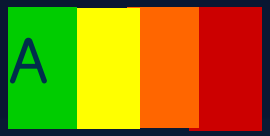
NO,
What the Matter Is
Not the Stenting Technique !

Young-Hak Kim, MD, PhD

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

Guideline Consensus

I IIa IIb III



Provisional side-branch stenting should be the intitial approach in patients with bifurcation lesions when the side branch is not large and has only mild or moderate focal disease at the ostium

I IIa IIb III

It is reasonable to use elective double stenting in patients with complex bifurcation morphology involving a large side branch where the risk of side-branch occlusion is high and the likelihood of successful side branch re access is low

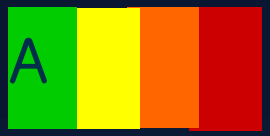
JACC. 2011 Dec 6;58(24):e44-122.
2011 ACCF/AHA/SCAI Guideline for PCI.

What the matter is …

- Technique ?
  - Single-stent in all case ?
  - Best double-stent technique ?
- Device ?
- Operator ?

Single-Stent Technique

I IIa IIb III



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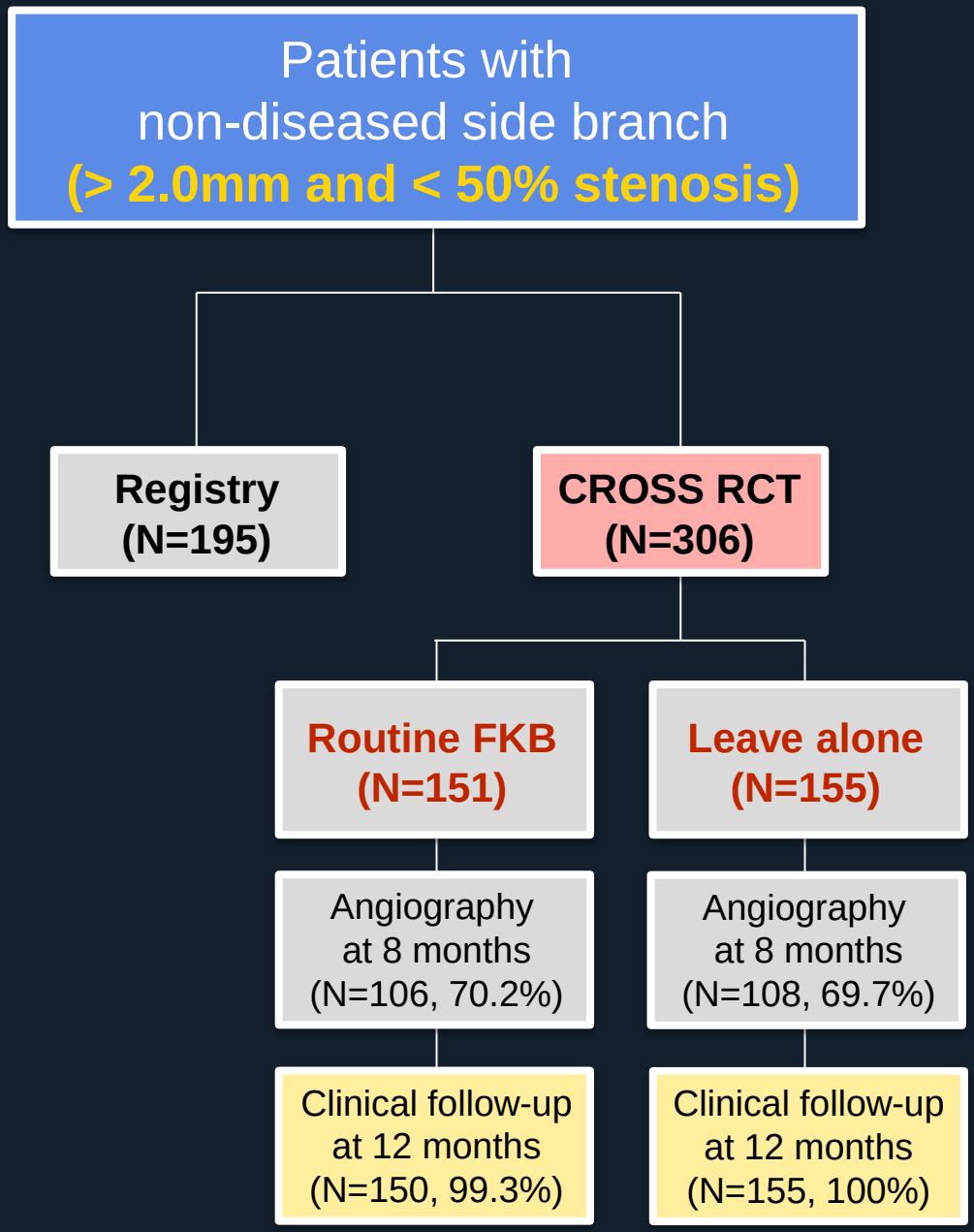
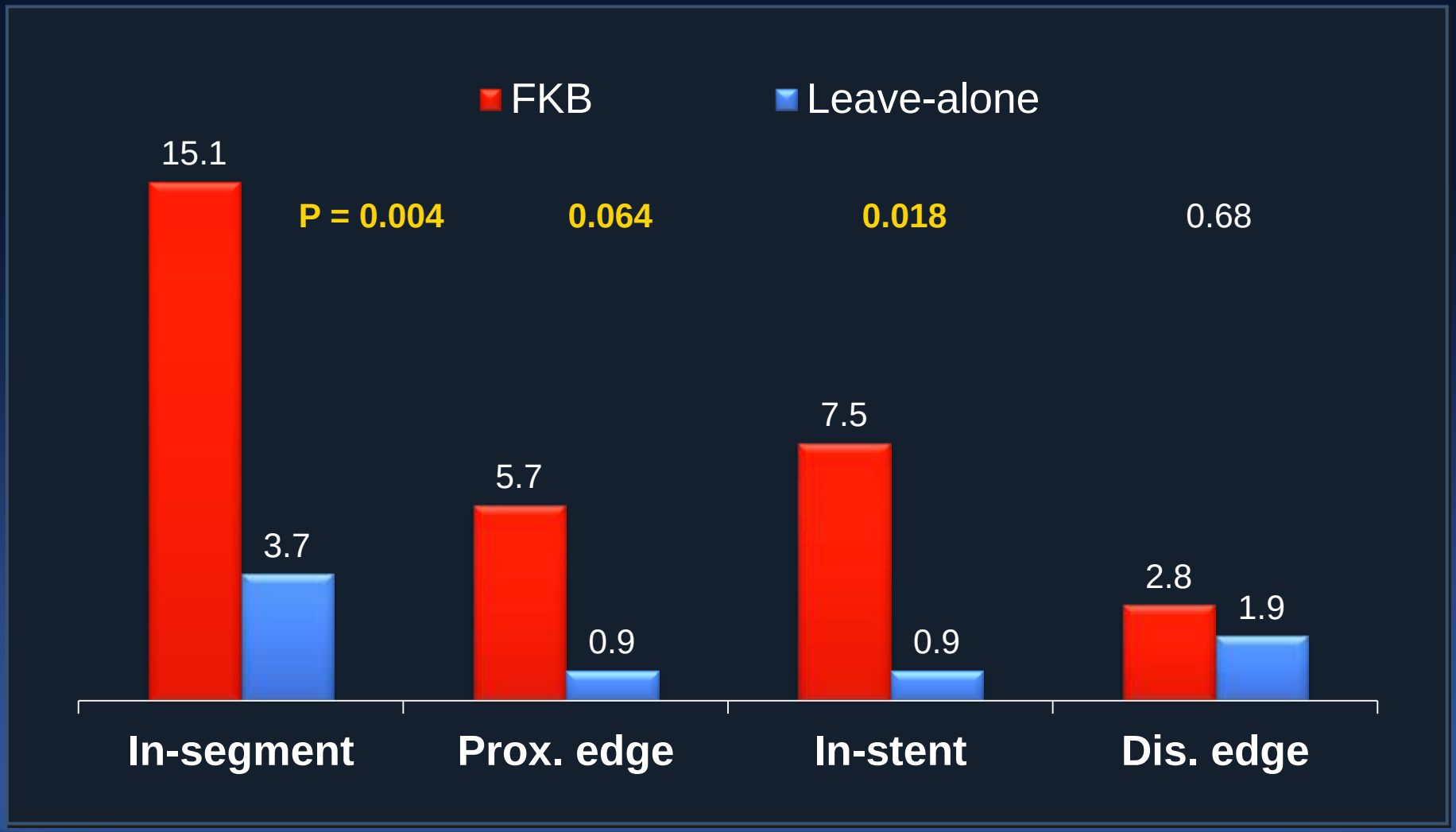
RCTs for Bifurcation Lesions

Trials	Comparison
NORDIC 1	Provisional T vs. Systemic T stenting
NORDIC 2	Crush vs. Culotte
NORDIC 3	Kissing balloon vs. leave alone
BBC	Simple vs. Complex
CACTUS	Provisional T vs. Crush
CROSS	FKB vs. no FKB for non-diseased SB
PERPECT	Crush vs. Provisional T for diseased SB

