

# **Step-by-step Approach for Complex Bifurcations Using Angiography, IVUS and FFR**

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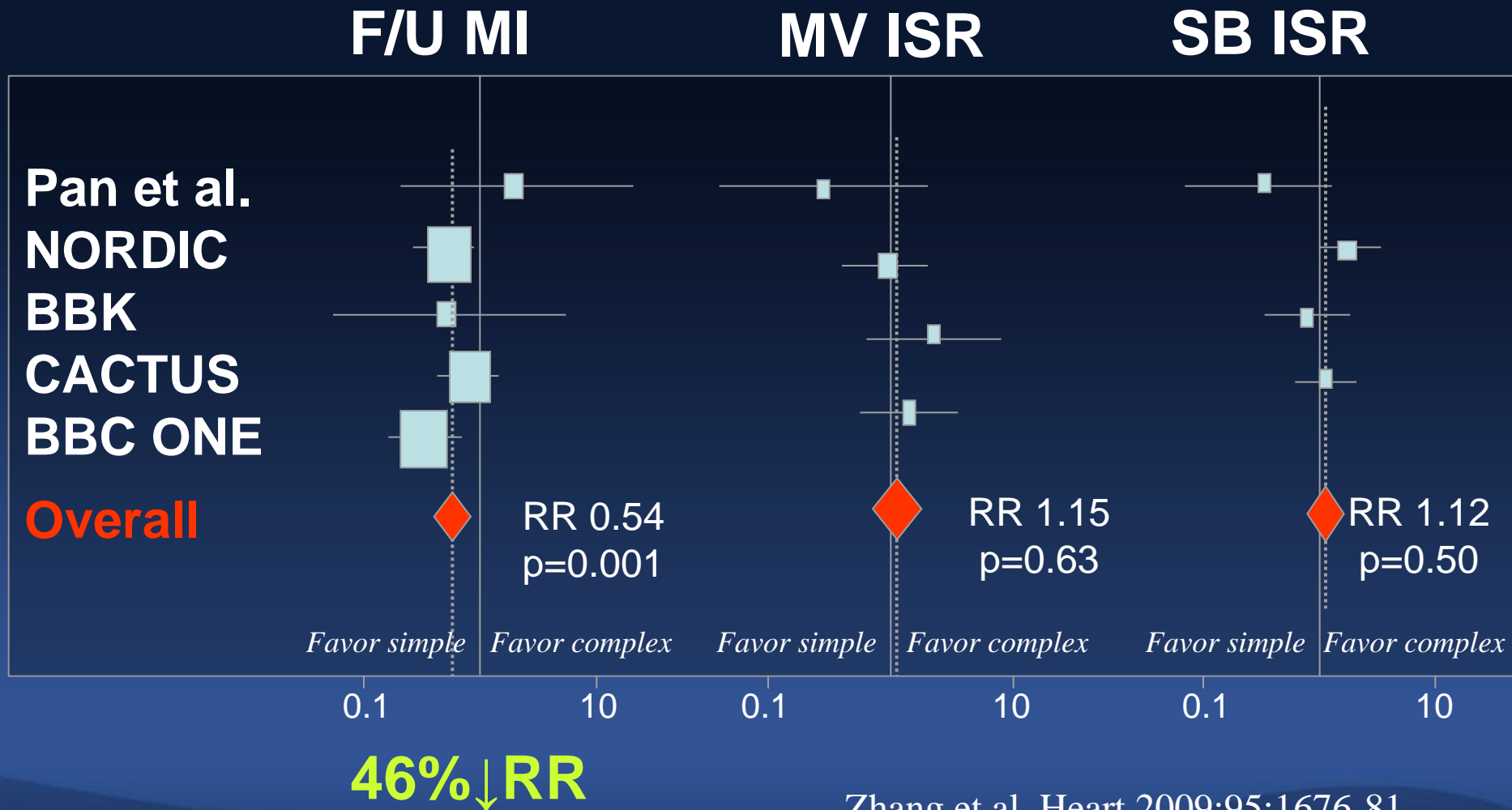
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# **Disclosure**

**I have nothing to disclose**

# Simple vs. Complex

## Relative Ratios of Adverse Events



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

# “Low Risk” Population

**BBK** in unselected population

**Routine T (101 pts.) vs. Provisional T (101 pts.)**

**Medina (1,1,1) in 33%**

	Routine T	Provisional	p
Need for SB stent		19%	
Death, 1-year	1.0%	2.0%	1.00
MI, 1-year	2.0%	1.0%	1.00
TLR, 1-year	8.9%	10.9%	0.64
MACE, 1-year	11.9%	12.9%	0.83
Stent thrombosis, 1-year	2.0%	2.0%	1.00

*Frenc et al. EHJ 2008;29:2859-67*

# “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
<b>TLR, 1-year</b>	<b>4.3%</b>	<b>13.0%</b>	<b>0.005</b>
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.*

# 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 (**<5-6 mm**)
- *Low risk for SB occlusion*

*JACC 2011;58:e44-122*

# 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	<b>18.8%</b>	Residual SB DS >75% or flow limiting dissec
NORDIC	<b>4.3%</b>	TIMI 0
BBC ONE	<b>3.0%</b>	Residual DS>70% or TIMI 0-2 or dissec (A)

