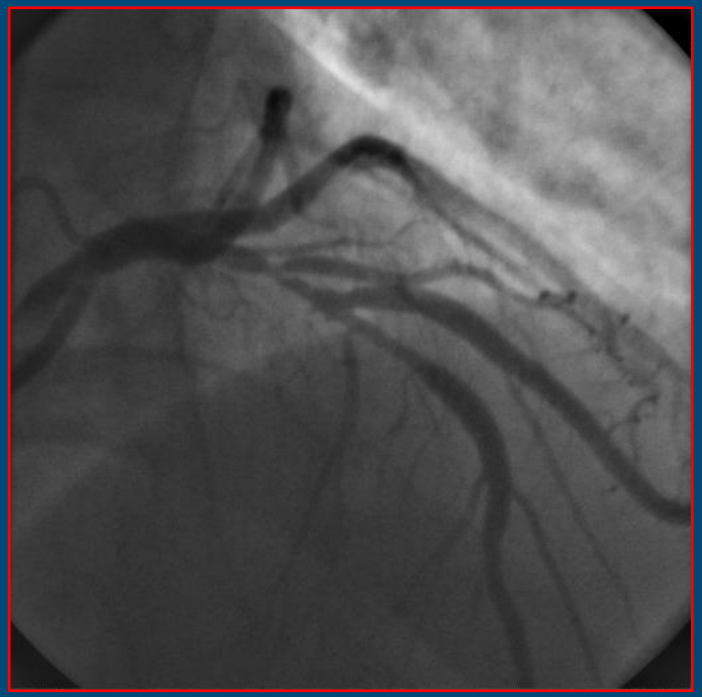
Bifurcation PCI: Contemporary Practical Approach

Jung-Min Ahn, MD

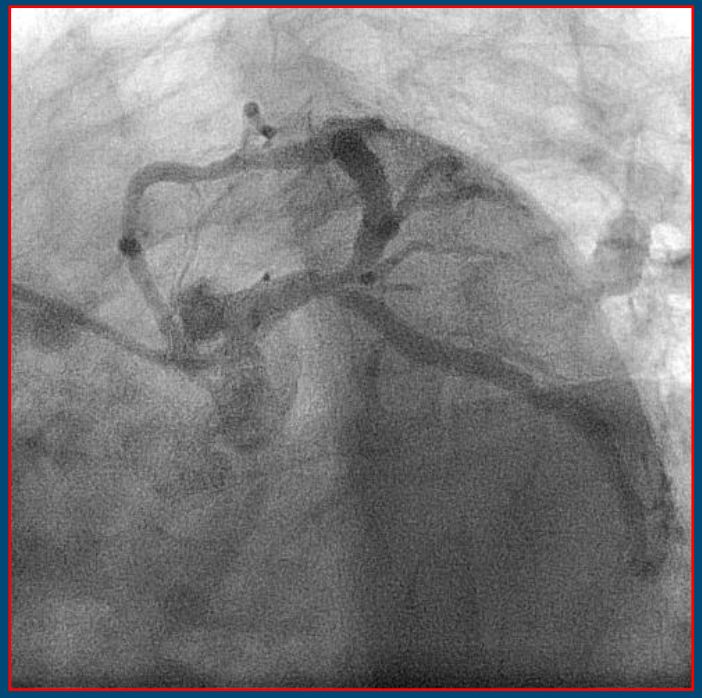
Heart Institute, Asan Medical Center, Ulsan University College of Medicine, Seoul, Korea

Bifurcation

Non-Left Main

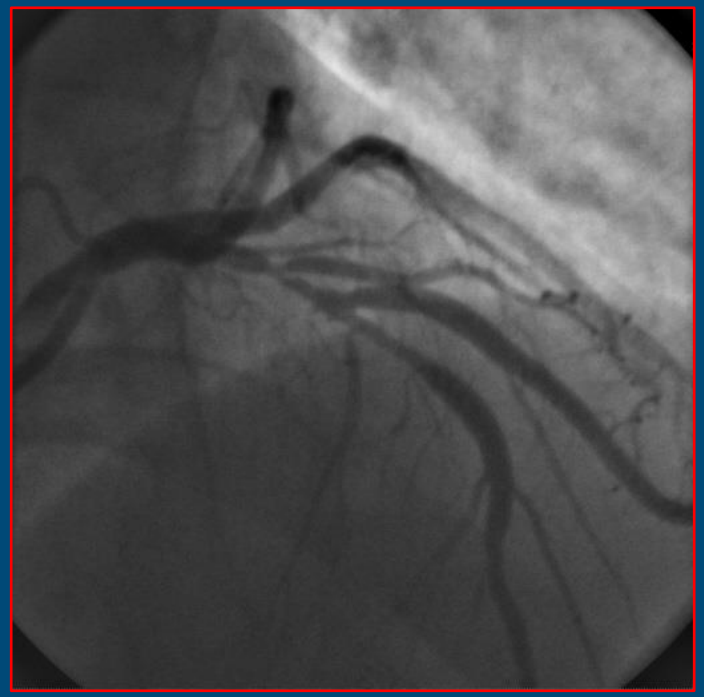


Left Main



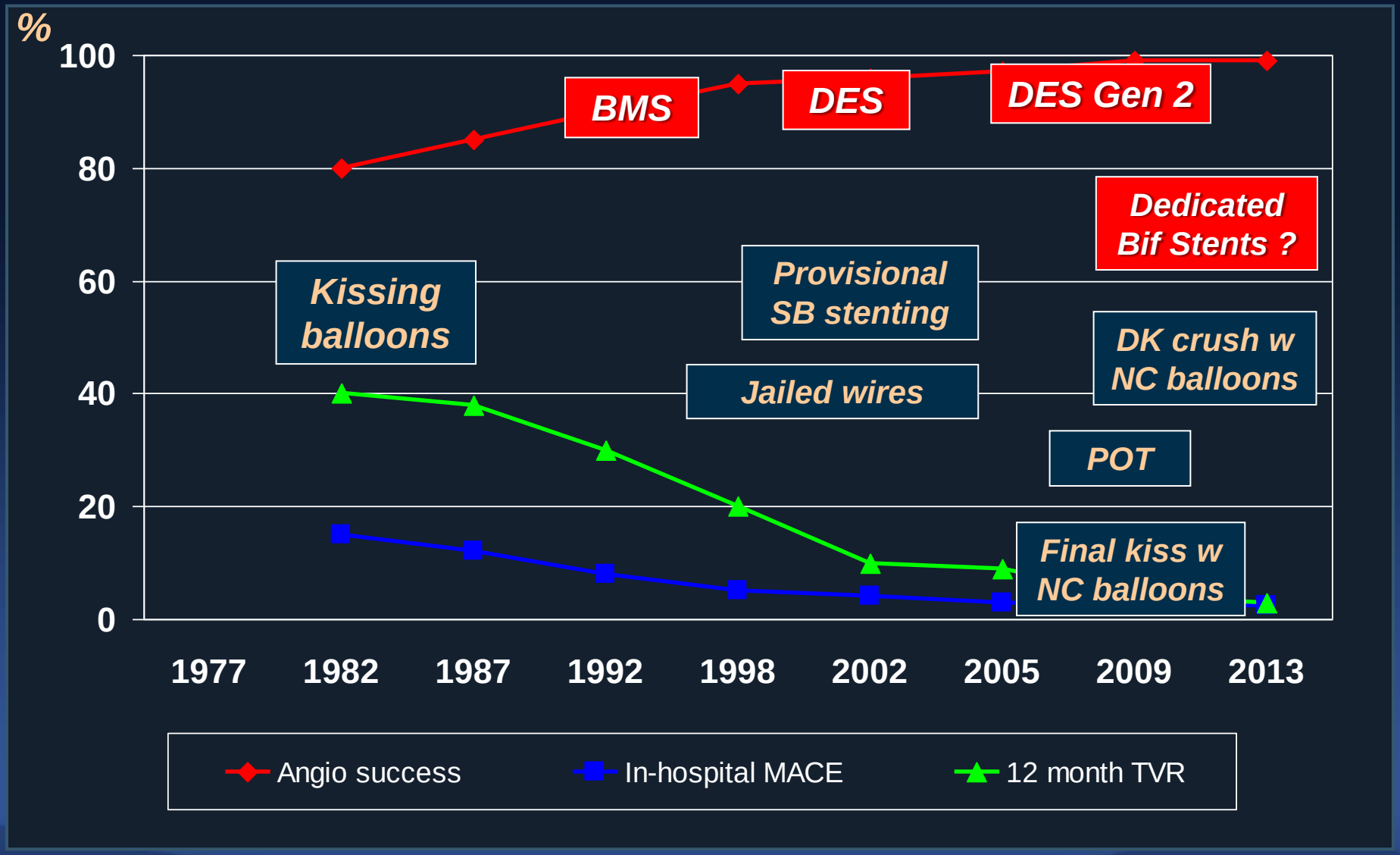
Bifurcation

Non-Left Main



- Simple Cross Over?
- Two Stent Technique?
- Side Branch Protection?

