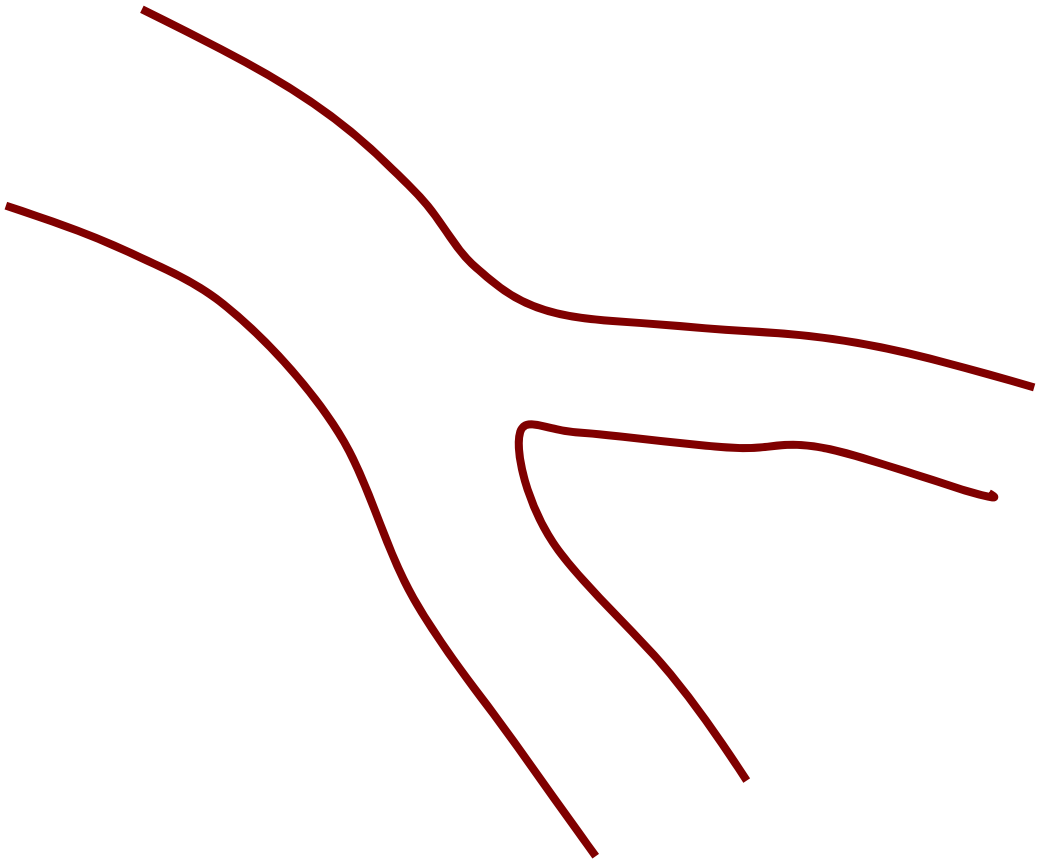
EBC Rules of Bifurcation PCI

Y. Louvard, ICPS, Massy, France

What is a coronary bifurcation ?



« Murray's law »

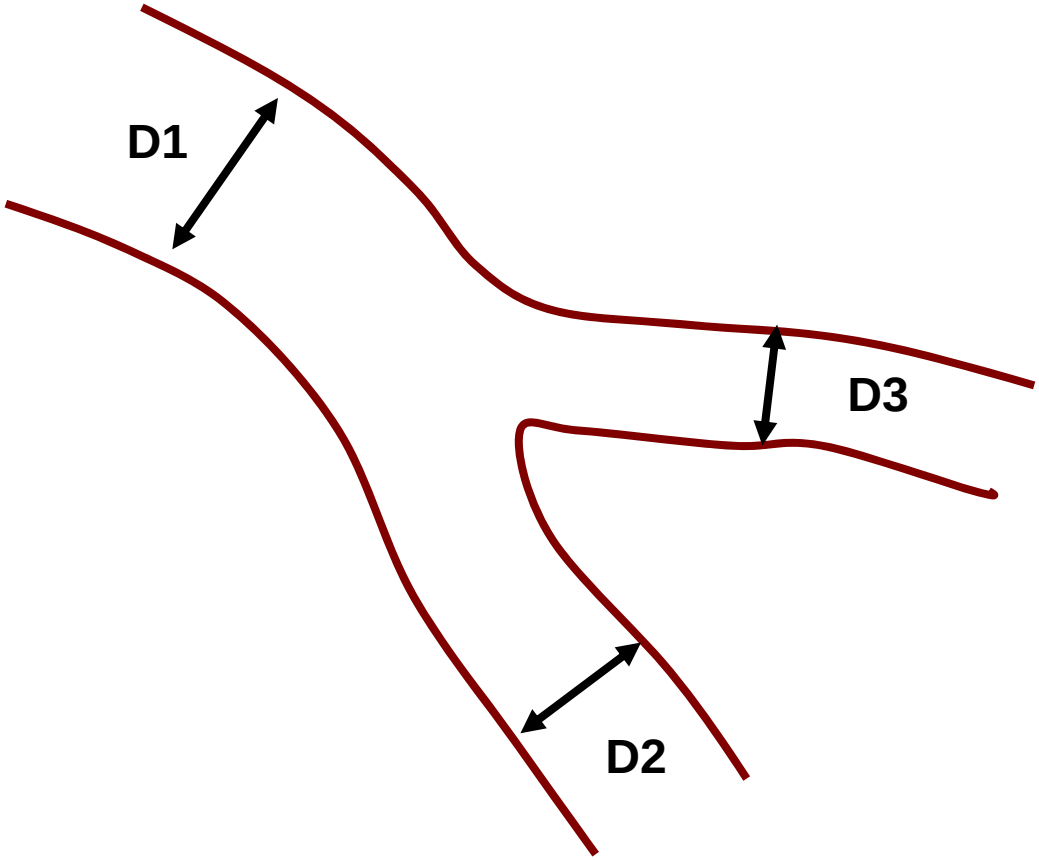
THE PHYSIOLOGICAL PRINCIPLE OF MINIMUM WORK. I. THE VASCULAR SYSTEM AND THE COST OF BLOOD VOLUME

By Cecil D. Murray

Department of Biology, Bryn Mawr College

Communicated January 26, 1926

Bifurcation branching laws



Murray's law

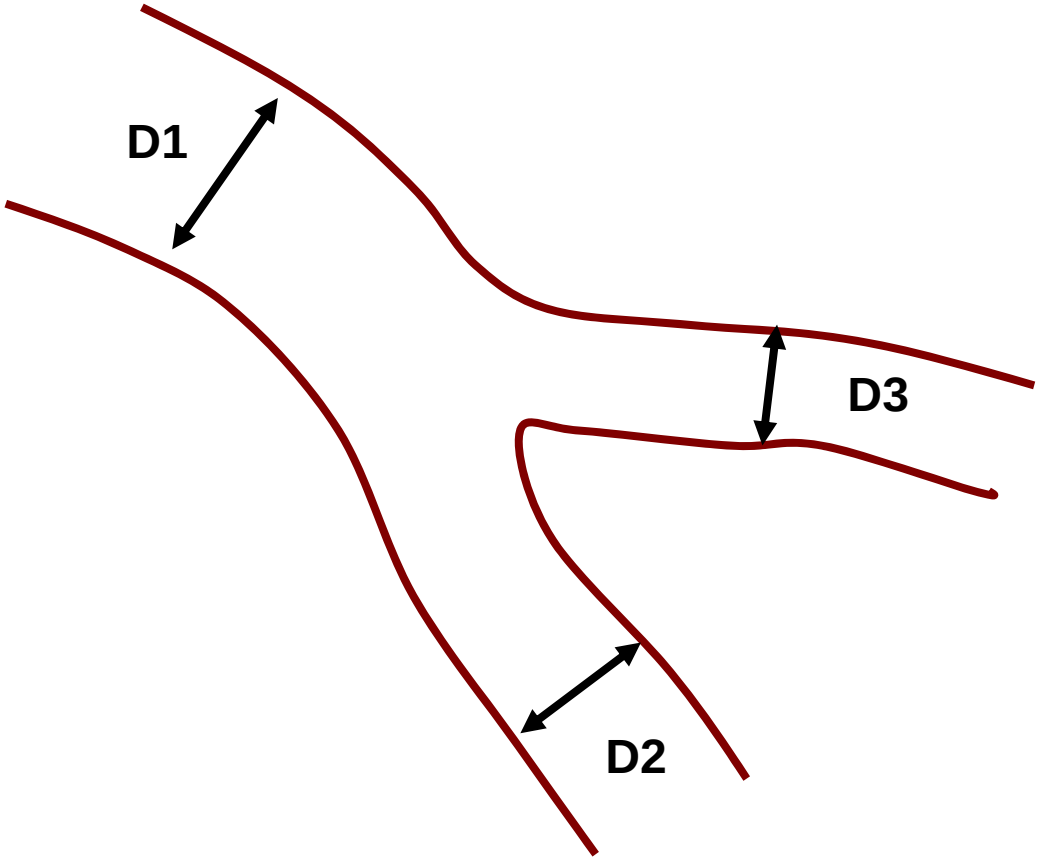
$$D_1^{3*} = D_2^{3*} + D_3^{3*}$$

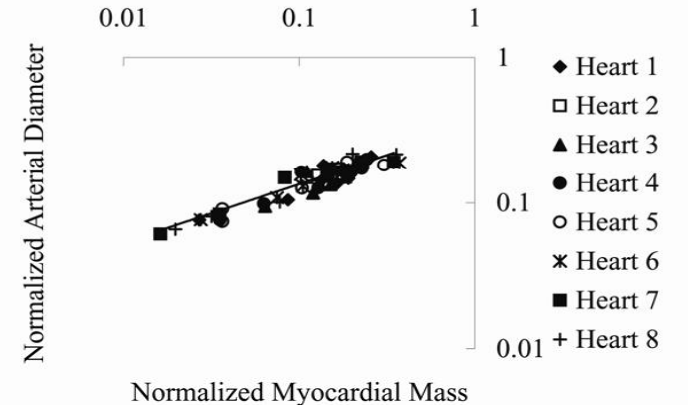
Finet's law

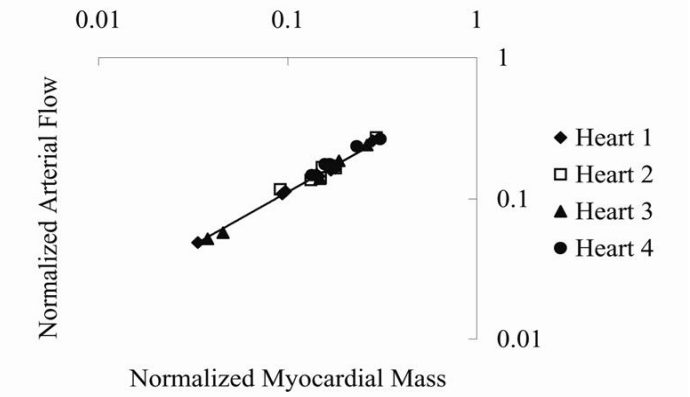
$$D_1 = 0.67(D_2 + D3)$$

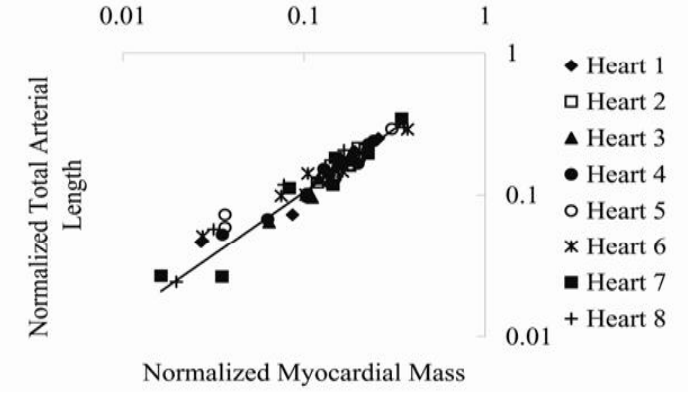
*** 2.3**

Structure-function scaling laws of vascular trees

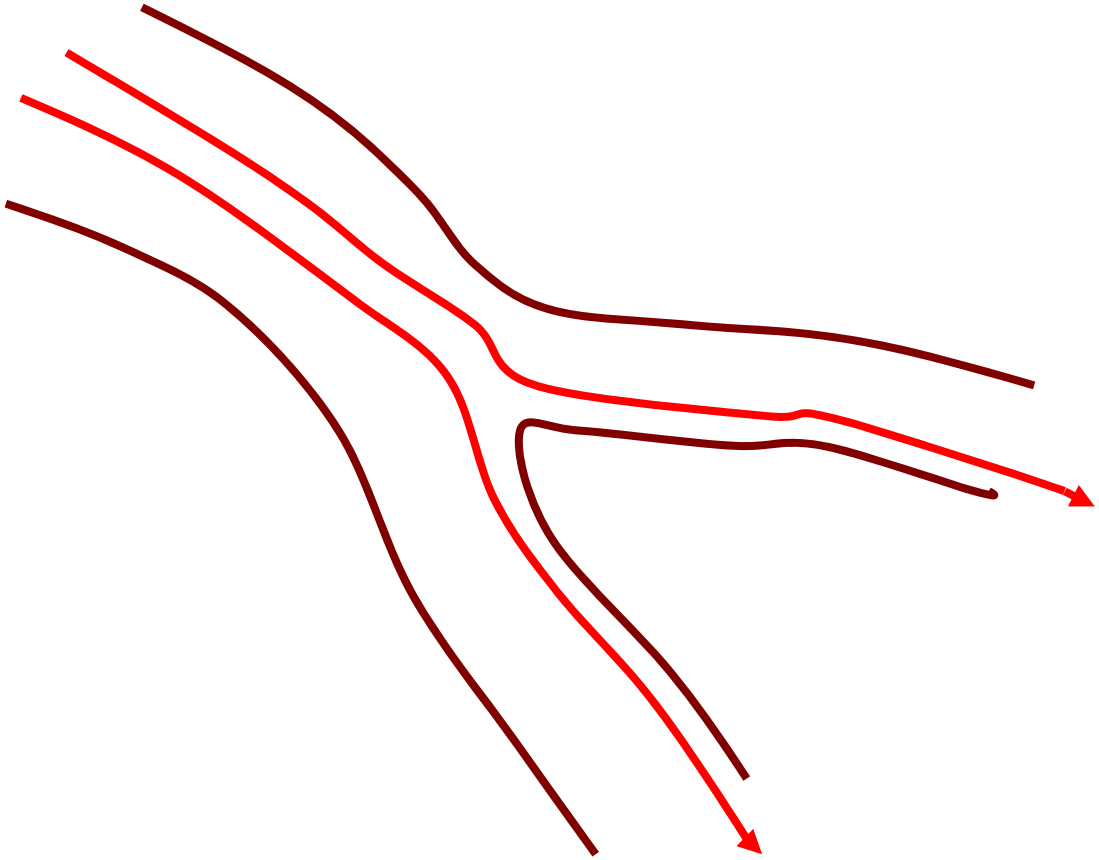








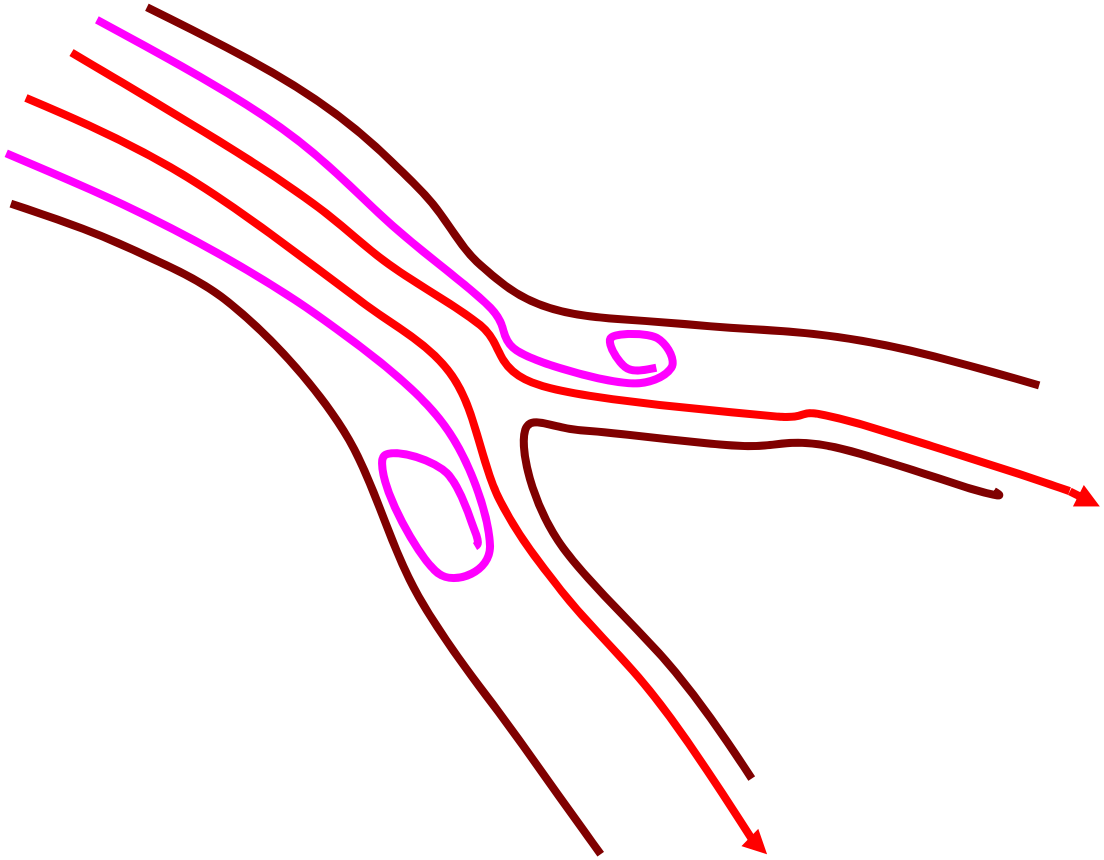
Flow Patterns and Spatial Distribution of Atherosclerotic Lesions in Human Coronary Arteries



