Distal Left Main Bifurcation PCI: Concept is More Important

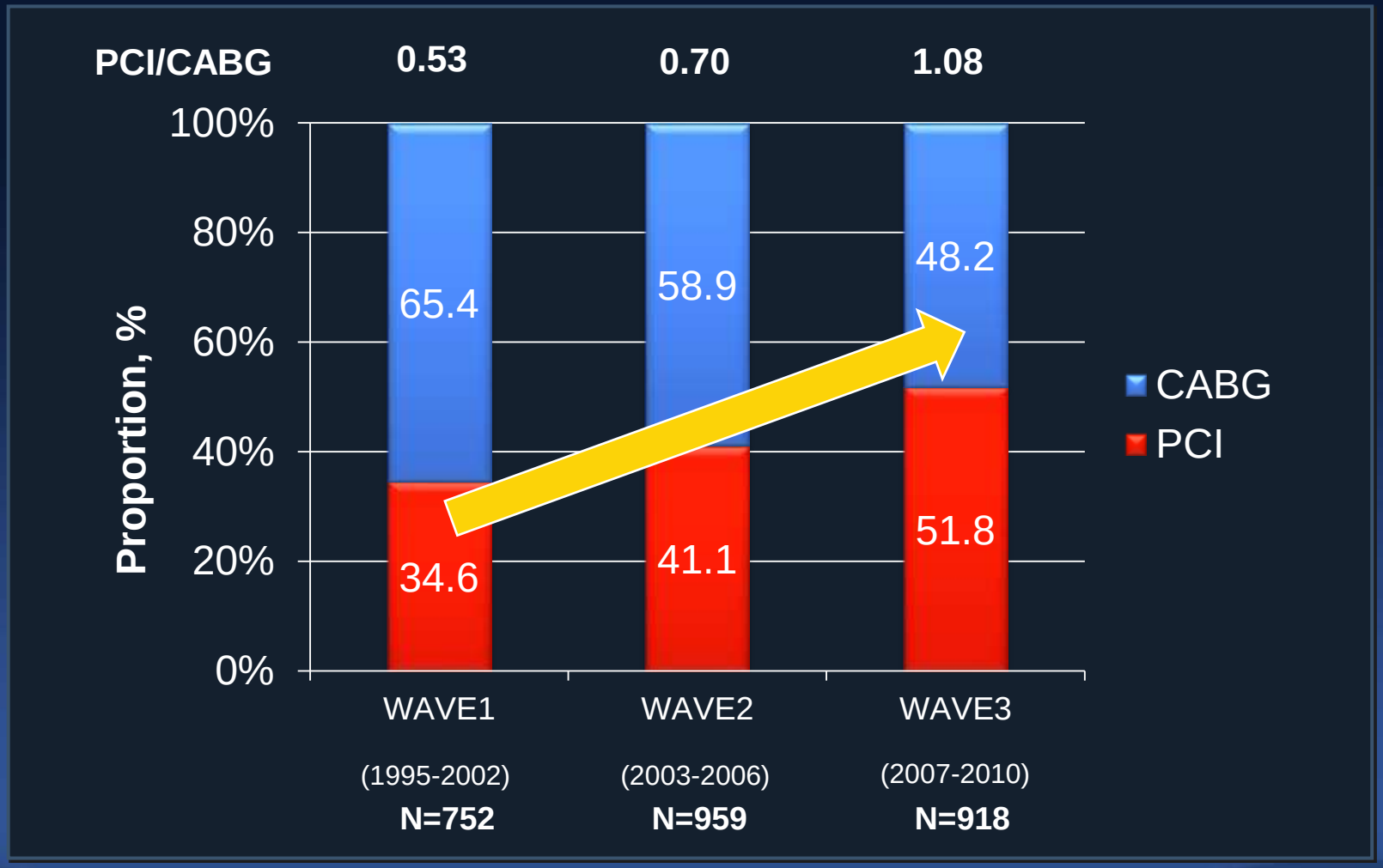
Jung-Min Ahn, MD

Heart Institute, Asan Medical Center, Ulsan University College of Medicine, Seoul, Korea

My Disclosure

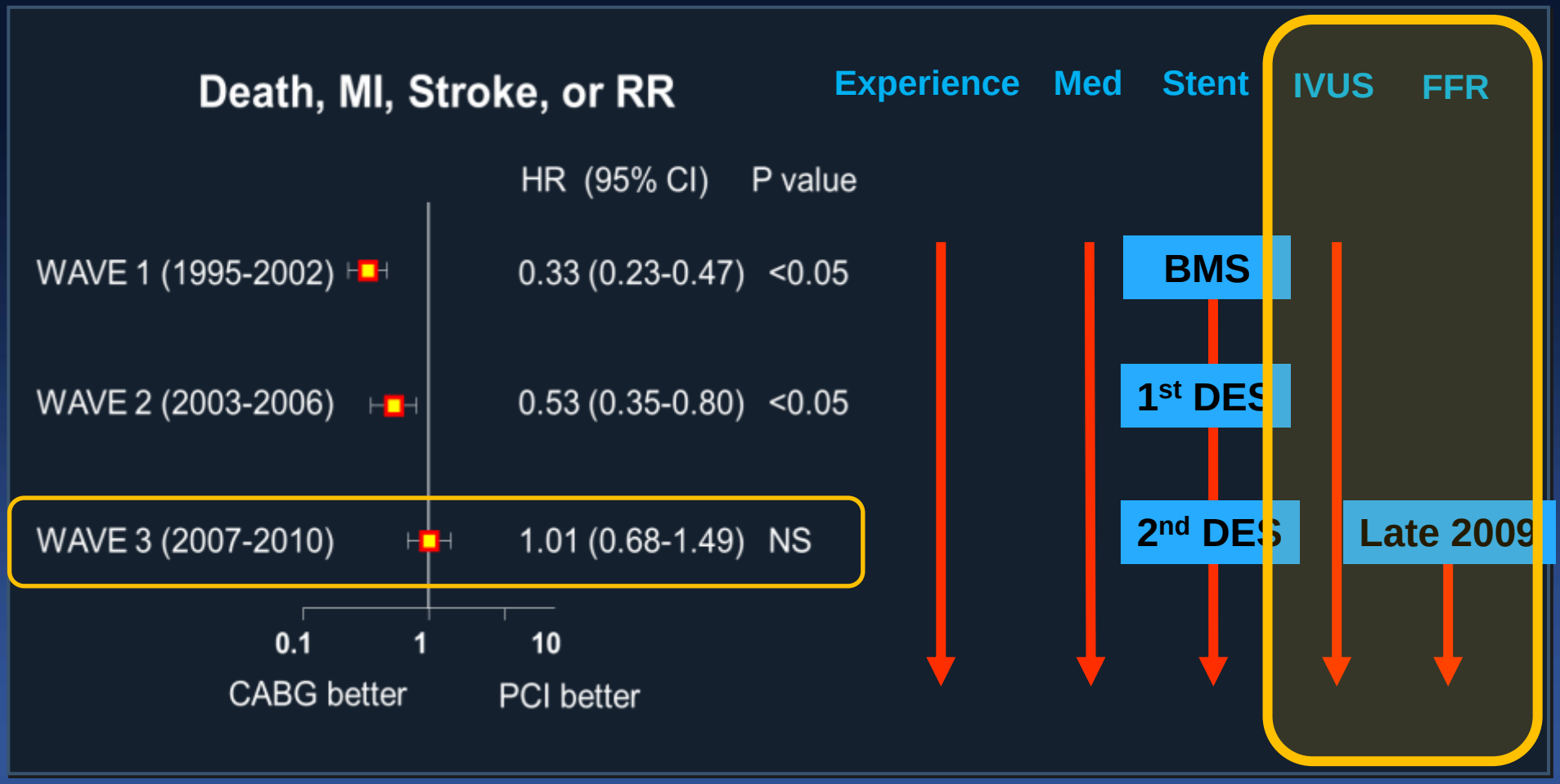
- I am an ***IVUS***-holic
- I am an *FFR* believer

ASAN LM Registry
Revascularization Strategy



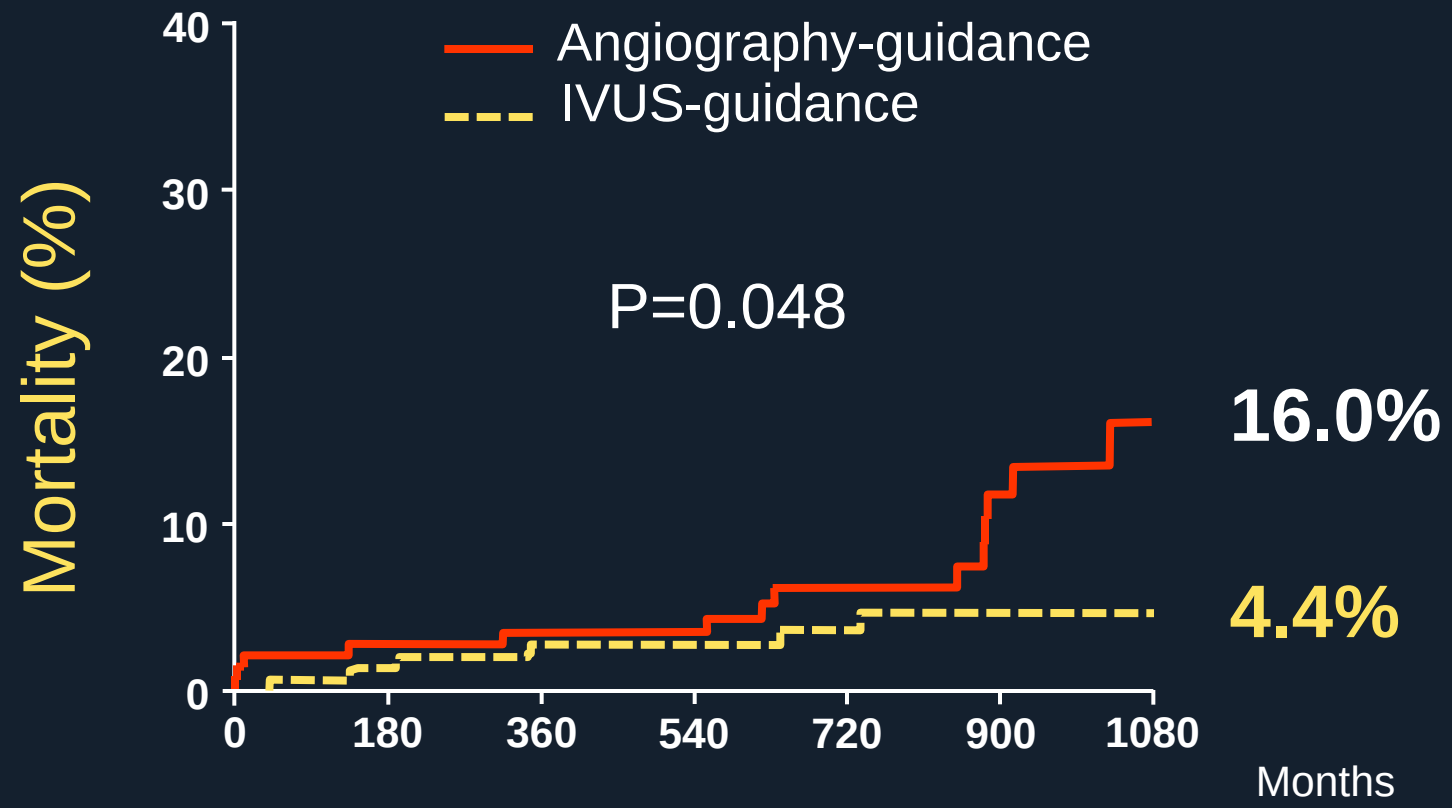
Park SJ, Ahn JM et al. Circ Cardiovasc Interv. 2015 Mar;8(3):e001846

ASAN LM Registry
Outcomes



Park SJ, Ahn JM et al. Circ Cardiovasc Interv. 2015 Mar;8(3):e001846

Why IVUS in LM Stenting ?
IVUS Guidance Saved Lives !



Patients after risk				
IVUS-guidance	145	140	98	37
Angiography-guidance	145	137	88	29

Park SJ et al, Circulation. Cardiovasc Interv. 2009;2(3):167-77.

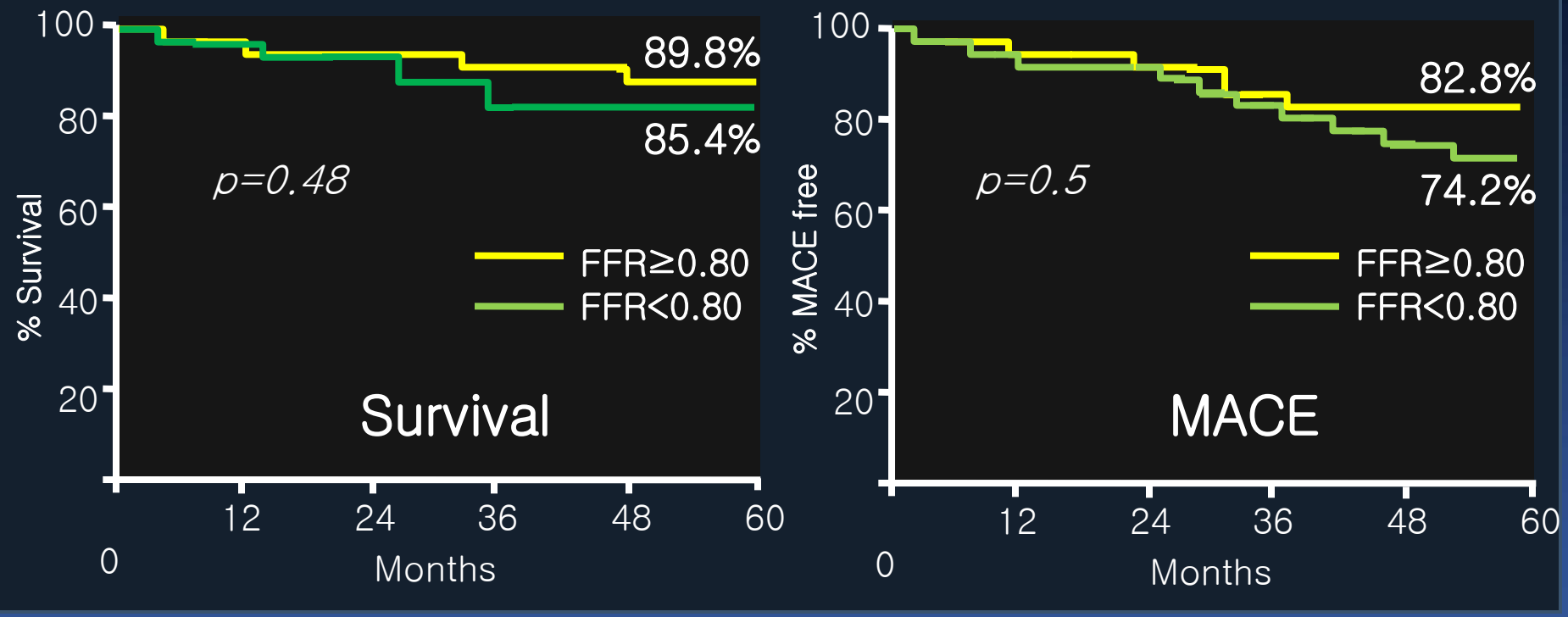
Despite inherent limitations of nonrandomized observational design, all studies uniformly indicated that IVUS guidance play a role in improving long-term clinical outcomes and mortality.

