

Step-by-Step Approach in Non-LM Bifurcation PCI using FFR and IVUS

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IVUS/FFR-guided PCI for complex lesions can improve outcomes!

Long-Term Outcomes of Intravascular Ultrasound-Guided Stenting in Coronary Bifurcation Lesions

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Stenting for bifurcation lesions is still challenging, and the effect of intravascular ultrasound (IVUS) guidance on long-term outcomes has not been evaluated. We assessed the long-term outcomes of IVUS-guided stenting in bifurcation lesions. We evaluated 758 patients with de novo nonleft main coronary bifurcation lesions who underwent stent implantation from January 1998 to February 2006. We compared the adverse outcomes (i.e., death, stent thrombosis, and target lesion revascularization) within 4 years, after adjustment using a multivariate Cox proportional hazard model and propensity scoring. IVUS-guided stenting significantly reduced the long-term all-cause mortality (hazard ratio [HR] 0.31, 95% confidence interval [CI] 0.13 to 0.74, $p = 0.008$) in the total population and in the patients receiving drug-eluting stents (DESs) (HR 0.24, 95% CI 0.06 to 0.86, $p = 0.03$) but not in the patients receiving bare metal stents (HR 0.41, 95% CI 0.13 to 1.26, $p = 0.16$).

Impact of Intravascular Ultrasound Guidance on Long-Term Mortality in Stenting for Unprotected Left Main Coronary Artery Stenosis

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Background—Although intravascular ultrasound (IVUS) guidance has been useful in stenting for unprotected left main coronary artery stenosis, its impact on long-term mortality is still unclear.

Methods and Results—In the MAIN-COMPARE registry, patients with unprotected left main coronary artery stenosis in a hemodynamically stable condition underwent elective stenting under the guidance of IVUS (756 patients) or conventional angiography (219 patients). Patients with acute myocardial infarction were excluded. The 3-year outcomes between the 2 groups were primarily compared using propensity-score matching in the entire and separate populations according to stent type. In 201 matched pairs of the overall population, there was a tendency of lower risk of 3-year mortality with IVUS guidance compared with angiography guidance (6.0% versus 13.6%, log-rank $P = 0.063$; hazard ratio, 0.54; 95% CI, 0.28 to 1.03; Cox-model $P = 0.061$). In particular, in 145 matched pairs of patients receiving drug-eluting stent, the 3-year incidence of mortality was lower with IVUS guidance as compared with angiography guidance (4.7% versus 16.0%, log-rank $P = 0.048$; hazard ratio, 0.39; 95% CI, 0.15 to 1.02; Cox model $P = 0.055$). In contrast, the use of IVUS guidance did not reduce the risk of mortality in 47 matched pairs of patients receiving

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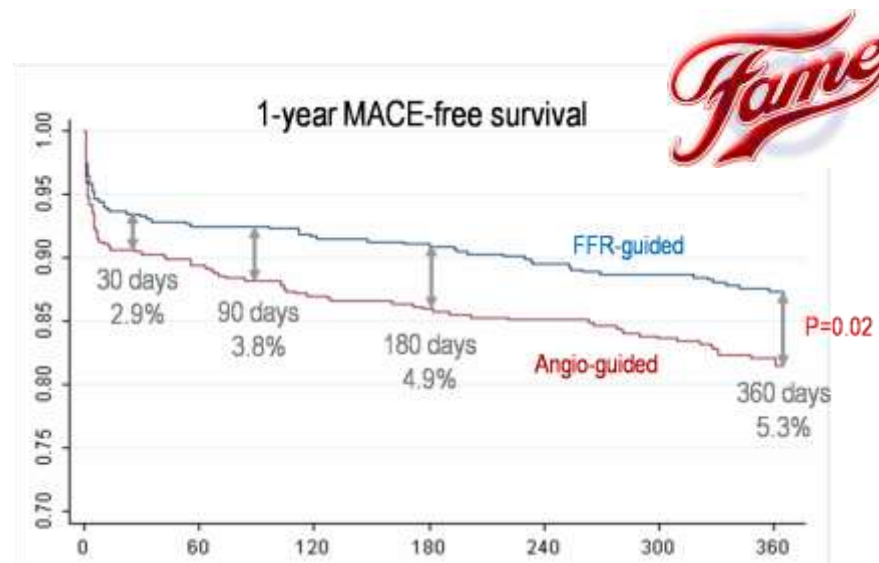
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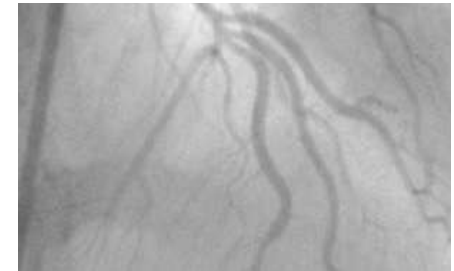
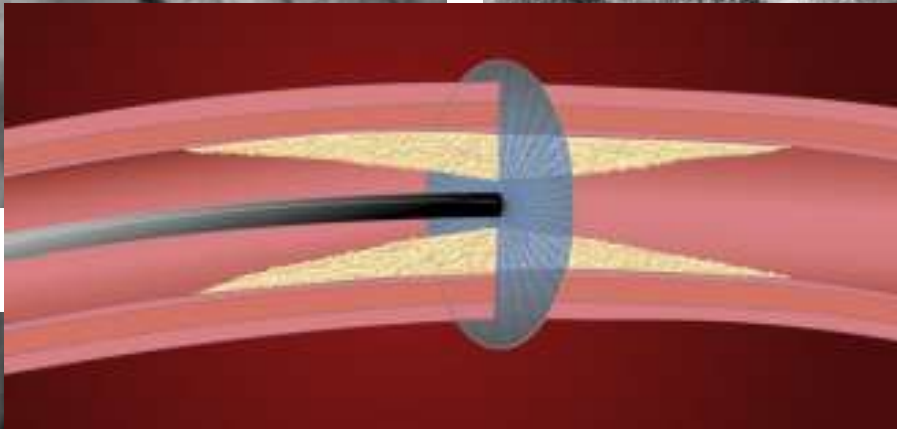
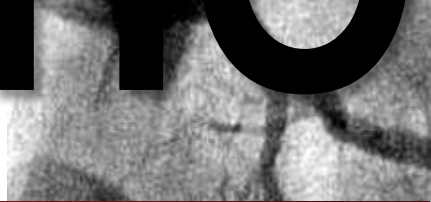
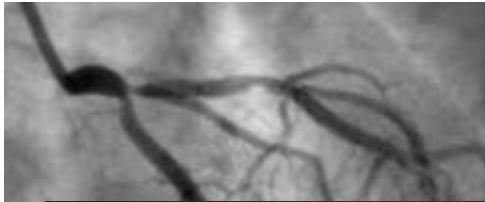
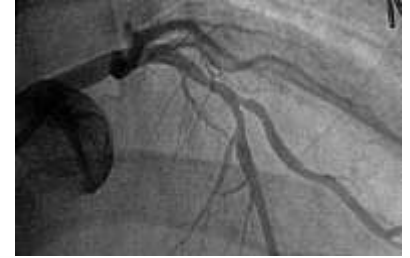
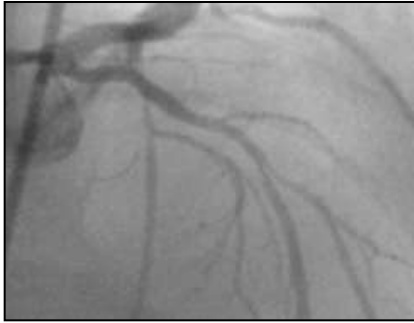
Fractional Flow Reserve versus Angiography for Guiding Percutaneous Coronary Intervention