Evolution of Bifurcation Therapy



Meta-Analysis of 12 Major Studies, 6961 Pts

Provisional Single-Stenting is Better !

DES Thrombosis

A

Study	Year	DDS	SDS	Weight*	RR (random) 95% CI
RANDOMIZED, CONTROLLED TRIALS					
NORDIC	2008	1/196	2/199	5.37%	0.50 (0.04–5.55)
Ferenc et al.	2008	2/101	1/101	5.40%	2.00 (0.18–21.71)
CACTUS	2009	3/177	2/173	9.73%	1.46 (0.24–8.66)
BBC-ONE	2010	5/249	1/248	6.71%	4.97 (0.58–42.31)
DK-CRUSH-II	2011	4/185	1/185	6.45%	4.00 (0.45–35.44)
META-ANALYSIS		**15/908**	**7/906**		**2.01 (0.77–5.23)**
Cochrane Q: 2.46 (p: 0.651) I^2: 0%					
NONRANDOMIZED, OBSERVATIONAL STUDIES					
Ge et al.	2007	3/57	0/117	3.54%	14.24 (0.74–271.13)
Di Mario et al.	2007	4/109	0/38	3.66%	3.19 (0.17–57.92)
ARTS II	2007	1/61	4/263	6.50%	1.07 (0.12–9.47)
COBIS	2010	2/292	9/1376	13.17%	1.04 (0.22–4.82)
J-CYPHER	2011	3/263	10/1870	18.64%	2.13 (0.59–7.70)
J-PMS	2011	4/37	2/263	11.12%	14.21 (2.69–74.92)
Assali et al.	2011	2/141	3/260	9.72%	1.23 (0.21–7.27)
META-ANALYSIS		**19/960**	**27/4187**		**2.55 (1.13–5.78)**
Cochrane Q: 8.06 (p: 0.234) I^2: 25.57%					
META-ANALYSIS		**34/1868**	**35/5093**	**100%**	**2.31 (1.33–4.03)**
Cochrane Q: 10.65 (p: 0.473) I^2: 0%					

DDS better / SDS better

0.01 0.1 1 10 100 1000

RR (LOG SCALE)

Single-stent **Two-stent**

Myocardial Infarction

C

Study	Year	DDS	SDS	Weight*	RR (random) 95% CI
RANDOMIZED, CONTROLLED TRIALS					
NORDIC	2008	39/196	20/199	16.86%	1.97 (1.19–3.26)
Ferenc et al.	2008	2/101	1/101	1.80%	2.00 (0.18–21.71)
CACTUS	2009	19/177	15/173	13.48%	1.28 (0.65–2.35)
BBC-ONE	2010	28/249	9/248	11.76%	3.09 (1.49–6.43)
DK-CRUSH-II	2011	6/185	4/185	5.59%	1.50 (0.43–5.22)
META-ANALYSIS		**94/908**	**49/906**		**1.88 (1.35–2.62)**
Cochrane Q: 3.59 (p: 0.453) I^2: 0%					
NONRANDOMIZED, OBSERVATIONAL STUDIES					
Ge et al.	2007	13/57	5/117	8.04%	5.33 (1.99–14.24)
Di Mario et al.	2007	7/109	2/38	4.01%	1.22 (0.26–5.62)
ARTS II	2007	3/61	16/263	5.94%	0.80 (0.24–2.68)
COBIS	2010	5/292	15/1376	7.78%	1.57 (0.57–4.28)
J-CYPHER	2011	6/263	39/1870	9.77%	1.09 (0.46–2.55)
J-PMS	2011	5/37	6/263	6.48%	5.92 (1.90–18.44)
Assali et al.	2011	7/141	10/260	8.49%	1.29 (0.50–3.32)
META-ANALYSIS		**43/960**	**93/4187**		**1.85 (1.03–3.32)**
Cochrane Q: 12.79 (p: 0.041) I^2: 53.11%					
META-ANALYSIS		**140/1727**	**142/5093**	**100%**	**1.86 (1.34–2.60)**
Cochrane Q: 16.34 (p: 0.129) I^2: 32.69%					

DDS better / SDS better

0.01 0.1 1 10 100 1000

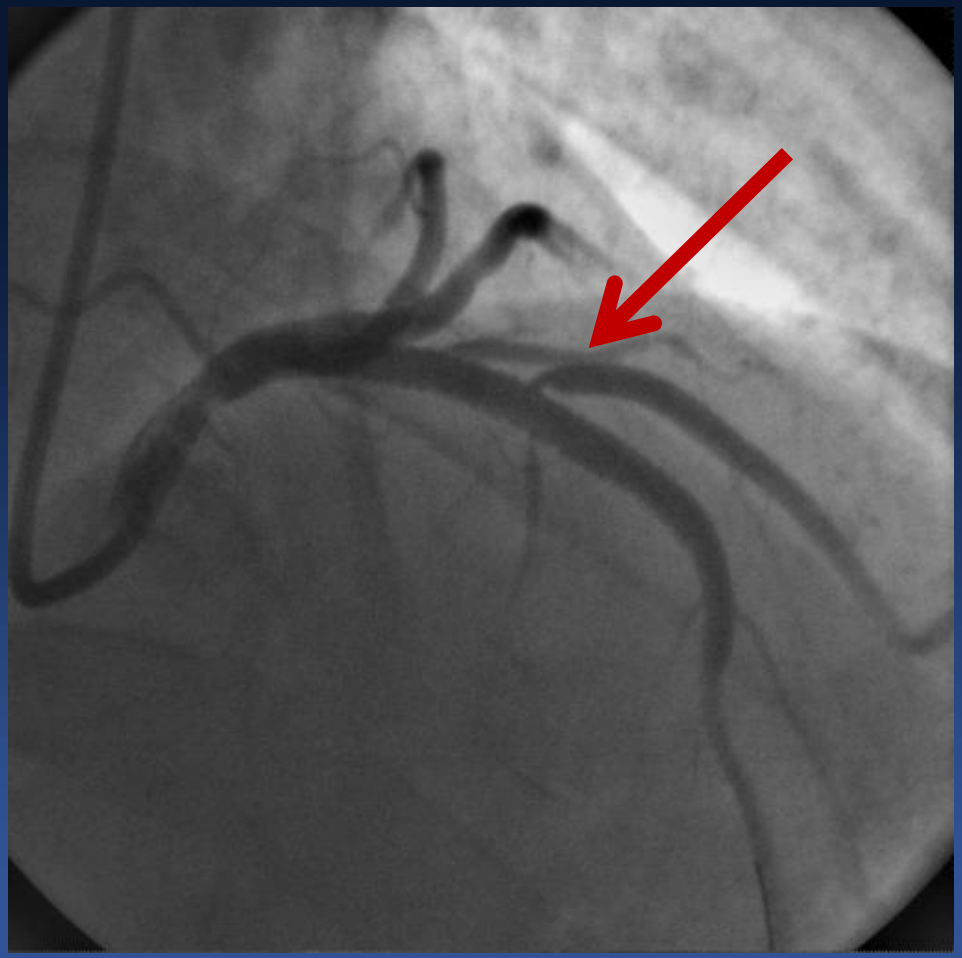
RR (LOG SCALE)

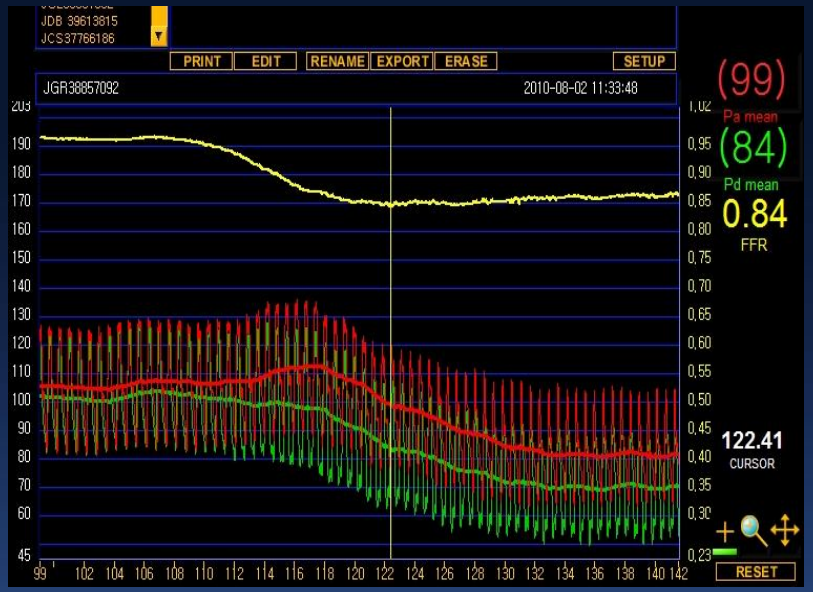
Single-stent **Two-stent**

- No randomized trials had shown that two-stenting was superior to single-stenting.
- Provisional one stent cross over with jailed wire has been a standard strategy to treat non-LM bifurcation, even true bifurcation.