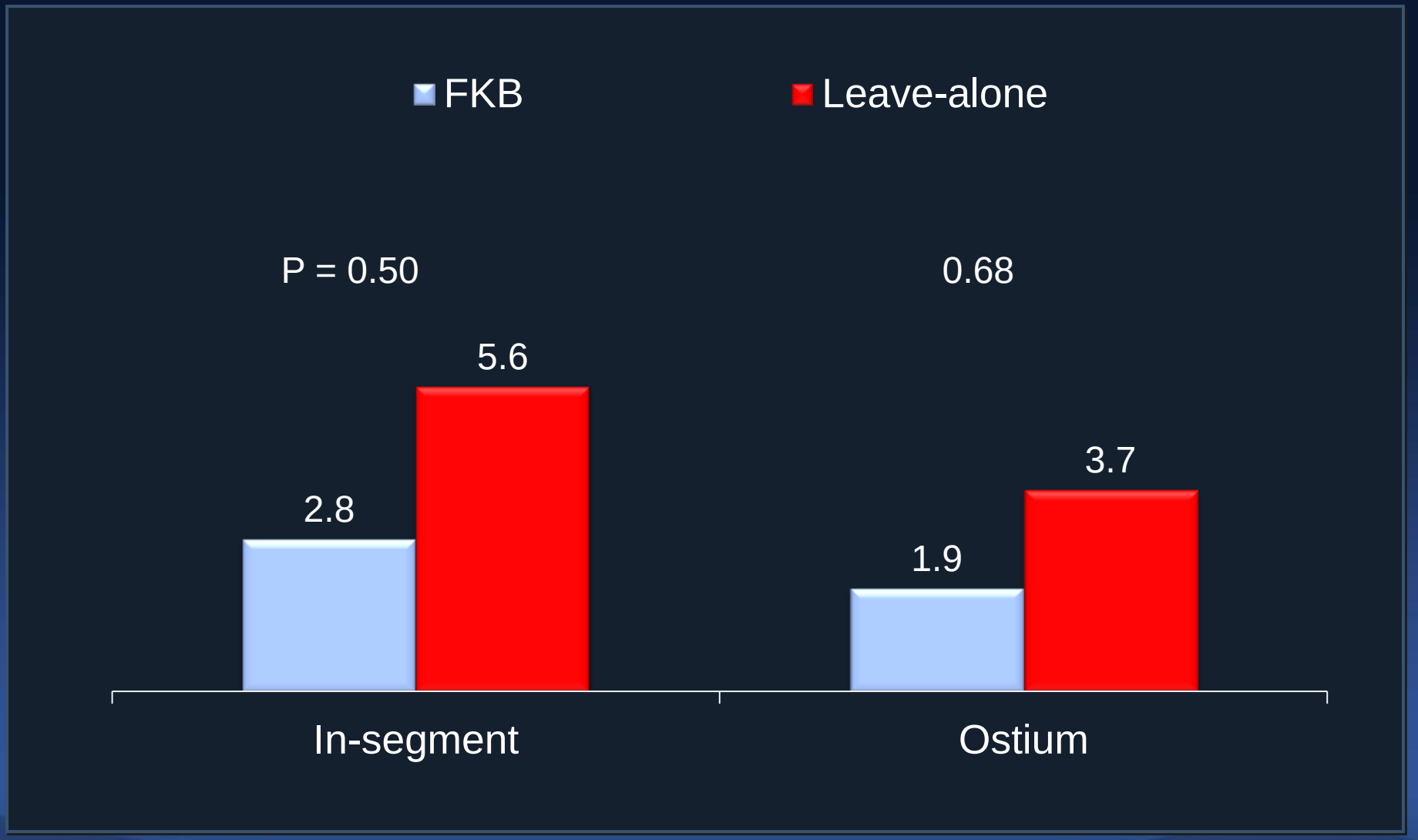

Patients with
non-diseased side branch
(> 2.0mm and < 50% stenosis)
Registry
(N=195)
CROSS RCT
(N=306)
Routine FKB
(N=151)
Leave alone
(N=155)
Angiography
at 8 months
(N=106, 70.2%)
Angiography
at 8 months
(N=108, 69.7%)
Clinical follow-up
at 12 months
(N=150, 99.3%)
Clinical follow-up
at 12 months
(N=155, 100%)

Restenosis of Main Branch



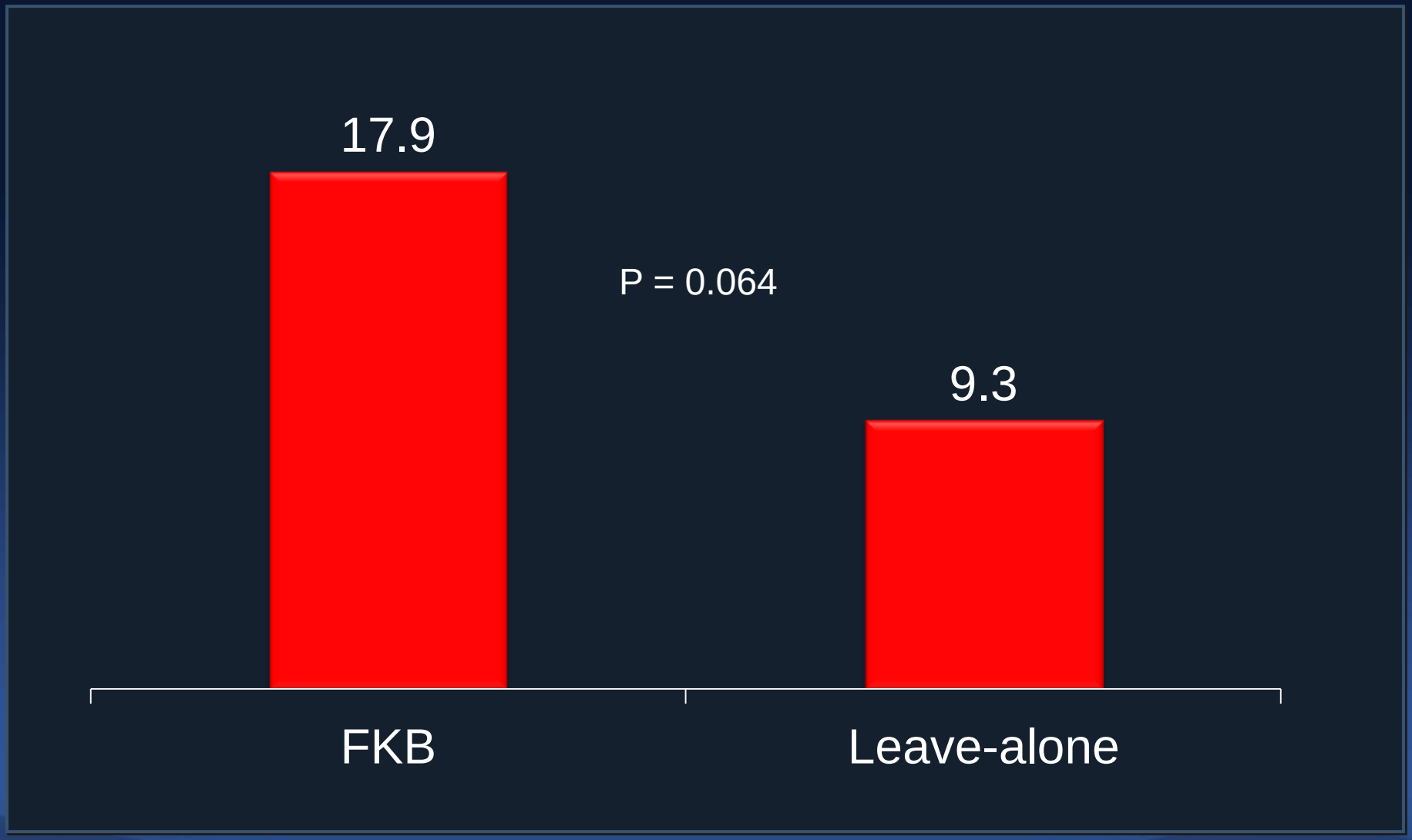
Kim YH, Park SJ et al. J Am Coll Cardiol Intv 2015;8:550

Restenosis of Side Branch



Kim YH, Park SJ et al. J Am Coll Cardiol Intv 2015;8:550

Overall Restenosis Rate

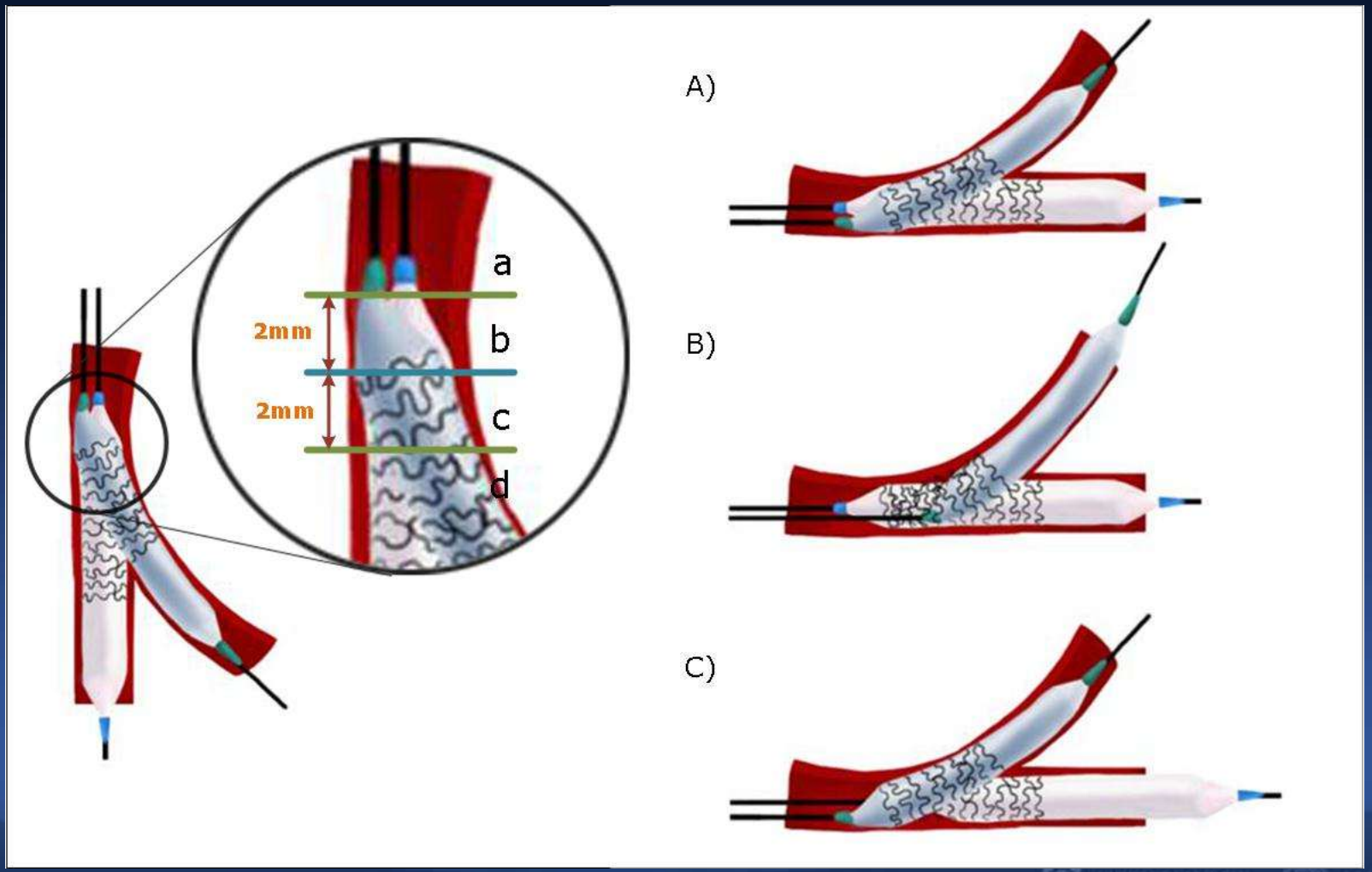


Kim YH, Park SJ et al. J Am Coll Cardiol Intv 2015;8:550

Technical Factors of FKB

Impact of Barotrauma

Impact of Kissing Arrangement



FKB used in 1-stent Technique

Variables	MB restenosis			SB restenosis		
MB restenosis	+ (N=18)	- (N=156)	P	+ (N=6)	- (N=168)	P
Position of overlapping segment			0.83			0.81
a	10 (55.6)	92 (59.0)		3 (50.0)	99 (58.9)	
b	6 (33.3)	51 (32.7)		3 (50.0)	54 (32.1)	
c	2 (11.1)	11 (7.1)		0	13 (7.7)	
d	0	2 (1.3)		0	2 (1.2)	
Arrangement of balloons			0.44			1.00
a	2 (11.1)	8 (5.1)		0	10 (6.0)	
b	2 (11.1)	25 (16.0)		1 (16.7)	26 (15.5)	
c	14 (77.8)	123 (78.8)		5 (83.3)	132 (78.6)	