Pim A.L. Tonino, M.D., Bernard De Bruyne, M.D., Ph.D., Nico H.J. Pijls, M.D., Ph.D., Uwe Siebert, M.D., M.P.H., Sc.D., Furniaki Ikeno, M.D., Marcel van't Veer, M.Sc., Volker Klauss, M.D., Ph.D., Ganesh Manoharan, M.D., Thomas Engström, M.D., Ph.D., Keith G. Oldroyd, M.D., Peter N. Ver Lee, M.D., Philip A. McCarthy, M.D., Ph.D., and William F. Fearon, M.D., for the FAME Study Investigators^{*}



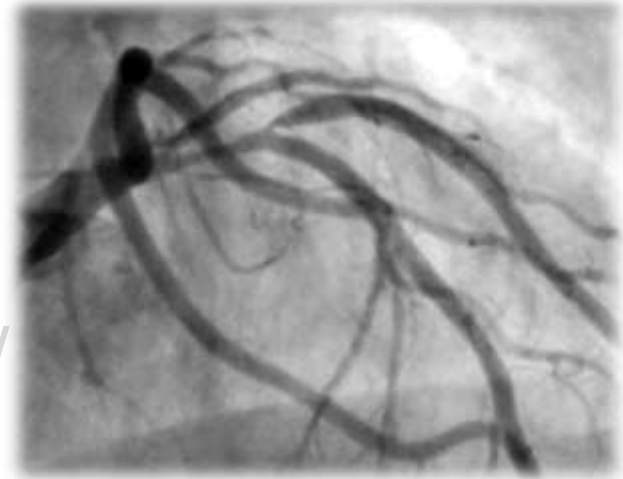
Bifurcations are complex!

HOW?