Park DW and Park SJ Circ Cardiovasc Interv. 2017 May;10(5)

	Year	N	Follow-Up, y	Study Design	Primary End Point	Key Findings
MAINCOMPARE[15]	2009	975	3	Observational study	All-cause mortality	A lower rate of mortality with IVUS than with angiography (6.0% vs 13.6%; *P*=0.06) in 201 propensity-matched cohort of PCI
						A significant lower rate of death (4.7% vs 16.0%; *P*=0.048) in 145 matched cohort of DES
IVUS-TRONCO-ICP[16]	2014	1670	3	Pooled analysis of 4 observational registries	MACE-free survival (cardiac death, MI, or TLR)	A higher survival free of MACE with IVUS than with angiography (88.7% vs 83.6%; *P*=0.04) in 505 propensity-matched cohort
						A lower incidence of death (7.4% vs 13.0; *P*=0.01)
						A lower incidence of stent thrombosis (0.6% vs 2.2%; *P*=0.04)
SCAAR[17]	2017	2468	Up to 10 y	Observational study	Composite outcome of all-cause death, restenosis, or definite stent thrombosis	A significant reduction of primary end point (adjusted HR, 0.63; 95% CI, 0.49–0.82) and all-cause death (adjusted HR, 0.61; 95% CI, 0.46–0.80) in overall population
						A significant reduction of primary end point (HR, 0.54; 95% CI, 0.37–0.80) and all-cause death (HR, 0.54; 95% CI, 0.36–0.81) in propensity-matched population

FFR guided PCI in Equivocal LMCA

- In 213 patients with an equivocal LMCA stenosis
- FFR ≥0.80: Medication (n=138) vs. FFR<0.80: CABG (n=75)

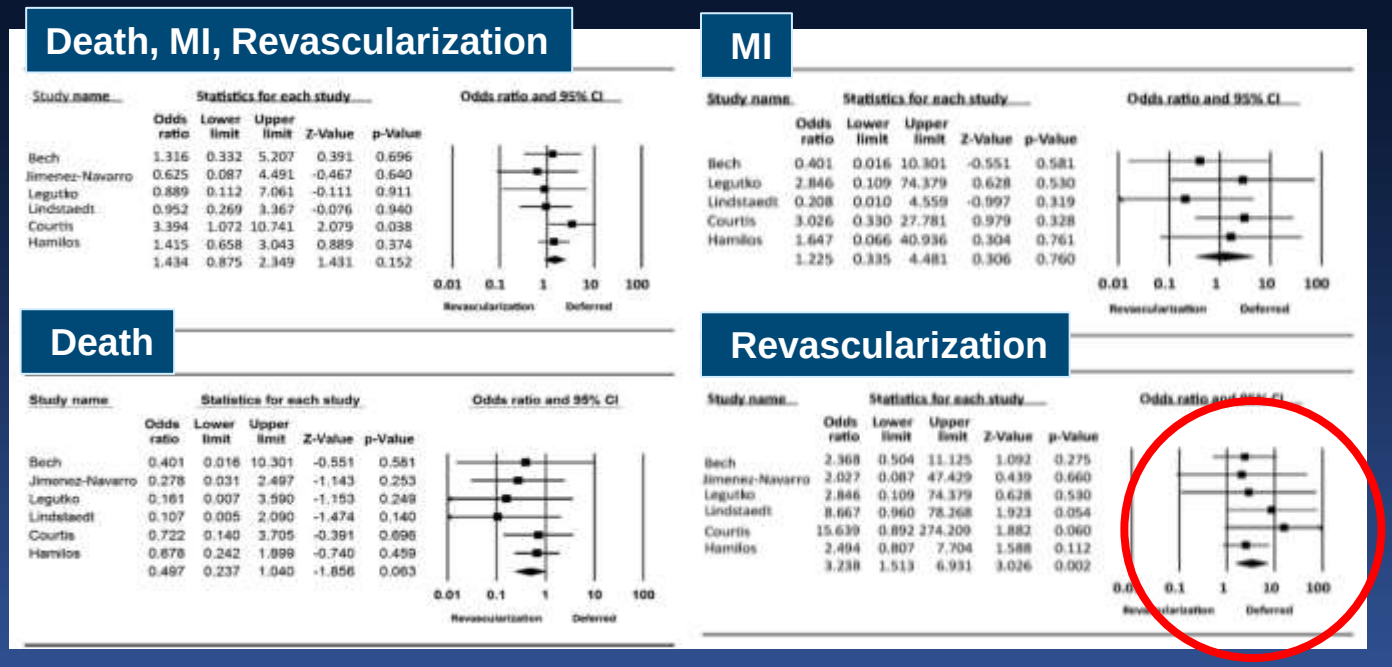


An FFR-guided strategy showed the favorable outcome.

Circulation. 2009;120:1505-1512

Meta-analysis
FFR Guided Treatment of LM

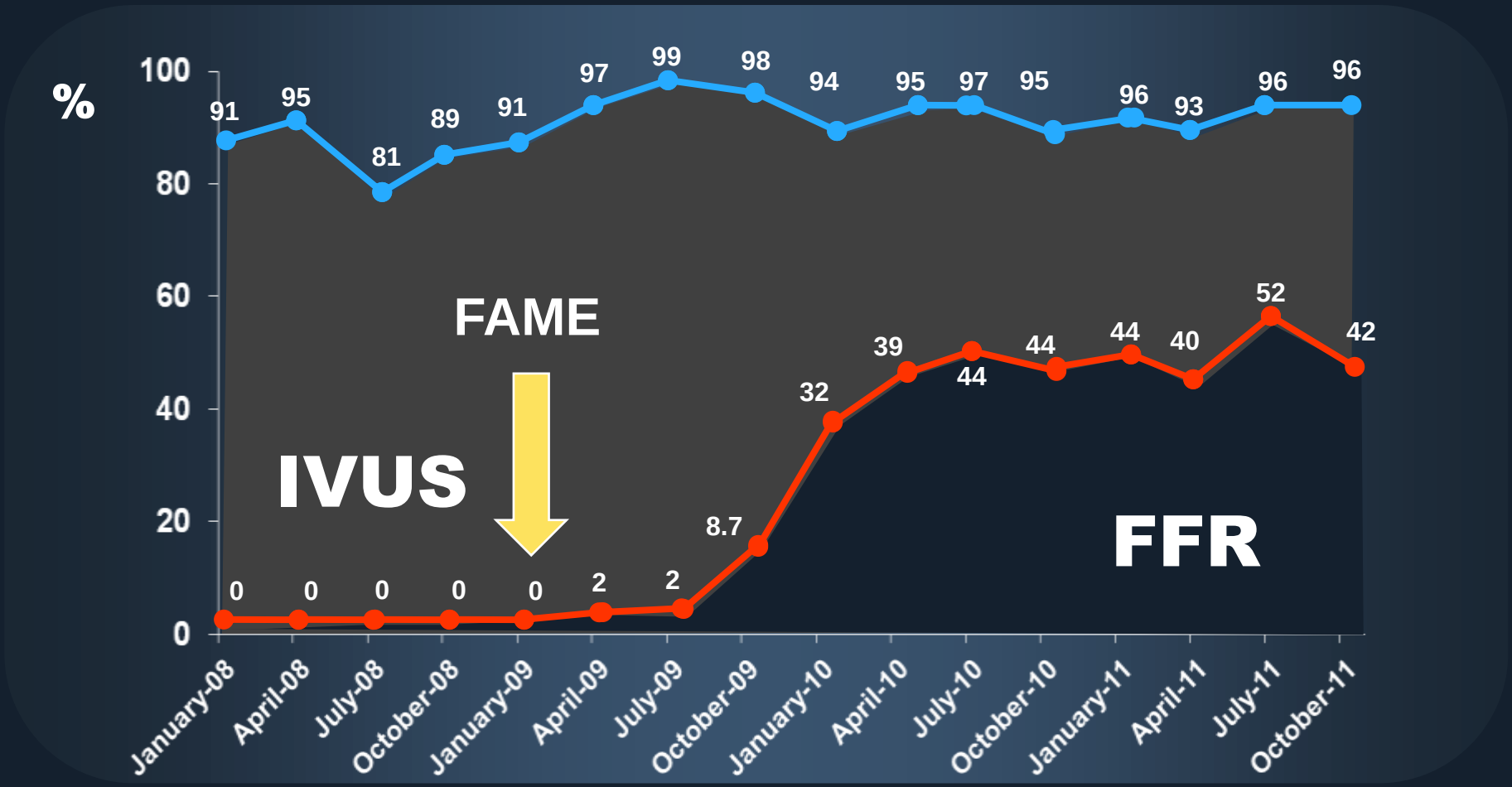
6 prospective cohort studies involving 525 patients met the inclusion criteria



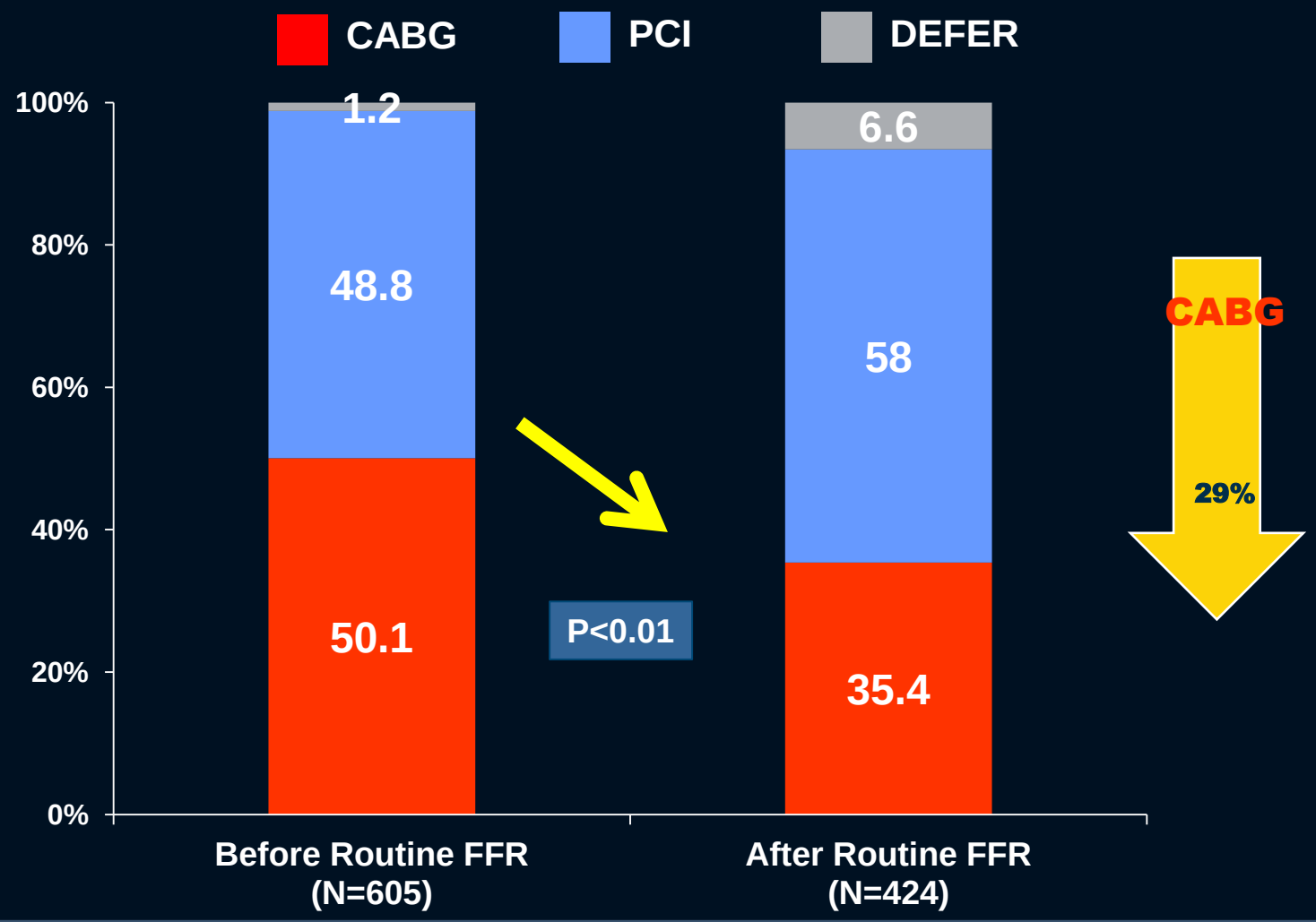
The long term clinical outcomes in patients with ambiguous LMCA stenosis for whom revascularization is deferred based on FFR are favorable and similar to the revascularized group in terms of overall mortality and MI

Catheterization and Cardiovascular Interventions 86:12–18 (2015)

FFR and IVUS During PCI for LM and 3VD
(n=1229)

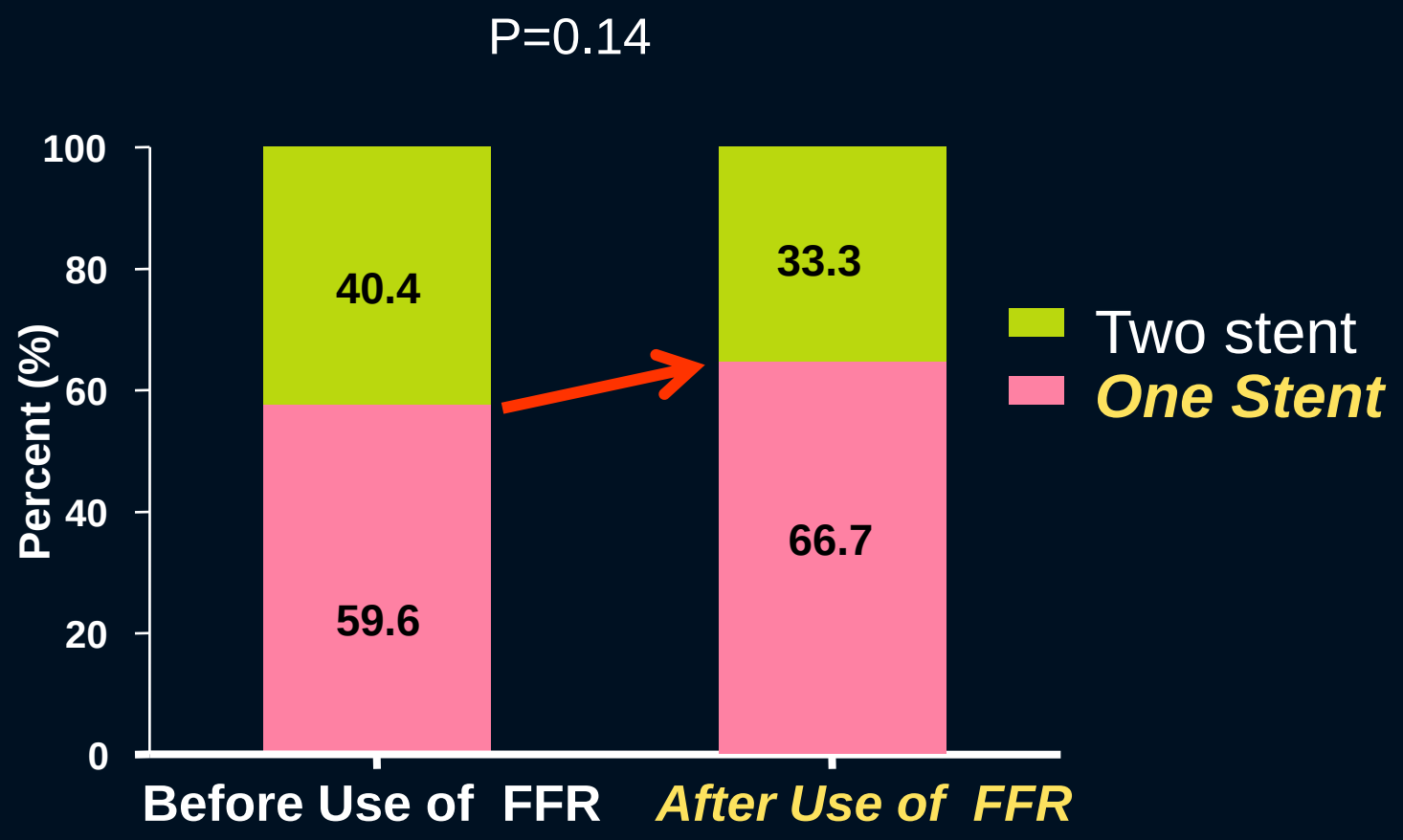


When You Use FFR, Less CABG



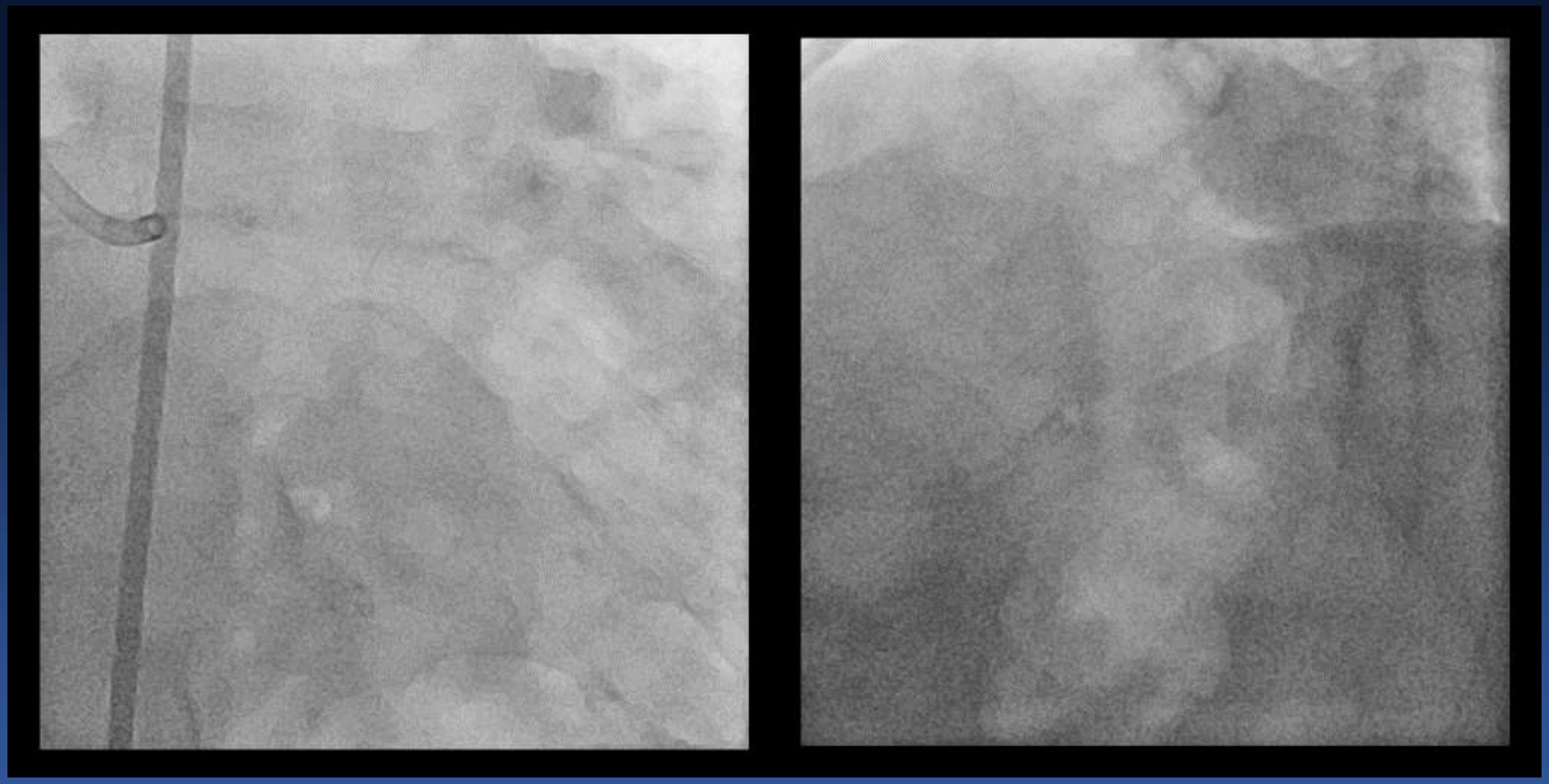
Ahn JM Park SJ et al. Am J Cardiol. 2015 Oct 15;116(8):1163-71.