FKB used in 1-stent Technique

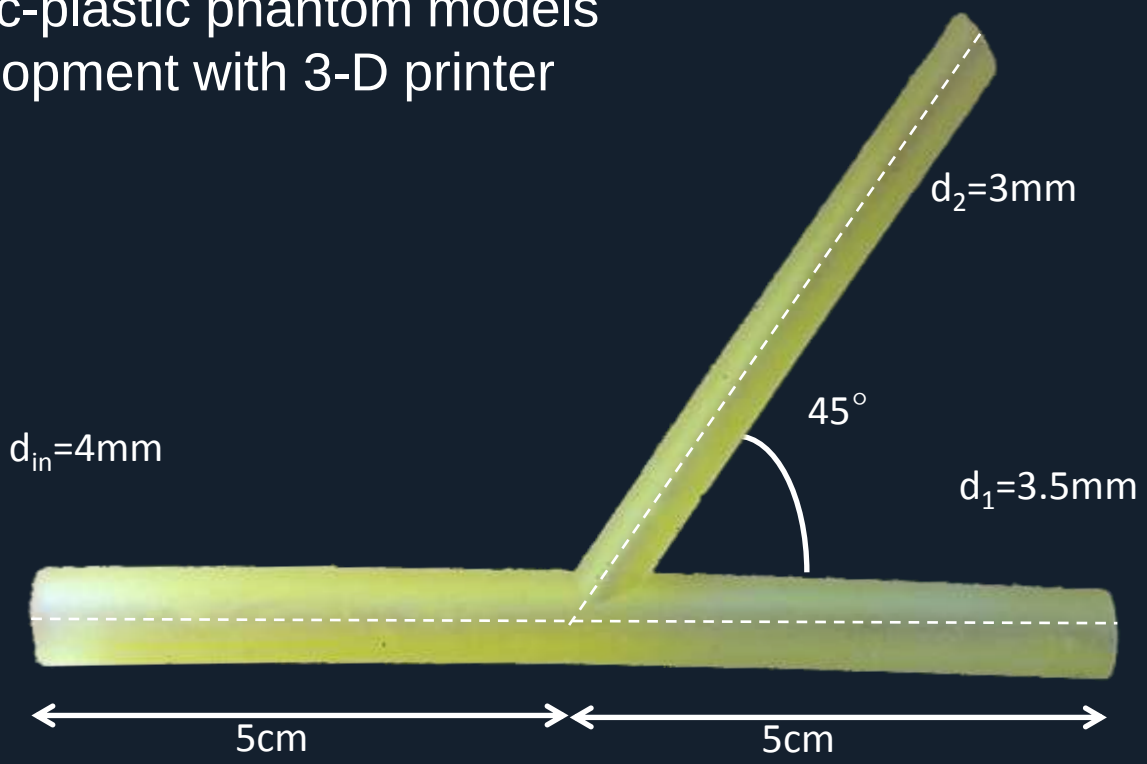
Variables	MB restenosis			SB restenosis		
MB restenosis	+ (N=18)	- (N=156)	P	+ (N=6)	- (N=168)	P
Sequential balloon dilation	14 (77.8)	122 (78.2)	1.00	5 (83.3)	131 (78.0)	1.00
SB-first dilation	3 (21.4)	50 (41.0)	0.16	2 (40.0)	51 (38.9)	1.00
Prox. RD of MB – Estimated dia. of 2 balloons, mm	-0.5 ± 0.5	-0.4 ± 0.8	0.62	-0.6 ± 0.4	-0.4 ± 0.8	0.70
Dist. RD of MB – dia. of MB balloon, mm	-0.7 ± 0.5	-0.7 ± 0.4	0.60	-1.0 ± 0.5	-0.7 ± 0.4	0.071
Dist. RD of SB – Dia. of SB balloon, mm	-0.3 ± 0.4	-0.2 ± 0.4	0.096	-0.2 ± 0.4	-0.2 ± 0.4	0.84
NC balloon for MB	9 (50.0)	89 (57.1)	0.57	2 (33.3)	96 (57.1)	0.41
NC balloon for SB	0	20 (12.8)	0.23	0	20 (11.9)	1.00
Pressure applied toward MB, atm	8.9 ± 3.0	9.8 ± 2.9	0.25	9.3 ± 1.0	9.7 ± 2.9	0.76
Pressure applied toward SB, atm	8.2 ± 2.3	9.2 ± 2.9	0.13	8.5 ± 1.8	9.2 ± 2.9	0.58
Total pressure applied, atm	17.1 ± 4.7	19.0 ± 4.9	0.12	17.8 ± 1.3	18.9 ± 5.0	0.15

Multivariate OR for Restenosis

Variables	CROSS Study			PERFECT Study		
	OR	95% CI	P	OR	95% CI	P
Predictors, MB restenosis						
SB NC balloon				0.17	0.02 – 1.36	0.09
Post-SB MLD				0.56	0.14 – 2.17	0.40
FKB inflation	4.61	1.46 – 14.58	0.009	0.48	0.13 – 1.77	0.27
Predictors, SB restenosis						
IVUS for MB				0.16	0.03 – 1.00	0.050
Total stent length in MB				1.02	0.99 – 1.06	0.25
IVUS for SB				0.77	0.21 – 2.75	0.68
Post-SB MLD				0.14	0.03 – 0.62	0.010
FKB inflation				1.01	0.25 – 4.14	0.99

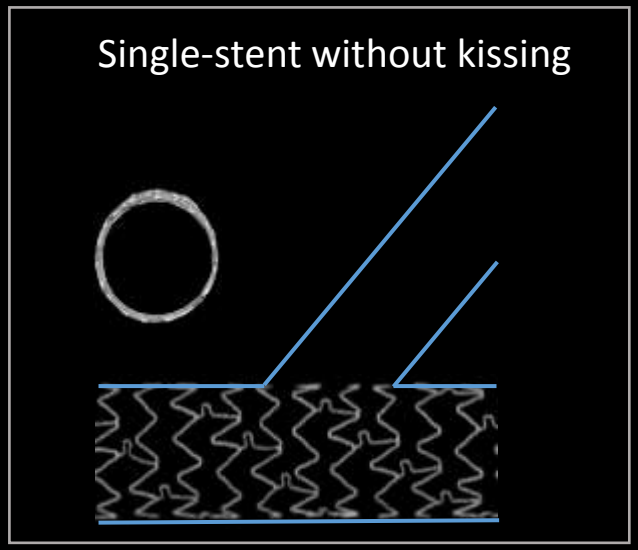
Bifurcation Phantom

- Acrylic-plastic phantom models
- Development with 3-D printer

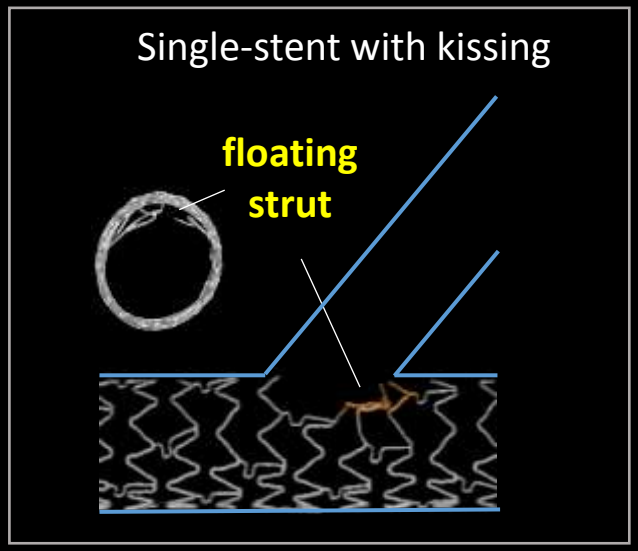


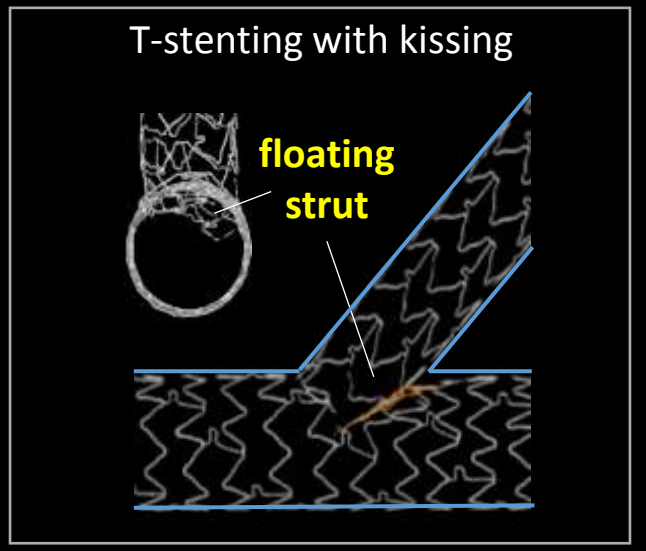
Floating Stent Strut after Final Kissing on Micro-CT

No kissing

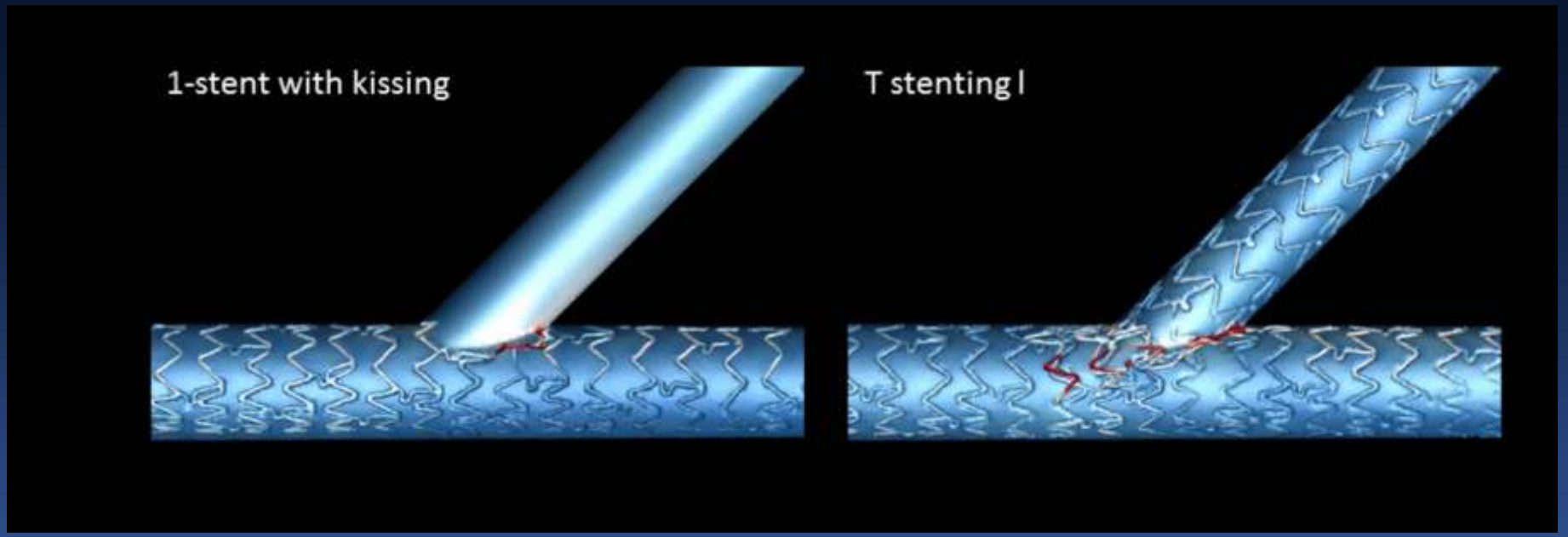


Kissing





Time-averaged Wall Shear Stress



Kwon JH, PhD, YH Kim, MD et al (in submission)

Impairment of flow pattern, indicated by shift of **low WSS to distal MB** due to **floating stent strut** made by FKB, may be one of mechanisms of higher rate of MB restenosis.

