

The image features a background ECG tracing with a red line and a green line. The y-axis is labeled from 19 to 135 in increments of 10. The x-axis is labeled with numbers from 16 to 30. A vertical yellow line is positioned at x=21. The text is overlaid on the ECG.

**Technical approach in (true)  
bifurcation lesions:**

**“What have we learned from FFR?”**

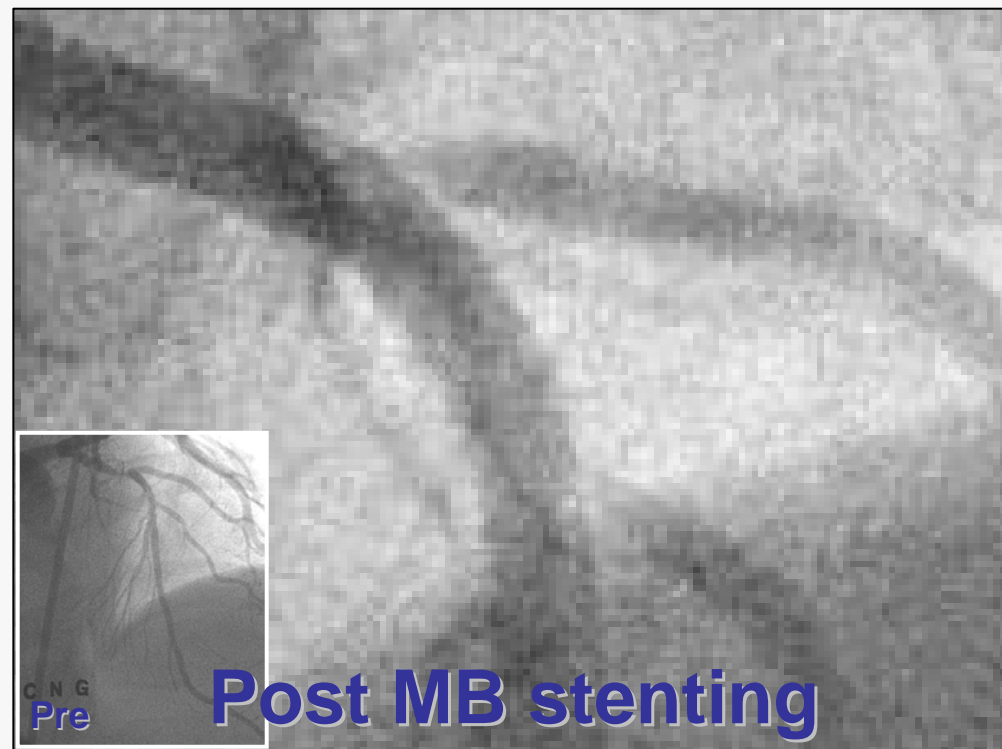
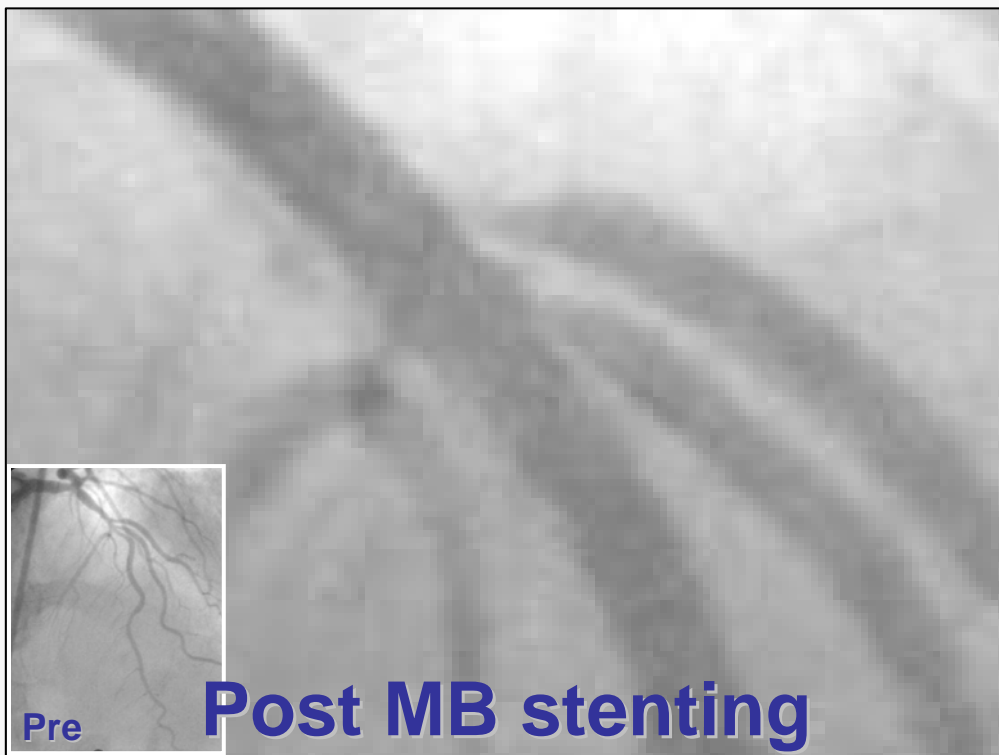
**Bon-Kwon Koo, MD, PhD**

Seoul National University Hospital, Korea

Stanford University Medical Center, USA

# Please remind....

- I have **NO** intention to say that FFR should be used in all bifurcation intervention.
- All FFR data of this presentation came from relatively short side branch os lesions.
- Side branch IVUS images from main branch catheter pull-back are not true SB ostial images.



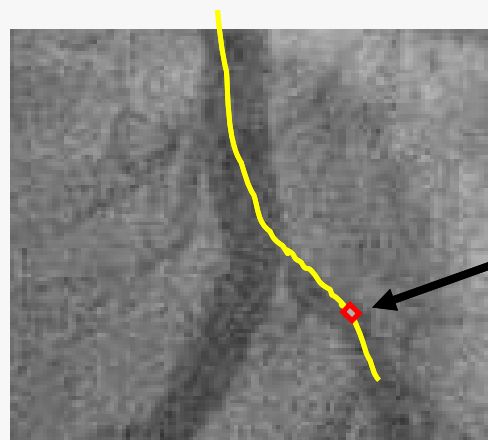
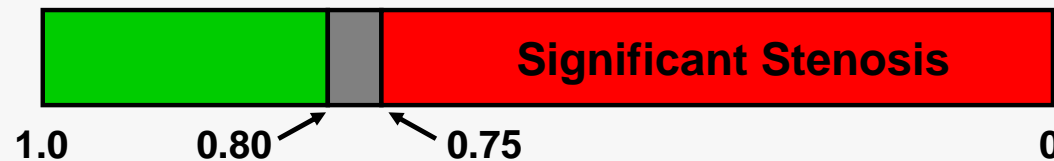
# What have we learned from “FFR”?

- **What is FFR?**
- “What you see” is NOT “what it is”.
- Why?
- Functional outcome of jailed SB lesions

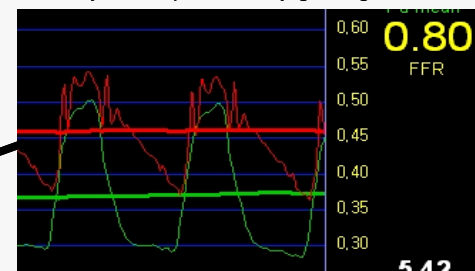
# Fractional Flow Reserve

$$\text{FFR} = \frac{Q_{max}^S}{Q_{max}^N} = \frac{(P_d - P_v)/R}{(P_a - P_v)/R} = \frac{P_d}{P_a}$$

- Easily obtained, Stenosis specific, Simple (<0.75 → ischemia)
- Reflects both degree of stenosis and myocardial territory

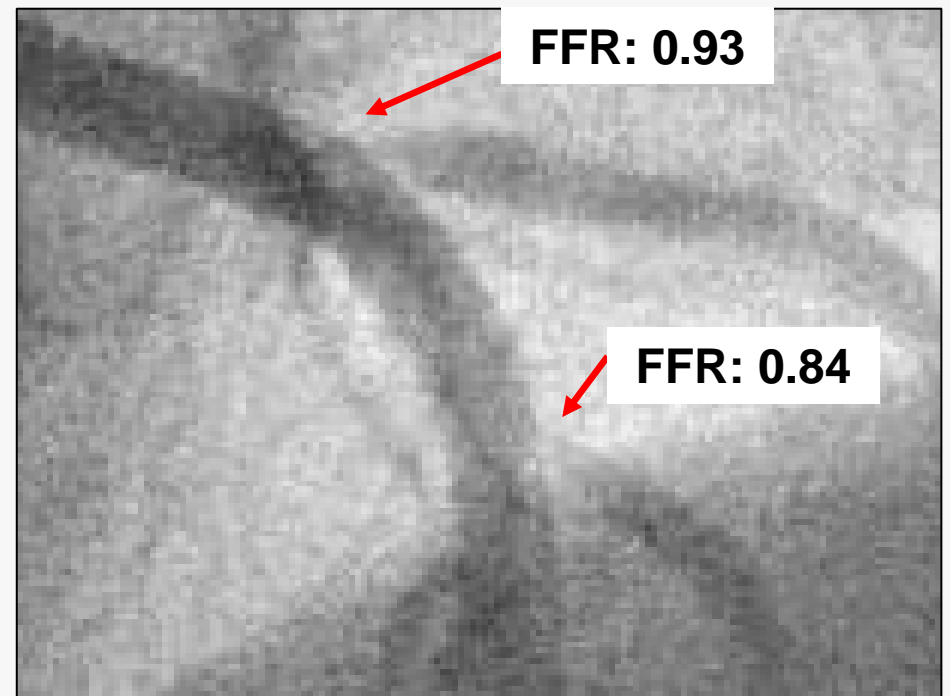
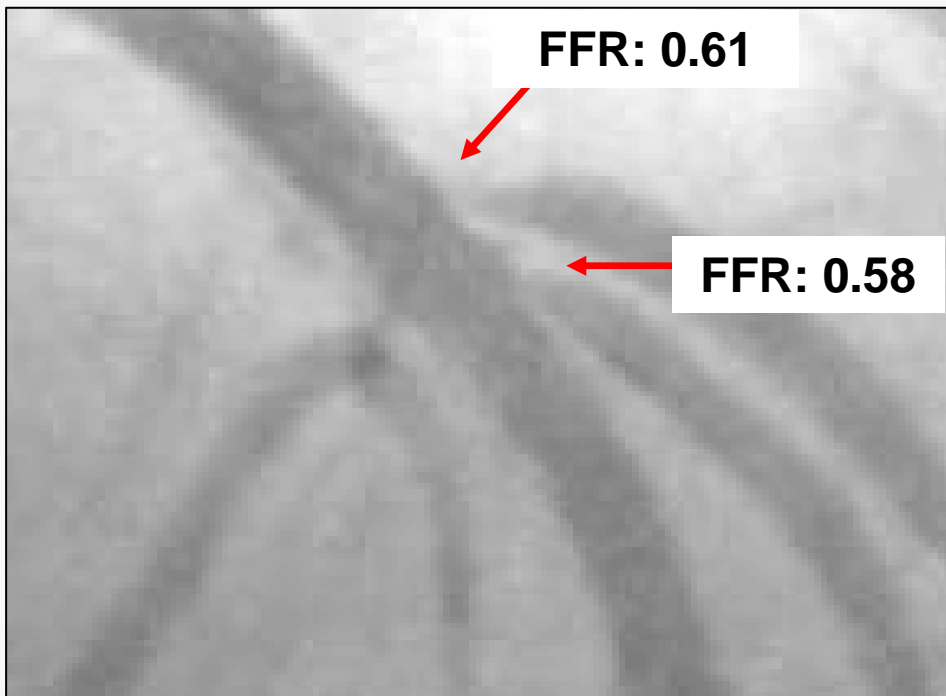


