

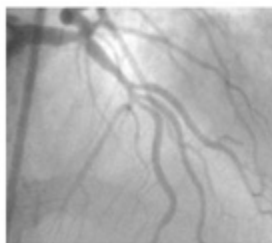
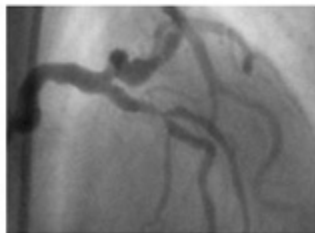
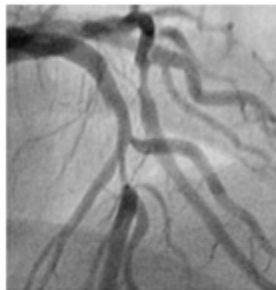
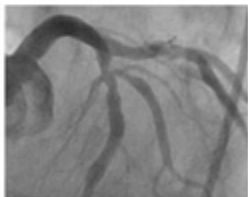
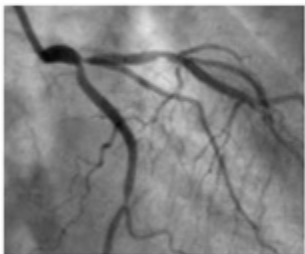
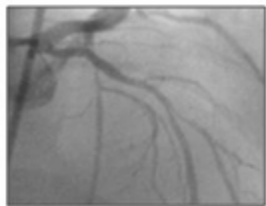
Usefulness of IVUS and FFR in Non-LM bifurcation PCI

Bon-Kwon Koo

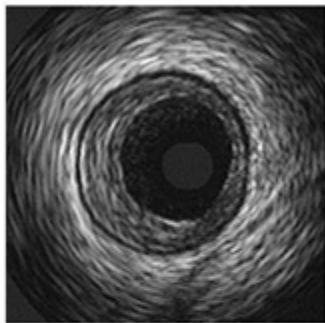
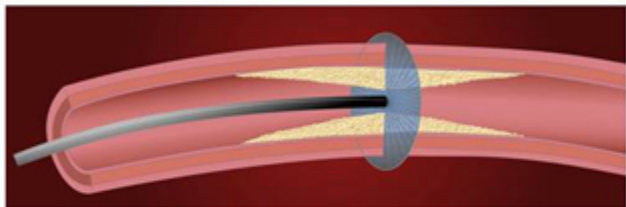
Seoul National University Hospital, Seoul, Korea



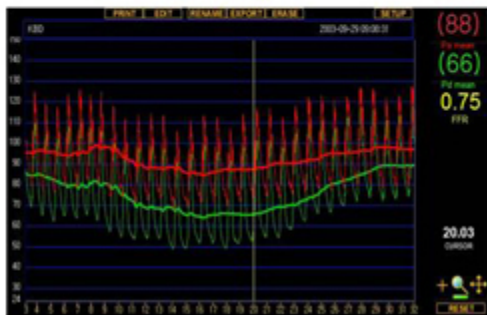
Bifurcations are complex!



Best of anatomical evaluation

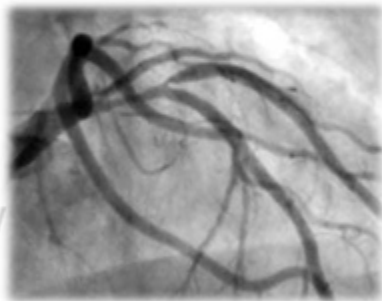


Best of physiological evaluation

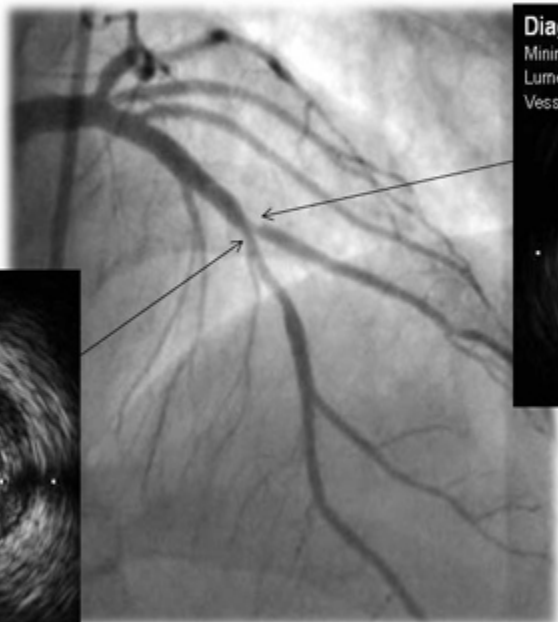


Use of IVUS and FFR in non-left main bifurcation PCI

- Pre-intervention
- After main branch stent implantation
- After side branch balloon angioplasty
- After side branch stenting



Precise anatomical assessment



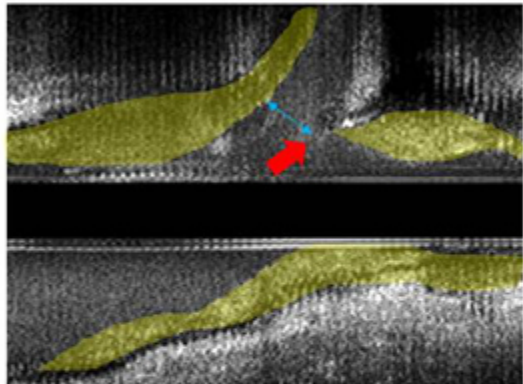
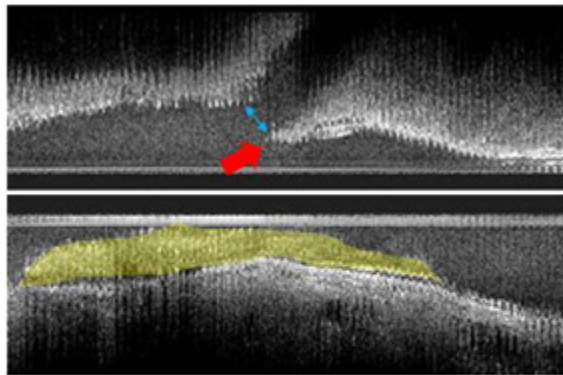
LAD:

