Left Main and Bifurcation Summit

IVUS-Guided Provisional Stenting: Plaque or Carina Shift

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Disclosure

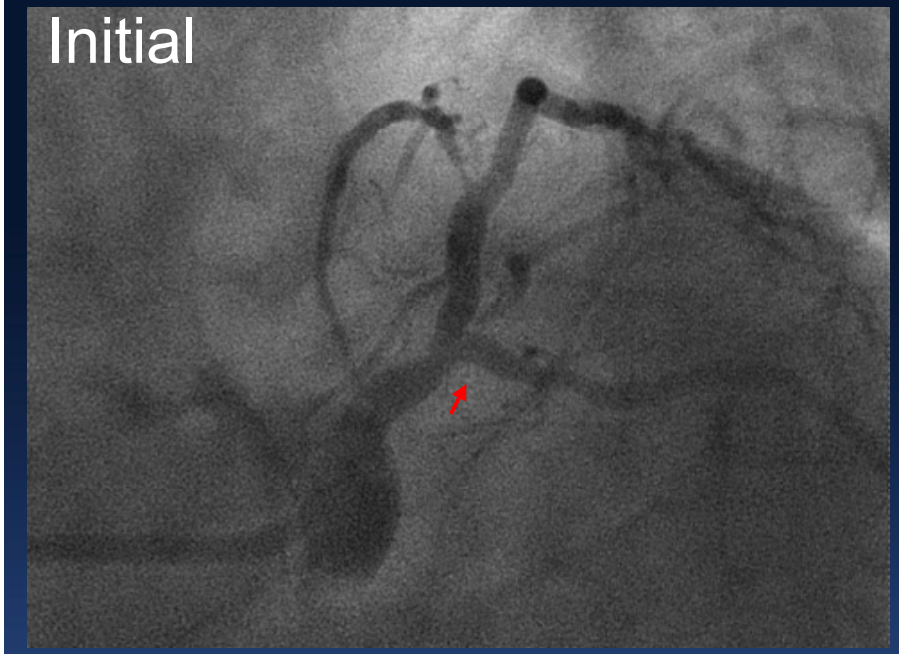
I have nothing to disclose

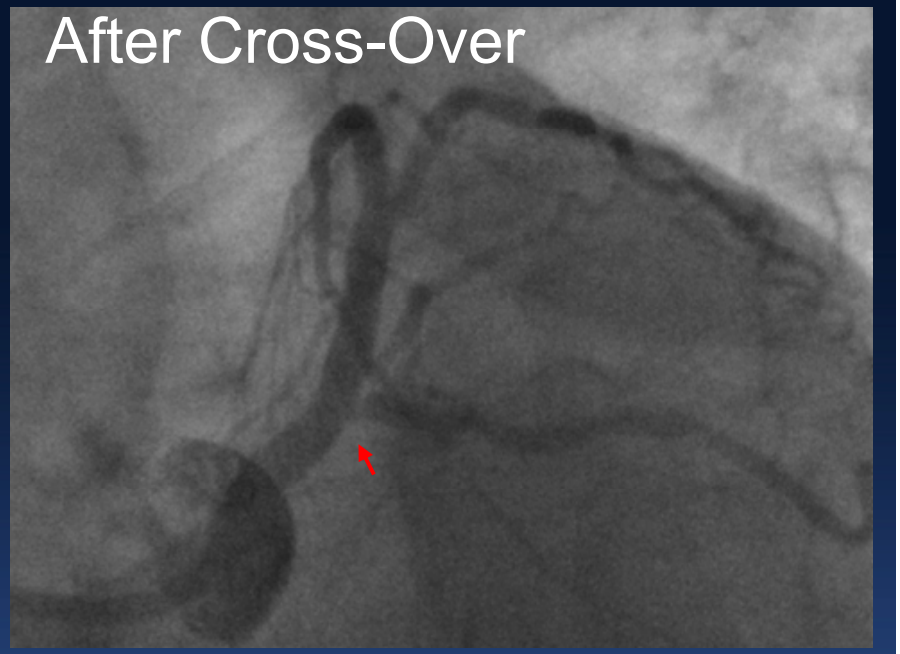
IVUS-Guided Provisional Stenting
Plaque or Carina Shift

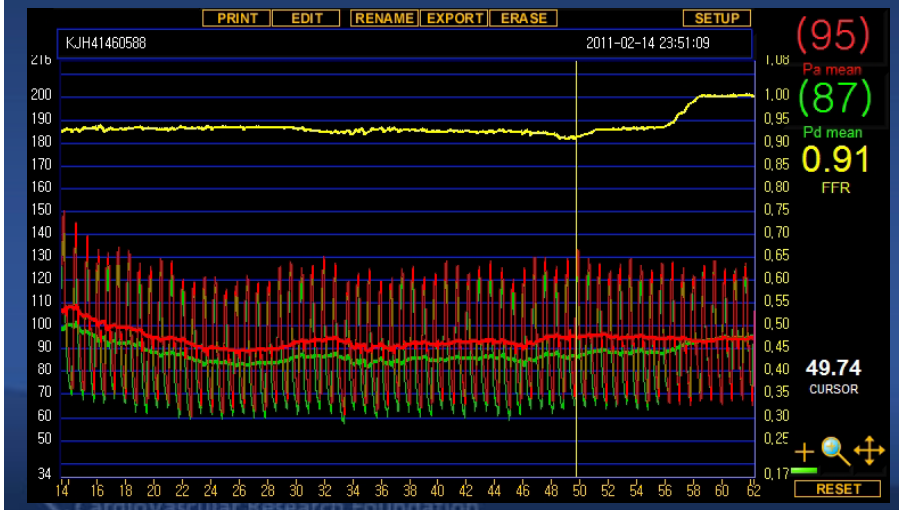
- **Mechanisms of SB Compromise**
- **Functional Significance of Jailing**
  - *"Anatomical-Functional Mismatch"*
- **Pre-PCI Predictors for Functional Jailing**

