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Bifurcation Interventions 2016:What we should really know

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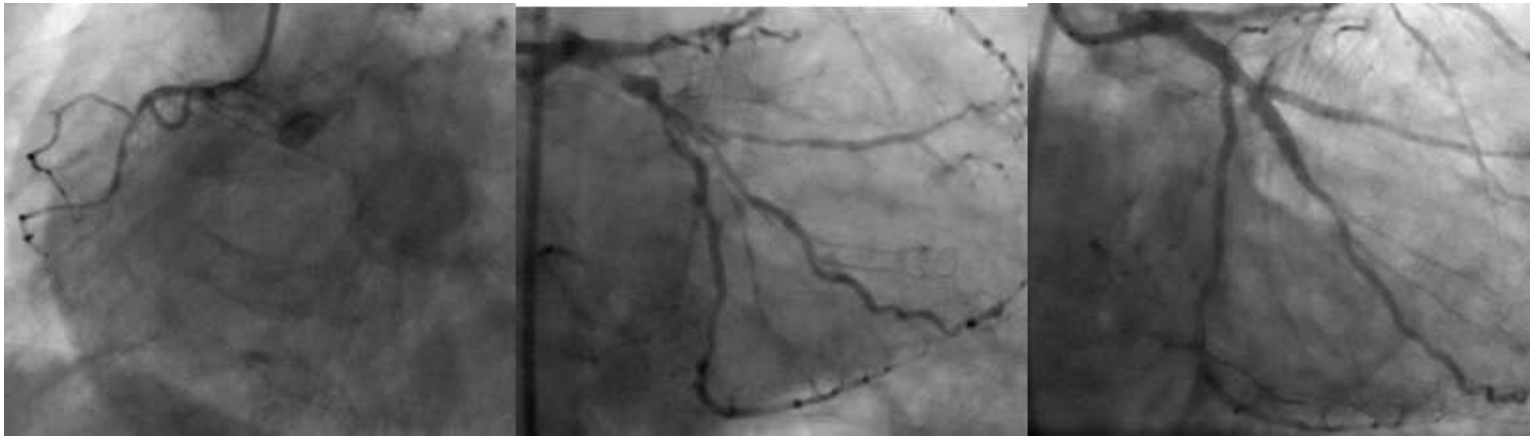
Definition of Biburcation Lesion

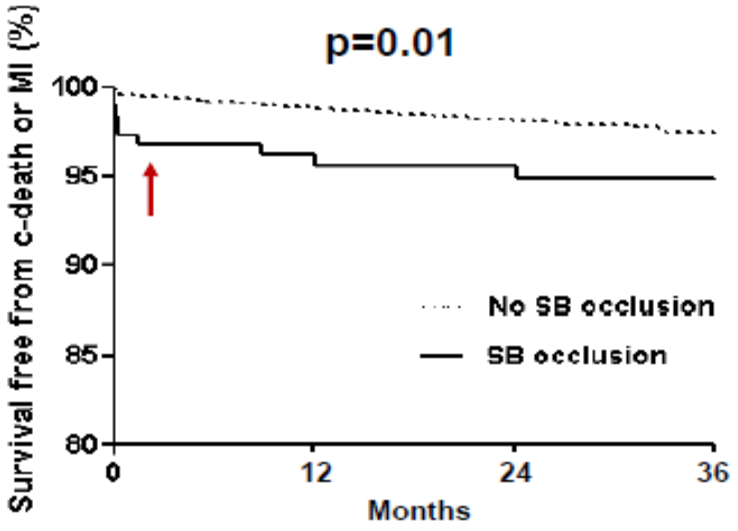
- **"A coronary artery narrowing occurring adjacent to, and/or involving, the origin of a significant side branch".**
- **A significant SB is a branch that you don't want to loose in the global context of a particular patient**

Y. Louvard Catheter Cardiovasc Interv. 2008 Feb 1;71:175-83



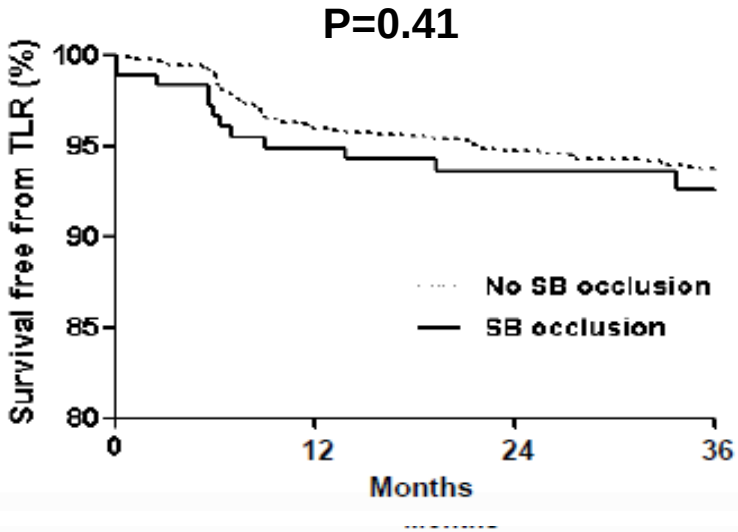
Clinical Impact of SB Occlusion

Cardiac Death / MI



SB occlusion	187	163	128	83
No SB occlusion	2040	1851	1542	991

TLR



SB occlusion	187	156	121	80
No SB occlusion	2040	1790	1478	950

Hahn JK, Gwon HC m J Am Coll Cardiol 2013

Independent predictors of SB occlusion

SB occlusion after MV stenting was defined as TIMI < 3 (N=187 , 8.4%)

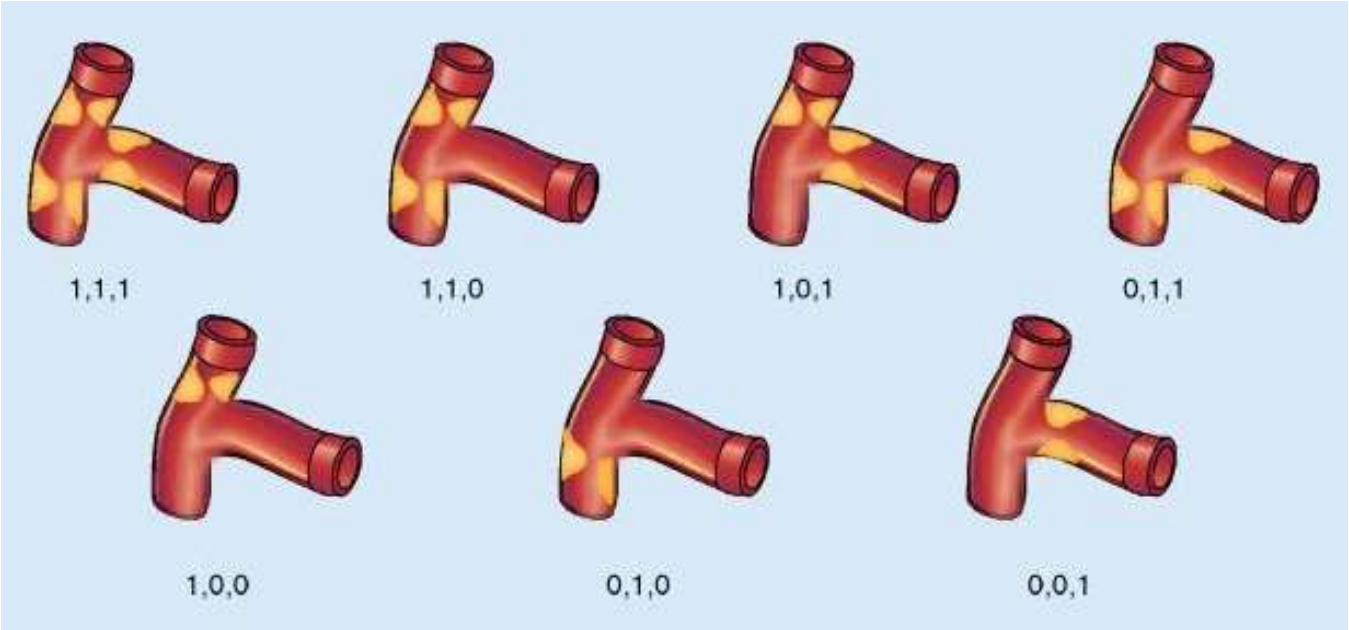
Variable	Odds ratio (95% CI)	P Value
Pre-procedural SB DS ≥ 50%	2.34 (1.59-3.43)	< 0.001
Pre-procedural prox MV DS ≥ 50%	2.34 (1.57-3.60)	0.03
SB lesion length (by 1 mm)	1.03 (1.003-1.06)	< 0.001
Acute Coronary Syndrome	1.53 (1.06-2.19)	0.02
LM lesions (vs non-LM lesions)	0.34 (0.18-0.72)	0.005

Non predictors : jailed wire technique, SB predilatation , IVUS guidance

Hahn JK, Gwon HC m J Am Coll Cardiol 2013

Proposed classification of Bifurcation Lesions

Medina Classification



Excellent and simple for defining plaque distribution at BL, but not for strategy selection because :

- **Lack of lesions Characteristics**
- **SB size and lesion length**
- **Angle**
- **Calcification/tortuosity/ thrombus**

Distal Left Main Bifurcation Lesion

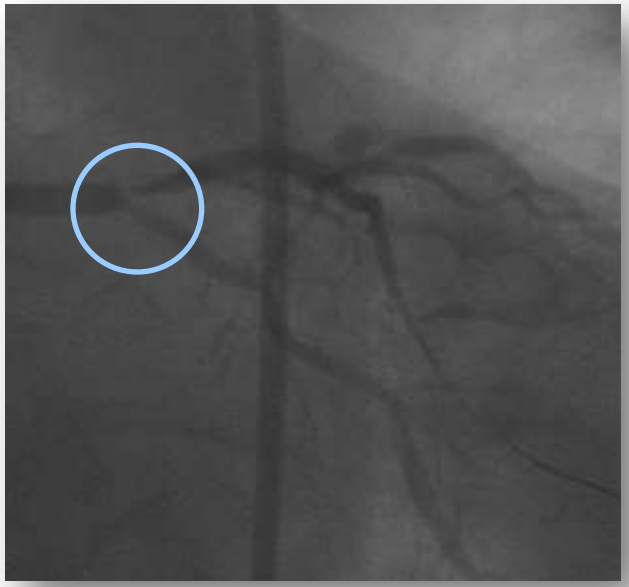
Medina 1,1,1

Medina 1,1,1

- **Can be enrtolled in the same Bifurcation Study ?**
- **Clinical Outcome will be the same ?**