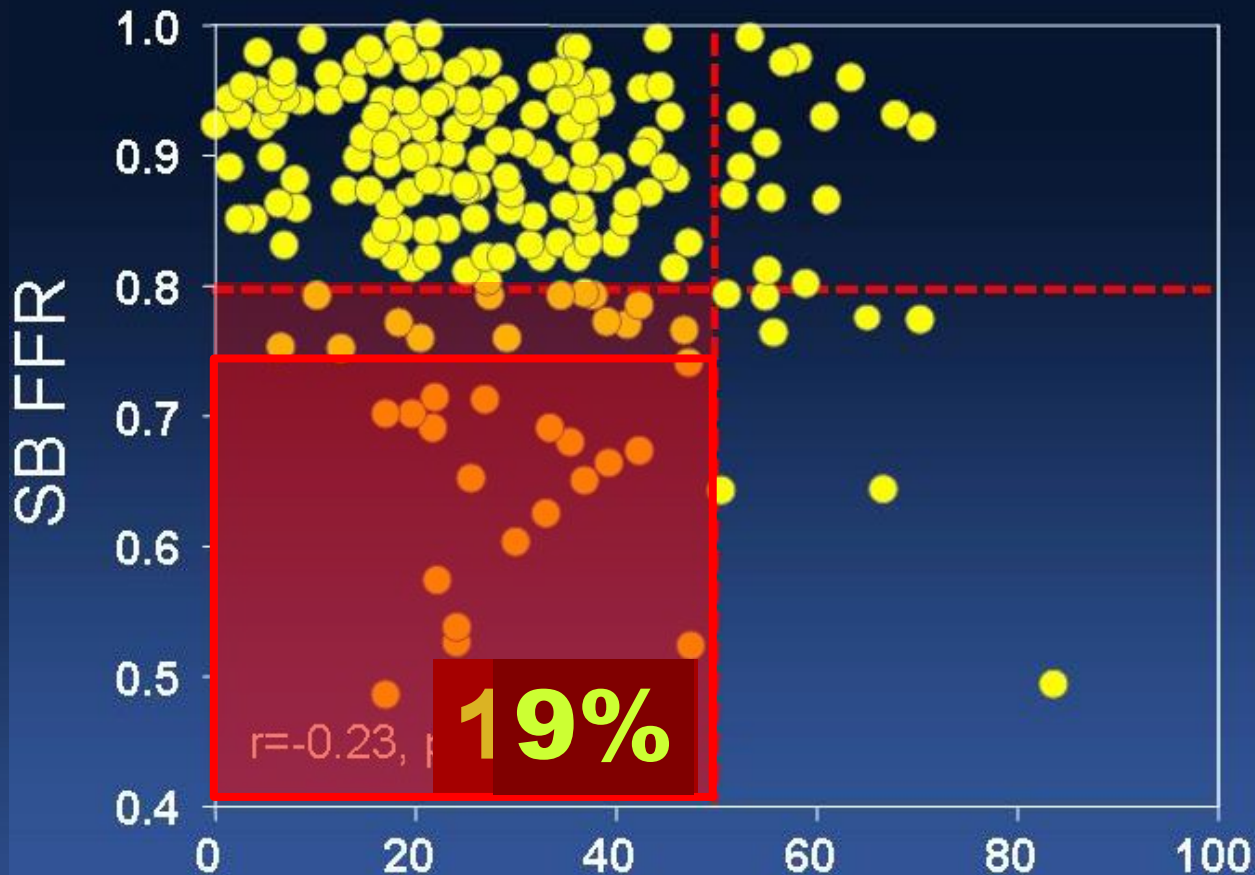
*Colombo et al. Circulation 2009;119:71-8*

*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*

# 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*)
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## What is ‘complex morphology’?

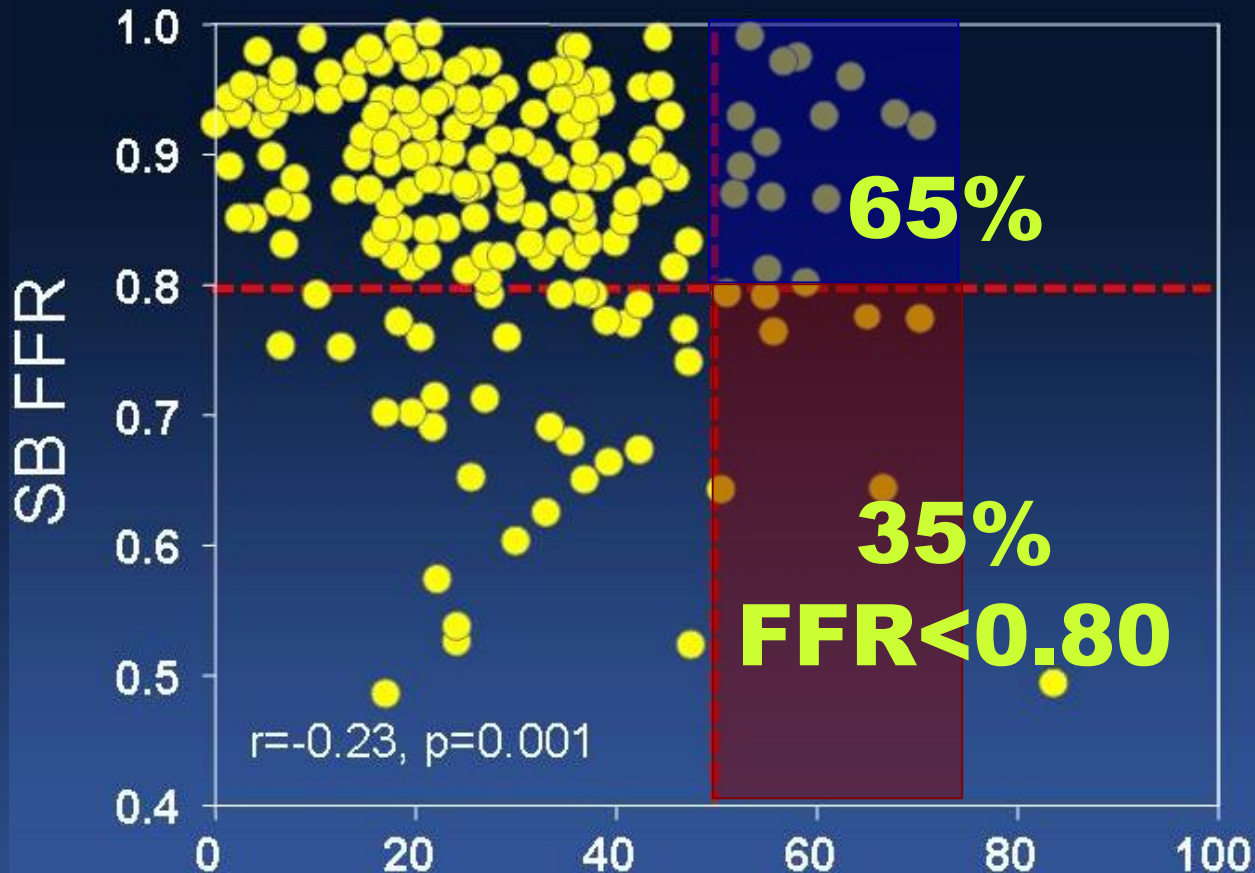
*JACC 2011;58:e44-122*

# What is 'Complex Morphology'?

- Medina 1,1,1
- Severity of SB stenosis (DS>50% or 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!**