Floating stent	Total	Prox. MB	Dist. MB	SB	POC	Dist. MB (prox. half)
Yes	3.13	3.50	**1.87**	3.65	4.42	**2.83**
No	3.49	3.18	**2.78**	3.91	5.08	**4.68**

✓ Unnecessary FKB after stent crossover is bad with any modifications for bifurcations without SB stenosis

Two-Stent Technique

I IIa IIb III

Provisional side-branch stenting should be the intitial approach in patients with bifurcation lesions when the side branch is not large and has only mild or moderate focal disease at the ostium

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It is reasonable to use elective double stenting in patients with complex bifurcation morphology involving a large side branch where the risk of side-branch occlusion is high and the likelihood of successful side branch re access is low

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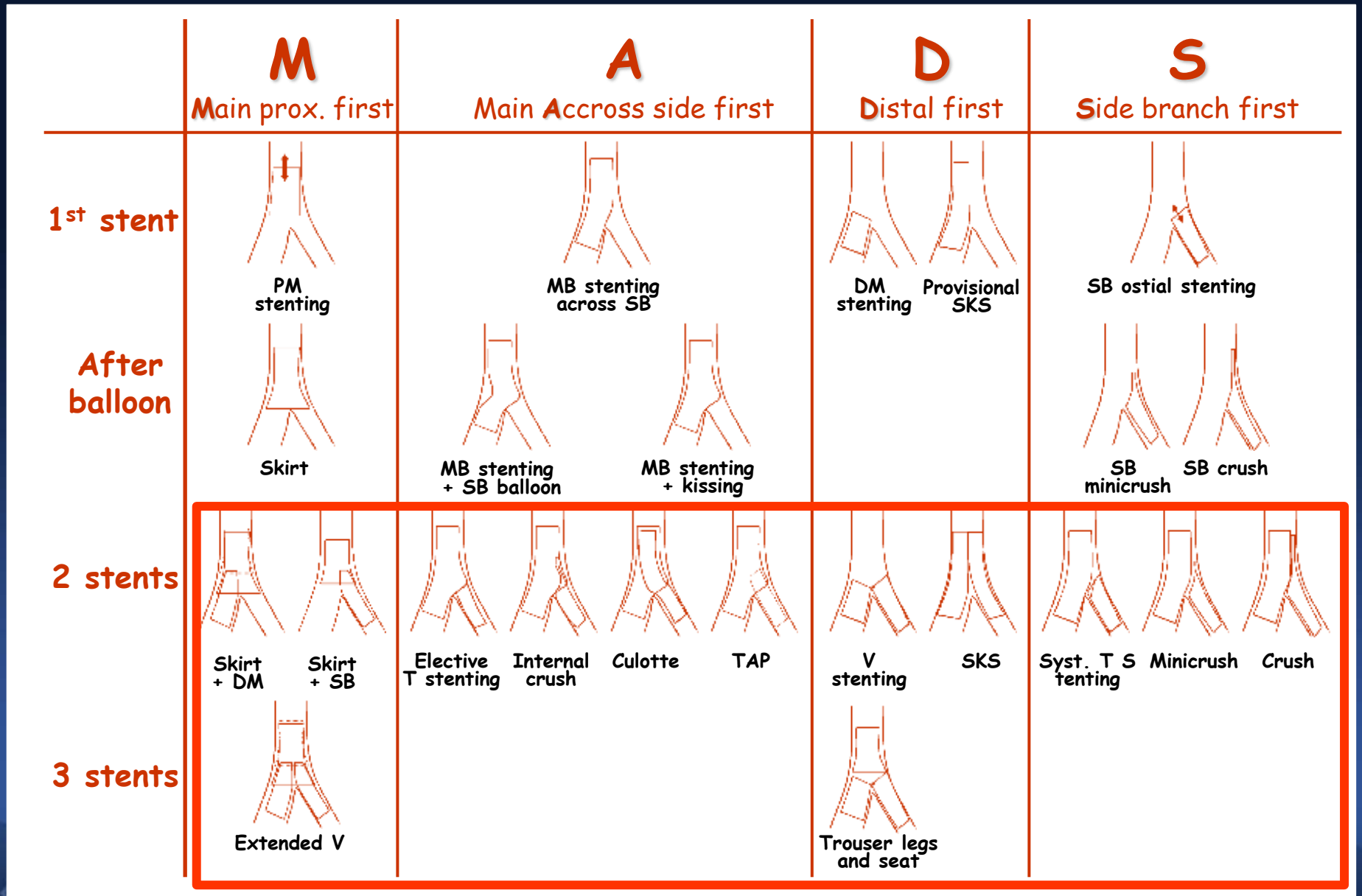
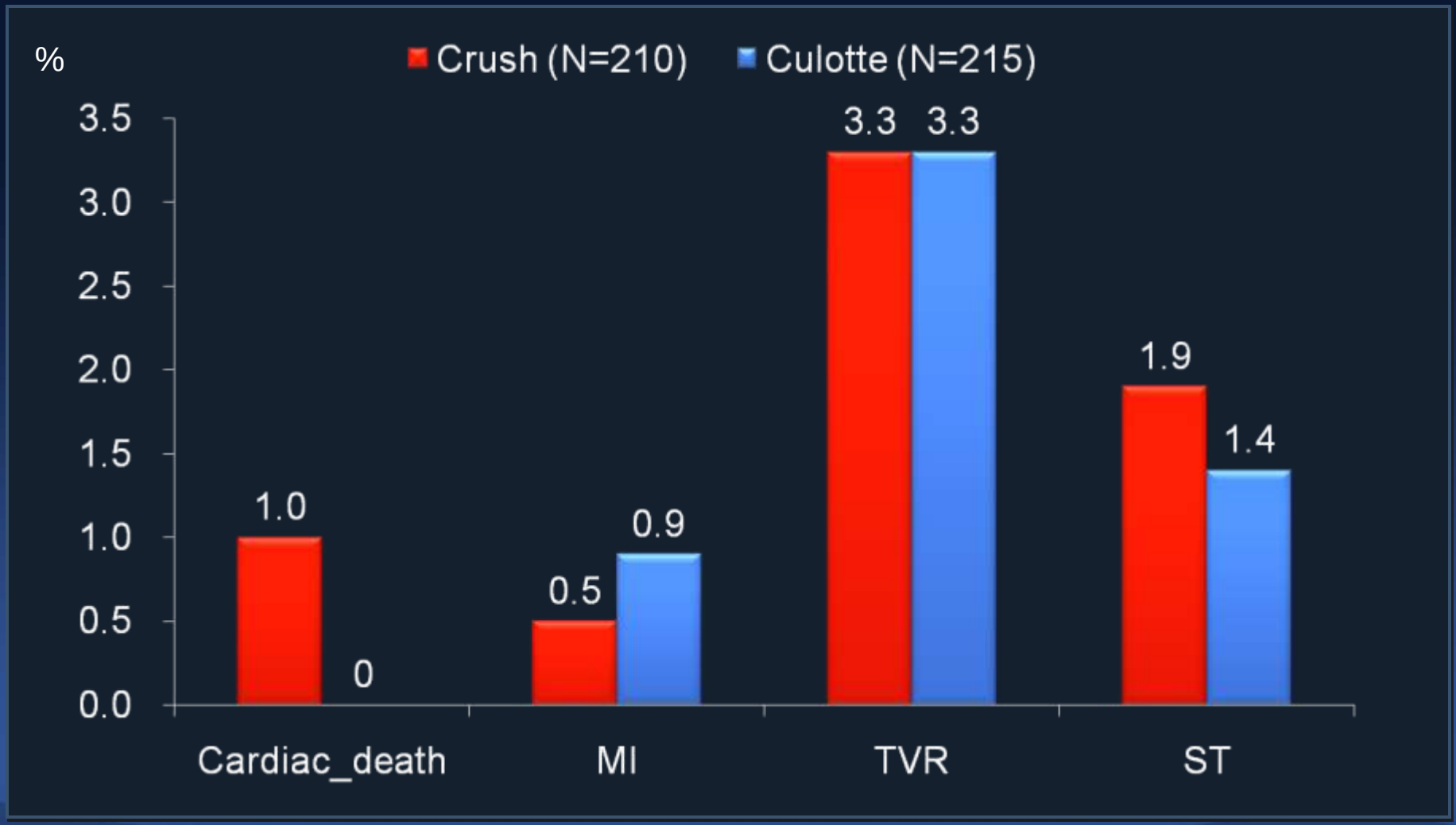
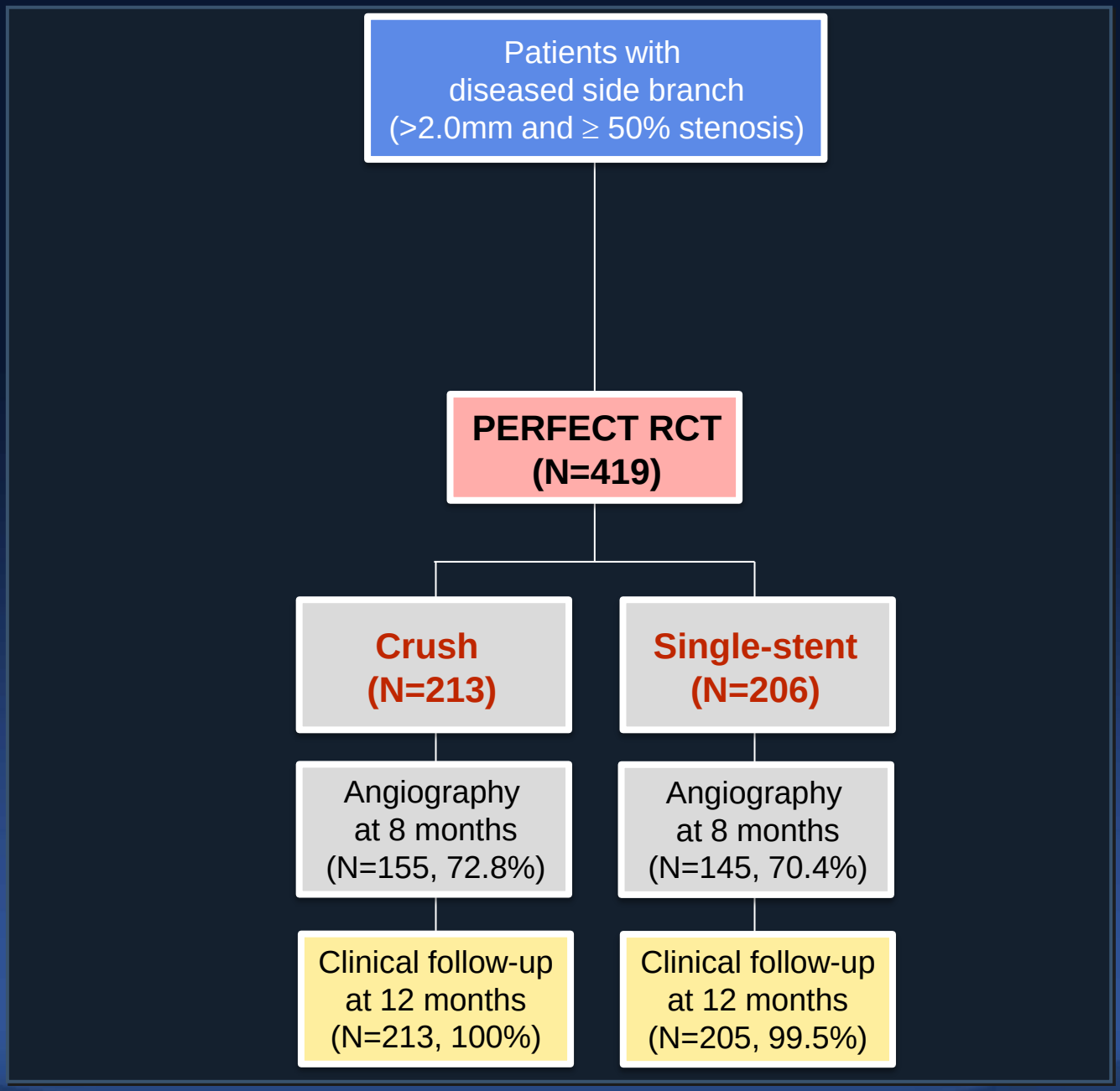
Best 2-stent technique ?