Bifurcation Lesions Location

Medina 0.1.1

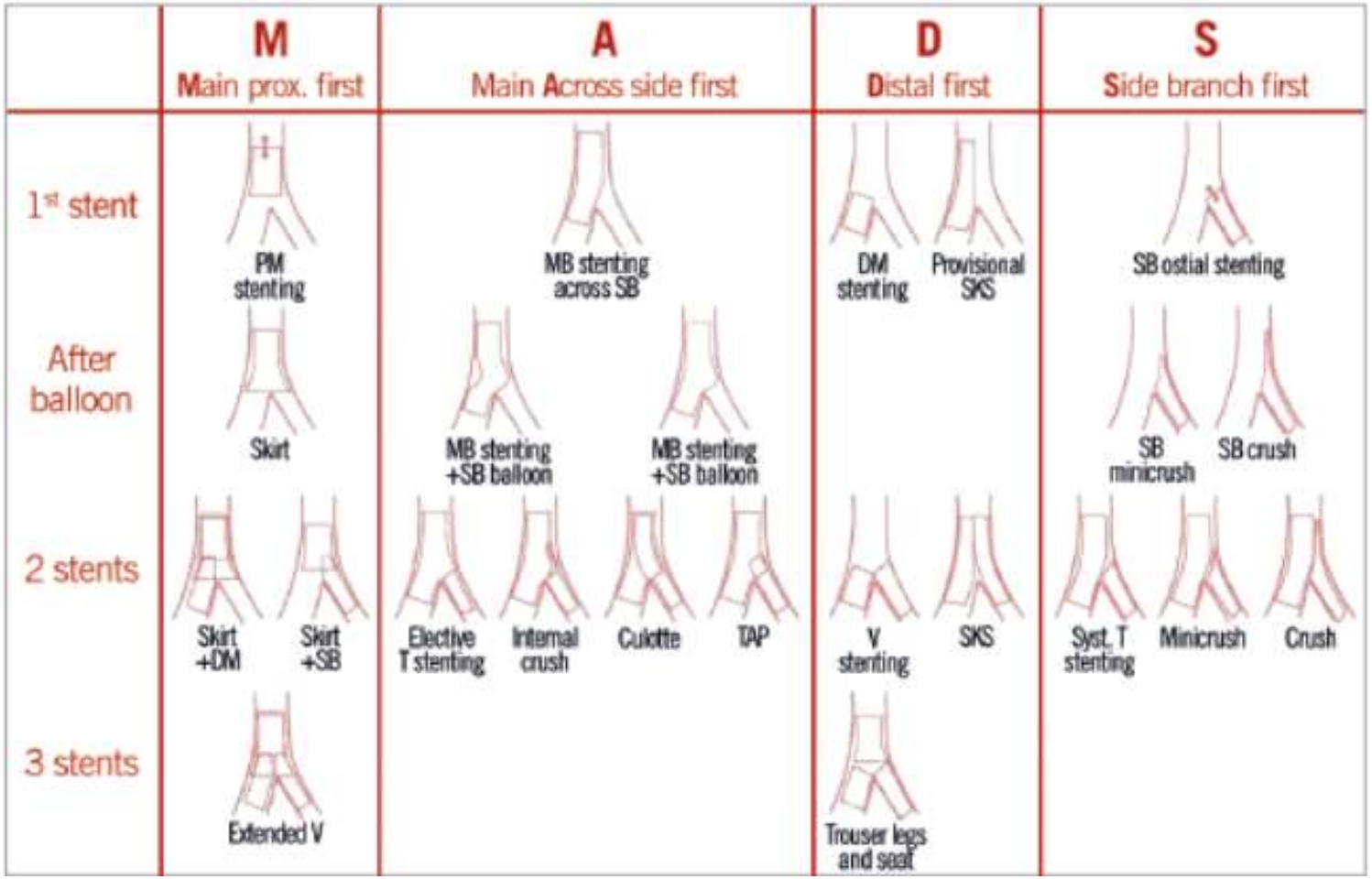


Medina 0.1.1

Medina 0.1.1

Different Clinical Impact …

The MADS classification of bifurcation stenting techniques



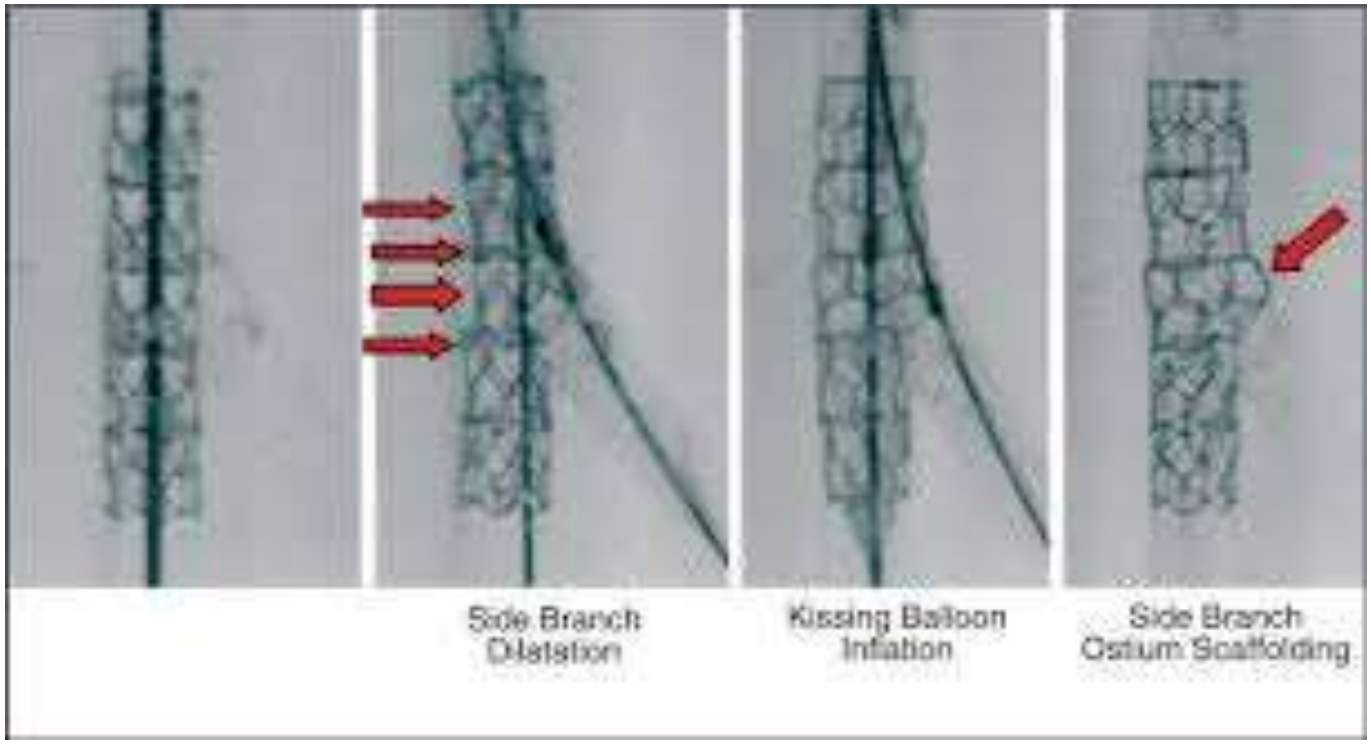
Eurointervention, 2014;10:545-560

Bifurcation Treatment principles

1. Limit the number of stents (carena)
2. Good apposition
3. Respect the anatomy and function

Y Louvard

Provisional T Stenting Technique



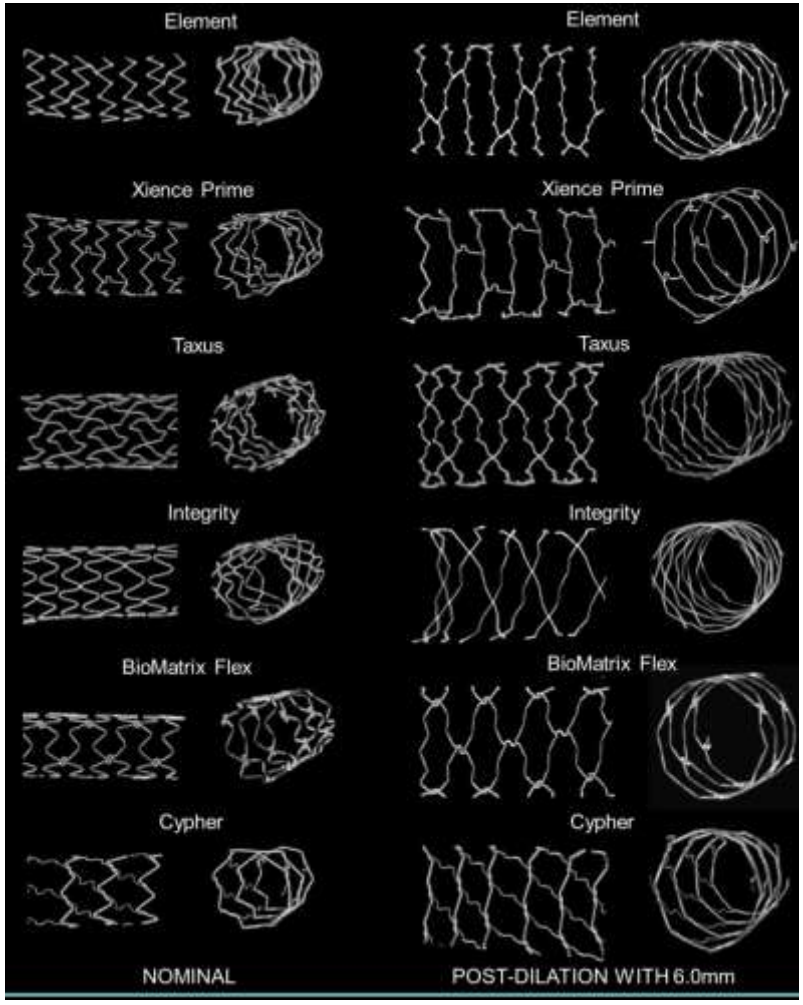
DES Design and Post-dilatation expansion designs

	Element	XIENCE	TAXUS	Integrity	BioMatrix	CYPHER
2.25	Very small workhorse (2 cells) *max exp: 3.0 mm*	Medium workhorse (6 crowns, 3 cells) *max expansion: 4.4 mm*	Small workhorse (6 crowns, 2 cells) *max expansion: 3.4 mm*	Small workhorse (7 crowns, 2 cells*) *max expansion: 4.9 mm* **1.5 cell in Resolute*	Medium workhorse (6 crowns, 2 cells) max expansion: 4.6 mm	Medium workhorse (6 crowns, 6 cells) max expansion: 4.7 mm
2.50	Small workhorse (8 crowns, 2 cells) *max expansion: 3.8 mm*					
2.75			Medium workhorse (9 crowns, 3 cells) *max expansion: 4.8 mm*			
3.00	Medium workhorse (8 crowns, 2 cells) *max expansion: 4.4 mm*			Medium workhorse (10 crowns, 2 cells) *max expansion: 5.4 mm*		
3.50		Large workhorse: (9 crowns, 3 cells) *max expansion: 5.6 mm*			Large workhorse (9 crowns, 3 cells) max expansion: 5.9 mm	Large workhorse (7 crowns, 7 cells) max expansion: 5.8 mm
4.00	Large workhorse (10 crowns, 2 cells) *max expansion: 5.7 mm*		Large workhorse (9 crowns, 3 cells) *max expansion: 6.0 mm*			
4.50						

Stent MLD (inner lumen) achieved after stepwise overexpansion and 2x final post-dilatation

Foin et al, Eurointervention 2013;8:1315-25

Stent Deformation with overexpansion



Stent deformation with over-expansion is a common problem in treating bifurcation lesions affecting both the side branch origin and the proximal main vessel (Markedly exaggerated in LM lesions)