When You Use FFR, More One-Stent

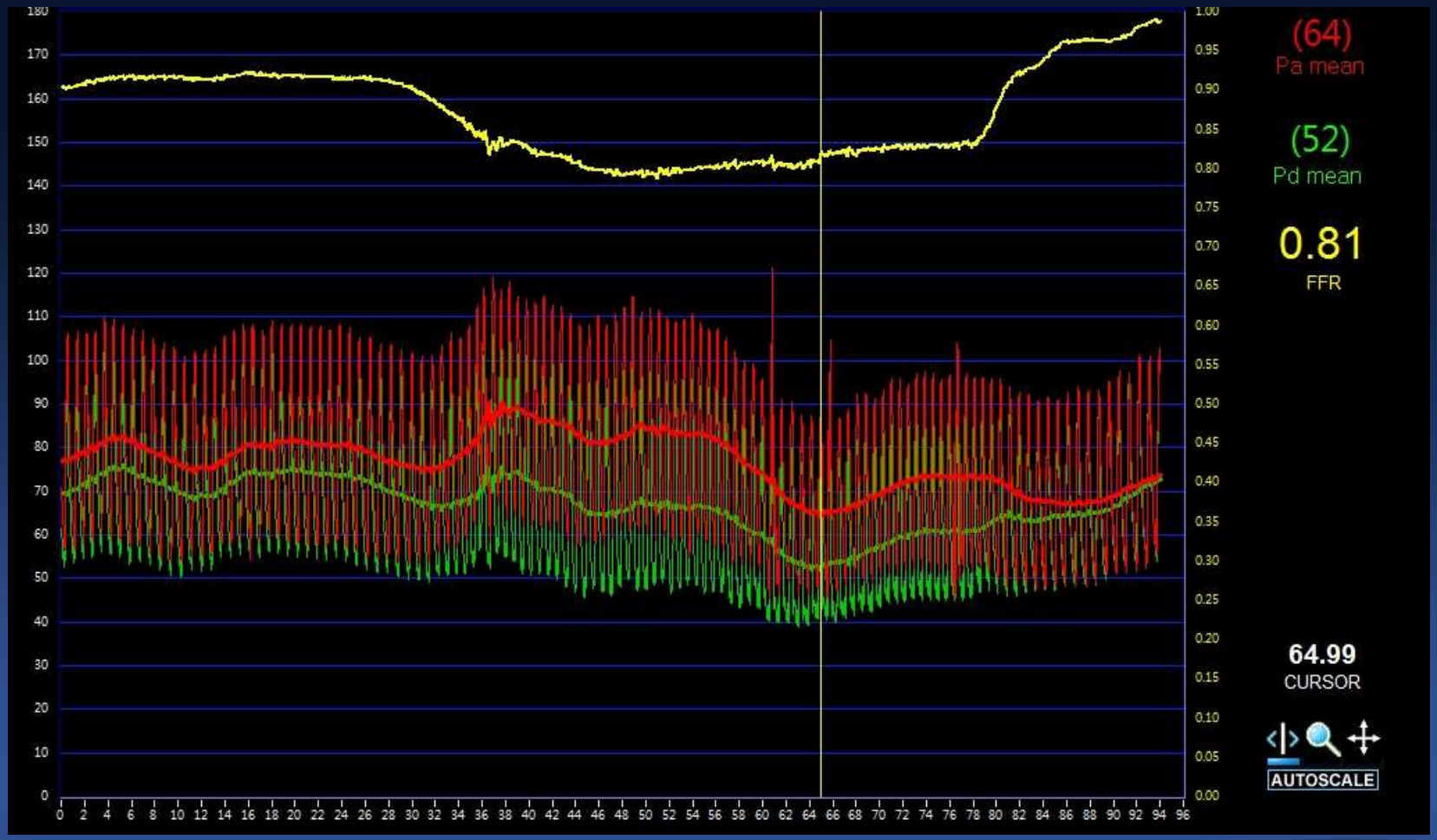


Ahn JM Park SJ et al. Am J Cardiol. 2015 Oct 15;116(8):1163-71.

M/60, DM/Hypertension
Effort Angina

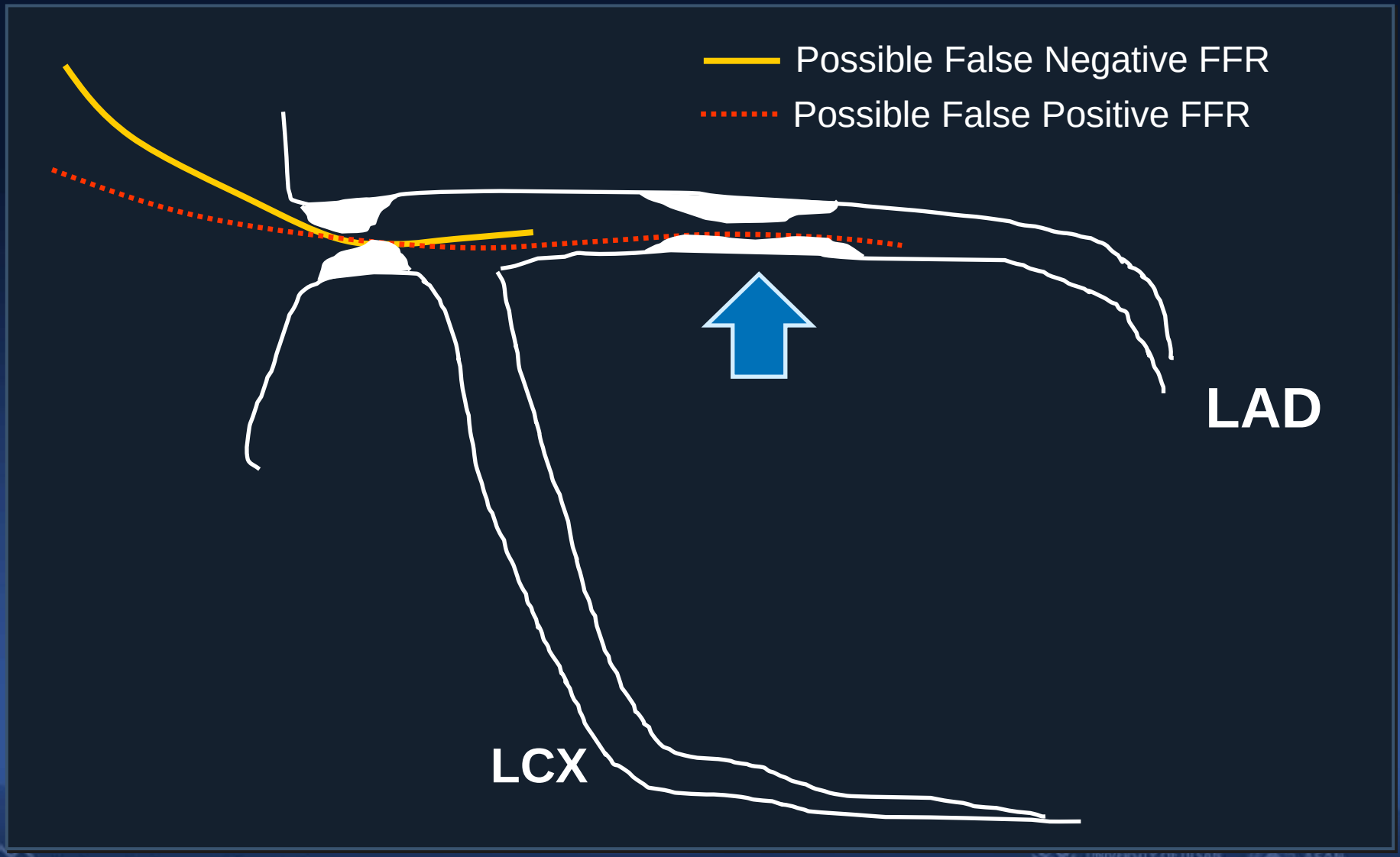


FFR 0.81 → Defer

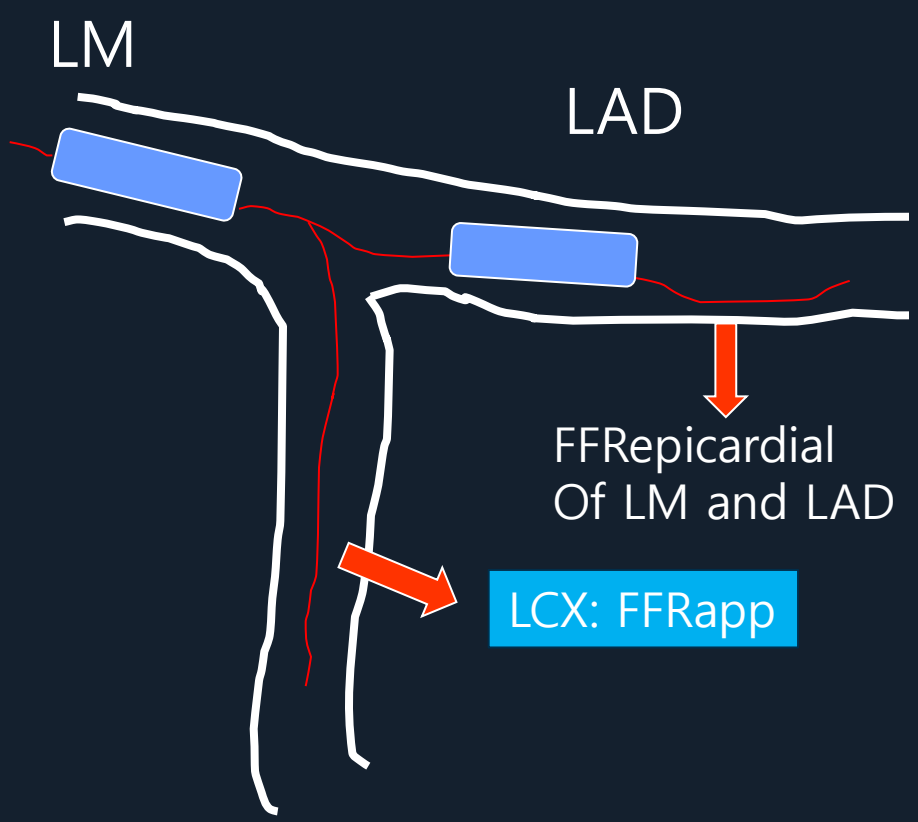


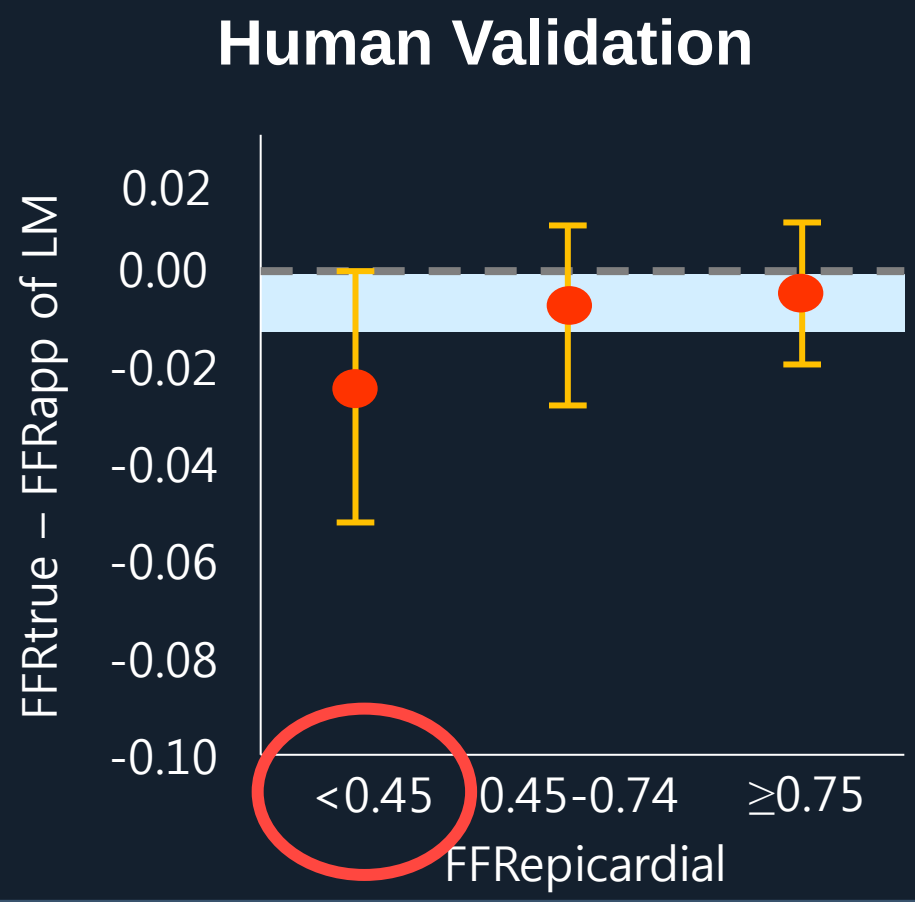
Conceptual Limitations of FFR for LM Disease