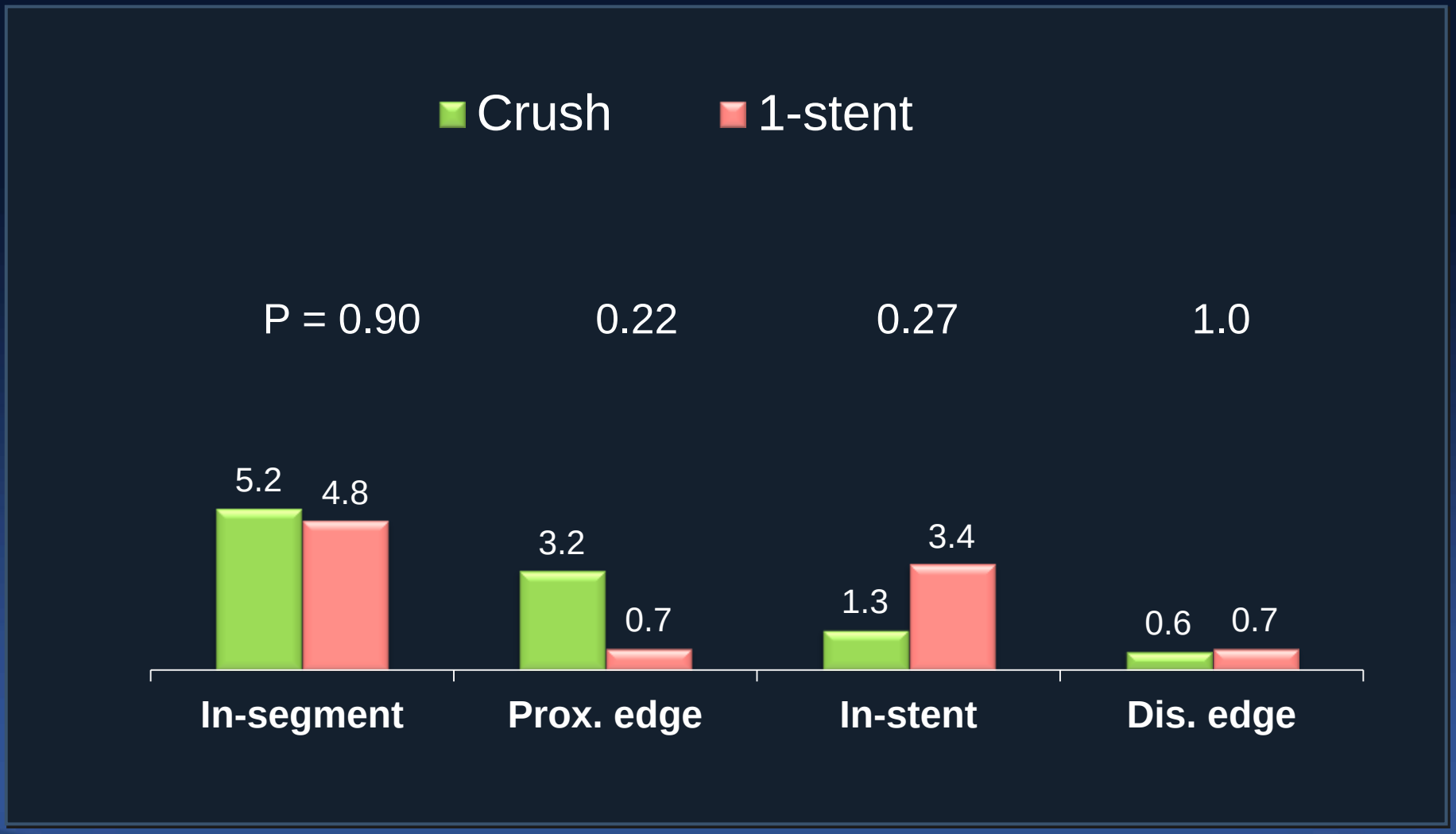
NORDIC II trial (425 pts)
Crush vs. Culotte



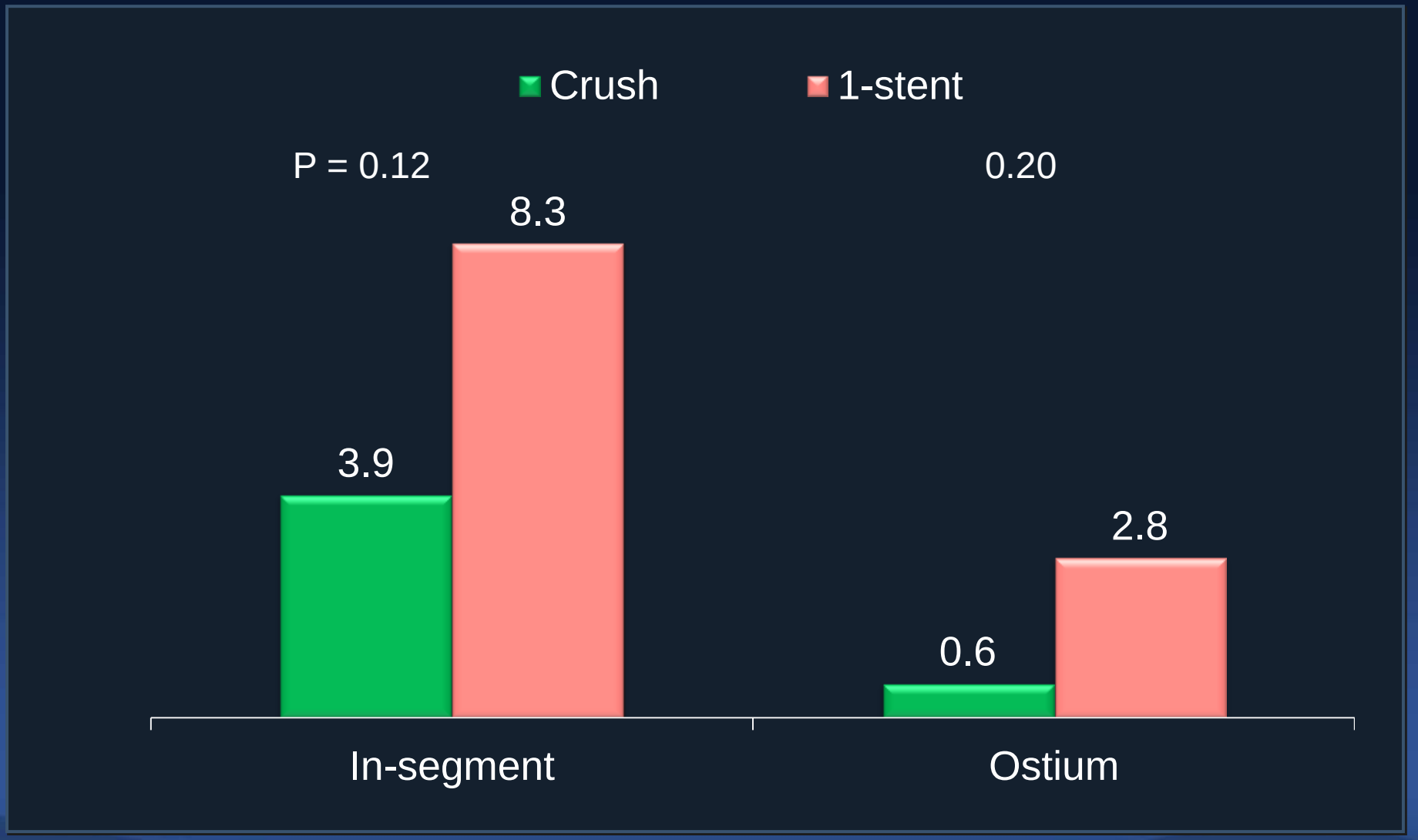
Erglis A et al, Circ Cardiovasc Intervent. 2009;2:27


Patients with diseased side branch (>2.0mm and ≥ 50% stenosis)
PERFECT RCT (N=419)
Crush (N=213)
Single-stent (N=206)
Angiography at 8 months (N=155, 72.8%)
Angiography at 8 months (N=145, 70.4%)
Clinical follow-up at 12 months (N=213, 100%)
Clinical follow-up at 12 months (N=205, 99.5%)