Mechanisms of Angiographic SB Jailing

Carina Shift



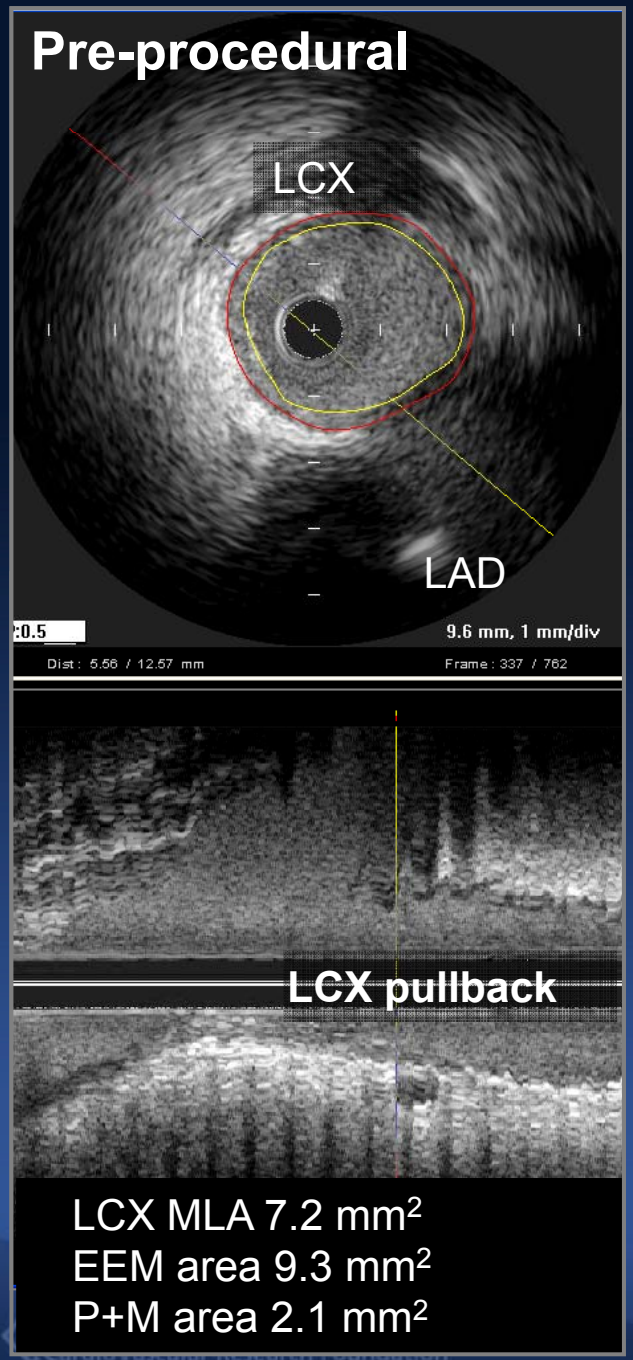




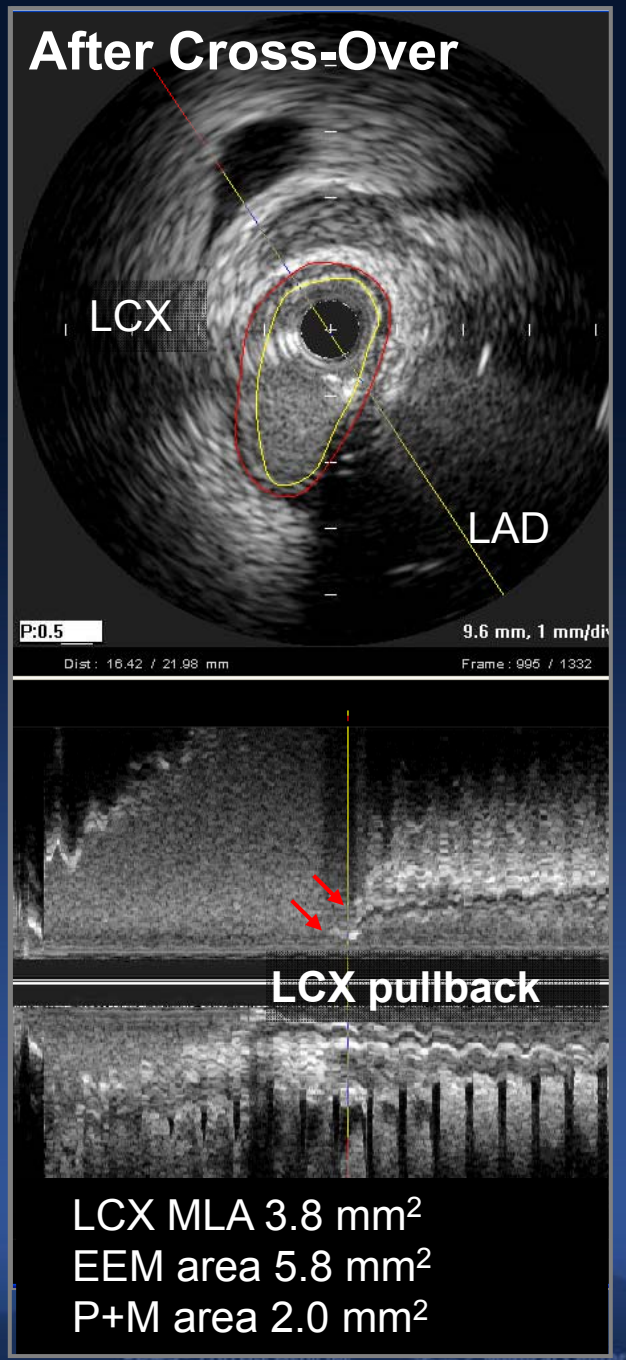
LCX FFR 0.91
Post-stenting

Carina Shift

After cross-over

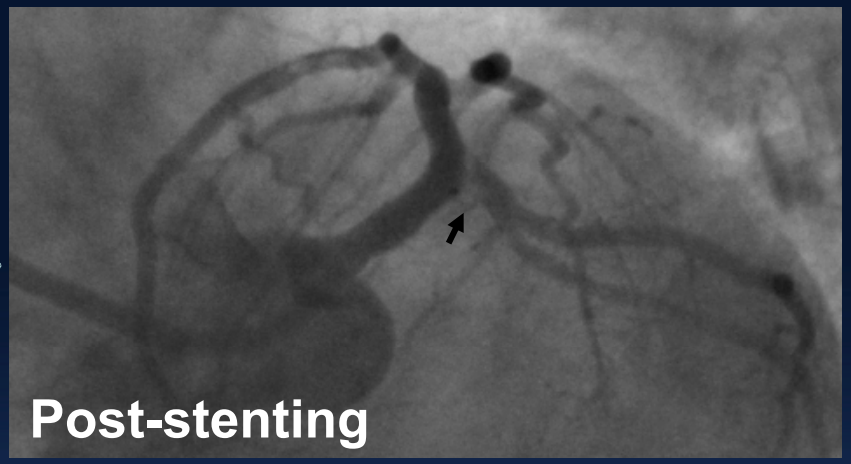


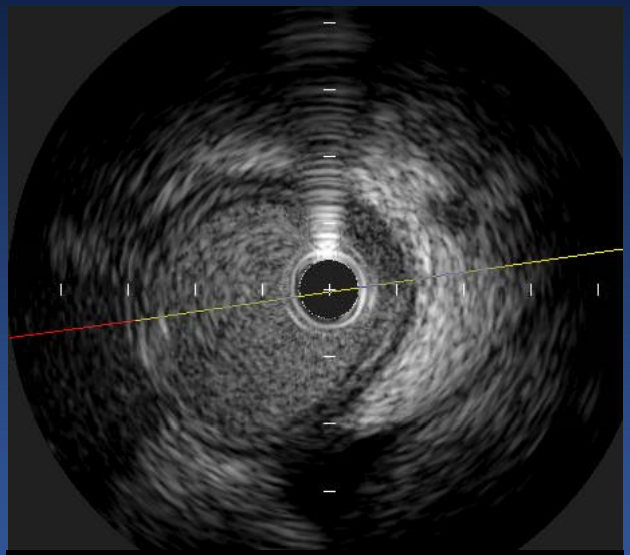
Area Change	
ΔLumen	-3.4 mm²
ΔVessel	-3.5 mm²
ΔPlaque	-0.1 mm²



Mechnisms of Angiographic SB Jaling

Plaque Redistribution

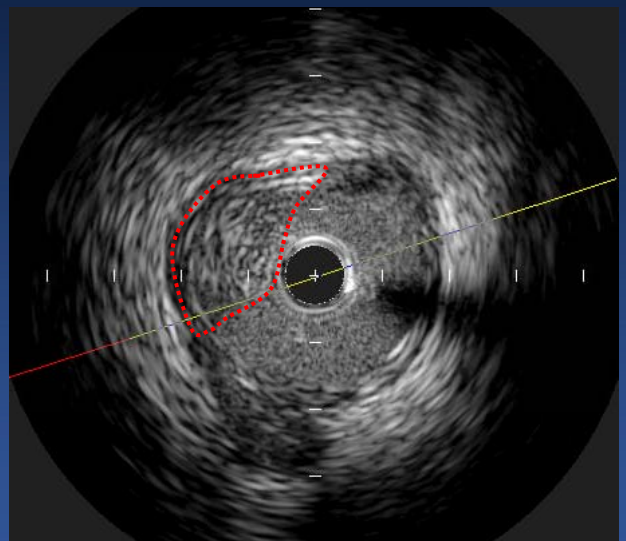




LCX MLA 6.9mm^2
EEM area 9.1mm^2
P+M 2.2 mm^2

After cross-over

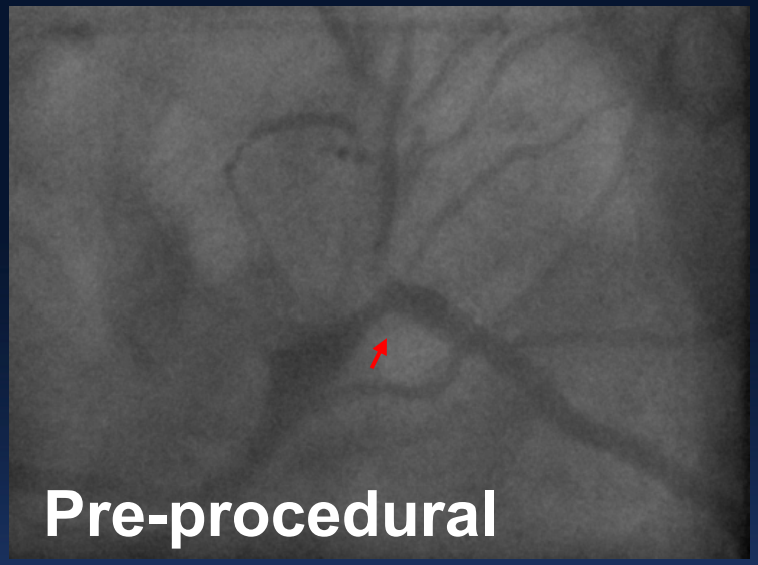
Area Change	
ΔLumen	-1.9mm^2
ΔVessel	-0.4mm^2
ΔPlaque	**+1.5mm^2**