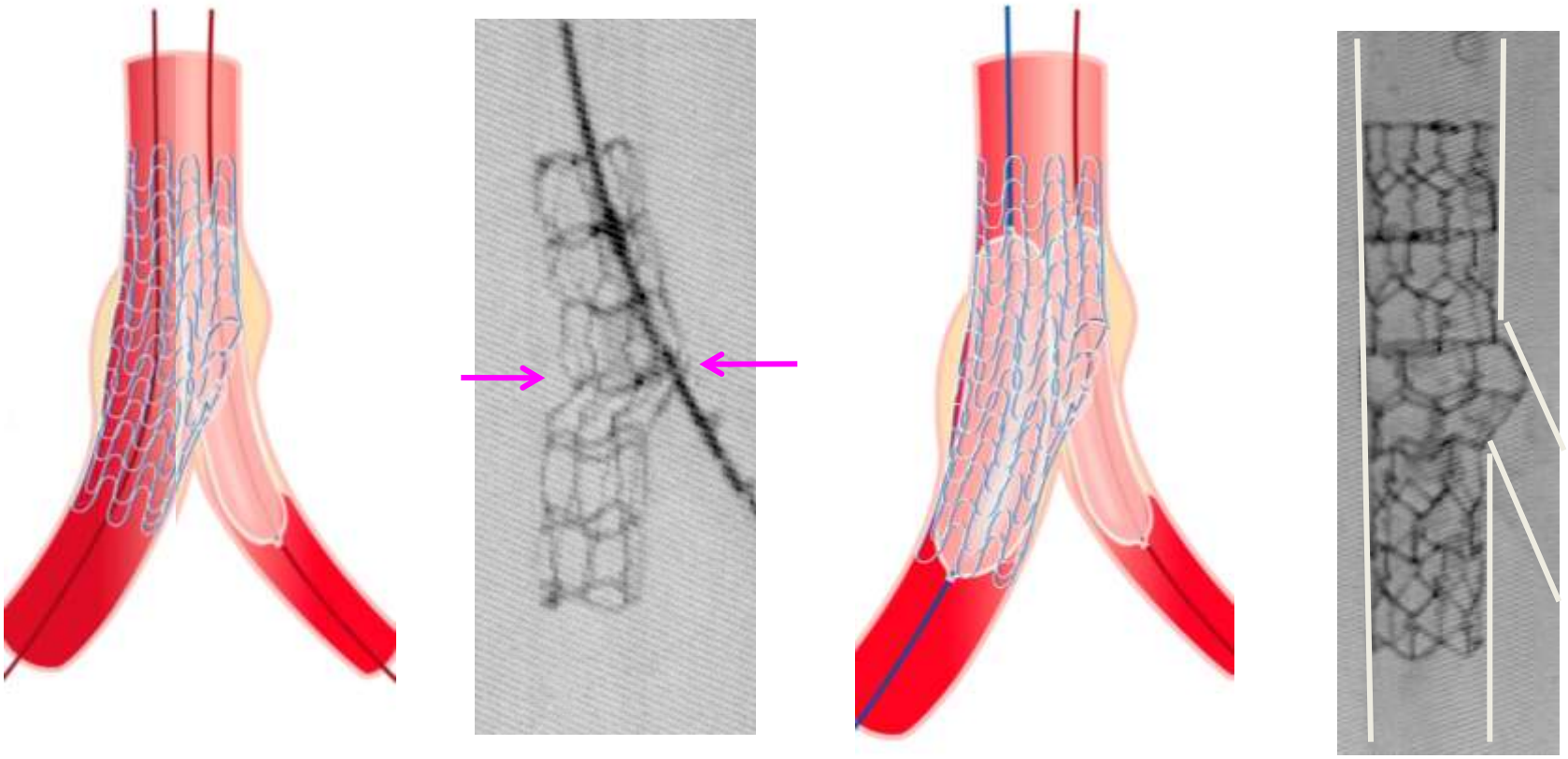
N. Foin , EuroInterv

Stent Deformation with SB dilatation or KB

Stent designs is important in stent selection for bifurcation lesions

N. Foin , EuroInterv

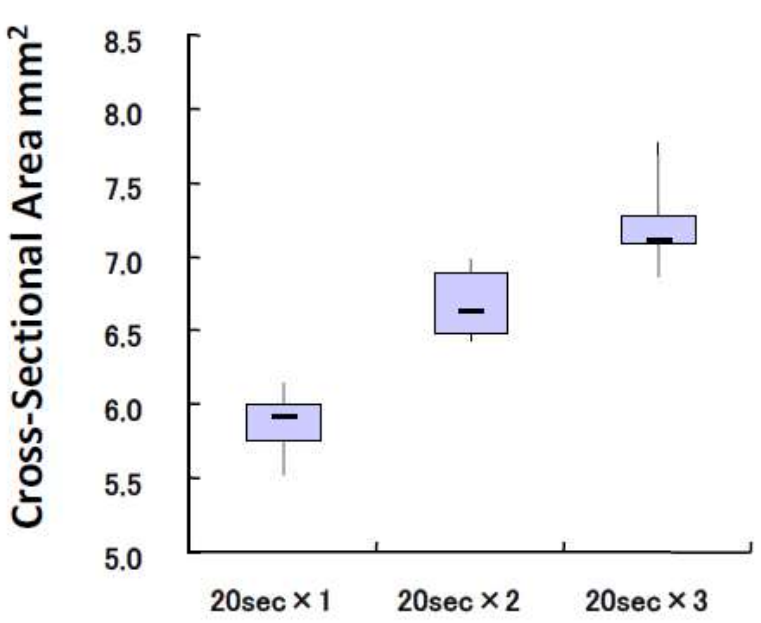
Final Kissing Balloon Inflation

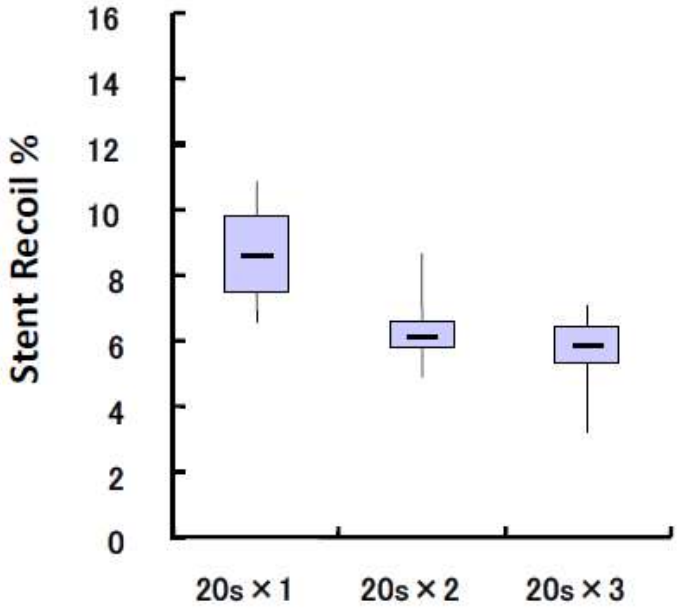


Kissing Balloon : When required do it appropriately !

Final Kissing Balloon Inflation

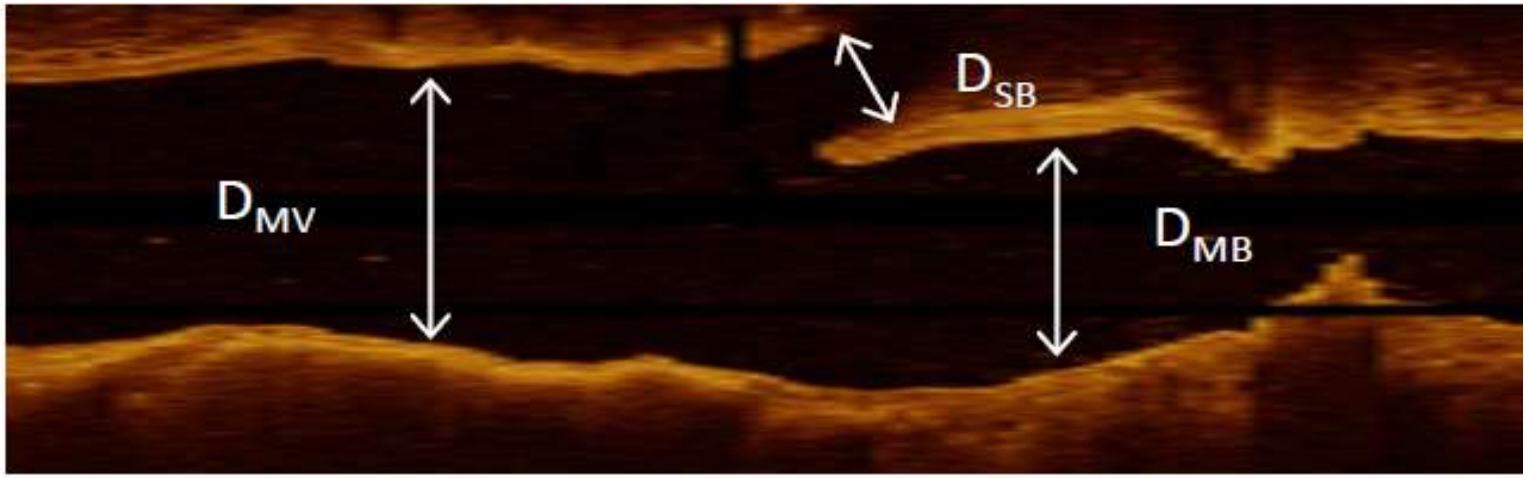
20 seconds of inflation is not enough

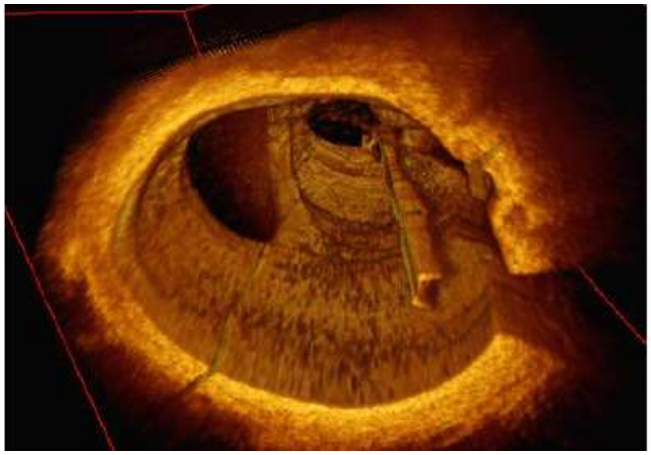




Hikichi et al. EBC 2009

Proximal Optimization Technique (POT) :Anatomy of Bifurcation





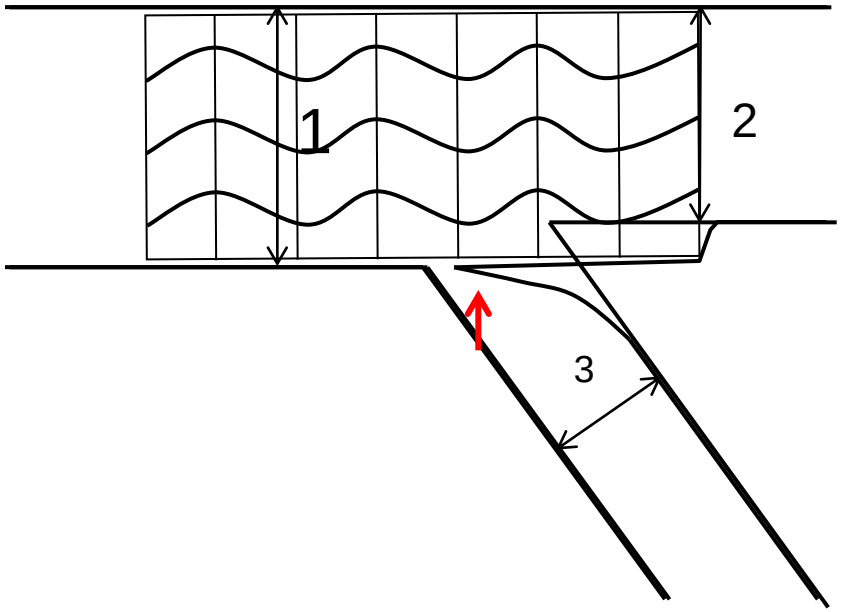
	Principle	Relation	*Ratio Dm/Dd for D_{d1}~ D_{d2}*
Murray's law	Minimum Work	$D_m3 = D_{d1}3 + D_{d2}3$	*1.26*
HK: Huo-Kassab	Minimum Energy	$D_m7/3 = D_{d1}7/3 + D_{d2}7/3$	*1.35*
Flow conservation	$Q_m = Q_{d1} + Q_{d2}$	$D_m2 = D_{d1}2 + D_{d2}2$	*1.4*
Finet	Measurement	$D_m = \underline{0.678}\ (D_{d1} + D_{d2})$	*1.36*

