



Université Cadi Ayyad



# Bifurcations : culotte

Dounia Benzarouel

MD-PHD

Mohamed VI University hospital

Marrakech

# Bifurcation: what is it?

- **Incidence 15 -20 % of all PCI pts**
- **Lower procedural success rate**
- **Higher incidence of periprocedural adverse outcome**
- **Higher longterm adverse outcome**

- **1 stent vs 2 stent strategy?**
- **Indications**
- **Techniques : FKB?**
- **Adjunctive IVUS / OCT / FFR?**

# Medina Classification



1,1,1



1,1,0



1,0,1



0,1,1



1,0,0



0,1,0



0,0,1

## What is our Medina classification ?

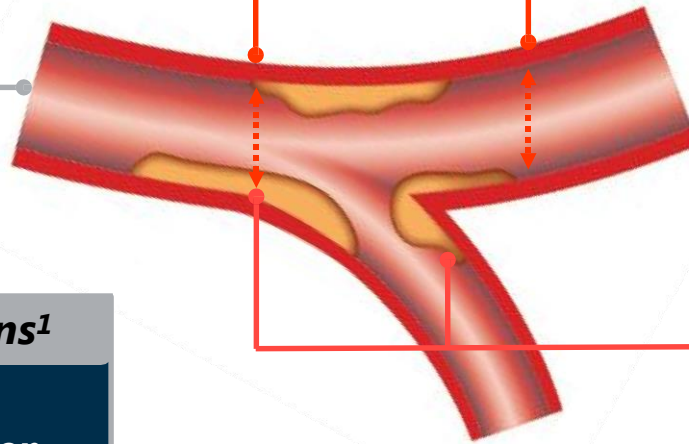
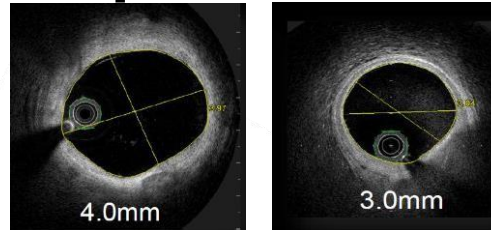
- Simple
- Easy to remember
- Research classification
- Incomplete (angle, SB lesion length, Ca++ ...)
- Can be completed by quantification
- Visual / base on quantification
- IVUS Medina, OCT Medina, FFR Medina ...

- **Why an individualized approach?**
  - **Variations in Anatomy**
    - **Left main bifurcation disease**
    - **Plaque burden & location of plaque**
    - **Angle between MB and SB**
  - **Dynamic changes in anatomy during treatment**
    - **Plaque shift**
    - **Dissection**
  - **No two bifurcations are identical**
  
- **An appropriate strategy from the outset saves time and minimizes complication**

# Each bifurcation lesion represents a unique challenge

## Vessel shape and sizing<sup>1</sup>

- *Discrepancies in diameter between the proximal and distal references*



## Variations in bifurcation and lesion anatomy<sup>1-3</sup>

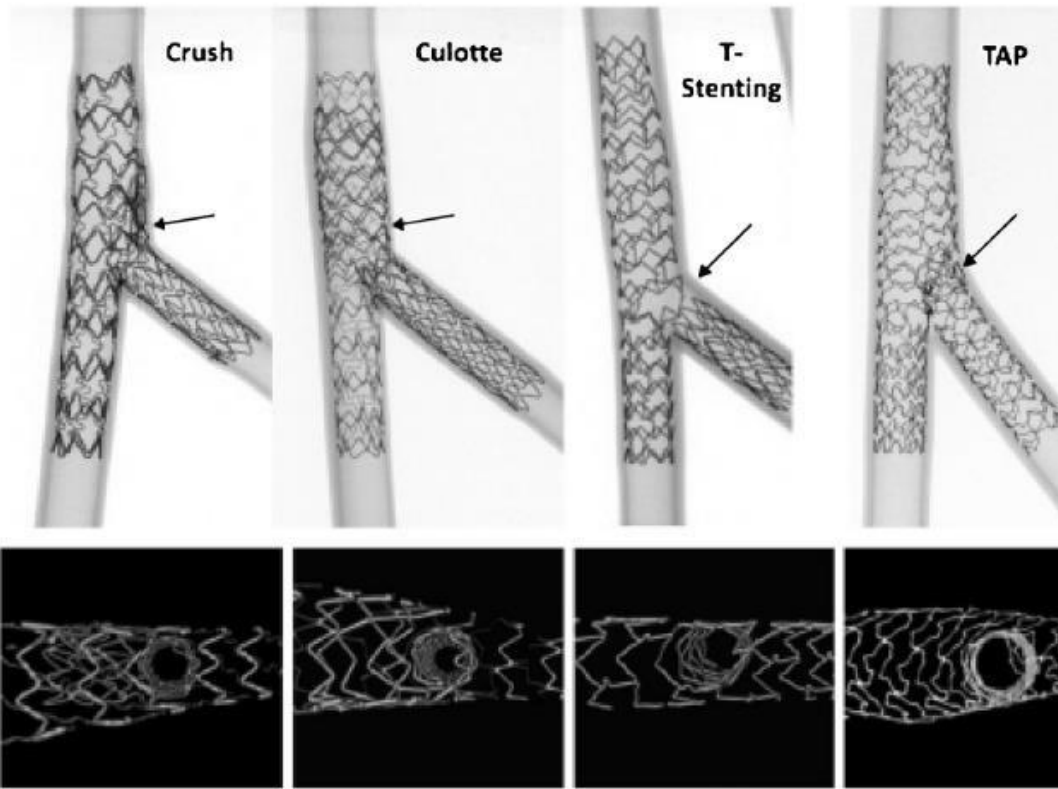
- *Side-branch patency*
- *Plaque distribution patterns*
- *Lesion composition*
- *Angle between main branch and side branch*
- *Location of affected vessel*

## Procedural complications<sup>1</sup>

- *Plaque shift*
- *Dissection or perforation*
- *Cardiac motion*

1. Dash D. Heart Asia 2014;6:18-25; 2. Lassen FJ et al. EuroIntervention 2016;12:38-46; 3. Waksman R, Bonello M. JACC Cardiovasc Interv 2008;1:366-8.