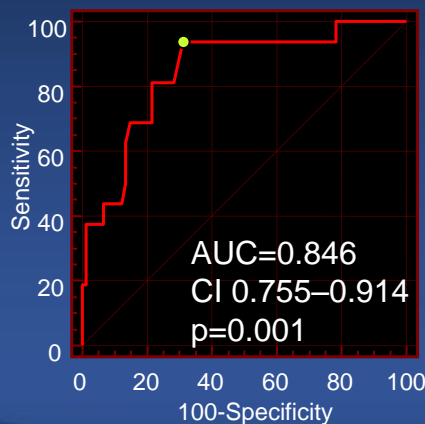
# Preintervention Angiographic and Intravascular Ultrasound Predictors for Side Branch Compromise After a Single-Stent Crossover Technique

Soo-Jin Kang, MD, PhD<sup>a</sup>, Gary S. Mintz, MD<sup>b</sup>, Won-Jang Kim, MD<sup>a</sup>, Jong-Young Lee, MD<sup>a</sup>, Duk-Woo Park, MD, PhD<sup>a</sup>, Seung-Whan Lee, MD, PhD<sup>a</sup>, Young-Hak Kim, MD, PhD<sup>a</sup>, Cheol Whan Lee, MD, PhD<sup>a</sup>, Seong-Wook Park, MD, PhD<sup>a</sup>, and Seung-Jung Park, MD, PhD<sup>a,\*</sup>

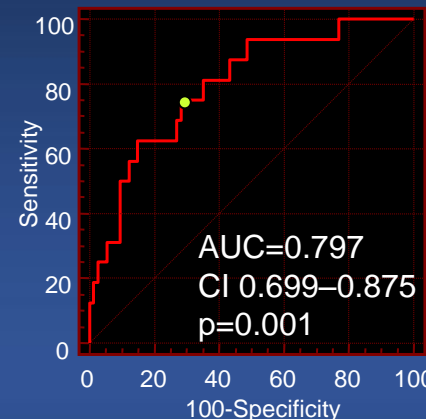
*In 90 non-LM bifurcation lesions with SB ostial DS <75%*