High wall shear stress = antiatherogenic

Asakura, Circulation Research 1990; 66:1045-1066

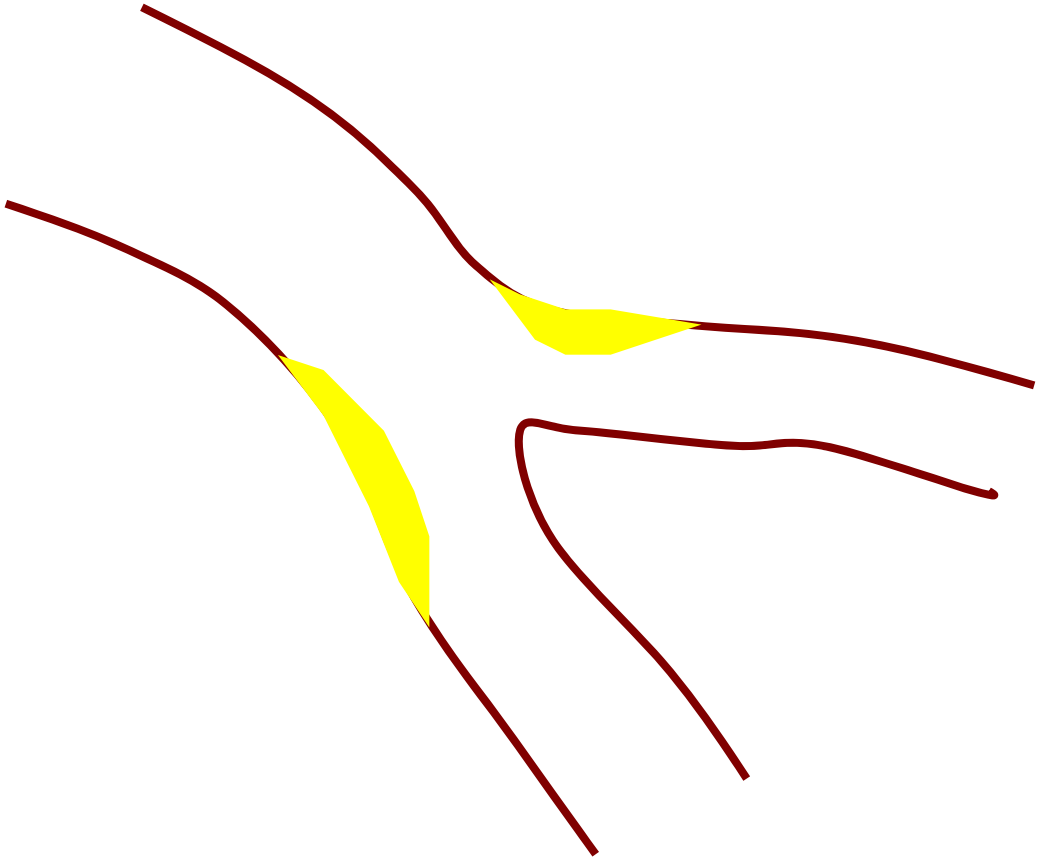
Flow Patterns and Spatial Distribution of Atherosclerotic Lesions in Human Coronary Arteries

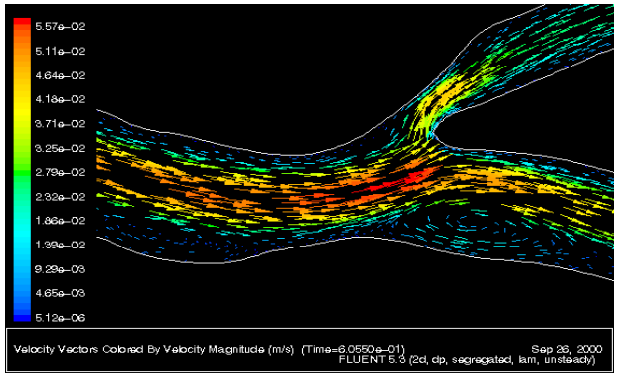


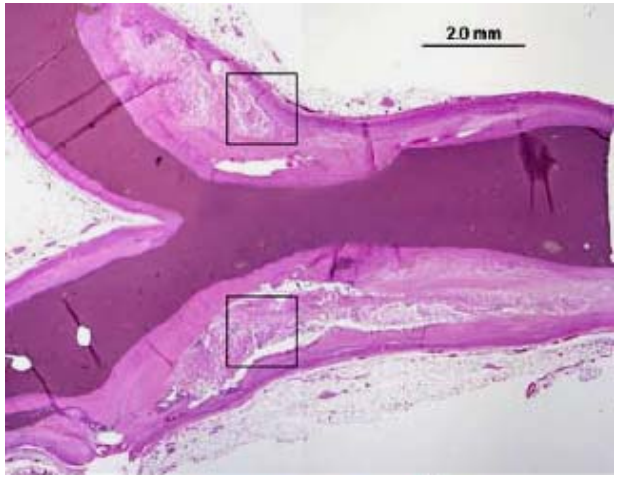
Low wall shear stress = proatherogenic

Asakura, Circulation Research 1990; 66:1045-1066

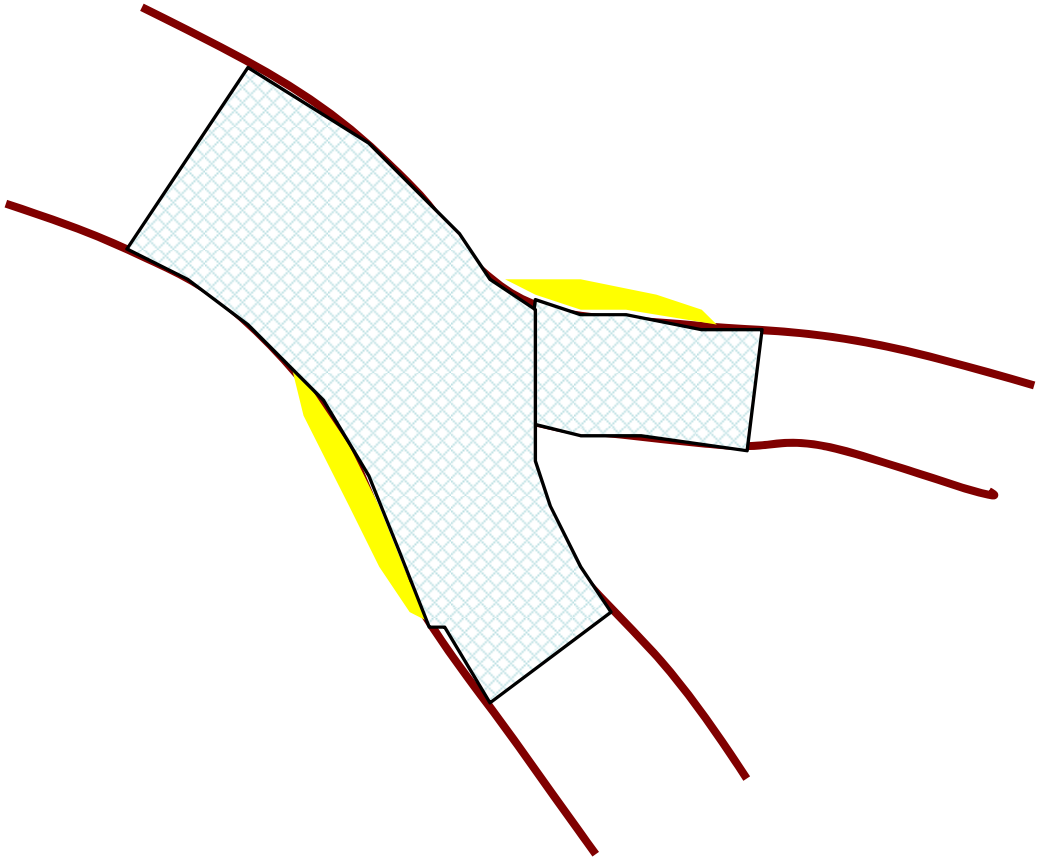
Coronary bifurcations are pro-atherogenic



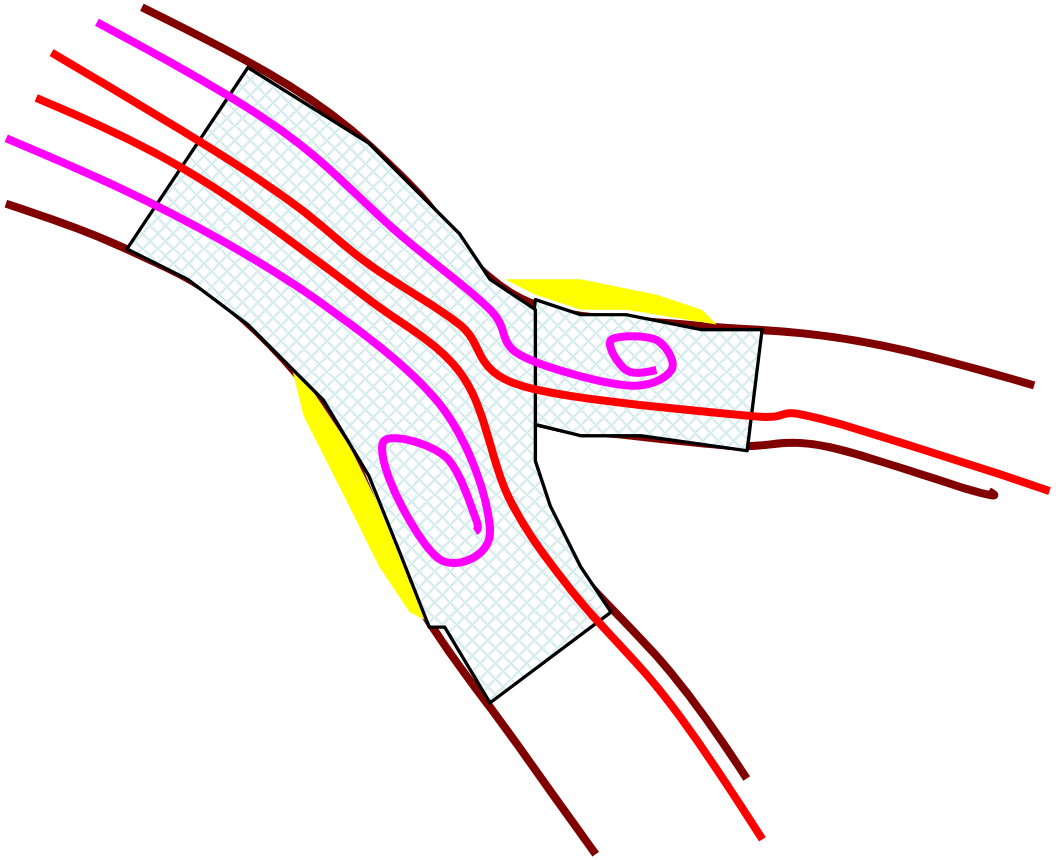




« Perfect treatment » ?



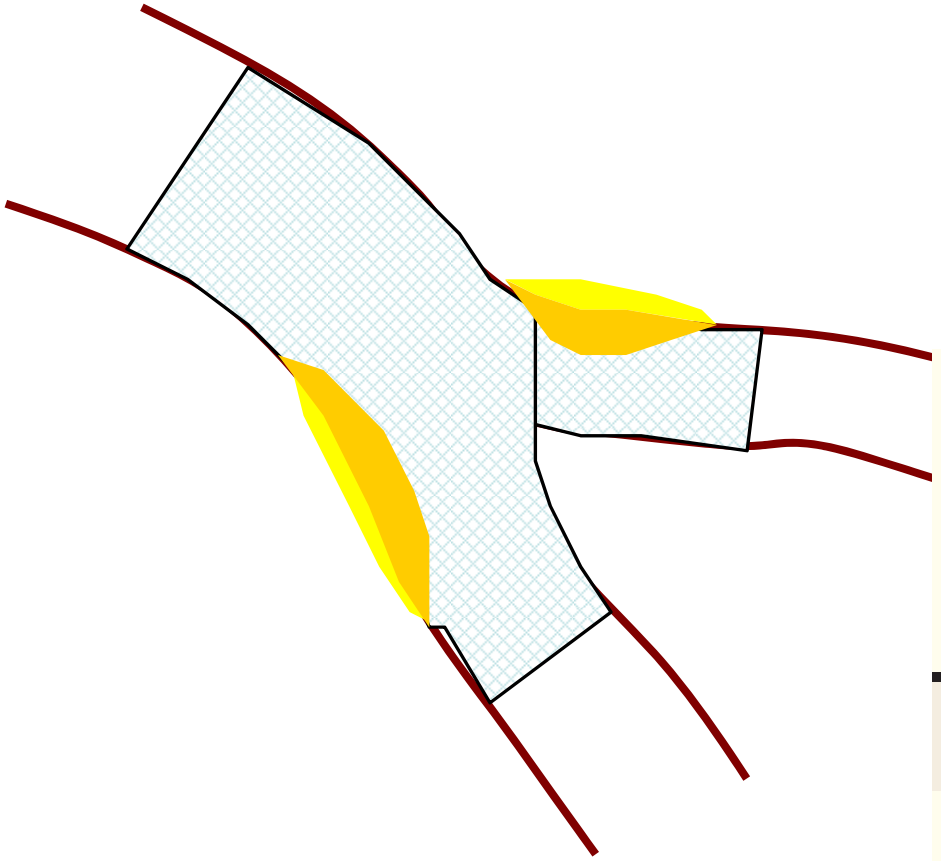
Restauration of initial flow (+ stent turbulences)



WSS < 0.5 Pa =
risk of restenosis

Ku 1997, Malek et al. 1999

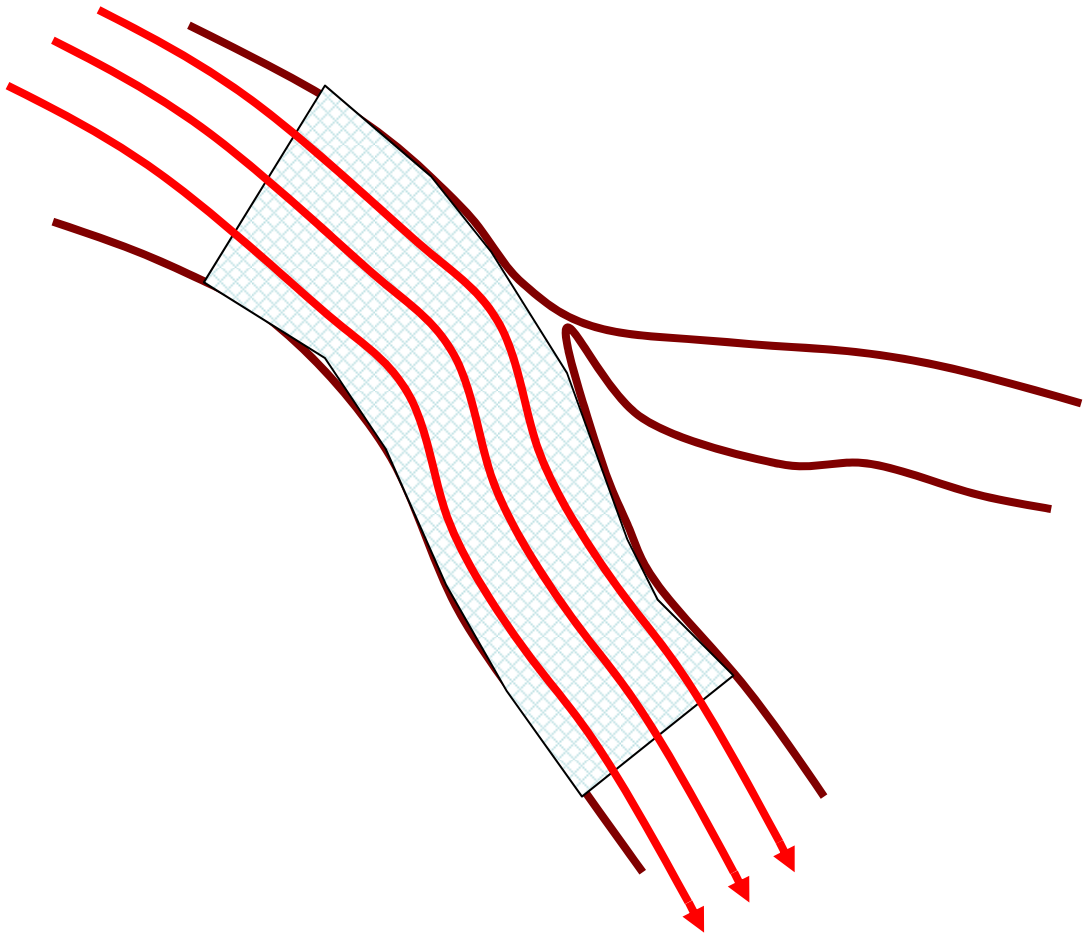
The Impact of Flow Distribution on Atherosclerosis and Arterial Healing After Stent Implantation



	DES (12 Lesions, 17 Stents)		
	Flow Divider	Lateral	p Value
Neointimal thickness (mm)	0.07 (0.03-0.15)	0.17 (0.09-0.23)	0.001
Fibrin deposition (% struts)	60 (21-67)	17 (0-55)	0.01
Uncovered struts (% struts)	40 (16-76)	0 (0-15)	0.001