Pa: systemic pressure by guiding catheter



Pd: distal pressure by pressure wire

# “Are these stenoses significant?”



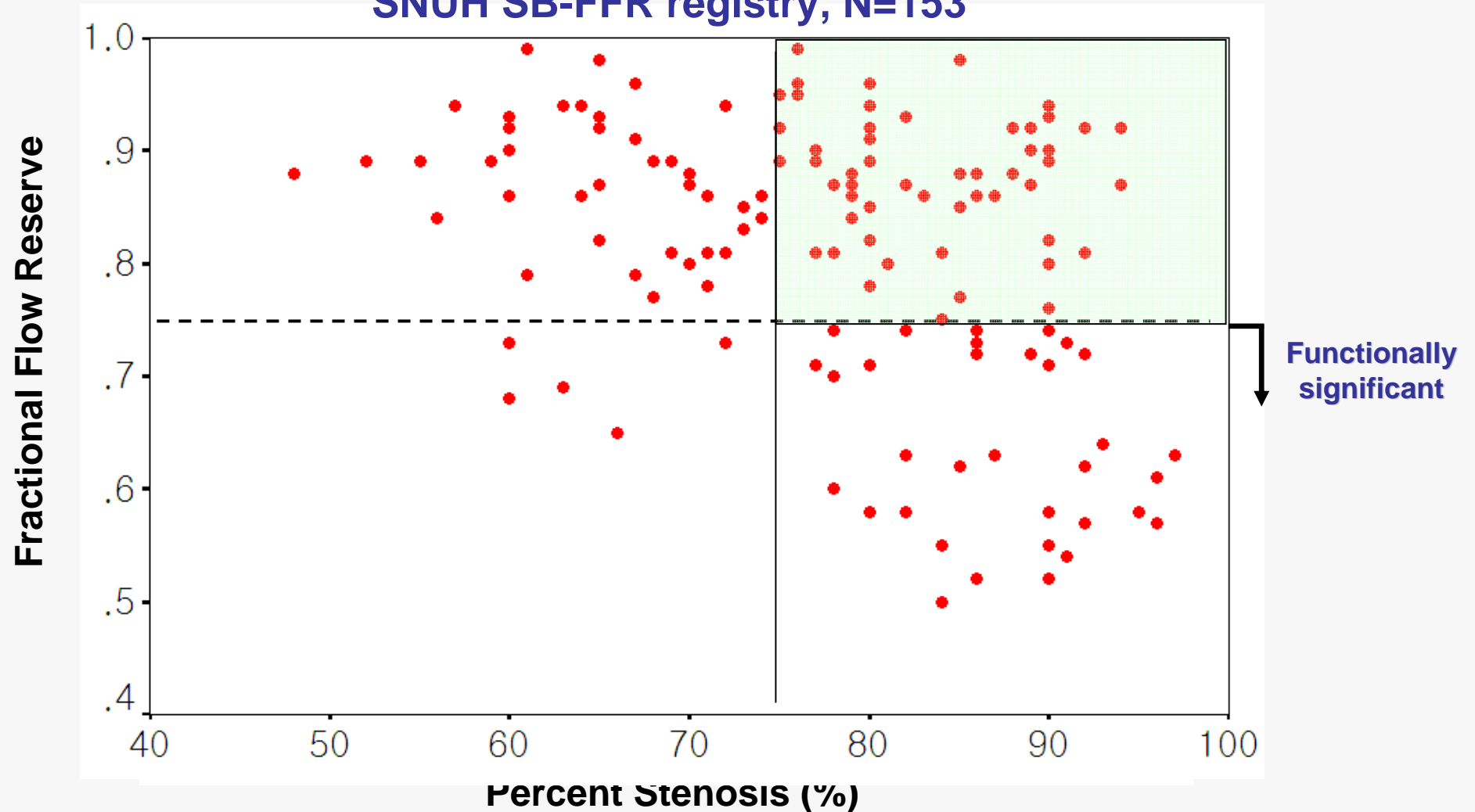
**FFR < 0.75 → functionally significant**

# What have we learned from “FFR”?

- What is FFR?
- **“What you see” is NOT “What it is”.**
- Why?
- Functional outcome of jailed SB lesions

# Angiographic severity vs. Functional significance

SNUH SB-FFR registry, N=153

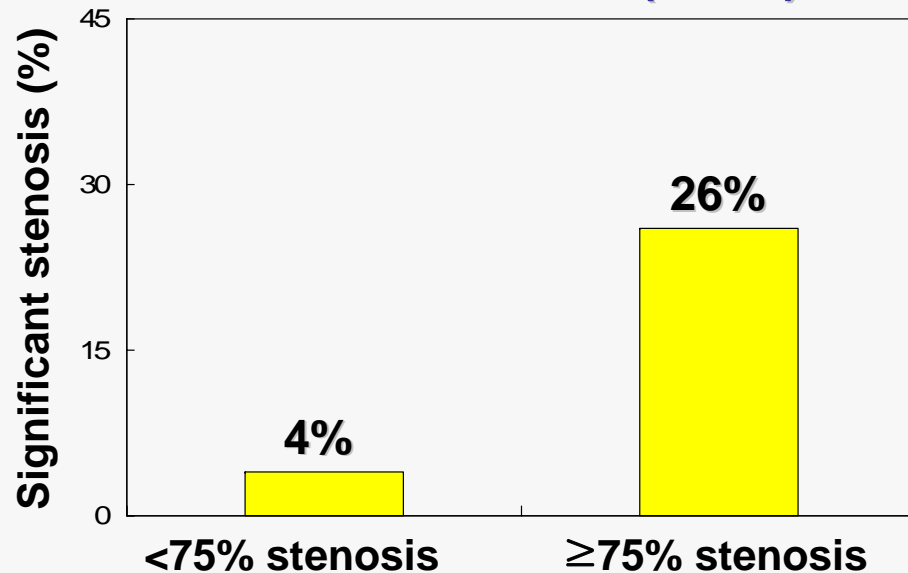




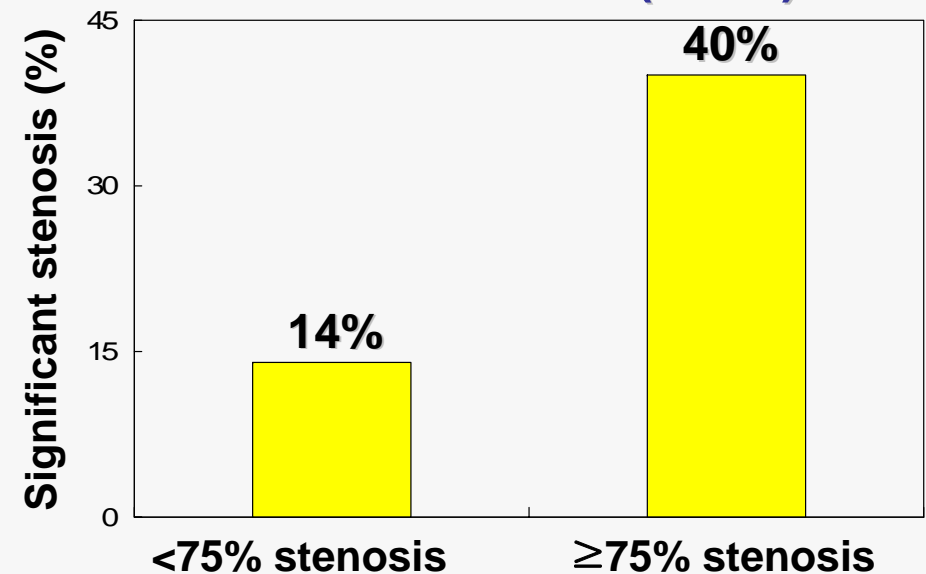
## Angiographic severity vs. Functional significance

N=153	Percent stenosis	
	50% ~ 75%	≥75%
FFR <0.75	5 (10%)	35 (34%)
FFR ≥0.75	46	67

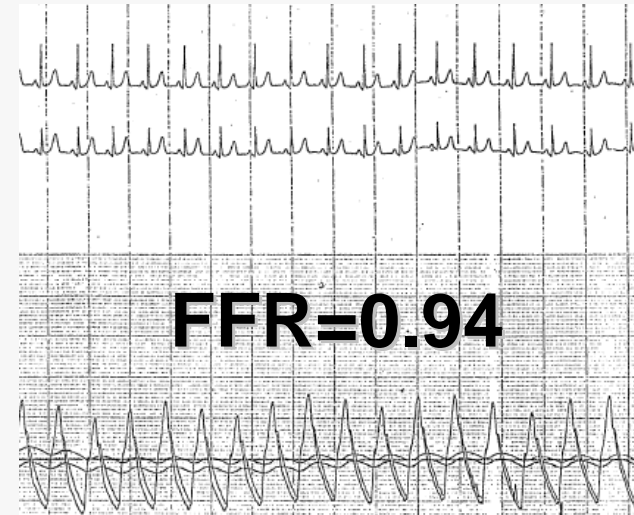
False Bifurcation (N=62)



True Bifurcation (N=91)



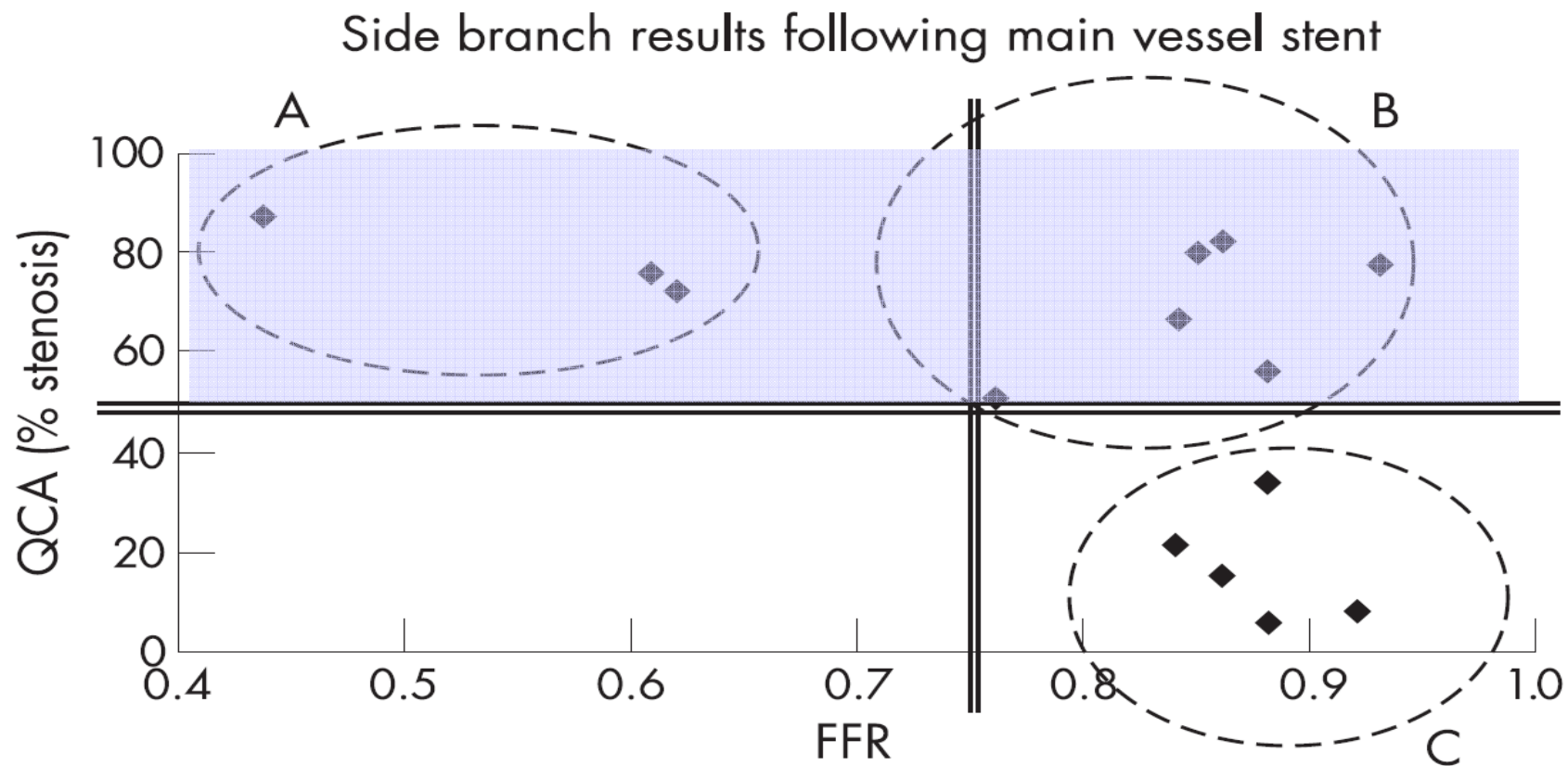
## Angiographic severity vs. Functional significance



FFR	$\geq 70\%$ Angiographic Stenosis	50%–70% Angiographic Stenosis
$\geq 0.75$	20	30
$< 0.75$	5	0

Sensitivity 100%, specificity 55%, and test accuracy 60%.