Zimarino et al. J Am Coll Cardiol Intv 2013;6:687–95

After Stenting at Main Vessel



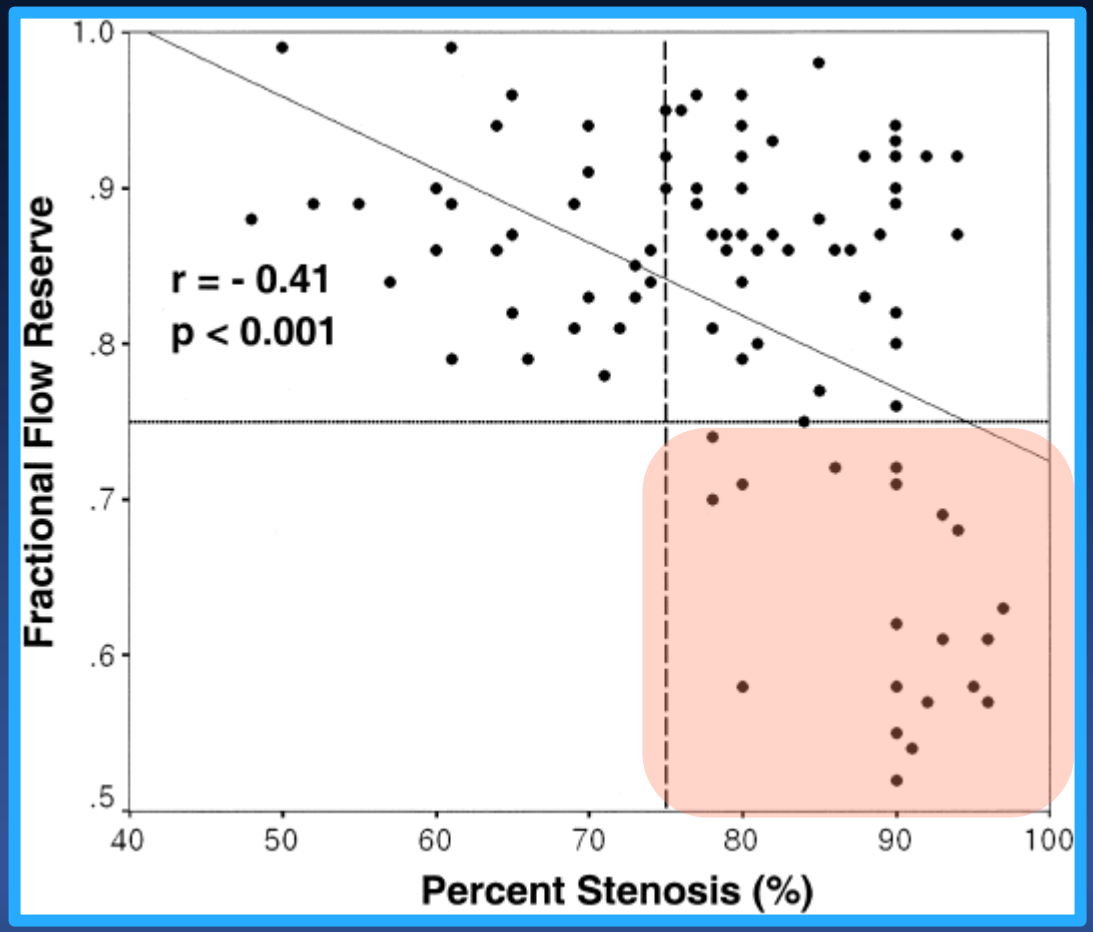


FFR 0.84

Leave it alone.

FFR of the Jailed Side Branch

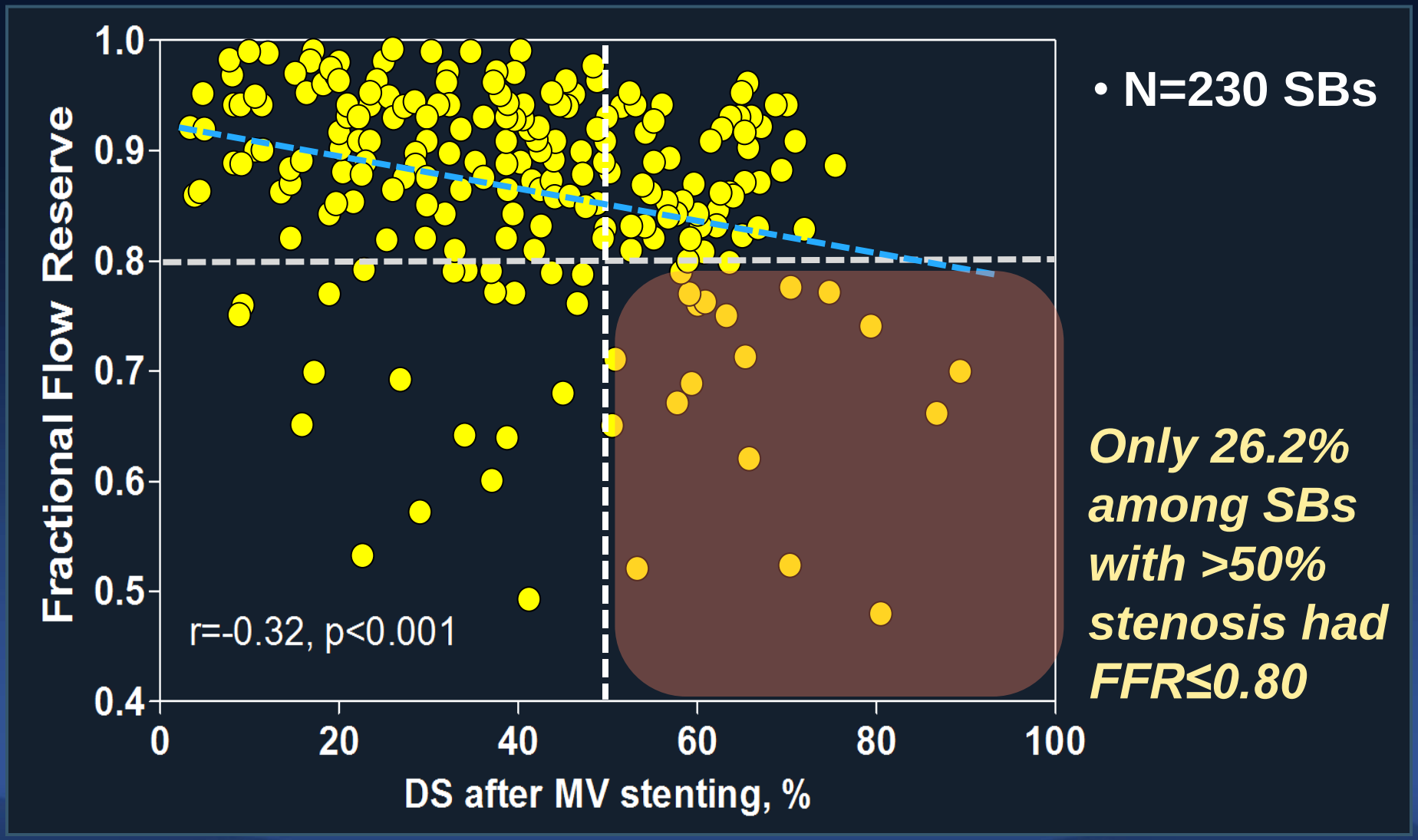
Among angiographic jailed side branches, functionally significant stenosis is not common.



Koo BK et al. J Am Coll Cardiol 2005;46:633–7.