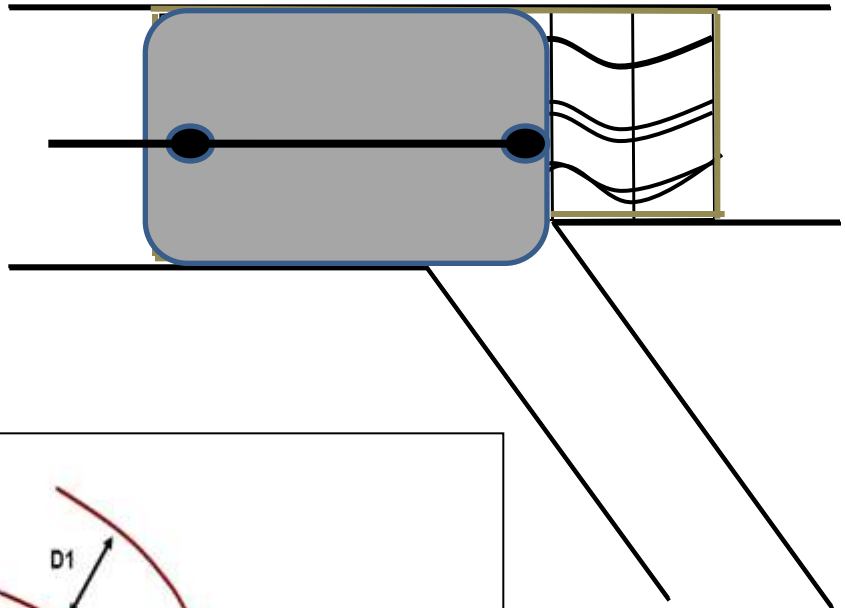
The larger the SB, the larger the change in MV diameter throughout the bifurcation

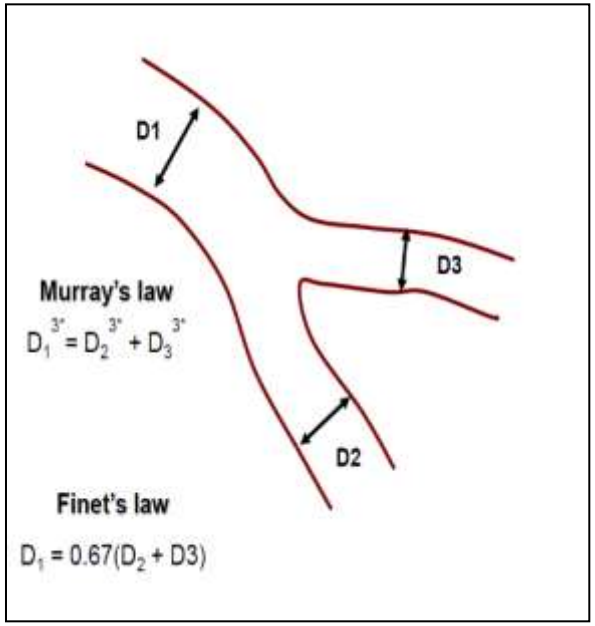
Courtesy of N Foin

Provisional technique

POT



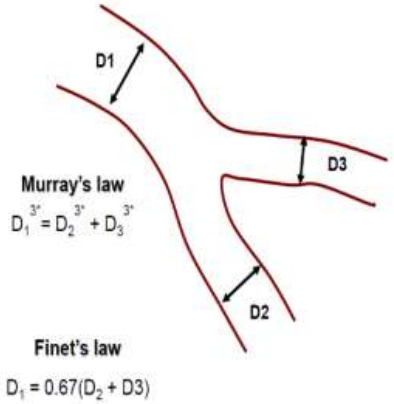


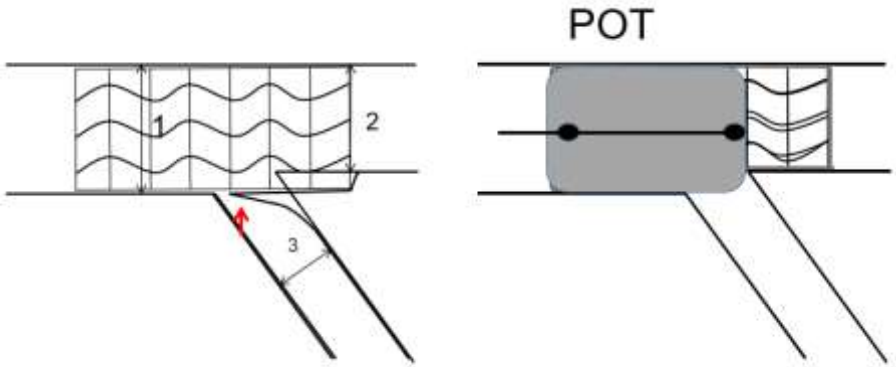


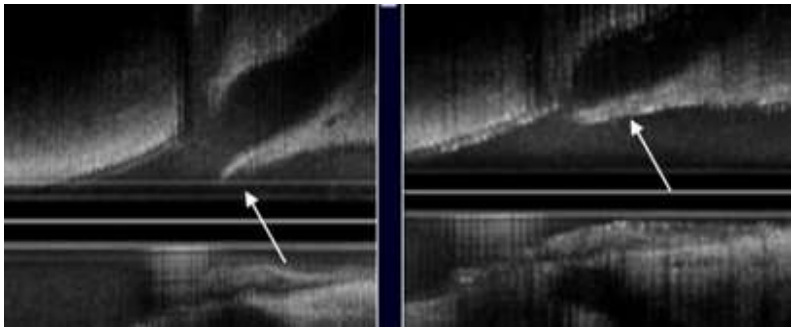
Proximal Optimization Technique (POT)

Why the POT ?

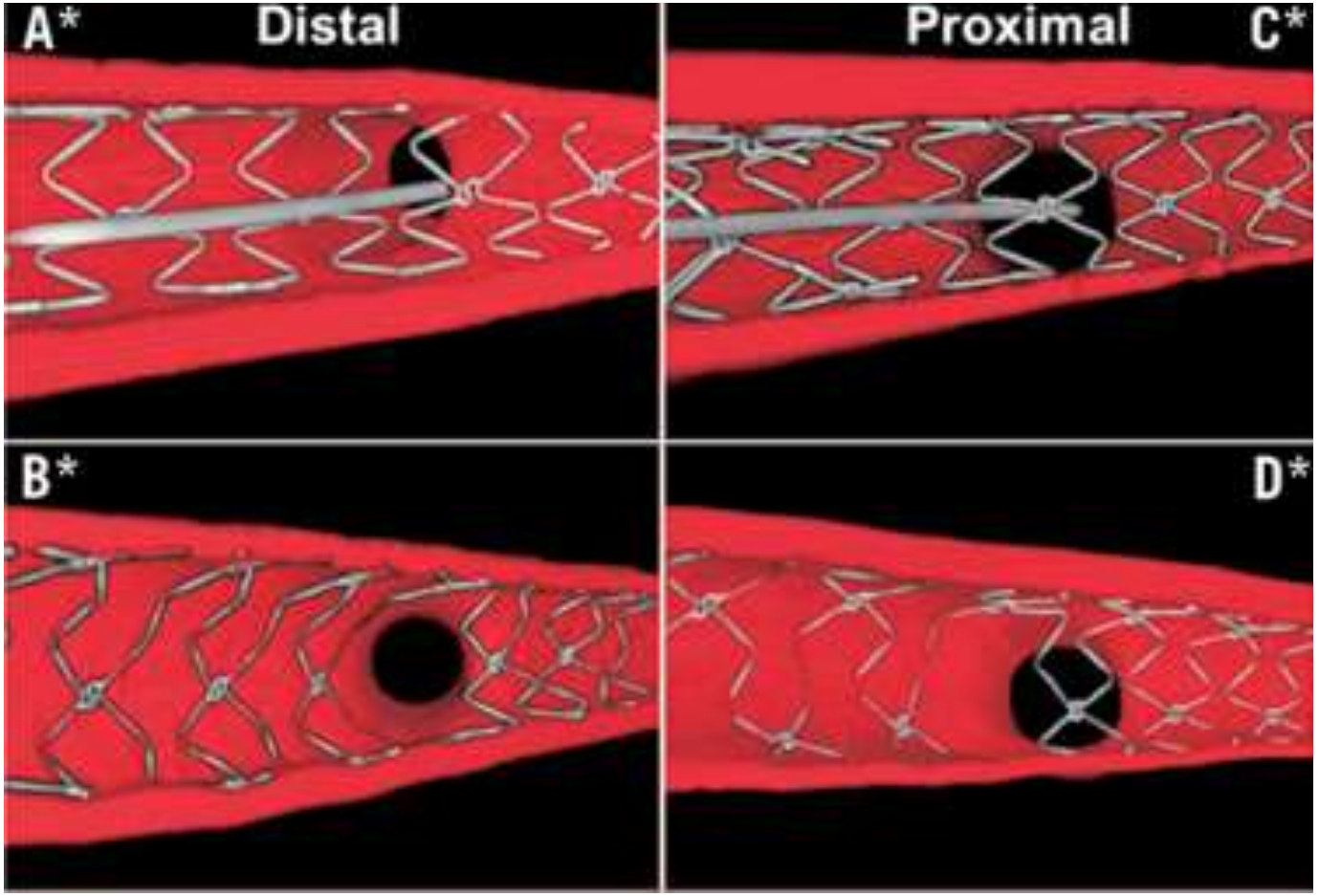
- **To adapt the stent to the anatomy of the bifurcation (different diameters across the bifurcation)**
- **Recrossing after POT becomes easy and safe (no risk of recrossing outside the undeployed proximal part of the stent)**