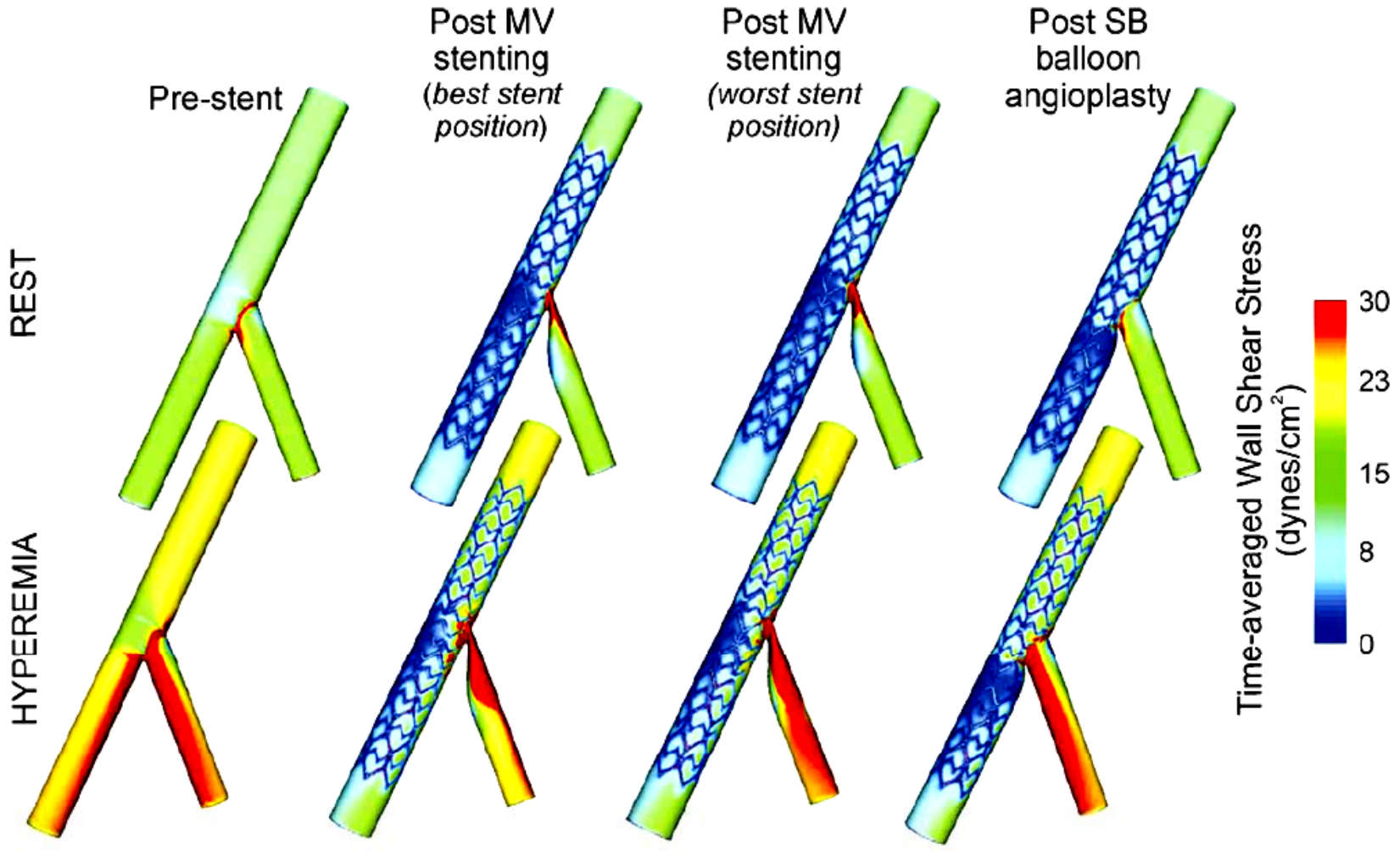
Nakazawa, J Am Coll Cardiol 2010;55:1679–87

Best solution ?



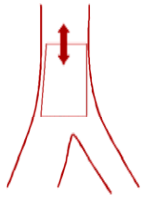
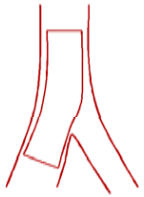
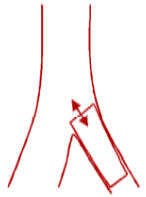
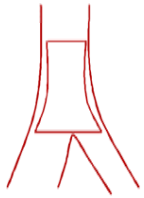
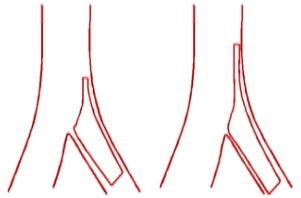
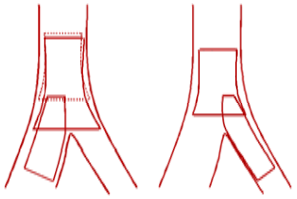
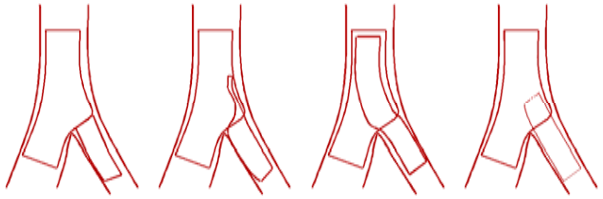
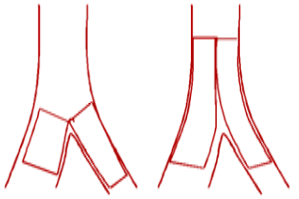
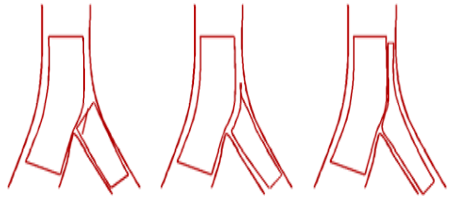
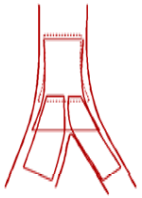
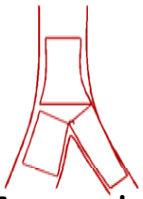
- At the best, a MACE in your database …
- At the worst, a short / long term clinically significant complication

Local hemodynamic changes caused by MB stenting and subsequent virtual SB balloon angioplasty in a representative coronary bifurcation



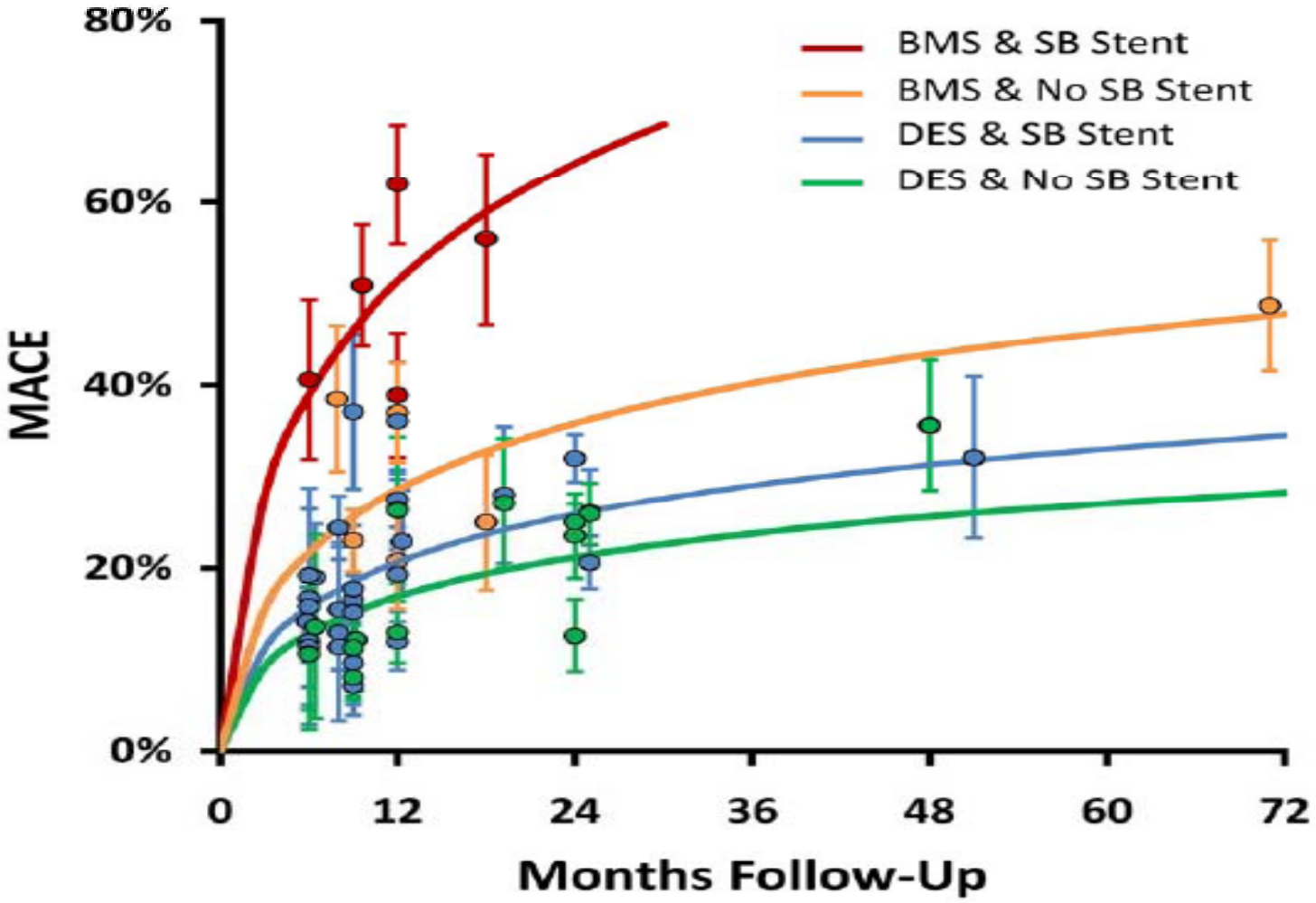
Williams J Appl Physiol (May 27, 2010)

EBC

	M Main prox. first	**A** Main Accross side first	**D** Distal first	**S** Side branch first
1st stent	 PM stenting	 MB stenting across SB	 DM stenting; Provisional SKS	 SB ostial stenting
After balloon	 Skirt	 MB stenting + SB balloon;  MB stenting + kissing		 SB minicrush; SB crush
2 stents	 Skirt + DM; Skirt + SB	 Elective T stenting; Internal crush; Culotte; TAP	 V stenting; SKS	 Syst. T Stenting; Minicrush; Crush
3 stents	 Extended V		 Trouser legs and seat	

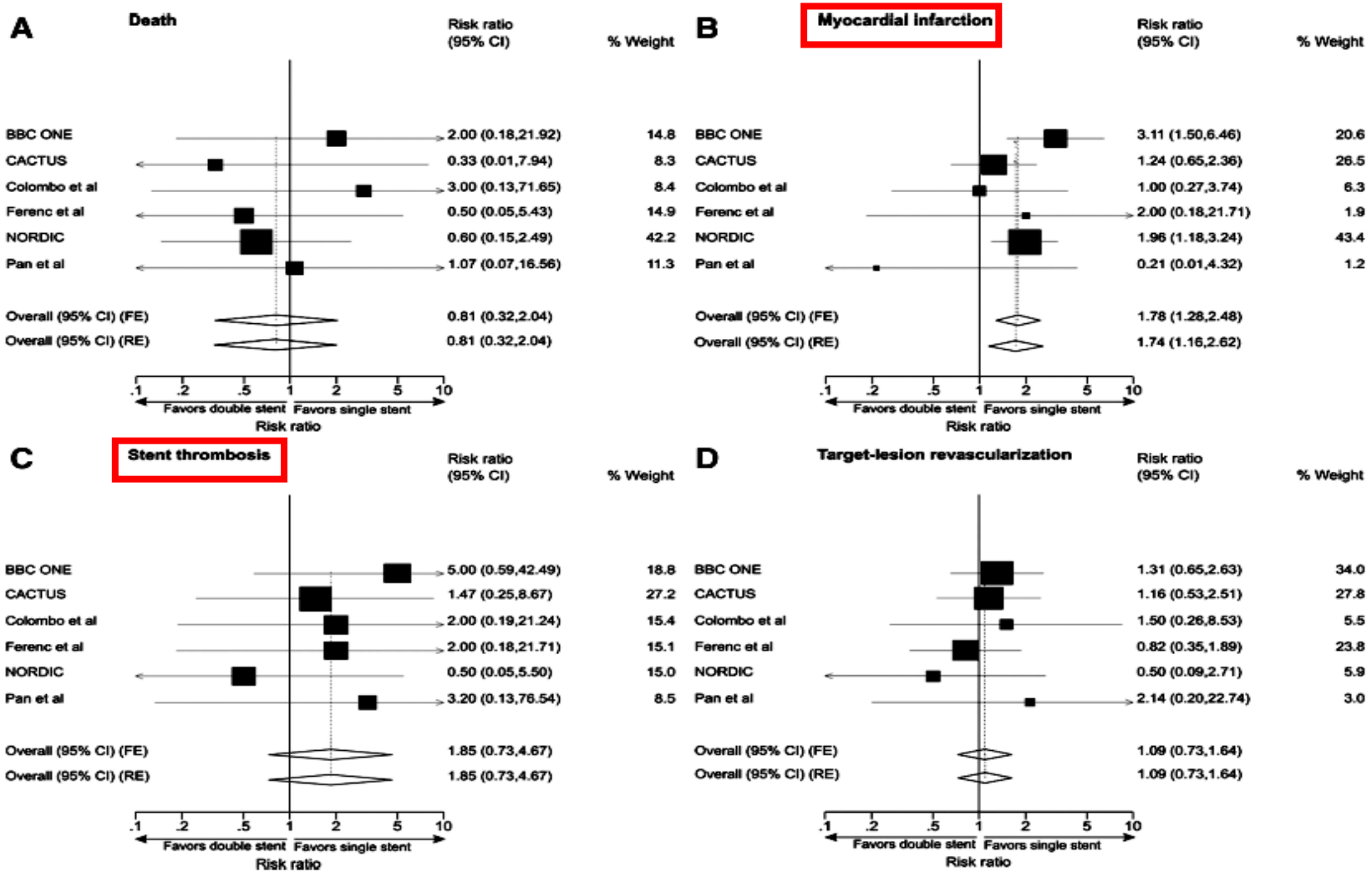
Y. Louvard, CCI 2008 Feb 1;71(2):175-83.

Long-term risk of clinical events from stenting SB of coronary bifurcation lesions with DES/BMS: meta-analysis