- **Respect bifurcation angulation!!**



Curr Cardiol Rep (2015)

Fig. 1 Differences of scaffolding in SB ostium according to the 2-stenting technique. This figure demonstrated the differences of overlapping layer of struts proximal to side branch ostium and scaffolding of side branch ostium by the struts among the 4 different 2-stenting techniques (crush, culotte, T-stenting, and T and protrusion techniques). The crush and culotte stenting showed overlapping of stent struts in proximal main vessel stents, and T-stenting showed a gap in stent scaffolding between

main vessel stent and side branch stent. T and protrusion (TAP) showed better scaffolding in side branch ostium with minimal amount of overlapping stent struts. (With permission from Foin N, Alegria-Barrero E, Tori R et al. Crush, culotte, T and protrusion: which 2-stent technique for treatment of true bifurcation lesions? Insights from in vitro experiments and micro-computed tomography. *Circ J* 2013;77:73–80) [24]

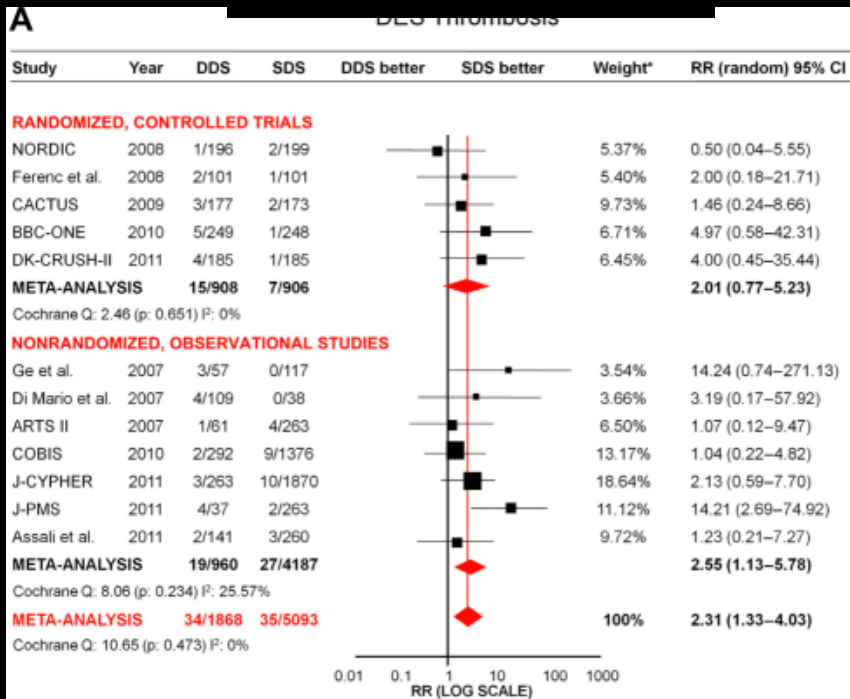


# Randomized Bifurcation Trials

	Patients (N)	Randomization	Primary End Point	Outcome (Provisional vs Systematic Unless Otherwise Specified)
NORDIC	413	Provisional vs systematic (crush, culotte, T)	Death, MI (nonprocedural), TVR, or stent thrombosis at 6 mo	2.9% vs 3.4% (P=NS)
CACTUS	350	Provisional vs systematic (crush)	Death, MI, TVR at 6 mo	15% vs 15.8% (P=NS)
BBC ONE	500	Provisional vs systematic (crush, culotte)	Death, MI, TVF at 9 mo	8.0% vs 15.2% (P<0.05)
Ference et al.	202	Provisional vs systematic (T)	Death, MI, TVF at 9 mo Angiographic restenosis (side branch) 9 mo	23.0% vs 27.7% (P=NS)
Colombo et al.	85	Provisional vs systematic (crush, T, culotte)	Angiographic restenosis (either branch) 6 mo	18.7% vs 28.0% (P=NS)
Pan et al.	91	Provisional vs systematic (T)	Angiographic restenosis (either branch) 6 mo	7% vs 25% (P=NS)
NORDIC 2	424	Systematic (crush vs culotte)	Death, MI (nonprocedural), TVR, or stent thrombosis at 6 mo	Crush 4.3% vs culotte 3.7% (P=NS)