FFR of the Jailed Side Branch

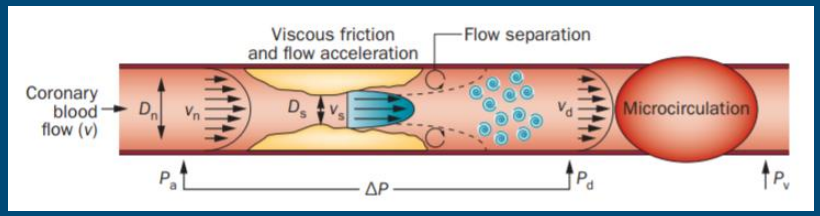
By Using Dedicated Bifurcation QCA



Park SJ, Ahn JM et al. JACC Cardiovasc Interv. 2012 Feb;5(2):155-61

Why? Determinants of FFR

Stenosis



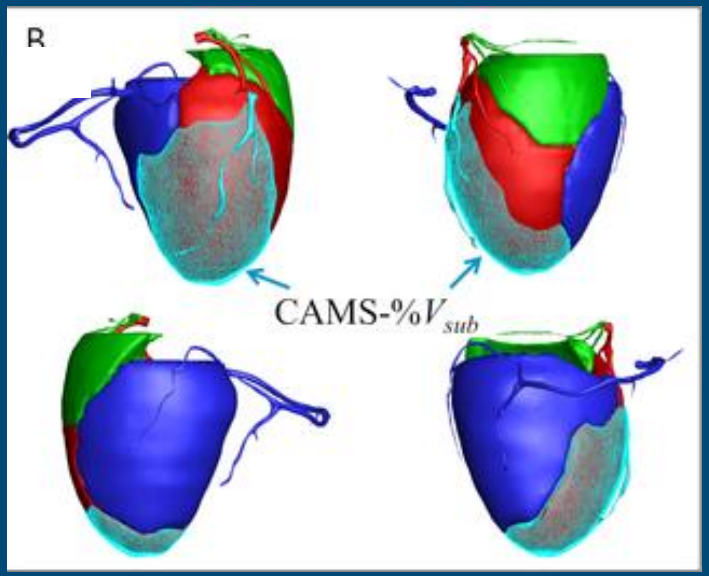
The pressure gradient across a stenosis is determined by the sum of viscous and separation losses.

$$\Delta P = Av + Bv^2$$

The most-important geometric parameter is the minimum diameter of the stenosis

Nat. Rev. Cardiol. 10, 439–452 (2013)

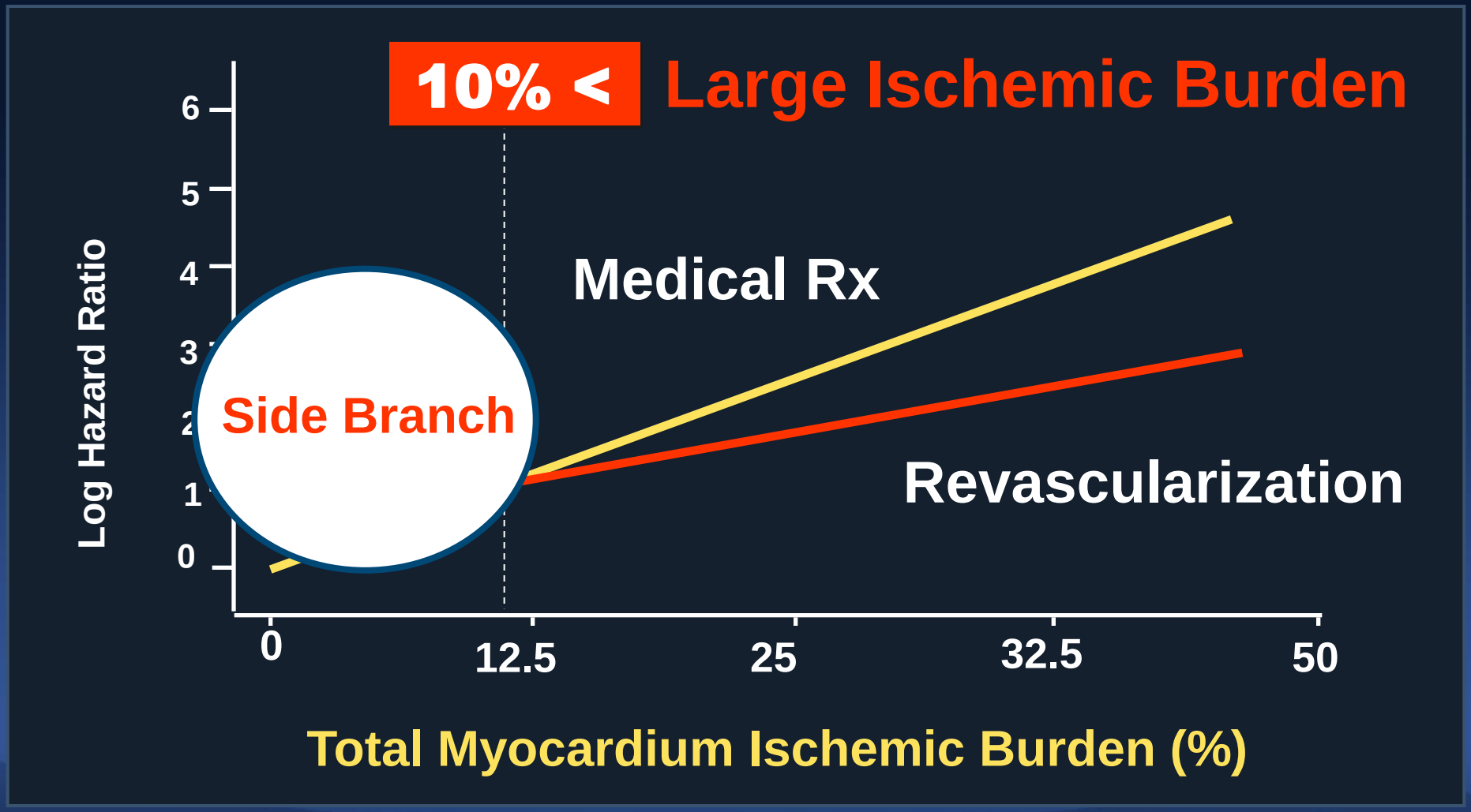
Myocardium



- Vascular territory on the FFR value
- Any given stenosis,
  Vascular territory ↑ FFR ↓
  Vascular territory ↓ FFR ↑