## Angiographic severity vs. Functional significance

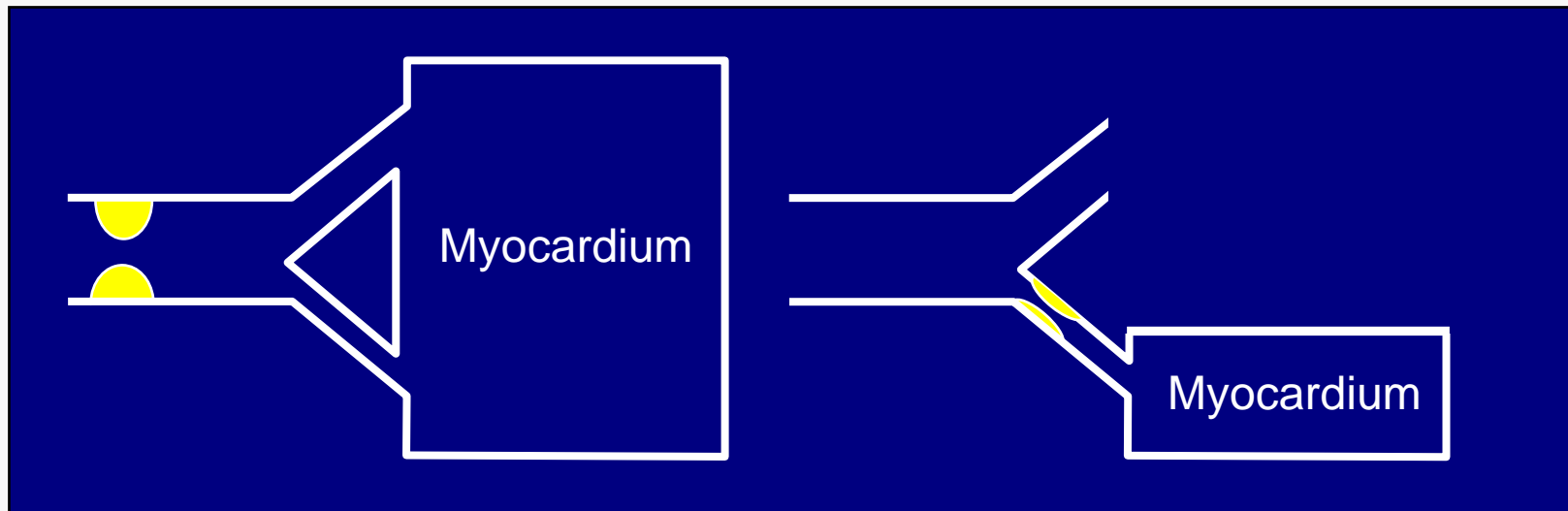


# What have we learned from “FFR”?

- What is FFR?
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- **Why?**
- Functional outcome of jailed SB lesions

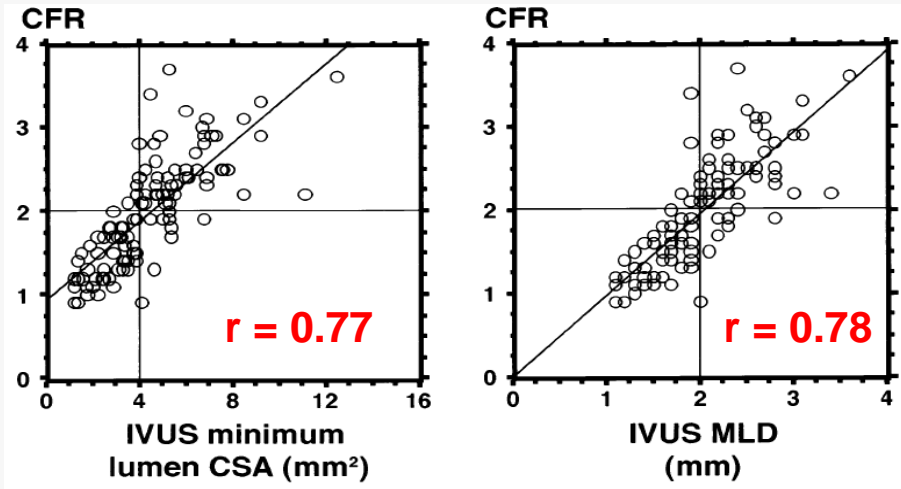
# Why the discrepancy?

- **Side branch is usually small vessel**
  - Myocardium supplied by SB is also small.