# Provisional Single-Stenting is Better

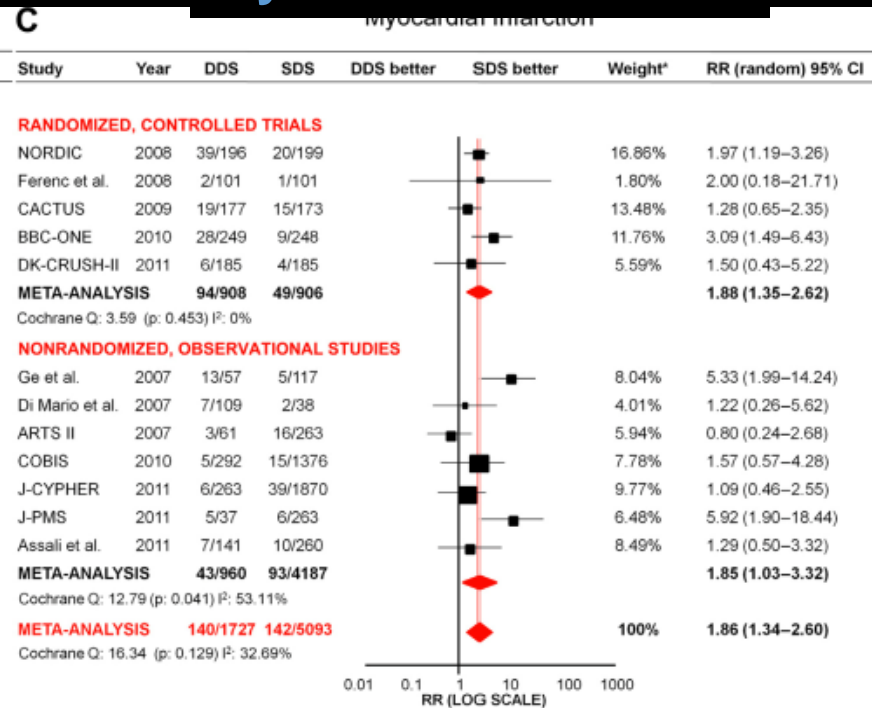
## DES Thrombosis



Single-stent

Two-stent

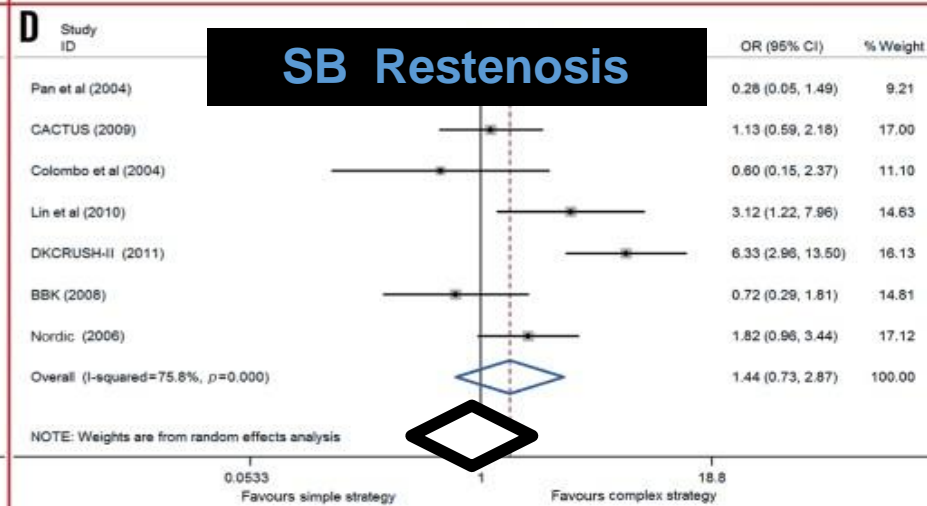
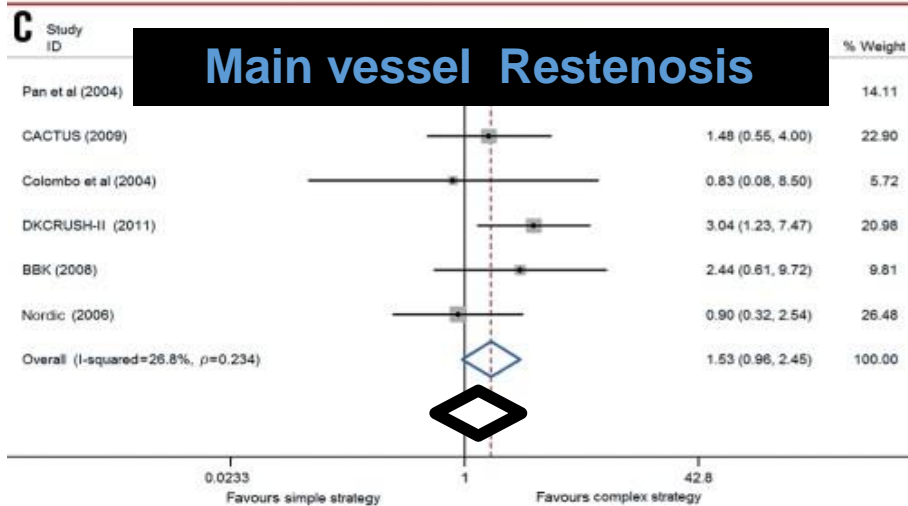
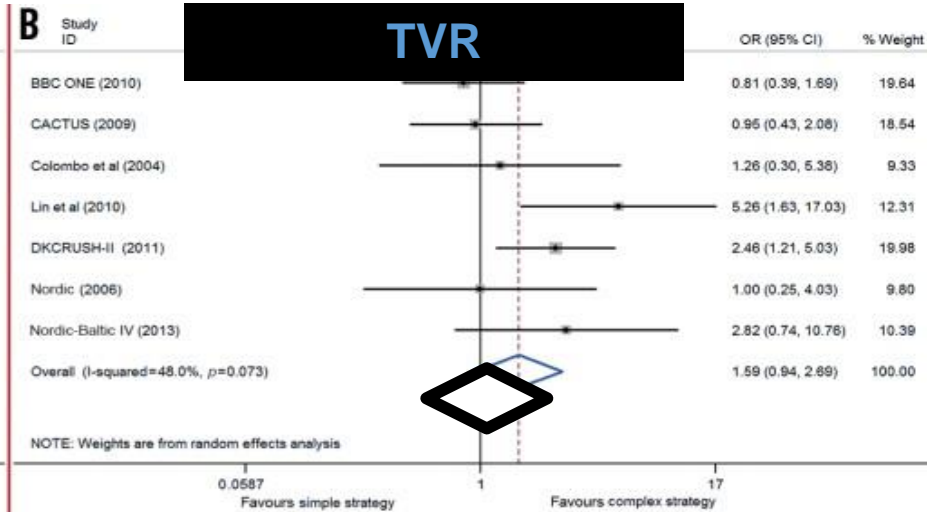
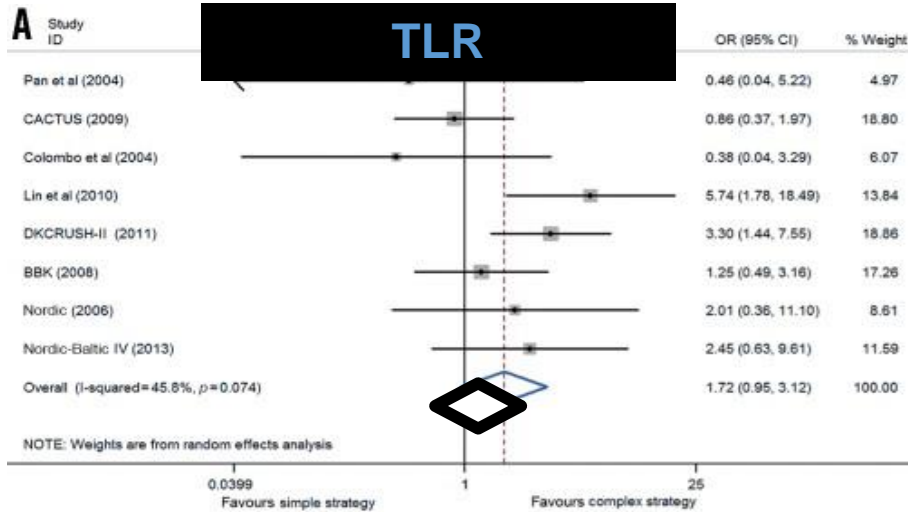
## Myocardial Infarction