Minimal lumen diameter: 1.8mm
Lumen area: 2.8mm²
Vessel area: 9.0mm²

Diagonal branch:

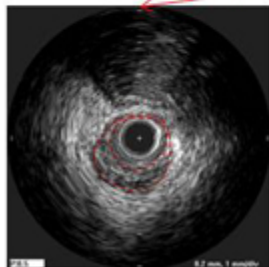
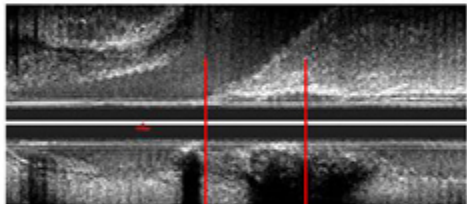
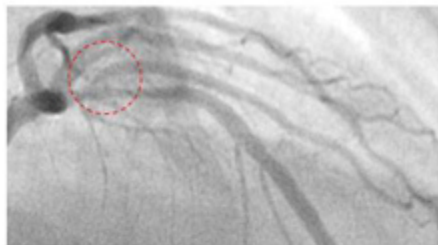
Minimal lumen diameter: 1.7mm
Lumen area: 2.7mm²
Vessel area: 5.0mm²

Important anatomical information

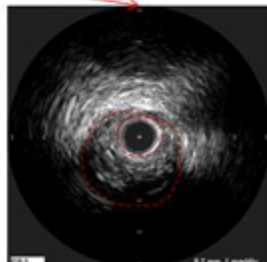


- Geometry of bifurcation lesion
- Amount, character and distribution of plaque
- Location, length of carina
- Distance between carina and outer lumen of a side branch

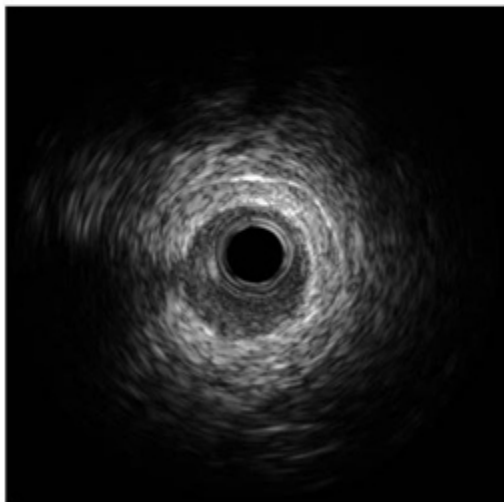
Mechanism of side branch stenosis



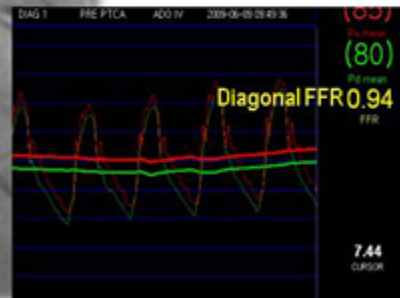
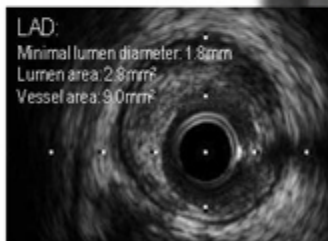
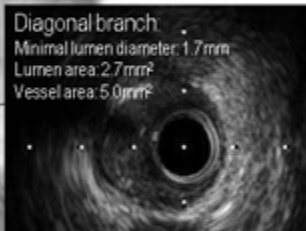
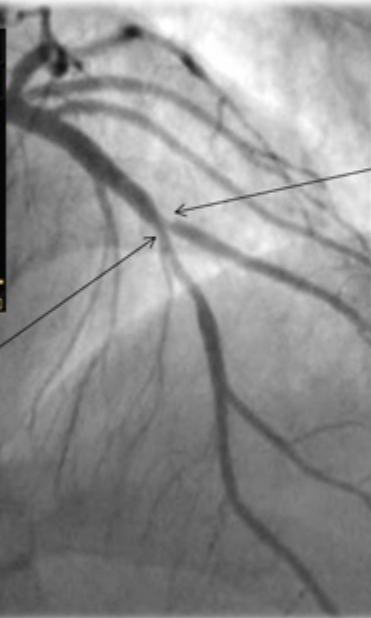
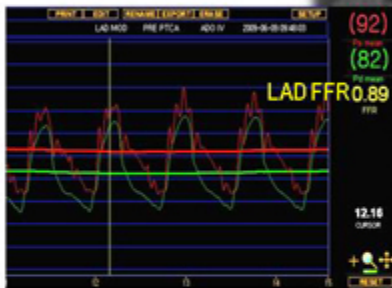
Plaque + Negative remodeling