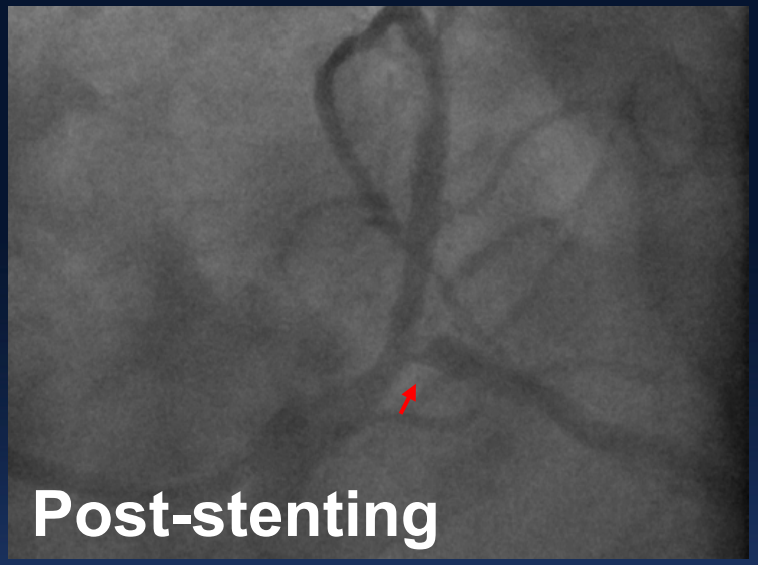


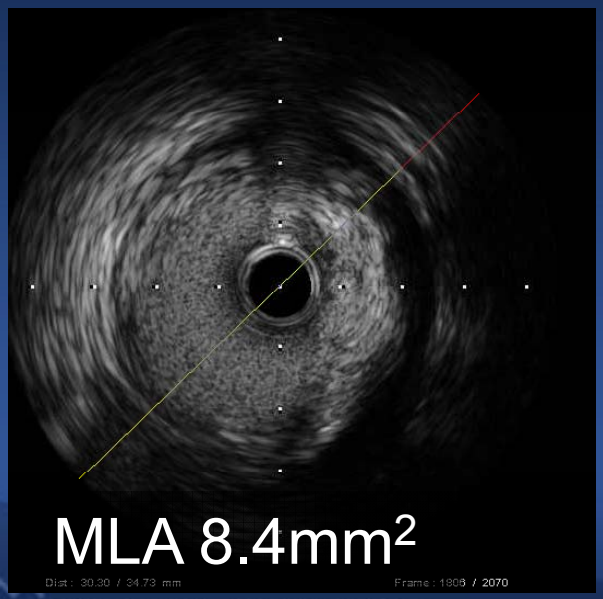
LCX MLA 5.0mm^2
EEM area 8.7mm^2
P+M 3.7 mm^2

Mechanisms of Angiographic SB Jaliing

Stent Strut Artifact

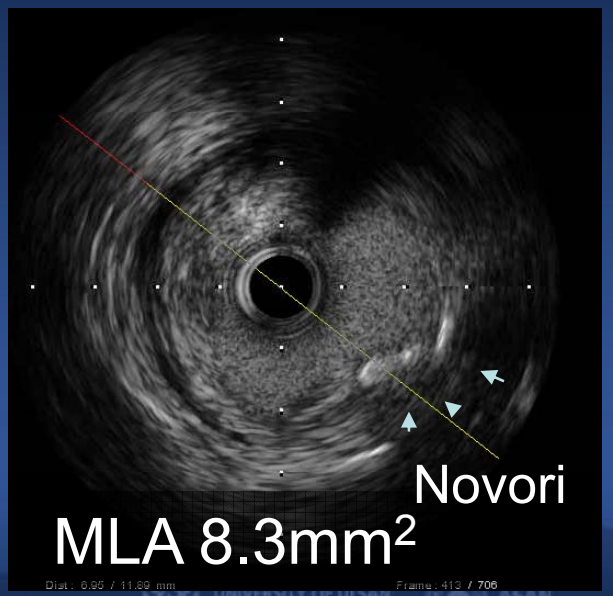






After cross-over

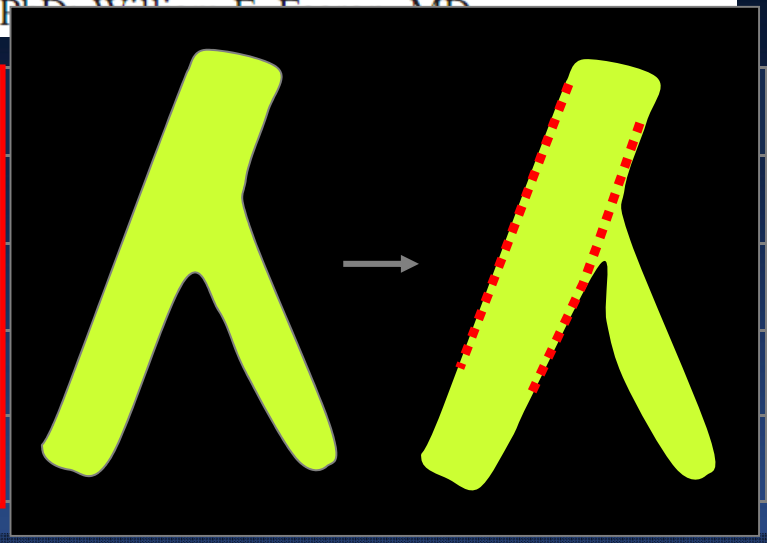
No changes in Lumen or Plaque



Anatomic and Functional Evaluation of Bifurcation Lesions Undergoing Percutaneous Coronary Intervention

Bon-Kwon Koo, MD, PhD; Katsuhisa Waseda, MD, PhD; Hyun-Jae Kang, MD, PhD; Hyo-Soo Kim, MD, PhD; Chang-Wook Nam, MD, PhD; Seung-Ho Hur, MD, PhD; Jung-Sun Kim, MD, PhD; Donghoon Choi, MD, PhD; Yangsoo Jang, MD, PhD; Joo-Yong Hahn, MD, PhD; Hyeon-Cheol Gwon, MD, PhD; Myeong-Ho Yoon, MD, PhD; Seung-Jea Tahk, MD, PhD; Woo-Young Chung, MD, PhD; Young-Seok Cho, MD, PhD; Dong-Ju Choi, MD, PhD; Takao Hasegawa, MD; Toru Kataoka, MD; Sung Jin Oh, MD; Yasuhiro Honda, MD; Peter J. Fitzgerald, MD,

	Distal MB segment		
	Pre	Post	p
Lumen VI	3.5±1.5	6.1±2.1	<0.001
Plaque VI	**5.4±1.8**	**5.3±1.7**	**0.227**
Vessel VI	**9.0±2.5**	**11.3±3.1**	**<0.001**



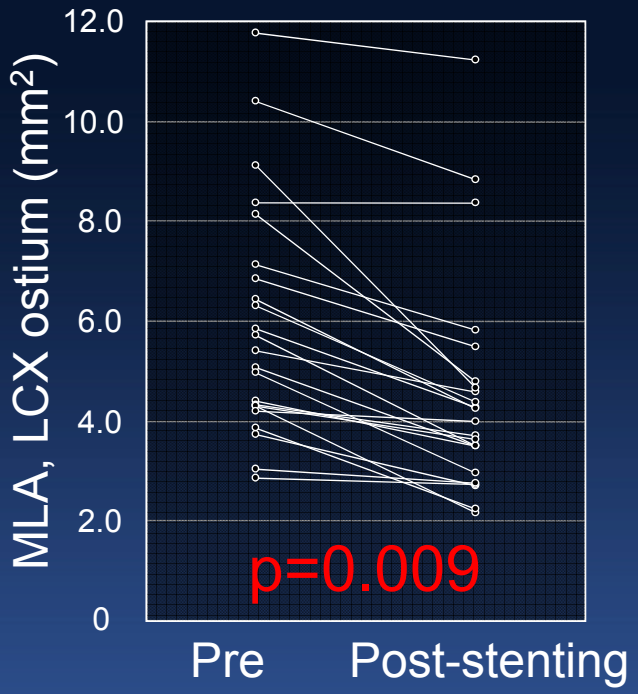
In distal MB, luminal gain is not caused by plaque shift but by vessel enlargement. Carina shift as a result mainly contributes to SB compromise

Koo et al. Circ Cardiovasc Interv 2010;3:113-9

Changes in LCX Ostial Geometry

After a Single Stent Cross-over of LM

MLA within LCX Ostium



	Pre	Post	%Δ
MLA, LCX ostium	5.4mm²	4.0mm²*	**-20%**
MLA, LCX carina	6.3mm²	4.3mm²*	**-31%**
P+M, LCX ostium	5.2mm²	5.4mm²	+4%
Eccentricity index	1.22	1.47*	**+20%**