Single-stent

Two-stent

# 2 Stent Techniques Are Also Good !



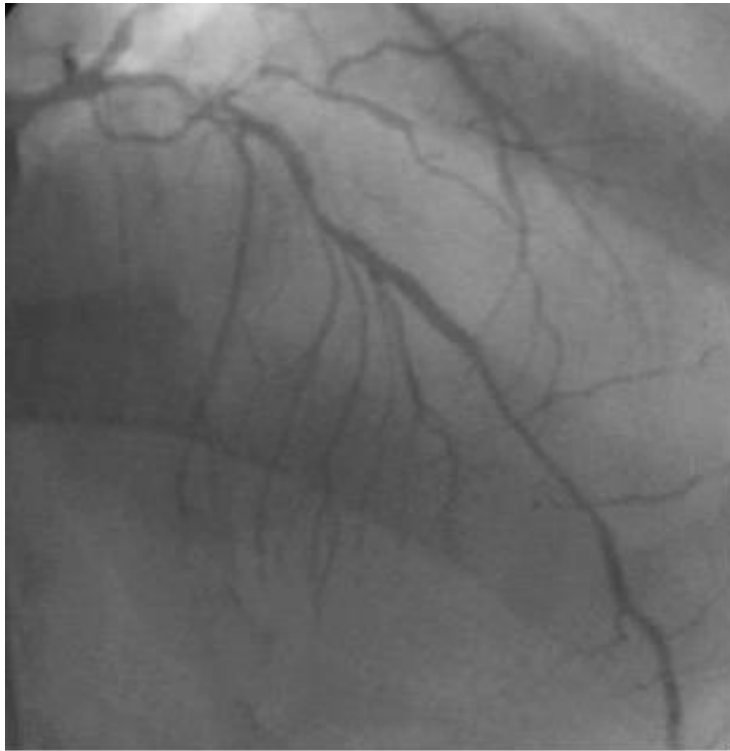
Single-stent

Two-stent

Single-stent

Two-stent

# ***SB diameter and territory***

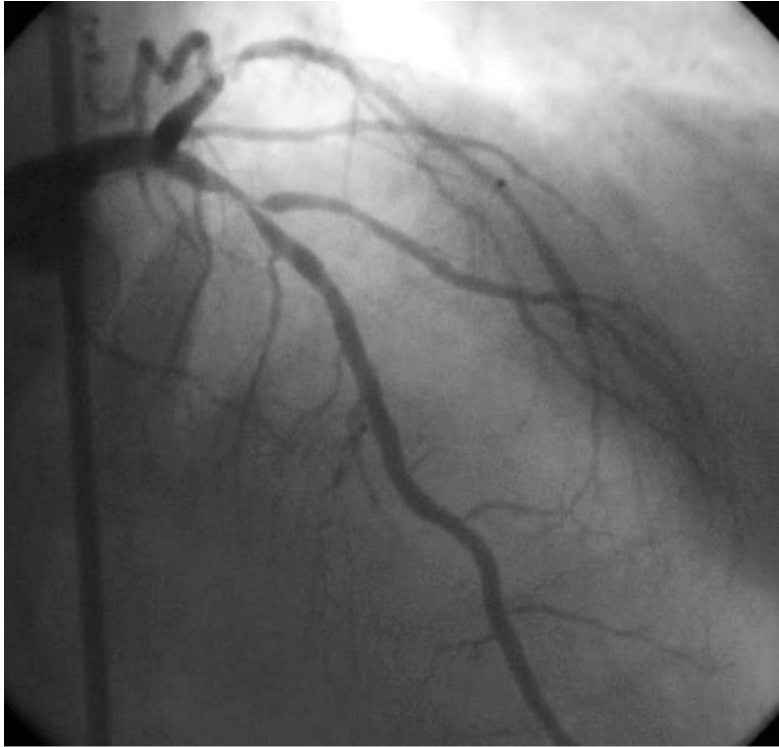


Small SB w diffuse disease

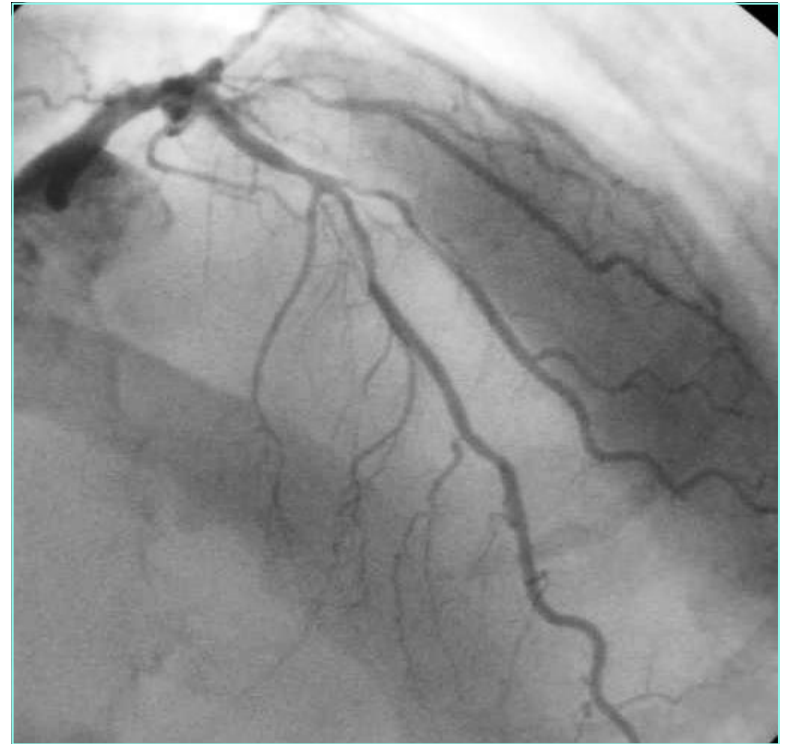


Large SB with large territory 2  
stents

# ***Extent of SB disease***



**Focal ostial SB disease**  
**Provisional**



**Diffuse SB disease**

# ***Bifurcation angle and wiring***



Difficult to access SB. Access may be even more challenging or even impossible after MB stenting

# Culotte baseline

- There are two distinct culotte technique
  - 1 - classical culotte
  - 2 - part of the provisional strategy