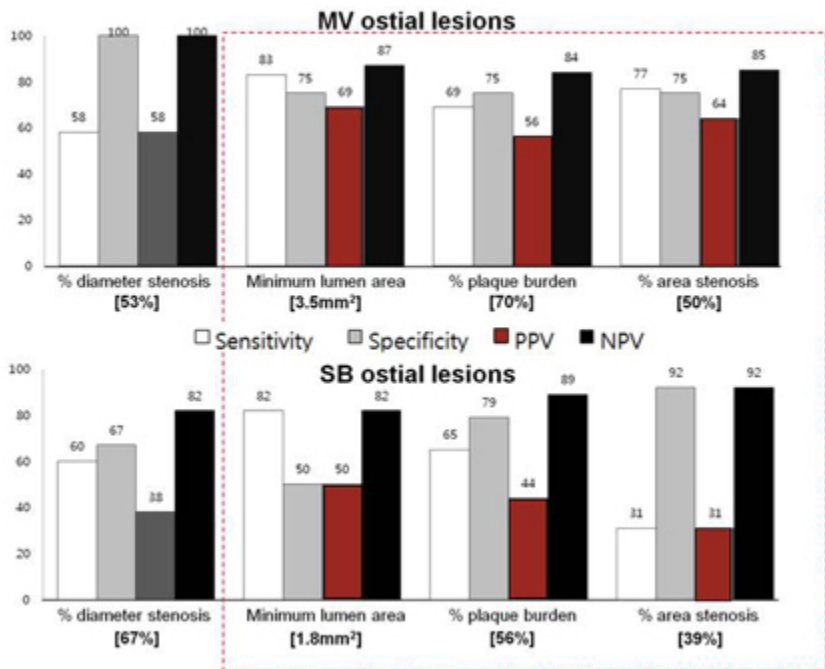
Plaque



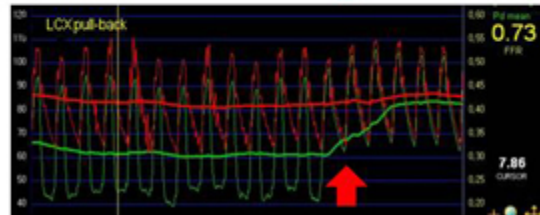
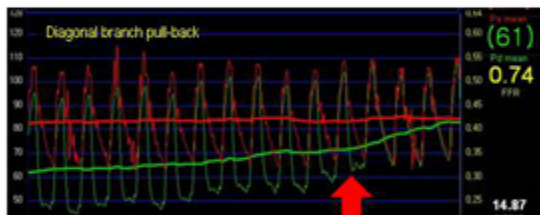
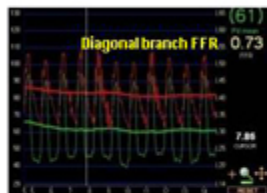
Precise physiological assessment



Diagnostic accuracy of IVUS parameters in pure ostial lesions

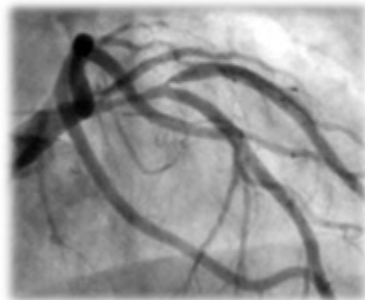


Functionally significant 0,0,1 lesion?



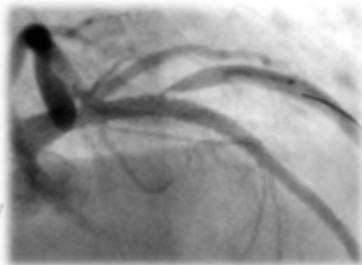
Pitfalls of IVUS/FFR in non-left main bifurcation PCI

- Pre-intervention
 - IVUS parameters have low positive predictive values in the prediction of ischemia causing stenosis.
 - Side branch FFR can be influenced by the plaque in the proximal main branch.
 - Pre-intervention side branch IVUS/FFR is not that helpful to predict the jailed side branch FFR.

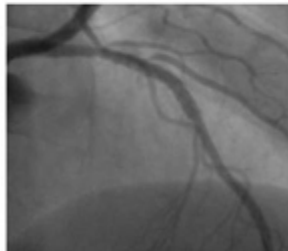
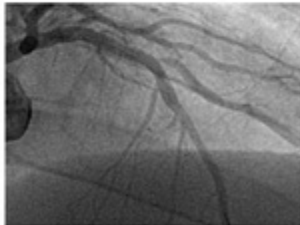
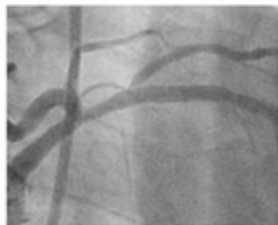
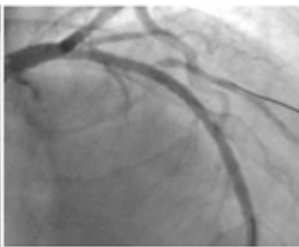
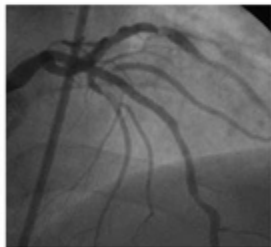
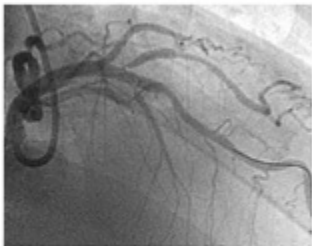