78% showed >10% reduction in MLA within LCX ostium

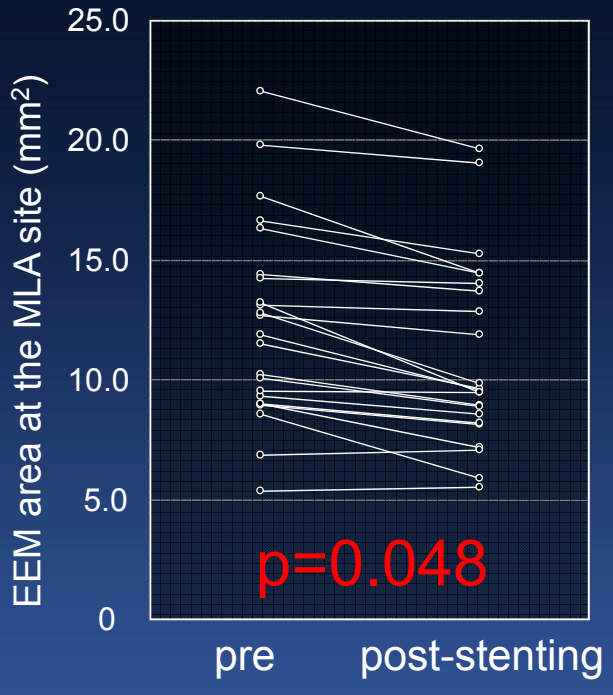
Kang et al. Circ Cariovasc Interv 2011 Accepted

Changes in LCX Ostial Geometry

After a Single Stent Cross-over of LM

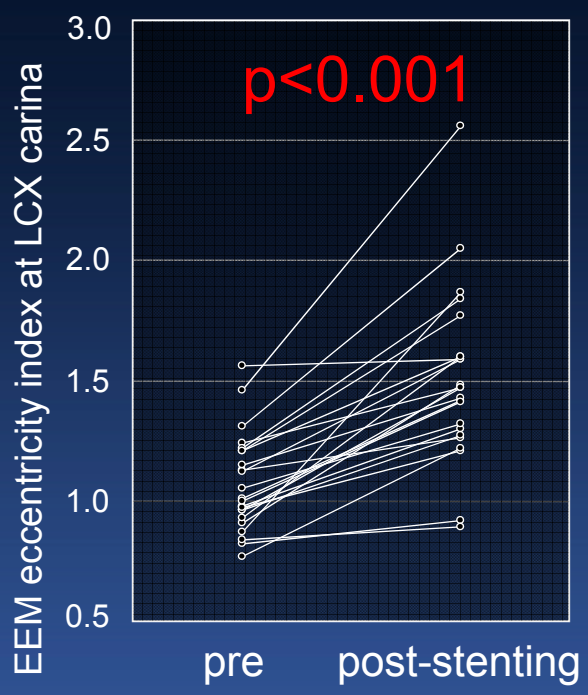
EEM area at MLA

11.8mm²→9.6mm²



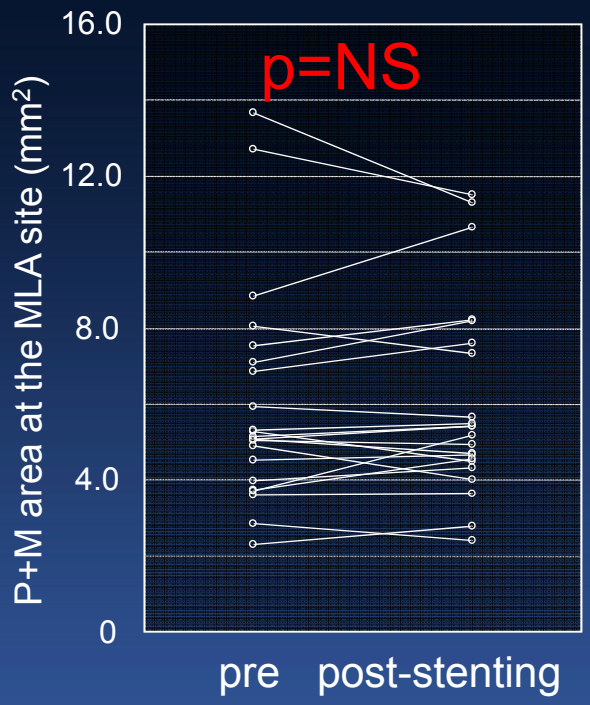
EEM eccentricity

1.22→1.47



P+M area

5.2mm²→5.4mm²



Carina shift is a general mechanism of SB compromise

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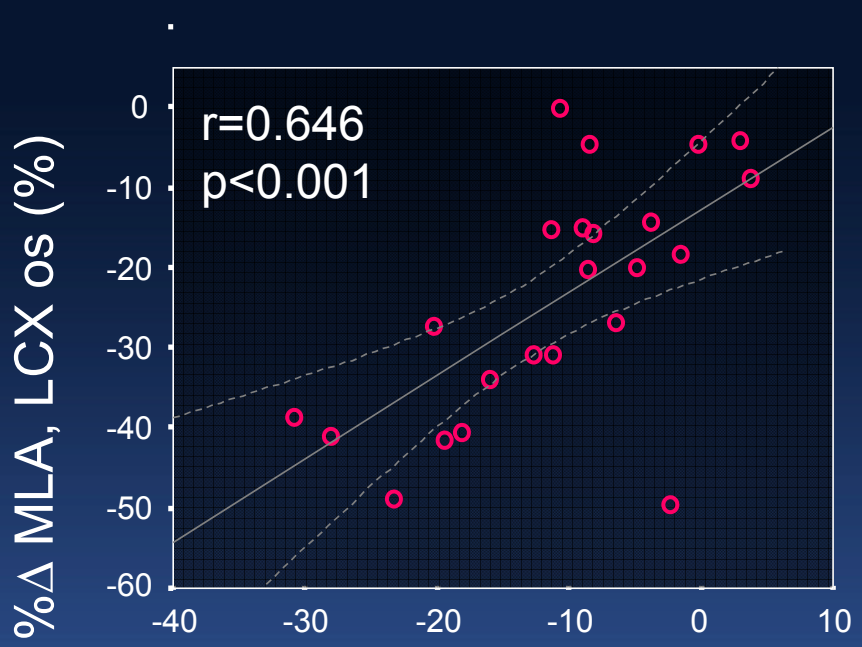
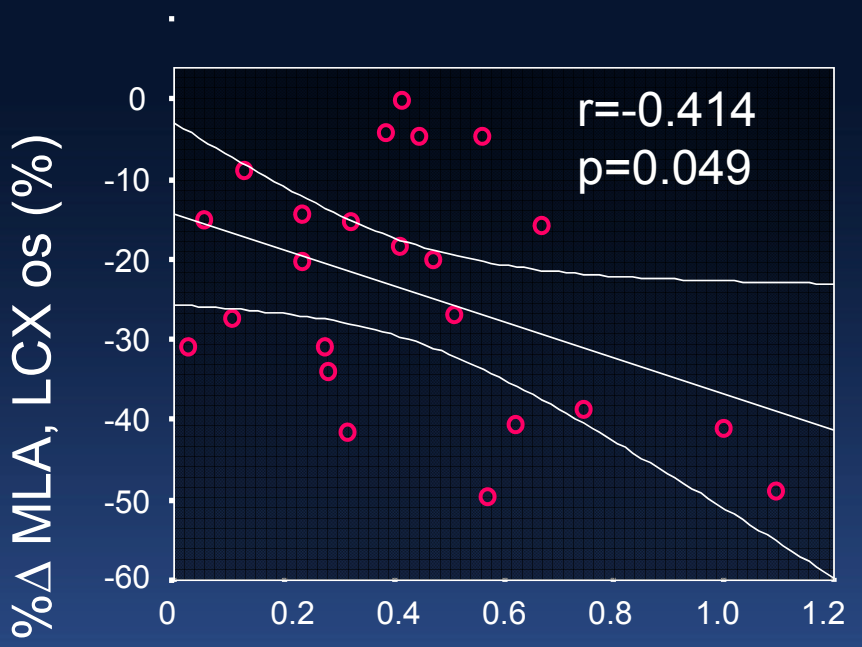
Carina Shift
Primary Mechanism of SB Compromise



%Δ EEM area at MLA site(%)