# Culotte Baseline

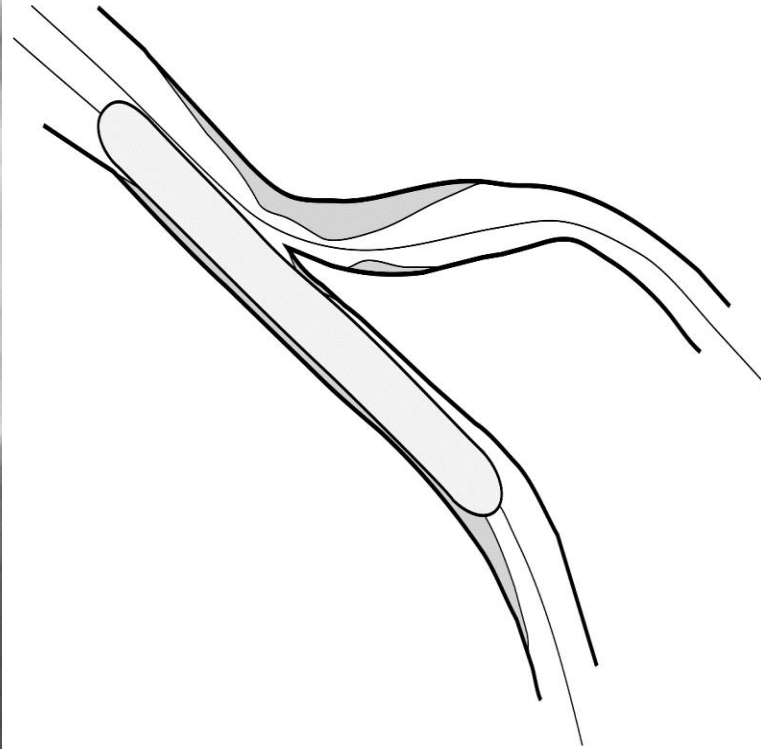




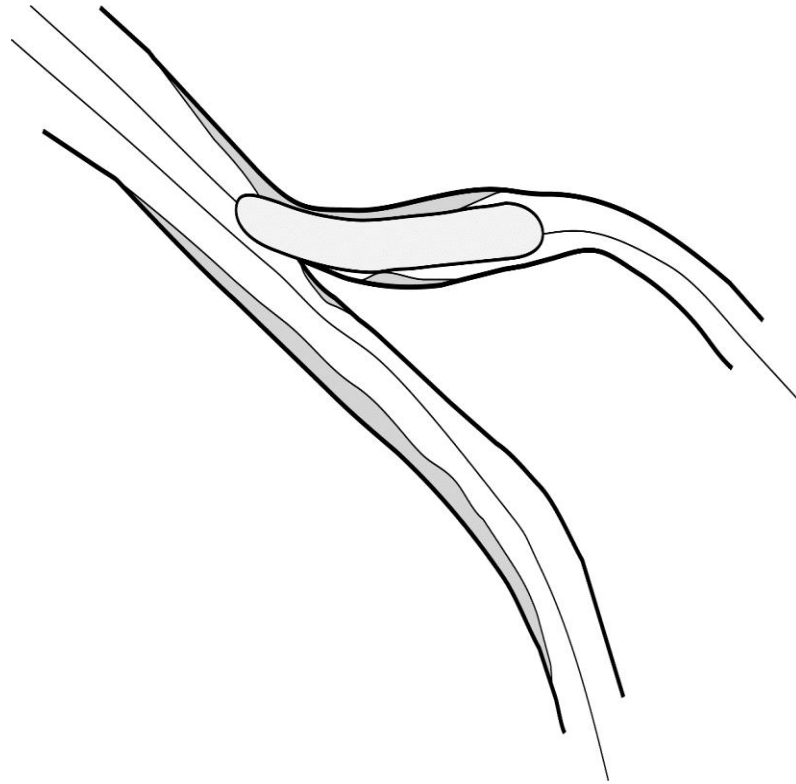
# Wiring of both branches



# Main branch predilatation



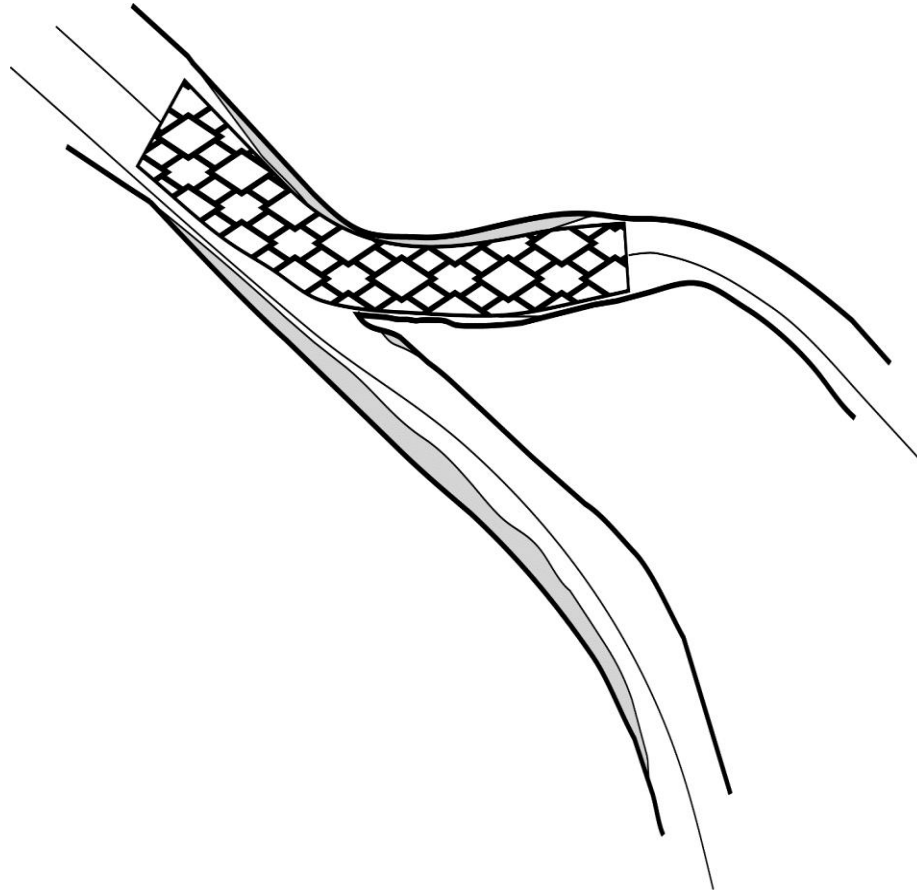