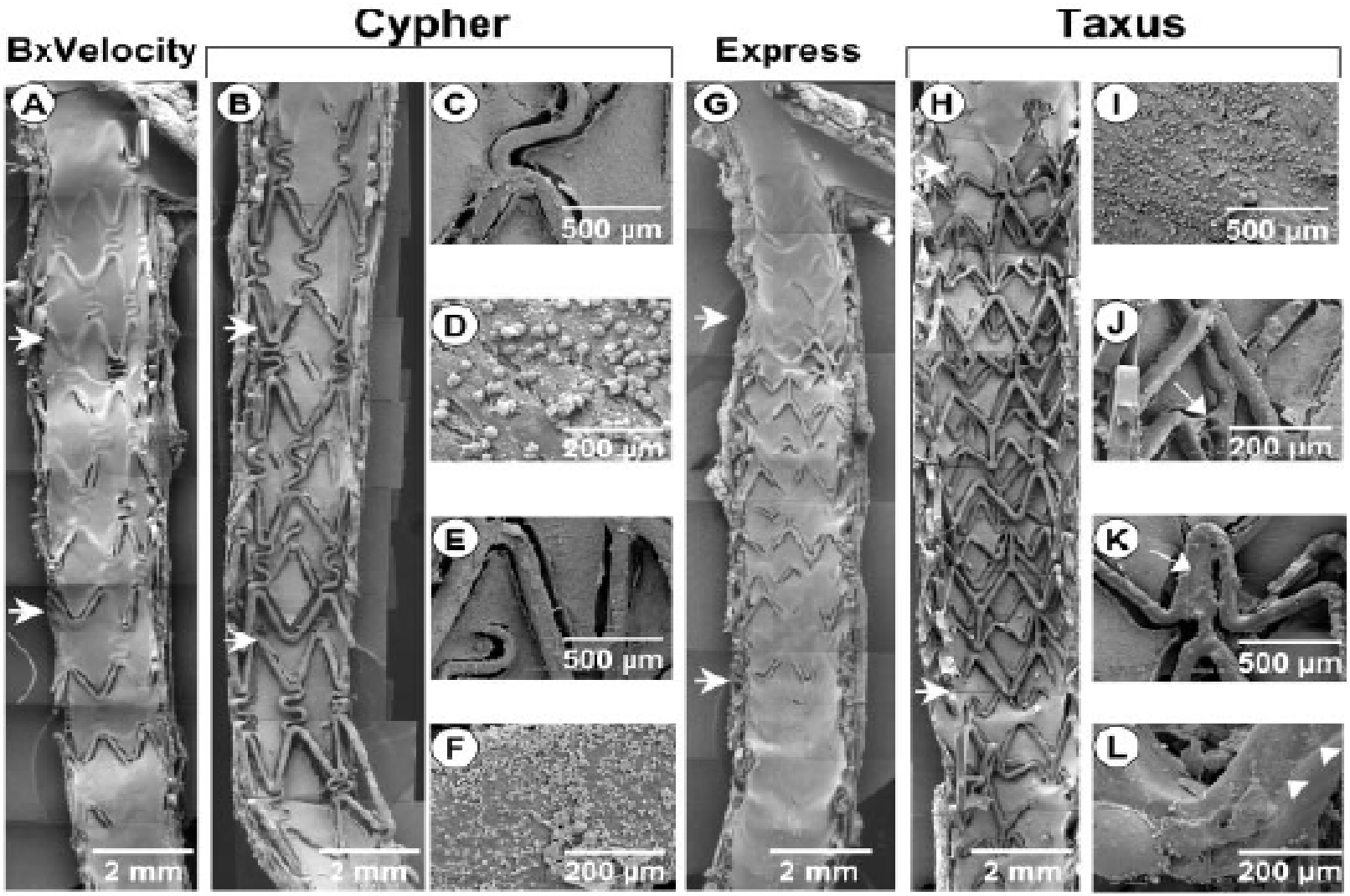
Zamani, CCI ahead of print

Double Vs Single Stenting for Coronary Bifurcation Lesions



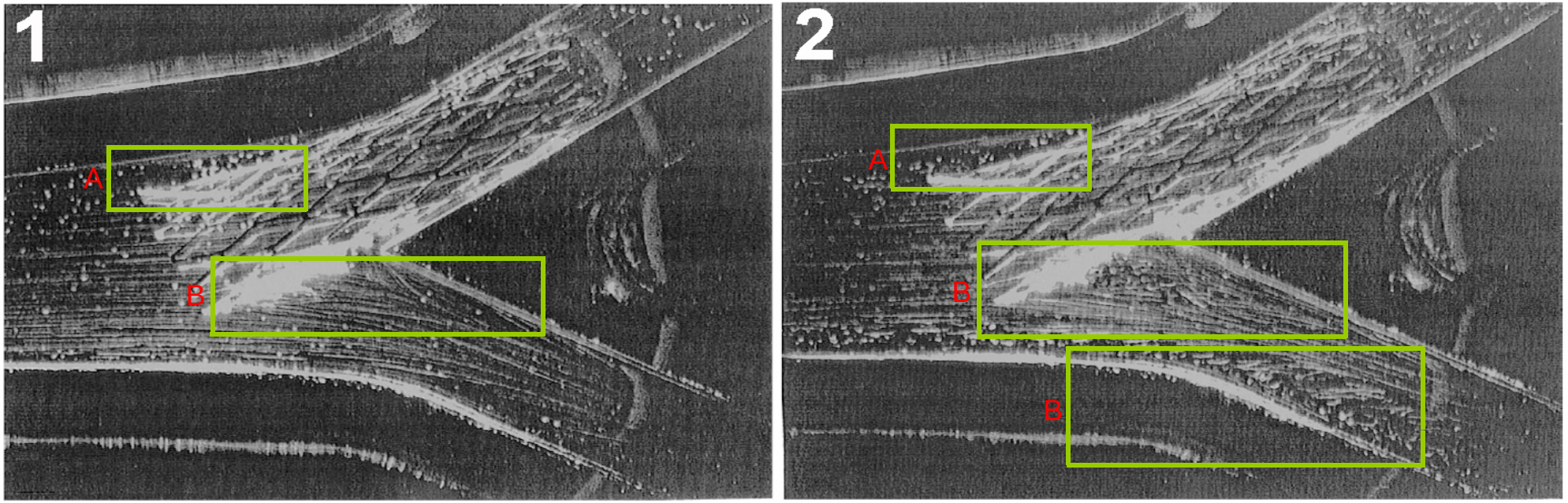
Kastritsis Circ Cardiovasc Intervent. 2009;2:00-00

Excess of Metal



Finn et al. Circulation; 112:270-8

Macroscopic flow perturbations at stented bifurcation site



Physiological flow through a bifurcation model with palmaz stent

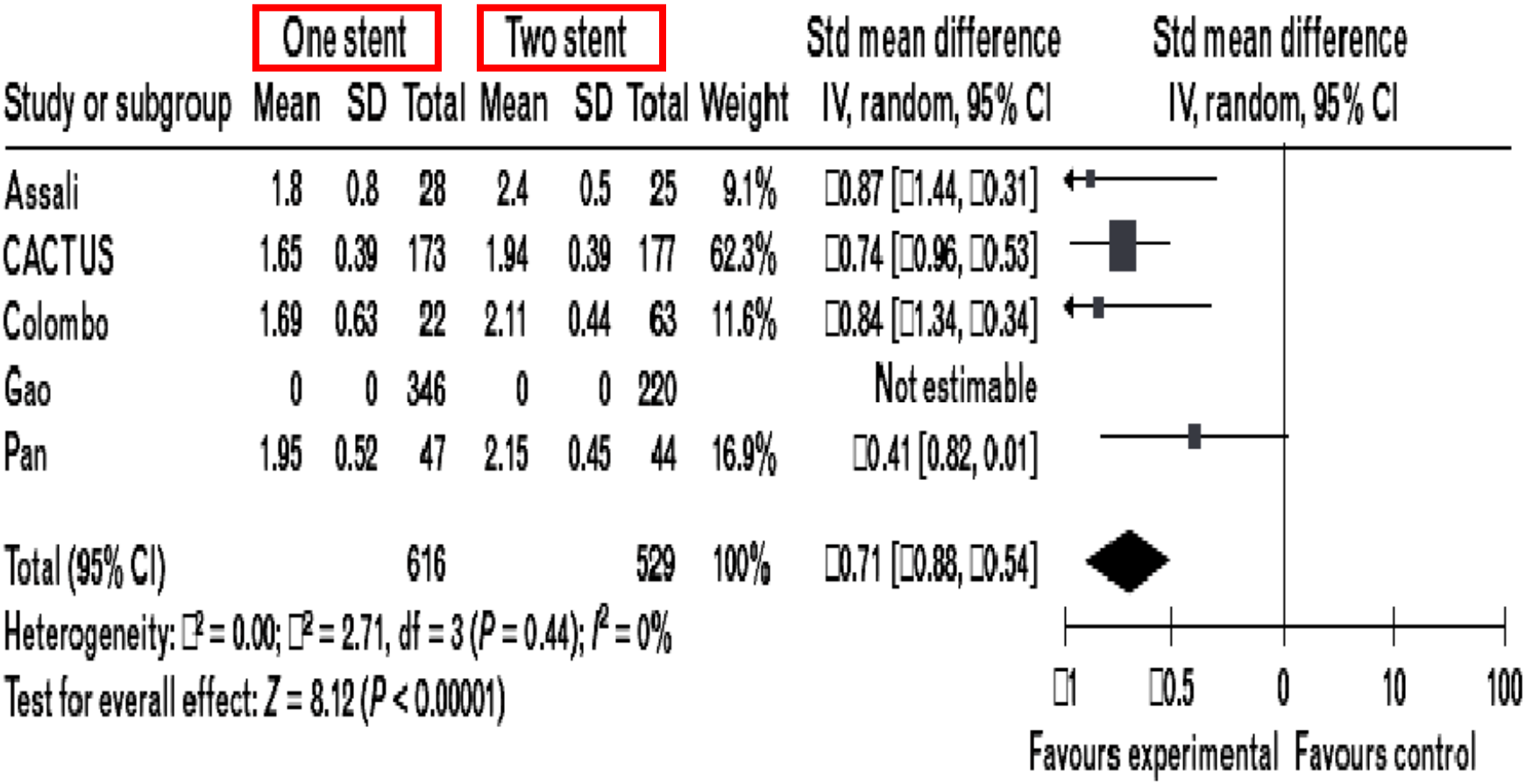
A stagnation zone (A) appear if the stent does not conform to the artery.

The stent implantation in a daughter branch induces recirculation zones in the healthy artery branch (B) due to the protruding part of the stent.

Fabregues, 1998, J. of Biomech.31

True coronary bifurcation lesions: meta-analysis and review of litterature

Postprocedural MLD of the side branch



Athappan, J Cardiovasc Med 11:103–110 Q 2010

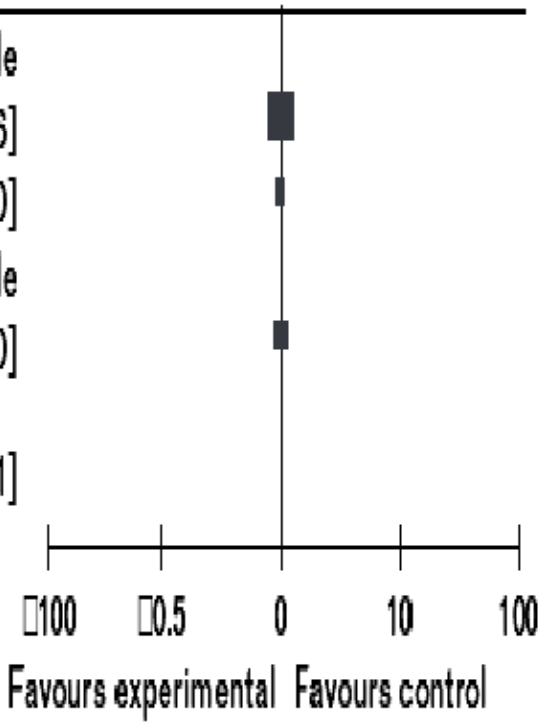
True coronary bifurcation lesions: meta-analysis and review of litterature

Follow-up MLD of the side branch

Study or subgroup	One stent Mean	SD	Total	Two stent Mean	SD	Total	Weight	Std mean difference IV, random, 95% CI
Assali	0	0	28	0	0	25		Not estimable
CACTUS	1.52	0.54	173	1.66	0.51	177	62.2%	□0.27 [□0.48, □0.06]
Colombo	1.42	0.5	22	1.59	0.61	63	16.0%	□0.29 [□0.78, □0.20]
Gao	0	0	346	0	0	220		Not estimable
Pan	1.78	0.42	47	1.73	0.71	44	21.8%	0.09 [□0.33, 0.50]
Total (95% CI)			616			529	100%	□0.19 [□0.40, 0.01]

Heterogeneity: $\square^2 = 0.01$; $\square^2 = 2.35$, df = 2 ($P = 0.31$); $I^2 = 15\%$

Test for overall effect: $Z = 1.85$ ($P < 0.06$)



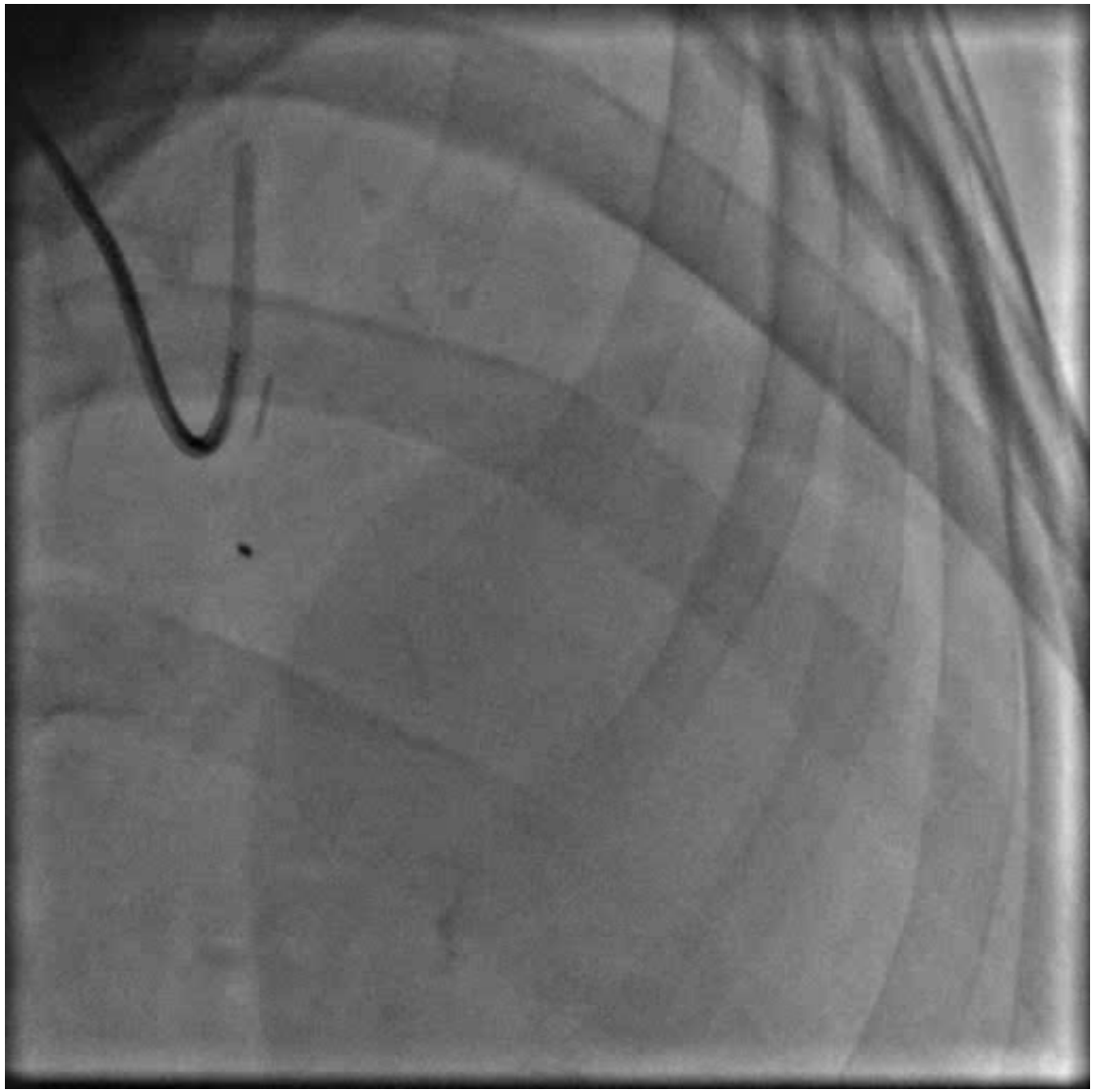
Athappan, J Cardiovasc Med 11:103–110 Q 2010

Bifurcation stenting: principles

1. Minimize the number of DES
2. Good apposition / Minimal overlapping
3. Respect the anatomy

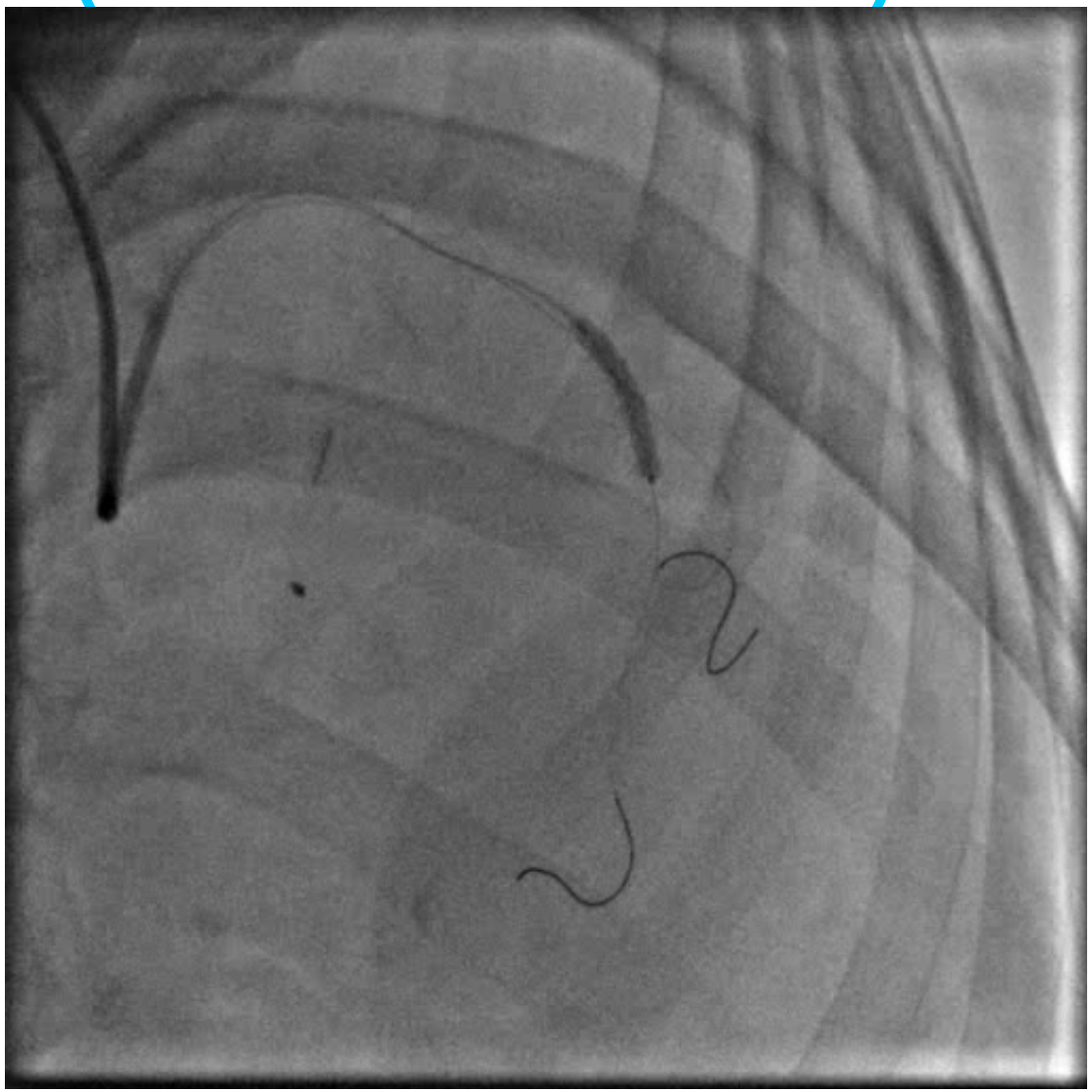
Let’s play a game !