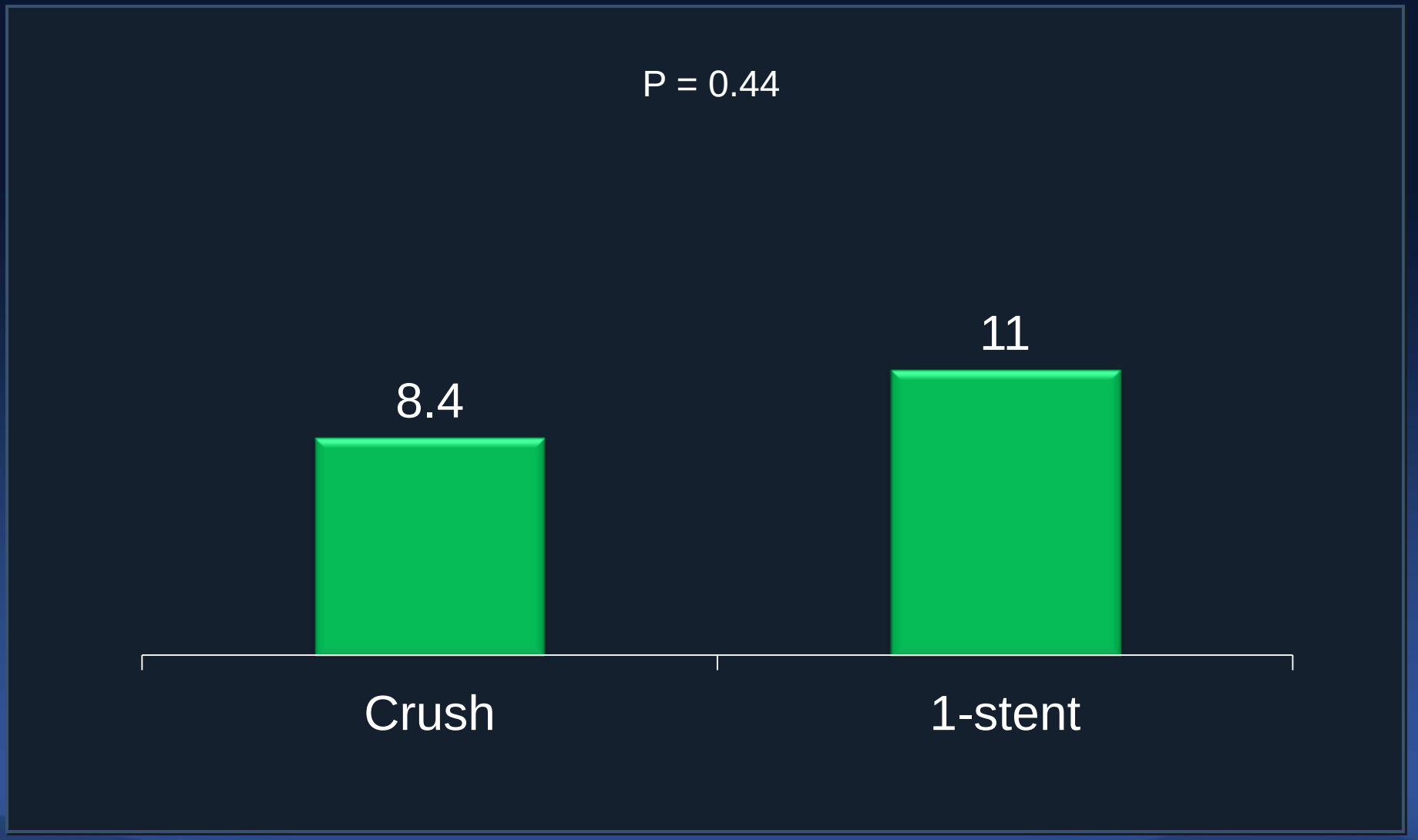
Restenosis of Main Branch



Restenosis of Side Branch



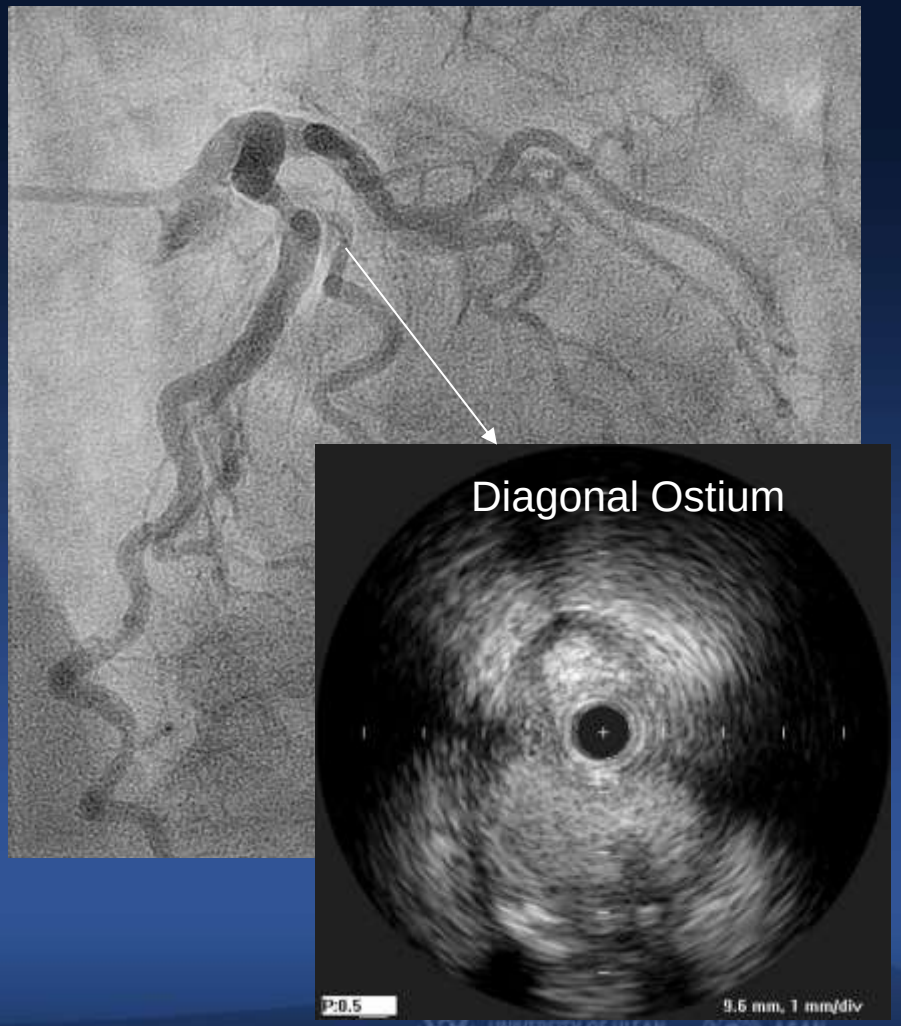
Overall Restenosis Rate



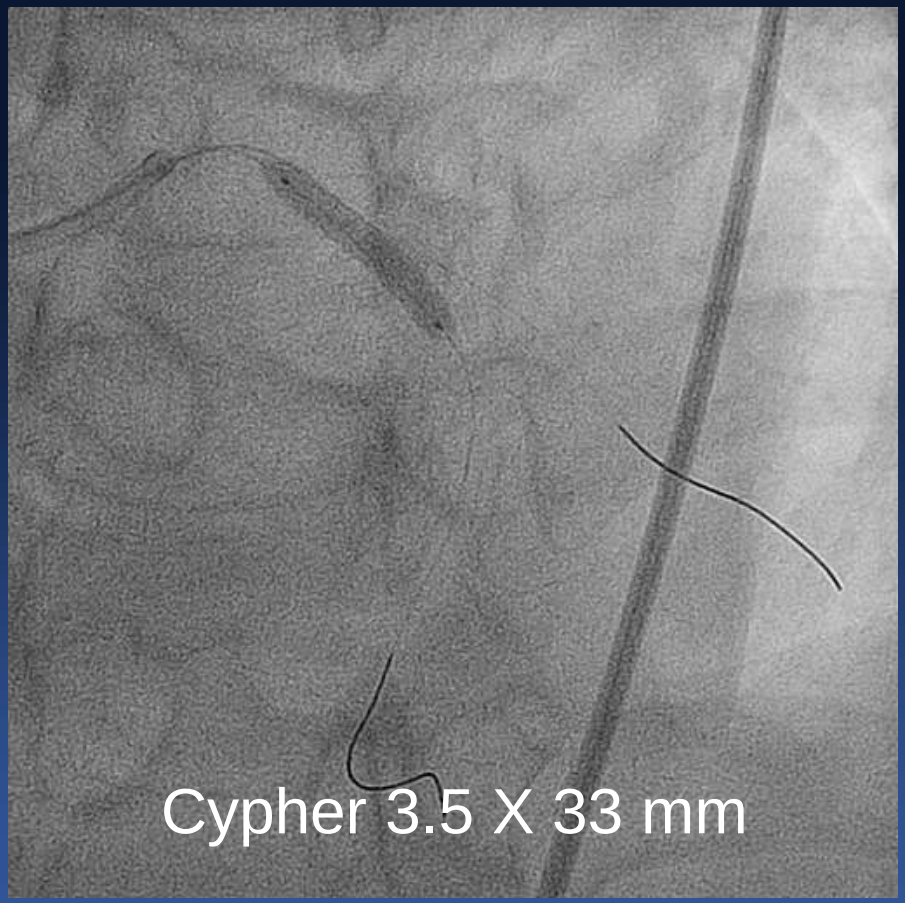
SB Stenting Techniques

Variables	Crush (N=213)	1-stent (N=206)	P
FKB	204 (95.8)	163 (79.1)	< 0.001
Stent	208 (97.7)	58 (28.2)	< 0.001
Stenting technique			< 0.001
Crush	206 (99.0)	15 (25.9)	
Provisional T	1 (0.5)	43 (74.1)	
Others	1 (0.5)	0	

Is 1-stent approach always good ?