PLoS Med 15(11): e1002693

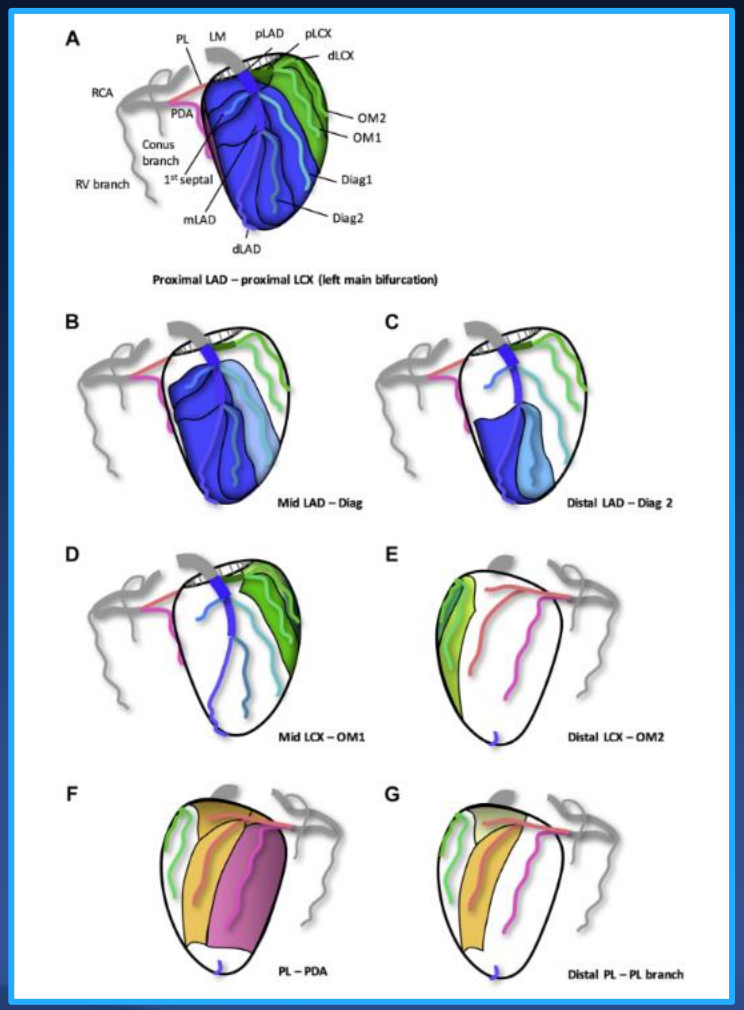
Survival Benefit of Revascularization



Hachamovitch R, Circulation. 2003;107:2900-2906

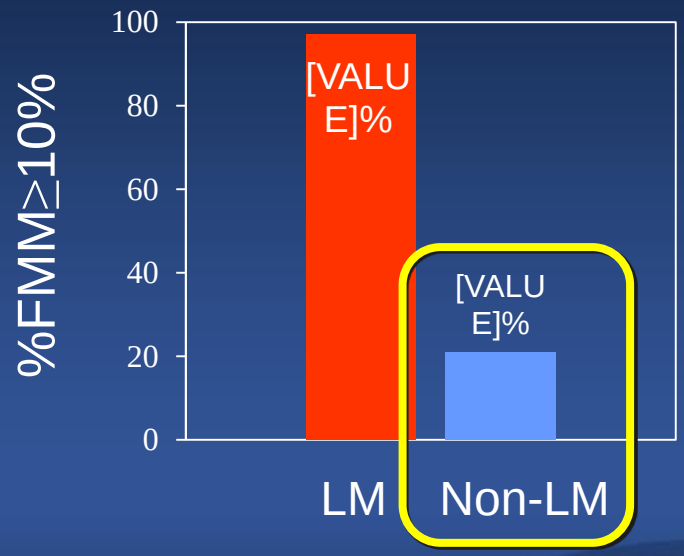
Myocardial Mass Supplied by Side Branch

Fractional Myocardial Mass (FMM)
Based on CT



Predictors of %FMM≥10%

- Side branch length ≥ 73mm
- Left main bifurcation



J Am Coll Cardiol Intv 2017;10:571–81

Simple Calculation

Ischemia Extent: %FMM>10% in SB: 21%

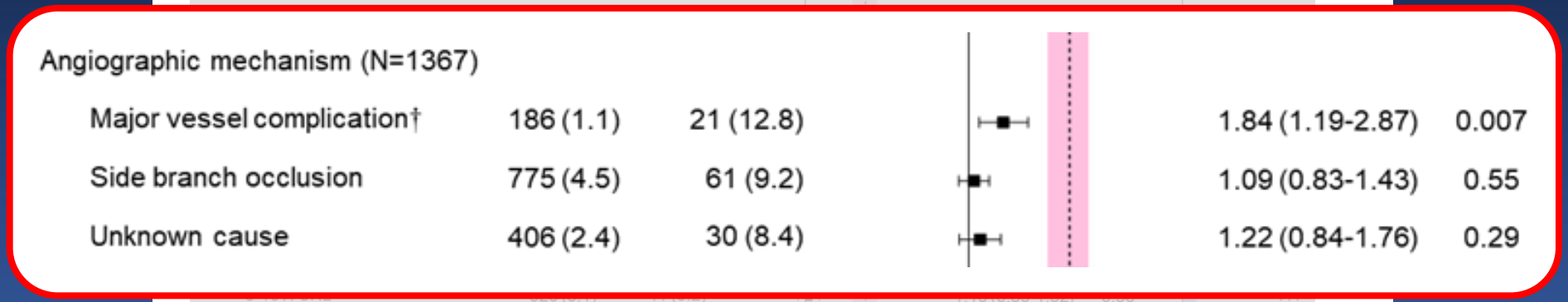
Ischemia Severity: FFR≤0.80 in SB: 26%

Clinically (Prognostically) Important SB is

Only 5.5%

Peri-Procedural MI:
Angiographic Complications

Side branch occlusion is not associated with long-term survival but main branch occlusion is associated with long-term survival after PCI.



Angiographic mechanism (N=1367)				
Major vessel complication†	186 (1.1)	21 (12.8)	1.84 (1.19-2.87)	0.007
Side branch occlusion	775 (4.5)	61 (9.2)	1.09 (0.83-1.43)	0.55
Unknown cause	406 (2.4)	30 (8.4)	1.22 (0.84-1.76)	0.29

Unpublished Data From Asan Medical Center

Symptomatically Important Side Branch

- Angina
- EKG change
- Arrhythmogenic potential

Balloon Occlusion

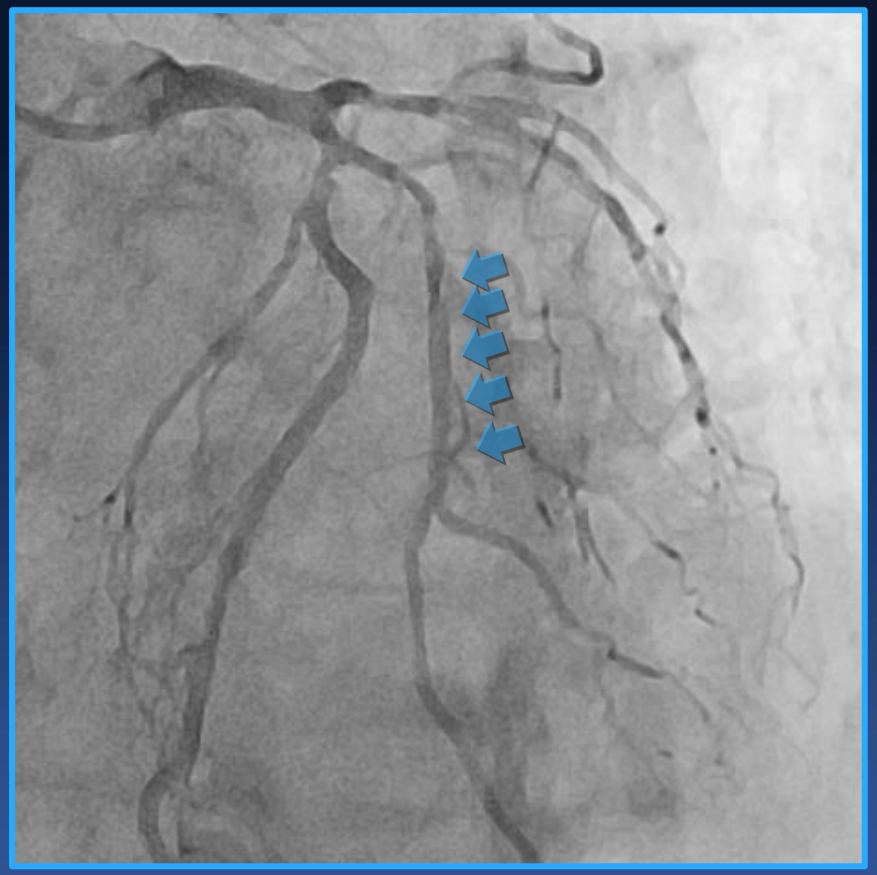
	LAD	Diagonal	p Value
Chest pain and ECG parameters, n = 65			
VAS pain score	5 (0–7)	2 (0–4)	<0.0001
ST-segment elevation ≥1 mm	60 (92.3)	23 (35.4)	0.001
QTc interval, ms	454.0 ± 45.4	440.4 ± 35.7	0.07
QTc dispersion, ms	83.8 ± 39.2	70.7 ± 28.5	<0.0001
Coronary hemodynamic parameters, n = 47			
Pre-intervention FFR	0.67 ± 0.10	0.71 ± 0.11	0.02
Pw, mm Hg	21.0 ± 6.5	26.7 ± 9.4	<0.0001
Pw/Pa	0.22 ± 0.07	0.27 ± 0.08	0.001

Diagonal Br. Scoring

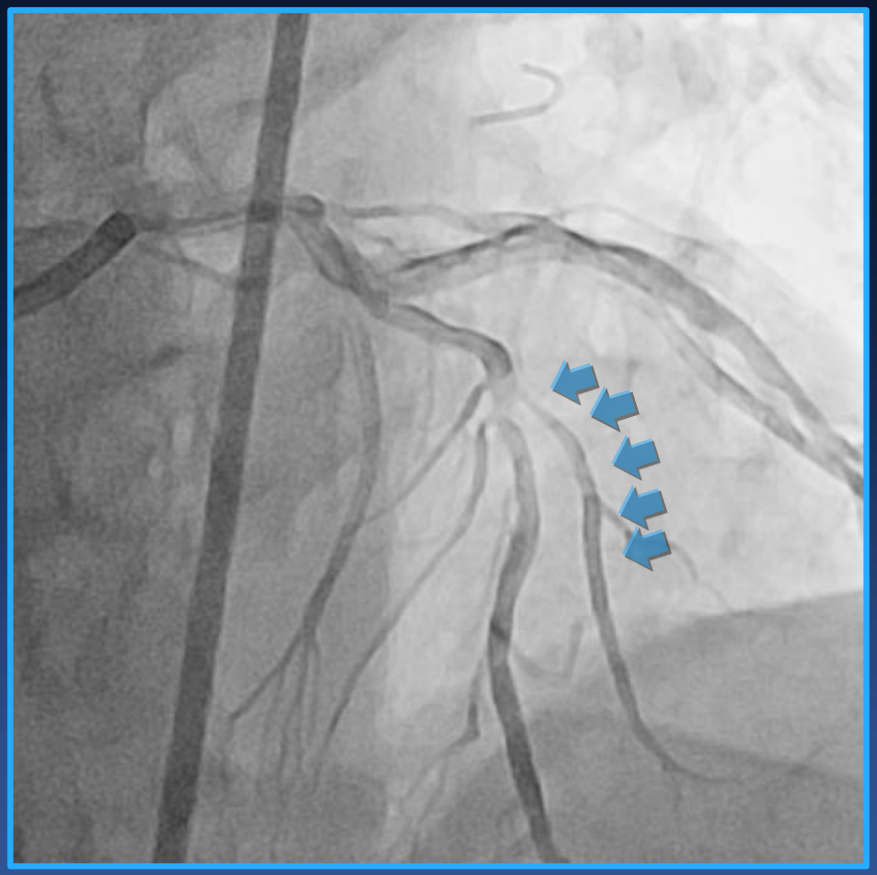
- *Vessel Size ≥ 2.5mm*
- *No. of Dia. Br. ≤ 2*
- *No Br. Below*