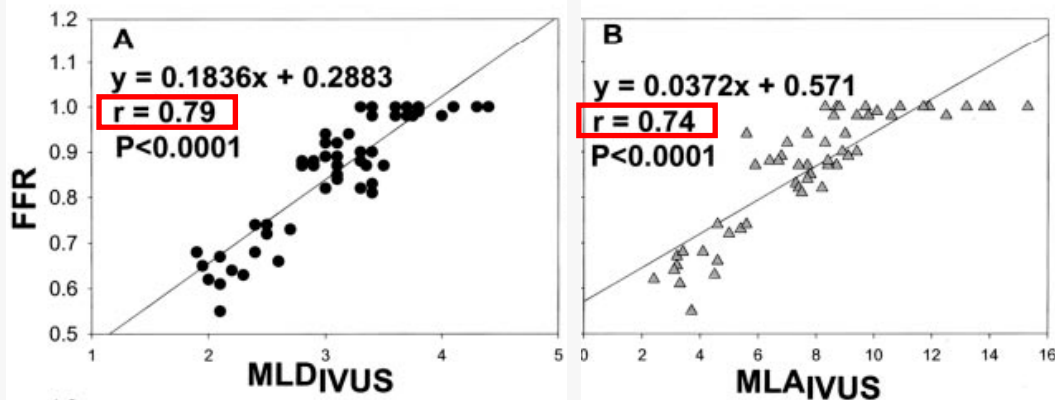
# IVUS vs CFR/FFR

## Vessel diameter: 2.9mm



Abizaid, et al. AJC 1998

## Vessel diameter: 4.2 ± 2.0mm



Jasti, et al. Circulation 2004

## Vessel diameter: 2.1 ± 0.4mm

### Pearson's correlation coefficients

MLA vs. FFR  $r = -0.04$

Max %Obst vs. FFR  $r = -0.06$

Lumen Volume vs. FFR  $r = 0.01$

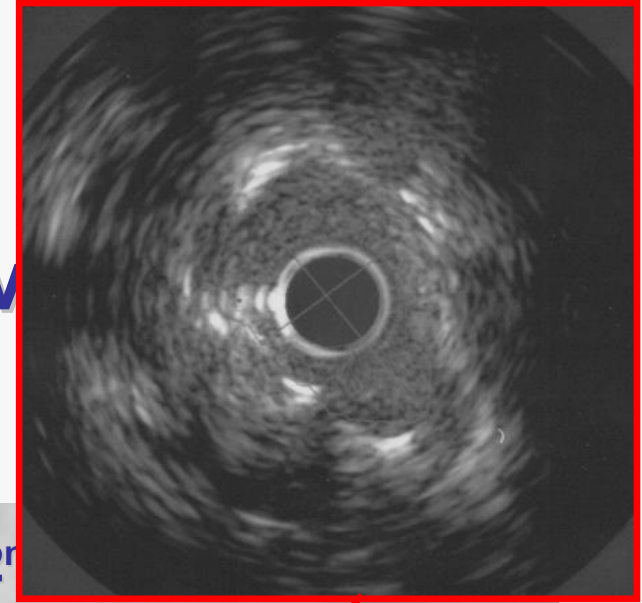
MLD vs. FFR  $r = 0.27$

%DS vs. FFR  $r = 0.01$

*All p values: not significant*

Costa, et al. AHJ 2007

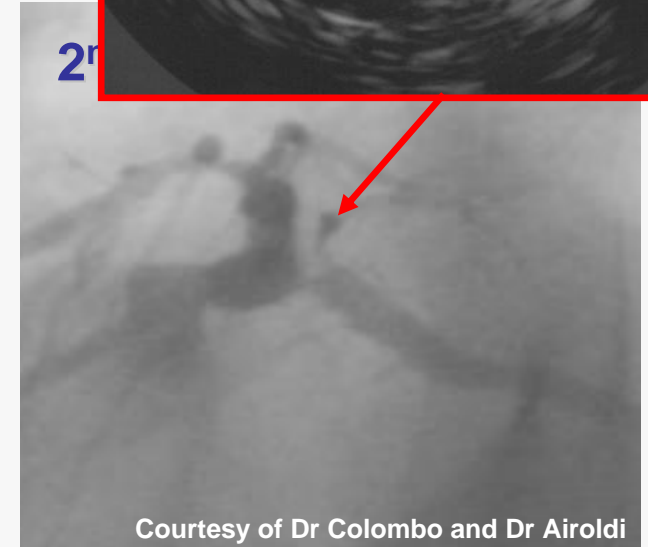
# Why the discrepancy in large v



FFR=0.67



FFR=0.93



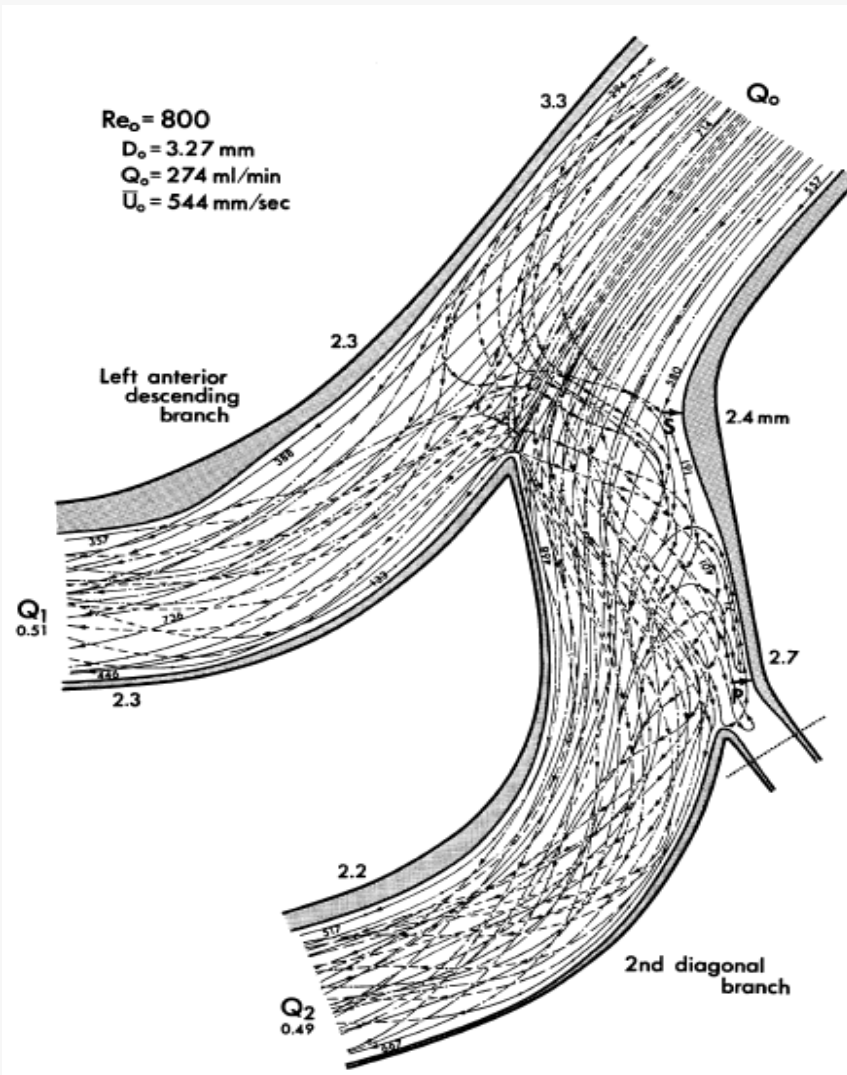
FFR=0.92

# Why the discrepancy?

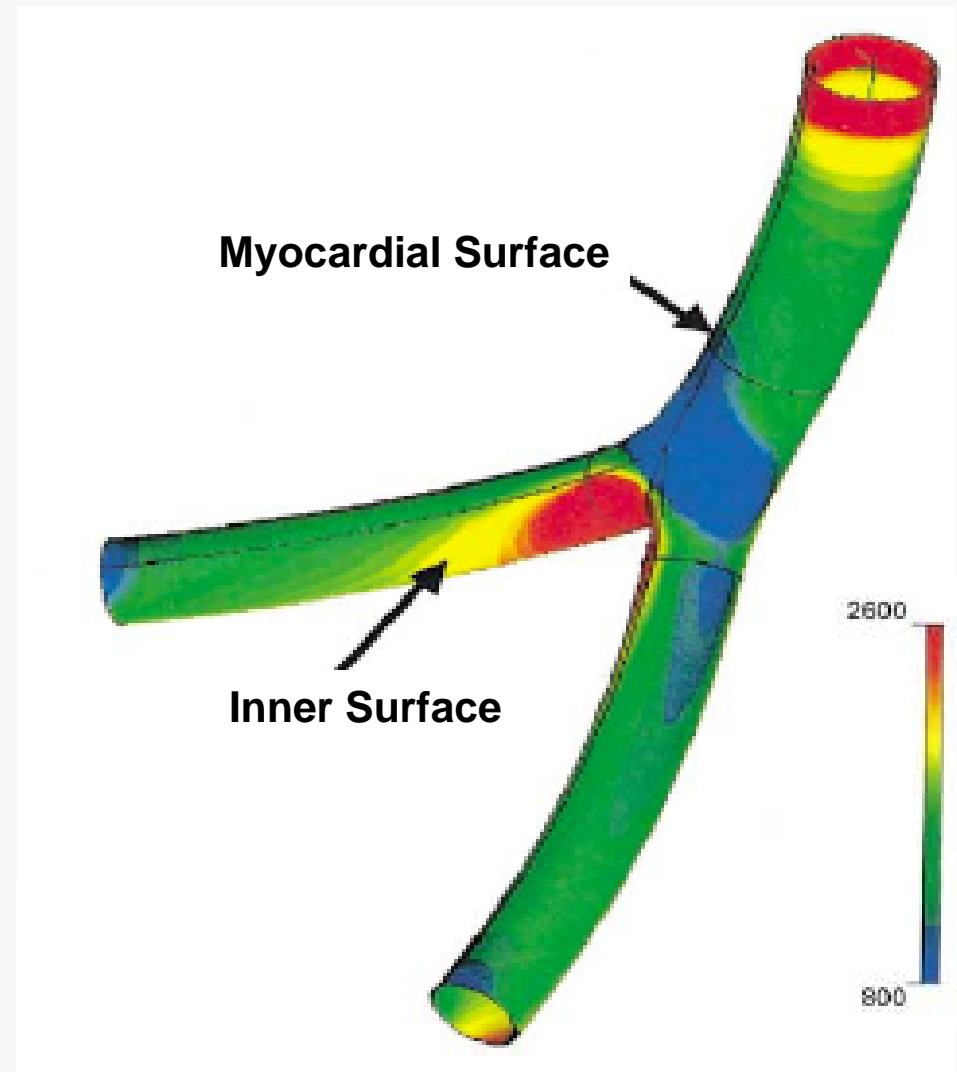
- Side branch is small vessel
  - Supplies smaller myocardial territory
- **SB ostial lesions are almost always eccentric**



# Bifurcation, Flow and Shear

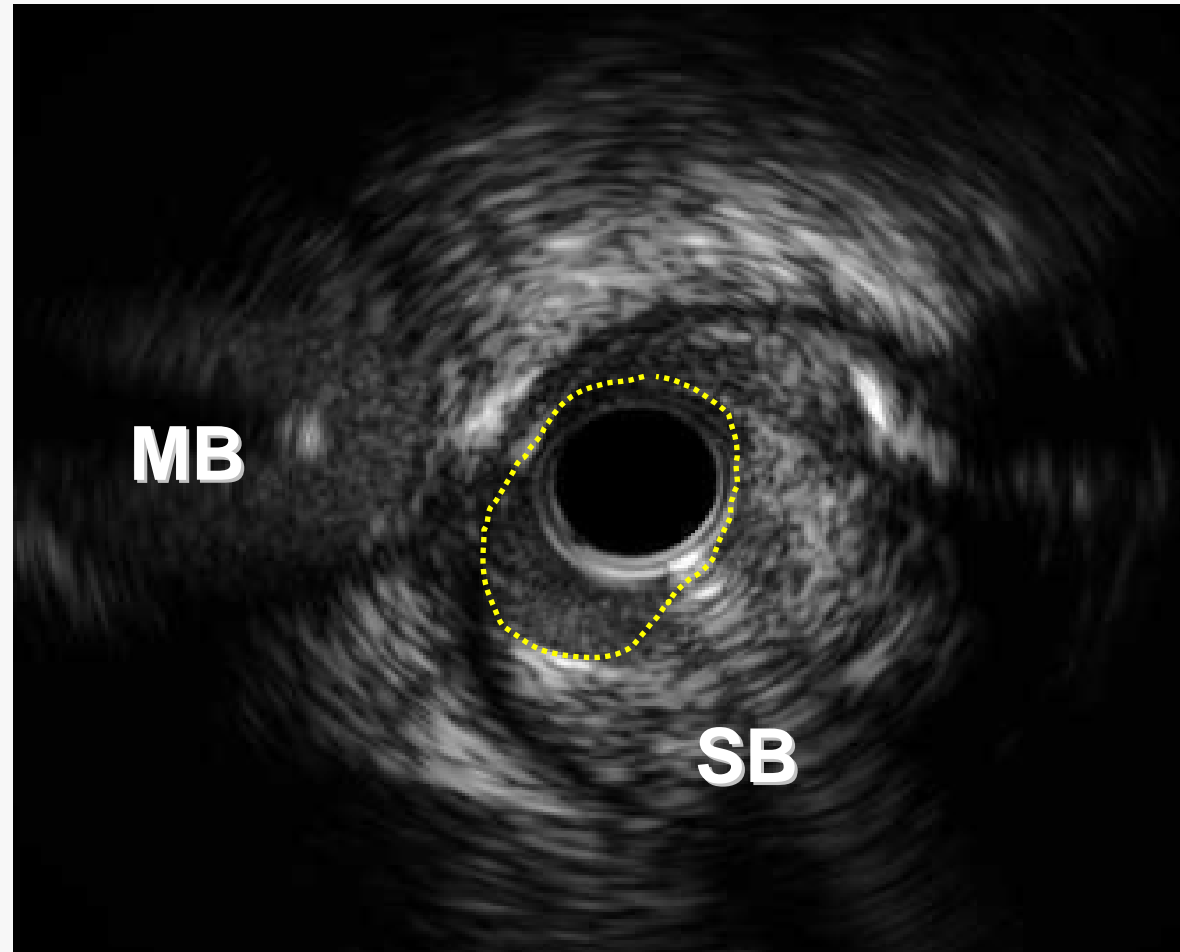


Asakura & Karino Circulation Res 1990



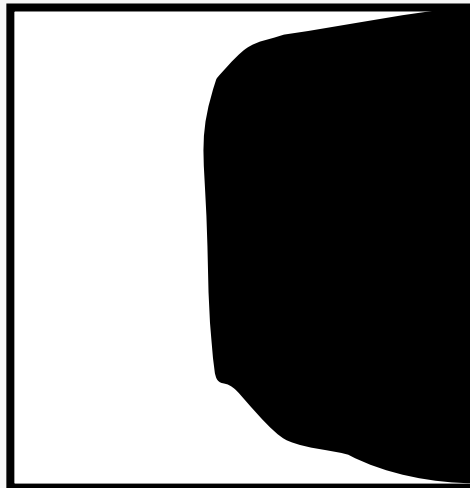
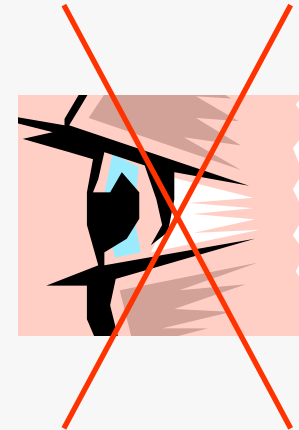
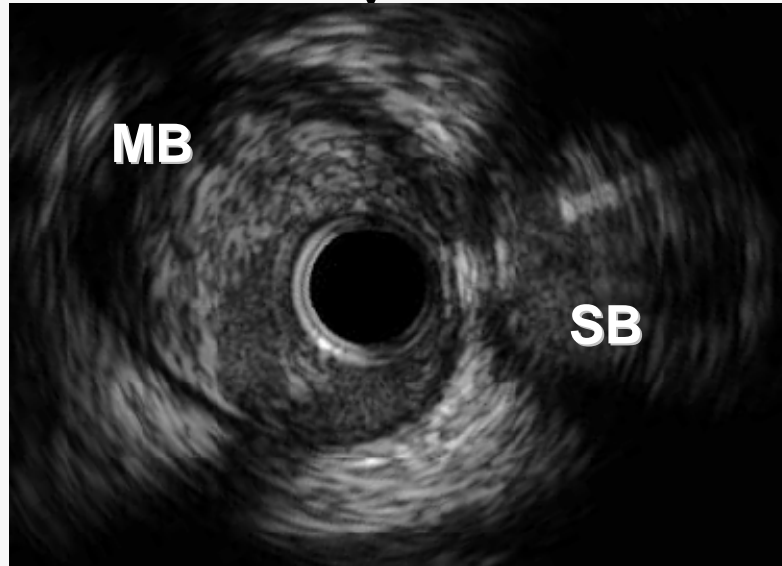
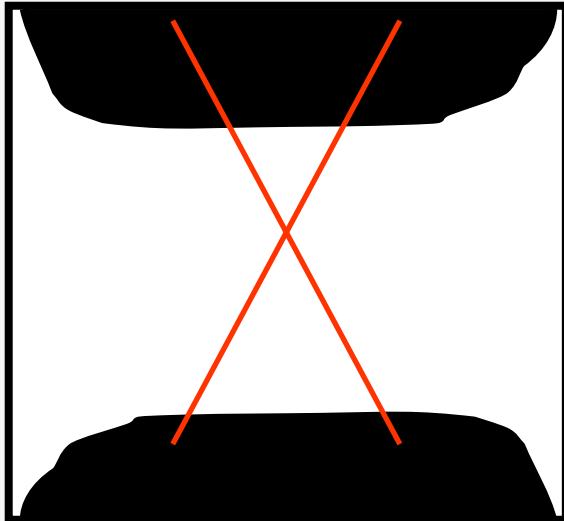
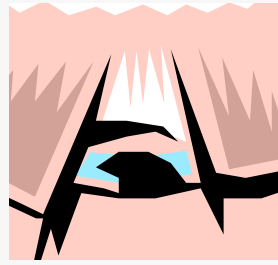
Weydahl & Moore J Biomech 2001