**MLA <2.4mm<sup>2</sup>**

**Plaque burden >50%**

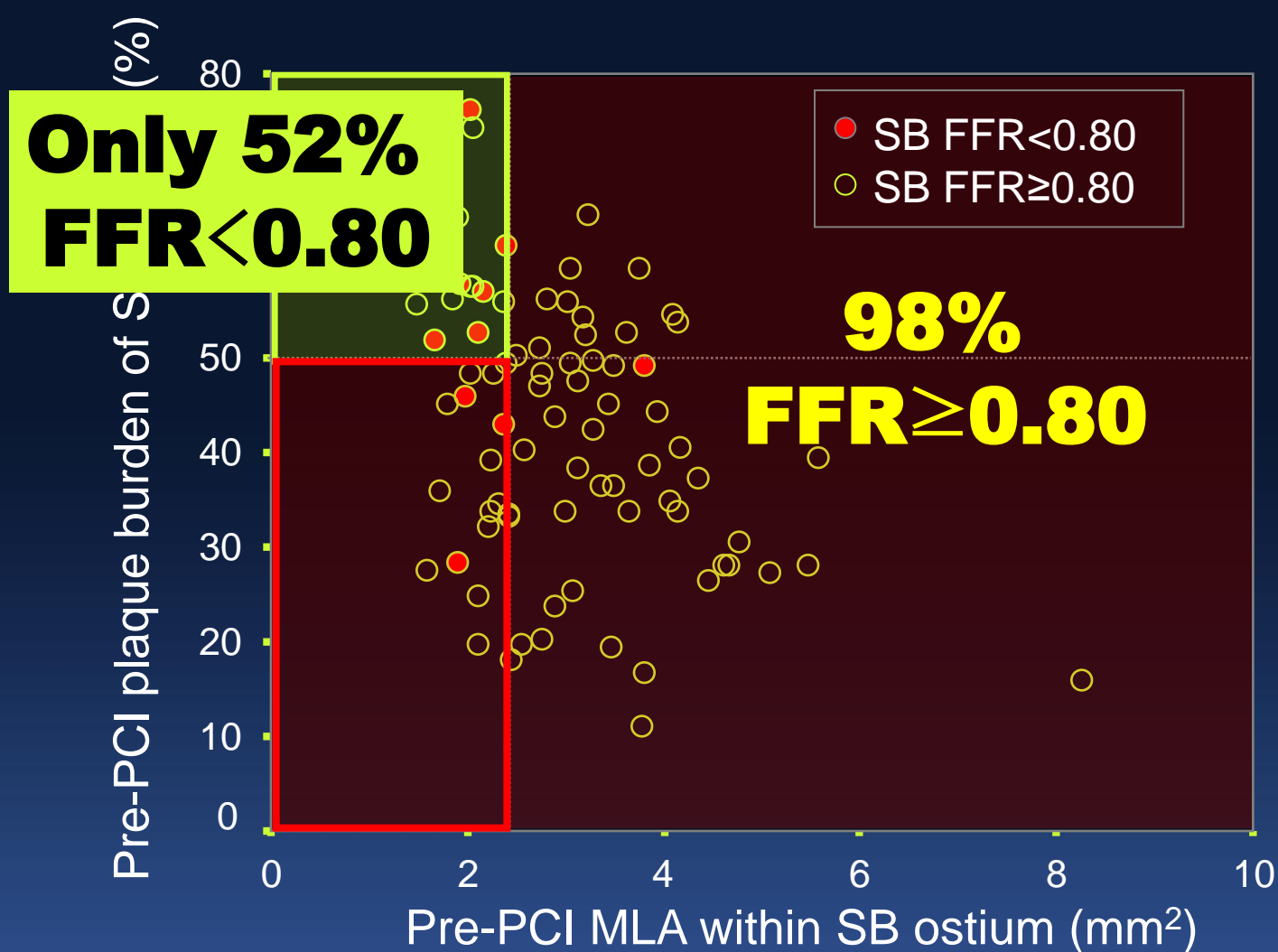


Sensitivity=94%  
Specificity=68%  
PPV=40%  
NPV=98%



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

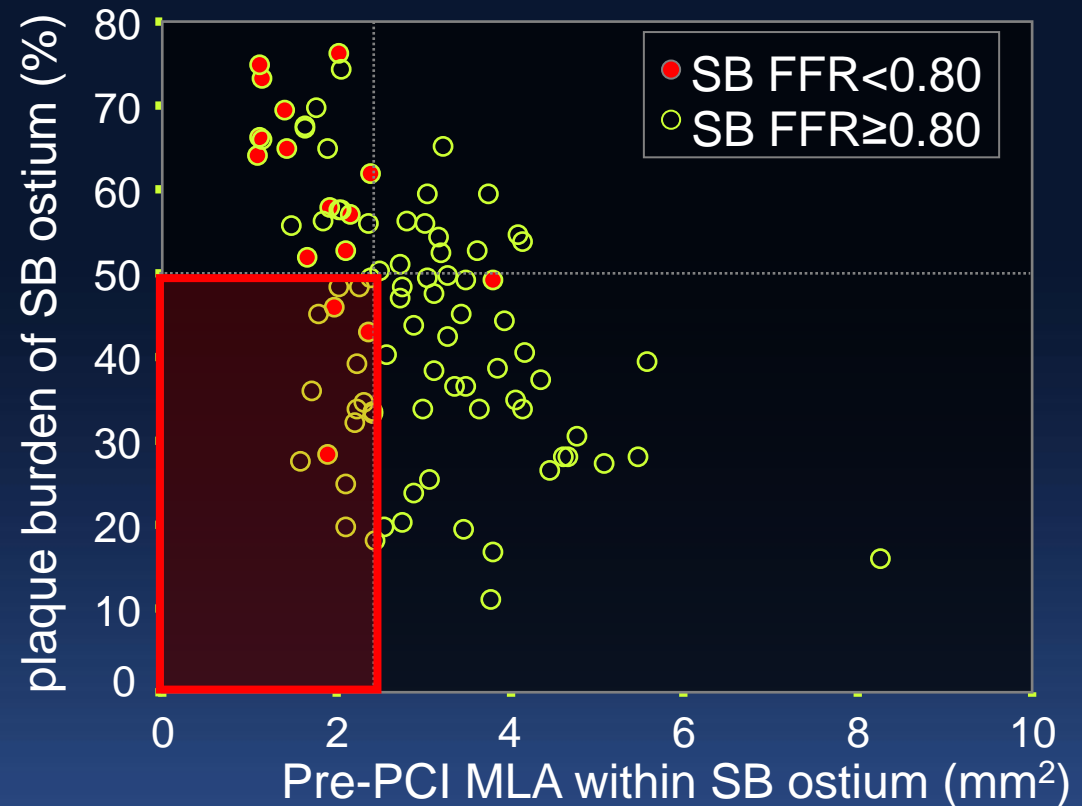
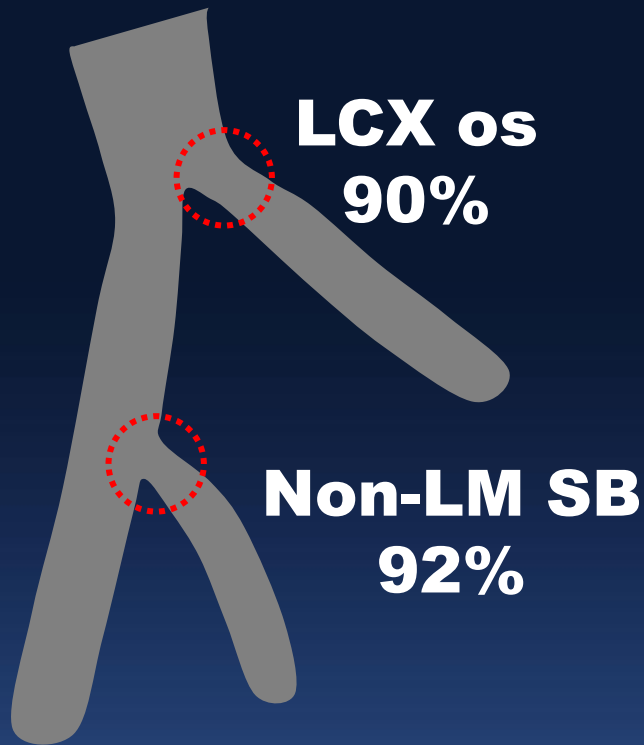
*Kang et al. Am J Cardiol 2011;107:1787-93*



**Small pre-procedural MLA poorly predicted functional SB compromise**

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

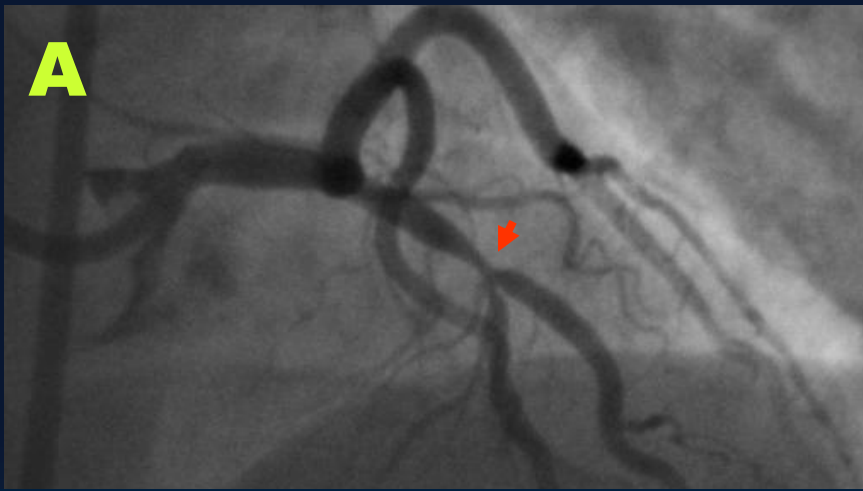
# Negative Remodeling at SB Ostium



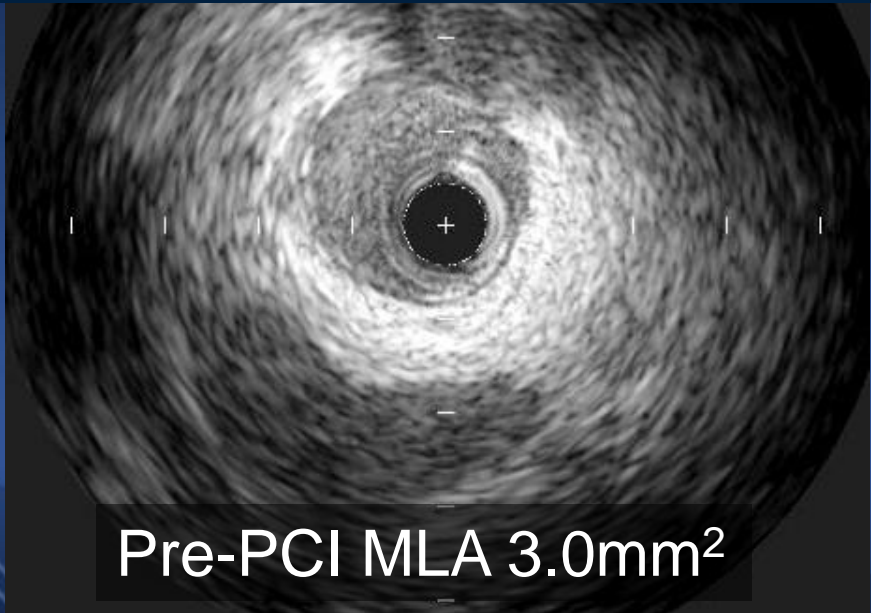
If small MLA is not caused by significant plaque, but by negative remodeling, **80%** show **normal FFR**

