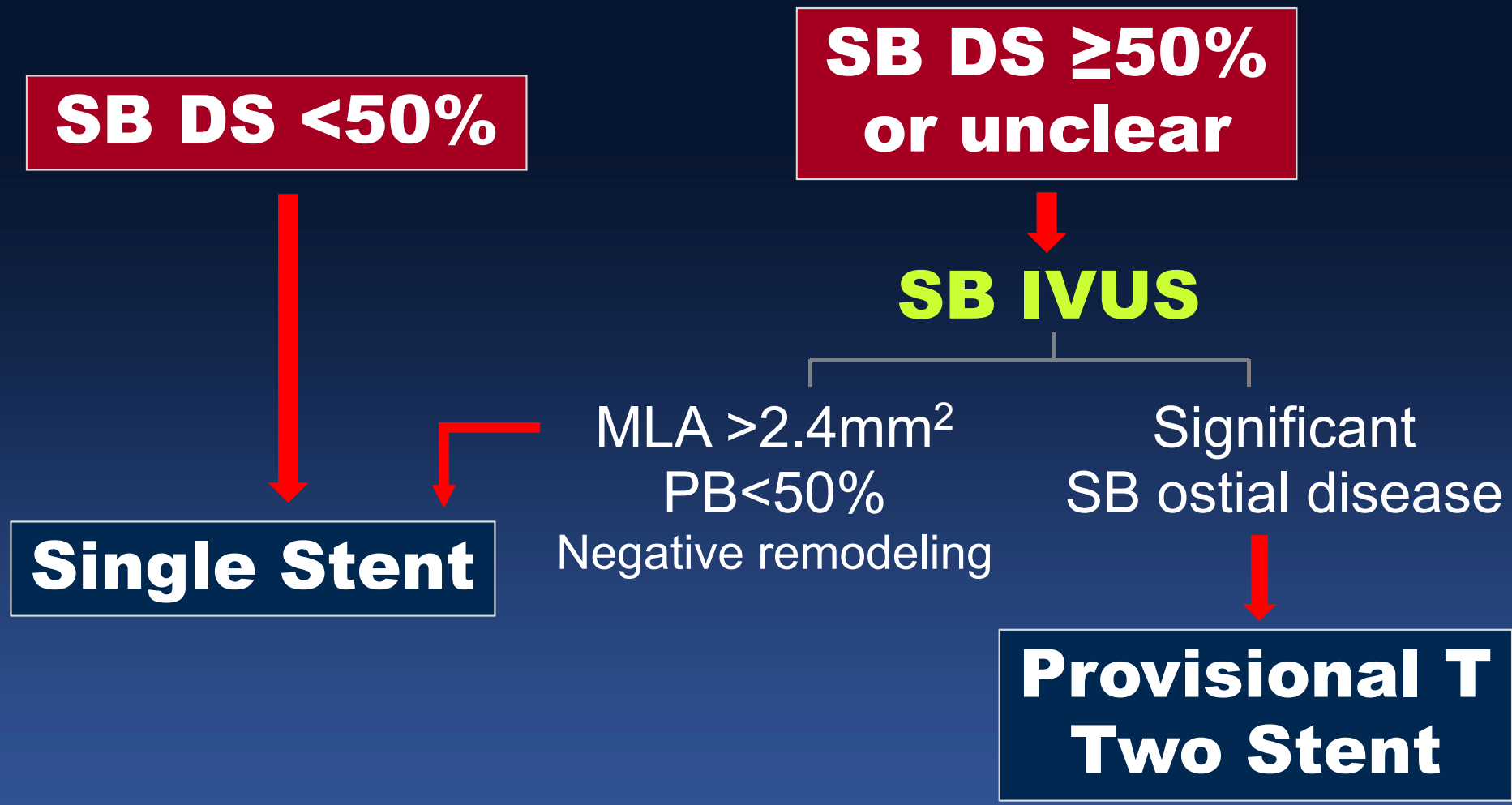
Treat or Not Treat?



**Treat the true bifurcation
as 'A Complex'**

Step-by-step Approach for Bifurcation

Initial Stent Strategy



When the SB is large, diffuse severe proximal disease and suitable for stenting, two-stent may be better

Step-by-step Approach for Bifurcation

Treatment of Jailed SB

After MB stenting, the high degree DS or small MLA poorly predicts FFR

If SB stenosis looks clinically significant, FFR is useful to confirm the SB ischemia and to avoid unnecessary SB PCI