LAD2, LAD3, Dg2 0,1,0

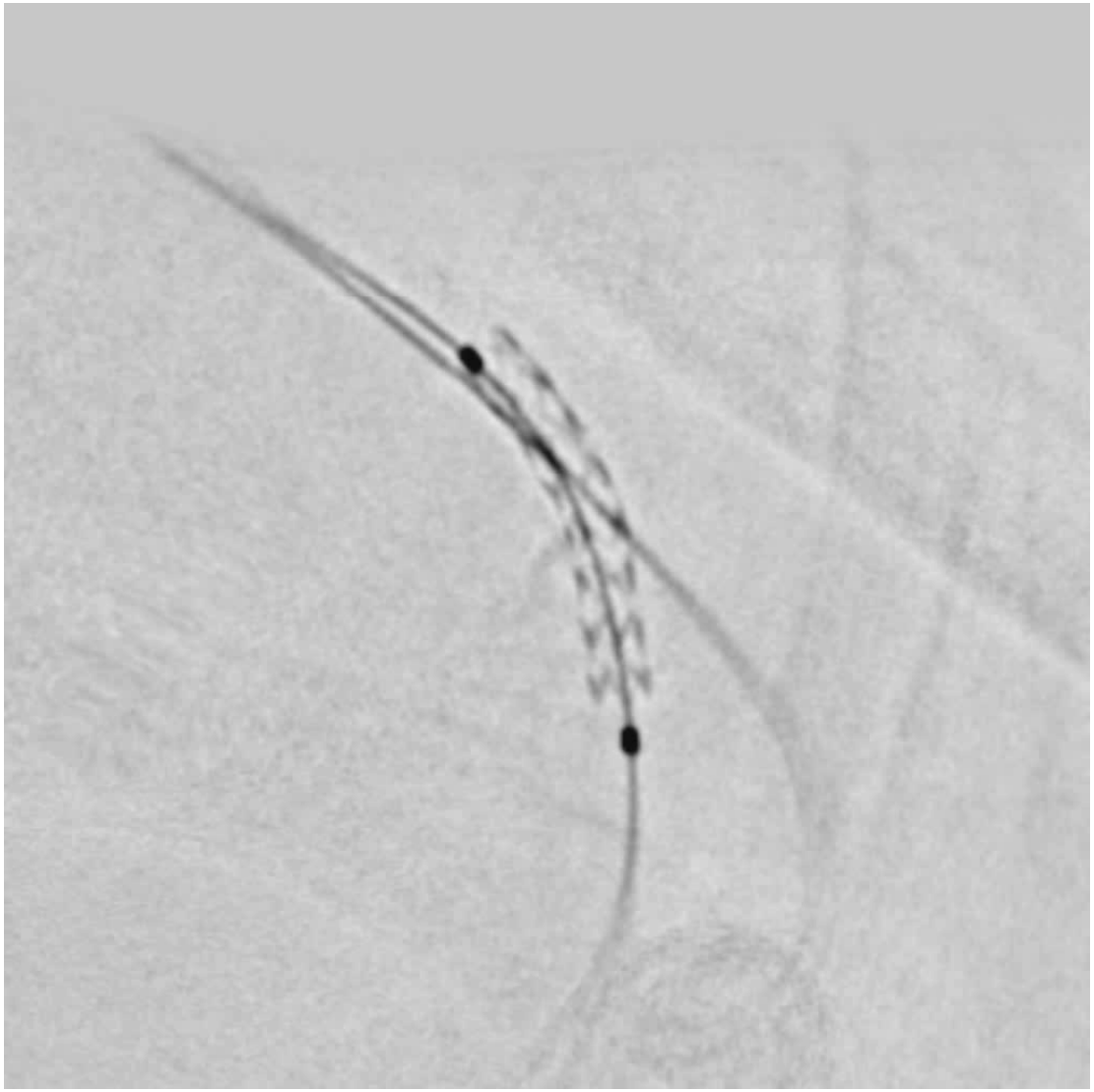


Minimize the number of DES: stent across first (PM to DM or PM to SB)

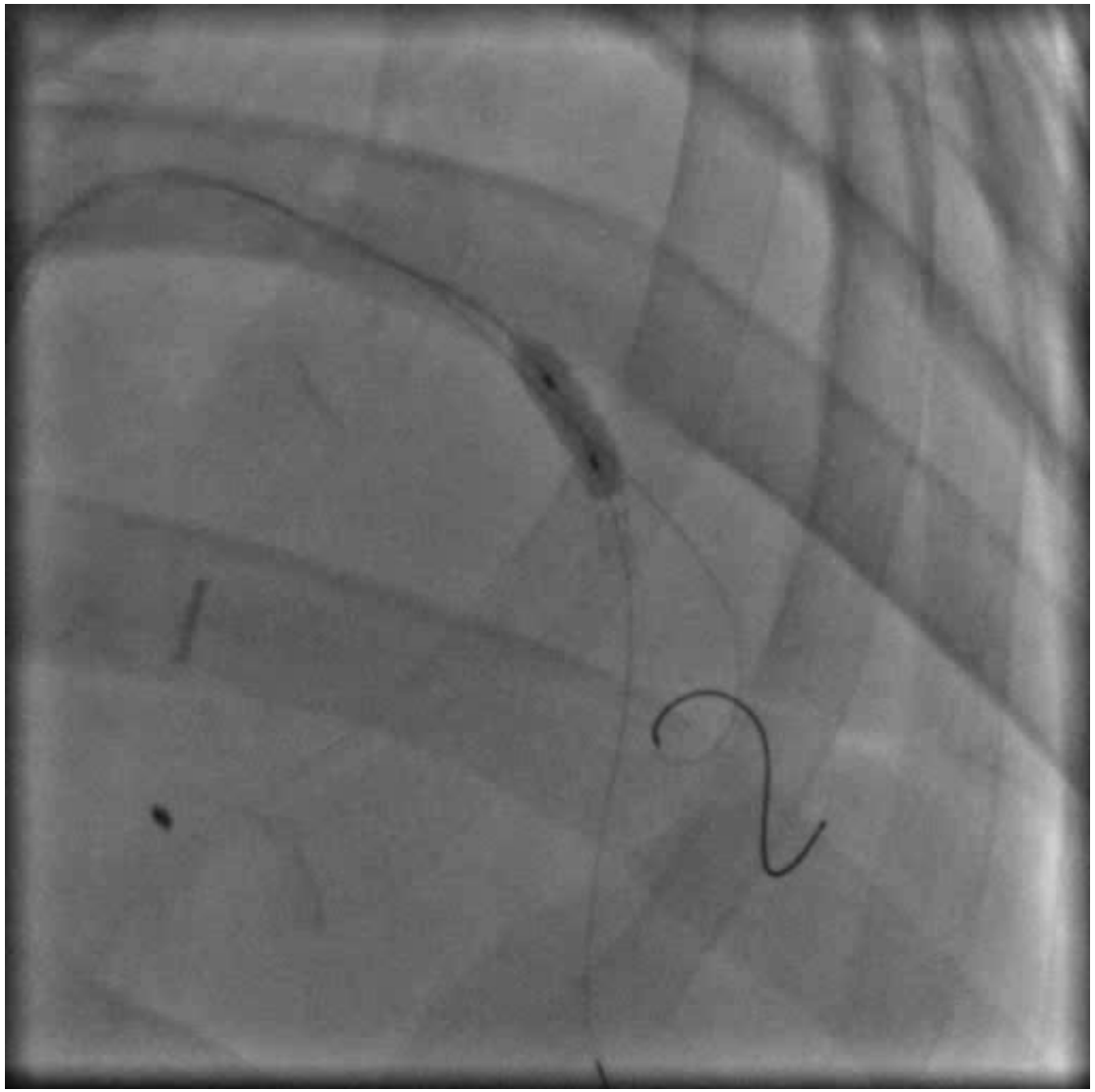
Always 2 wires: basis of many salvage techniques