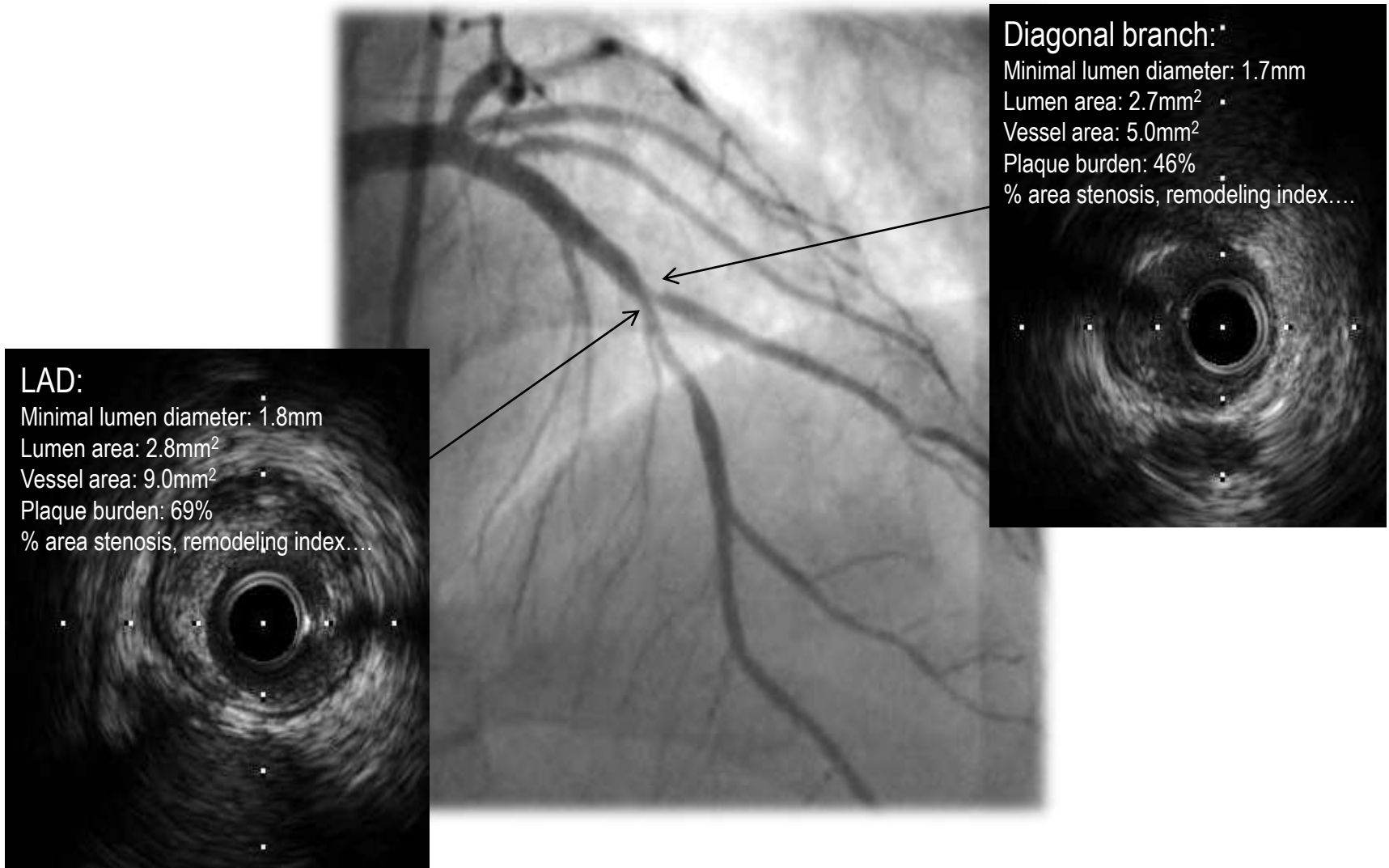


IVUS and FFR in non-LM bifurcation PCI : Step-by-Step Approach

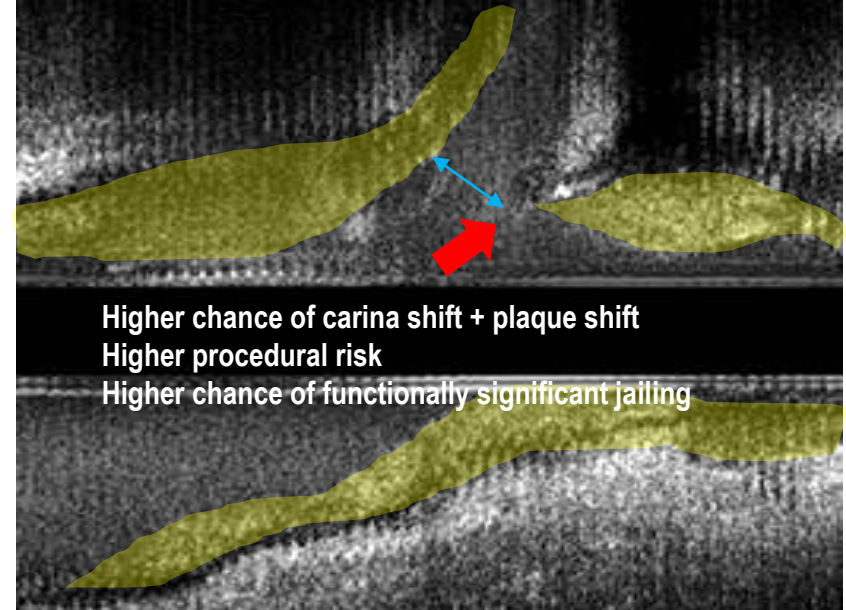
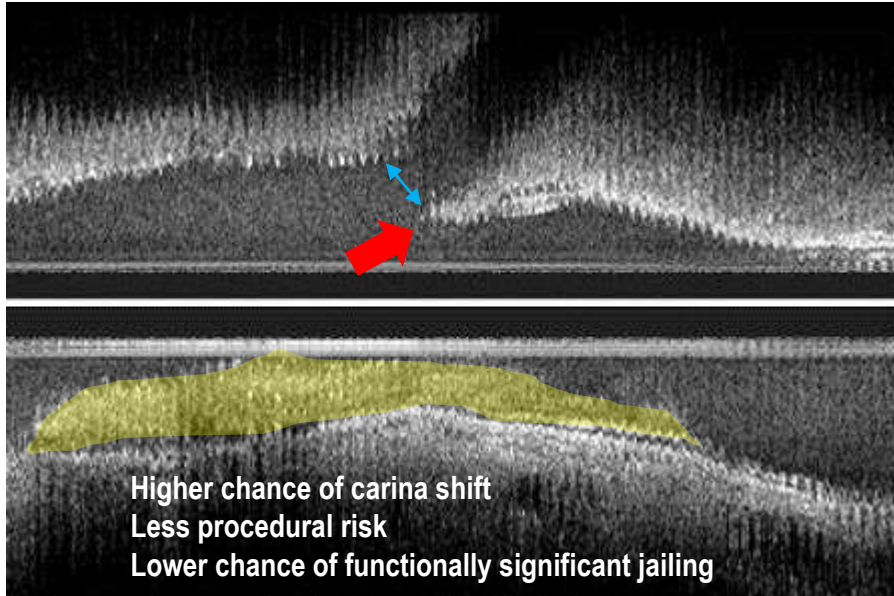
- Pre-intervention
- After main branch stent implantation
- After side branch balloon angioplasty
- After side branch stenting



Precise anatomical assessment: Use IVUS!



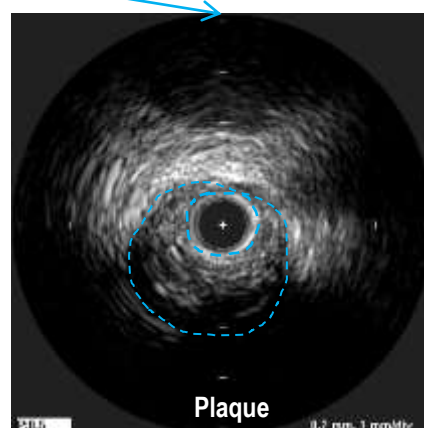
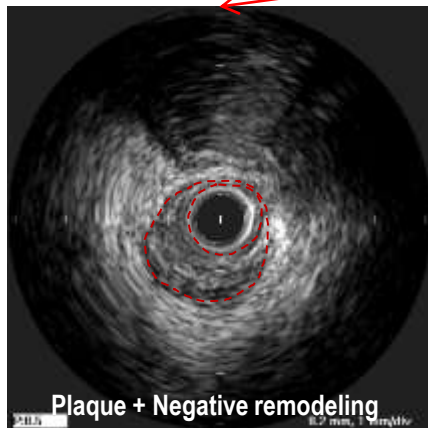
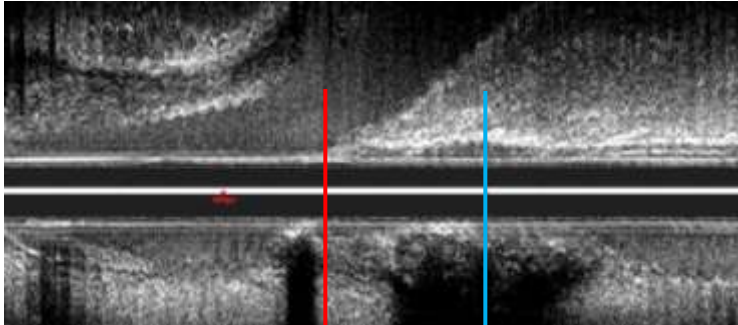
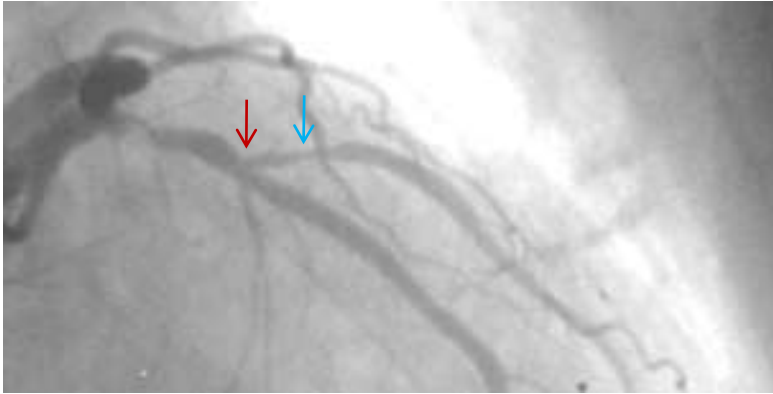
Longitudinal image of bifurcation