Due to Down Stream Disease



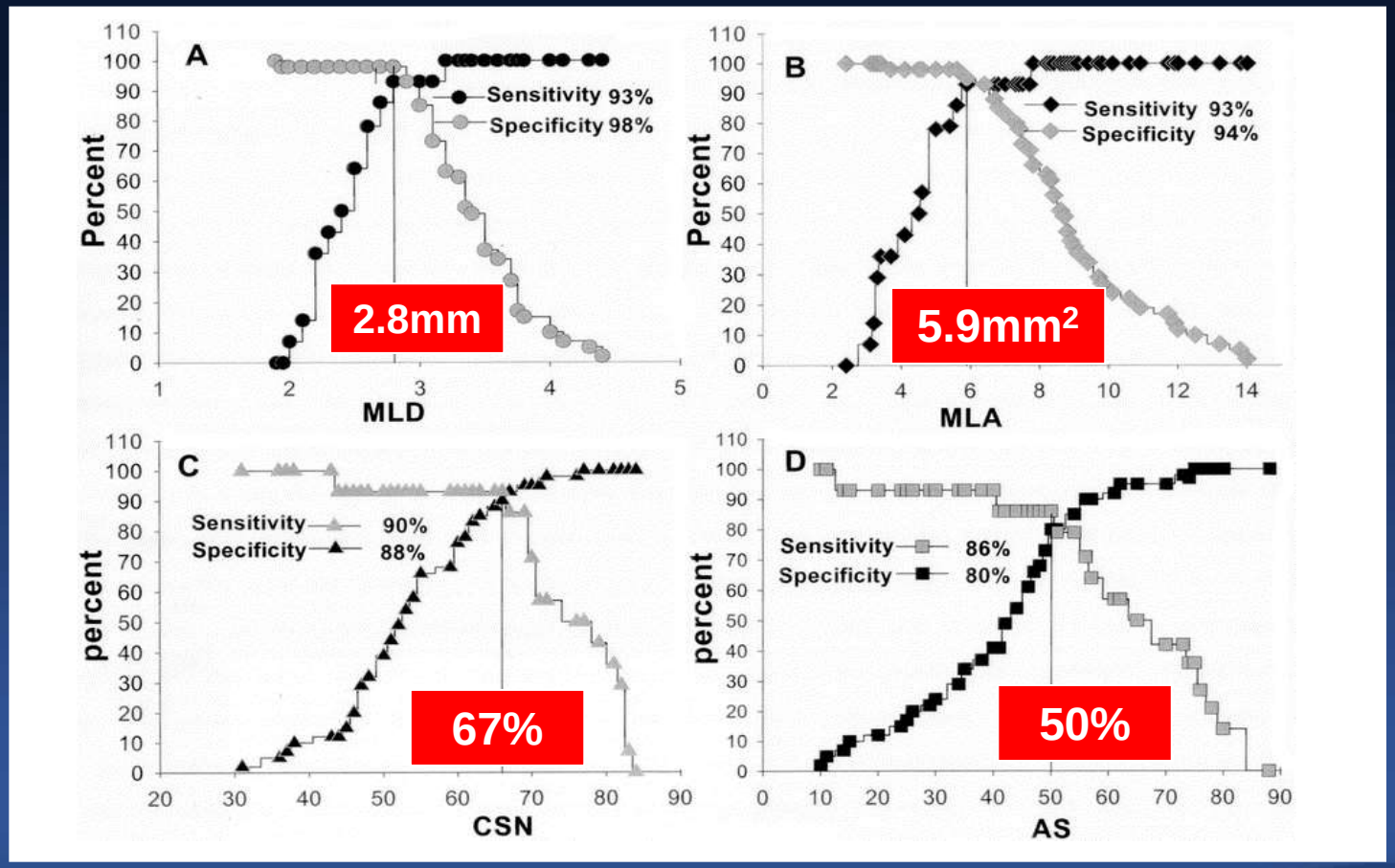
Unless downstream stenosis is very significant, its impact is mild





Fearon WF, et al JACC Cardiovasc Interv. 2015 Mar;8(3):398-403

MLA < 6.0 mm² Corresponding to FFR <0.75 (n=55, LM disease)



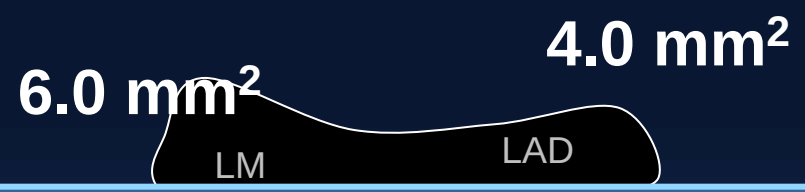
Jasti V et al. Circulation 2004;110:2831-6

Background

Geometric Assumption By Murray's Law

Old

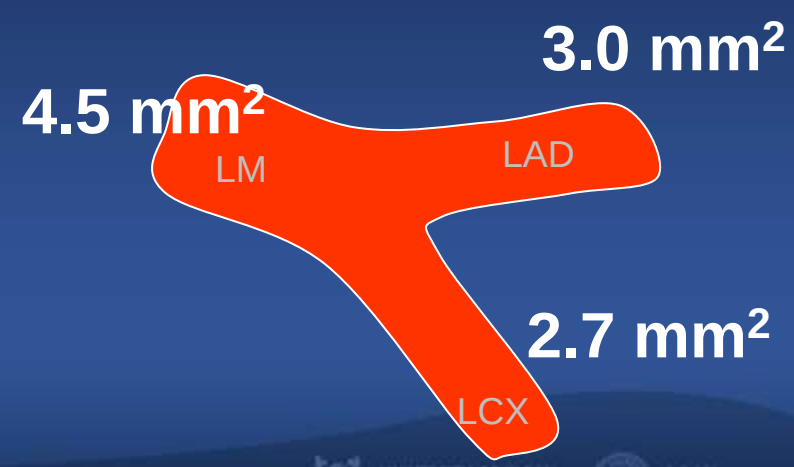
		Murray's	Finet's
LAD	LCX	LM	LM
4.0	4.0	6.35	7.35



Not Anymore 6.0 mm² !
According to Any Geometric Assumption.

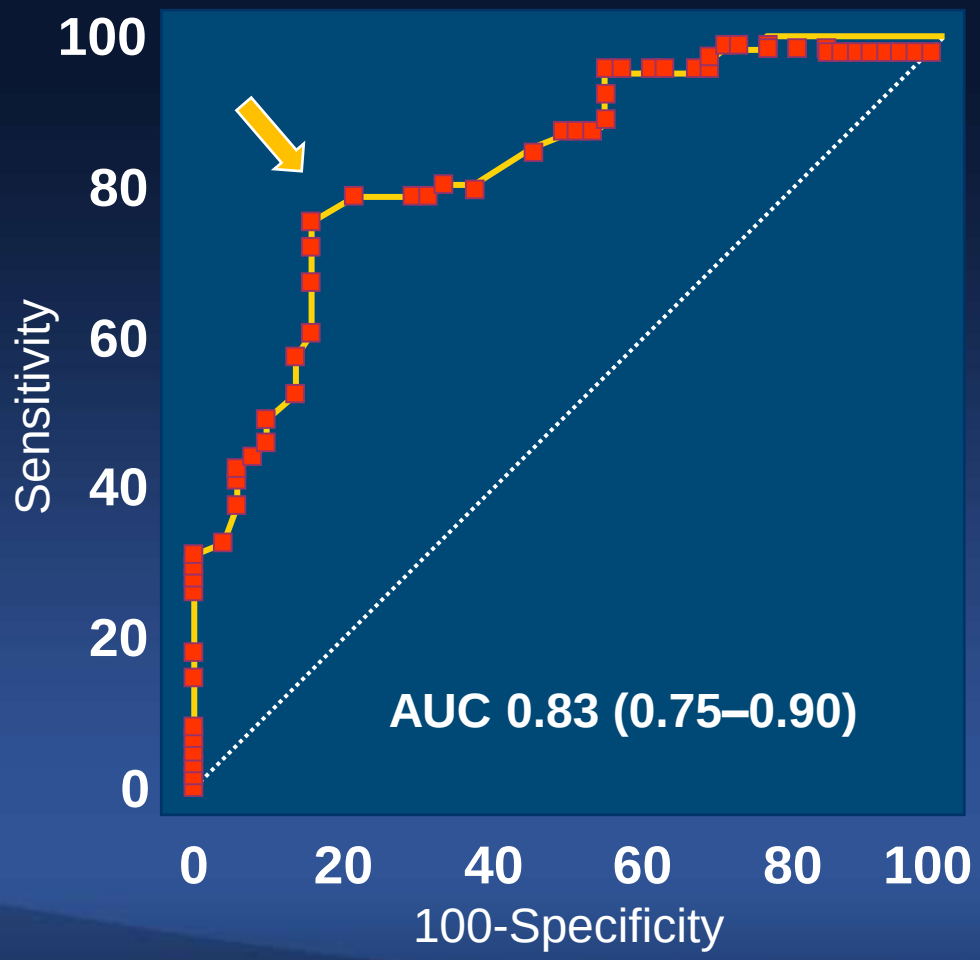
New Data

		Murray's	Finet's
LAD	LCX	LM	LM
3.0	3.0	4.76	5.52
3.0	2.9	4.68	5.42
3.0	2.8	4.60	5.33
3.0	2.7	4.53	5.24
3.0	2.6	4.45	5.14
3.0	2.5	4.37	5.05



MLA < 4.5 mm² Corresponding to FFR <0.80 (n=112, Os and Shaft LM disease)

For LM lesions IVUS-MLA performs better and shows a better correlation with FFR



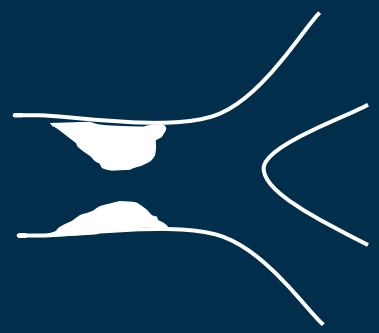
Cut-off = 4.5 mm²

Sensitivity	79%
Specificity	80%
PPV	83%
NPV	76%
Accuracy	80%

Park SJ, Ahn JM et al. *JACC Interv, 2014;7(8):868-874*

How do I Implement ?

Ostial and Shaft
LM Disease



Smaller than 4.5 mm^2
Positive FFR

Bifurcation with
Ostial Disease

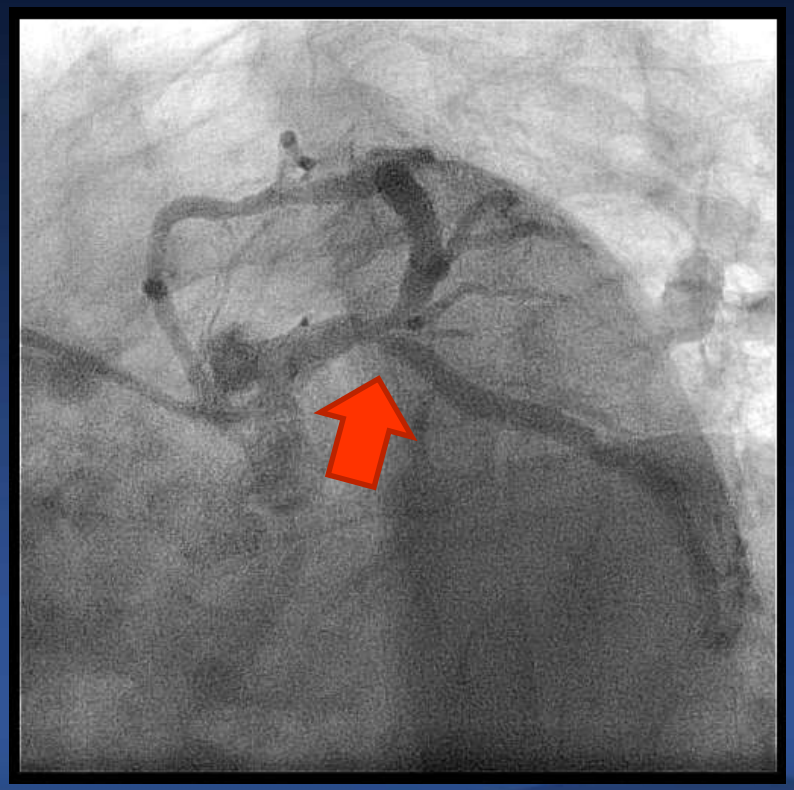
? 4.5~6.0 mm^2
Consider FFR !

Larger than 6.0 mm^2
Negative FFR

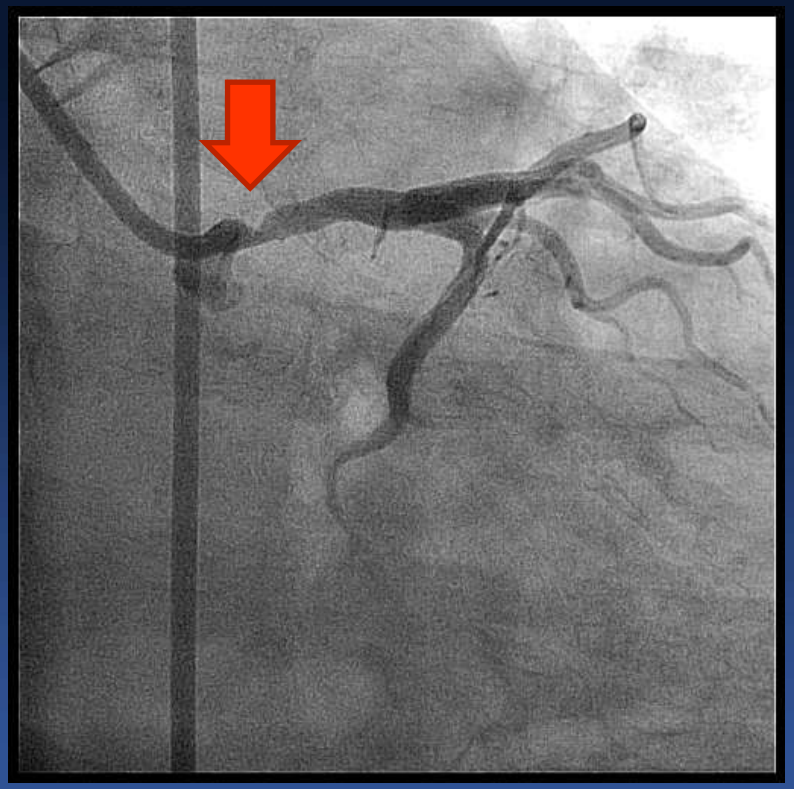
LM PCI Strategy

Ostial and Shaft Disease

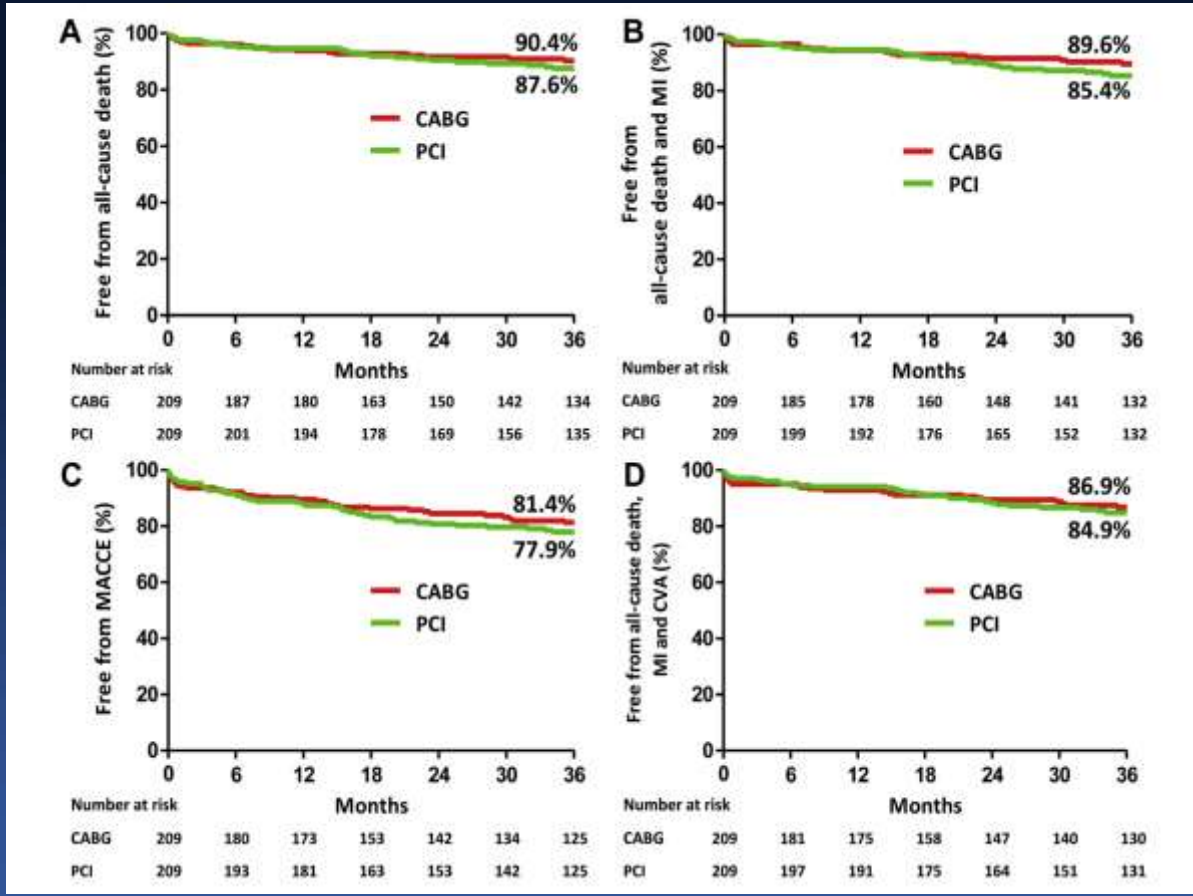
Bifurcation Disease



Ostial or Shaft Stenosis



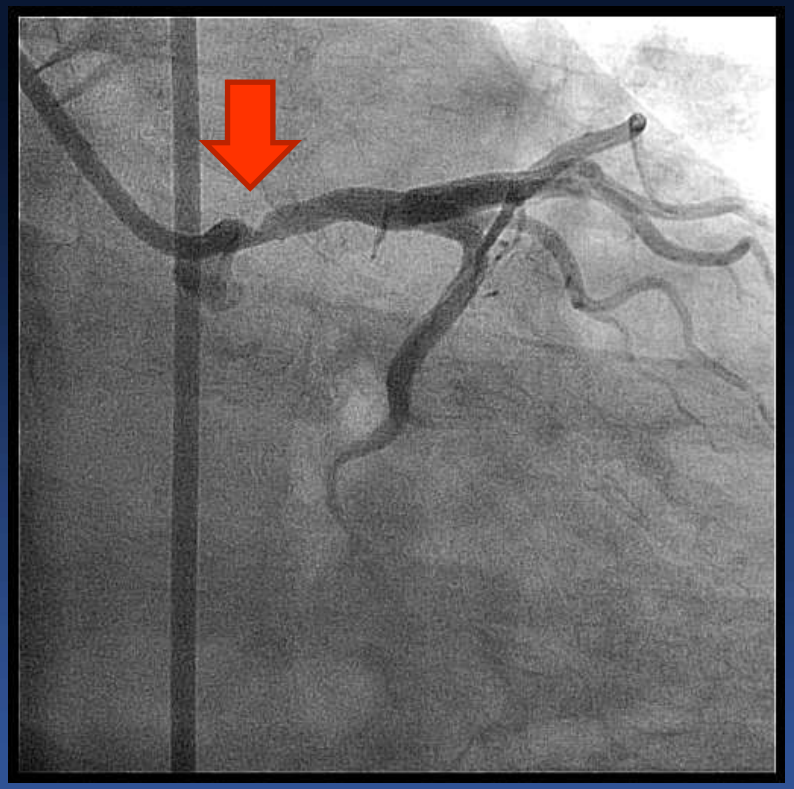
Ostial or Shaft Stenosis: Favorable Stenting Outcome