# Side branch predilatation



# Side branch stent positioning and deployment

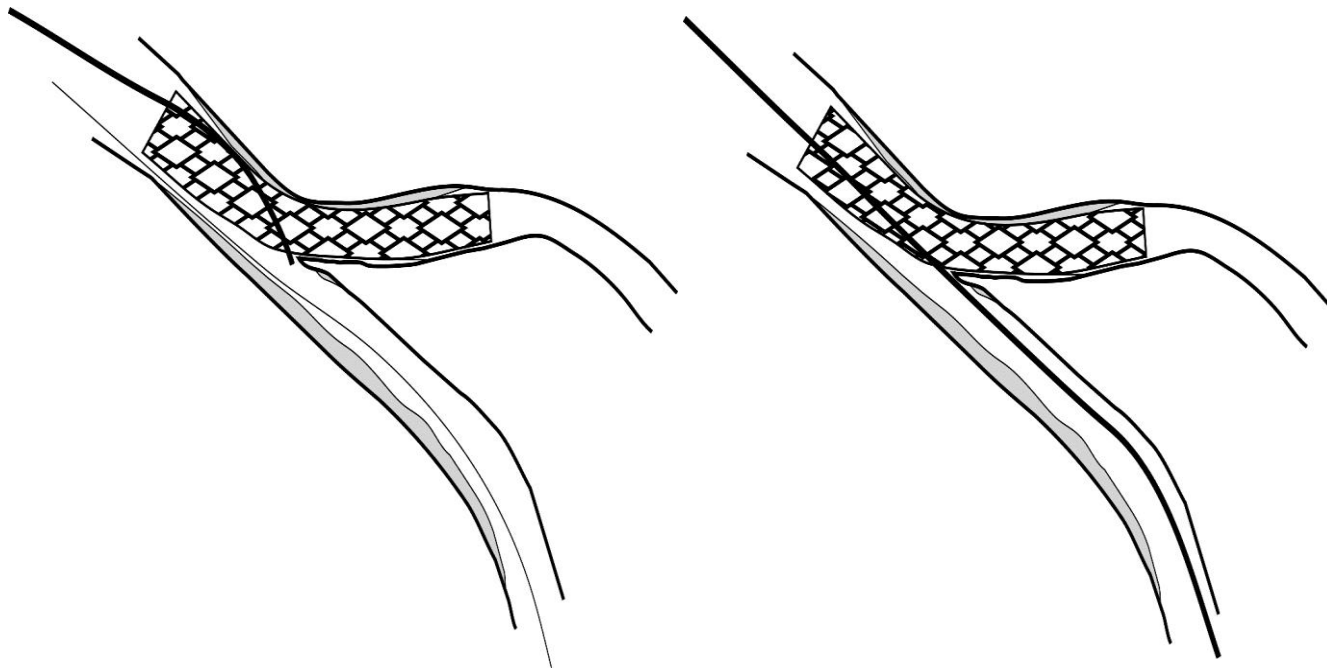


# Result after SB stent deployment

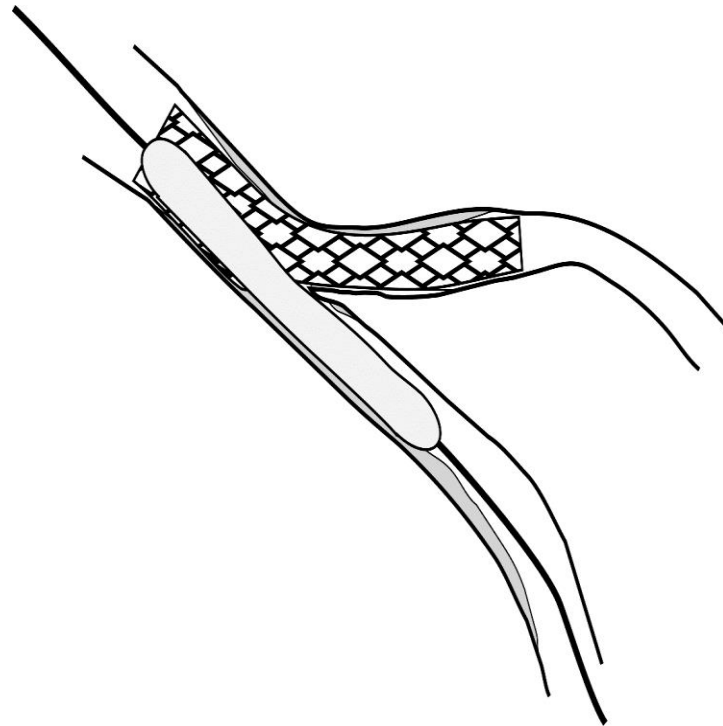


# Main branch rewiring

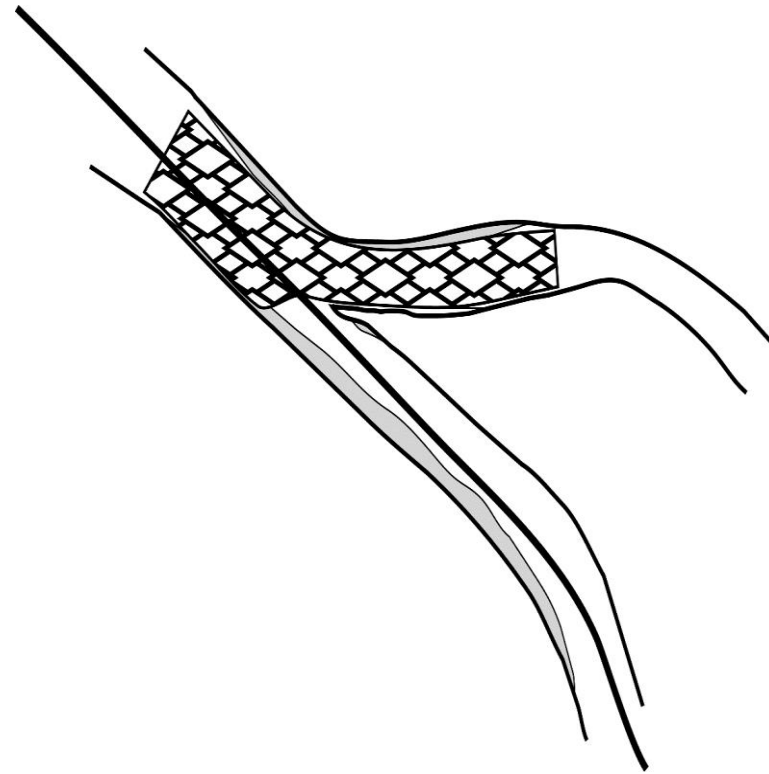