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

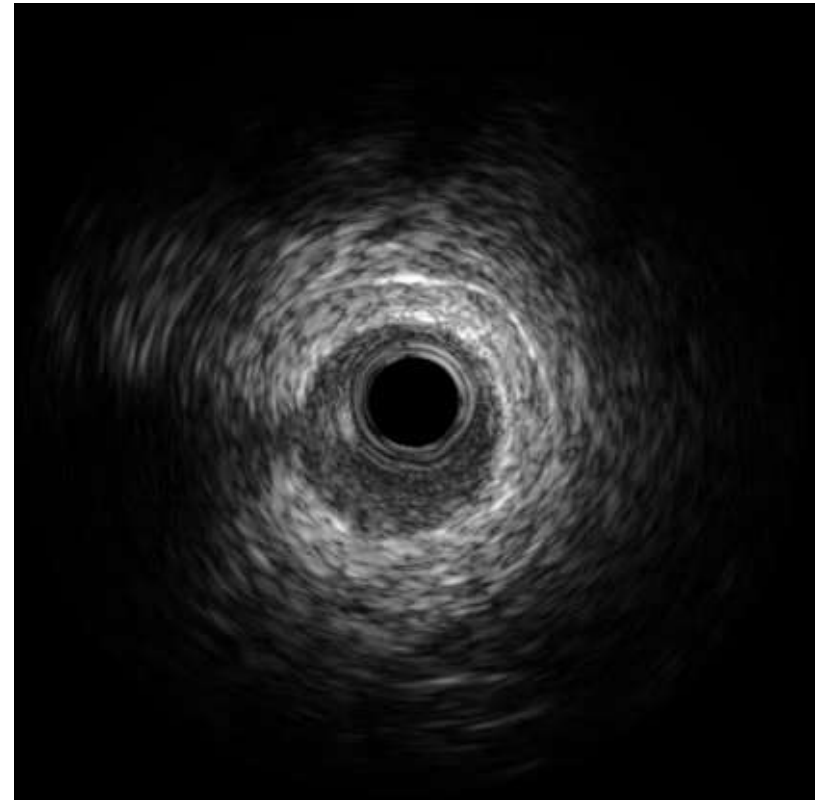
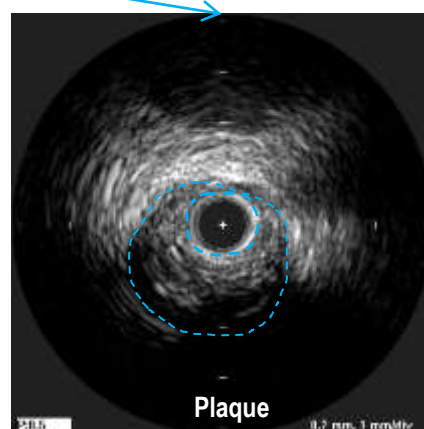
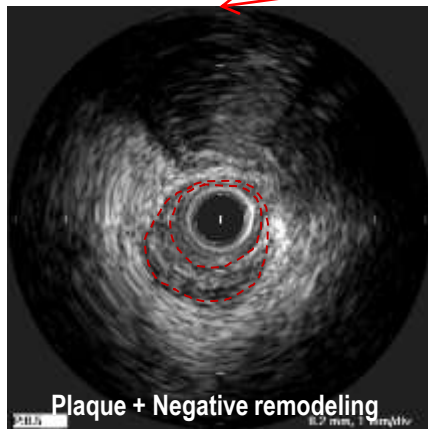
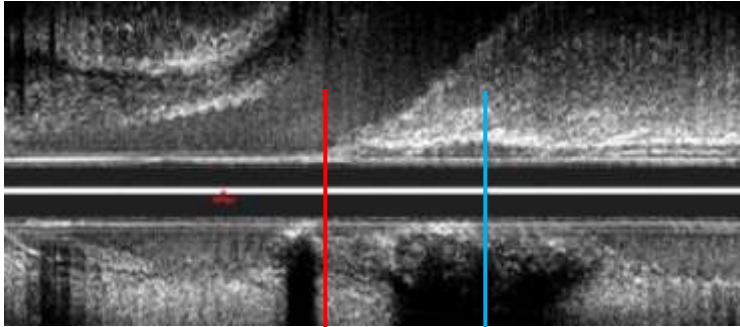
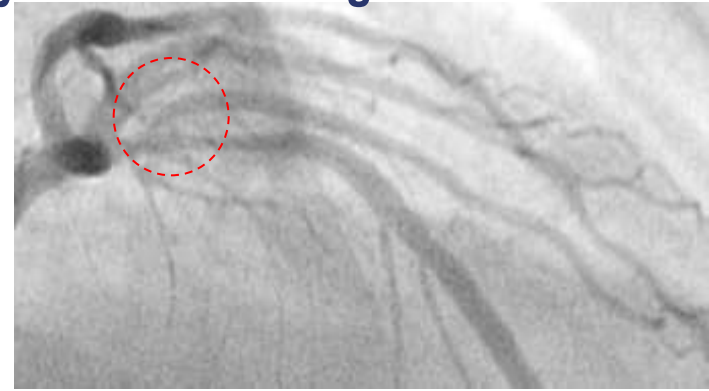
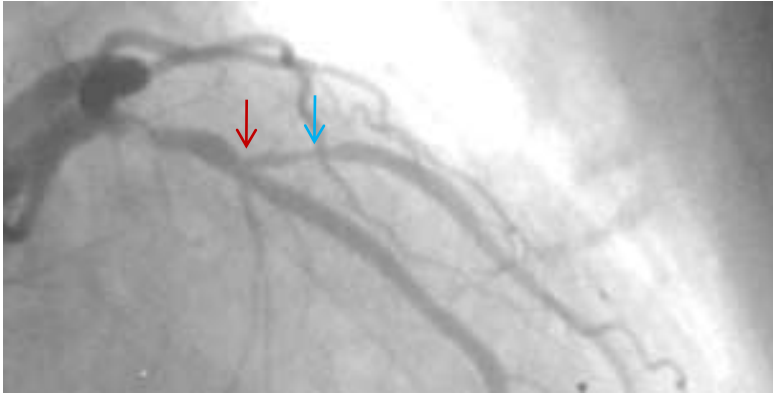
Mechanism of SB stenosis

: You should know this before you do something for SB!



Mechanism of SB stenosis

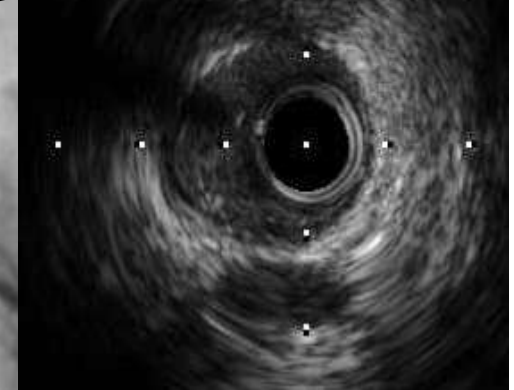
: You should know this before you do something for SB!



To know whether PCI is needed: Use FFR!



Diagonal branch: *
Minimal lumen diameter: 1.7mm
Lumen area: 2.7mm²
Vessel area: 5.0mm²
Plaque burden: 46%
% area stenosis, remodeling index....

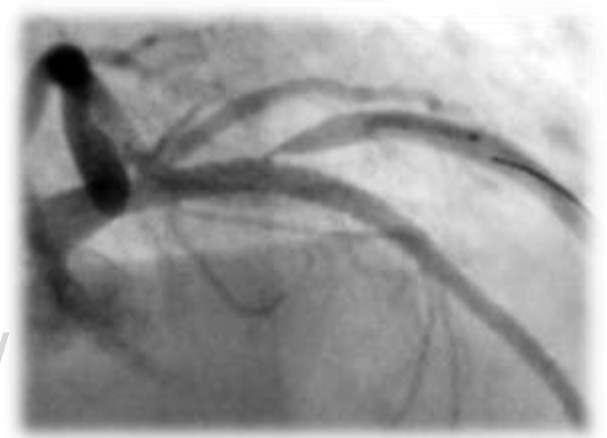


LAD:
Minimal lumen diameter: 1.8mm
Lumen area: 2.8mm²
Vessel area: 9.0mm²
Plaque burden: 69%
% area stenosis, remodeling index....