SB recrossing for FKB



Eurointervention, 2014;10:545-560

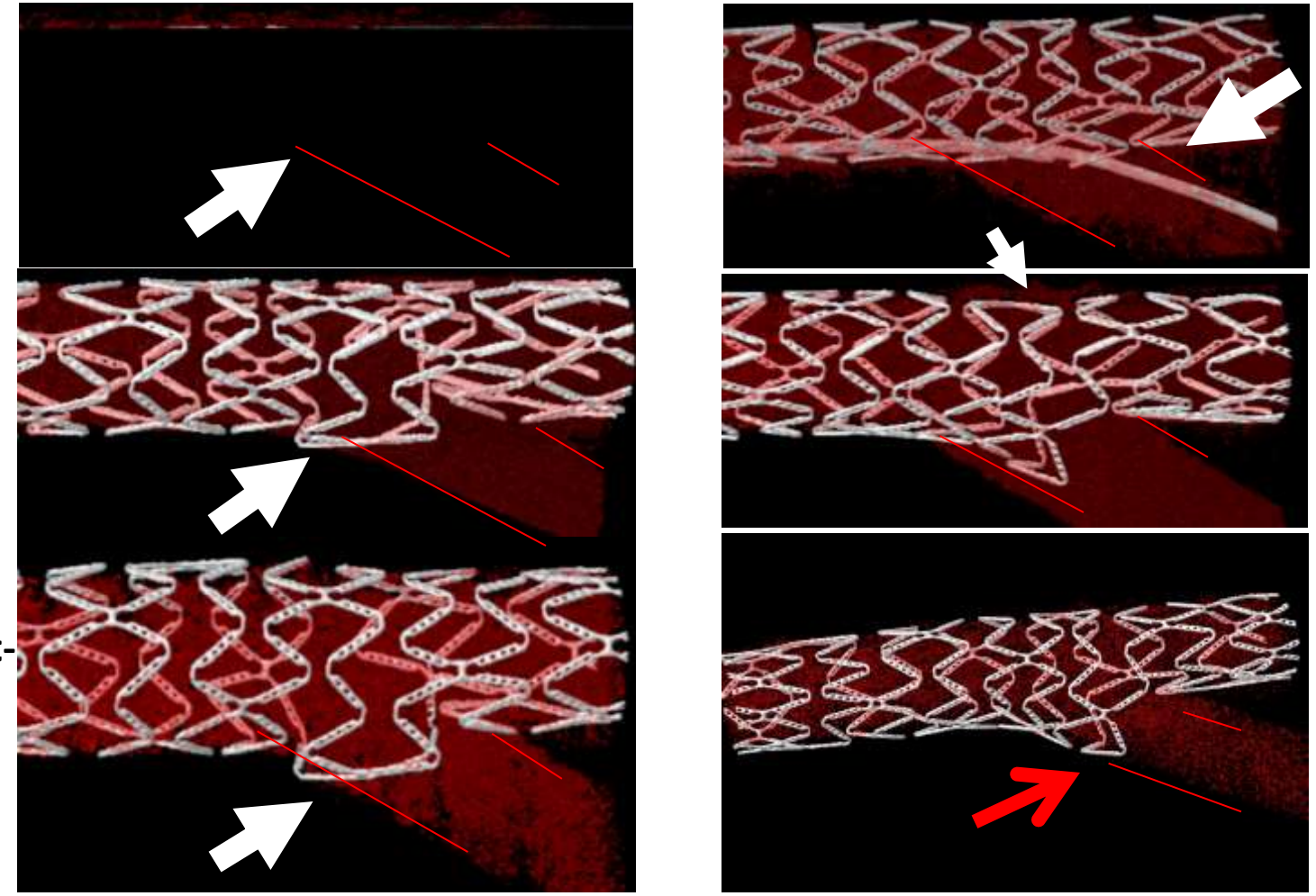
SB recrossing for FKB

Proximal cross

Distal cross

Single balloon SB dilatation

Kissing balloon post-dilatation



J. Ormiston

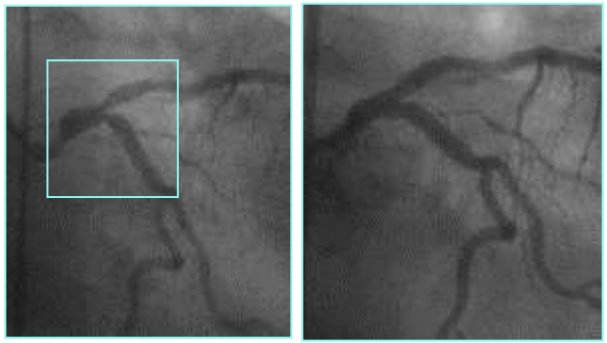
Two stents as intention to treat

Bifurcation lesion with no disease proximal to the bifurcation or very short left main

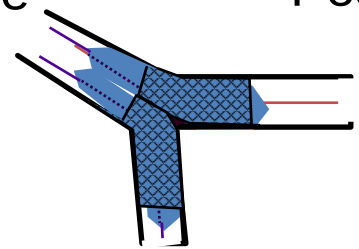
Bifurcation lesion with MB disease extending proximal to the bifurcation and SB which has origin with about 90° angle

Bifurcation lesion with MB disease extending proximal to bifurcation and SB which has origin with < 70° angle

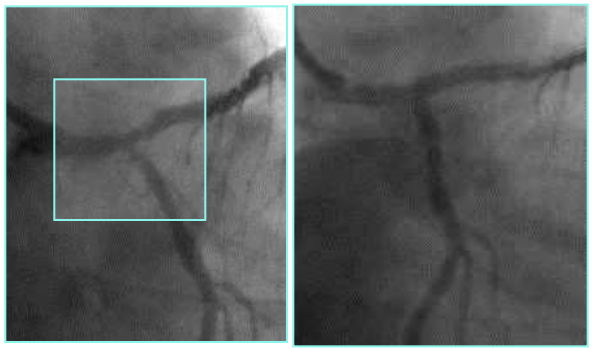
V-Stent



Pre Post



T/TAP-Stent



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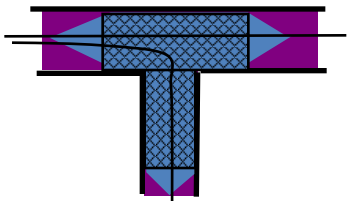
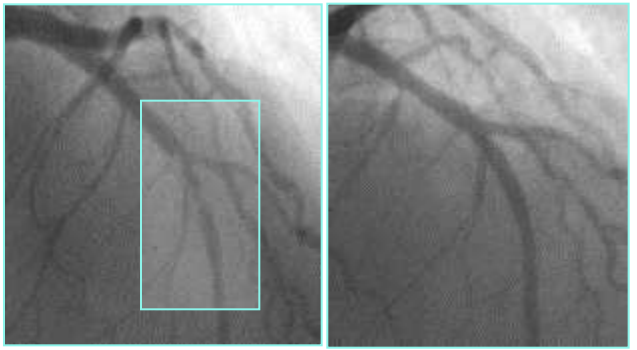


Mini Crush/DK Crush /Culotte



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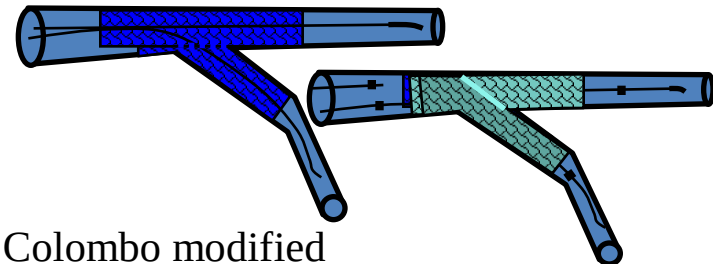
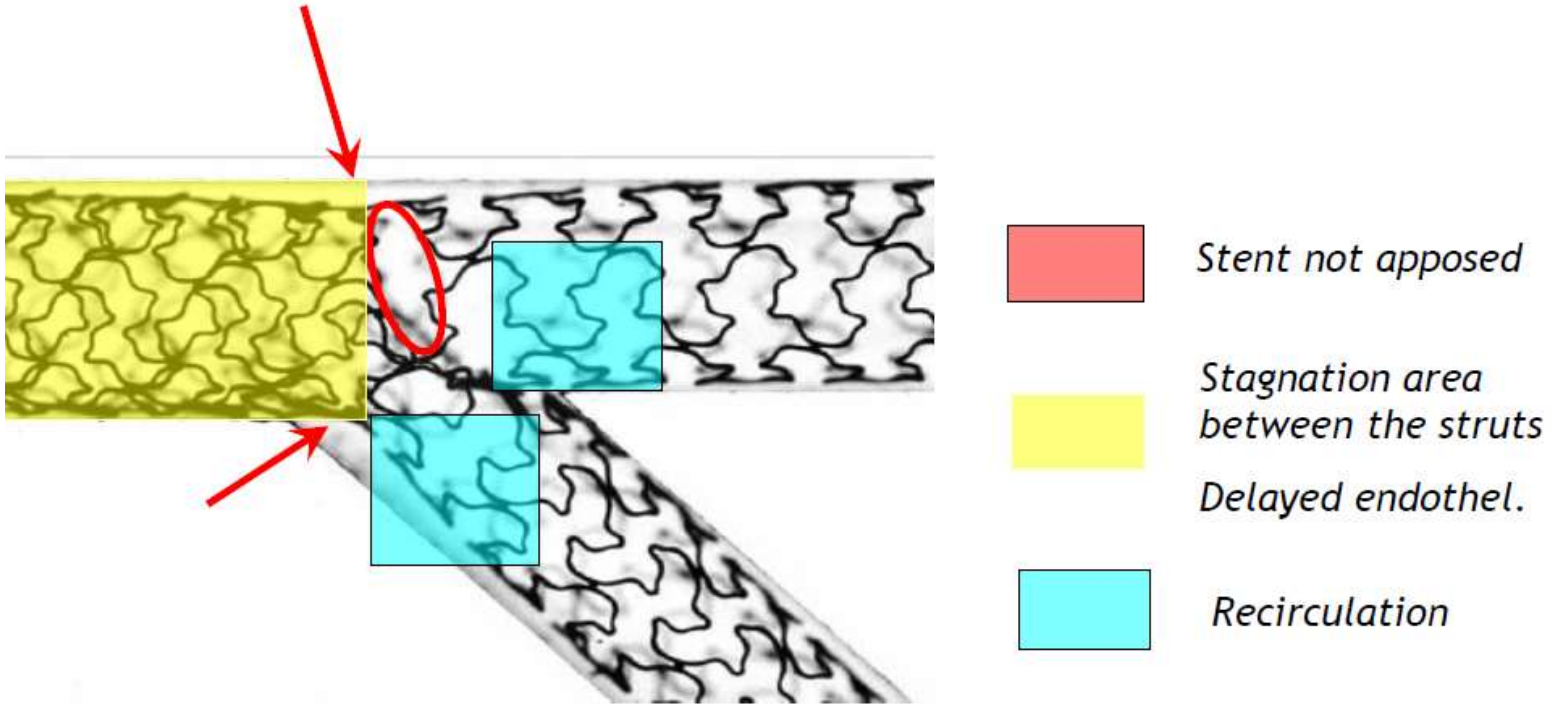