*Kang et al. Catheter Cardiovasc Interv 2013 in press*



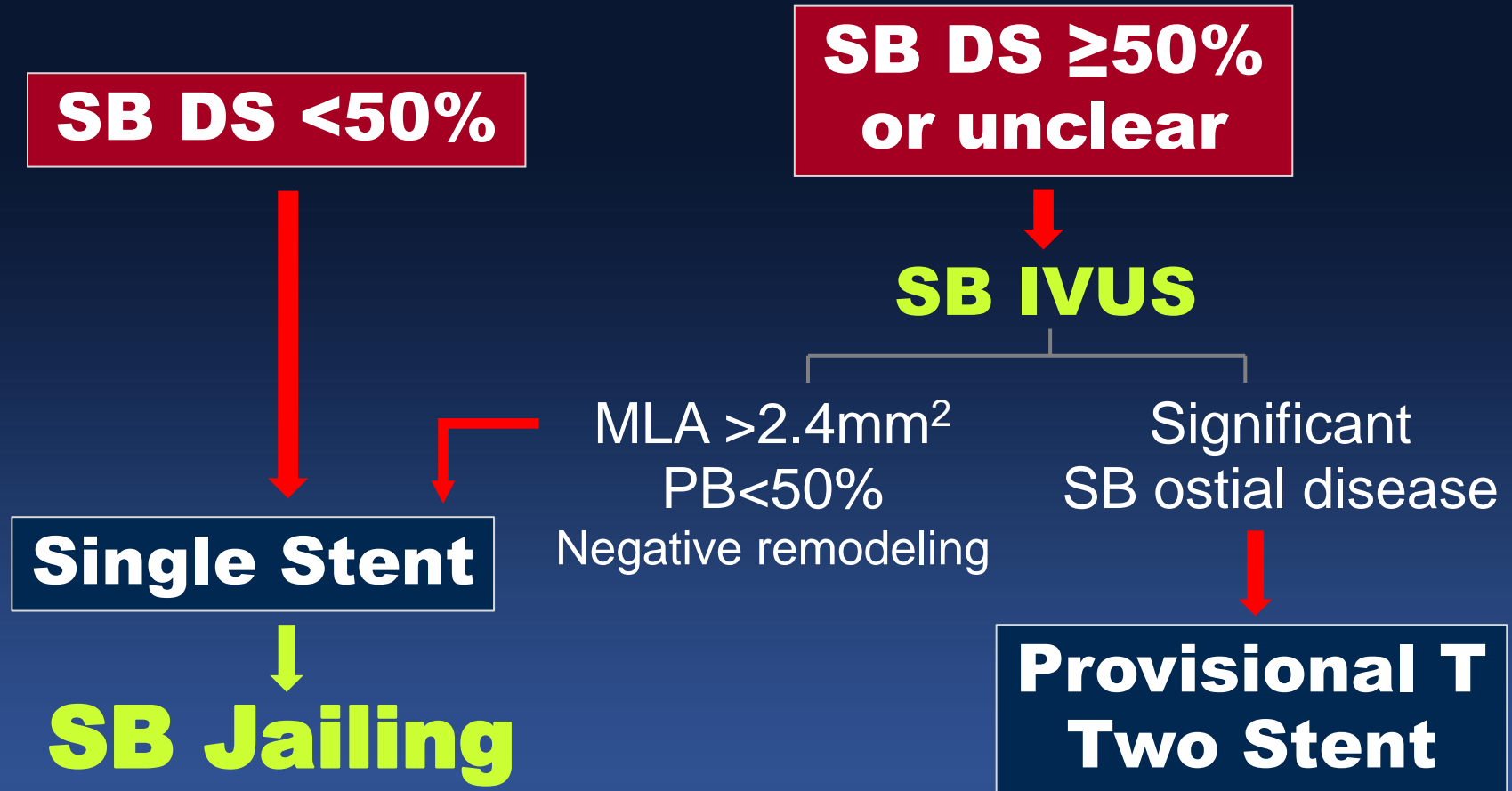


**If SB disease looks significant, we need IVUS to avoid unnecessary two-stent**



# 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



# Angiographic SB Jailing

## After MB Stenting



MB  
Cross-over



Even in the bifurcations with SB ostial DS <50%,  
**48%** had angiographic jailing (DS >50%)