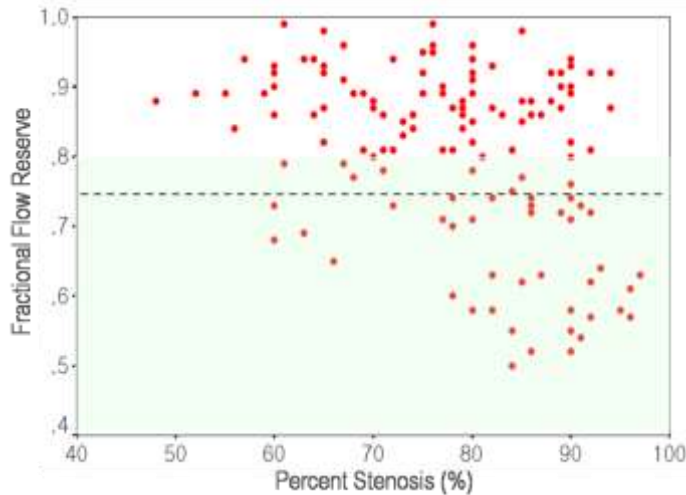
IVUS and FFR in non-LM bifurcation PCI : Step-by-Step Approach

- Pre-intervention
- After main branch stent implantation
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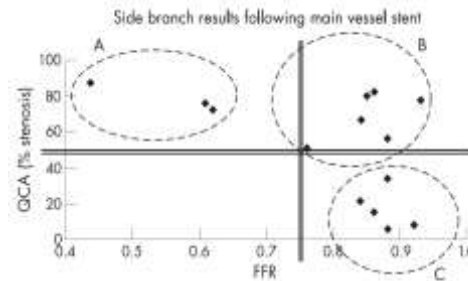


To decide SB intervention or not, use FFR!

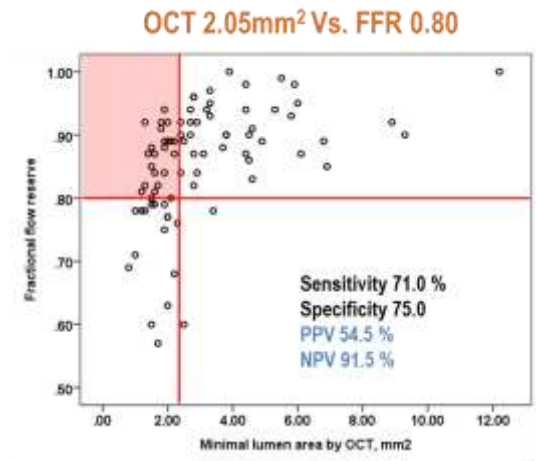
FFR vs. anatomical stenosis in side branches