Use of IVUS and FFR in non-left main bifurcation PCI

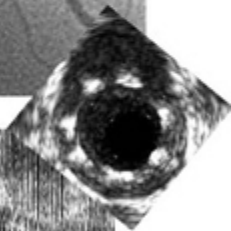
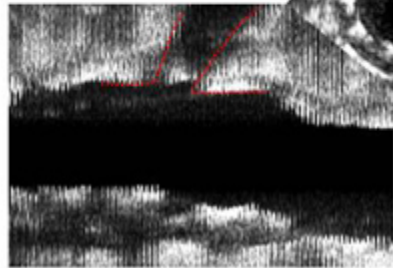
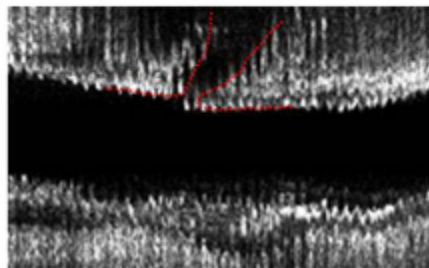
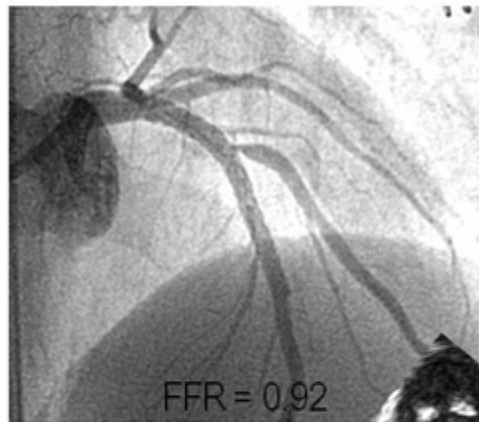
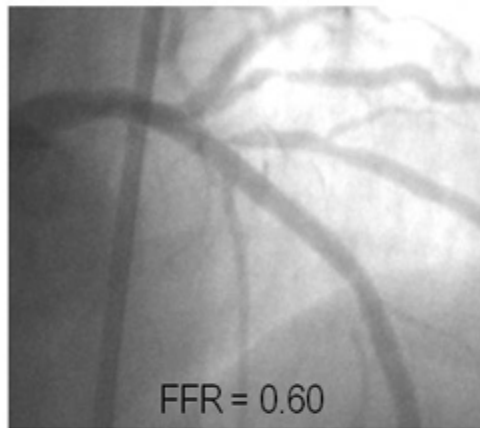
- Pre-intervention
- After main branch stent implantation
- After side branch balloon angioplasty
- After side branch stenting



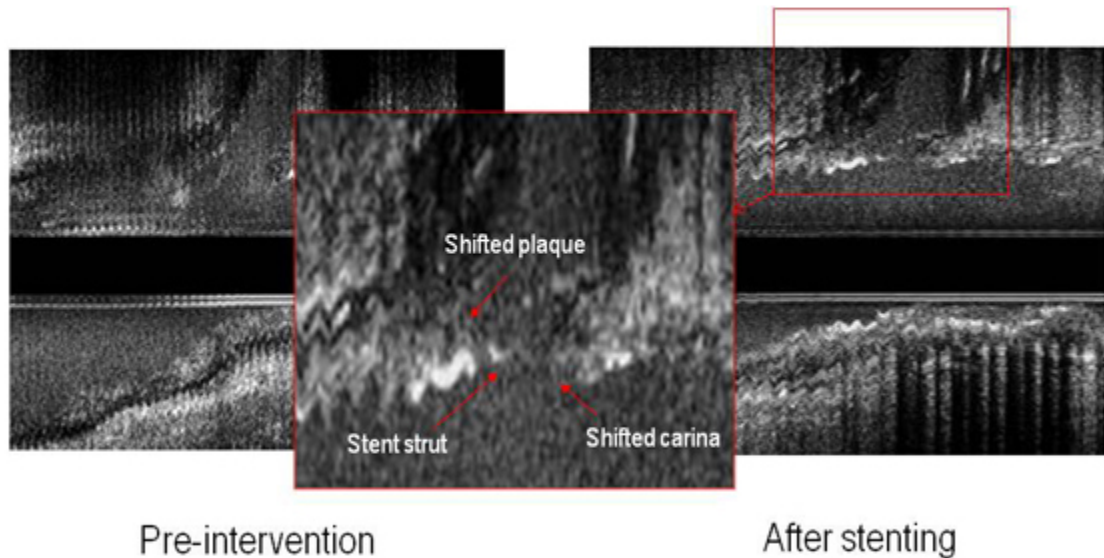
How can these jailed SB be assessed?



Same stenosis?



Complexity of SB jailing: Plaque, Carina, Stent.....



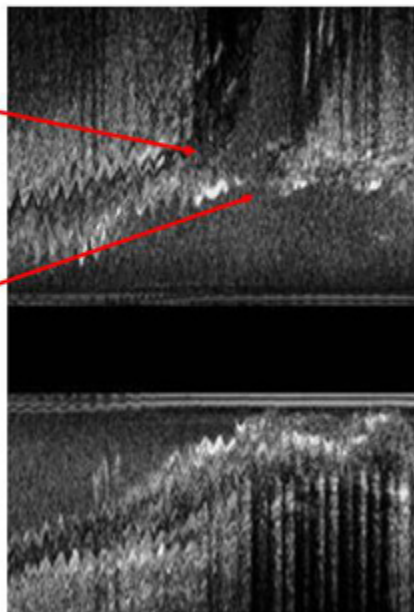
Different target, different strategy

- **Target: SB plaque**

- Large balloon, high pressure
- More injury, more dissection
- Higher chance of SB stenting
- More late loss

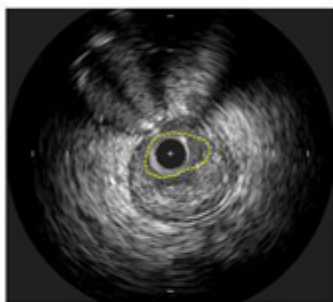
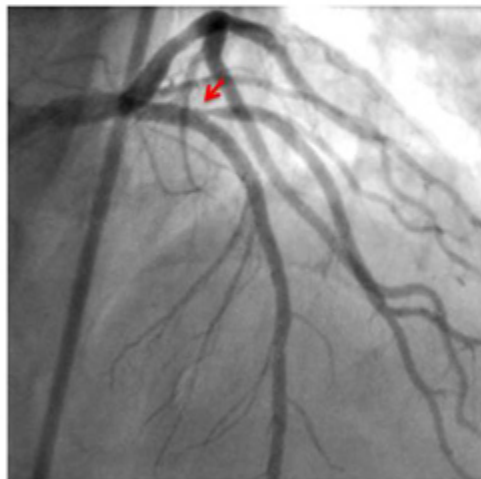
- **Target: Shifted carina**