Koo BK et al. JACC: Cardiovascular Interventions Volume 5, Issue 11, Pages 1126-1132

Important



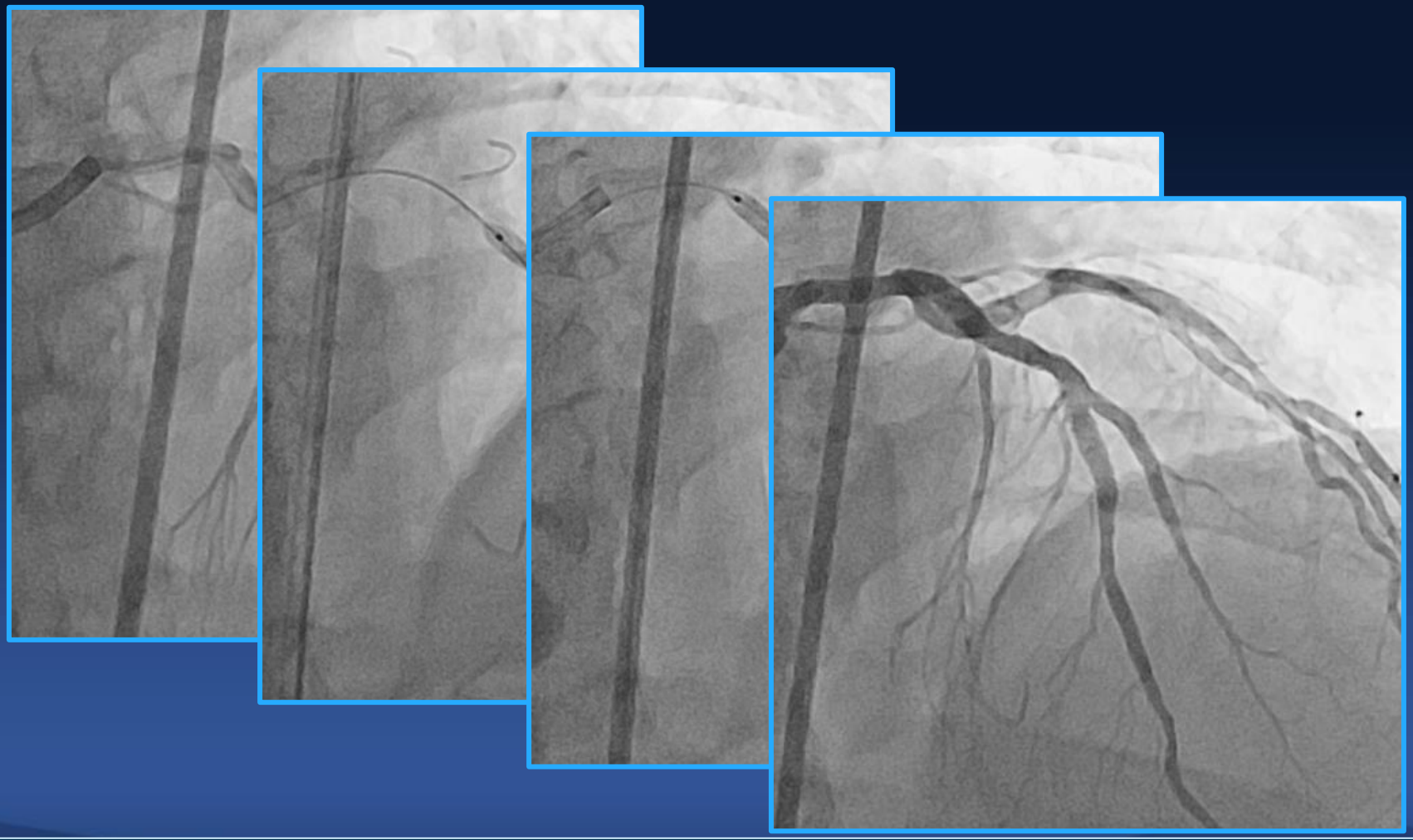
Less Important



When We Do Initial Two Stenting?

Big SB, Hard to Re-Wire, to Avoid ***Pain***

(>2.5mm) (Very tight, acute angle, calcification etc)



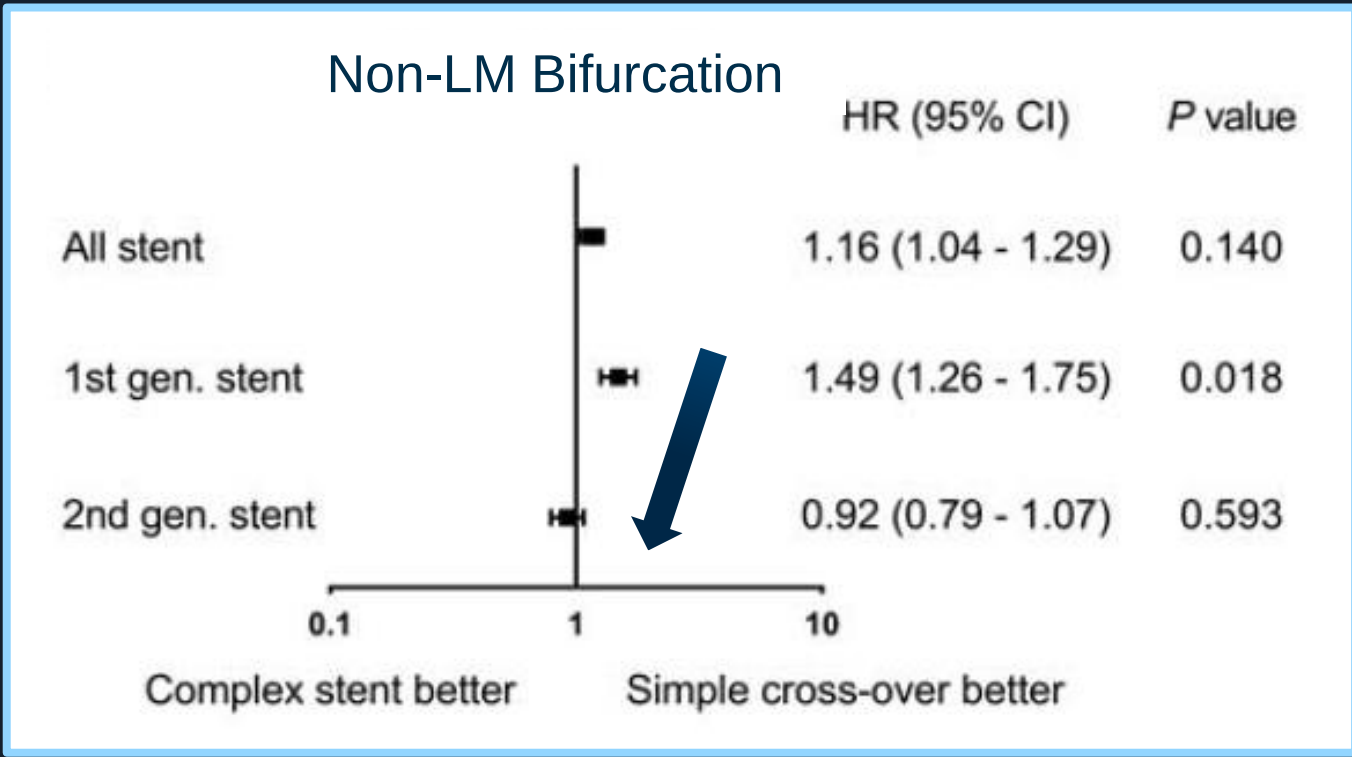
Not For Better Prognosis But For No Pain during PCI