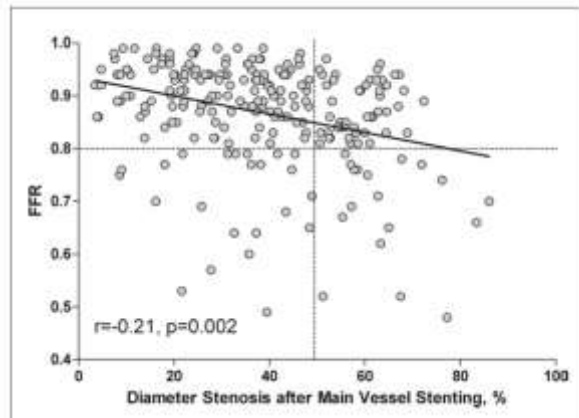
Park SH & Koo BK J Geriatr Cardiol 2012



Bellenger, et al. Heart 2007

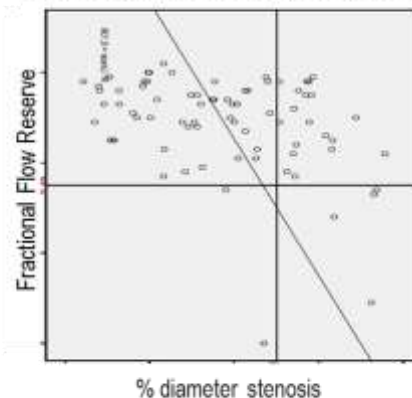


Ha J, Kim JS, et al JACC Imag 2013



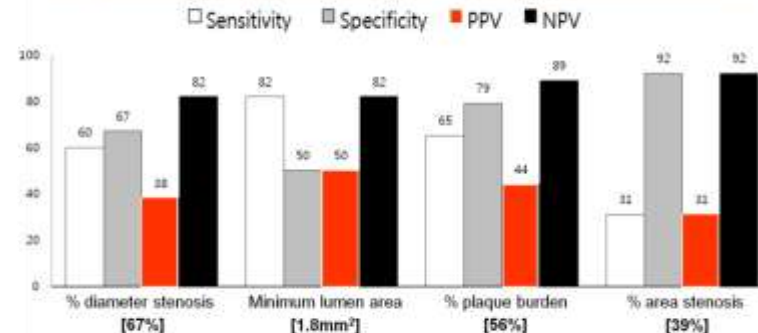
Ahn JM, et al. JACC interv 2012

SB FFR substudy Nordic Baltic Bifurcation III



Kumsars I, et al. Eurointervention 2011

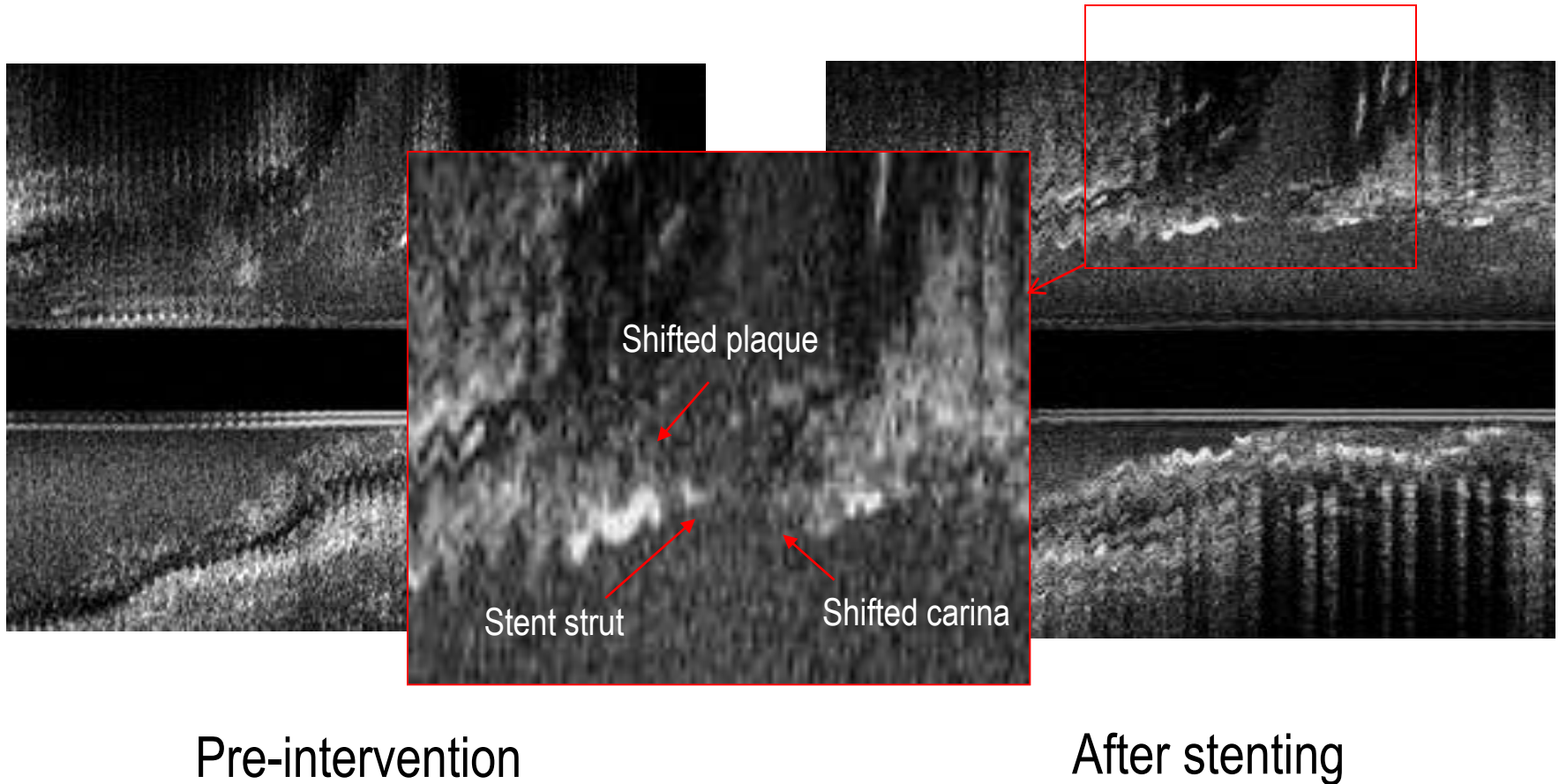
Diagnostic accuracy of anatomic parameters in SB ostial lesions



Koh JS, Koo BK, et al., JACC Intv, 2012

To know what happened in SB, use IVUS!

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





To decide how to do SB intervention, use IVUS!

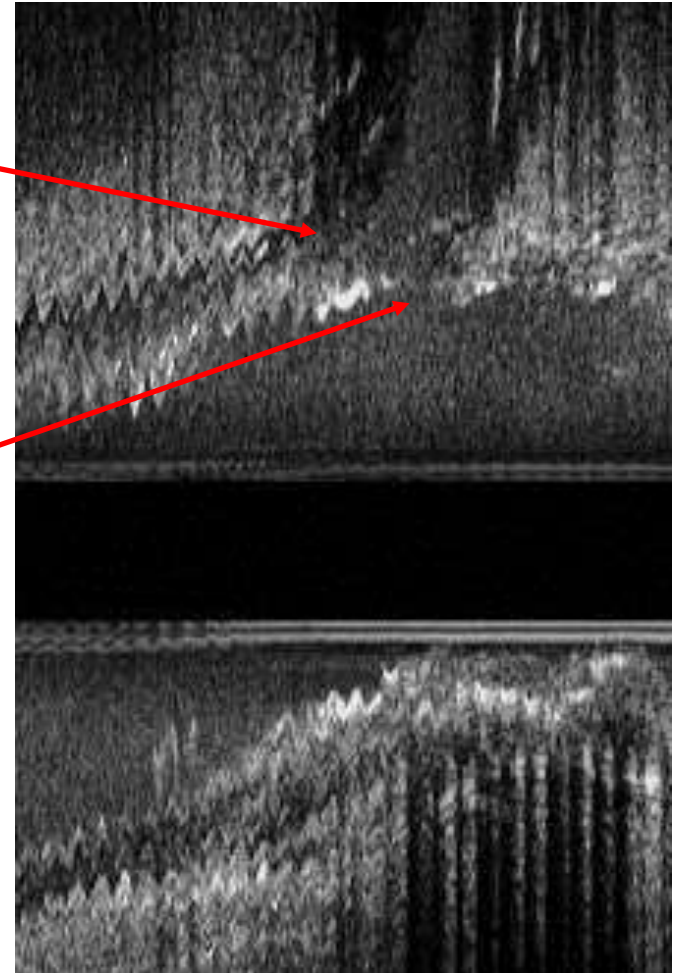
Different target, different strategy

- **Target: SB plaque**

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

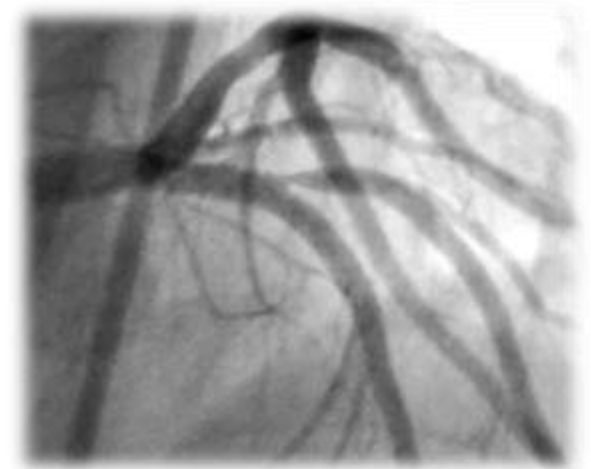
- **Target: Shifted carina**

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



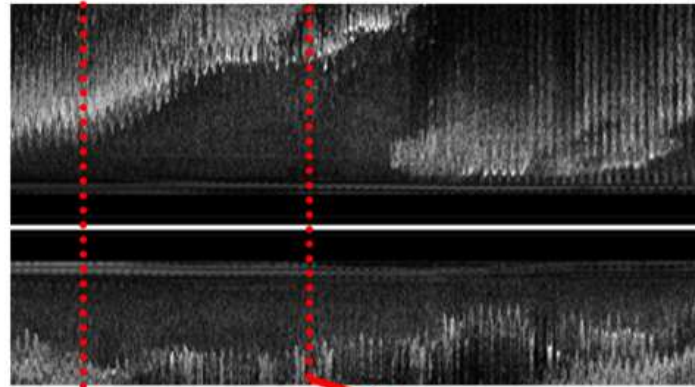
IVUS and FFR in non-LM bifurcation PCI : Step-by-Step Approach

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To see your procedure: use IVUS!

Lumen area, lumen eccentricity, fractal ratio....