Change in EEM eccentricity

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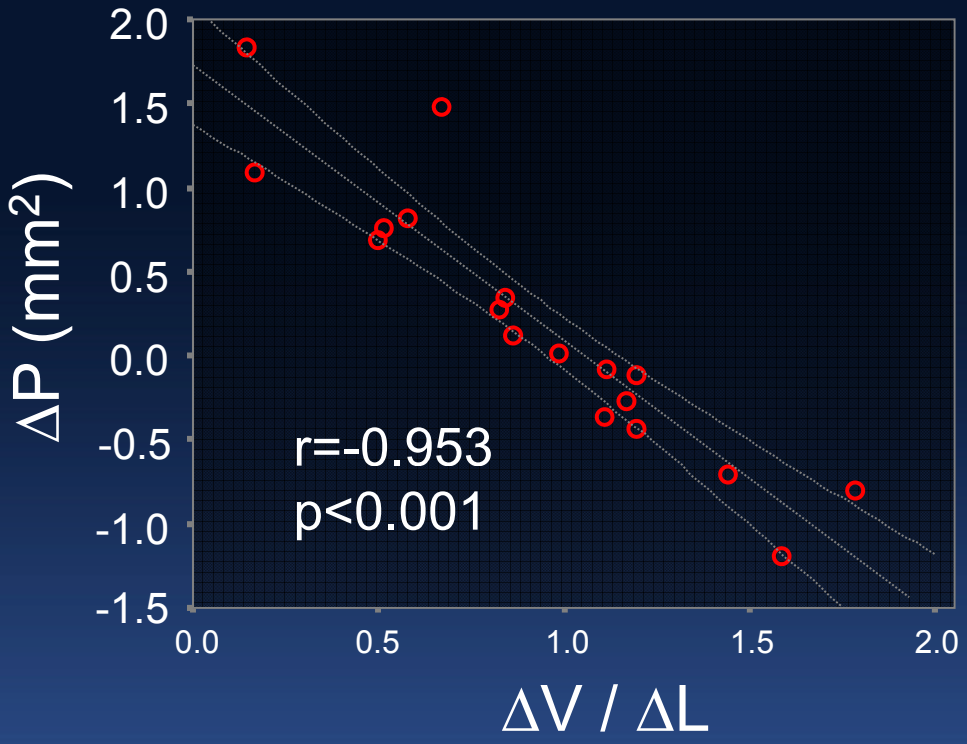
Plaque Redistribution

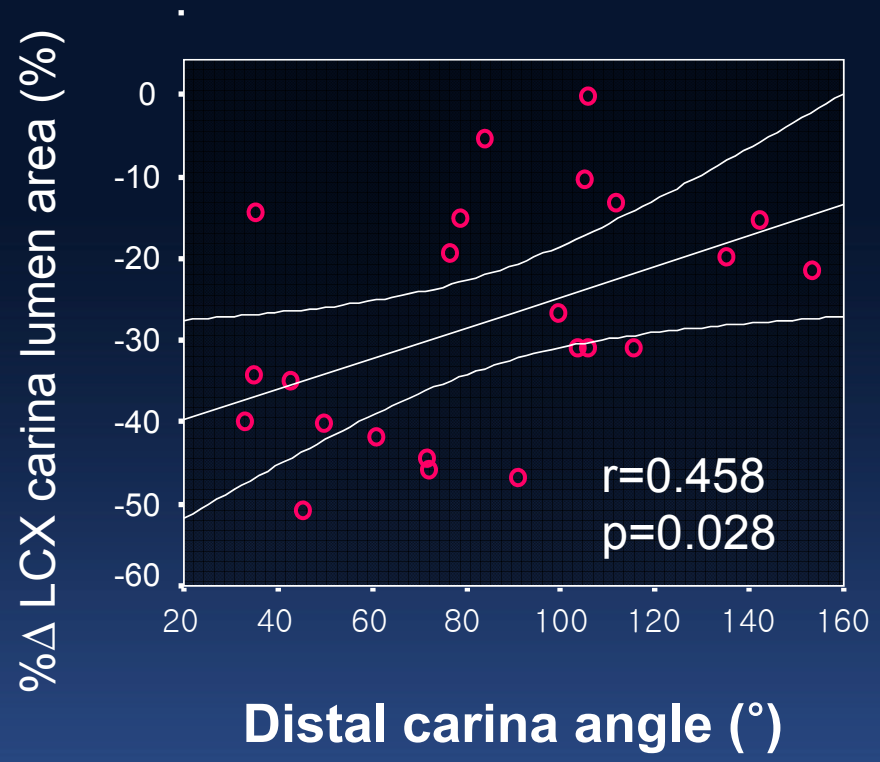
Second Mechanism of SB Compromise

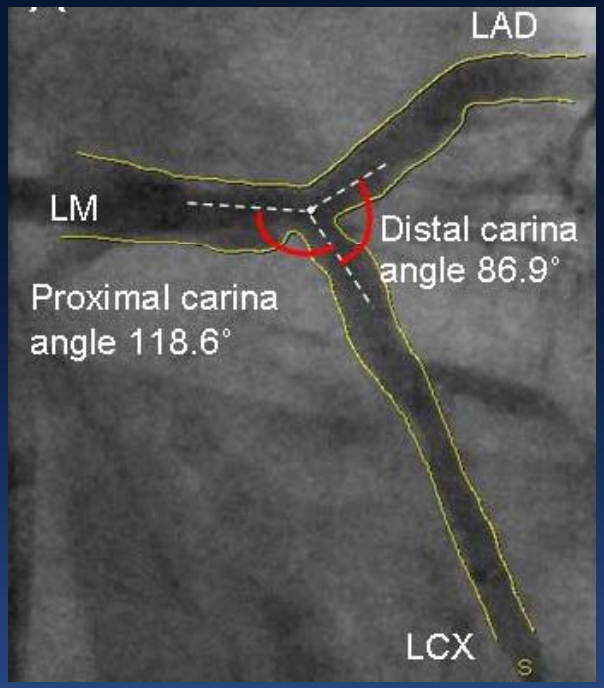


In minority, plaque redistribution may be superimposed on carina shift to lead to the further MLA loss

Kang et al. Circ Cariovasc Interv 2011 Accepted

Pre-Procedural Predictor for Anatomical SB Compromise



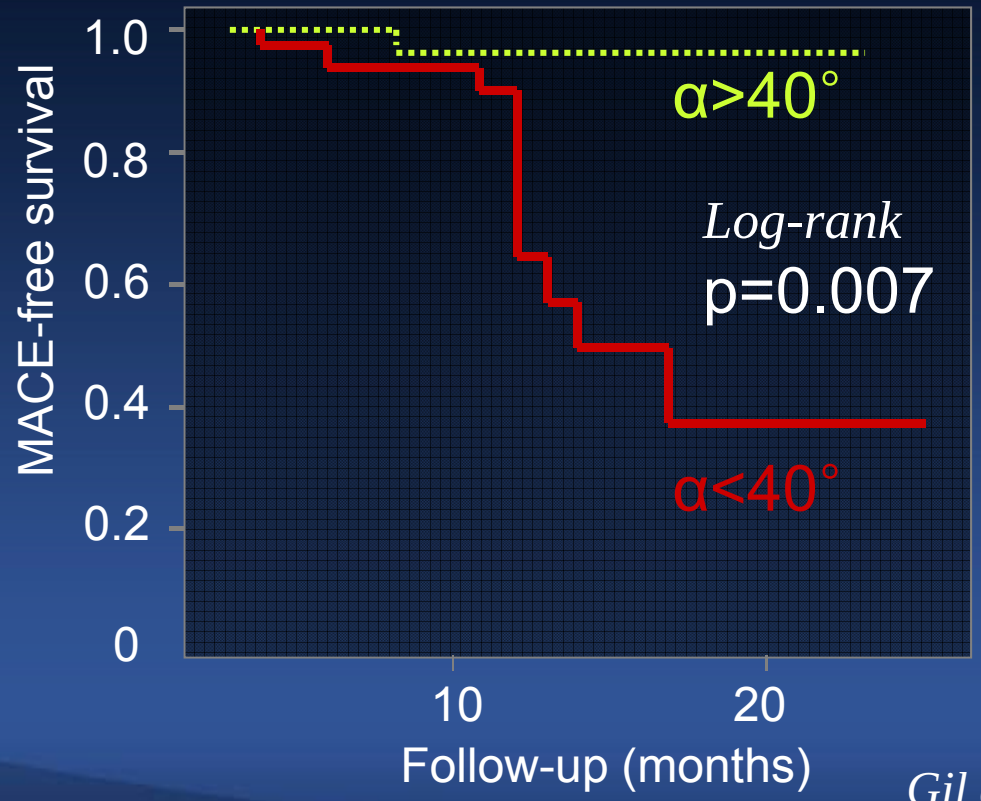


A narrow distal carina angle between LAD and LCX predicted **a greater reduction in MLA as well as EEM area** at the LCX ostium

Kang et al. Circ Cariovasc Interv 2011 Accepted

The Carina Angle—New Geometrical Parameter Associated with Periprocedural Side Branch Compromise and the Long-Term Results in Coronary Bifurcation Lesions with Main Vessel Stenting Only