- Relatively small balloon, low pressure
- Less injury, less dissection
- Less chance of SB stenting
- Less late loss

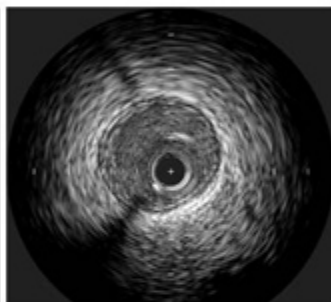


Anatomical severity vs. Functional significance

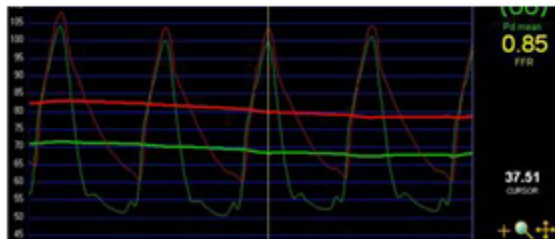
- IVUS vs. FFR in SB ostial lesions -



Min Lumen Area: 2.0mm²
MLD: 1.2mm

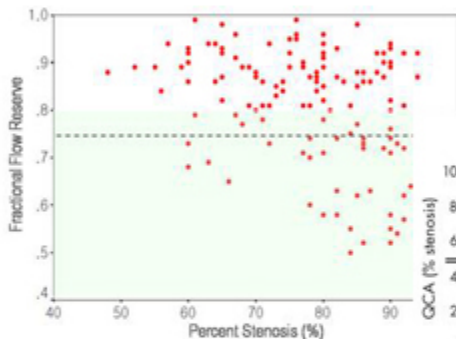


Reference segment

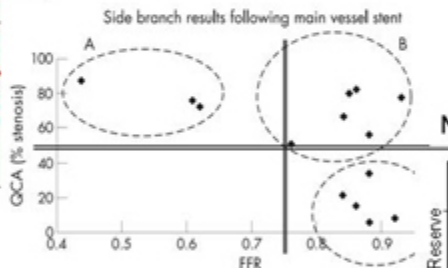


Can anatomical severity predict the functional significance?

FFR vs. % diameter stenosis in Jailed side branches

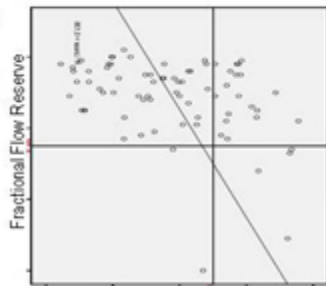


SNUH SB-FFR registry



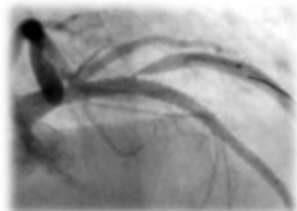
Bellenger, et al. Heart 2007

SB FFR substudy
Nordic Baltic Bifurcation III



Kumsars I, et al. Eurointervention 2011

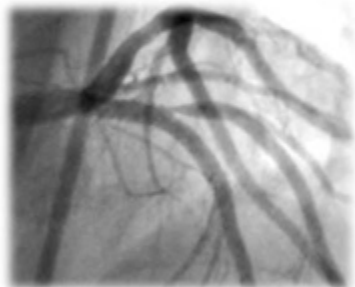
Pitfalls of IVUS/FFR in non-left main bifurcation PCI



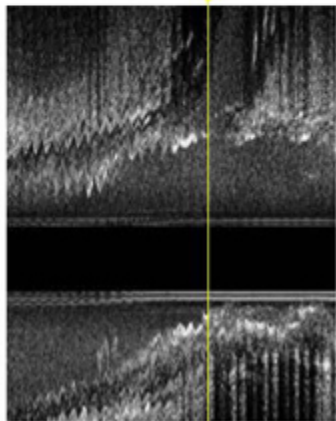
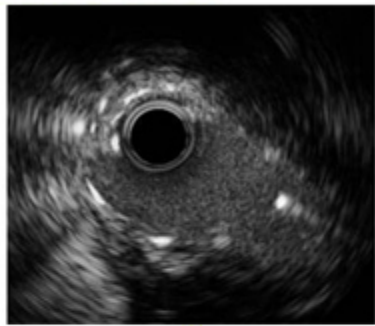
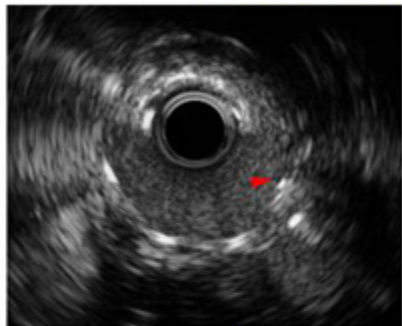
- After main branch stent implantation
 - IVUS for jailed side branches is generally not recommended.
 - The pressure wire itself should not be jailed.
 - FFR should be measured in a clinically relevant side branches.
 - Most published FFR data were obtained in short ostial side branch lesions. Therefore, the results cannot be applied **as they are** to diffuse or multiple side branch lesions.