Temporal Changes in Non-LM Bifurcation PCI

Data from IRIS-DES and LM Registry

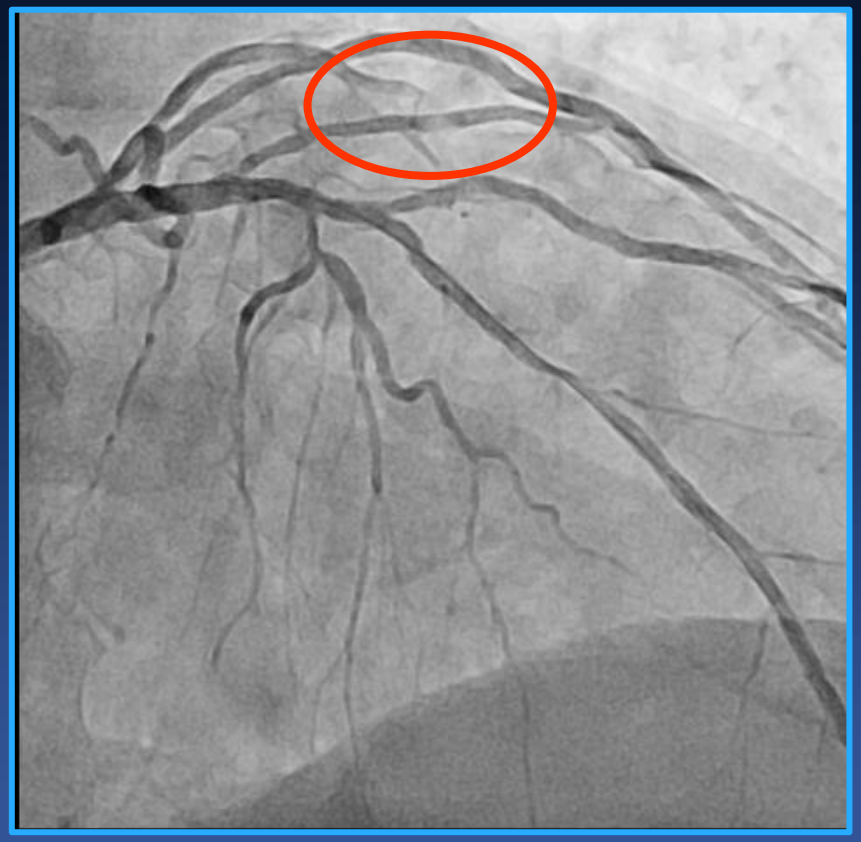
The Outcome of 2-Stenting Has Improved

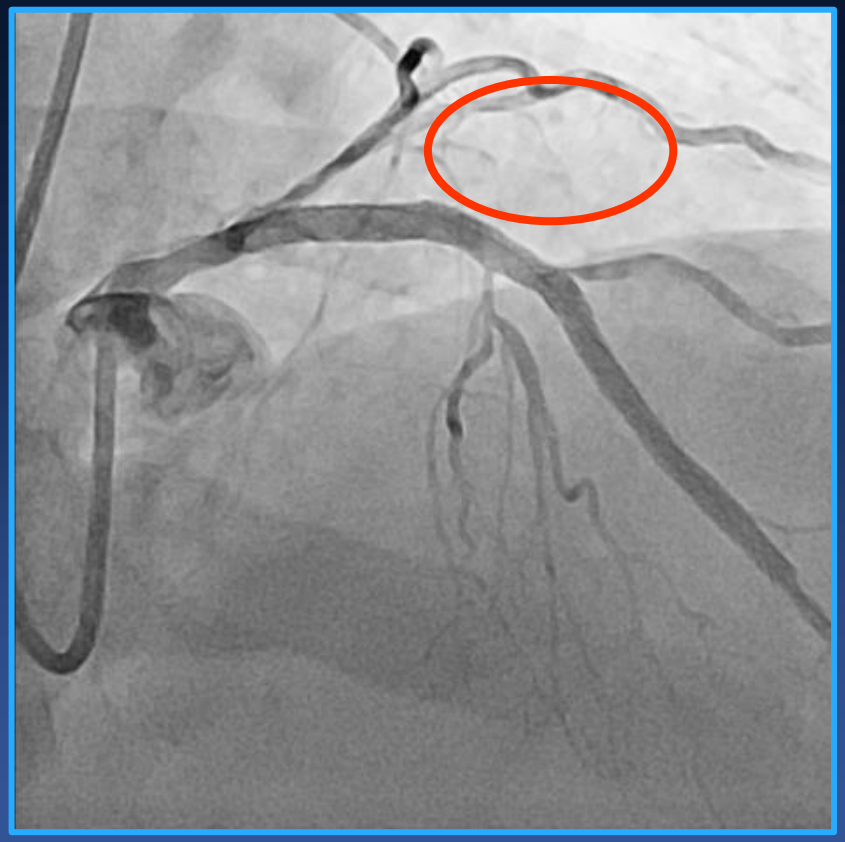
Target-Vessel Failure



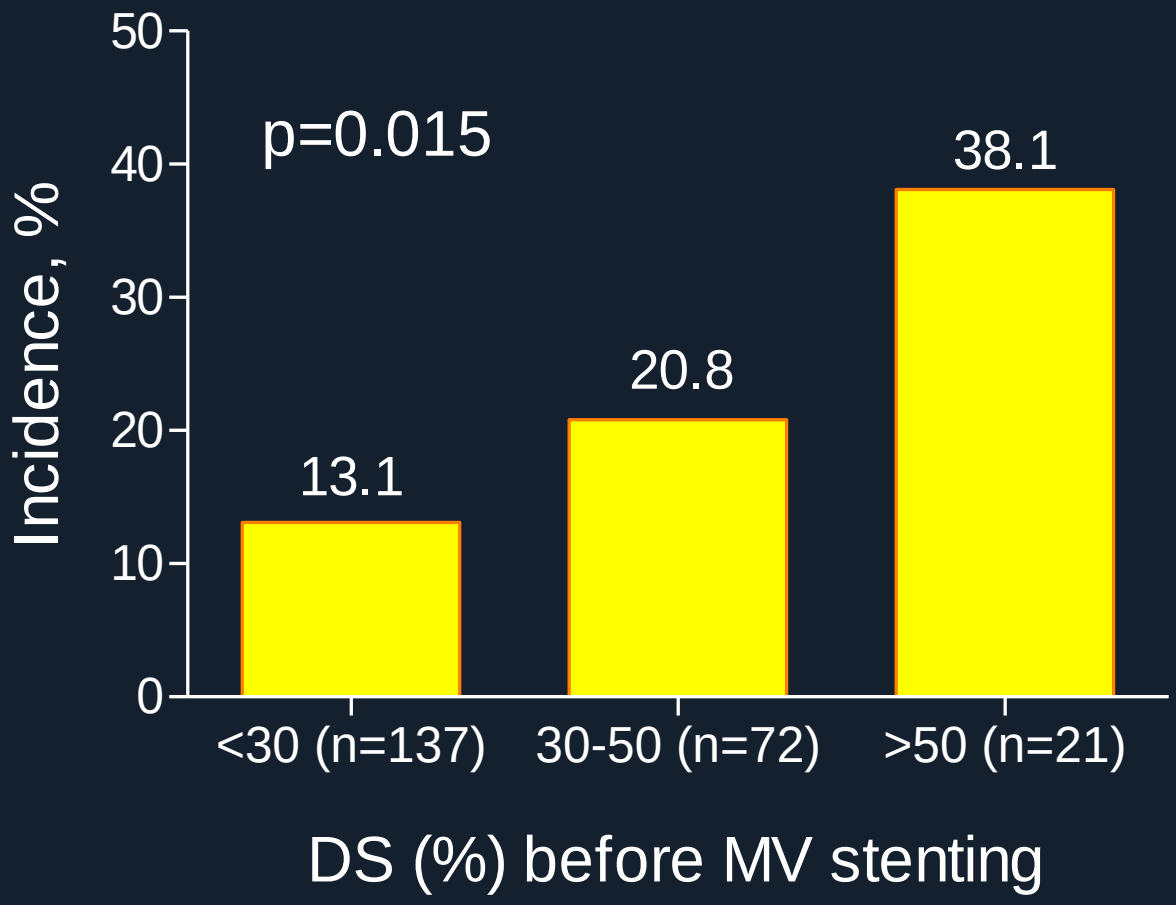
Coron Artery Dis. 2019 Jan;30(1):33-43

Diagonal Branch Disappeared after Stenting





Pre-Stenting DS vs. Post-Stenting FFR of Side Branches



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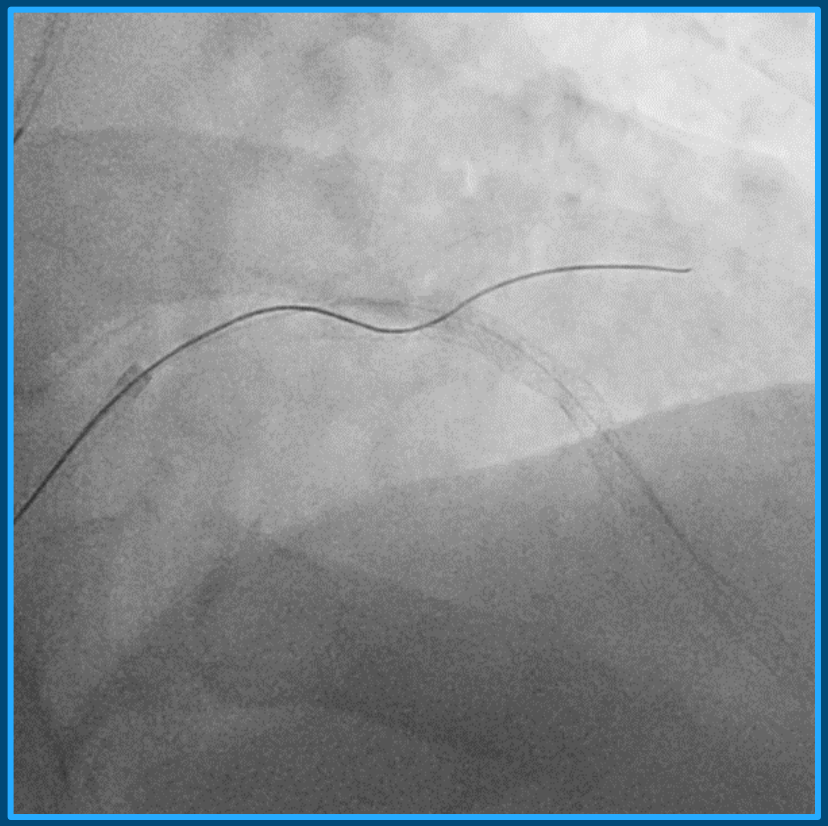
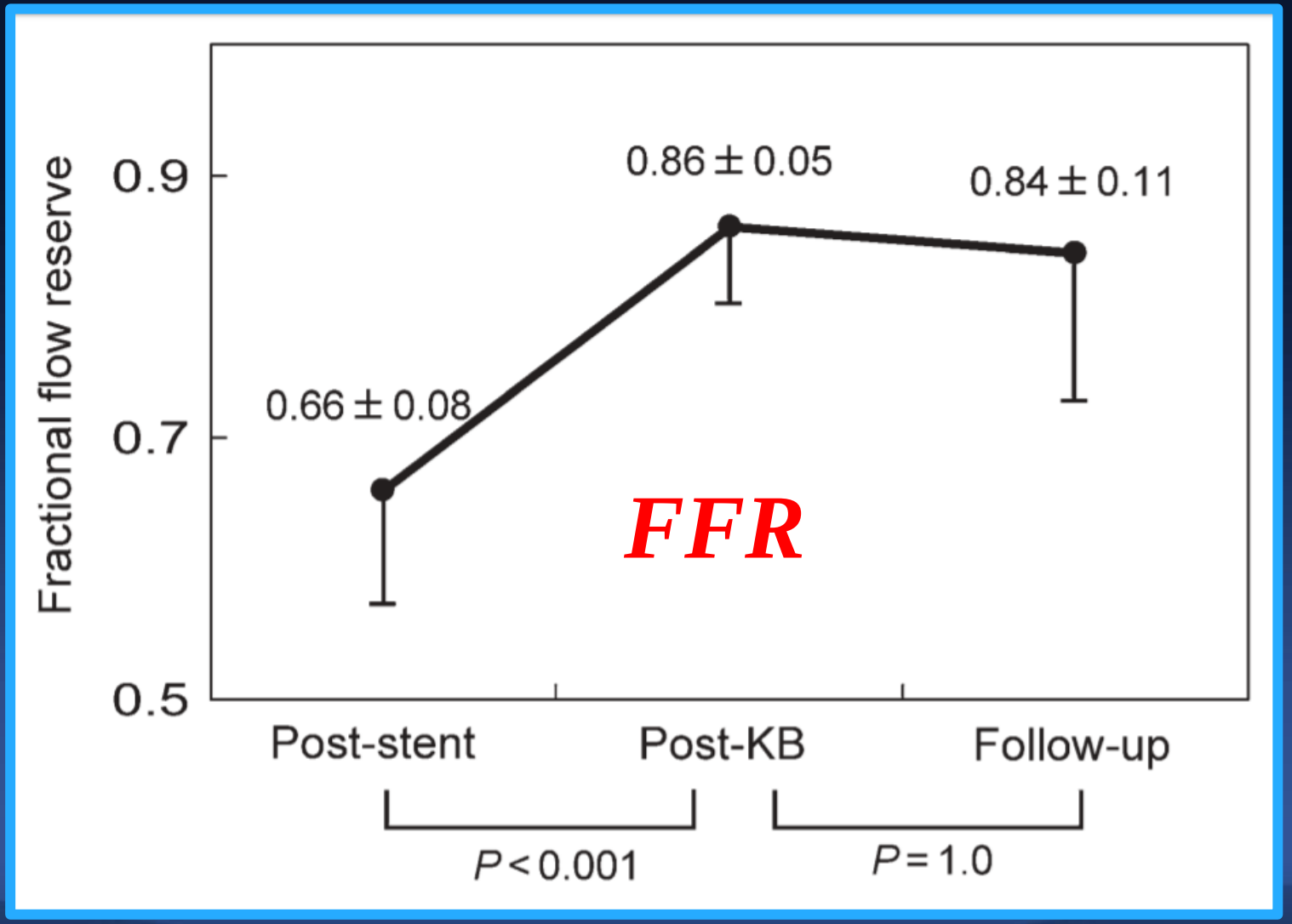


- Provisional Stenting?
- Kissing Balloon?