ROBERT J. GIL, M.D., PH.D., F.E.S.C.,[1] DOBRIN VASSILEV, M.D.,[2]
RADOSLAW FORMUSZEWICZ, M.D.,[3] TERESA RUSICKA-PIEKARZ, M.D.,[3]
and ALEXANDER DOGANOV, M.D.[2]



Smaller carina angle predicted higher SB compromise and 1-year MACE rates (also restenosis)

Gil et al. J Interven Cardiol 2009;22:E1–10

IVUS-Guided Provisional Stenting
Plaque or Carina Shift

- **Mechanisms of SB Compromise**
- **Functional Significance of SB Jailing**
  "Anatomical-Functional Mismatch"
- **Pre-PCI Predictor for Functional Jailing**

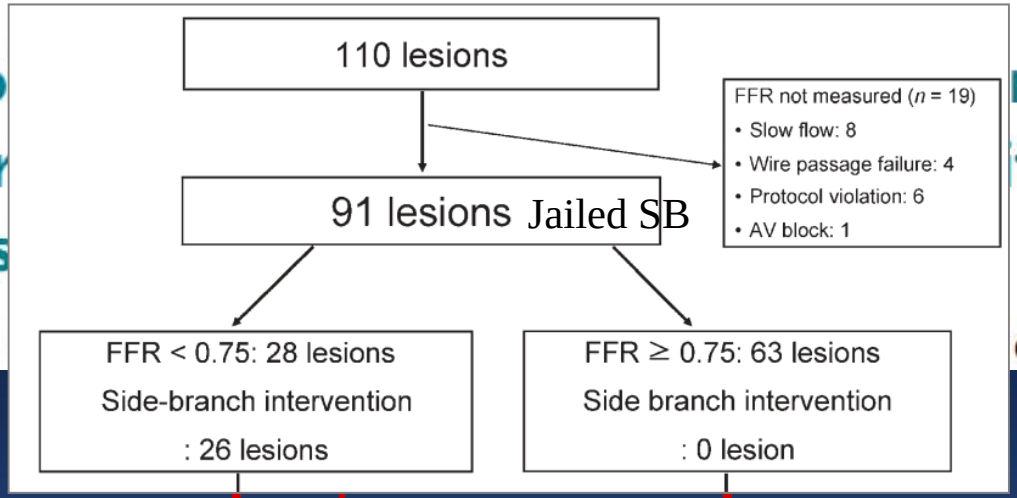
What is Treatment of Jailed SB Based on, Anatomy or Function?

European Heart Journal (2008) **29**, 726–732
doi:10.1093/eurheartj/ehn045

CLINICAL RESEARCH
Interventional cardiology

Physio … nal
side-br … furcation
lesions

Bon-Kwon … Cho[2],



SB intervention
26 lesions

2 lesions

No SB intervention
65 lesions

6 Mo f/u

No change in SB FFR (0.87±0.06→0.89±0.07)
Functional restenosis rate (FFR<0.75)→only 8%

Koo et al. Eur Heart J 2008;29:726–32

No serial changes in SB FFR during 6-month

	Post-intervention	Follow-up	*P*-value
Main branch	0.96 ± 0.04	0.96 ± 0.04	0.9
Jailed side branch	0.87 ± 0.06	0.87 ± 0.09	0.7
KB group	0.86 ± 0.05	0.84 ± 0.11	0.4
Non-KB group	0.87 ± 0.06	0.89 ± 0.07	0.1

9-month MACE FFR-guided vs. Conventional

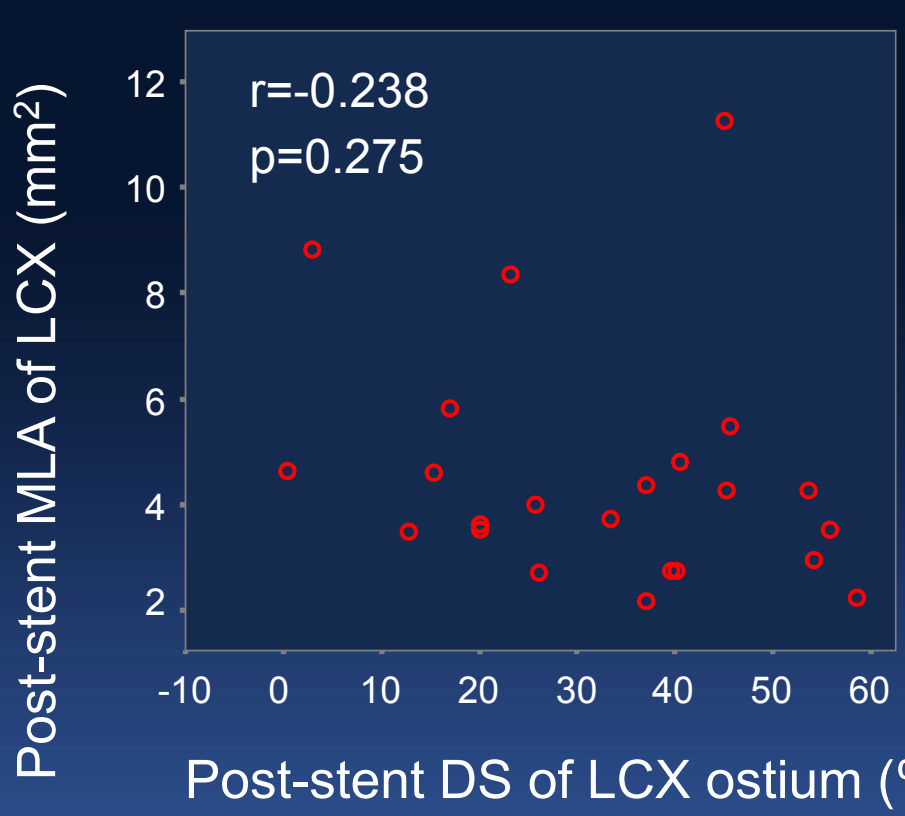
	FFR group, $n = 108$[a]	Conventional group, $n = 108$[b]	*P*-value[c]
Cardiac death	0	0	1
Myocardial infarction	0	0	1
Target vessel revascularization, *n* (%)	5 (4.6)	4 (3.7)	0.7

FFR-guided provisional SB intervention strategy in bifurcating lesion resulted in a low rate of functional restenosis and 9-month cardiac events