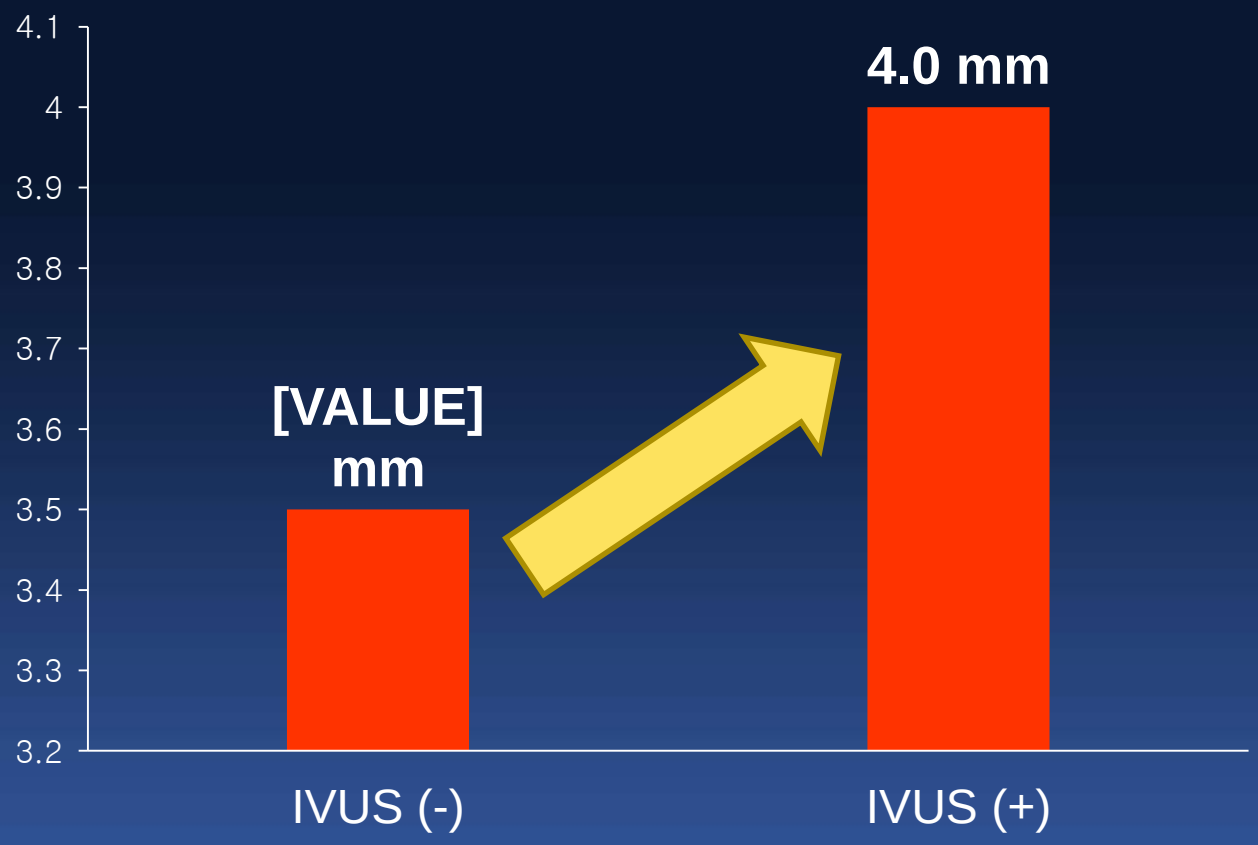
DELTA Registry J Am Coll Cardiol Intv 2014;7:354–61

Ostial or Shaft Stenosis

Just Stent it

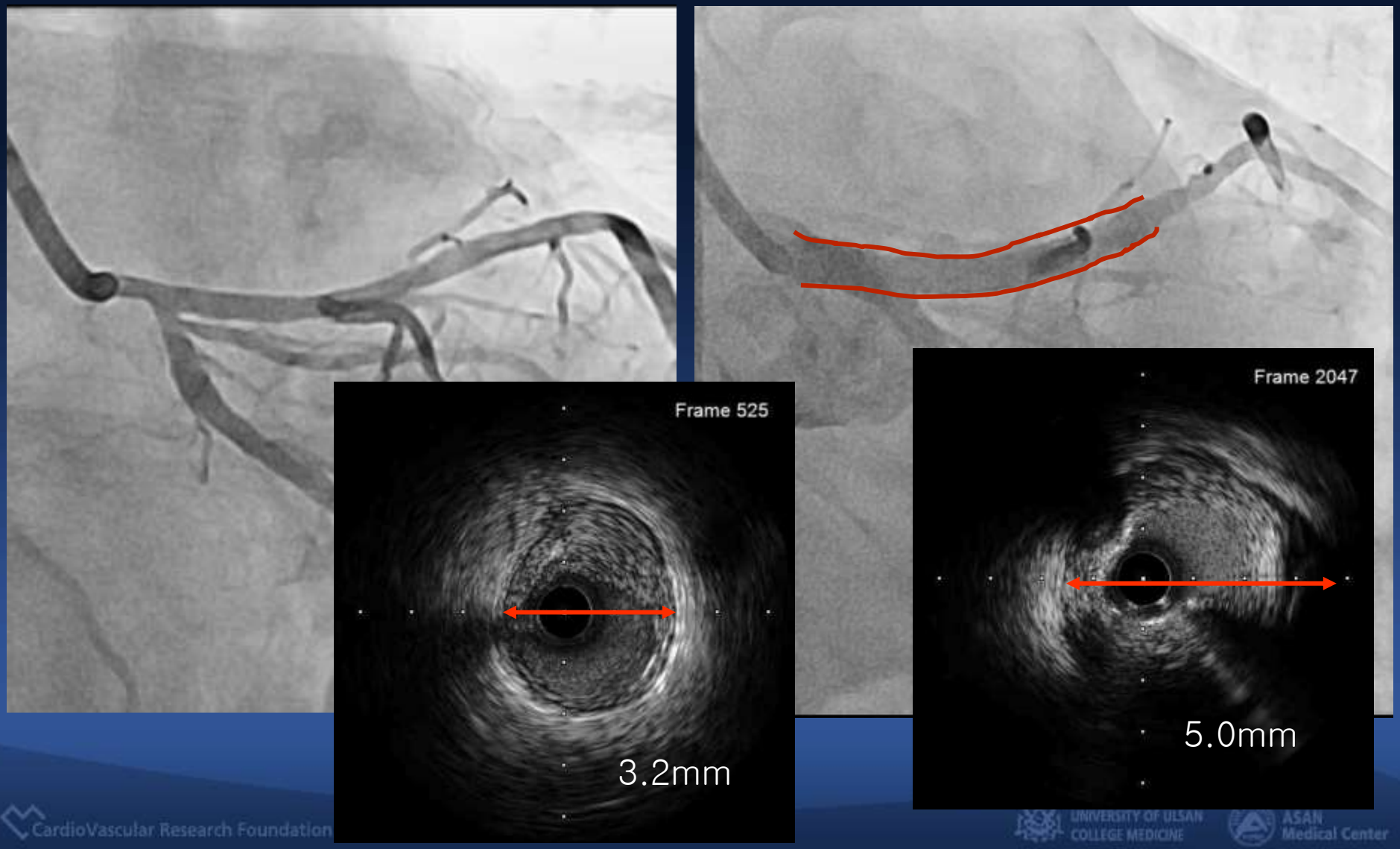


You Can Select Bigger Stent

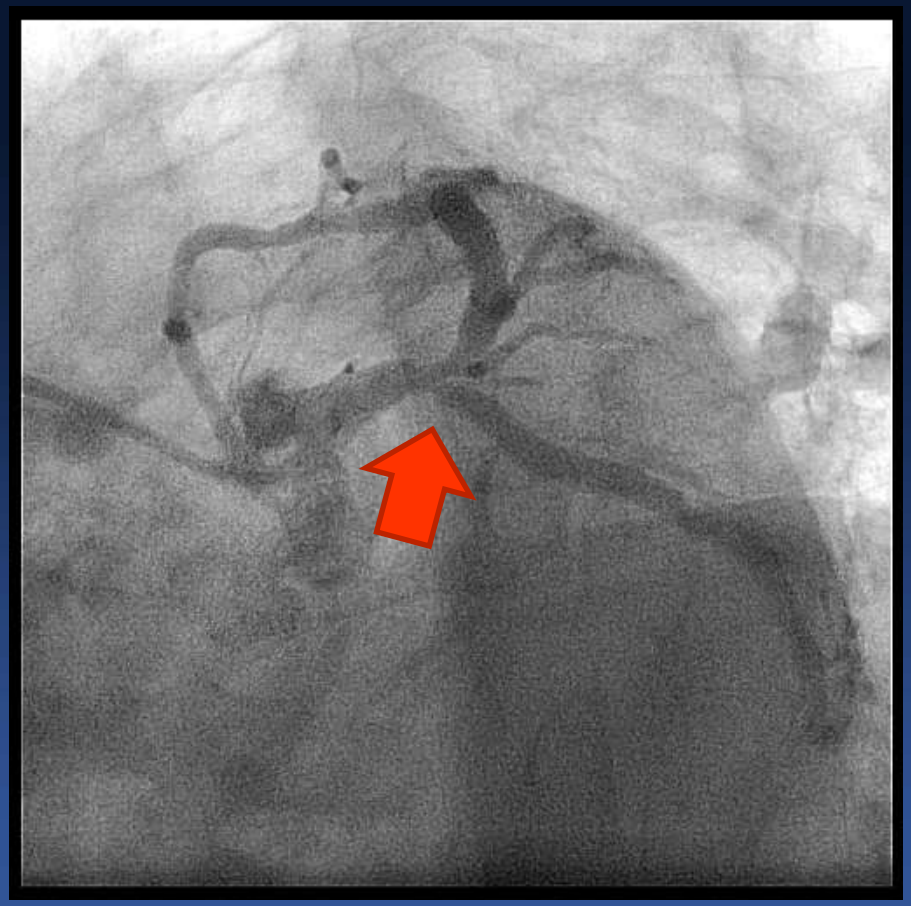


Andell P et al. Circ Cardiovasc Interv. 2017;10:e004813

Xience 3.5(30) and NC Balloon 4.0(20) upto 4.2mm



For Bifurcation Stenosis



One Stent Better Than Two Stent For LM Bifurcation Stenosis

	Patients N		FU	Hazard Ratio			
	1 Stent	2 Stent	(M)	MACE	Death	MI	TVR
Palmerini[1]	456	317	24	0.48 P=0.001	-	-	-
Toyofuku[2]	261	119	36	-	0.61 P=0.09	-	0.32 P<0.01
Kim[3]	234	158	36	0.89 P<0.001	0.77 P=0.62	0.38 P<0.01	0.16 P=0.005
Song[4]	509	344	36	0.42 P<0.001	0.30 P=0.02	0.41 P=0.04	0.47 P<0.01

[1]Circ Cardiovasc Interv. 2008;1:185-92

[2]JACC Cardiovasc Interv. 2014;7:255-63

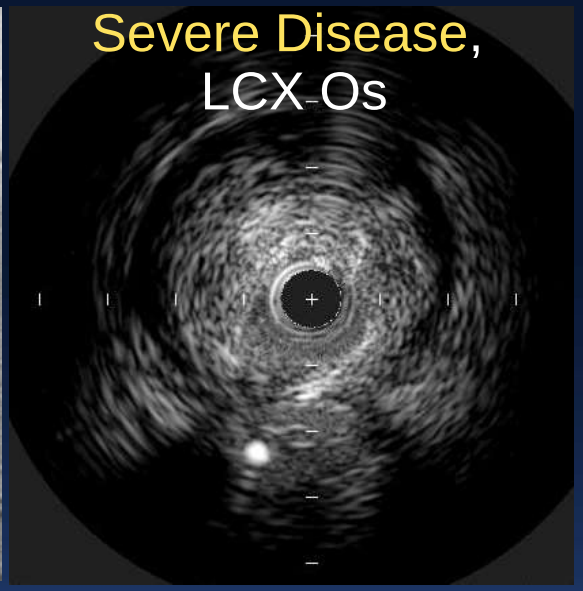
[3]Catheter Cardiovasc Interv. 2011;77:775-82

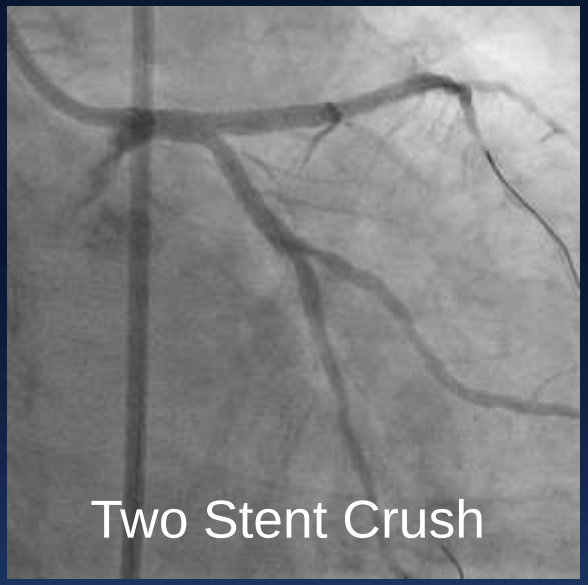
[4]Circulation. 2009;120:1866-74

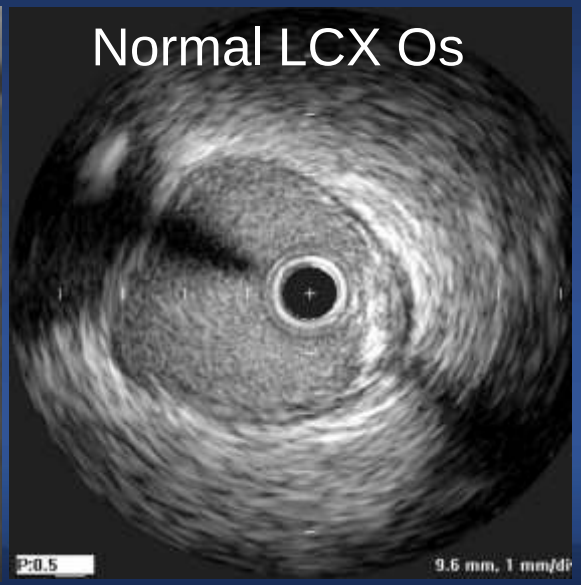
LM Bifurcation Treatment

Stent Cross Over	***Normal Ostial LCX (Medina 1.1.0., 1.0.0)*** Normal or Diminutive LCX Small LCX with < 2.5 mm in diameter Focal disease in distal LCX
Two Stent	***Diseased LCX (Medina 1.1.1., 1.0.1)*** Large LCX with ≥ 2.5 mm in diameter Diseased left dominant coronary system Concomitant diffuse disease in distal LCX