Use of IVUS and FFR in non-left main bifurcation PCI

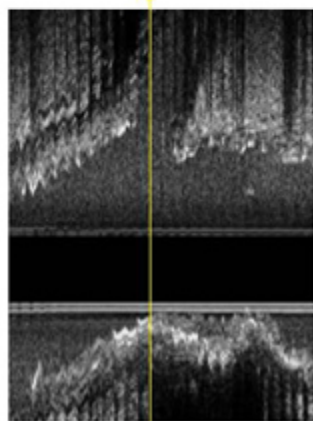
- Pre-intervention
- After main branch stent implantation
- After side branch balloon angioplasty
- After side branch stenting



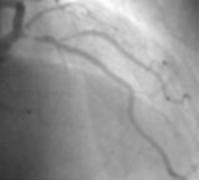
Assessment of procedural results



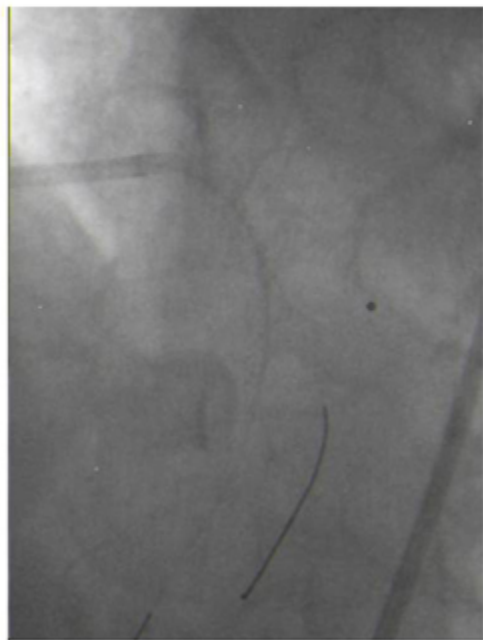
Before Kissing balloon inflation



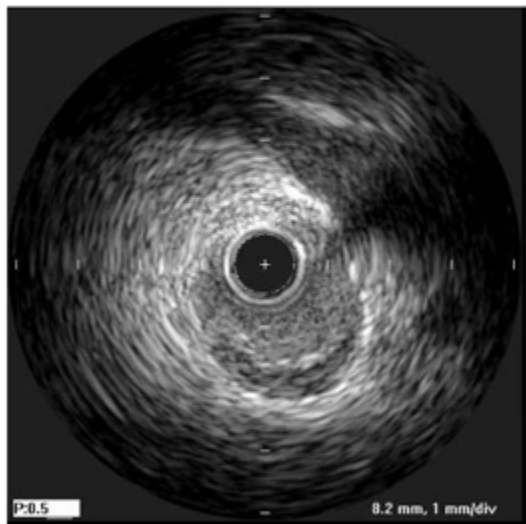
After Kissing balloon inflation



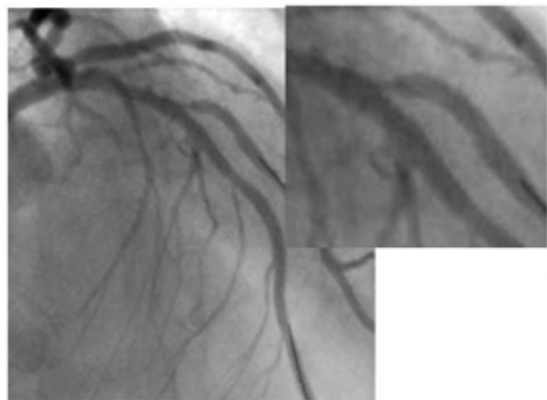
What happened?



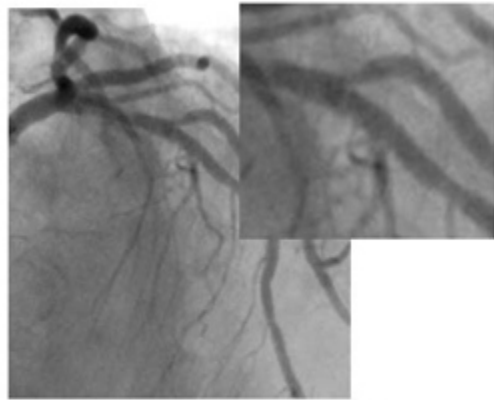
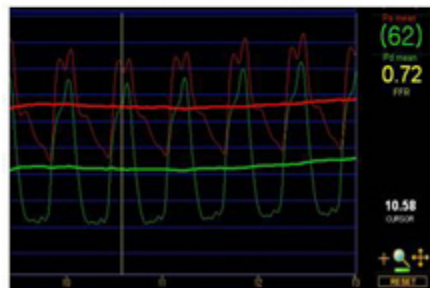
After Kissing balloon inflation



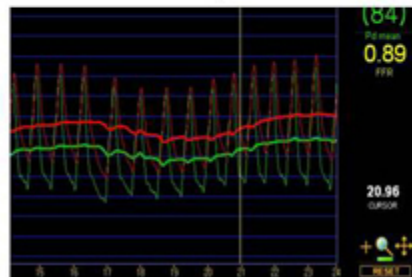
Angiographic vs. FFR changes during PCI



After MB stenting

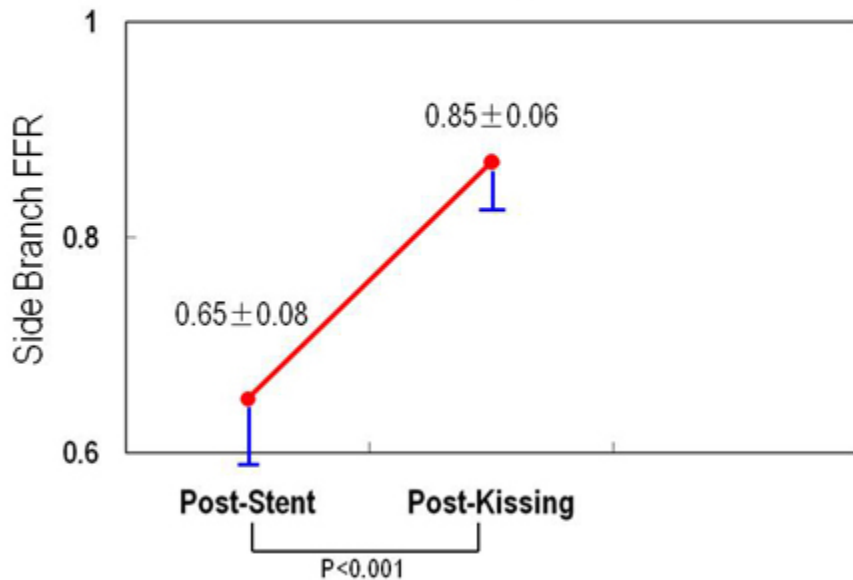


After kissing balloon



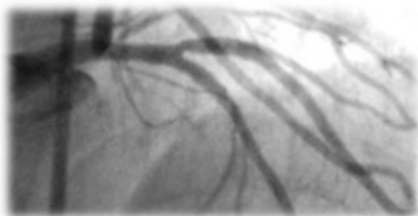
Changes of side branch FFR after kissing balloon