*AMC preliminary*

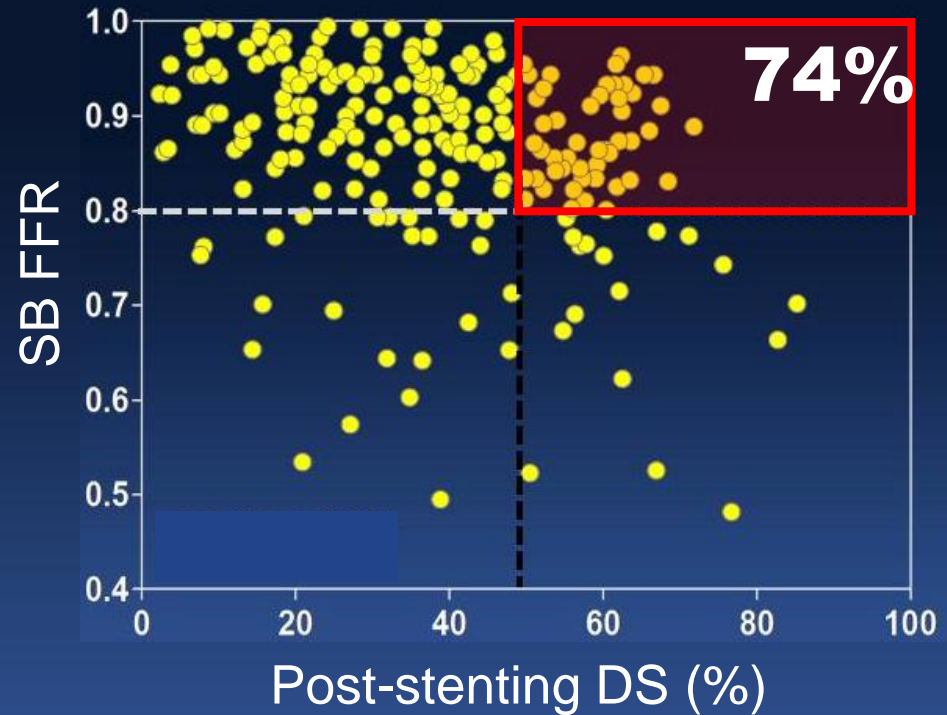
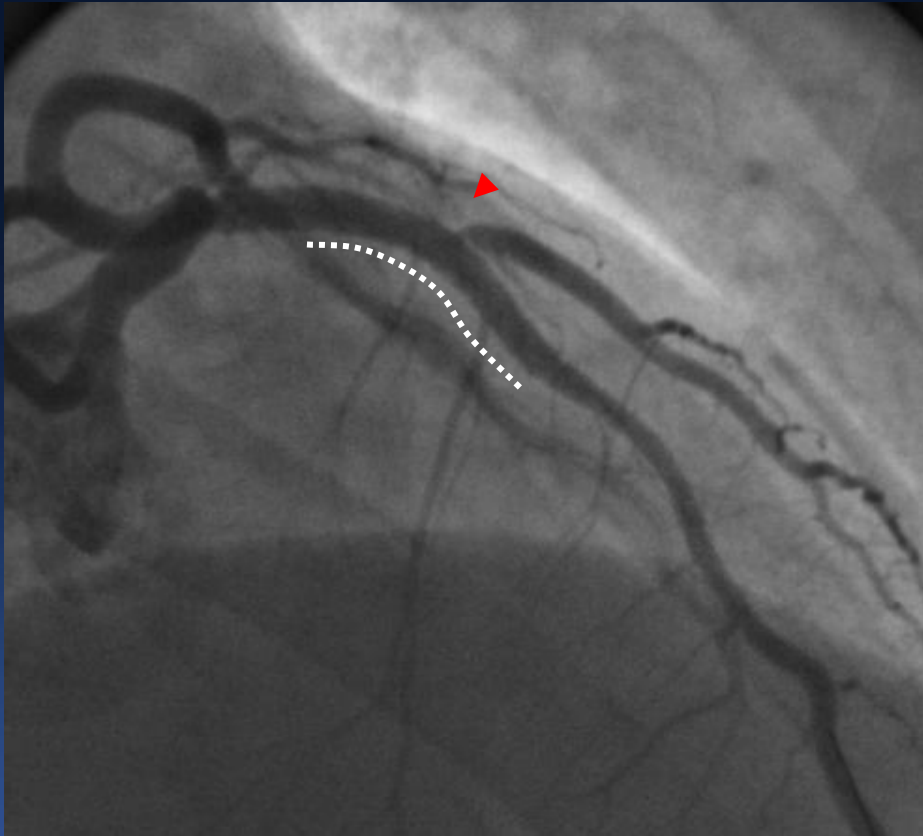
# How to Treat the SB Stenosis?