- Keep It Open?

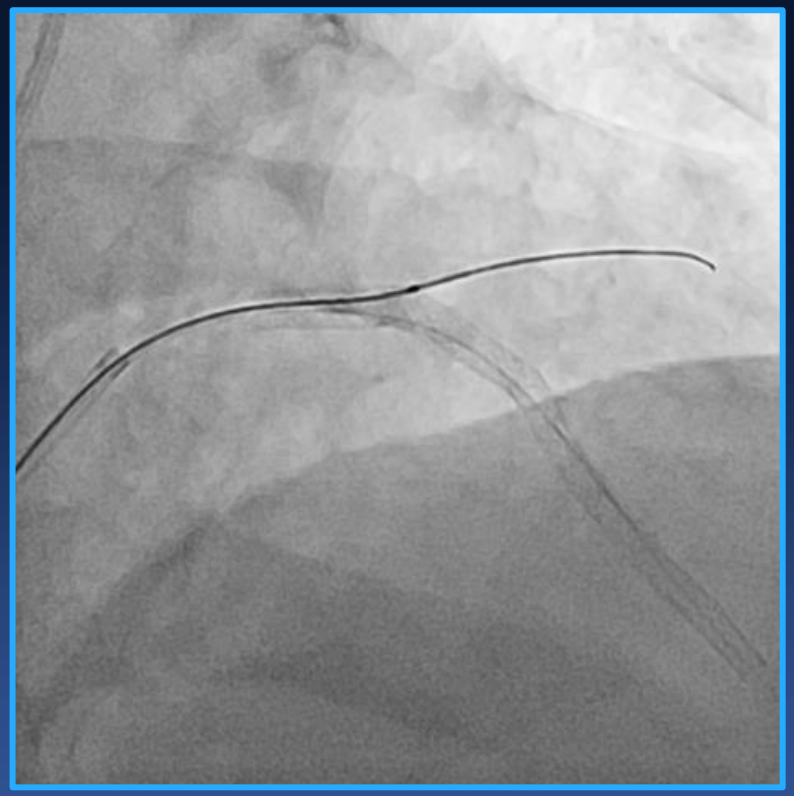
Kissing Balloon:

Keep It Open With Small Balloon



Koo BK et al. Eur Heart J. 2008 Mar;29(6):726-32

Keep It Open Using Small Balloon



Tazuna 1.5(15)mm

TIMI 3 flow

Contemporary Practical Approach for Non-LM Bifurcation PCI

Provisional Stenting Is Always Enough	**Any 2 Stent Technique**
• Jailing Side Branch ? • How to Treat ?	It Would Be OK !

With Simple Technique ; POT, Sequential HP Inflation on Both Branches, and Finally Kissing !

Key Message of
Non-LM Side Branch PCI

(FFR) Concept is More Important than Technique