# Side branch ostial lesion



**Eccentric plaque with disease free wall at carina**

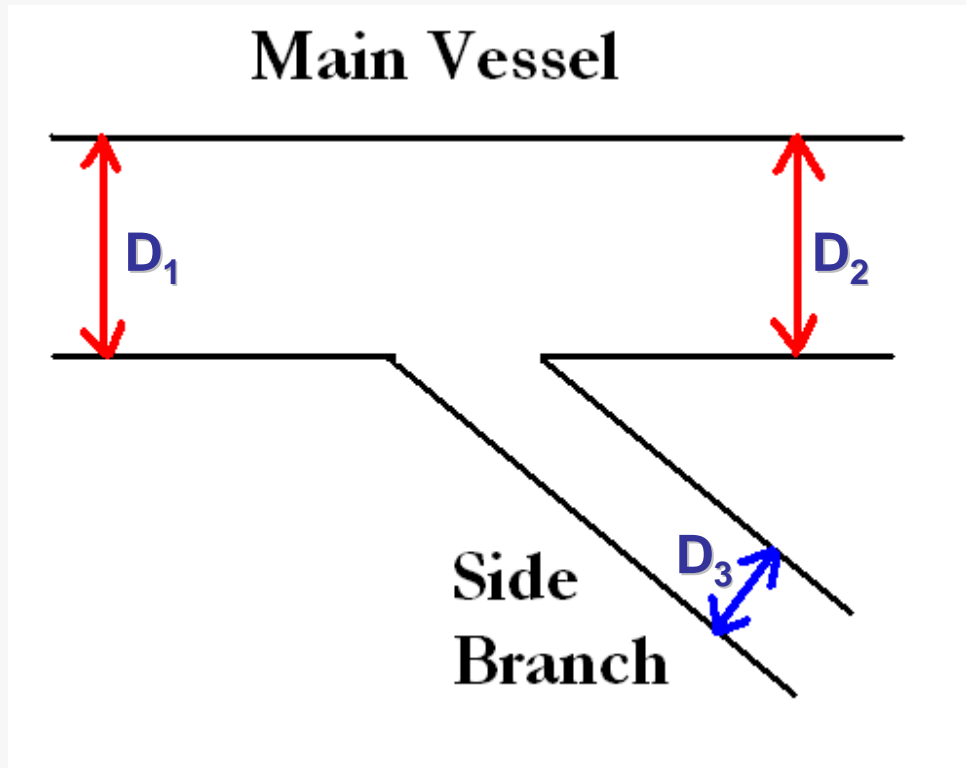
Why discrepancy????



# Why the discrepancy?

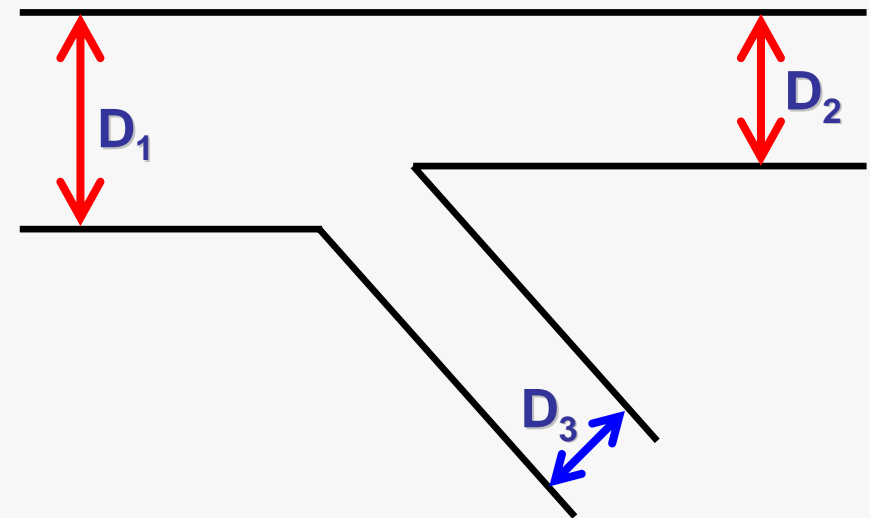
- Side branch is small vessel
  - Supplies smaller myocardial territory
- SB ostial lesions are almost always eccentric
- **Side branch jail occurs due to both plaque and carina shift**