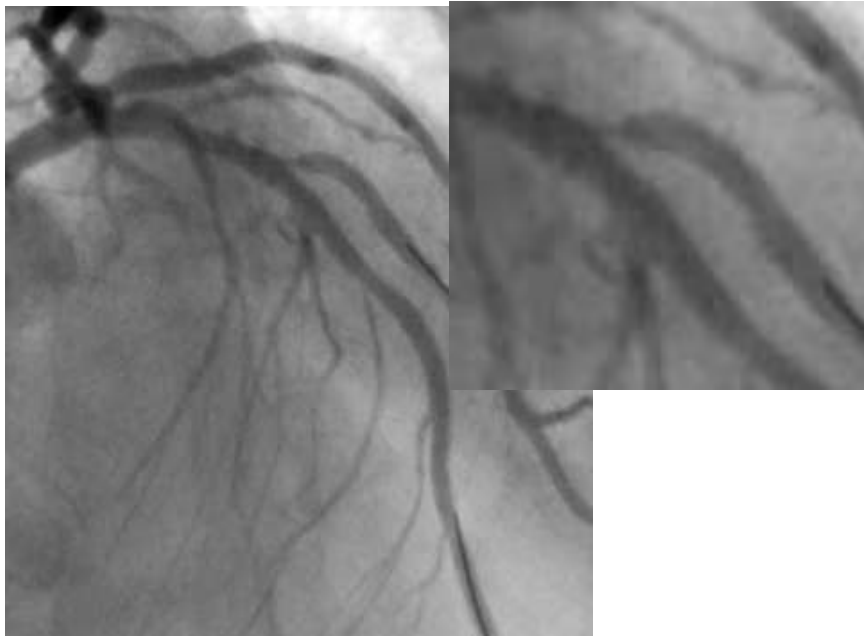


Reference segment
Average diameter 3.7mm
Eccentricity: $3.51/3.75 = 0.93$

Proximal MB
Average diameter: 4.2 mm
Eccentricity: $3.6/5.0 = 0.71$

Estimated diameter
by fractal ratio = 3.7mm
Optimality index: $4.2/3.7 = 1.13$

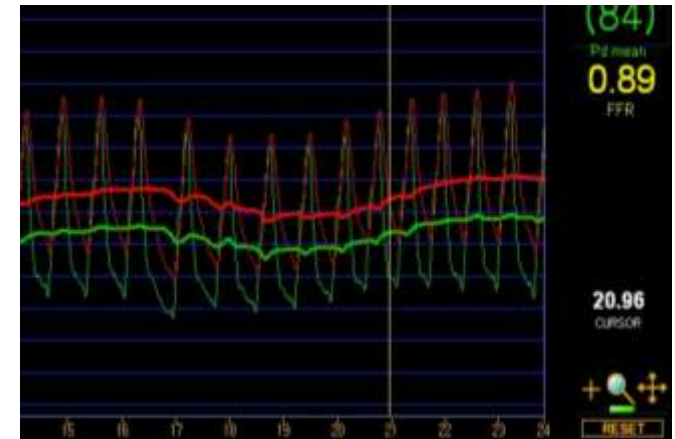
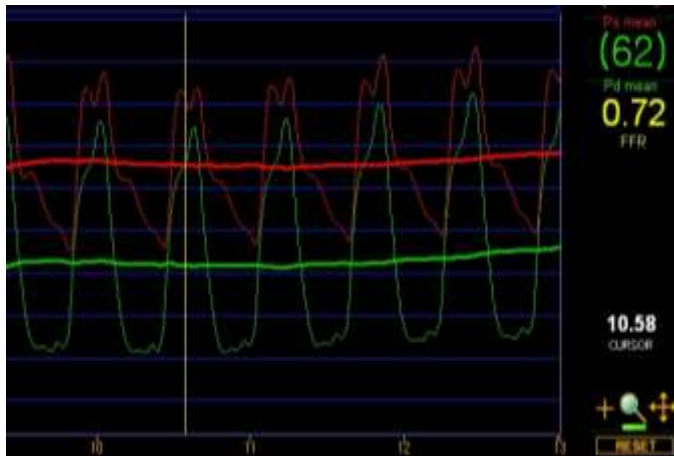
To determine what to do: FFR is helpful!



After MB stenting



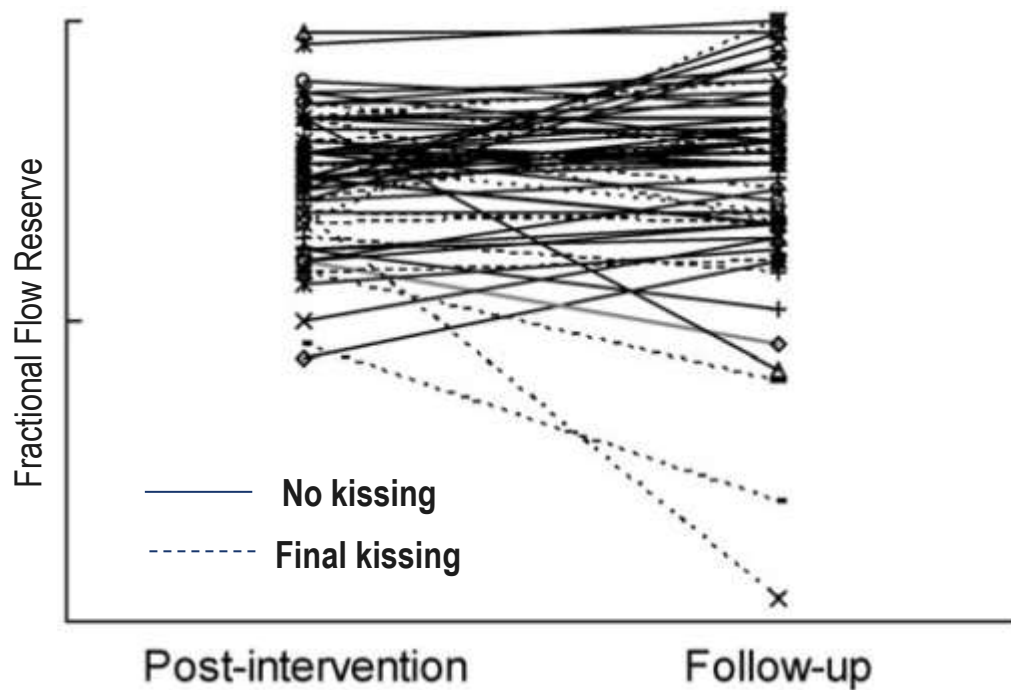
After kissing balloon



Koo BK & de Bruyne B, Eurointervention 2010

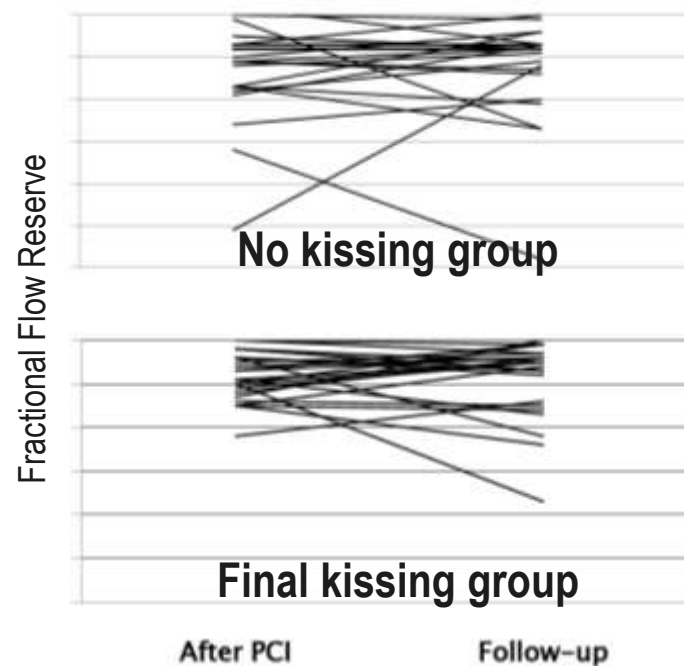
Functional outcome of Jailed side branches