Stent diameter = DM diameter



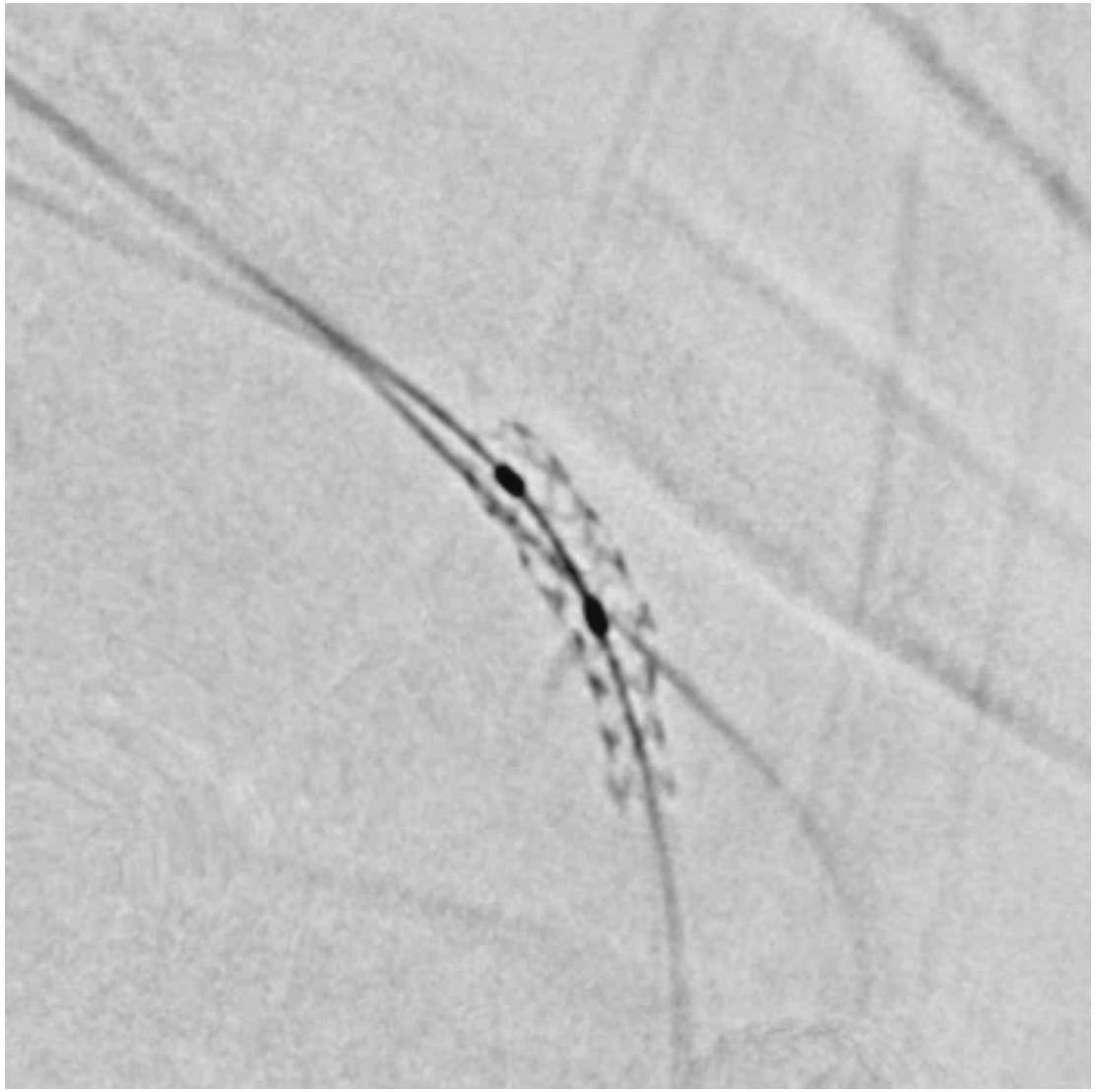
Respect the anatomy / apposition: POT*



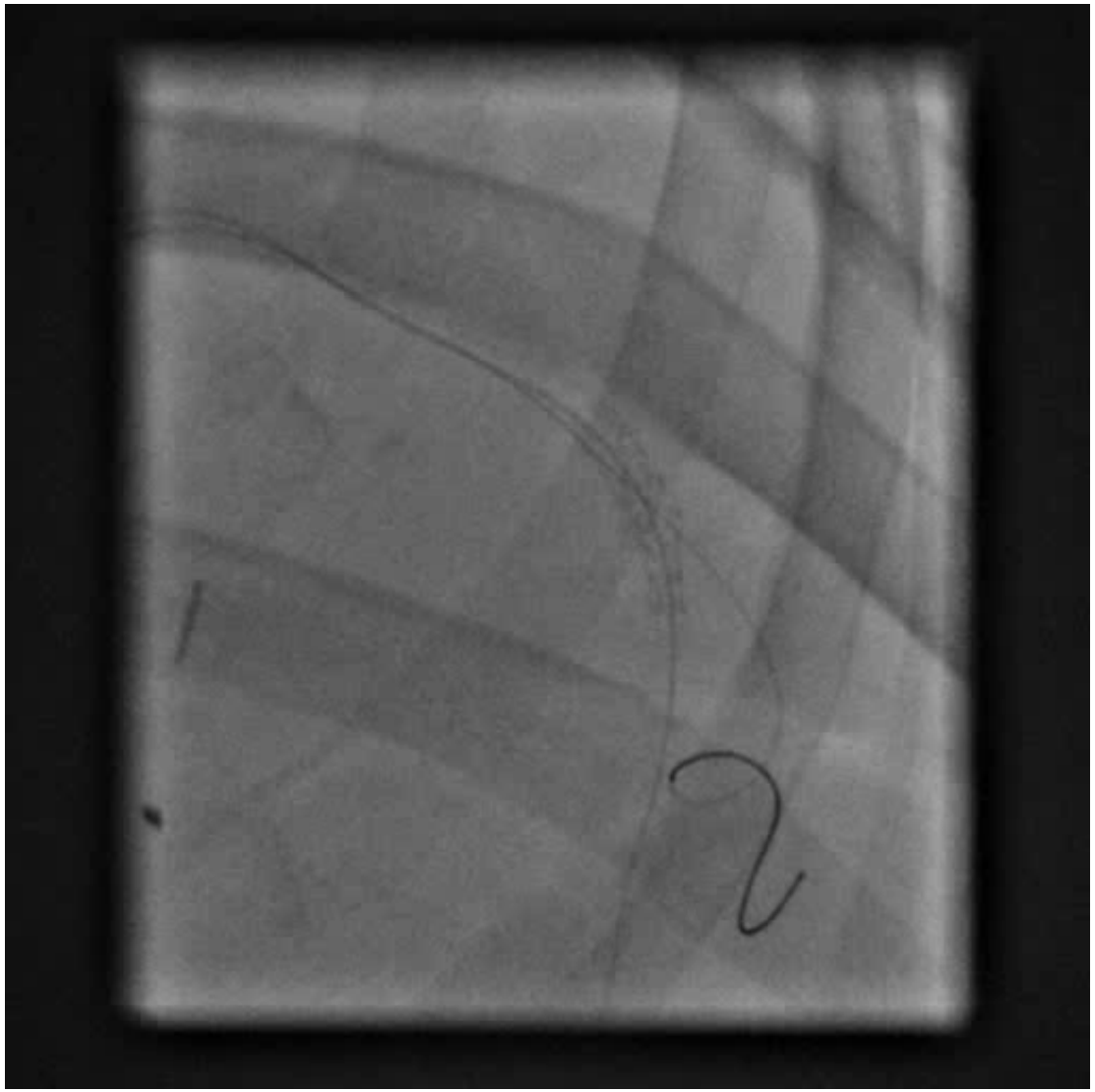
**Proximal optimisation technique*

O. Darremont

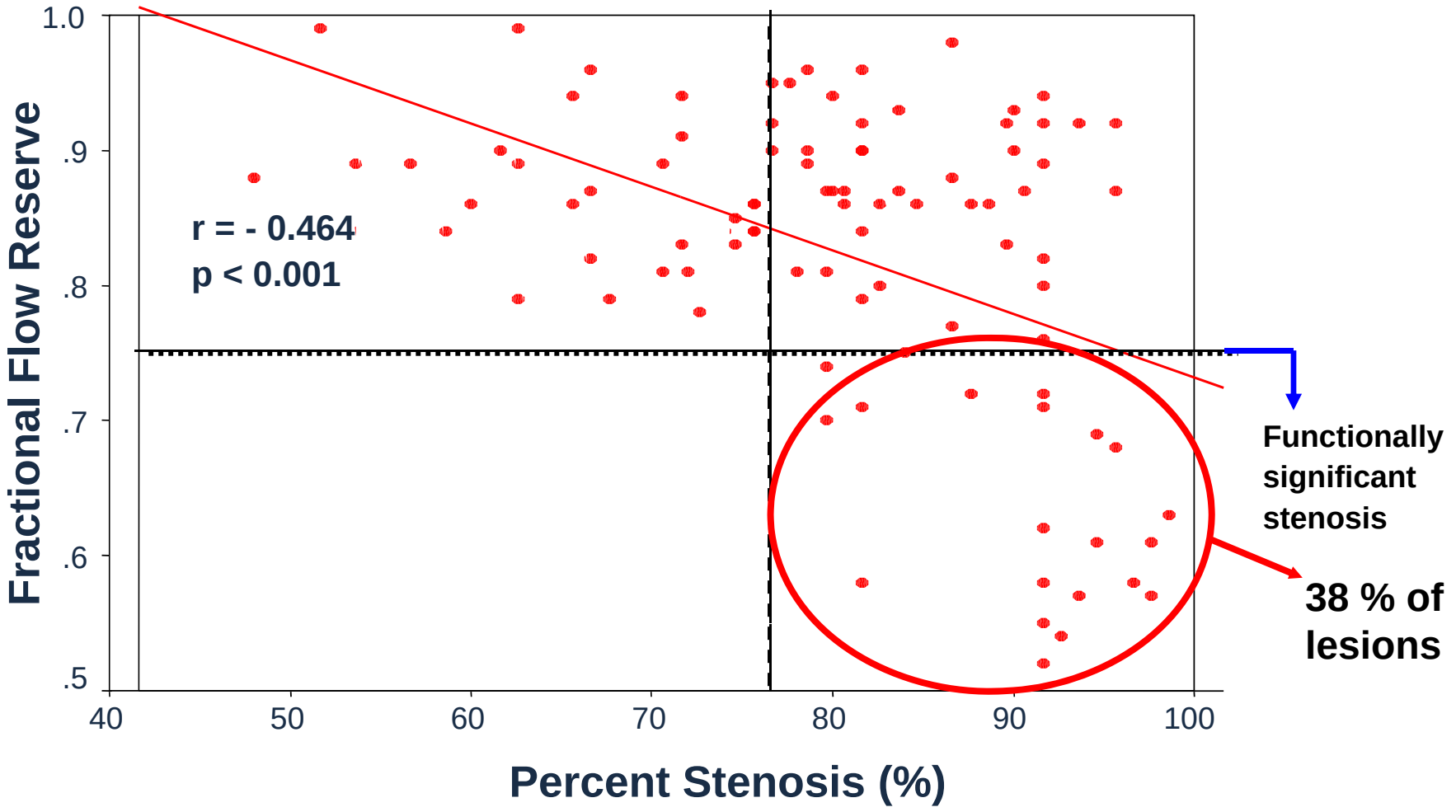
1 stent: 2 diameters



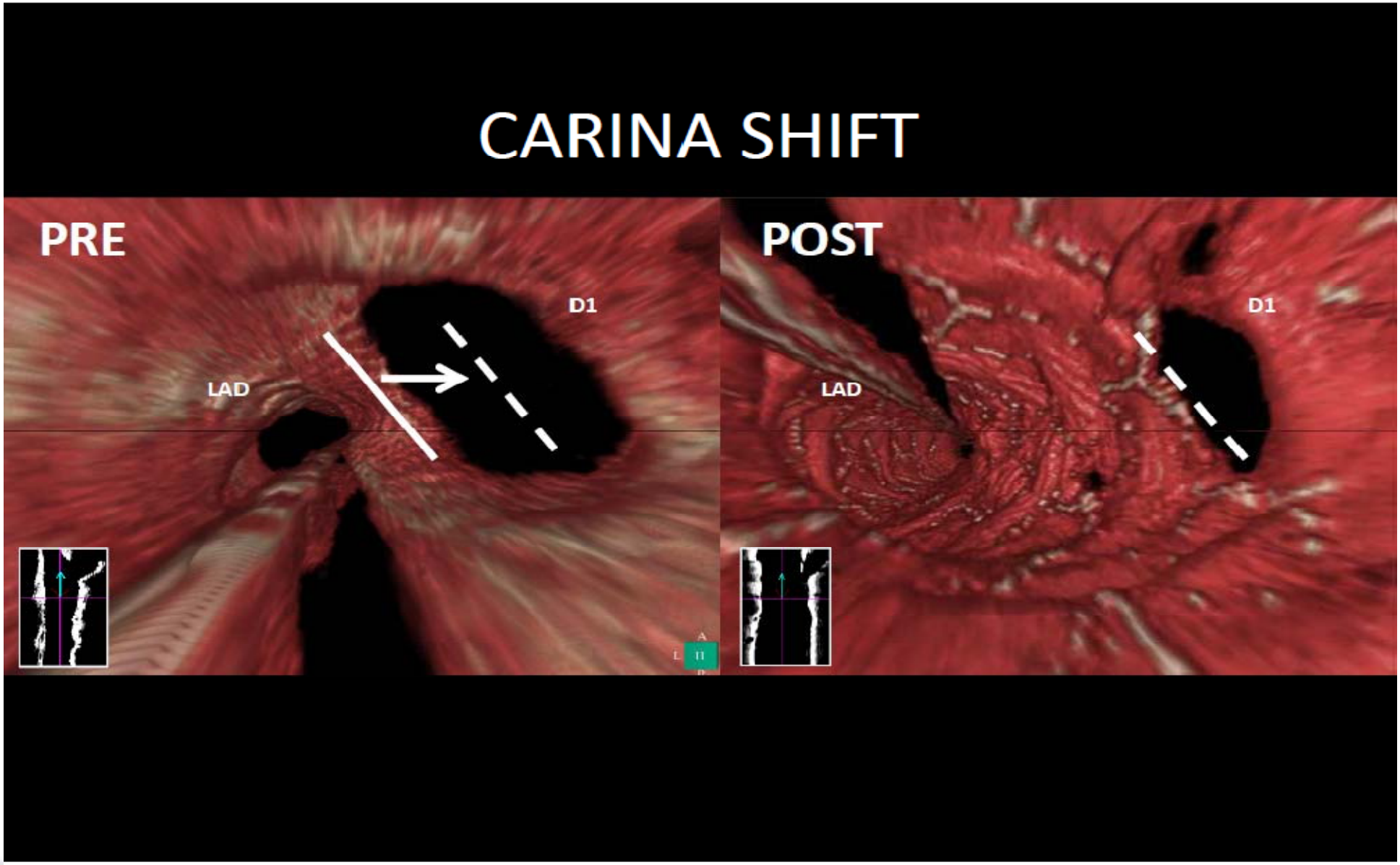
SB stenosis: carena / plaque shift



Significant Post Stenting SB Stenosis:QCA vs FFR (jailed side branch lesions, n=94)



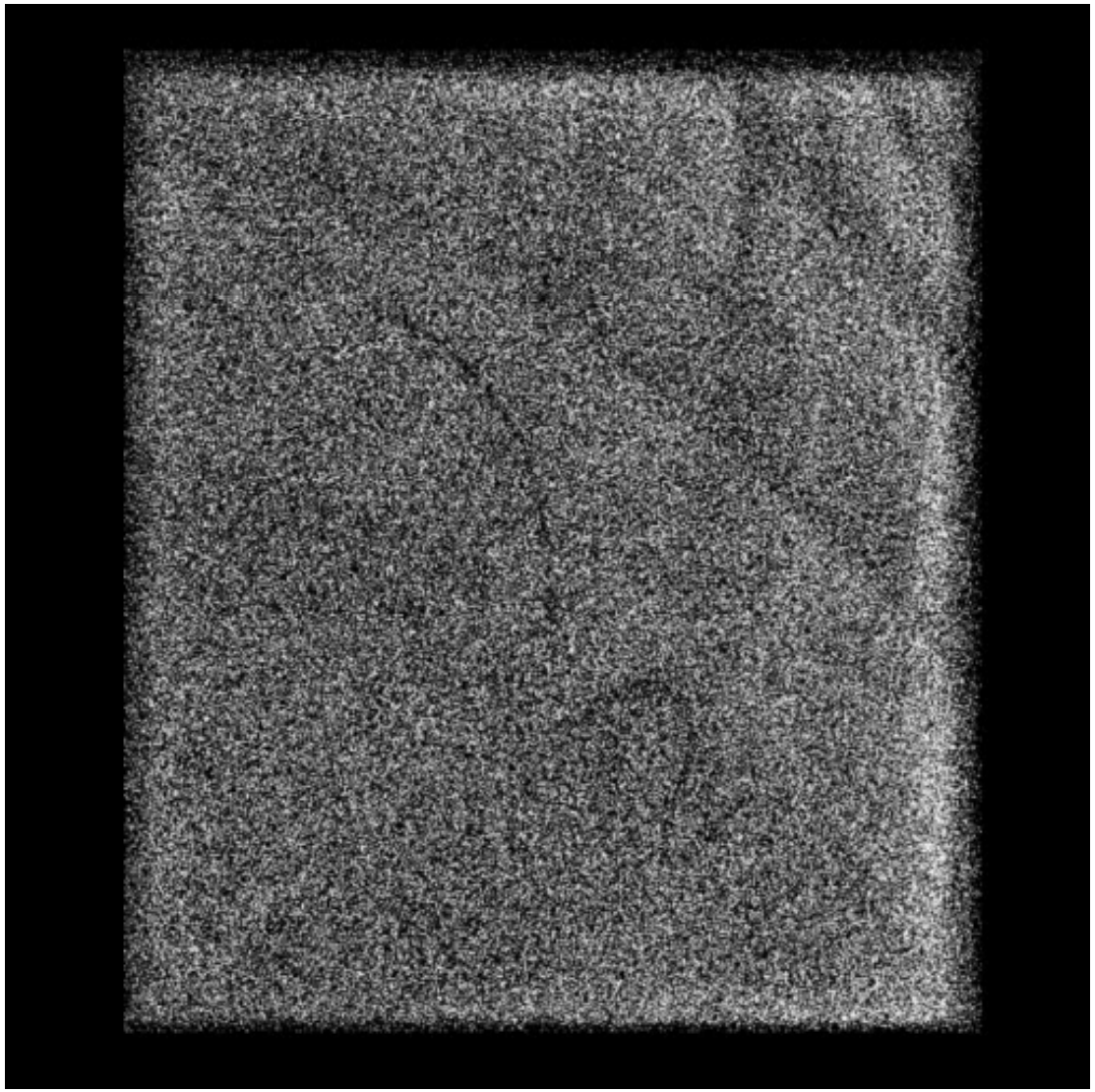
Bon-Kwon Koo et al JACC 2005; 46: 633-7



Courtesy of P. Serruys

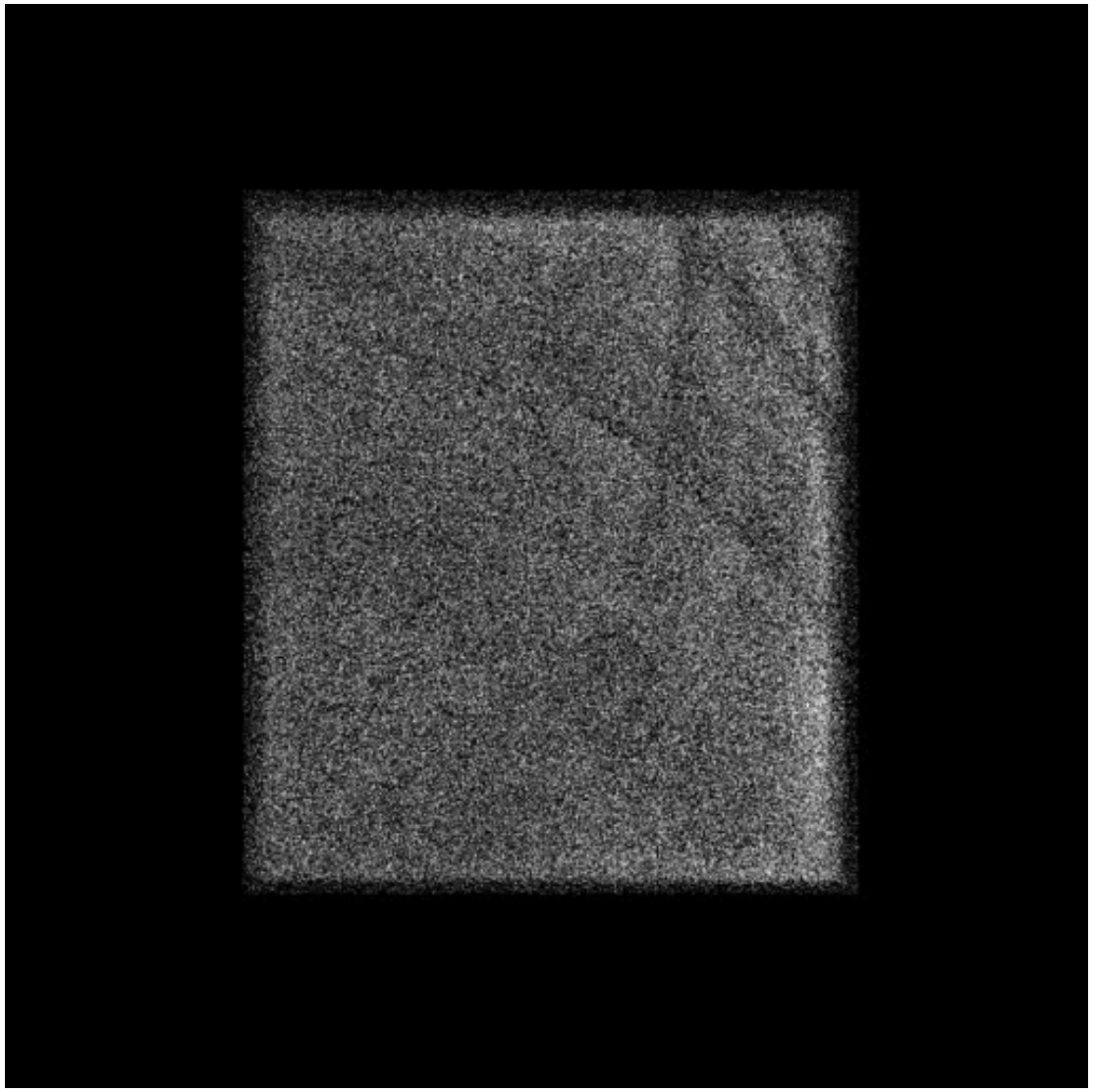
Wire exchange

MB wire: long shape !

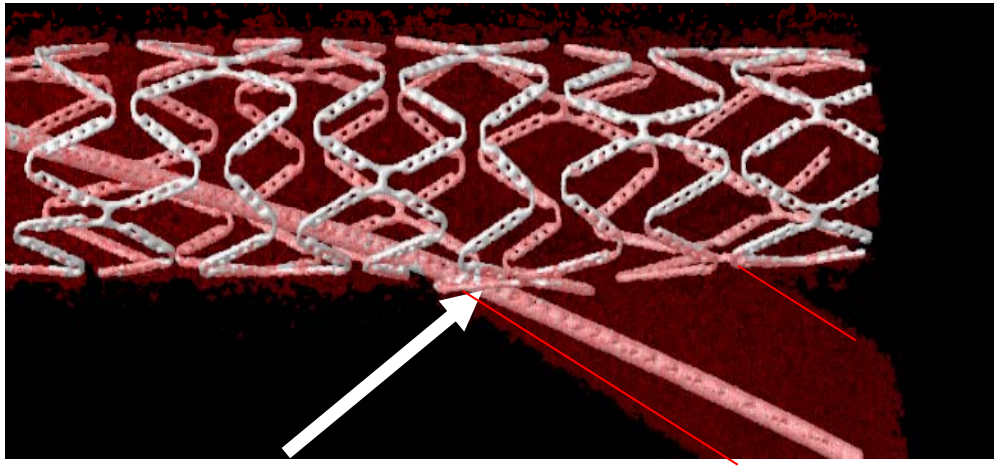


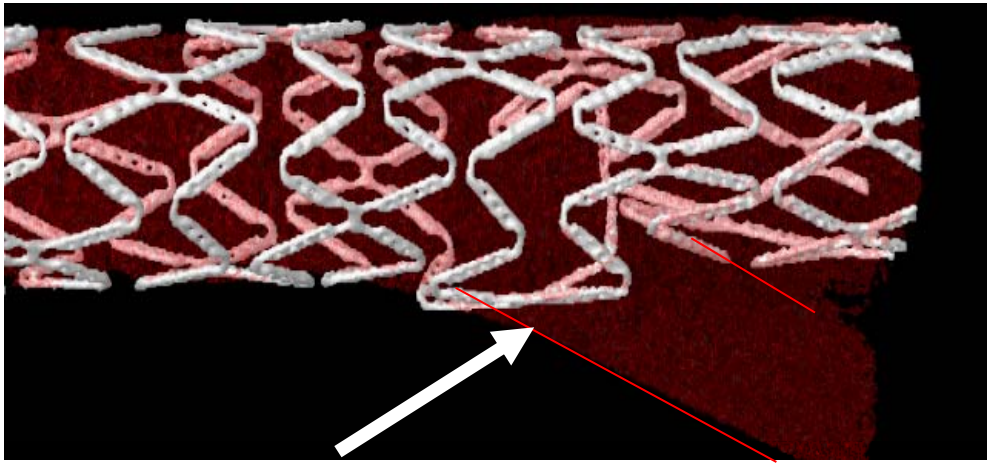
Wire exchange

MB wire: long shape !