Courtesy of A. Colombo modified

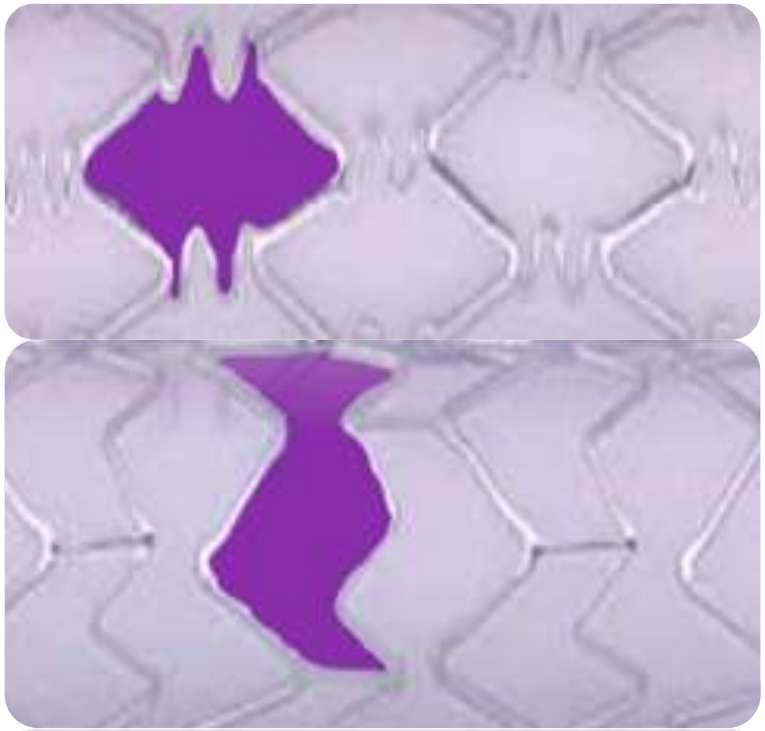
Limitations of Culotte Technique

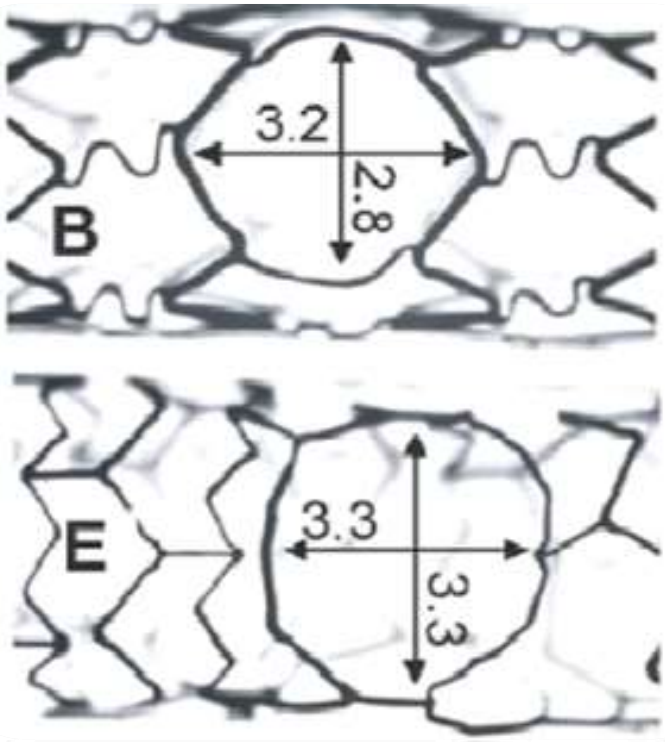


Courtesy of John Ormiston

Stent design is important in Culotte Tehnique

Strut width and Side Branch Accesss





Courtesy of Dr. Ormiston

DK Crush (Double Kissing Crush Technique)

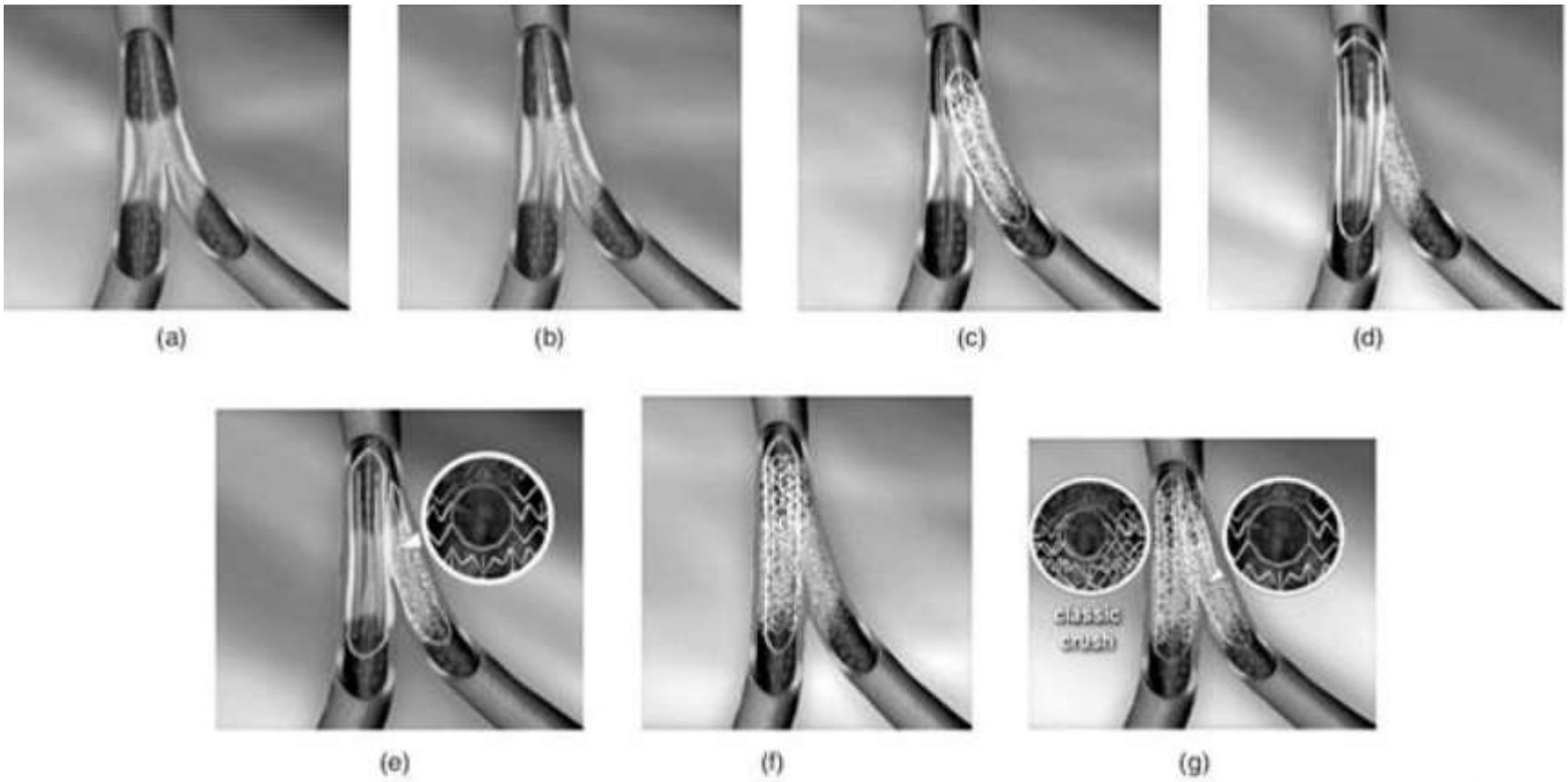
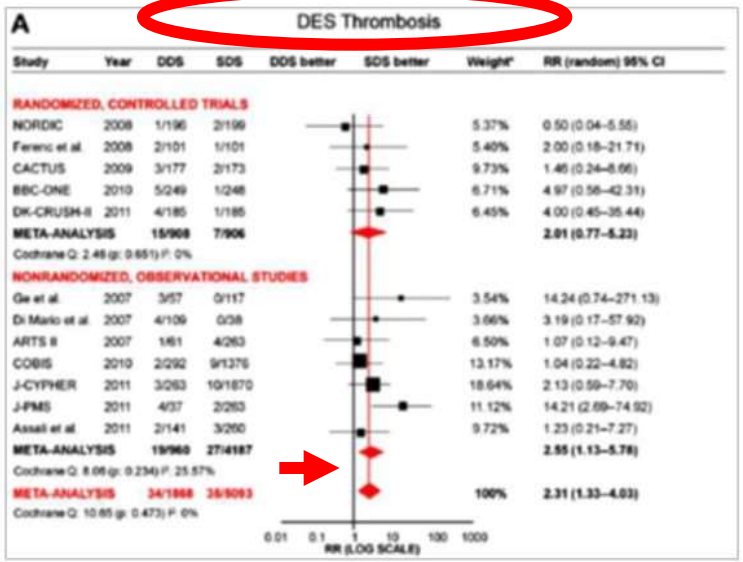
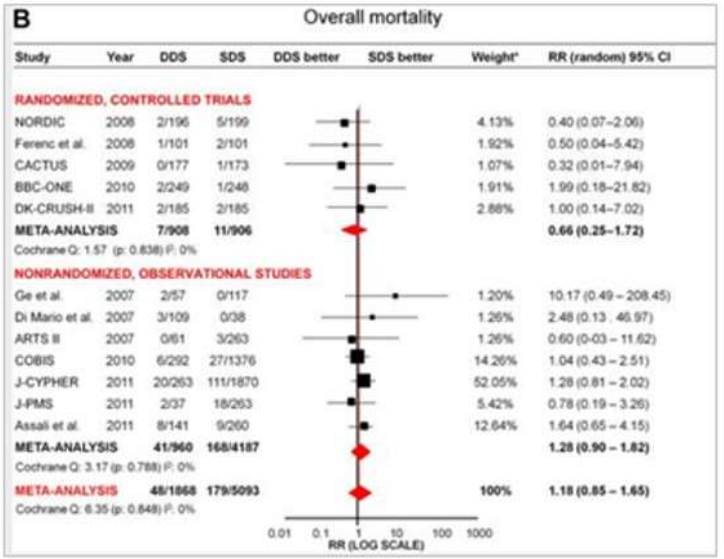


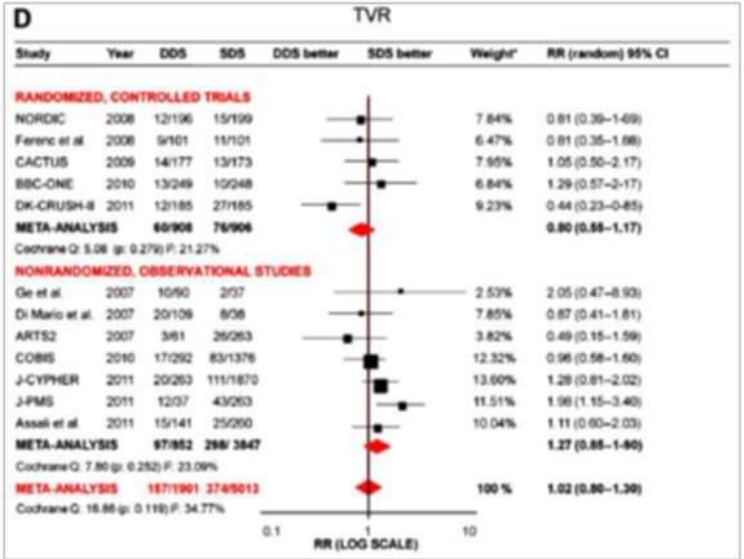
Figure 4. Double kissing (DK) crush technique. Two wires are inserted into two vessels (a). One stent and balloon are advanced into side branch and main vessel simultaneously (b). Inflated side stent firstly (c), then the balloon in the main artery is inflated after removal of stent balloon and wire from side branch (d). First kissing balloon inflation is performed after successful rewiring to side branch (e). Stenting main vessel is underwent (f), with final kissing inflation as the final step (g). The orifice of side branch is relatively largely expanded, compared to classical crush (g).