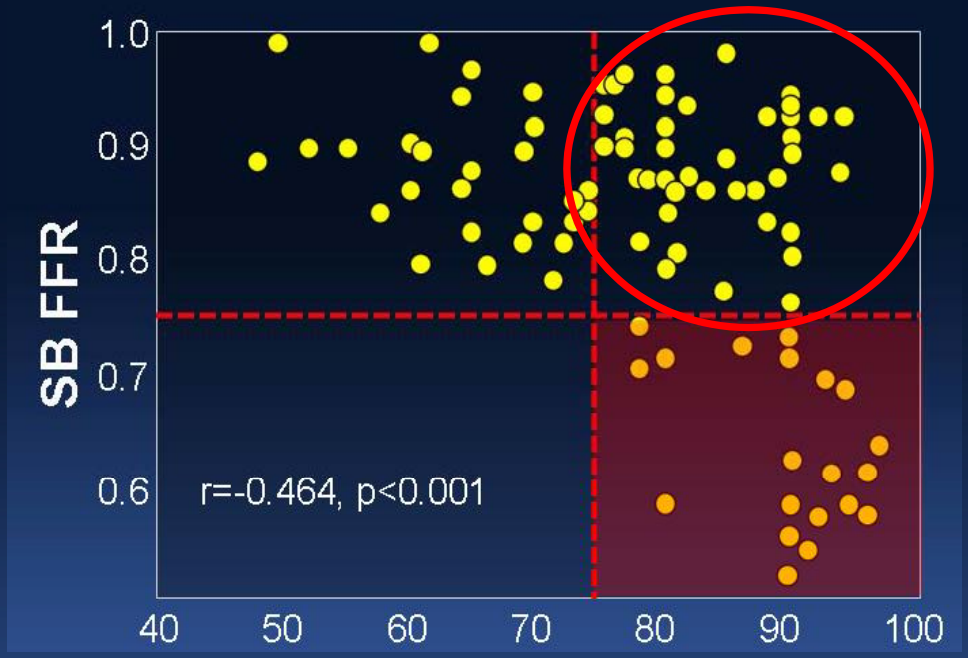
Koo et al. Eur Heart J 2008;29:726–32

%DS Predicts Neither MLA Nor FFR

at the SB Ostium after Cross-over



Kang et al. Circ Cariovasc Interv 2011 Accepted

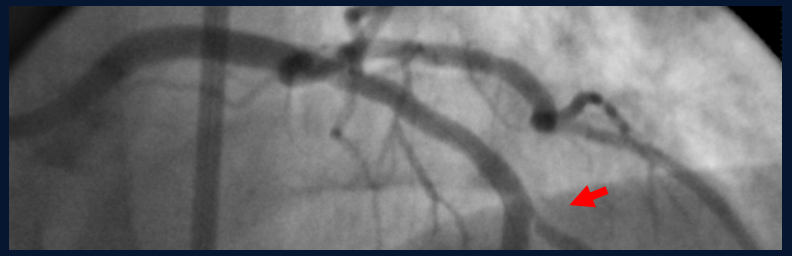


73% Mismatch

Koo et al. JACC 2005;46:633

Most lesions (73%) with angiographic compromise are not functionally significant

Anatomical vs. Functional Mismatch



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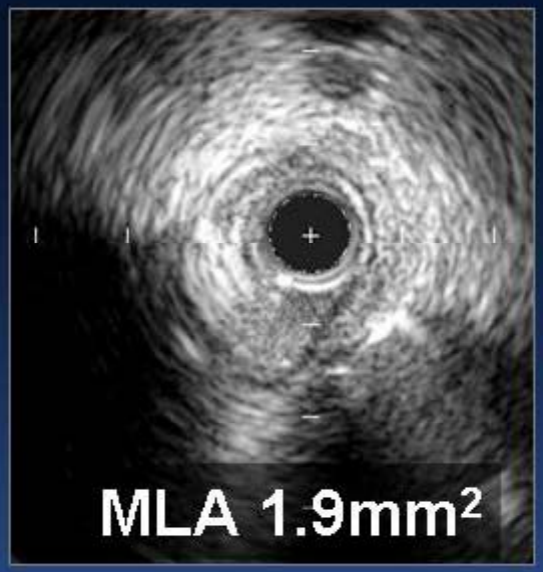

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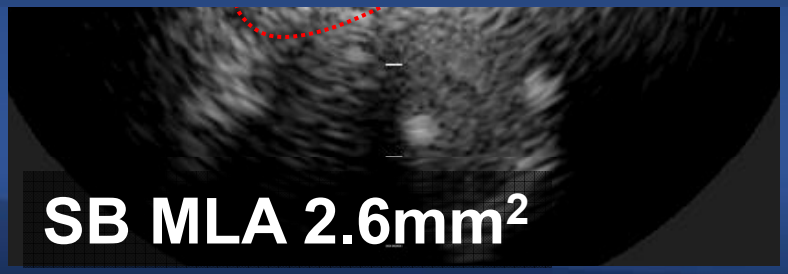
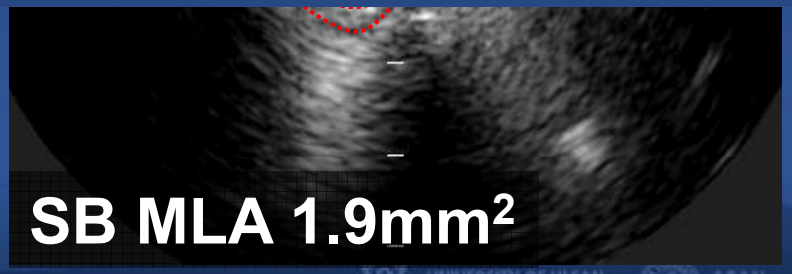
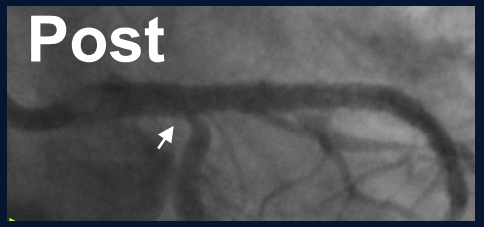




Anatomical vs. Functional Mismatch



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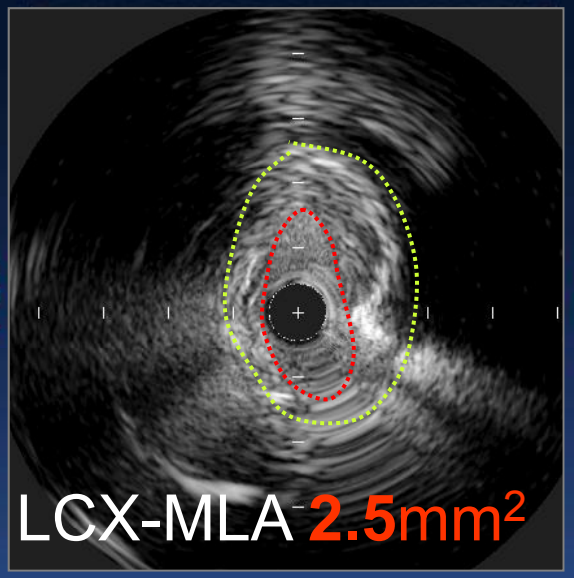

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LCX FFR
0.81

Pitfalls of Pre-PCI IVUS vs. FFR of SB

- Although IVUS assess ***"Anatomical compromise"*** more accurately than QCA, it still has limitations to assess the ***"Functional SB compromise"***

- *MLA as one of the various anatomical factors*
- *FFR is affected by myocardial territory supplied by SB*
- *Technical difficulty in obtaining SB-pullback*

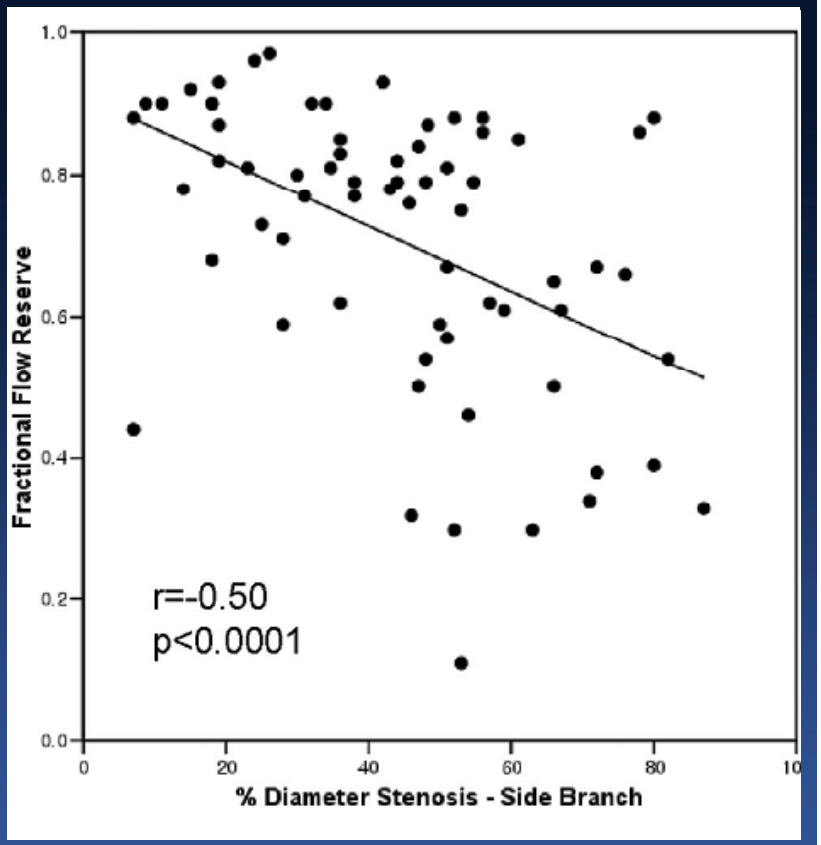
IVUS-Guided Provisional Stenting
Plaque or Carina Shift

- **Mechanisms of SB Compromise**
- **Functional Significance of Jailing**

  "Anatomical-Functional Mismatch"
- **Pre-PCI Predictors for Functional Jailing**

Pre-PCI Angiographic Predictor of Functional Compromise **(SB FFR<0.80)**

	OR	95% CI	p
MB ref MLD	1.10	0.29-4.23	0.89
MB ref DS	1.00	0.95-1.05	0.99
SB ref MLD	0.27	0.06-1.31	0.11
SB %DS	**1.05**	**1.01-1.09**	**0.01**
Lesion length	1.06	0.89-1.25	0.53
Carina angle	3.62	0.23-58.1	0.37
Distal MB MLD	3.86	1.03-14.4	0.05



Koo et al. Circ Cardiovasc Interv 2010;3:113-9

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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,*]