Total occlusion and complex procedure in provisional approach

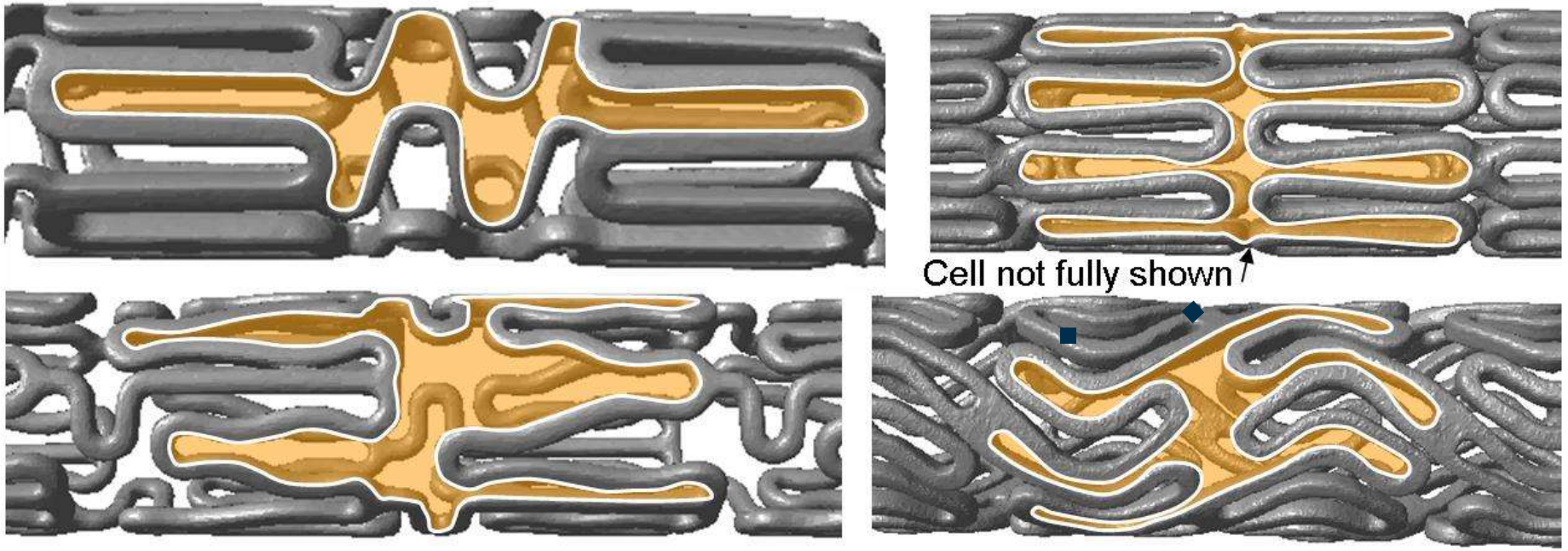


Rewiring with CTO wire and T stenting

Difficult rewiring because of calcified ostium

- ✓ There is nothing which is always good ….
- ✓ In selected cases, a planned 2-stent may be better.

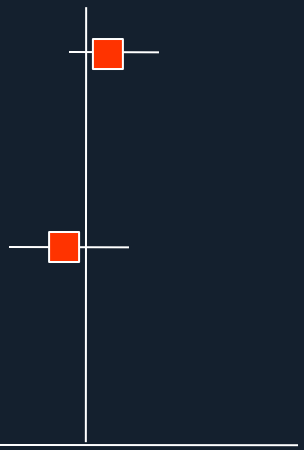
Does a good fit lead to better a clinical outcome ?



Mortier et al. EBC 2008

Biological Efficacy of DES
TVF in Subgroups of TWENTE RCT

	Resolute	Xience V	Relative risk (95% CI)	P value
Bifurcation	10.1% (18/179)	8.2% (15/183)	1.23 (0.64, 2.36)	0.54
Non-bifurcation	7.5% (39/518)	8.0% (45/511)	0.94 (0.62, 1.43)	0.77



0.1 10

Resolute better **Xience V better**

von Birgelen C et al. J Am Coll Cardiol 2012;59:1350

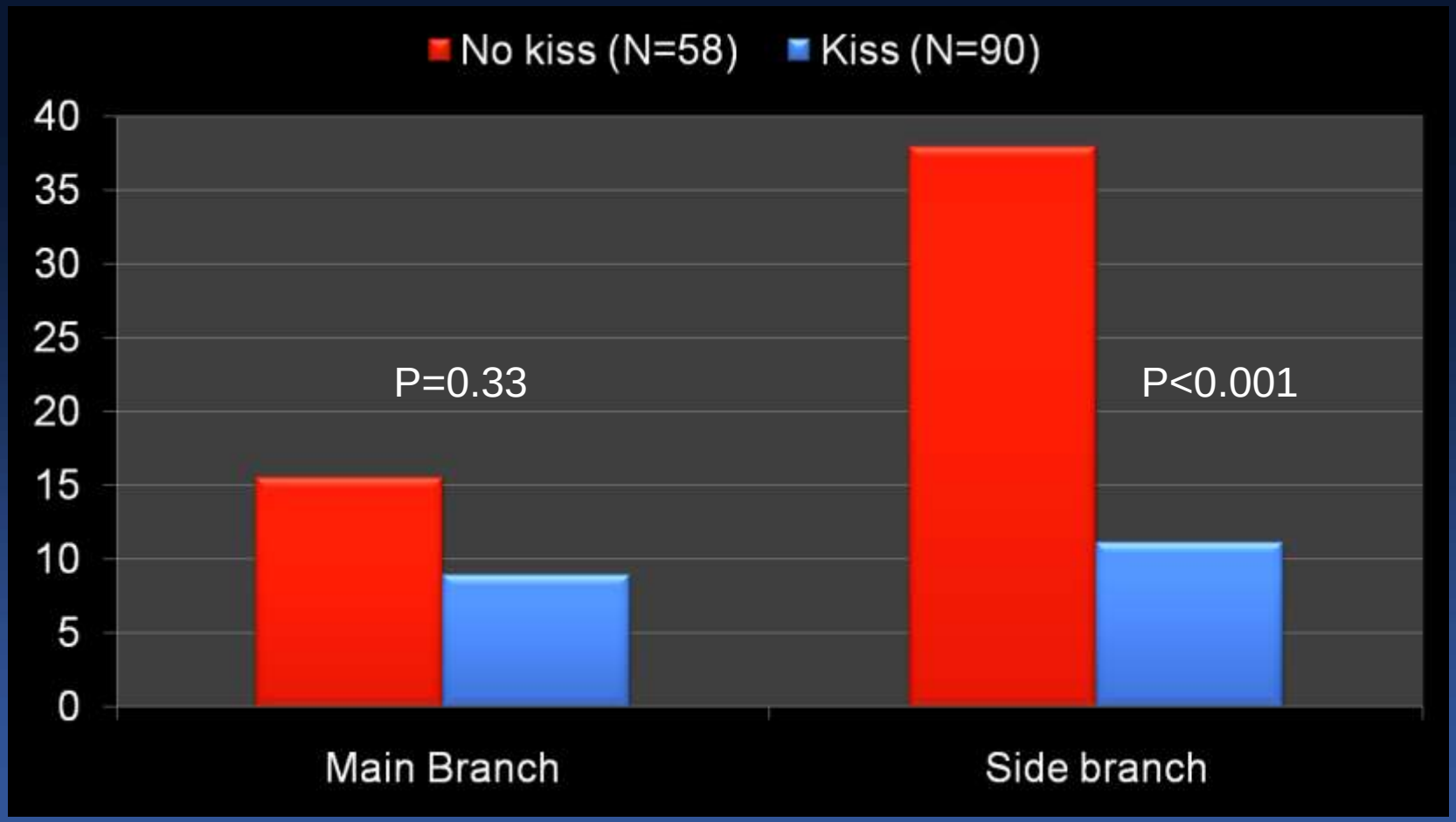
Biological Efficacy of DES
SEA-SIDE RCT

	Cypher (N=75)	Xience V (N=75)	P
Any events	7 (9%)	9 (12%)	0.60
Cardiac death	1 (1%0	1 (1%)	0.56
Peri-MI	1 (1%)	3 (4%)	0.31
Spont-MI	1 (1%)	3 (4%)	0.31
TVF	5 (7%)	5 (7%)	1.00
Angiographic failure	6 (8%)	5 (7%)	0.75
Associated with MACE	5 (7%)	5 (7%)	1.00
Detected but, not treated	1 (1%)	0	0.32

Burzotta F et al. J Am Coll Cardiol Intv 2011;4:327

Impact of FKD after Crush

Restenosis Rate



Ge L et al. J Am Coll Cardiol 2005;46:613

Studies of Crush Stenting

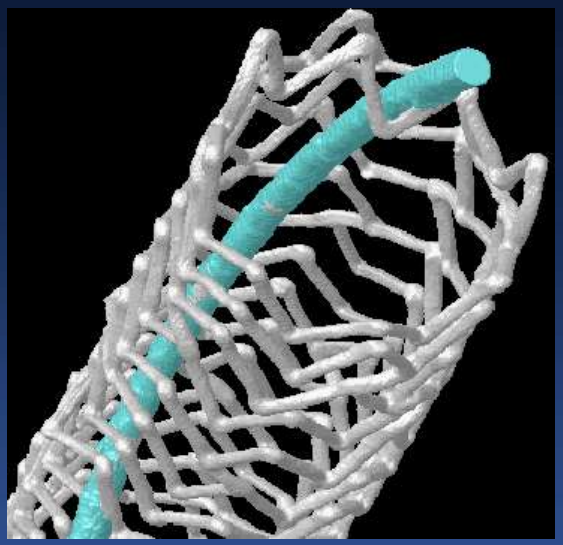
Which (who) is a major contributor of very high success rate of FKB ?

Author	No.	Type	FKB	IVUS	MACE	ST
Ge L et al [1]	181	Classic	64%		26.5% (9M)	2.8%
Colombo A et al [2] (CACTUS)	177	Classic	92%		15.8% (6M)	1.7%
Galassi AR et al [3]	199	Mini-crush	88%		20.6%(25M)	1.0%
Moussa I et al [4]	120	Classic	88%	< 10%	13.0% (6M)	1.7%
HS David et al [5] (BBC)	169	Classic	72%		15.2% (9M)	-
Erglis A et al [6] (NORDIC2)	209	Classic	85%		4.3% (6M)	-
Chue CD et al [7]	100	Classic	75%		28% (3Y)	-

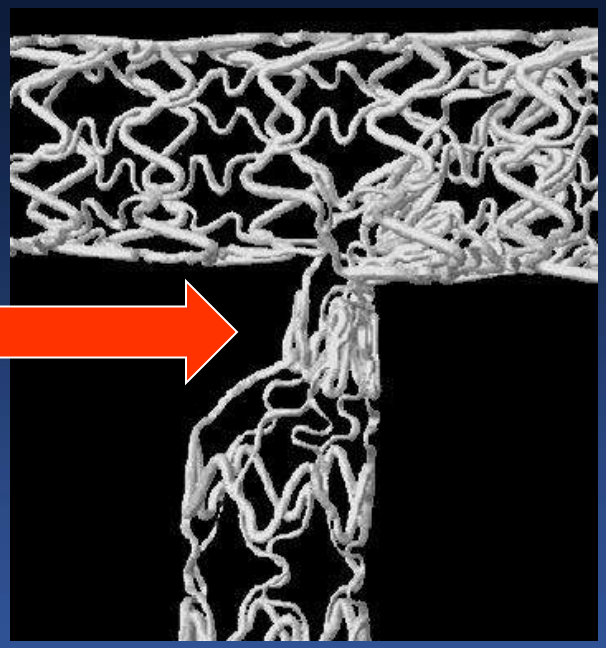
1. J Am Coll Cardiol 2005;46:613
2. Circulation. 2009;119:71
3. J Am Coll Cardiol Intv 2009;2:185
4. Am J Cardiol 2006;97:1317
5. Circulation. 2010;121:1235
6. Circ Cardiovasc Intervent. 2009;2:27
7. Cath Cardiovasc Interv 2010;75:605

Why does this happen ?
Technique, stent, wire, balloon ?