# Bifurcation Model

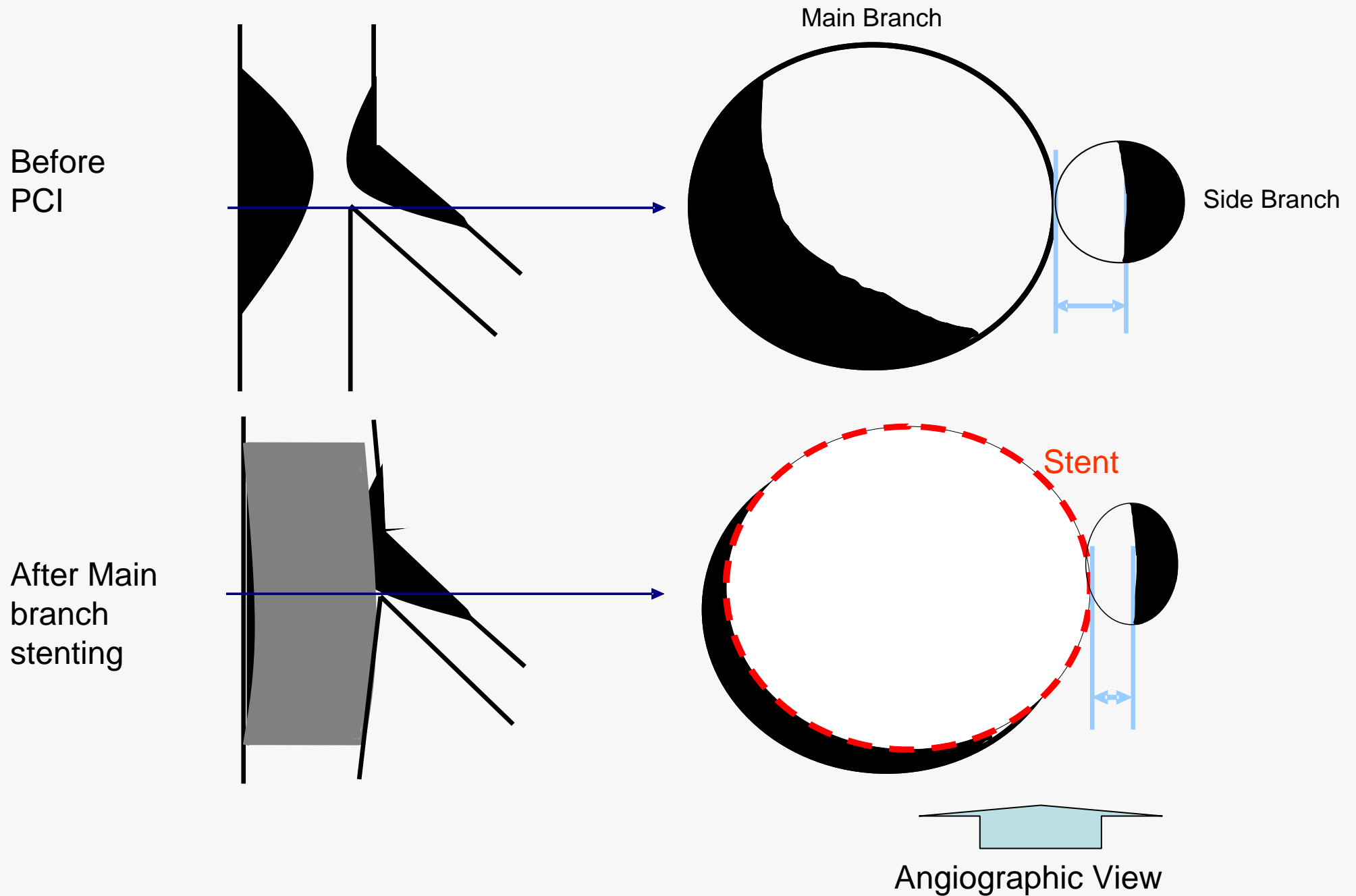


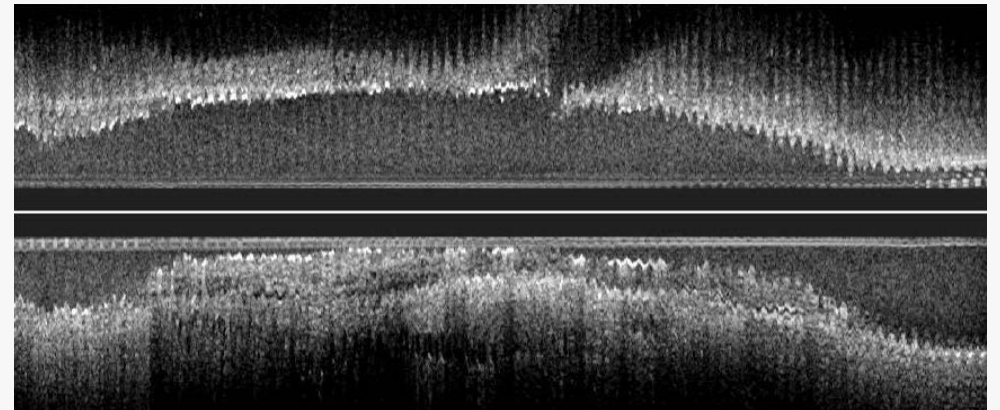
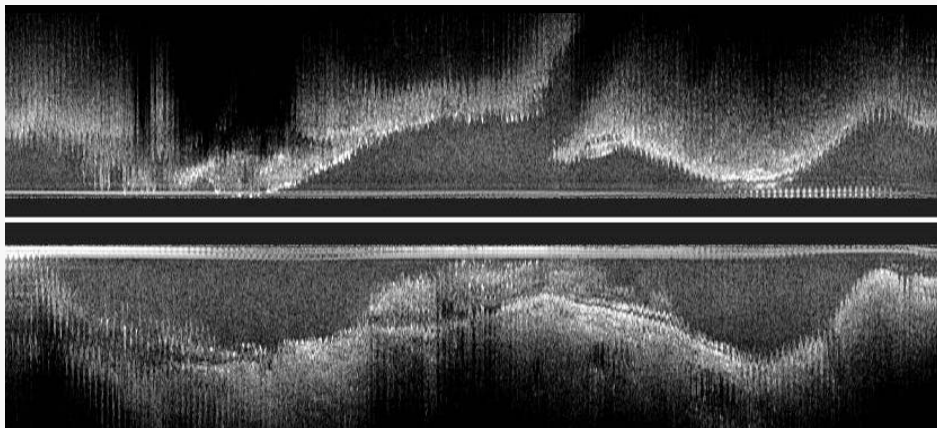
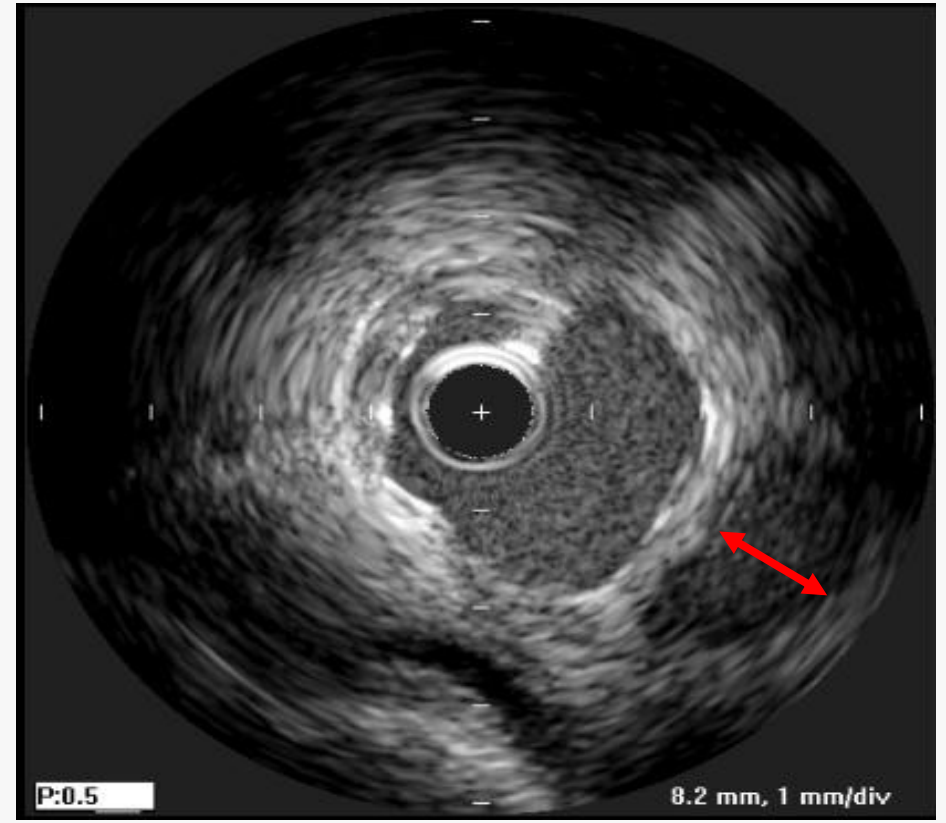
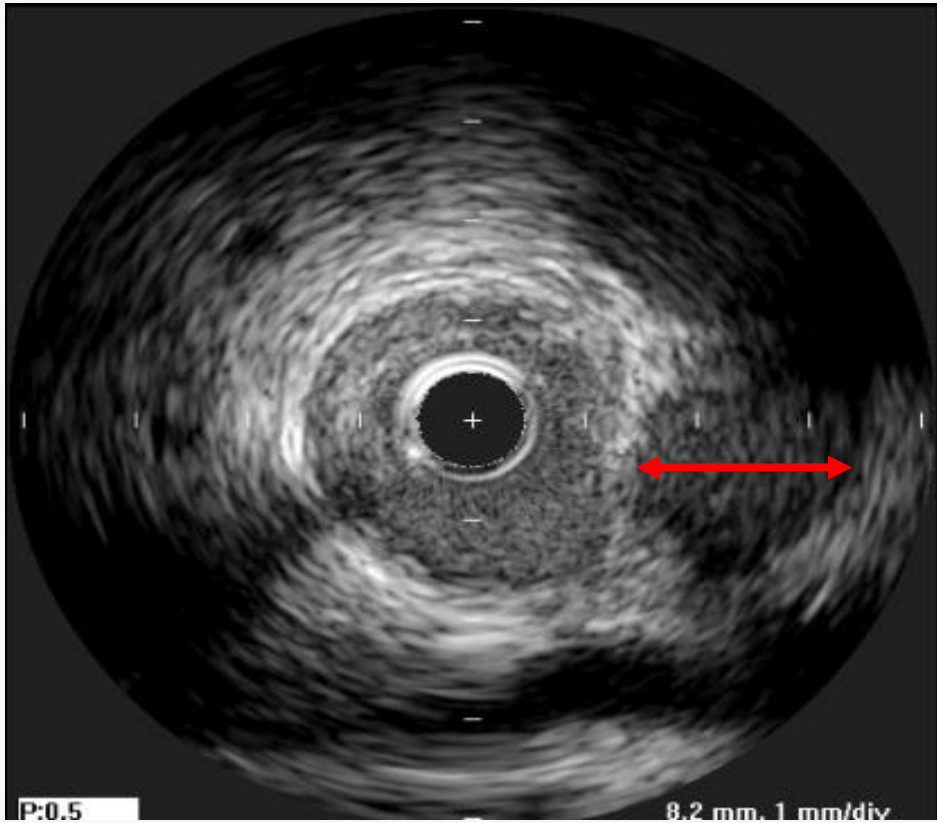
## Finet's law

$$D_1 = 0.678(D_2 + D_3)$$



# Why discrepancy????

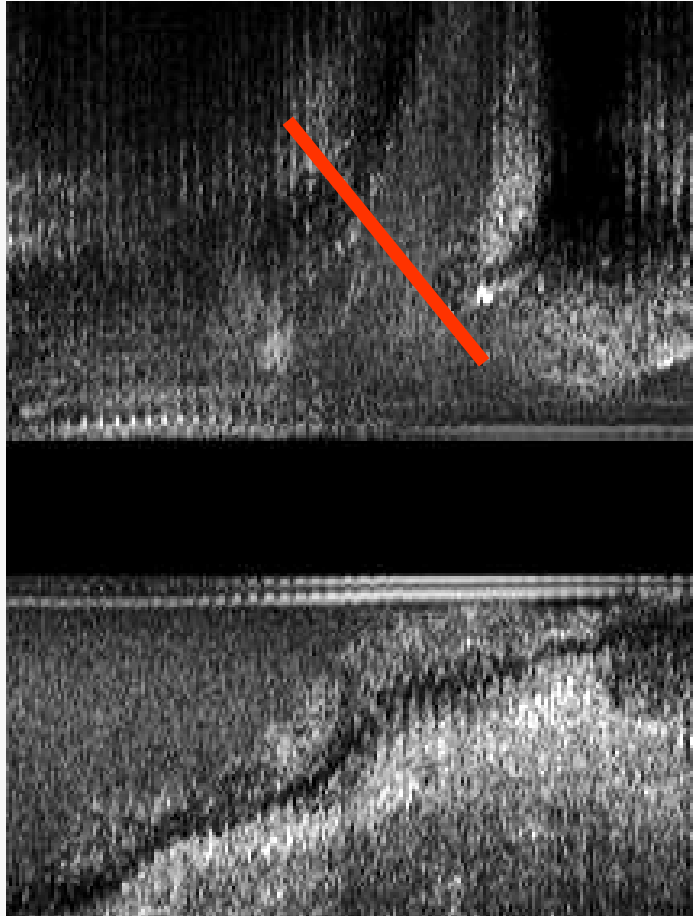




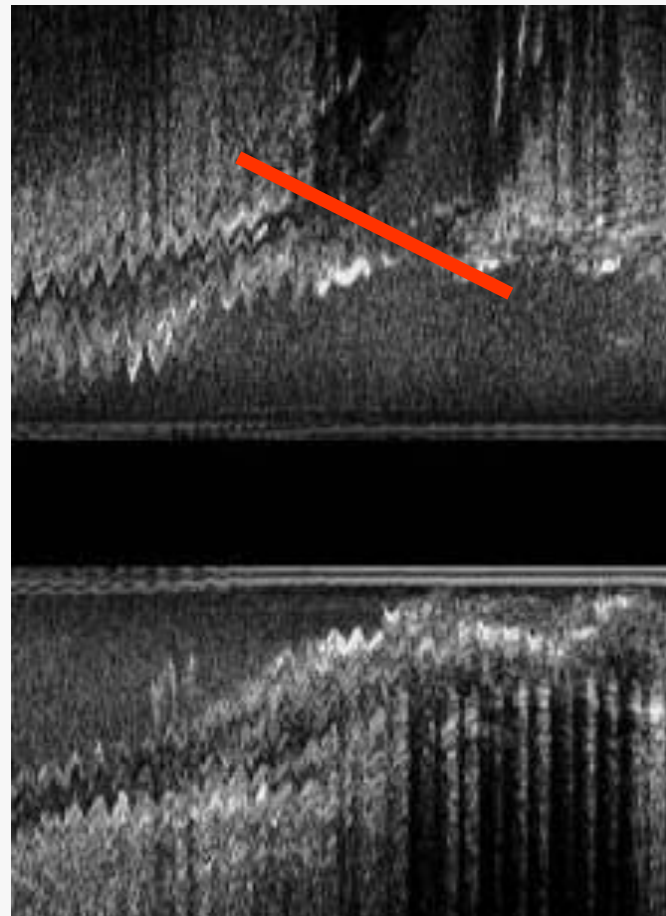
**Lumen Area loss  $\ll$  Angiographic diameter loss**