## Main branch primary wire withdrawal



# Struts dilatation toward MB

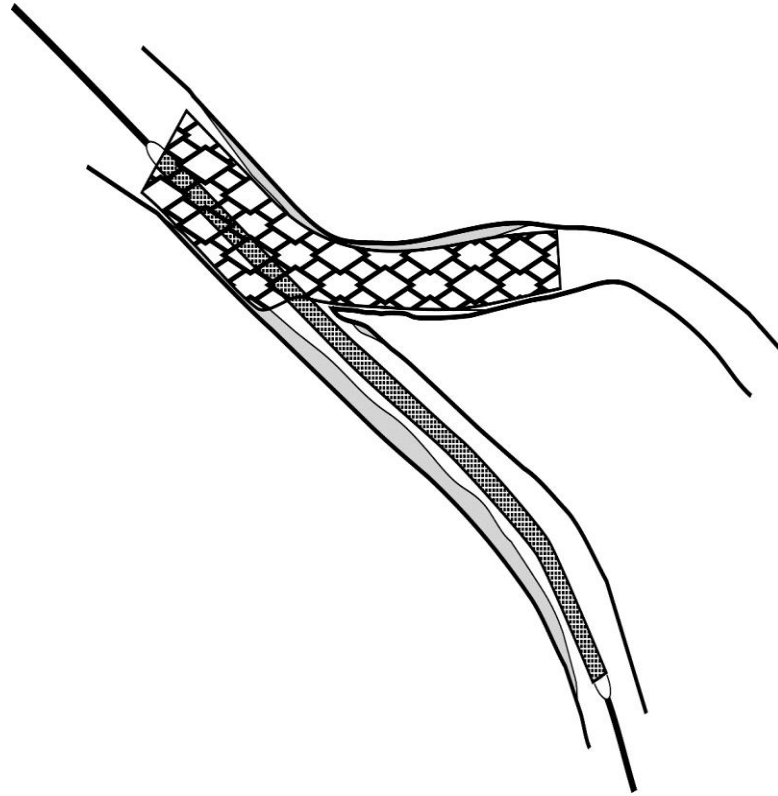


# Result after struts dilation

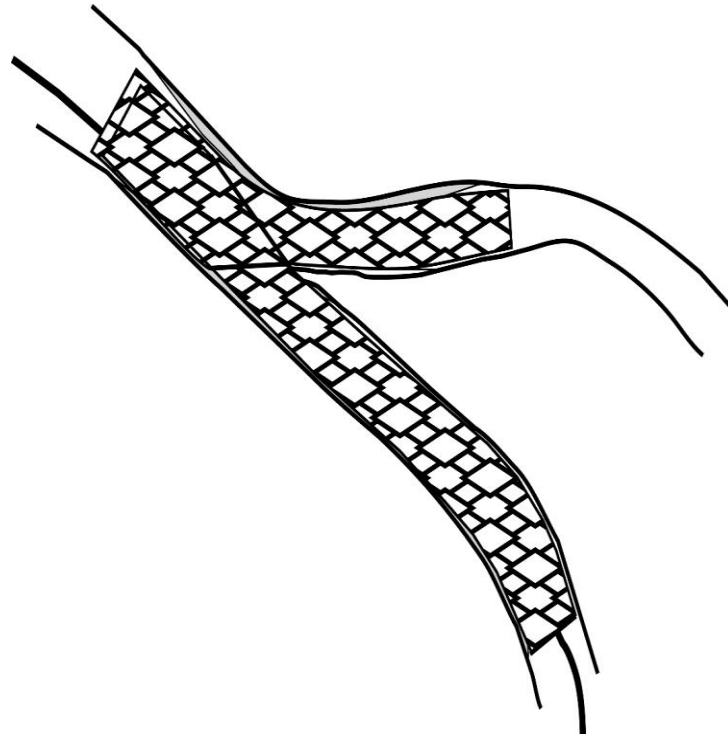




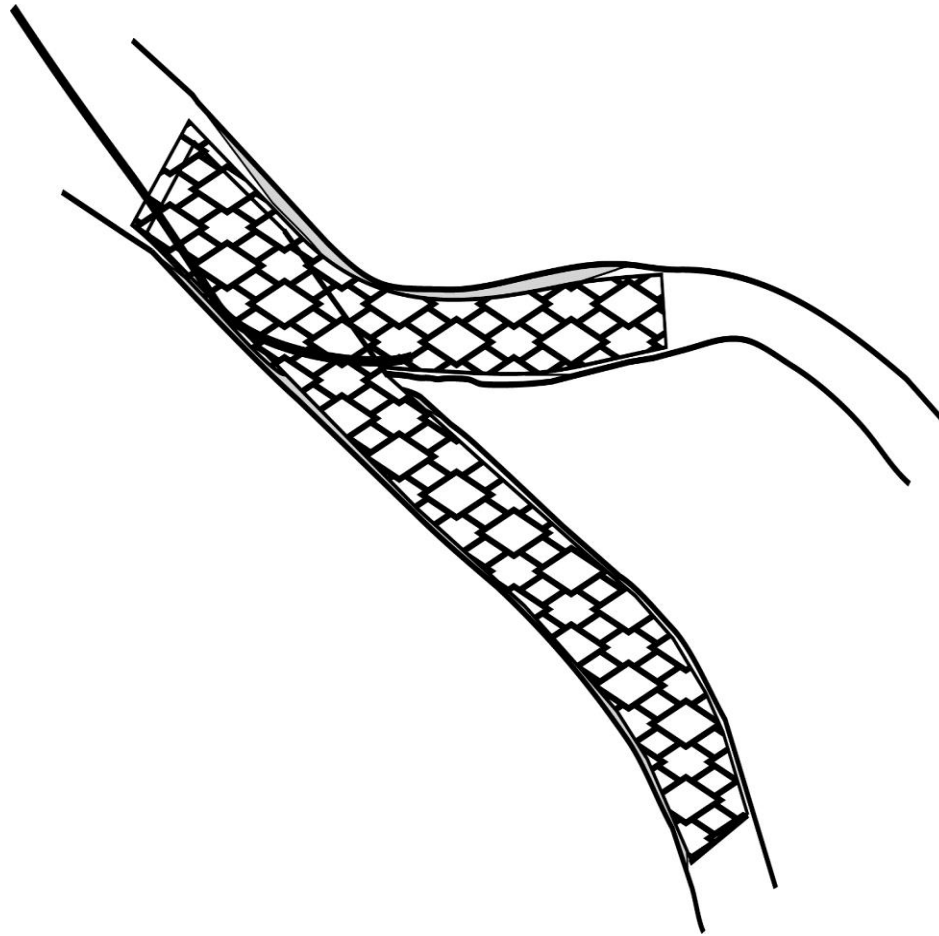