SB wire pass outside of stent

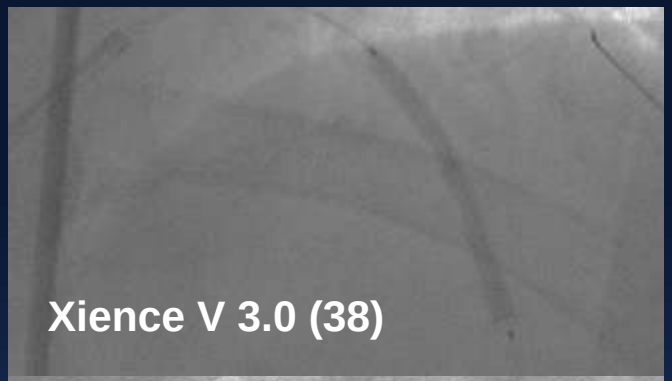


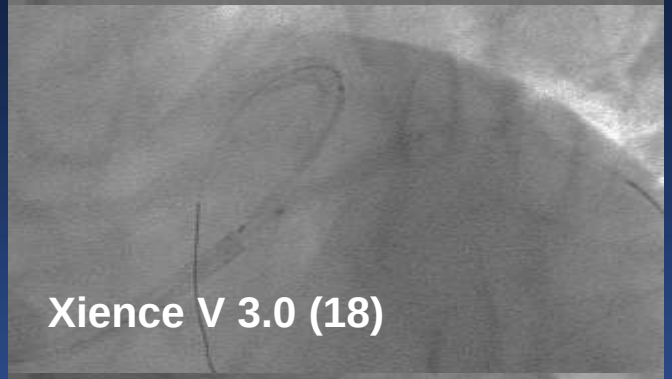
SB Balloon



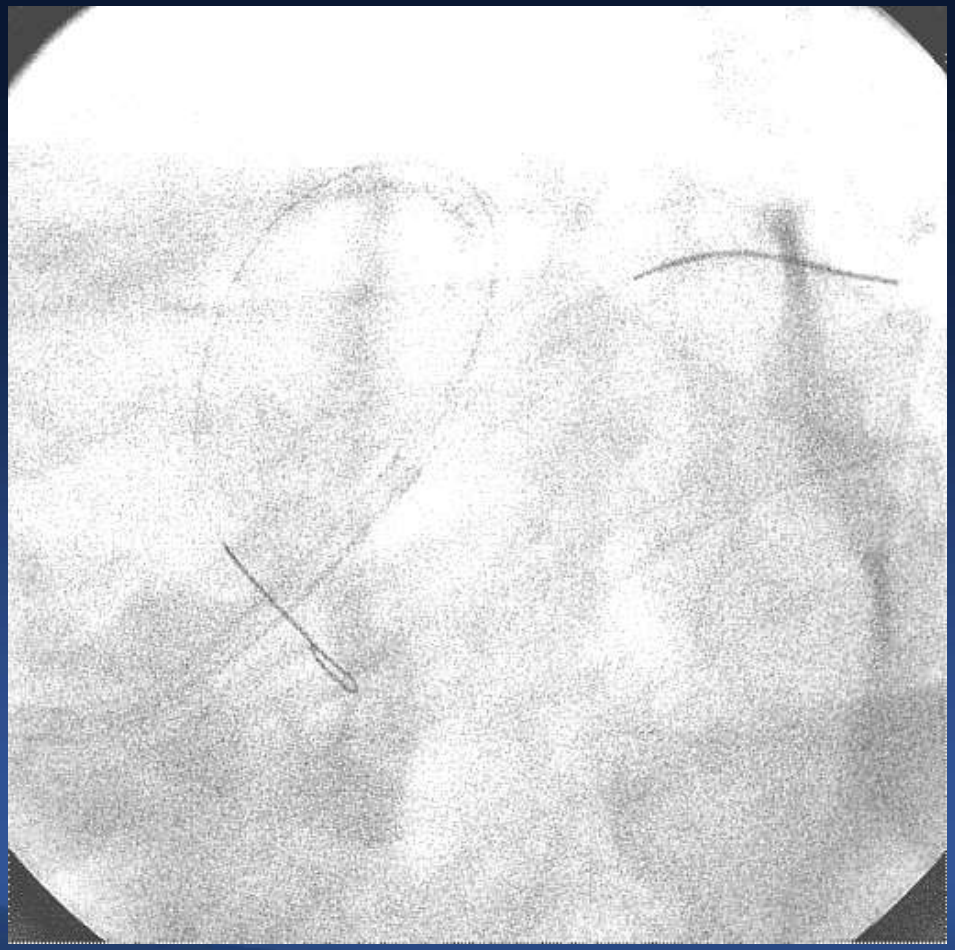
Courtesy of Ormiston J in TCT 2012

Crush for LAD Bifurcation

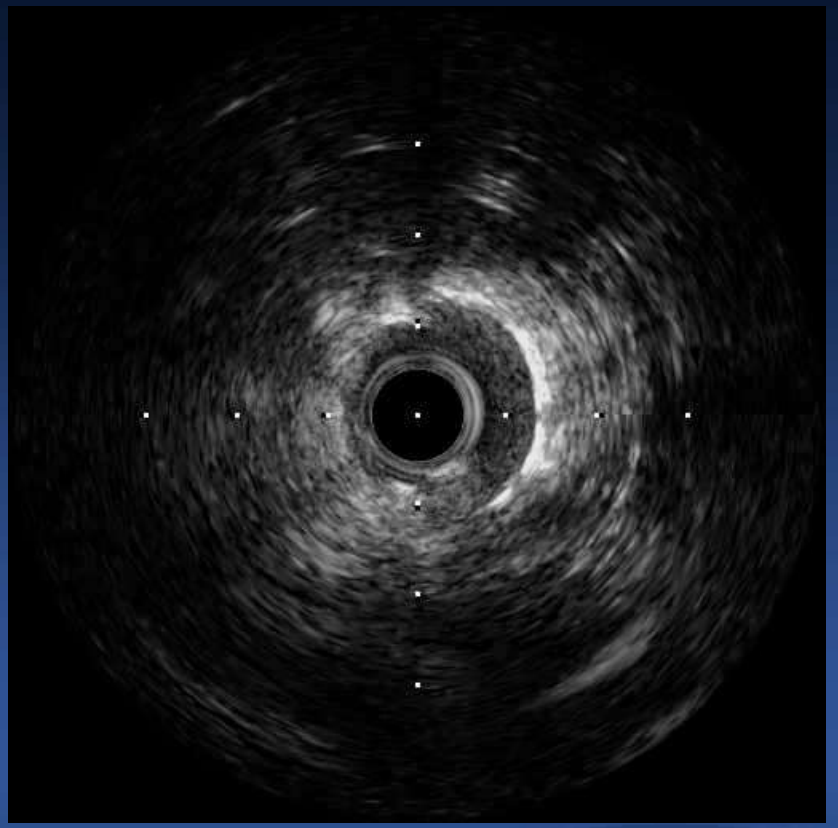




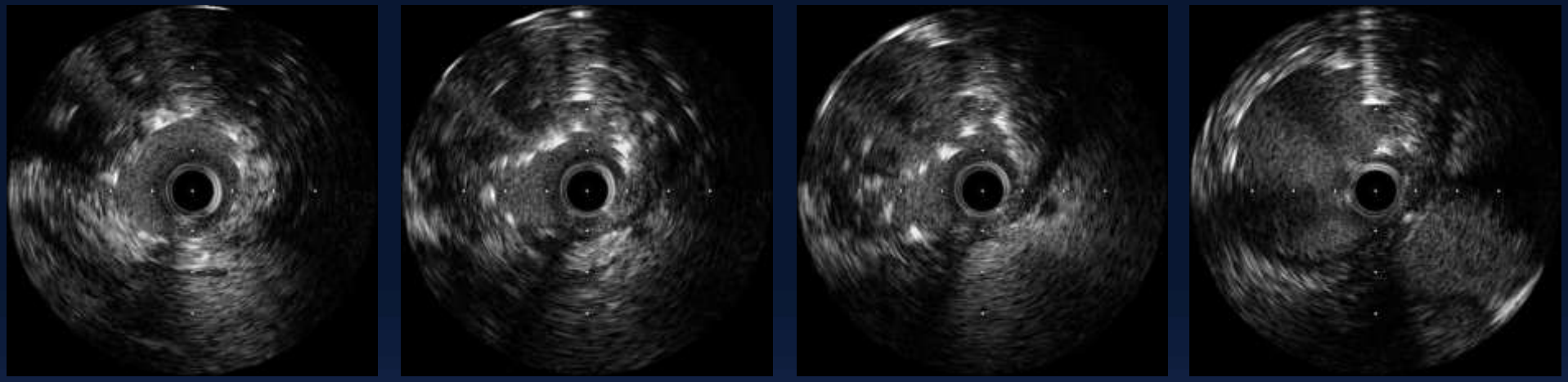
- The recrossed SB wire was placed outside of MB stent.
- Therefore, SB stent was not completely crushed but was tunneled like the morphology of kissing stenting.



IVUS from SB



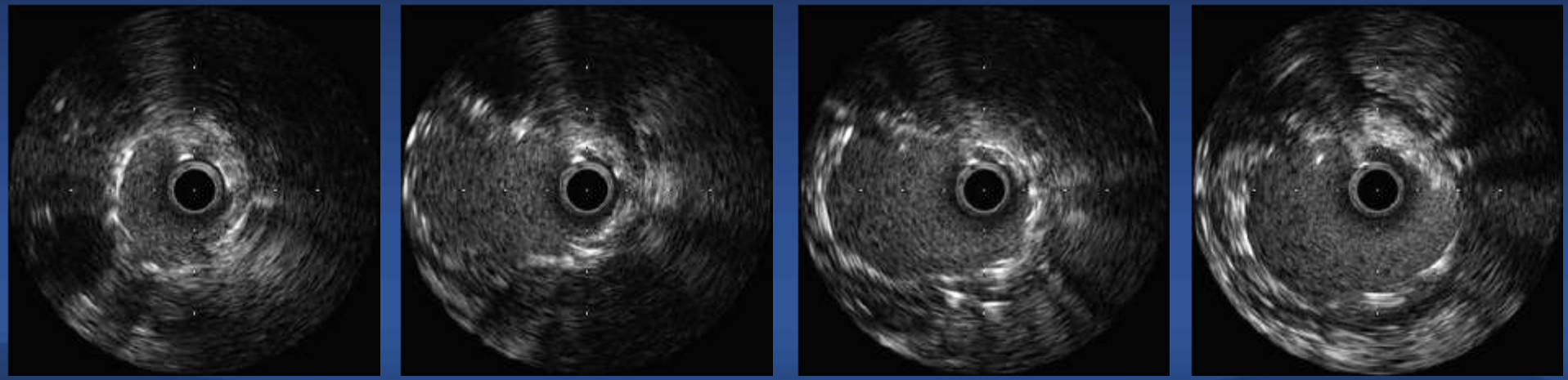
Post stent



distal

proximal

Final after repeated final kissing inflation



What the matter is …

- Technique
- Device
- Operator's smart decision-making and experienced hands