SNUH SB FFR registry



Koo BK, et al Eur Heart J 2009

**Nordic Baltic Bifurcation III
: SB FFR substudy**



Kumsars I, et al. Eurointervention 2011

After 2 stenting, use IVUS!

Angiographically excellent, but.....

604 Costa et al.
Crush Stenting for Bifurcation Lesions

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

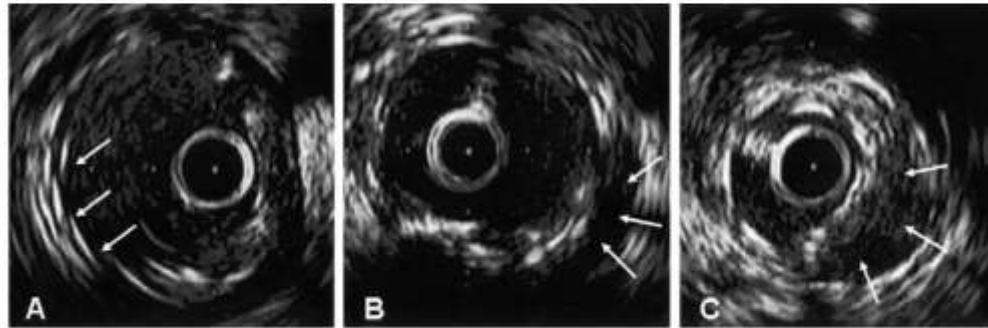
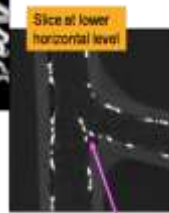
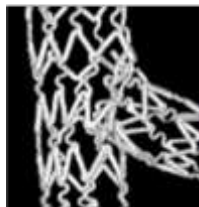
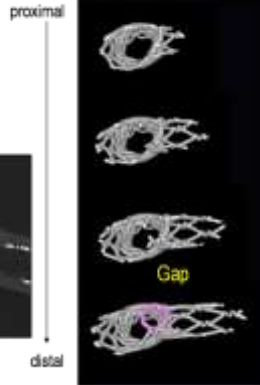


Figure 4. (A) Intravascular ultrasound image showing complete crush (apposition) of the side branch (SB) stent; arrows indicate the three layers of stent struts. (B, C) Intravascular ultrasound images showing incomplete crush (apposition) of the SB stent struts (arrows).

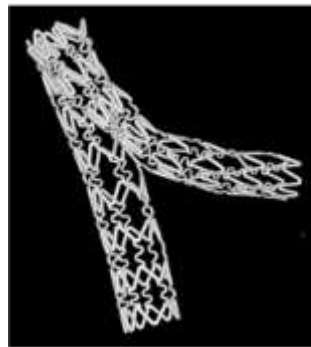
Modified T-stenting



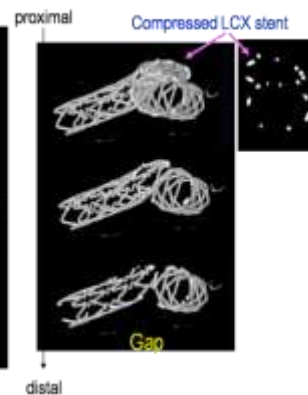
Cross sectional view



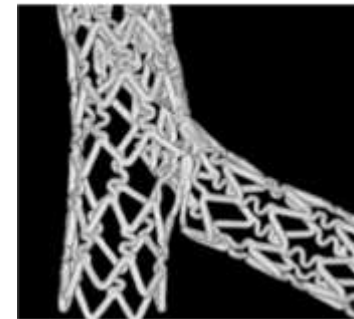
Kissing stenting



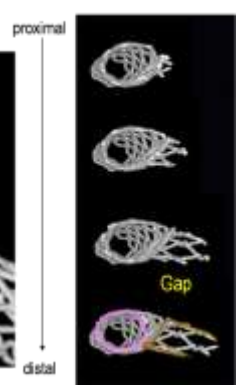
Cross sectional view



Crush technique



Cross sectional view



Courtesy of Dr. Murasato

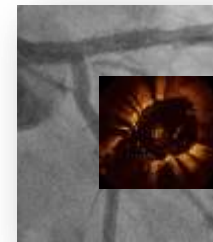
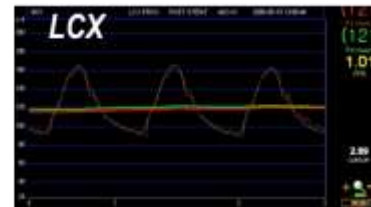
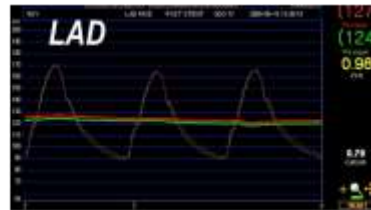
FFR after SB stenting has different meaning

: When it is bad, it really is bad, but high FFR does not always guarantee the favorable outcomes

SB FFR after crush stenting Pre- and Post- final kissing balloon



**Functionally complete
revascularization**



Pre-KBA FFR
0.90
0.96
0.95
0.96
0.92
0.95
0.94
1.00
0.94
0.88
0.88
0.97

0.94 ± 0.04



Post-KBA FFR
0.96
1.00
0.95
0.96
1.00
0.98
0.96
1.00
0.94
0.94
0.94
1.00

0.97 ± 0.03

Lee BK, et al. Clinical Cardiol 2010

IVUS and FFR in non-LM bifurcation PCI

: Step-by-Step Approach

- Use of IVUS and/or FFR is feasible and helpful at each step of bifurcation PCI.
- However, adequate knowledge on coronary anatomy/physiology and pitfalls of IVUS/FFR is essential to properly use IVUS/FFR at each step of bifurcation PCI.

	FFR	IVUS
<i>Pre-intervention</i>		
Main branch ischemia	+++	+
Side branch ischemia	++	+
Planning the procedure	+	+++
<i>After main branch stenting</i>		
Mechanism of side branch jailing	-	+++
Jailed side branch ischemia	+++	+
<i>After side branch intervention</i>		
Residual ischemia	+++	+
Procedural success after 2 stenting	+	+++