**FFR >0.75** is safe for deferral of jailed SB

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

*Koo et al. Eur Heart J 2008;29:726–32*

# Discordance Between Post-stenting QCA vs. SB FFR

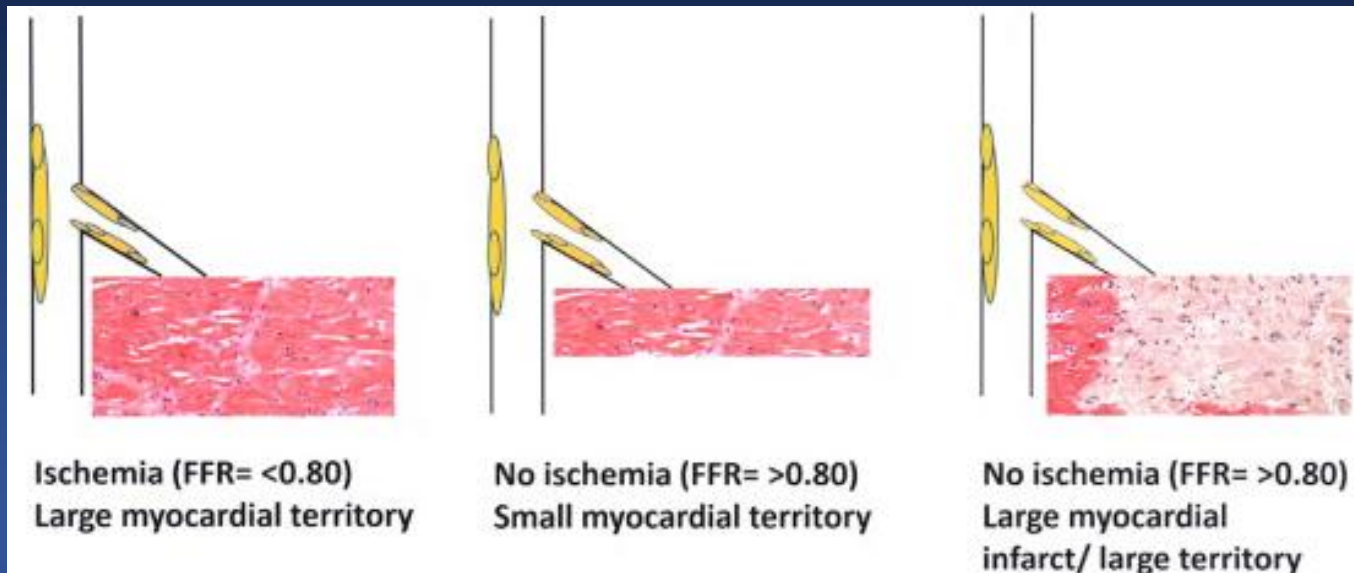


**Post-stenting DS 80%**  
**SB FFR 0.88**

*Ahn et al. JACC Interv in Press*

# Why Mismatch?

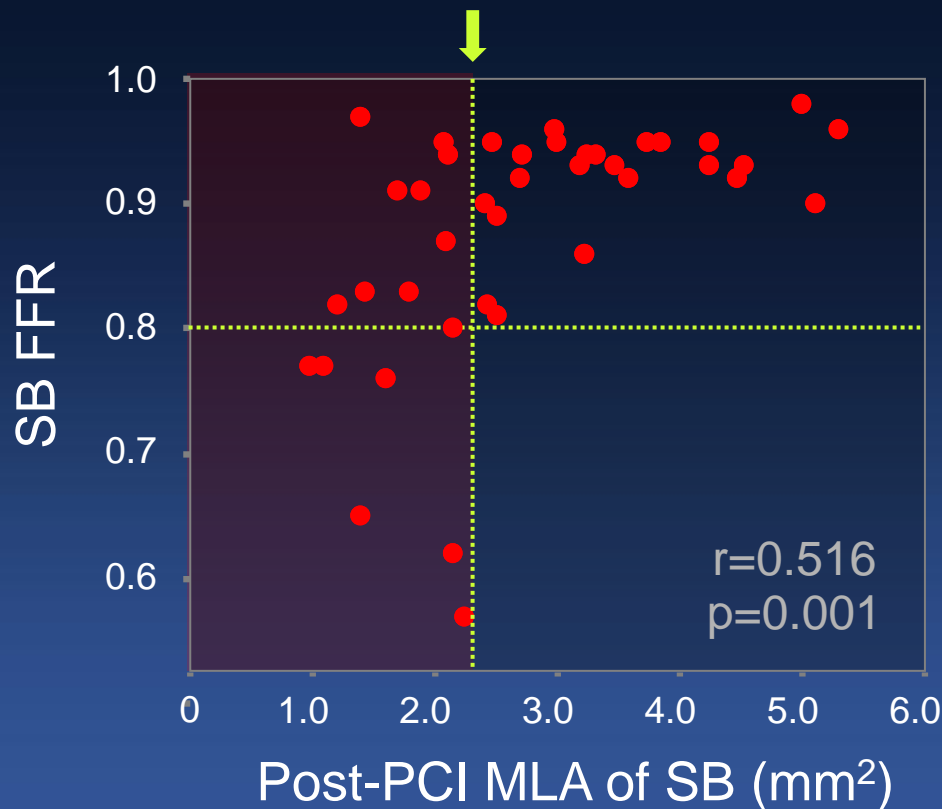
- Lesion eccentricity of SB
- Negative remodeling of ostium
- Various size of myocardium
- Strut artifacts



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

# Discordance Between Post-stenting MLA vs. SB FFR

**SB MLA < 2.25mm<sup>2</sup>**



**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



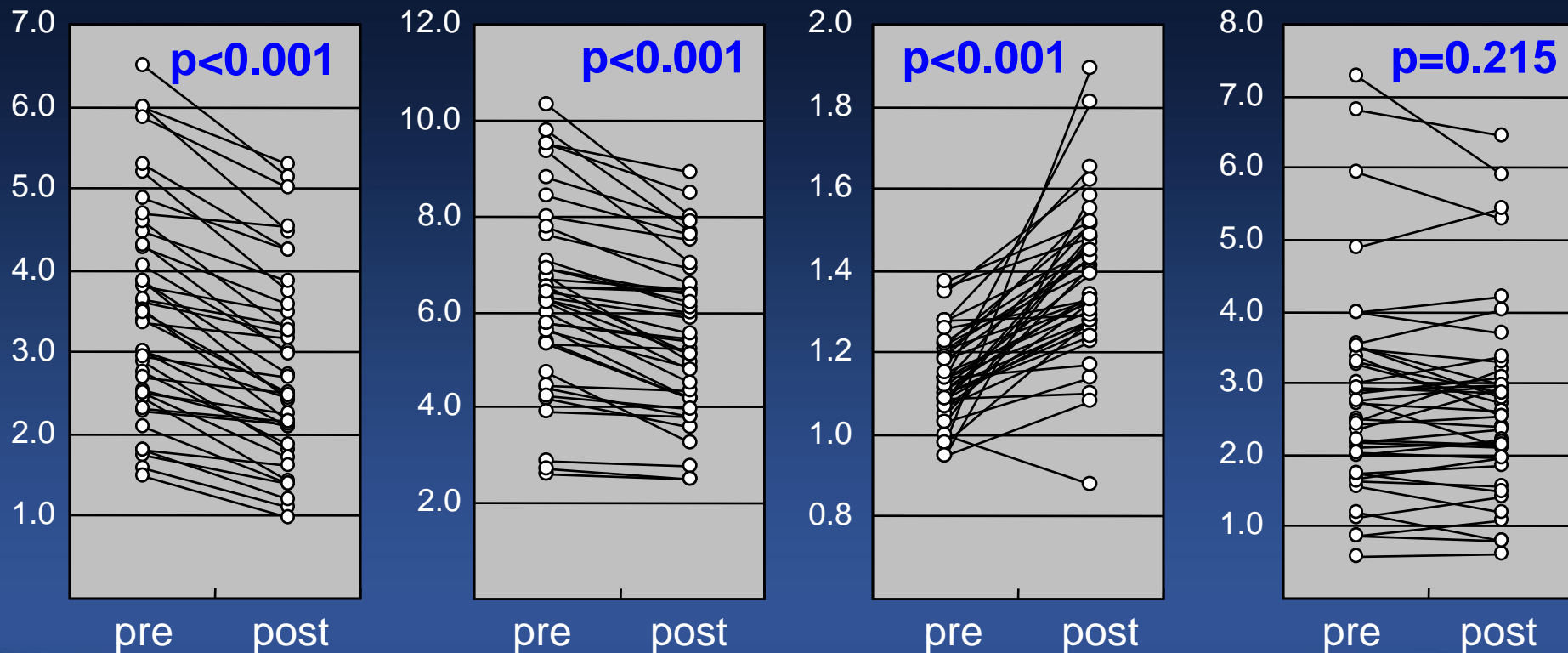
# Post-stenting SB-IVUS is Not Routinely Recommended

- Use of SB-IVUS is limited by technical difficulty and potential risk for strut damage
- Even small MLA rarely correlates with FFR. So, FFR is needed to decide SB treatment
- To understand the mechanism of SB jailing, IVUS is still useful