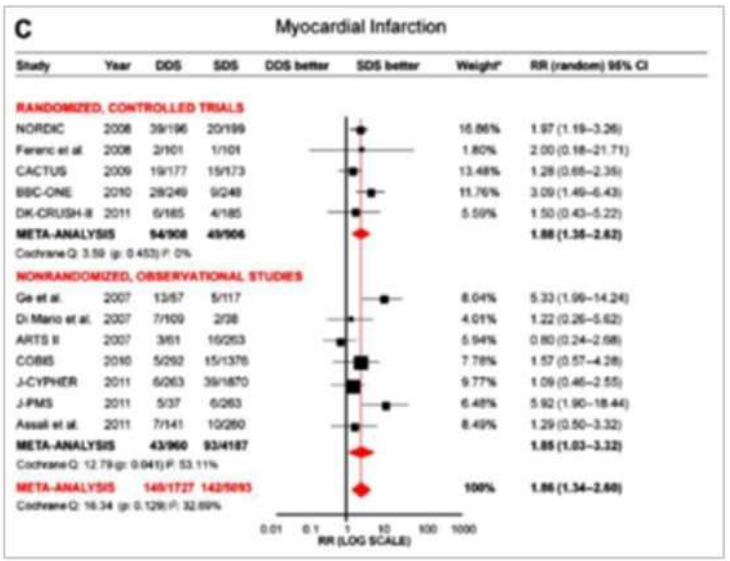
Every time you are performing complex stenting remember clinical trials on Bifurcation Inttreventions !!!

Late Thrombosis After Double Versus Single Drug-Eluting Stent in the Treatment of Coronary Bifurcations: A Meta-Analysis of Randomized and Observational Studies









M. Zimarino et al ; *Am Coll Cardiol Intv*. 2013;6(7):687-695.

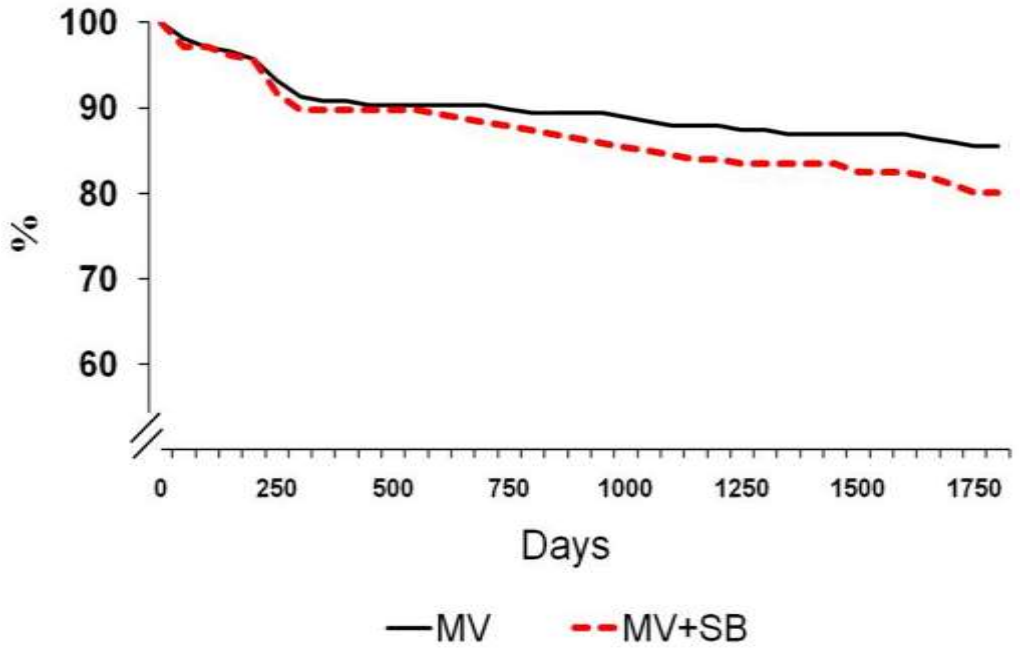
Randomized Study on Simple versus Complex Stenting of Coronary Artery Bifurcation Lesions: 5-Year Follow-up in The Nordic Bifurcation Study

Primary Endpoints at 5-year FU

	MV (n=203)	MV+SB (n=202)	P-value
Total death (%)	6.4	9.9	0.20
Cardiac death (%)	2.0	3.0	0.54
Myocardial infarction (%)	3.4	6.4	0.17
TLR (%)	11.3	15.3	0.24
TVR (%)	13.3	18.3	0.18
TVR, CABG (%)	2.0	3.5	0.38
Def. stent thromb. (%)	3.4	1.5	0.33

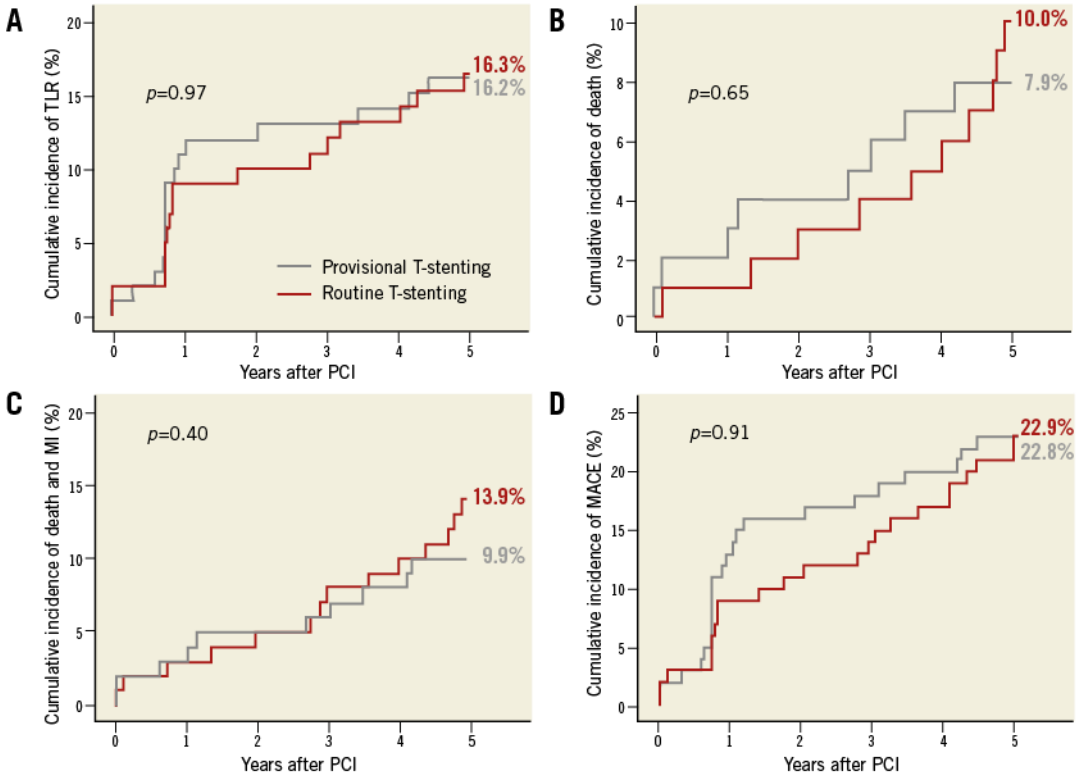
MACE Free Survival

(Cardiac Death , MI , TVR, Stent Thrombosis)

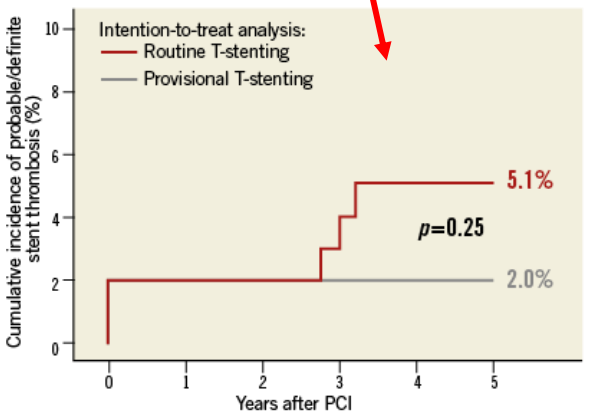


L. Thuesen et al (for the Nordic Baltic PCI Study Group)

Long-term outcomes of routine versus provisional T-stenting for de novo coronary bifurcation lesions: five-year results of the Bifurcations Bad Krozingen I study



Stent Thrombosis



M. Fenrenc et al , EuroInterv 2015, 11: 856-859

Simple and Complex Bifurcation : Definition Study

Major Criteria

1. **For LMd: SB-DS ≥70%, SB lesion ≥10 mm**
2. **For Non-LMd: SB-DS ≥90%, SB lesion ≥10 mm**

Minor Criteria

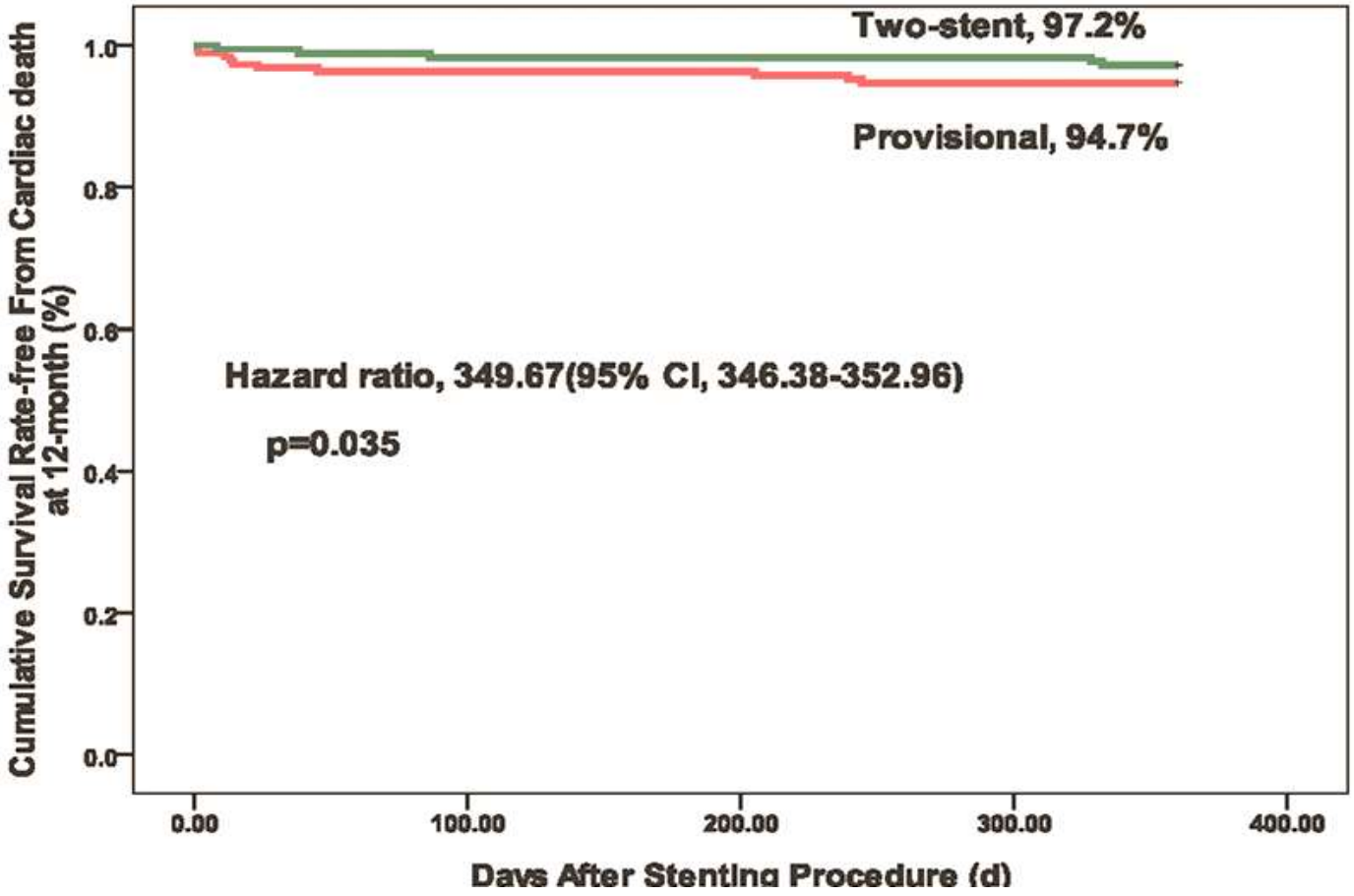
1. **Minor 1: ≥Moderate calcification**
2. **Minor 2: Multiple lesions**
3. **Minor 3: LVEF<30%**
4. **Minor 4: eGFR<30ml/min/1.73m2**
5. **Minor 5: Thrombus-containing lesions**
6. **Minor 6: MV lesion length ≥ 25 mm**

By Visual Estimation

1 major + 2 minor criteria = Complex Bifurcation

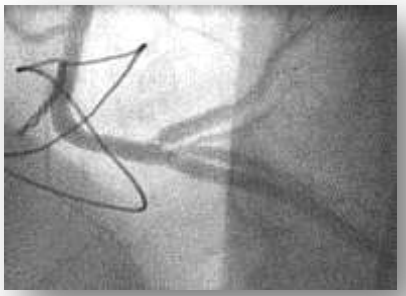
Chen et al. JACC Cardiovasc Interv. 2014 ;7:1266-1276.