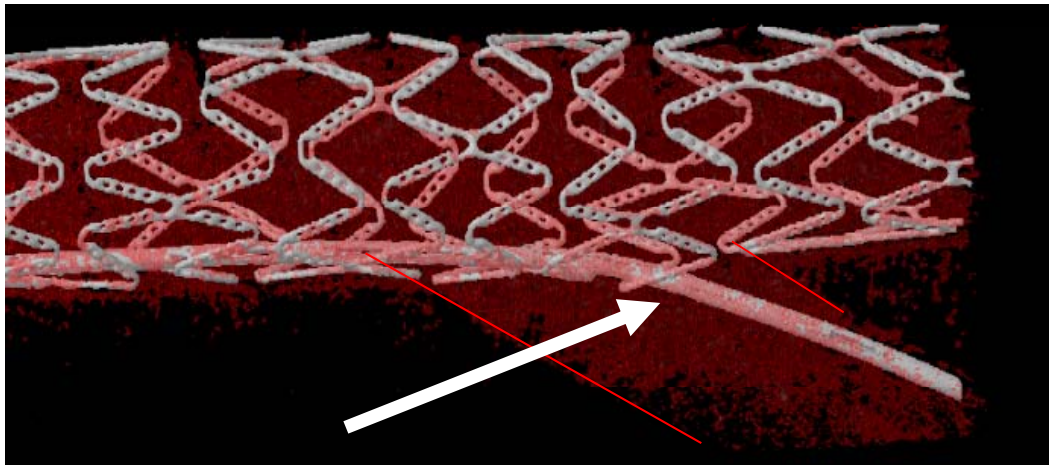


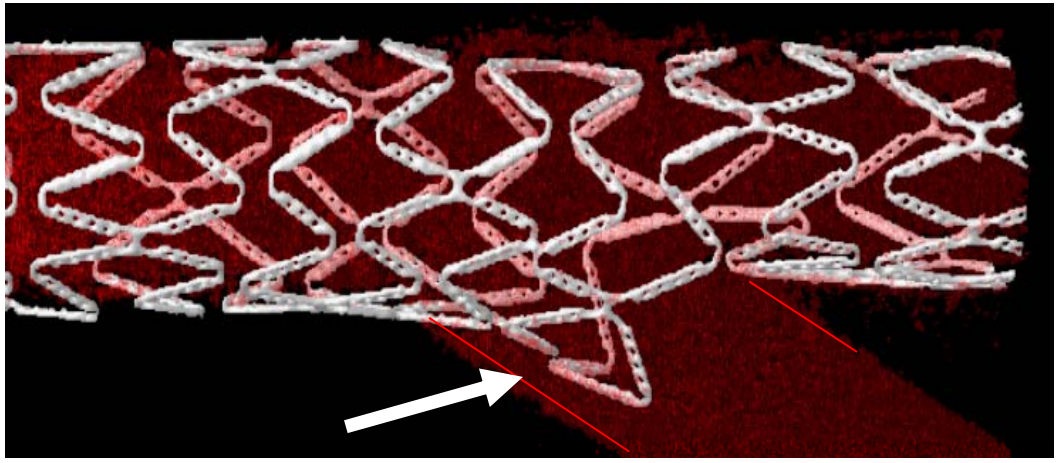
Proximal crossing



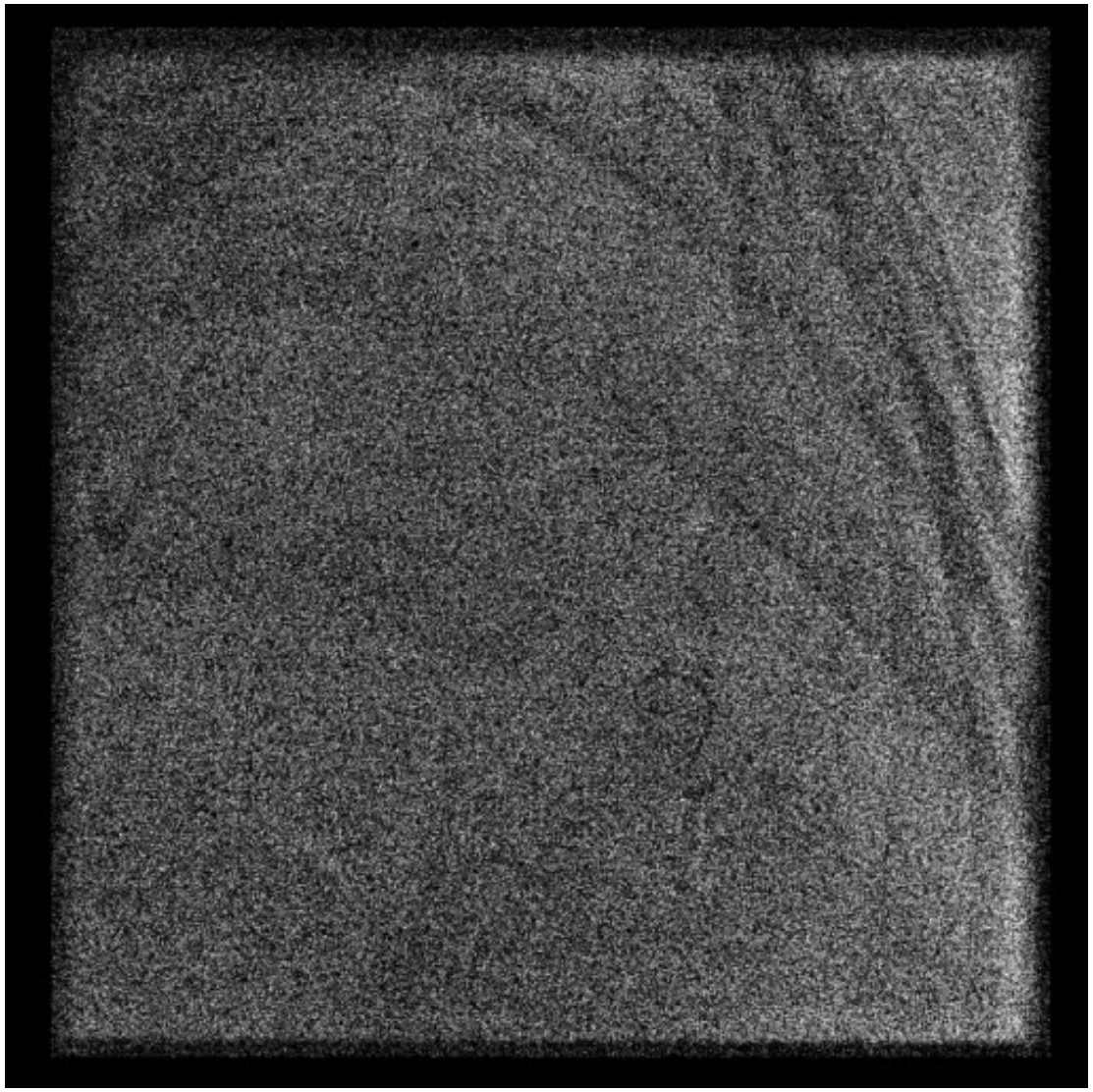


Distal crossing

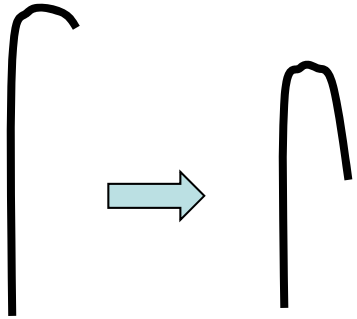




Wire exchange

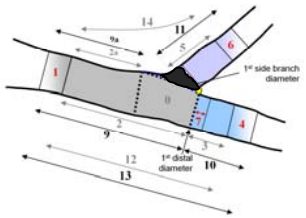


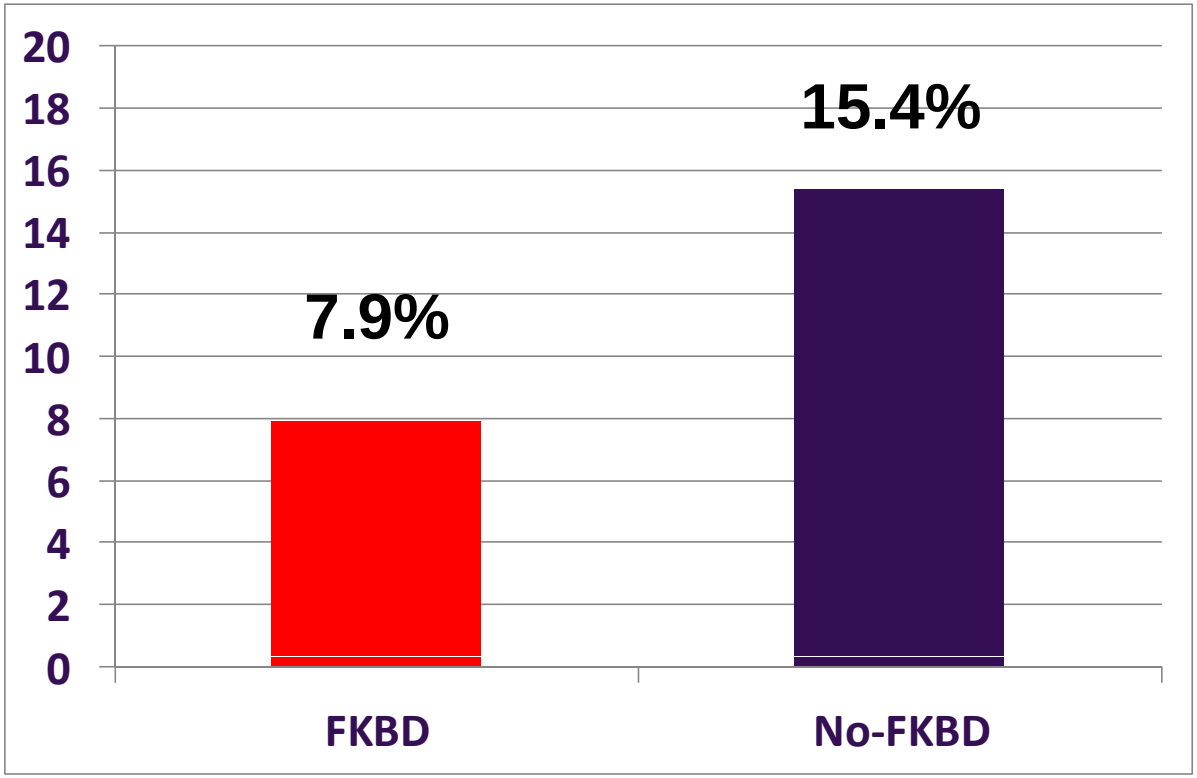
SB wire: short loop !



Nordic-Baltic Bifurcation Study III (6 m): kissing /not ?

(Re)stenosis: Ostial Side Branch



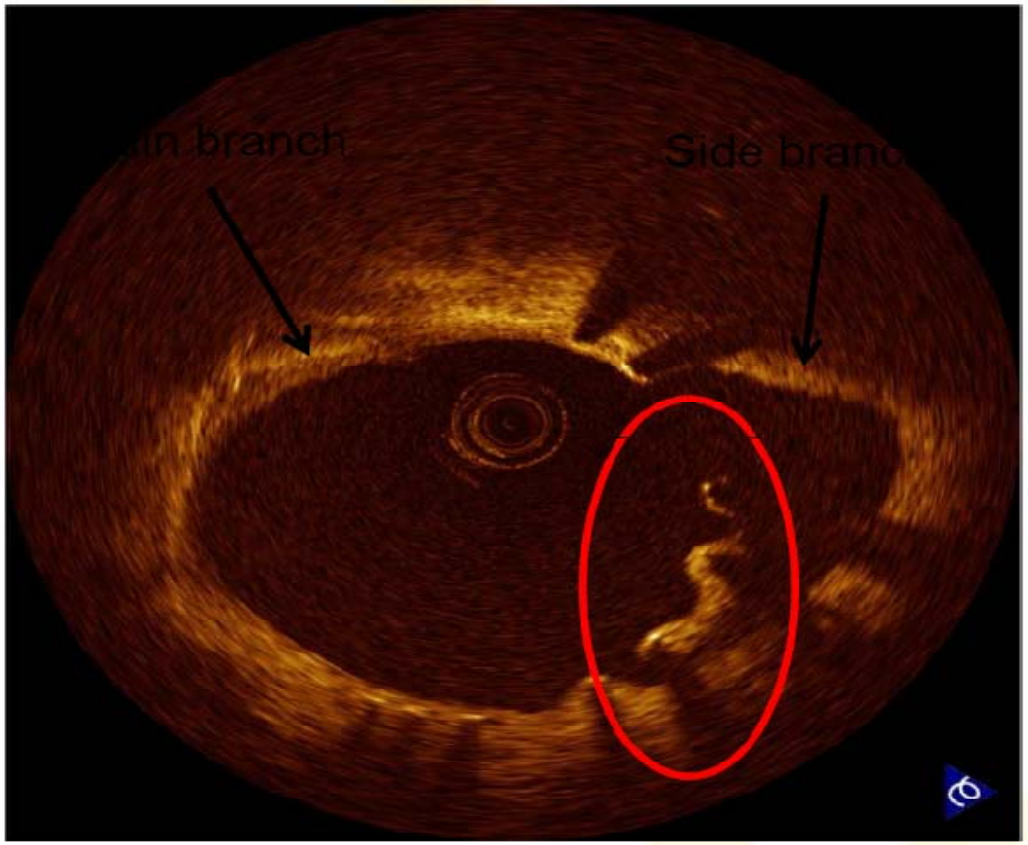


p=0.039

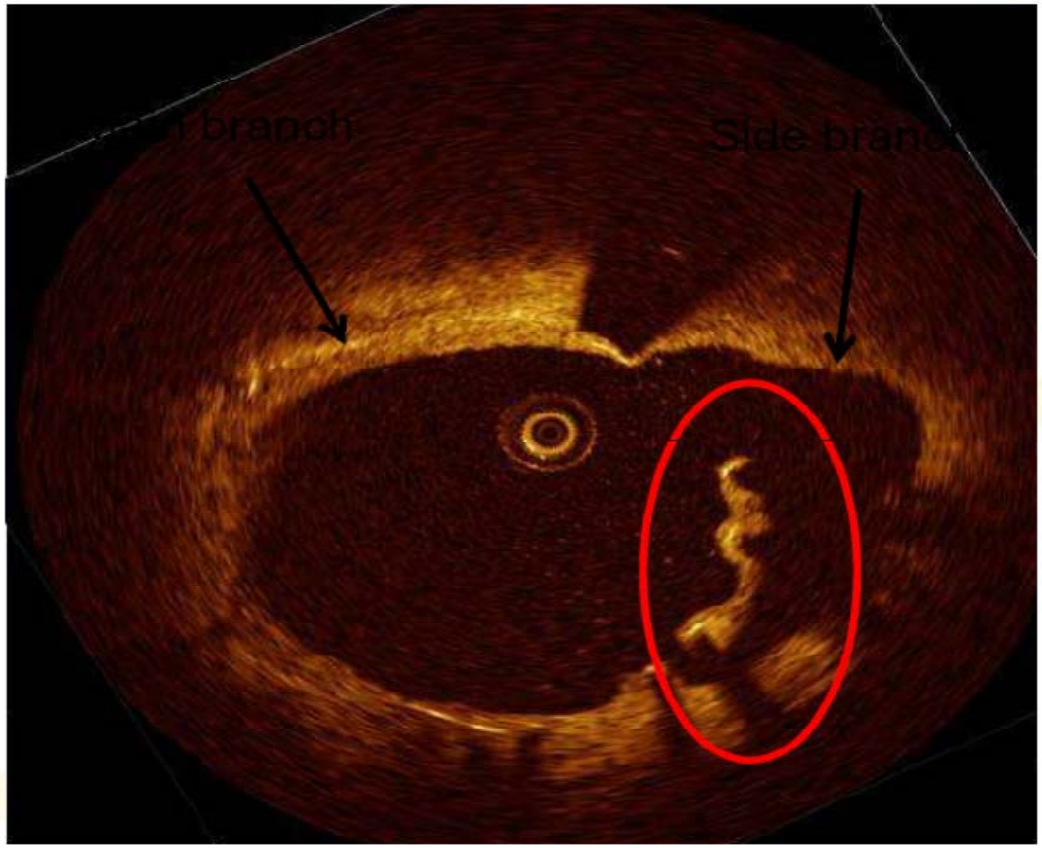
Binary Restenosis: ≥50% diameter stenosis at follow-up

Repetitive OCTs in bifurcation lesions stented with DES

Serial changes of neointimal thickness and coverage



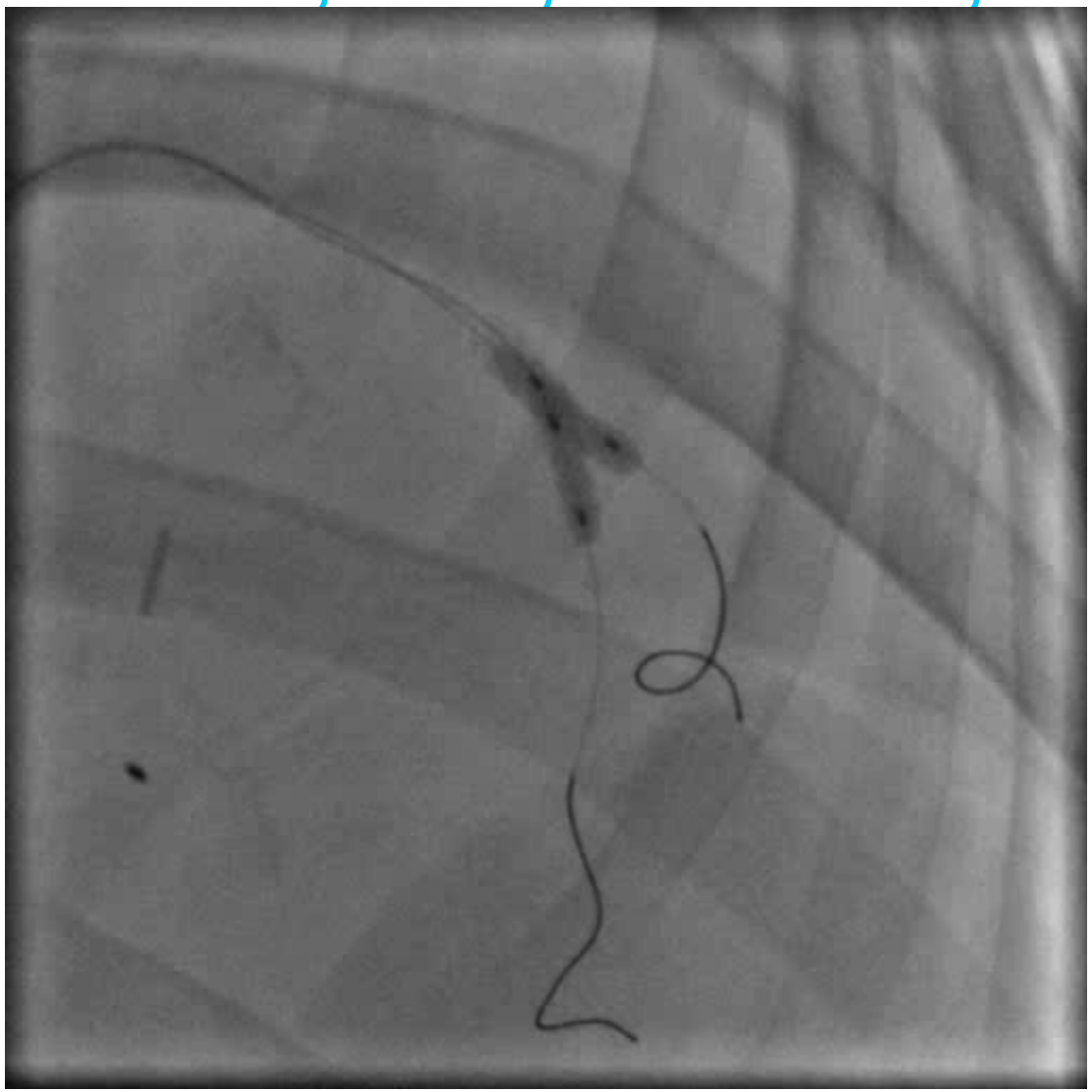
9 months later



20 months later

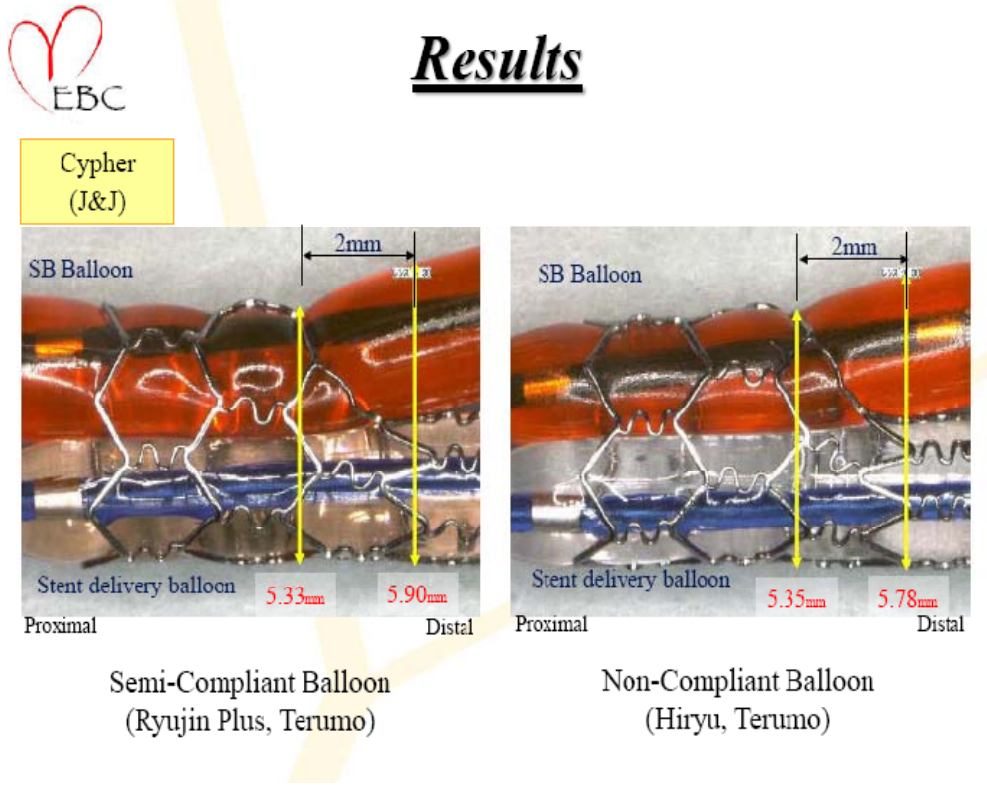
Courtesy of Kinoshita

Kissing balloon:
DM/SB diameters, short, NC balloon, MB first …



Don’t kiss too big (non-compliant balloons)