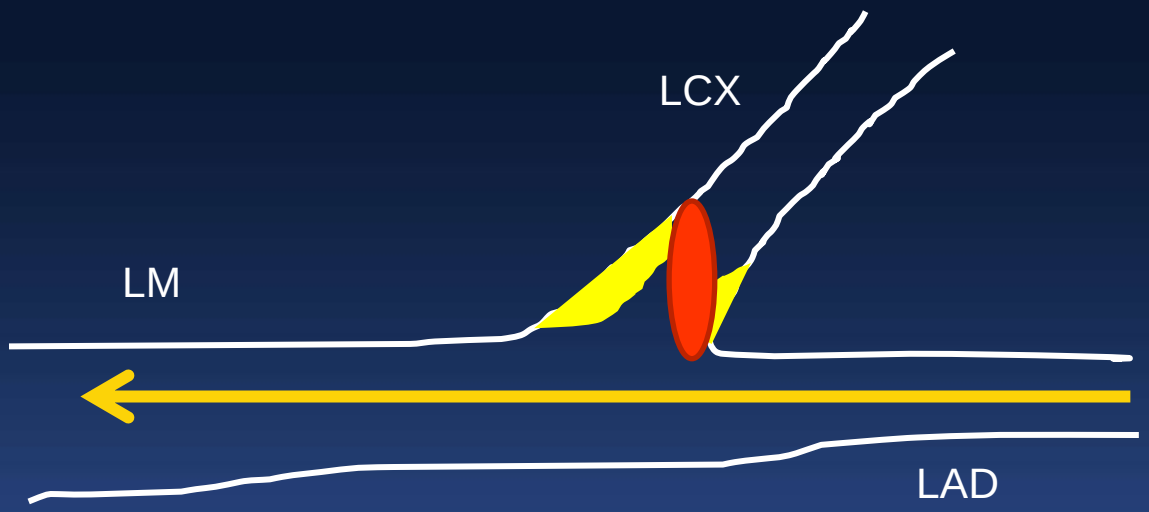
LCX Ostial Disease (By IVUS) Determines Strategy



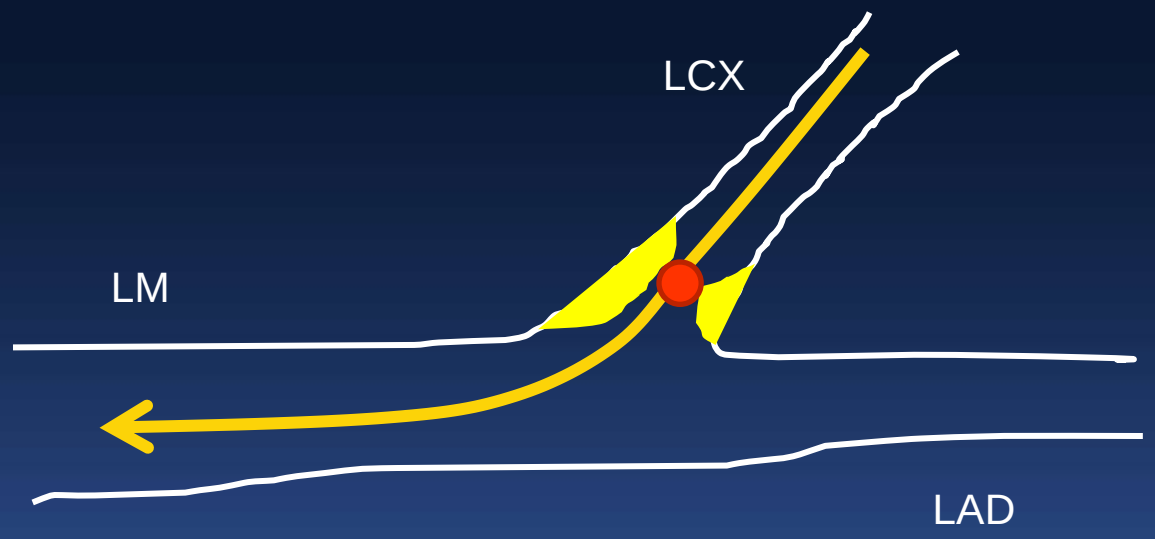




Direct LCX pullback IVUS
LAD pullback overestimates LCX ostial MLA



Direct LCX pullback IVUS
LAD pullback overestimates LCX ostial MLA



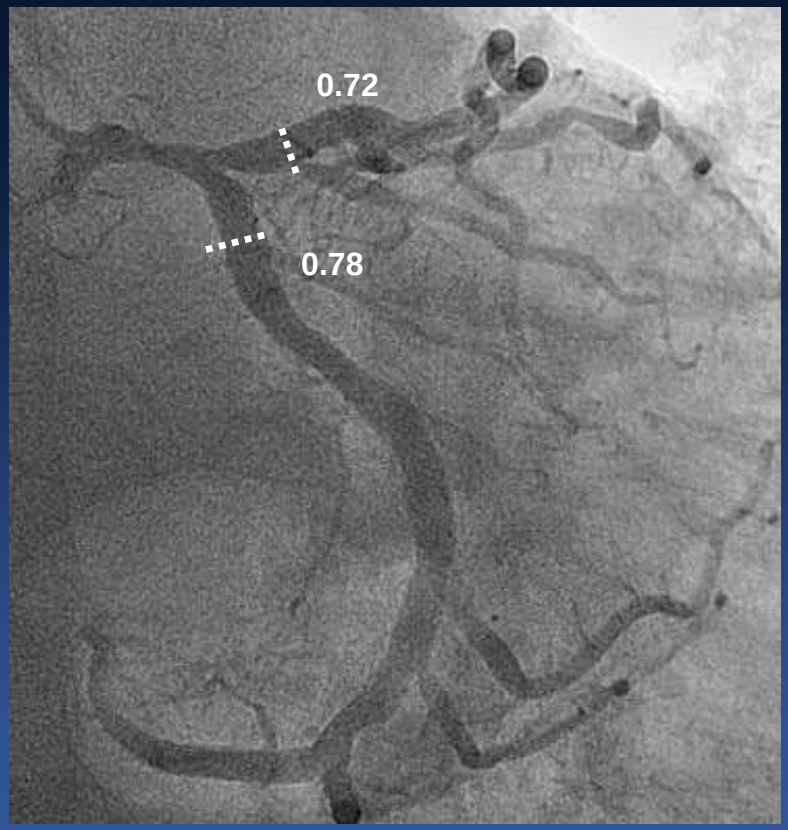
IVUS-derived minimal lumen >3.7 mm^2 or plaque burden <56% in the LCX ostium can exclude functional SB compromise (FFR <0.80) after MV stenting in treating LM bifurcations

Kang SJ et al. Catheter Cardiovasc Interv. 2014;83(4):545-52

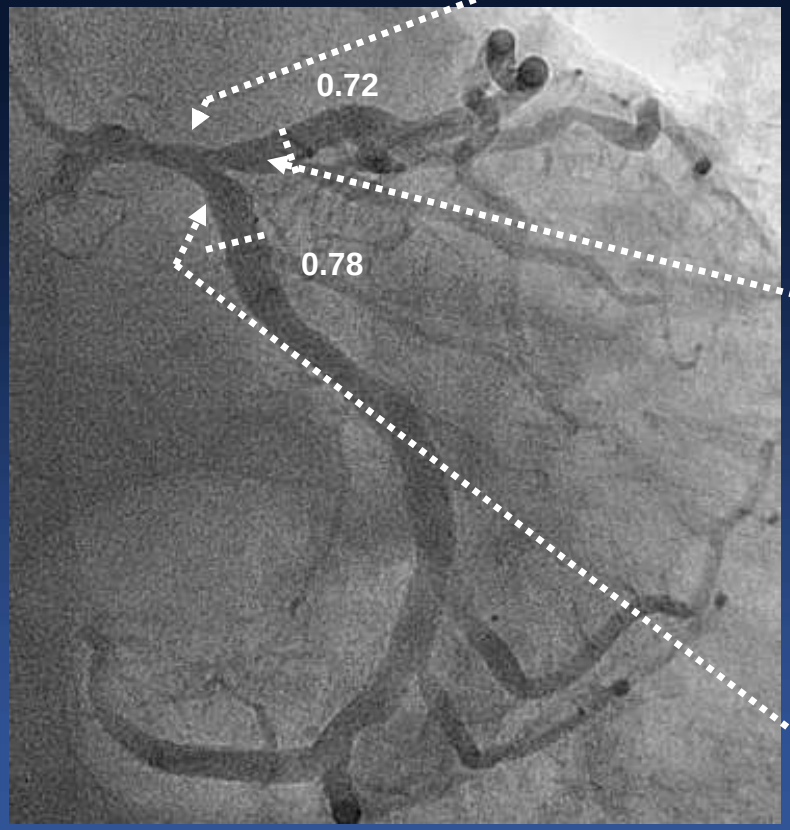
LM Bifurcation Lesion (Medina 1,0,0) with Minimal LCX Disease