(Side branch balloon/artery ratio: 0.9 ± 0.1)

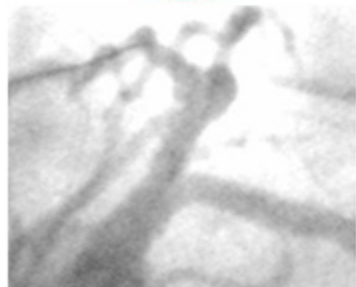
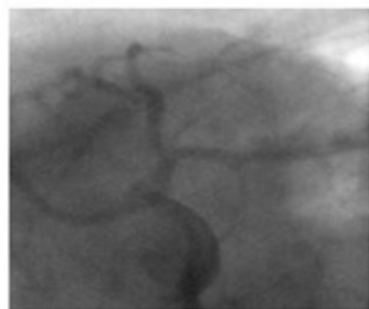


Use of IVUS and FFR in non-left main bifurcation PCI

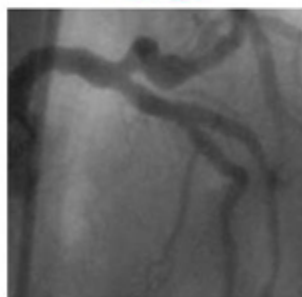
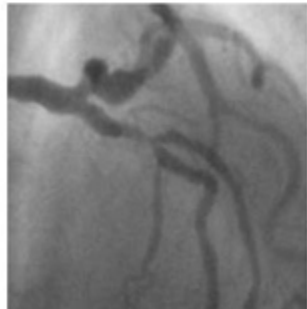
- Pre-intervention
- After main branch stent implantation
- After side branch balloon angioplasty
- After side branch stenting



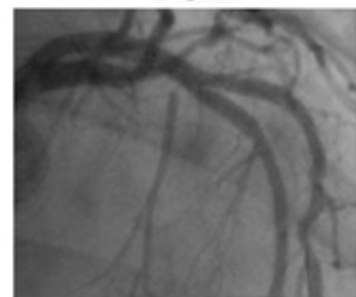
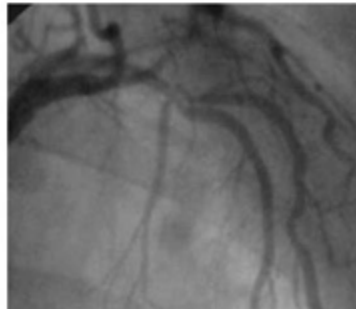
Excellent results?



Modified T



Kissing



Crush

Angiographically excellent, but.....

604 Costa et al.
Crush Stenting for Bifurcation Lesions

JACC Vol. 46, No. 4, 2005
August 16, 2005:599-605

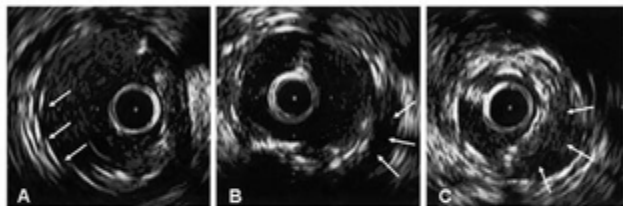
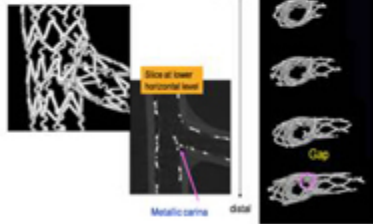


Figure 4. (A) Intracoronary ultrasound image showing complete crush (apposition) of the side branch (SB) stent; arrows indicate the three layers of stent. (B, C) Intracoronary ultrasound images showing incomplete crush (apposition) of the SB stent stents (arrows).