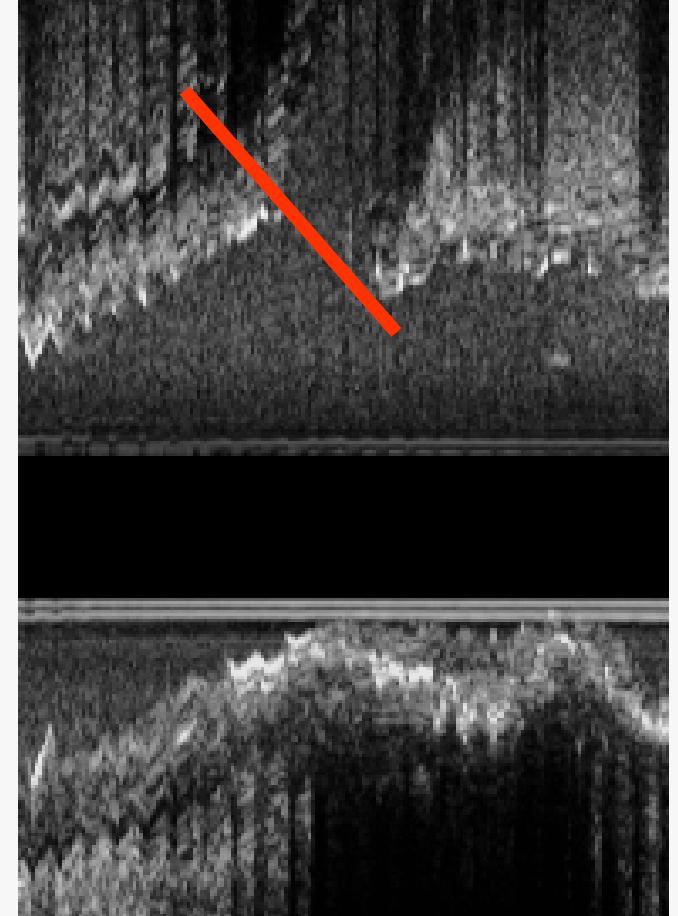
# “Gentle kiss” to relocate the carina



**Pre-intervention**



**MB stenting**

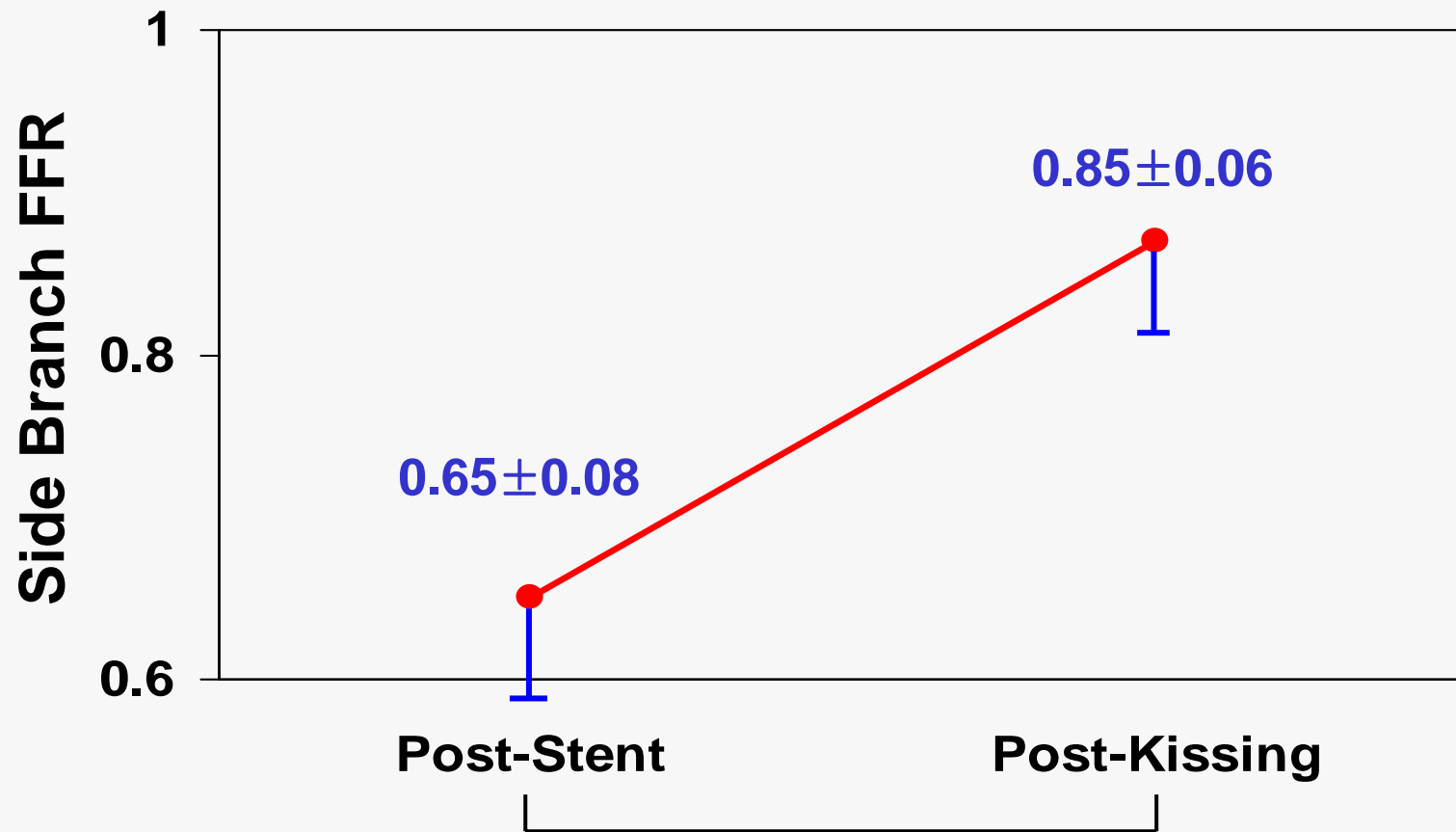


**Kissing balloon**

\* Gentle kiss: Balloon/Artery < 1



# Changes of side branch FFR after “gentle kiss”

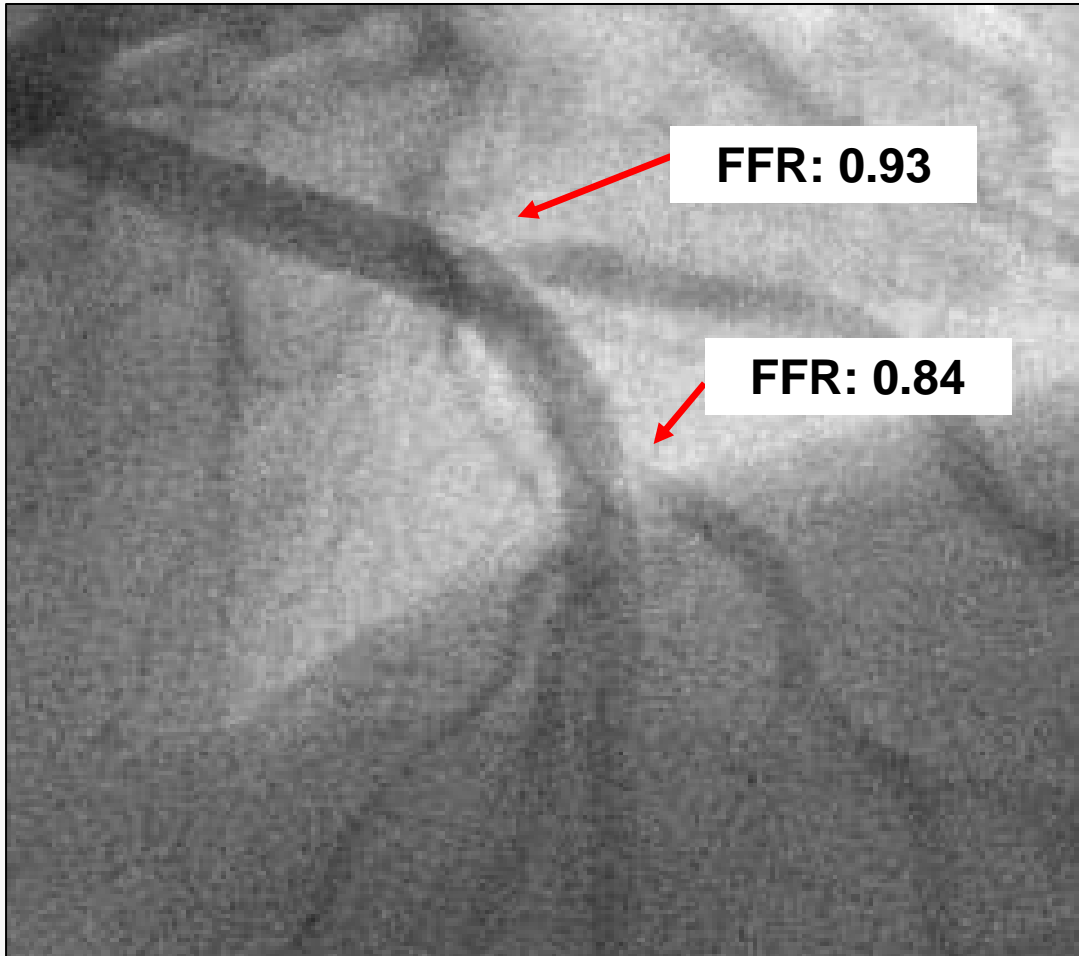


$P < 0.001$

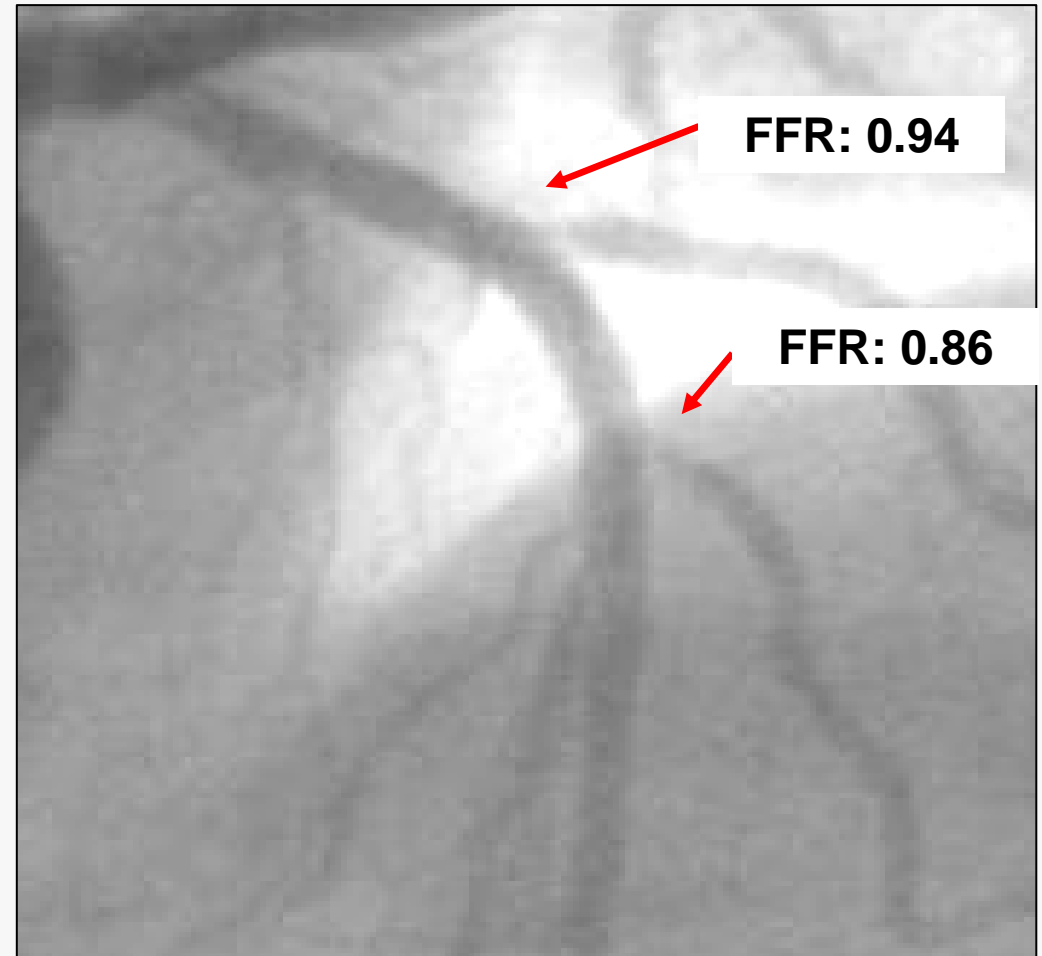
*Koo BK, et al. Eur Heart J 2008*

# What have we learned from “FFR”?

- What is FFR?
- “What you see” is NOT “what it is”.
- Why?
- **Functional outcome of jailed SB lesions**