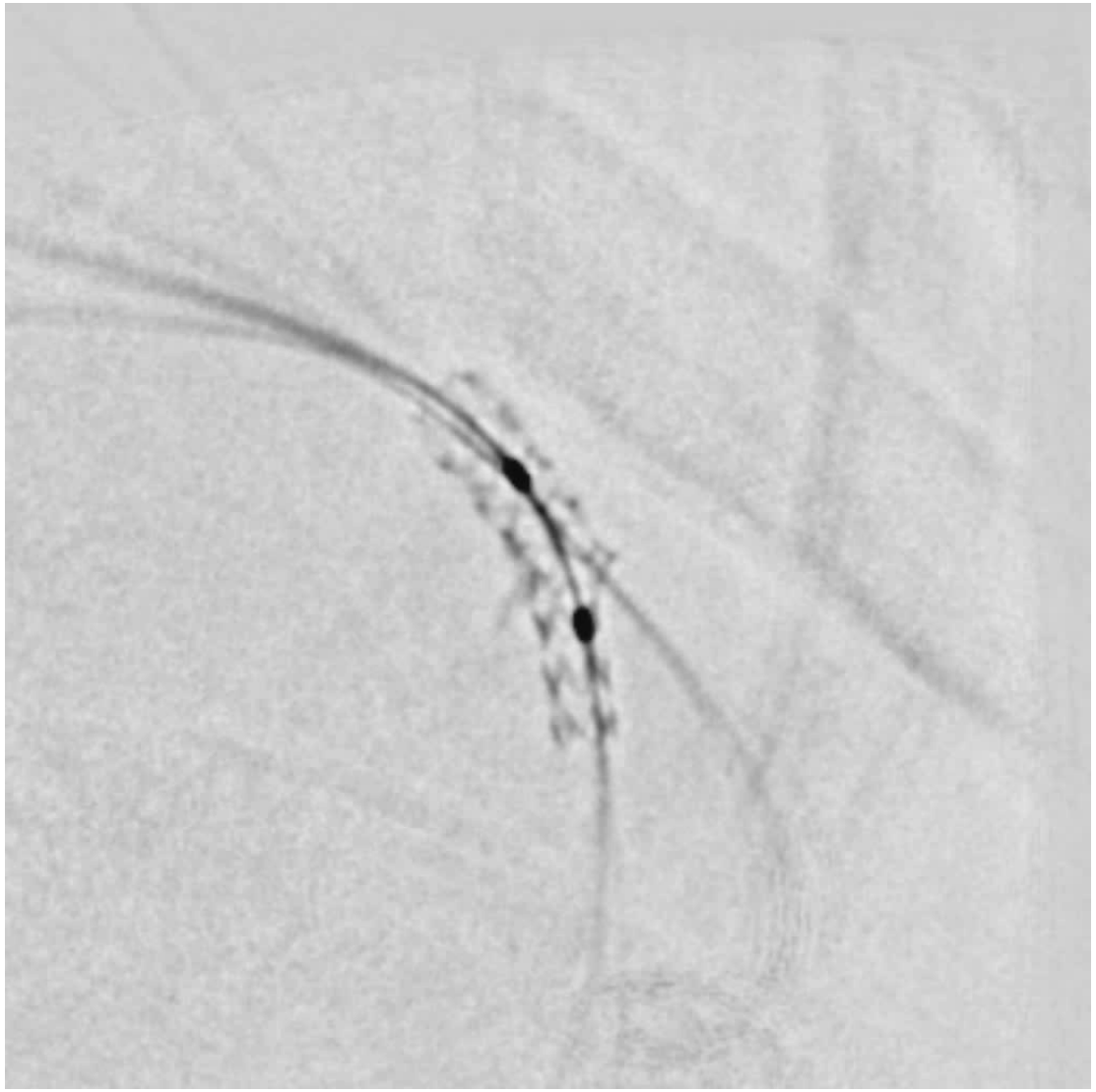
Bifurcation lesions (n)	**100**
FKS success (%)	**100**
FKS success without SB opening (%)	**97**
Metal projection in SB (%)	**89**
Need for SB stenting (%)	**7**
In-hospital MACE (%)	**0**



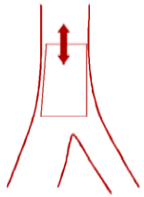
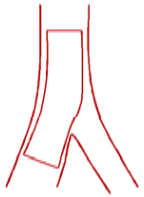
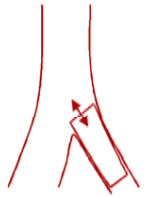
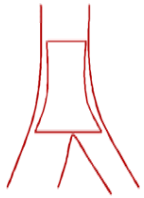
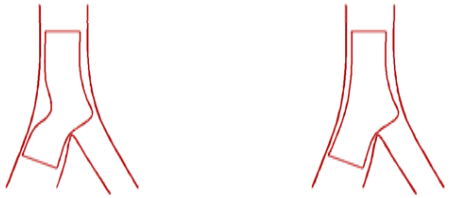
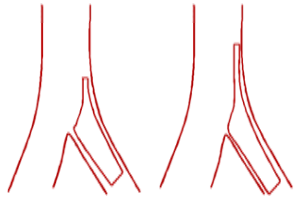
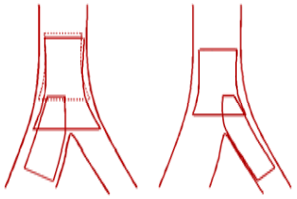
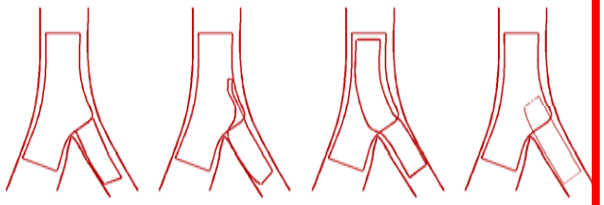
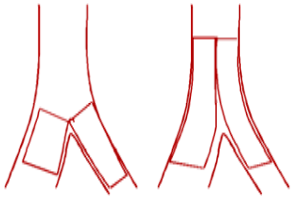
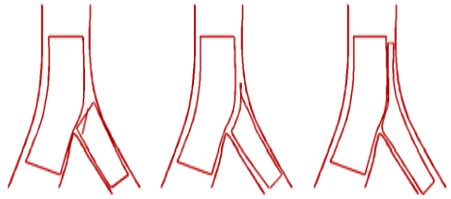
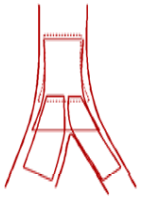
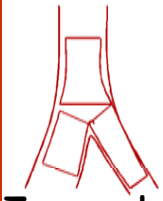
Hovasse et al. AHA 2009

Kinoshita, EBC 2009

Ready for a second stent

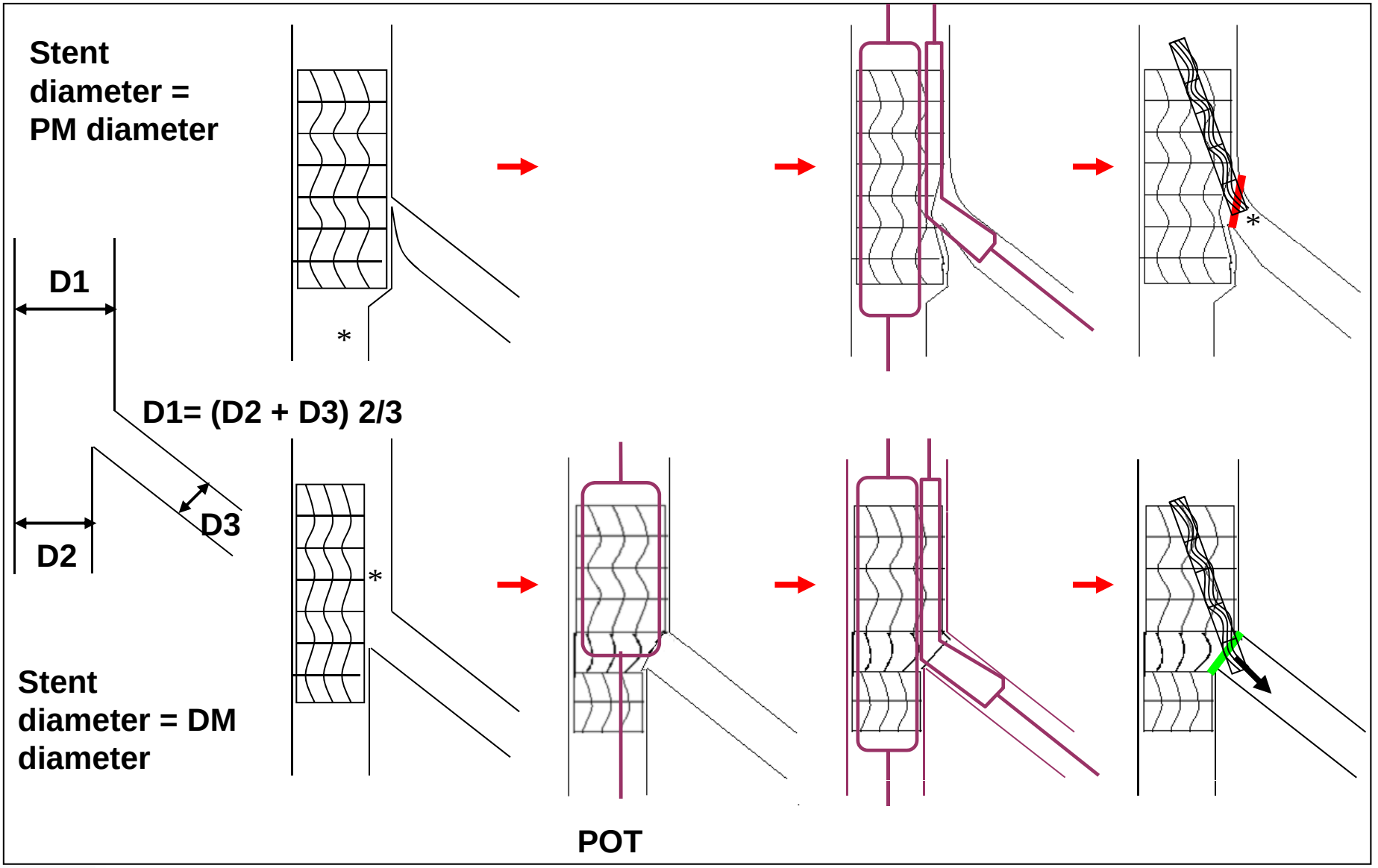


EBC

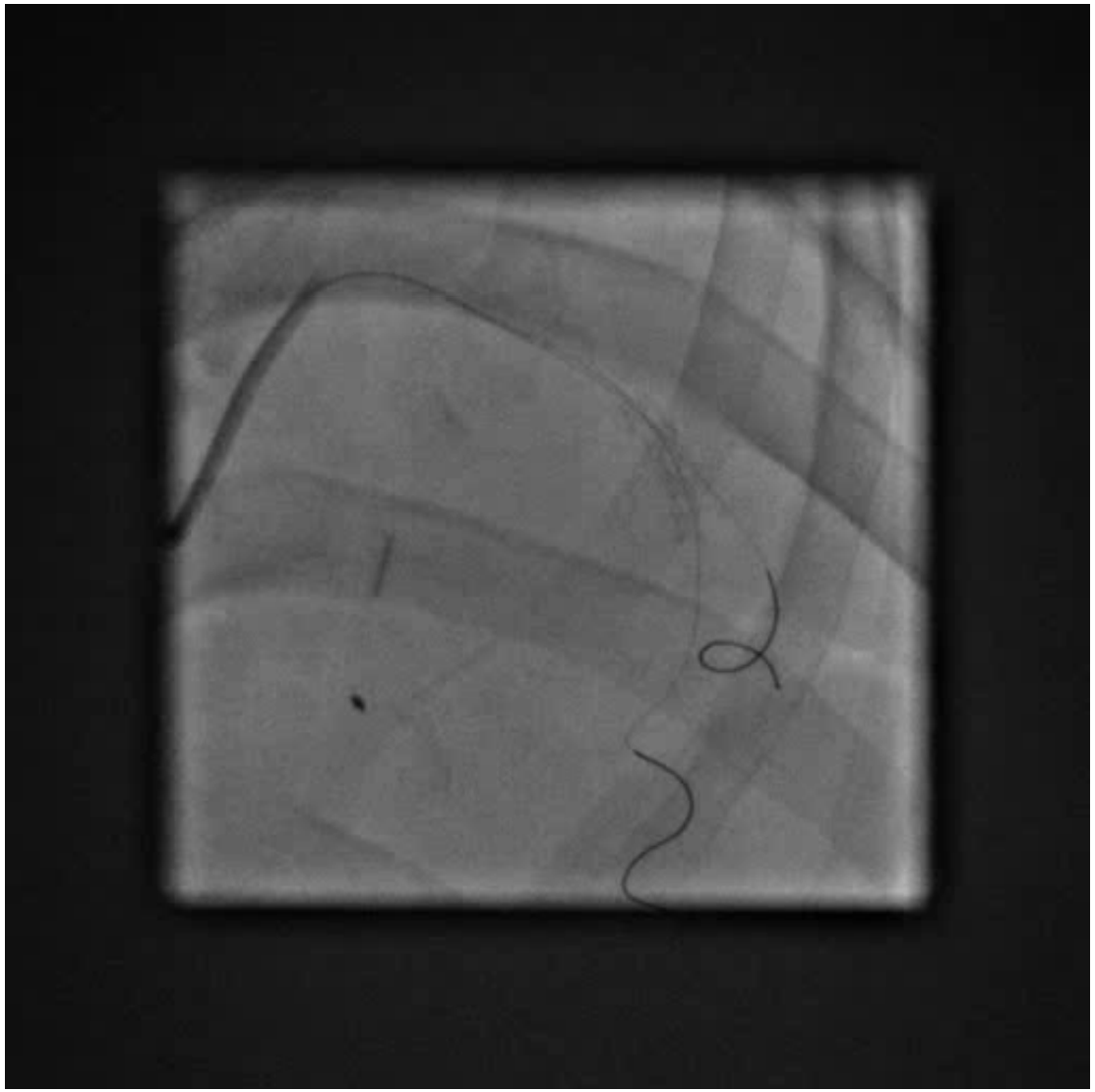
	M Main prox. first	**A** Main Accross side first	**D** Distal first	**S** Side branch first
1st stent	 PM stenting	 MB stenting across SB	 DM stenting; Provisional SKS	 SB ostial stenting
After balloon	 Skirt	 MB stenting + SB balloon; MB stenting + kissing		 SB minicrush; SB crush
2 stents	 Skirt + DM; Skirt + SB	 Elective T stenting; Internal crush; Culotte; TAP	 V stenting; SKS	 Syst. T Stenting; Minicrush; Crush
3 stents	 Extended V		 Trouser legs and seat	

Y. Louvard, CCI 2008 Feb 1;71(2):175-83.

Stent diameter choice and POT



But …why ?



Conclusions

- Provisional SB stenting strategy is highly effective
- Adapted to most types of lesion (single or double stenting)
- Different steps guided by results
- POT is essential (safety, respect of anatomy)
- Kissing is important for big SB (flow, future access)
- Many tips and tricks and bailout techniques (SB)
- Guidance: angio, IVUS ?, OCT ?