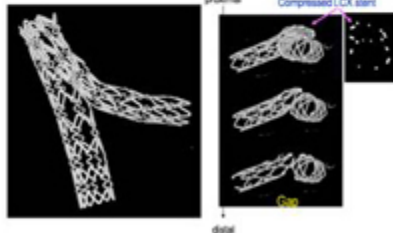
Modified T-stenting

Cross sectional view



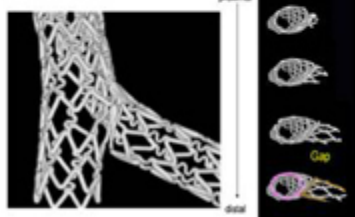
Kissing stenting

Cross sectional view



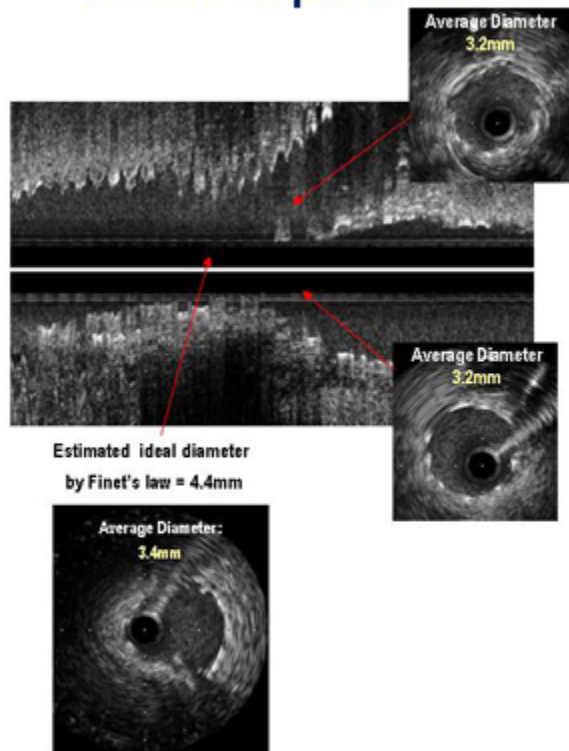
Crush technique

Cross sectional view

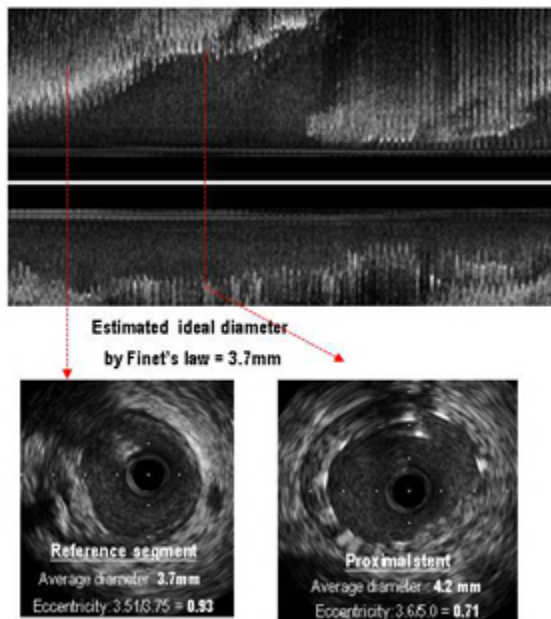


Courtesy of Dr. Murasato

Under-expansion



Over-expansion



FFR after side branch stenting

The Acute Changes of Fractional Flow Reserve in DK (Double Kissing), Crush, and I-Stent Technique for True Bifurcation Lesions

FEI YE, M.D., JUN-JIE ZHANG, M.D., NAI-LIANG TIAN, M.D., SONG LIN, M.D., ZHI-ZHONG LIU, M.D., JING KAN, M.D., HAI-MEI XU, M.D., ZHONGSHENG ZHU, M.D., and SHAO-LIANG CHEN, M.D., F.S.C.A.I., F.A.C.C.

From the Nanjing First Hospital, Nanjing Medical University, Nanjing, China

FFR before and after PCI (DK crush vs Provisional)

	DK Group	I-Stent Group	P Value
FFR preprocedure			
MB FFR at baseline	0.83 ± 0.15	0.89 ± 0.13	0.109
SB FFR at baseline	0.84 ± 0.15	0.91 ± 0.12	0.100
MB FFR at hyperemia	0.76 ± 0.15	0.83 ± 0.10	0.029
SB FFR at hyperemia	0.76 ± 0.15	0.83 ± 0.16	0.103
FFR postprocedure			
MB FFR at baseline	0.96 ± 0.02	0.95 ± 0.03	0.376
SB FFR at baseline	0.97 ± 0.02	0.96 ± 0.03	0.043
MB FFR at hyperemia	0.92 ± 0.04	0.92 ± 0.05	0.581
SB FFR at hyperemia	0.94 ± 0.03	0.90 ± 0.08	0.028

Efficacy of Fractional Flow Reserve Measurements at Side Branch Vessels Treated With the Crush Stenting Technique in True Coronary Bifurcation Lesions

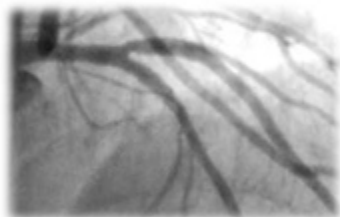
Byoung Kwon Lee, MD; Hyun Hee Choi, MD; Kyung-Soon Hong, MD; Byoung-Keuk Kim, MD; Jaemin Shim, MD; Jung-Sun Kim, MD; Young-Guk Ko, MD; Donghoon Choi, MD; Yongsoo Jang Myeong-Ki Hong, MD, PhD

	Pre-KBA MLD, MV/SB (mm)	Post-KBA MLD, MV/SB (mm)	Pre-KBA FFR	Post-KBA FFR
1	2.4/2.5	2.6/2.6	0.90	0.96
2	2.9/2.5	2.9/2.4	0.96	1.00
3	3.0/2.3	3.0/2.5	0.95	0.95
4	2.7/2.3	2.8/2.4	0.96	0.96
5	2.9/2.2	2.9/2.4	0.92	1.00
6	3.1/1.8	3.2/2.0	0.95	0.98
7	3.0/2.2	2.9/2.3	0.94	0.96
8	2.8/1.6	2.7/1.8	1.00	1.00
9	3.0/2.8	2.9/2.8	0.94	0.94
10	3.1/2.9	3.0/3.0	0.88	0.94
11	3.4/2.4	3.3/2.3	0.88	0.94
12	3.2/2.1	3.2/2.3	0.97	1.00

0.94 ± 0.04 0.97 ± 0.03

Pitfalls of IVUS/FFR in non-left main bifurcation PCI

- After side branch stenting
 - Keeping the natural anatomy is more important than acquiring more than enough lumen area.
 - When post-stenting side branch FFR is bad, it really is bad. However, high FFR does not always guarantee the excellent results.



Use of IVUS and FFR in non-left main bifurcation PCI

- IVUS/FFR-guided intervention strategy for bifurcation lesion is feasible and helpful from the beginning till the end of the procedures.
- Adequate knowledge on coronary anatomy/physiology and pitfalls of IVUS/FFR is mandatory to properly use IVUS/FFR in complex bifurcation lesion and in complex bifurcation PCI.