SB FFR <0.80: 18% post-stenting

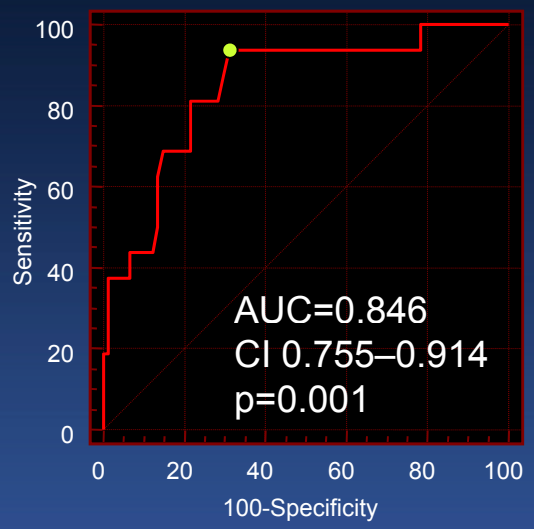
Independent Predictors for SB FFR	β	95% CI	p
Pre-PCI MLA of SB ostium	0.216	0.001 – 0.035	0.040
Pre-PCI PB at SB ostium	-0.296	-0.003 – -0.001	0.005
Pre-PCI MLA of distal MB	0.250	0.005 – 0.027	0.025
Maximal balloon pressure	-0.265	-0.010 – -0.002	0.003

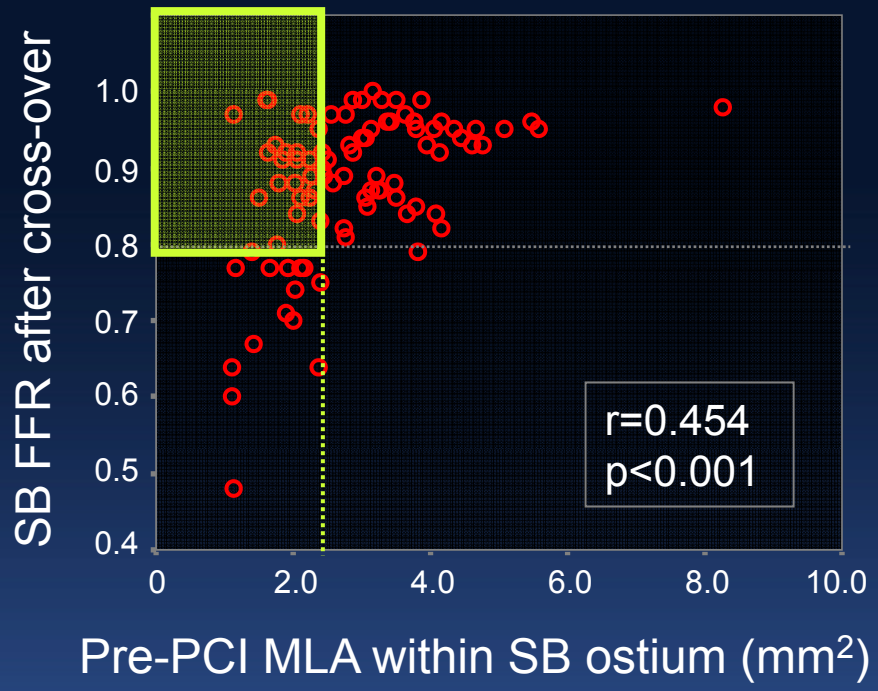
Kang et al. Am J Cardiol 2011 in press

Pre-procedural IVUS-MLA within SB Ostium Predicts SB FFR <0.80 after MB stenting

MLA of SB Ostium

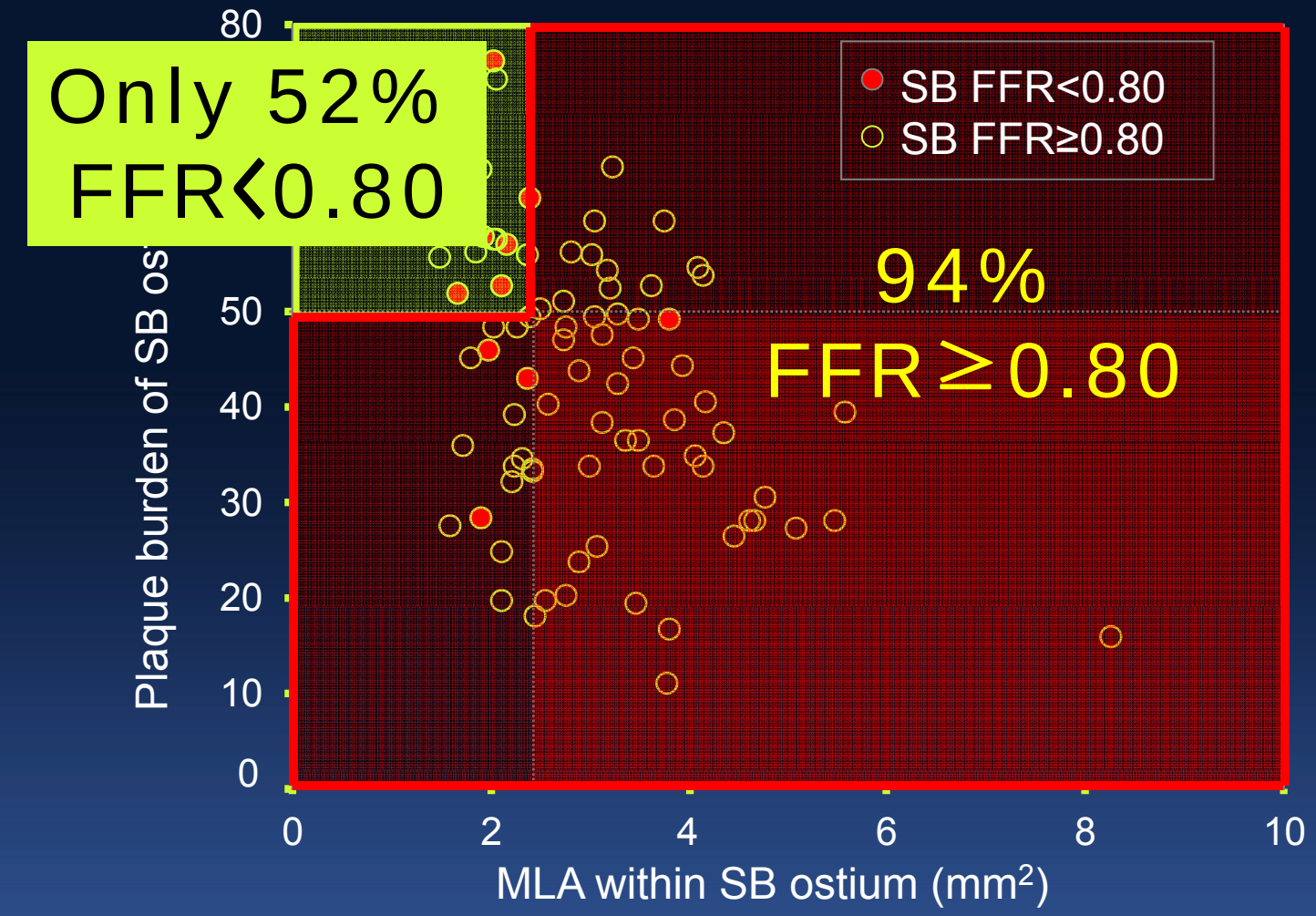
Cut-off =2.4mm^2





Kang et al. Am J Cardiol 2011 in press

32% of SB lesions without functional significance may undergo unnecessary PCI



Combining pre-PCI IVUS-MLA and plaque burden, diagnostic accuracy predicting FFR<0.80 was 83%

Kang et al. Am J Cardiol 2011 in press

Summary Use of IVUS vs. FFR
Pre-procedural

	SB-pullback IVUS	SB FFR
Advantage	▪ useful to assess the anatomical severity - MLA, PB, remodeling ▪ Predictive value for SB FFR after MB stent	▪ functional significance only in isolated SB stenosis, not in true bifurcation
Pitfalls	▪ MLA-FFR mismatch ▪ No IVUS criteria of SB ▪ Low feasibility	▪ Affected by proximal MB or distal SB stenosis ▪ SB geometry is usually changed after MB stenting ▪ No pre-PCI FFR cut-off

Summary Use of IVUS vs. FFR
After MB Cross-over

	SB-pullback IVUS	SB FFR
Advantage	▪ Mechanism of SB jailing ▪ SB MLA	▪ Confirm the functional SB compromise ▪ Prognostic implication
Pitfalls	▪ MLA-FFR mismatch ▪ No IVUS criteria for SB ▪ Low feasibility	▪ Minority - not feasible

Pre-PCI IVUS identifies SB disease and may predict functional SB compromise which is confirmed by post-stenting SB FFR. IVUS provides the precise mechanism