55/M, Stable angina,

FFR in Both LAD and LCX,

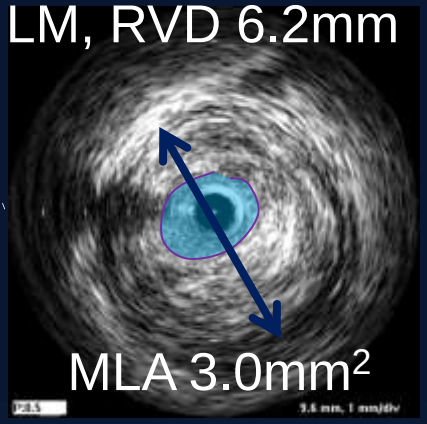


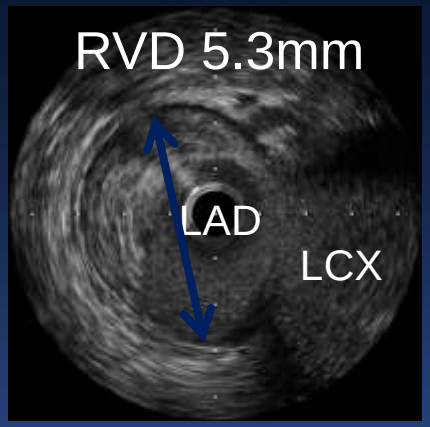
IVUS in Both LAD and LCX,

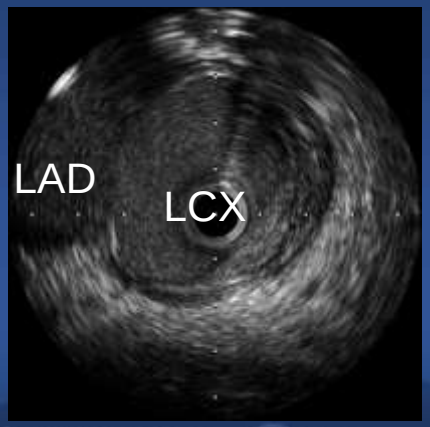


Minimal disease at LCX ostium

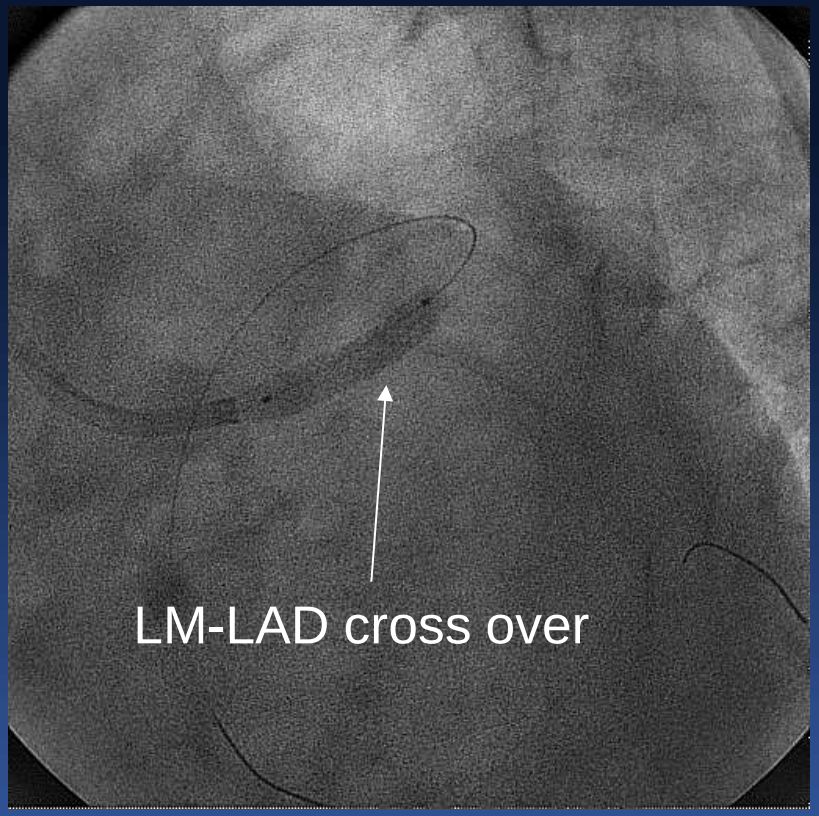
Distal LM, RVD 6.2mm



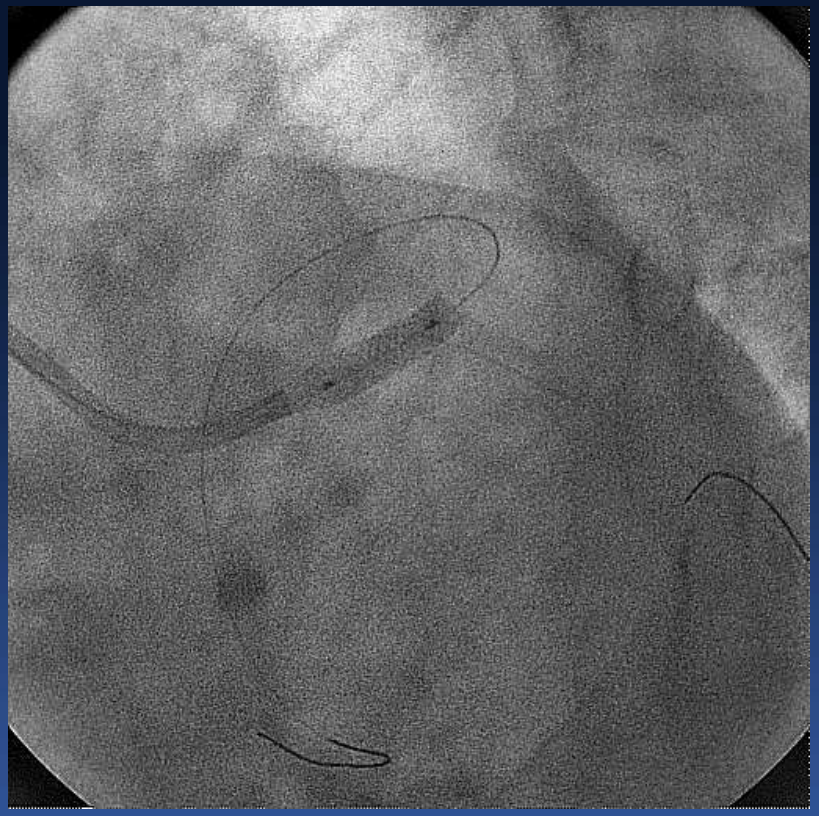




Single Stent Cross-Over
with minimal-disease at LCX OS

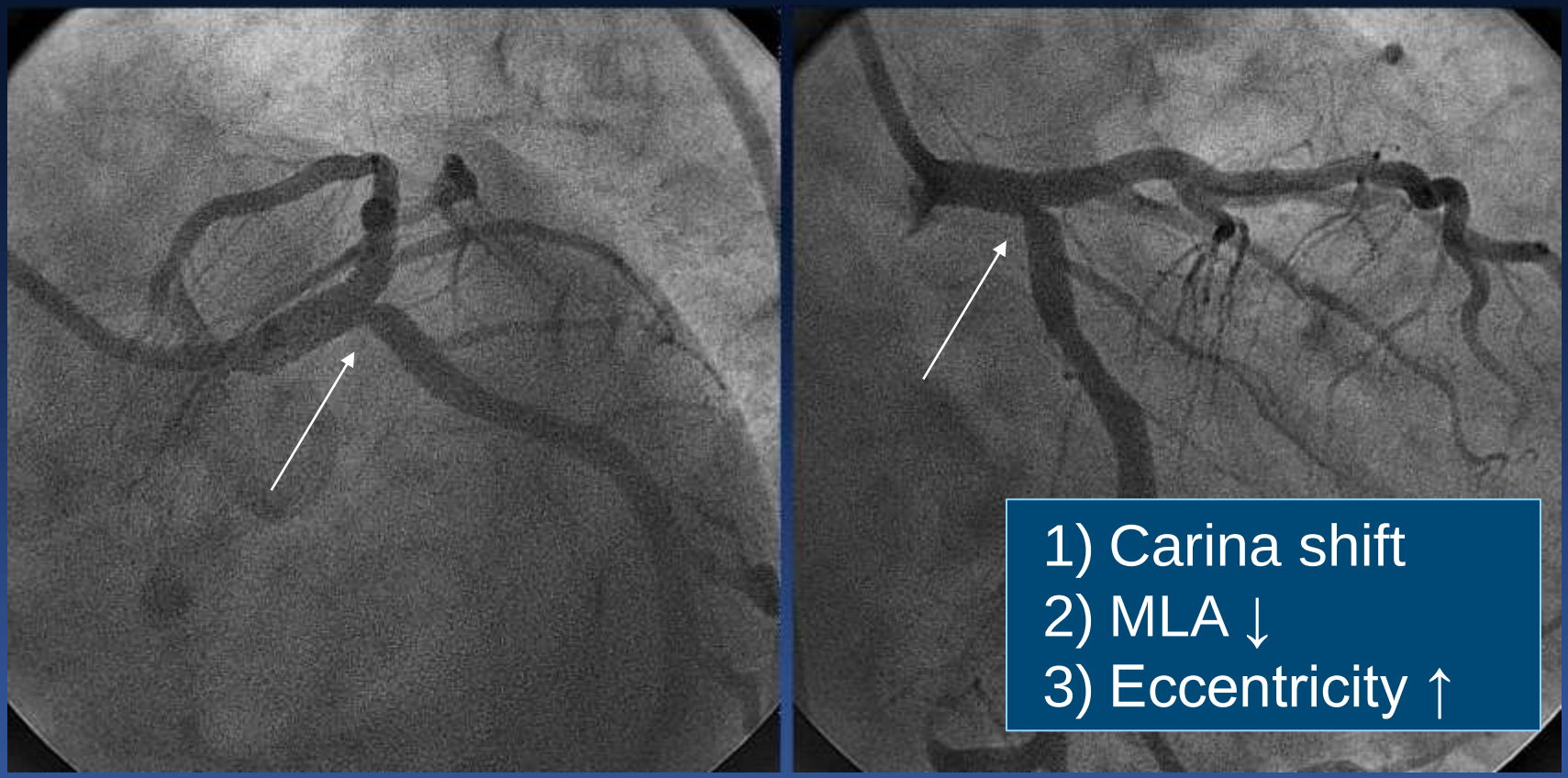


Promus Element
4.0x20



Additional high pressure
Inflation with 4.0 mm
non-compliant balloon

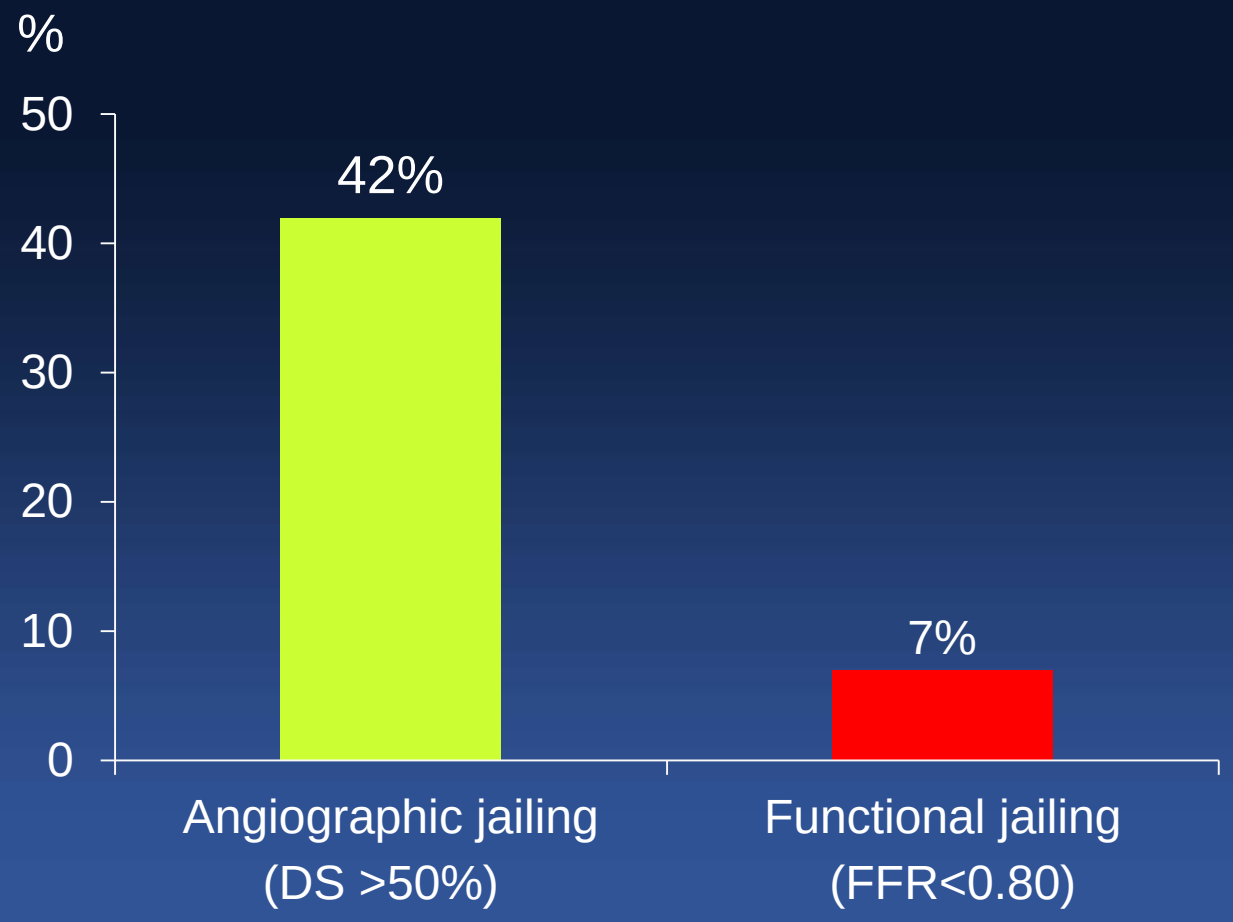
After Single Stent Cross-Over,
Angiographic Compromise of LCX Ostium.



Kang SJ et al. Circ Cardiovasc Interv. 2011;4:355-361.

Functionally Significant LCX Jailing

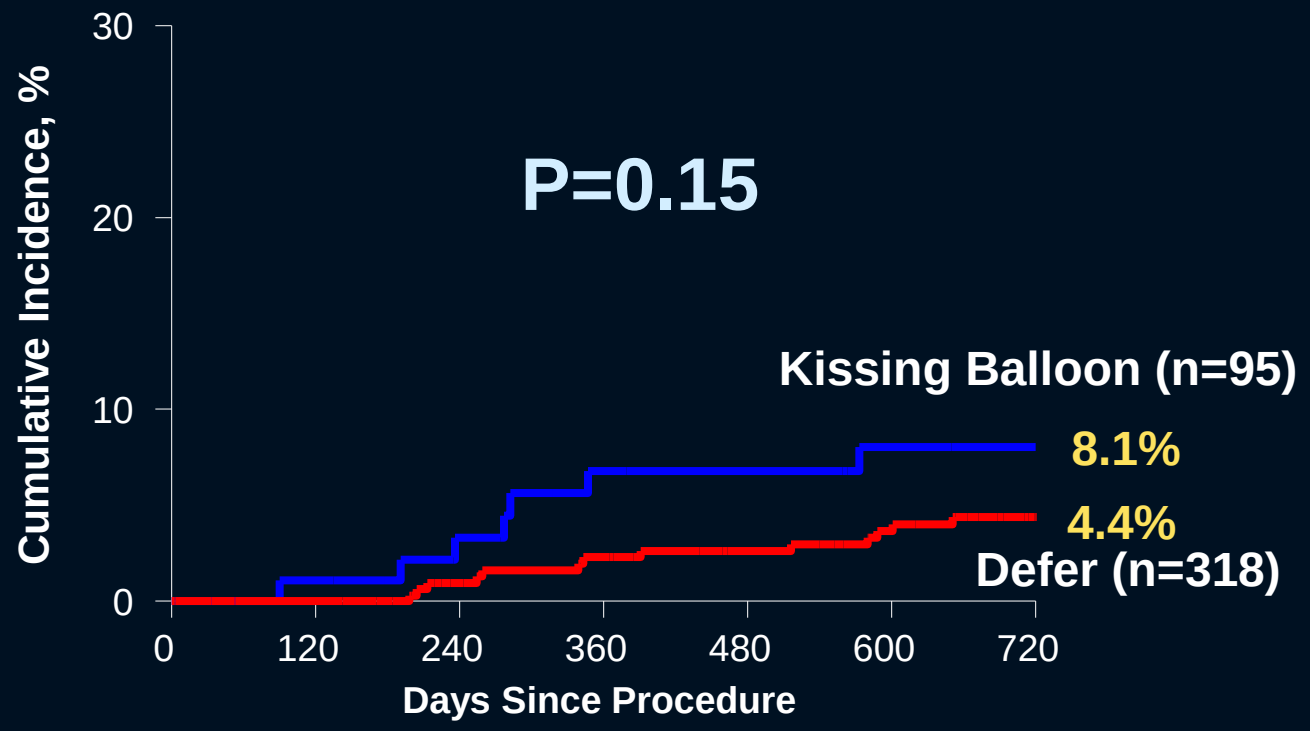
After Stent Crossover (LCX ostial DS<50%)



Kang SJ, Catheterization and Cardiovascular Interventions. 2014;83(4):545-52.

FKB: Not Associated With Better Outcomes

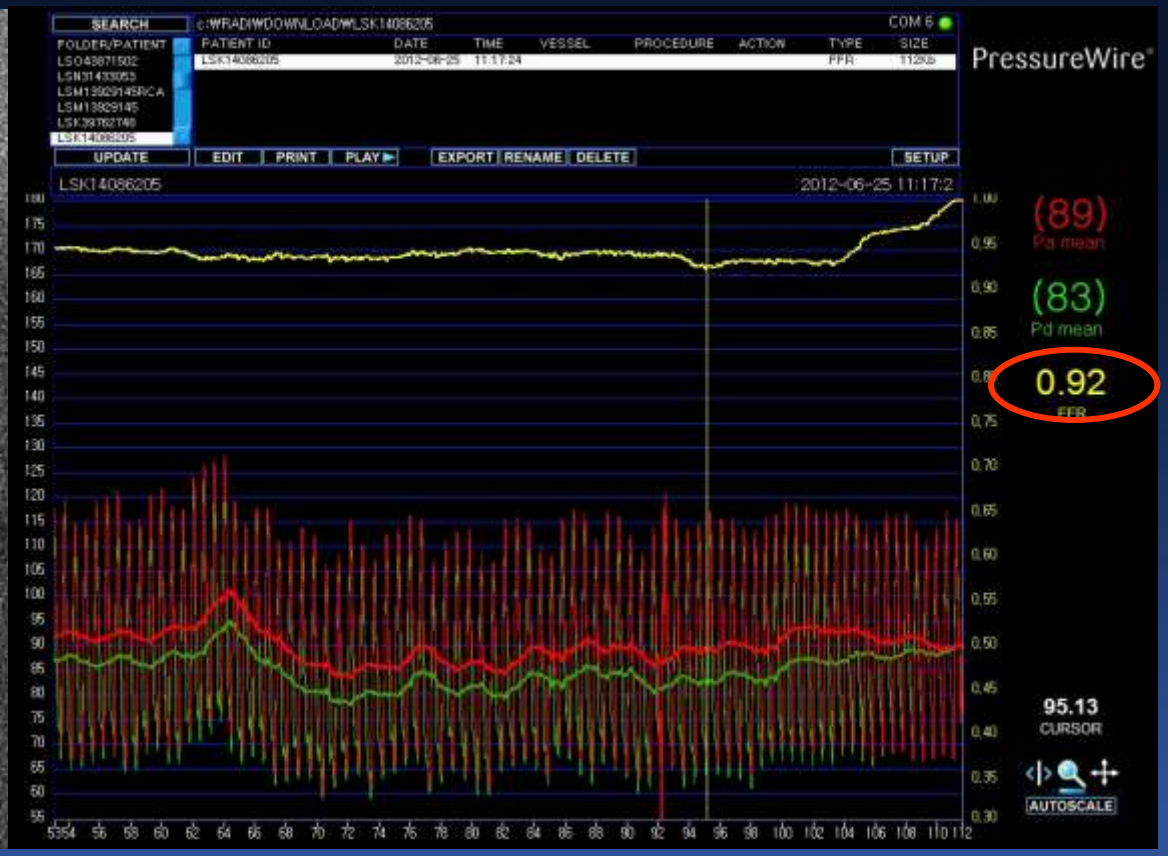
Left Main-TLR *at 2 Years*



No. at Risk			
FKB	95	79	74
No-FKB	318	293	265

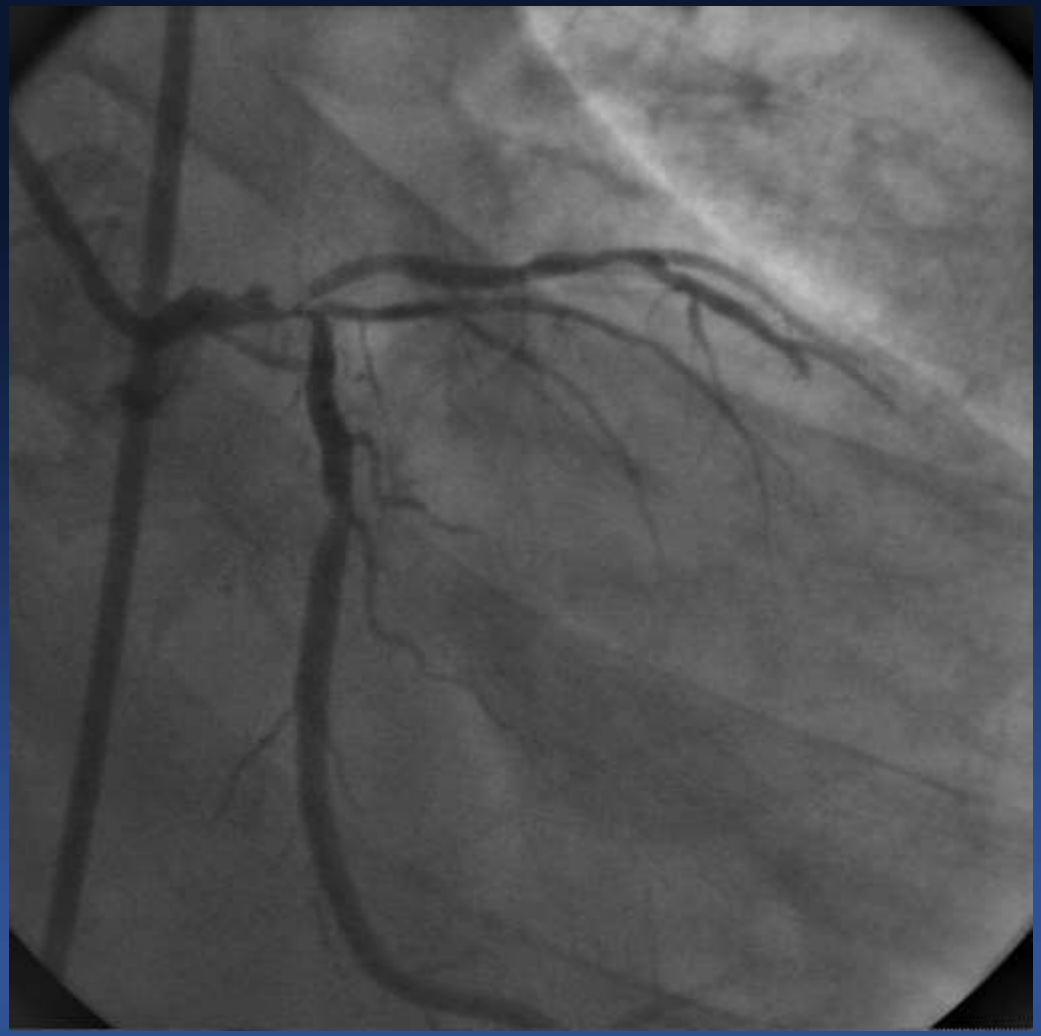
Ahn JM, Park SJ, et al. Am J Cardiol. 2017 Feb 15;119(4):528-534

Do You Want to Do Something?
Consider FFR, First !