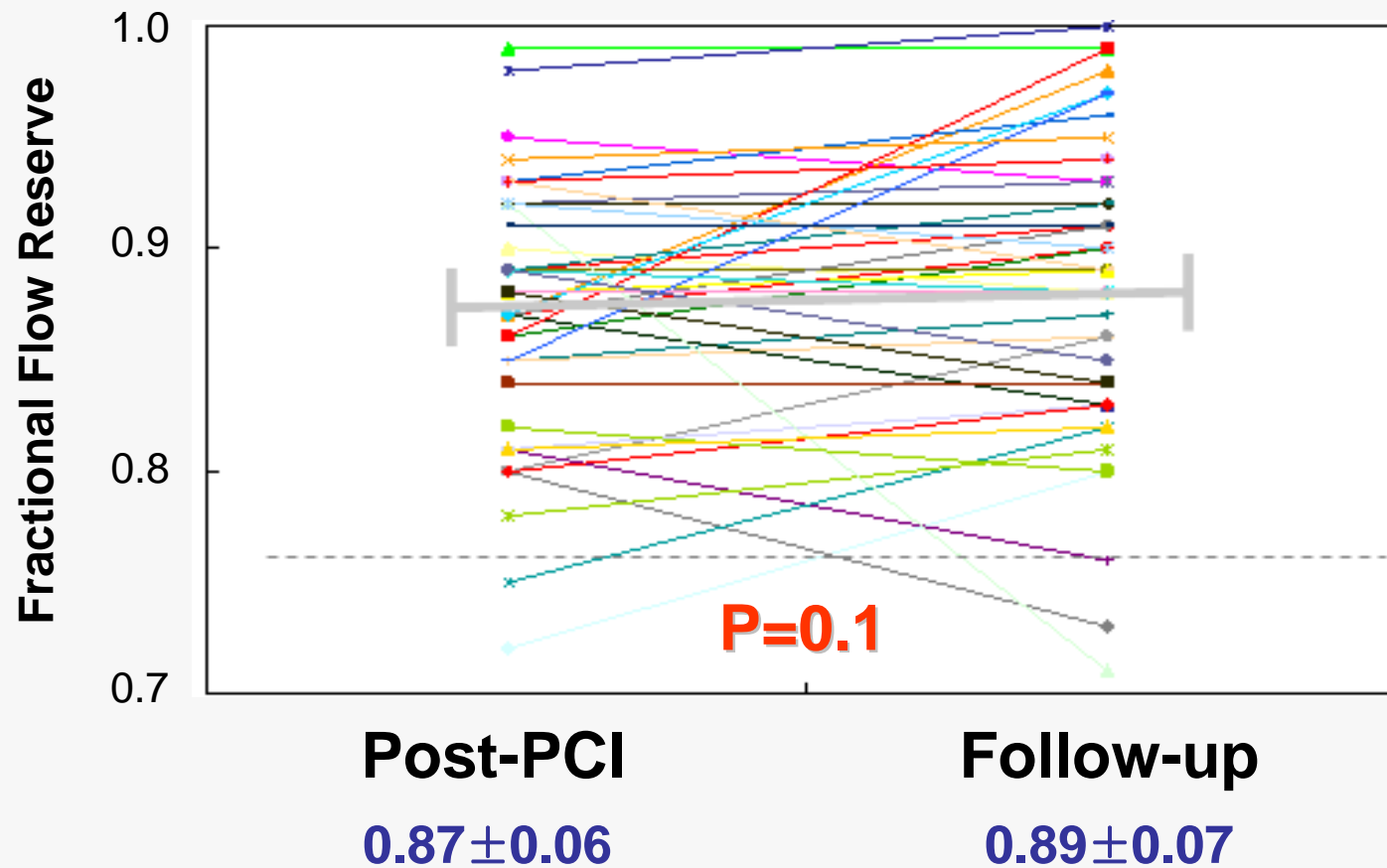
**Post-PCI**



**6 Month Follow-up**

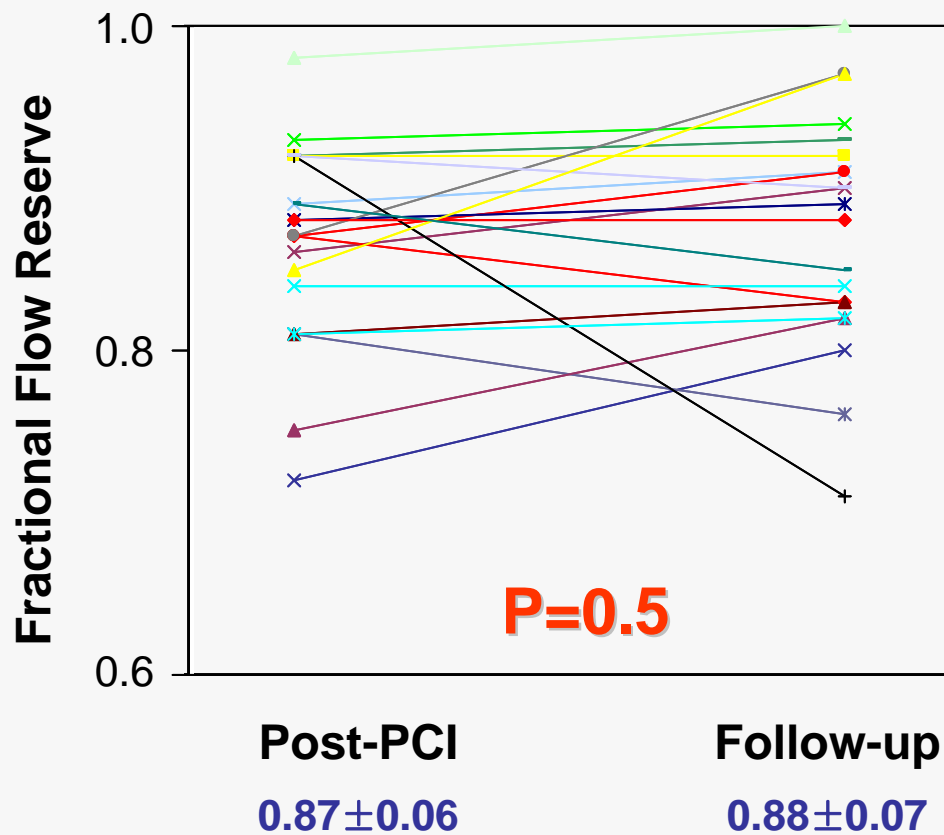
# Functional outcome of Jailed side branches

## Not-treated jailed side branches

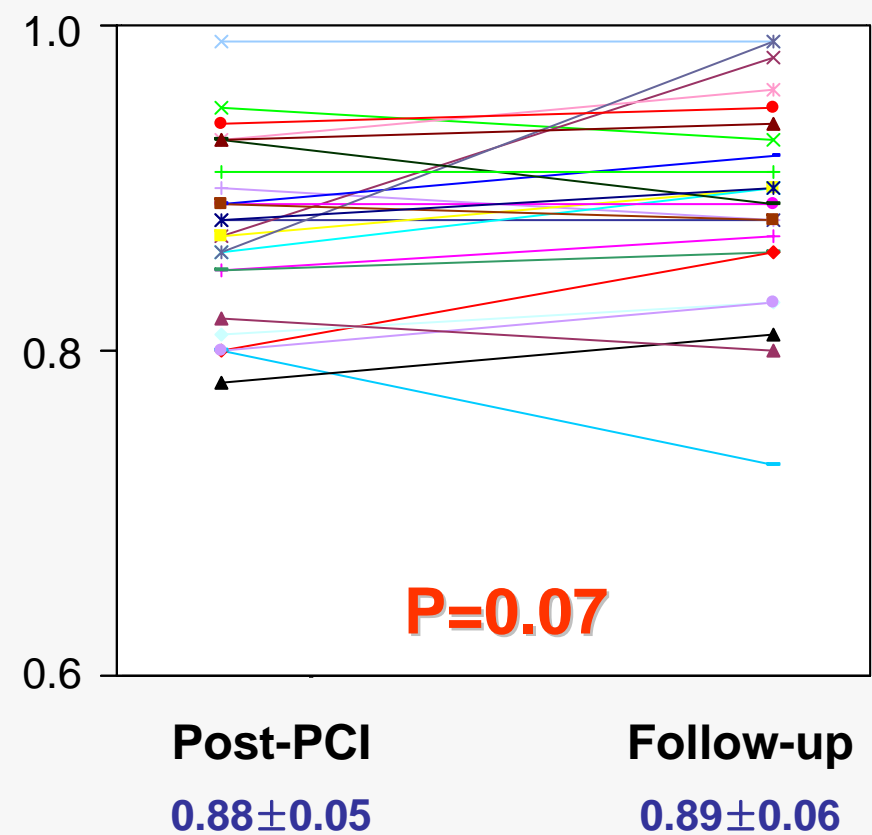


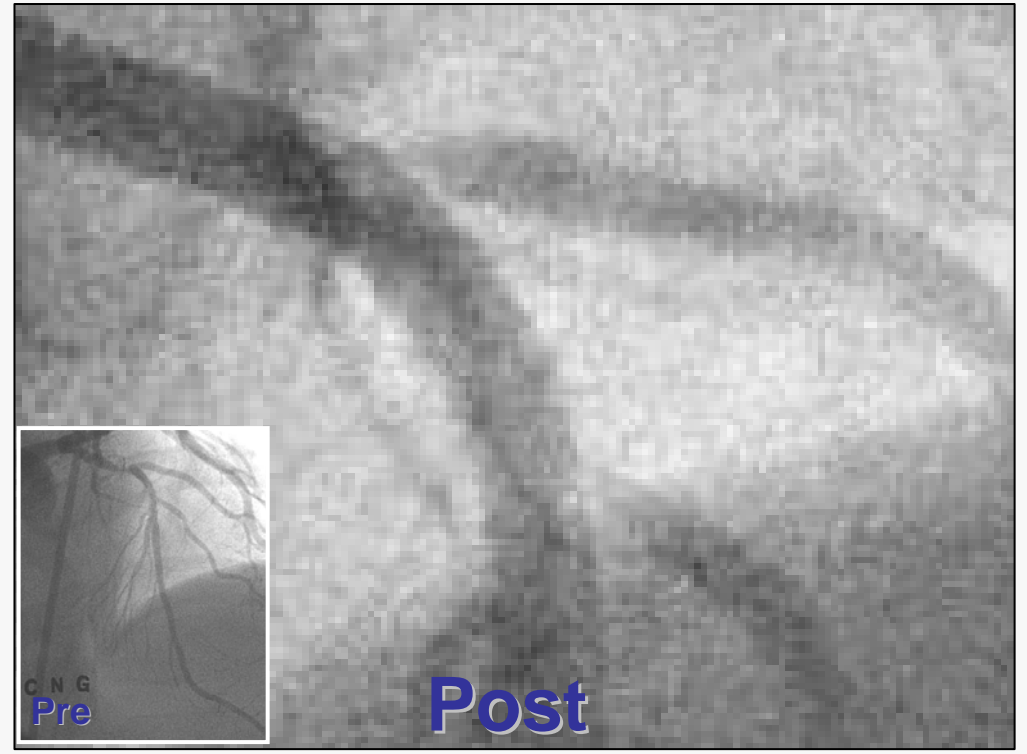
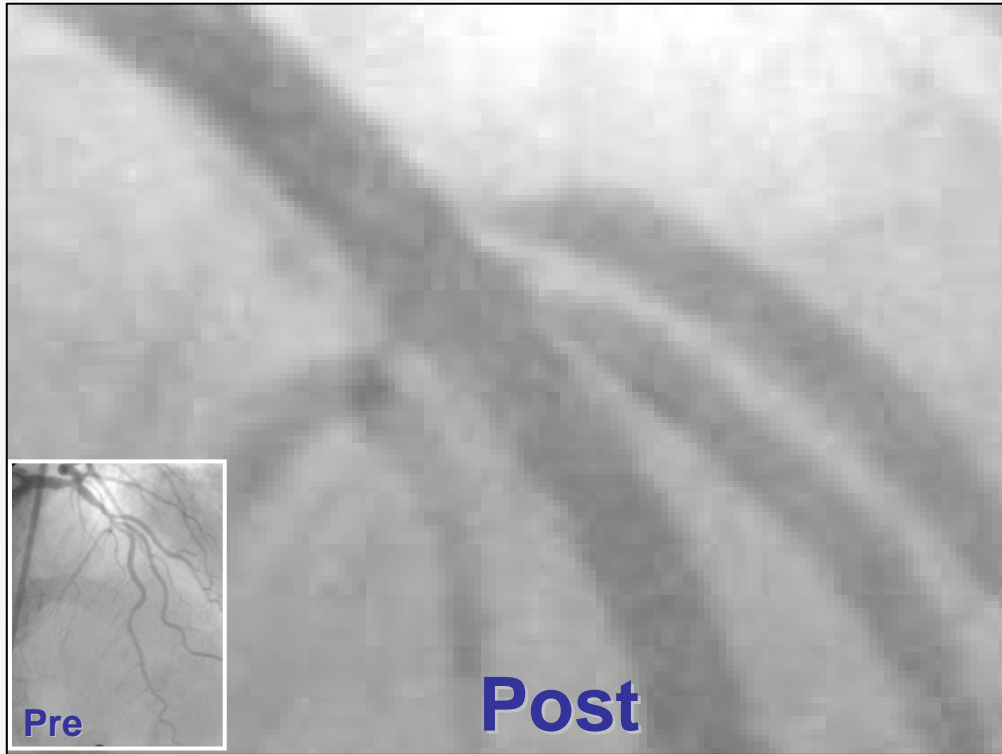
## Functional outcome of Jailed side branches

### True bifurcation



### False bifurcation





# What have we learned from “FFR”?

- Jailed SB lesion is different from usual MB lesion.
- Angiography overestimates the severity of jailed SB lesion.
- Outcome of functionally non-significant SB lesions is good despite the angiographic severe stenosis.
- More comprehensive anatomical, physiological and rheological insight of bifurcation lesions is still needed.