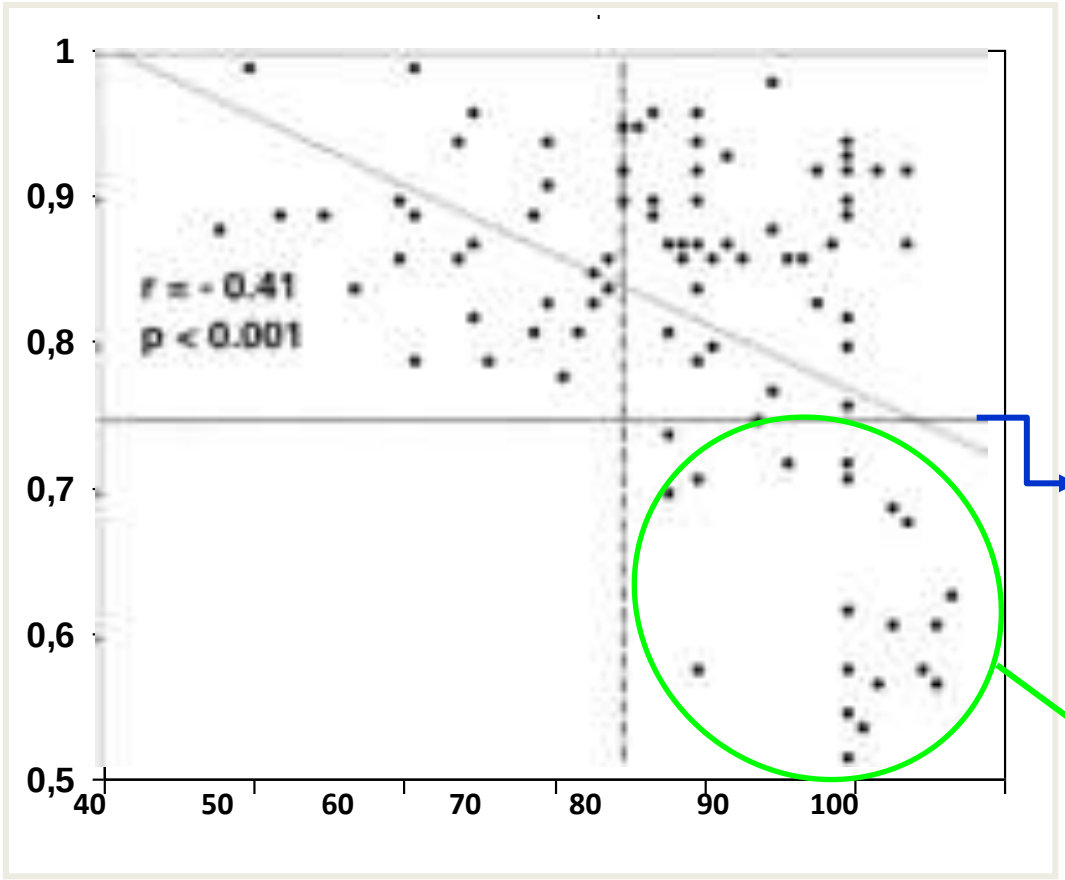
One Year Death-Free Survival between Provisional stenting and two stents in patients with Complex Bifurcation



Chen et al. JACC Cardiovasc Interv. 2014 ;7:1266-1276.

Significant Post Stenting SB Stenosis: QCA vs FFR



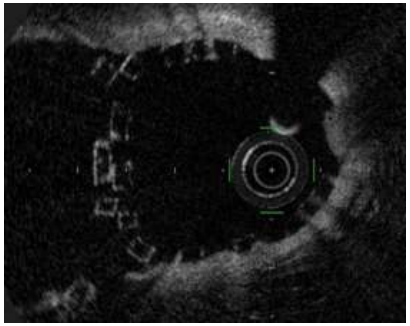
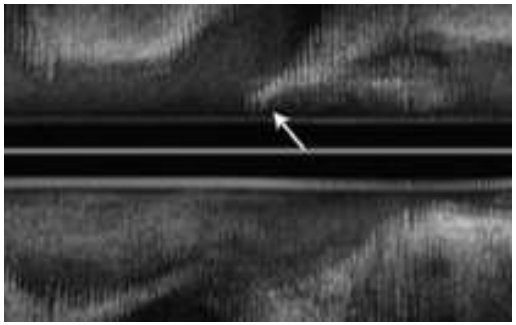
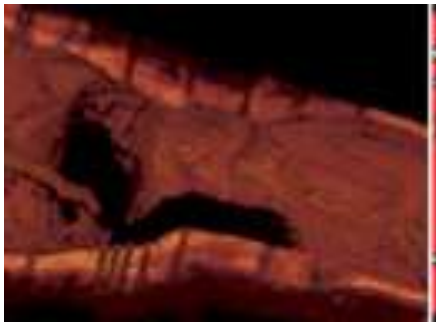
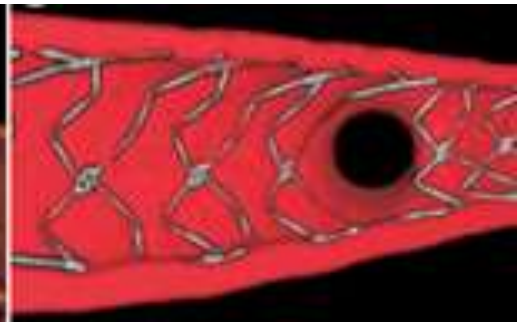


Functionally significant stenosis

38 % of lesions

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

Intracoronary imaging in bifurcation

- IVUS and OCT may be of particular value in guiding bifurcation treatment and are recommended for left main bifurcation treatment.
- Segments overlapping on angiography can be evaluated by intracoronary imaging. OCT may be superior to IVUS in evaluation of the SB ostium by MV pullback.
- Evaluation of wire positions may be of importance whenever crossing stents in single and double stenting.
- Intracoronary evaluation of optimal vessel and stent expansion is superior to angiographic assessment.

Eurointervention, 2014;10:545-560

The Ideal Dedicated Bifurcation Stent

- Predictable and safe
- Easy and quick to use
- Simplify the procedure:
  - shorten procedural time
  - reduce x-ray exposure
  - reduce contrast media
- Allow continuous SB access with a non-jailed wire
- Predictable ostial side branch coverage after stenting
- Predictable long-term results (restenosis & ST rates, low)
- Able to treat all kinds of bifurcations
- Flexible during cardiac cycles after implantation

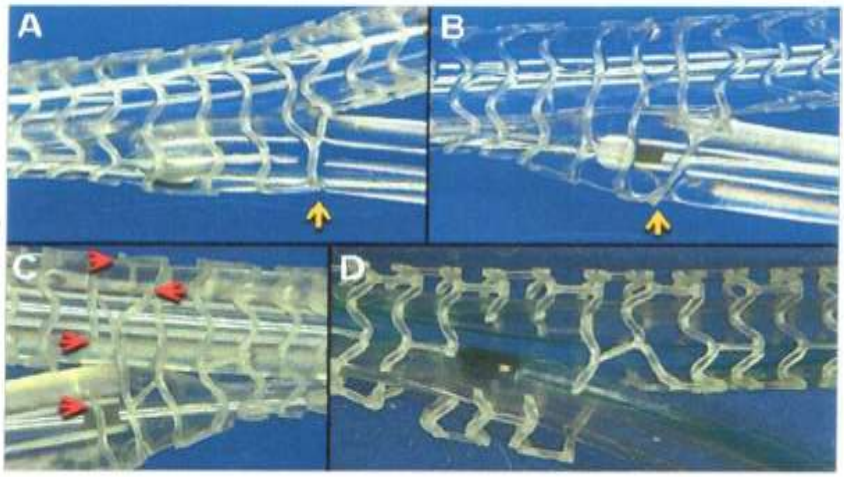
JF Lassen and G Stankovic ; EuroInterv2015; 11: 850-851

Limitations of BVS in Bifurcation

- **Struts Thickness**
- **Limited expansion**
- **Reduced radial strength**
- **Possible fracture**

BRS; Risk of strut fractures

Figure 4. *Mini-KBPD at low (5 atm) and high (>15 atm) balloon pressures. Panel A is a photograph of mini-KBPD with 3.0 mm NC balloons inflated slowly to 5 atm in a 3.0 mm Absorb scaffold showing that there were no strut fractures. The yellow arrow indicates a strut that is restraining balloon expansion at this pressure. In panel B, the simultaneous balloon inflation pressure was increased to 15 atm in the same scaffold. The SB balloon had prolapsed forward (''melon seeding'') and the scaffold strut no longer restrained balloon expansion because, as shown in panel C, struts had fractured (red arrows). The photograph D shows a scaffold severely damaged by high-pressure mini-KBPD with multiple fractures.*



Ormiston et al. EuroIntervention; 2014, may: 10 online (published ahead of print)

EBC Consensus on BVS in Bifurcations

Recommendations today:

1. Select the stent according to proximal reference in suitable anatomy (otherwise distal reference);
2. POT 0.5 mm bigger balloon than the reference;
3. If no SB compromise, procedure is finished;
4. If SB compromise, dilate with adequately sized balloon (≤12-14atm) and final POT;
5. Routine Final kissing balloon not recommended, Mini-final kissing balloon inflation if needed, 5atm;
6. If second stent needed: T/TAP; Metallic DES for SB;
7. Recommendations apply to current generation BRS and may need to be revised with new stent designs

Final Remarks

- **Provisional T Stenting is the default strategy for simple bifurcation lesions with a low rate of SB stenting**

- **All bifurcation stenting techniques require step by step approaches and each step need to be respected to provide the optimal outcome**

- **Complex stenting should be the default strategy in complex bifurcations . No Gold Standard approach has been identified, however Culotte and DK Mini Crush seem to provide excellent results .**

Thanks for your kind attention!!!!!