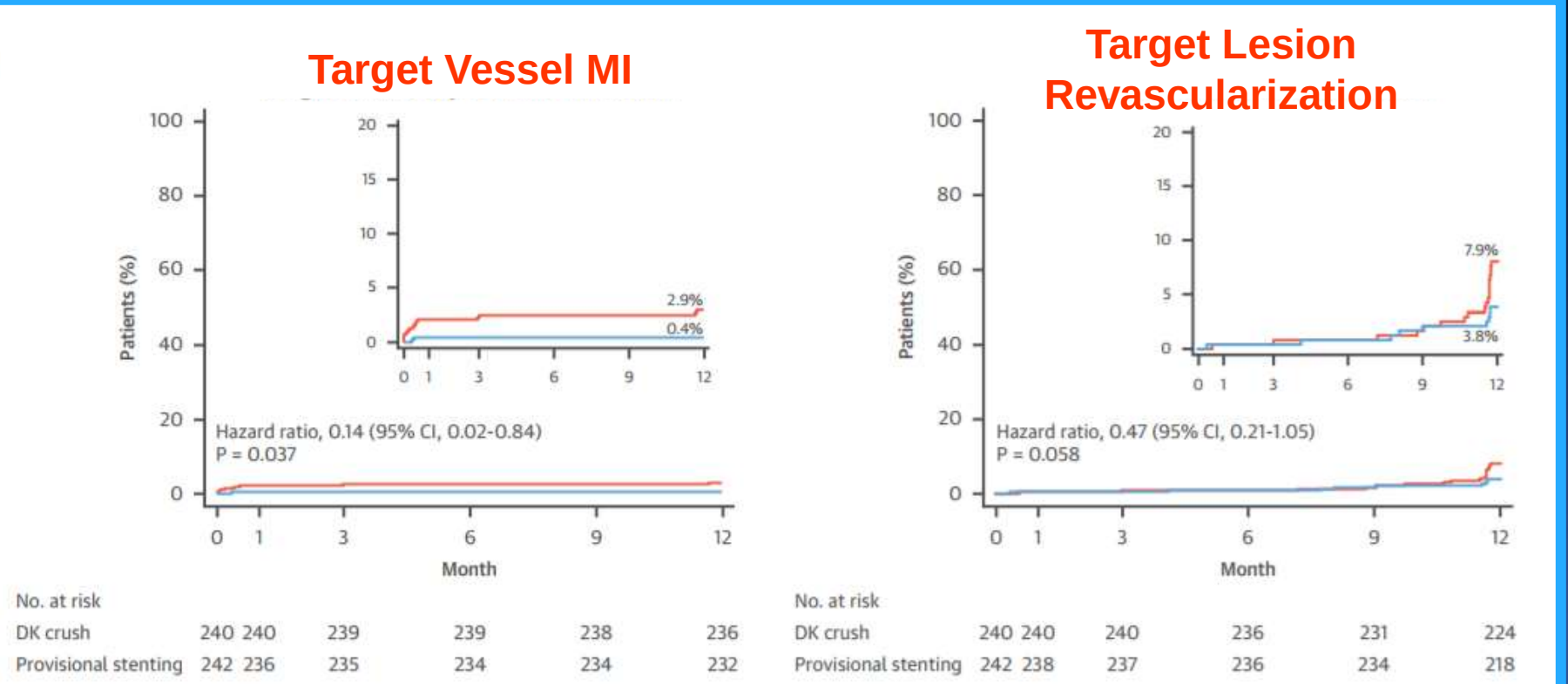
Just Defer !

For True Bifurcation



Don't Do One Stent For *True* Bifurcation

DK CRUSH V



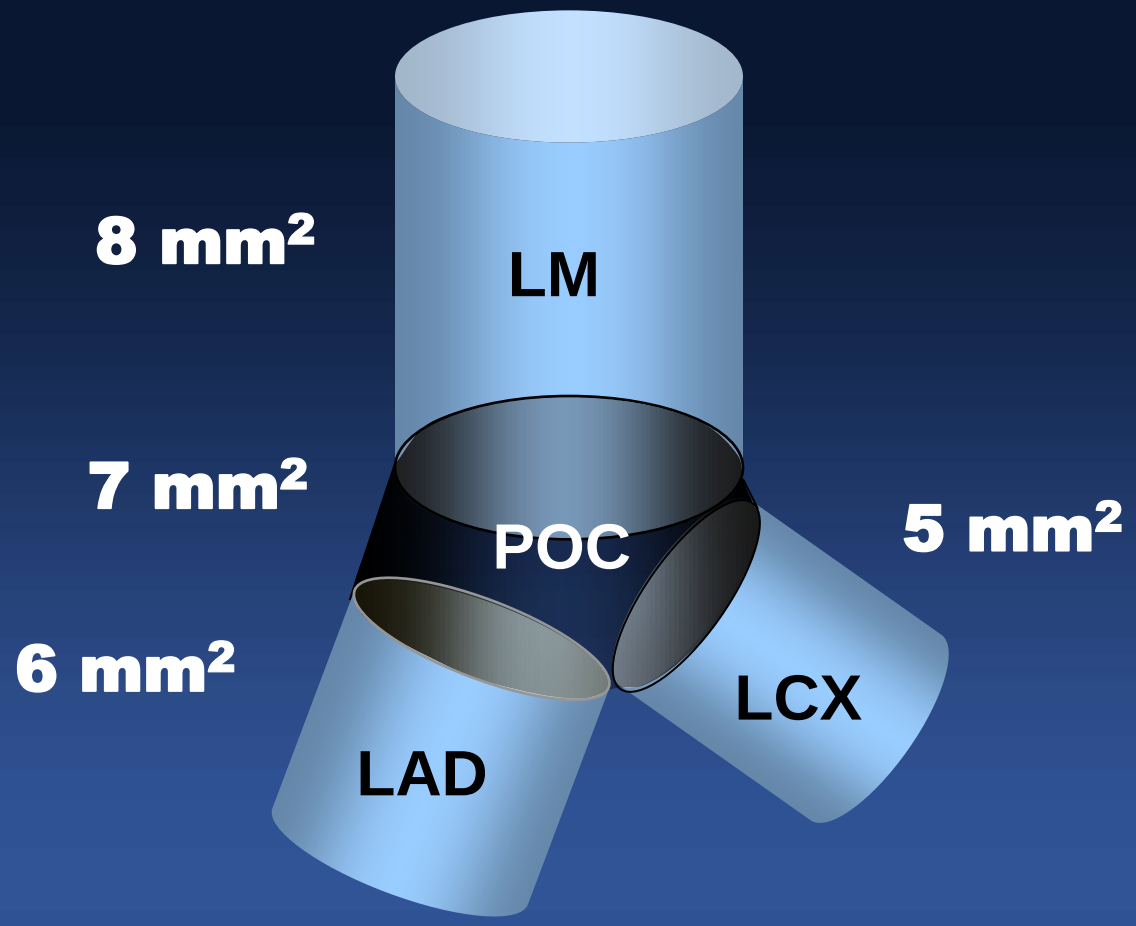
Chen SL et al. J Am Coll Cardiol. 2017 Nov 28;70(21):2605-2617

Is There Difference in Outcomes?

	Advantages	Disadvantages
Culotte	Compatible with 6 Fr guider Independent of bifurcation angle Predictable scaffolding	Leaves multiple layers of strut Potential acute closure of MB
Classic crush	Relatively simple Low risk of SB occlusion Good coverage of SB ostium	Difficult FKI Requires 7 or 8 Fr guider Leaves multiple layers of strut
Mini-crush	Minimises multiple layers of strut Good scaffolding at SB ostium Facilitates FKI Compatible with 6 Fr guider using balloon crushing	Still leaves multiple layers of strut
DK-crush	Good scaffolding at SB ostium Facilitates FKI Compatible with 6 Fr guider	Complex procedural steps
Simultaneous kissing stenting	No risk of occlusion for both branches No need to re-cross any stent Technically easy and quick	Requires 7 or 8 Fr guider Leaves long metallic carina Over-dilatation in proximal MB Diaphragmatic membrane formation at the overlapped stents Difficulty in repeat revascularisation
T-stenting	Good SB scaffolding with angles >70°	Potential gap at SB ostium Protrusion of SB stent into the MB (in the case of TAP)

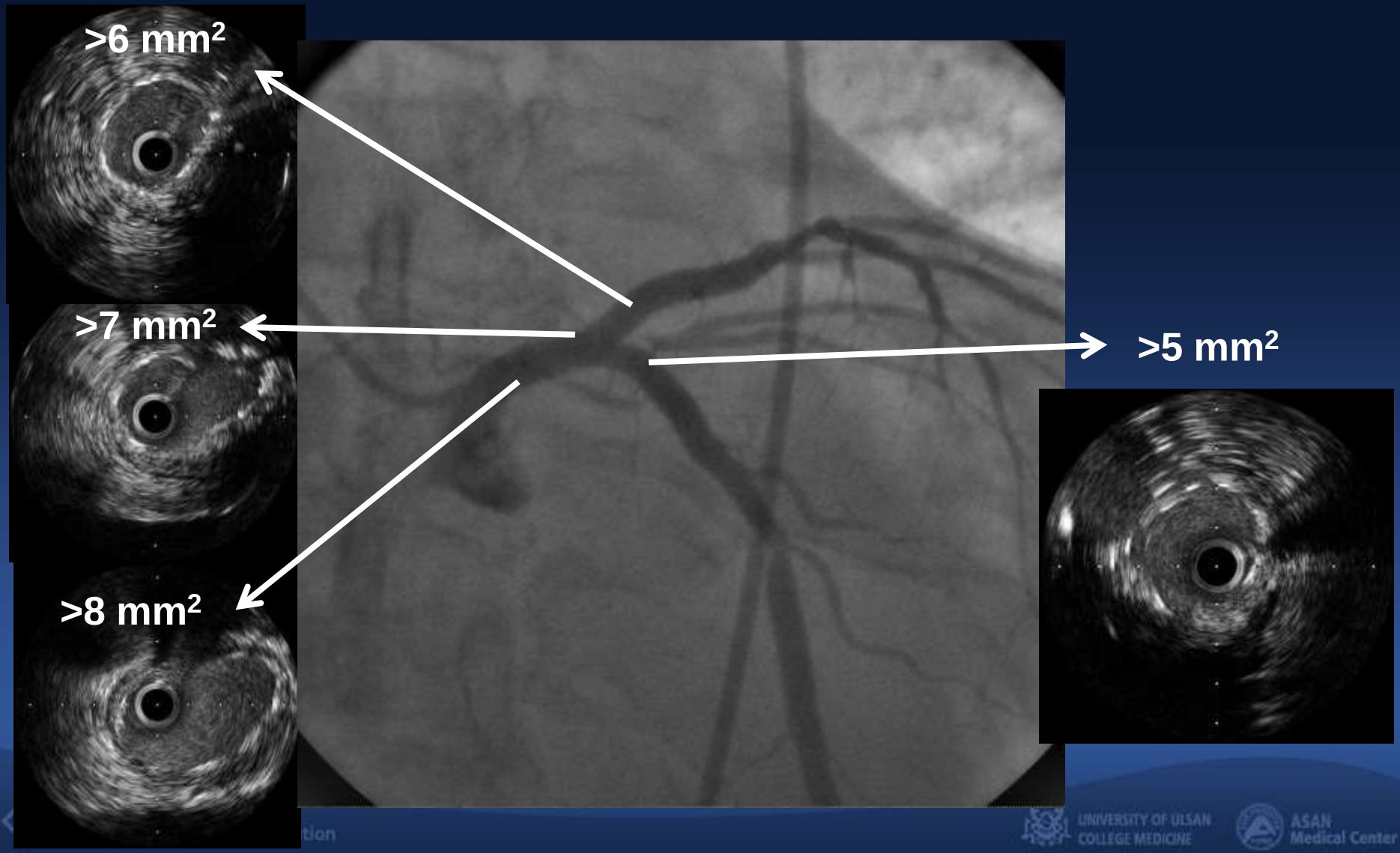
Roh JH et al. Eurointervention 2015;11 Suppl V:V125-8

Effective IVUS Stent Area (Rule of 5,6,7,8) Can Reduce Restenosis Rate

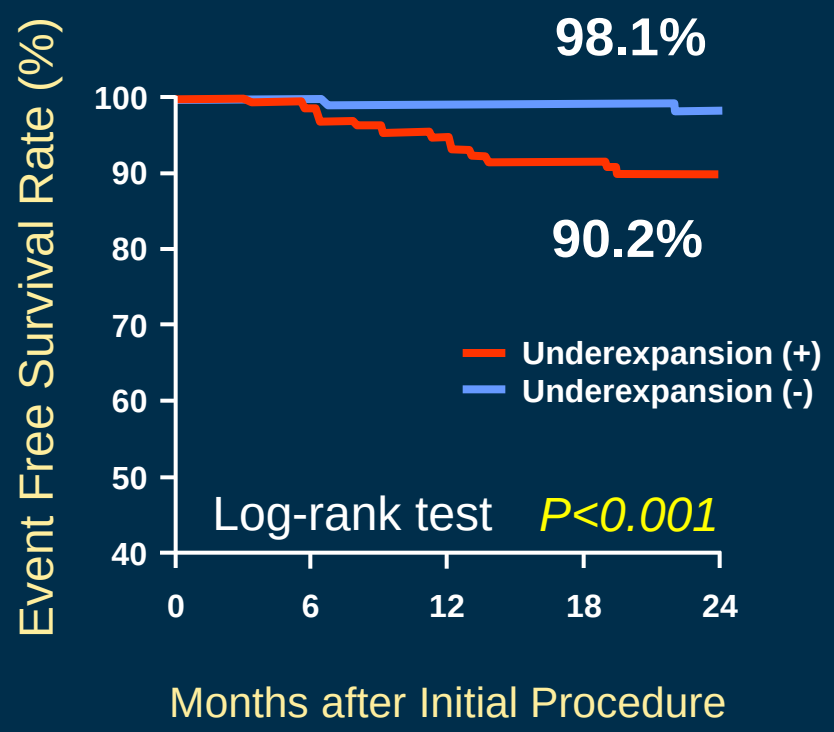


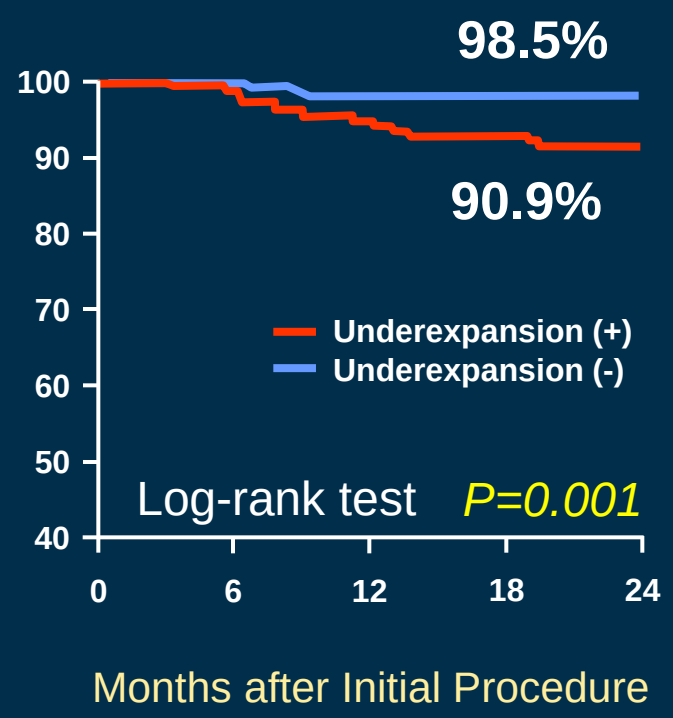
Kang et al. Circ Cardiovasc Interv 2011;4:1168-74

Post Stent IVUS Surveillance For Further High Pressure Ballooning



MACE and TLR Rate < 2% at 2 Year





Kang et al. Circ Cardiovasc Interv 2011;4:1168-74

Distal LM Bifurcation Stenosis

IVUS Evaluation of Both LAD and LCX, FFR if necessary

- **No or mild stenosis of LCX ostium**
- Small LCX

Provisional One Stent Approach

- True Bifurcation
- Big LCX
- Diffuse LCX disease

Two Stent Technique

Integrated Use of FFR and IVUS,
It's a Matter of Concept
rather than Technique !

Finish PCI

FKB or
T stenting

IVUS Optimization

Finish PCI

Ahn JM, Park SJ et al BMC Cardiovasc Disord 2016;16:49