# Hemodynamic Impact of Changes in Geometry of Non-LM Bifurcation

*Non-LM bifurcation lesions with SB ostial DS<50%*

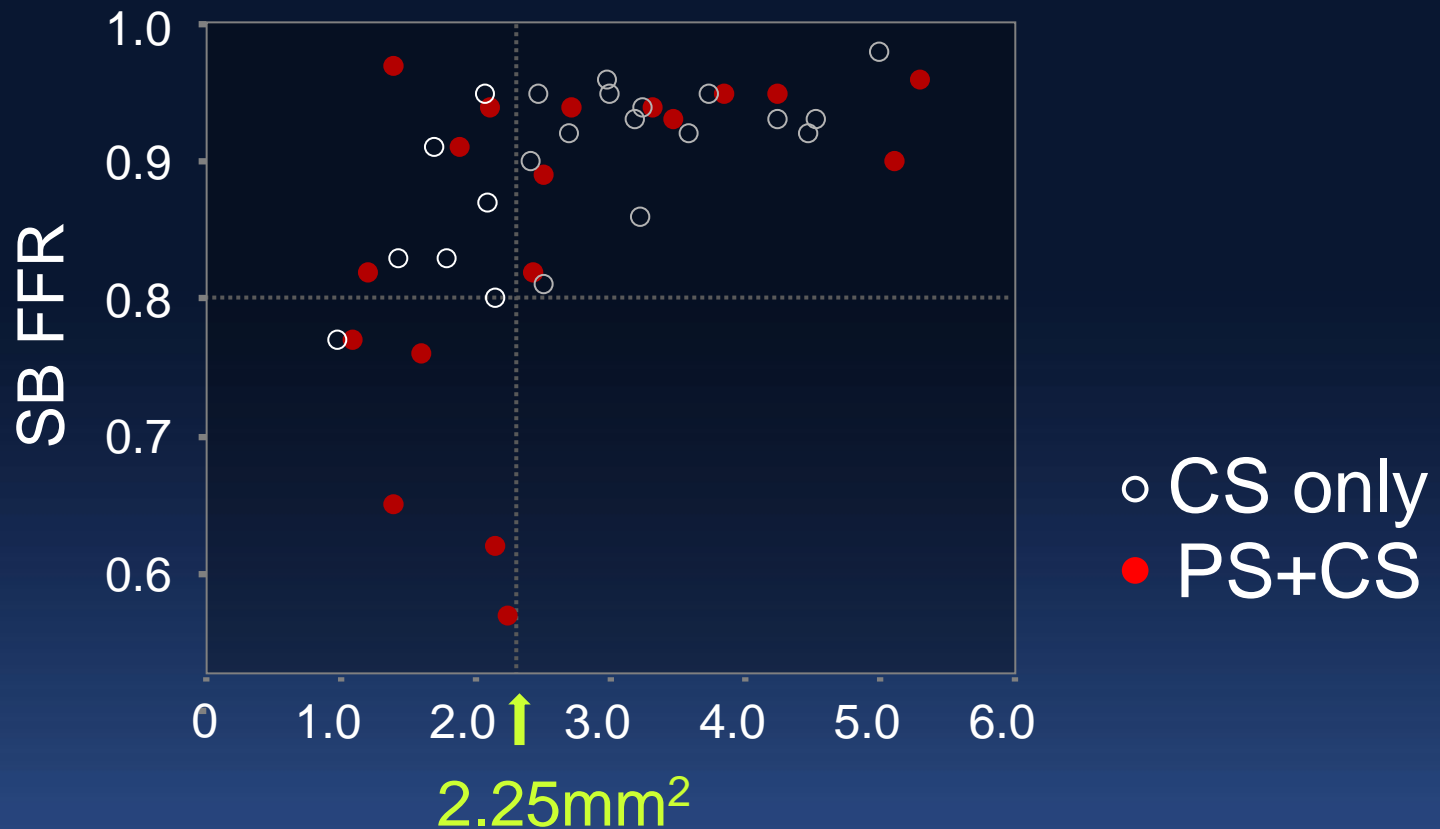
**SB MLA (mm<sup>2</sup>)** **EEM (mm<sup>2</sup>)** **Eccentricity** **P+M (mm<sup>2</sup>)**  
 $3.5 \pm 1.3 \rightarrow 2.8 \pm 1.2$   $6.3 \pm 1.9 \rightarrow 5.5 \pm 1.7$   $1.1 \pm 1.1 \rightarrow 1.4 \pm 0.2$   $2.8 \pm 1.5 \rightarrow 2.7 \pm 1.3$



*Kang et al. Catheter Cardiovasc Interv 2013 in press*



# Hemodynamic Impact of Mechanisms



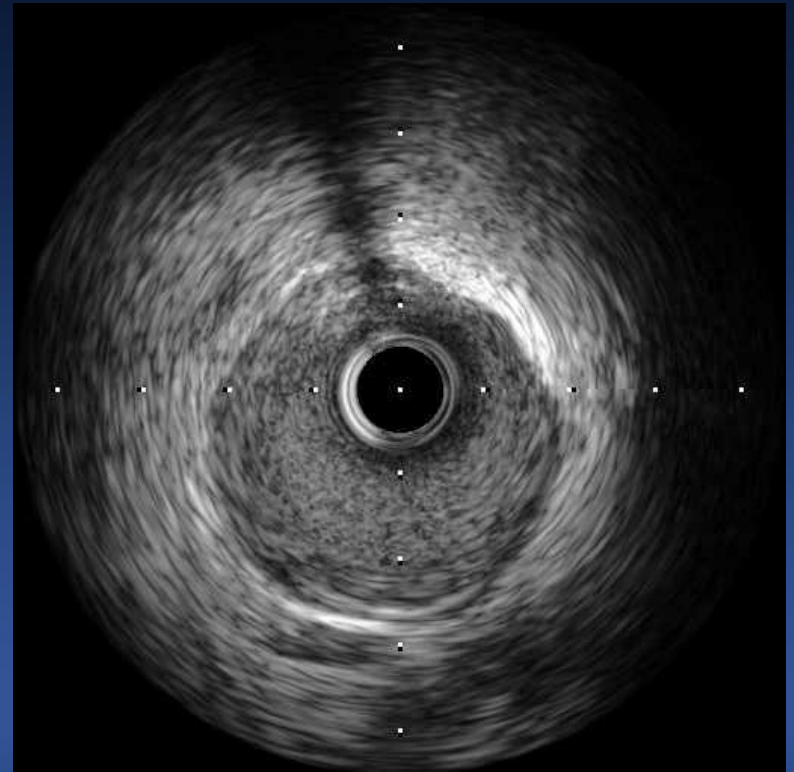
Post-PCI MLA of SB (mm²)

**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

## How to treat Jailed SB?

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

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