# Main branch stent positioning



# Result after MB stent deployment

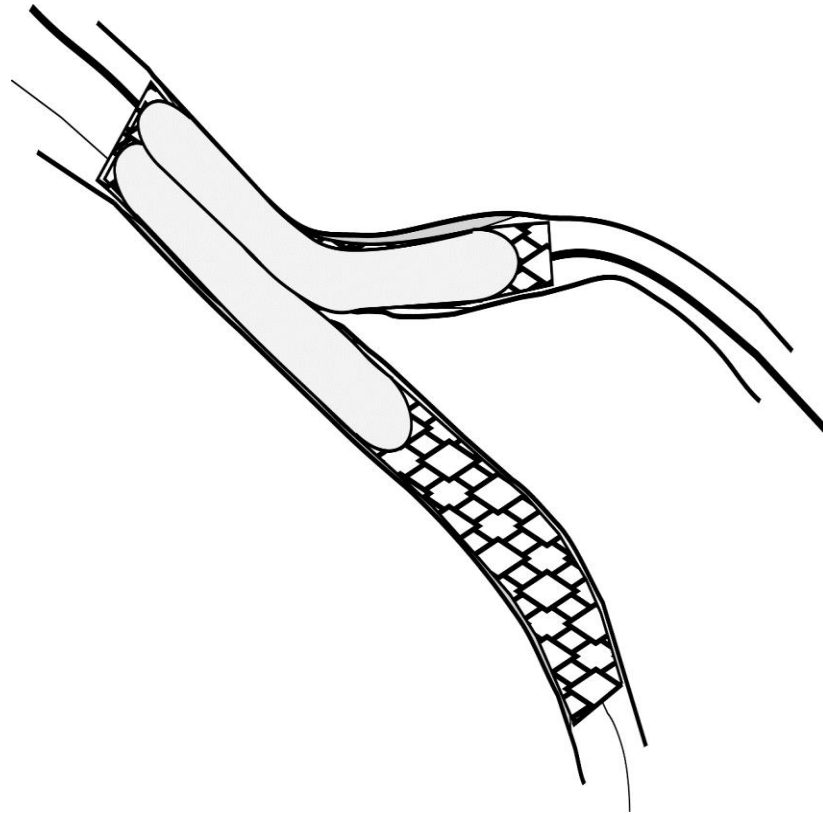
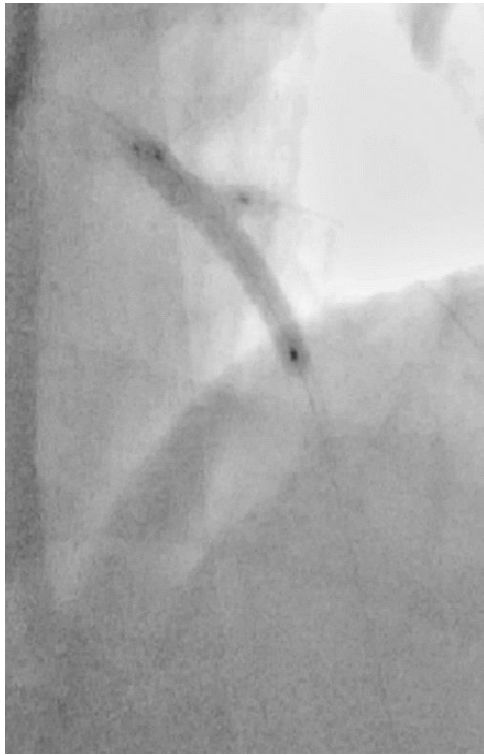


# Side branch rewiring

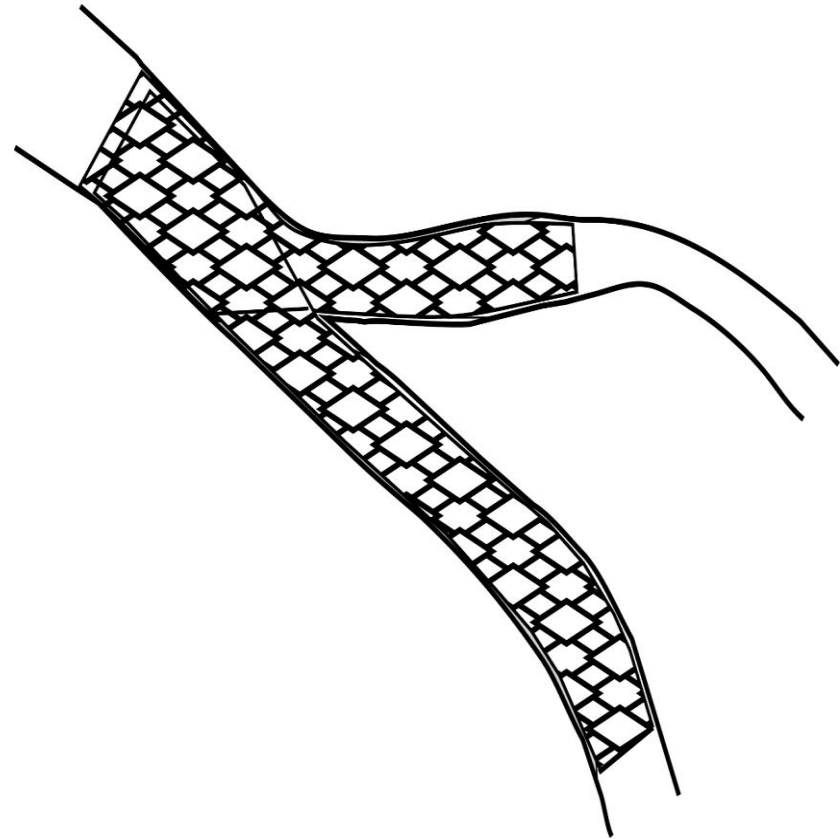


# Main branch wiring

## Final kissing

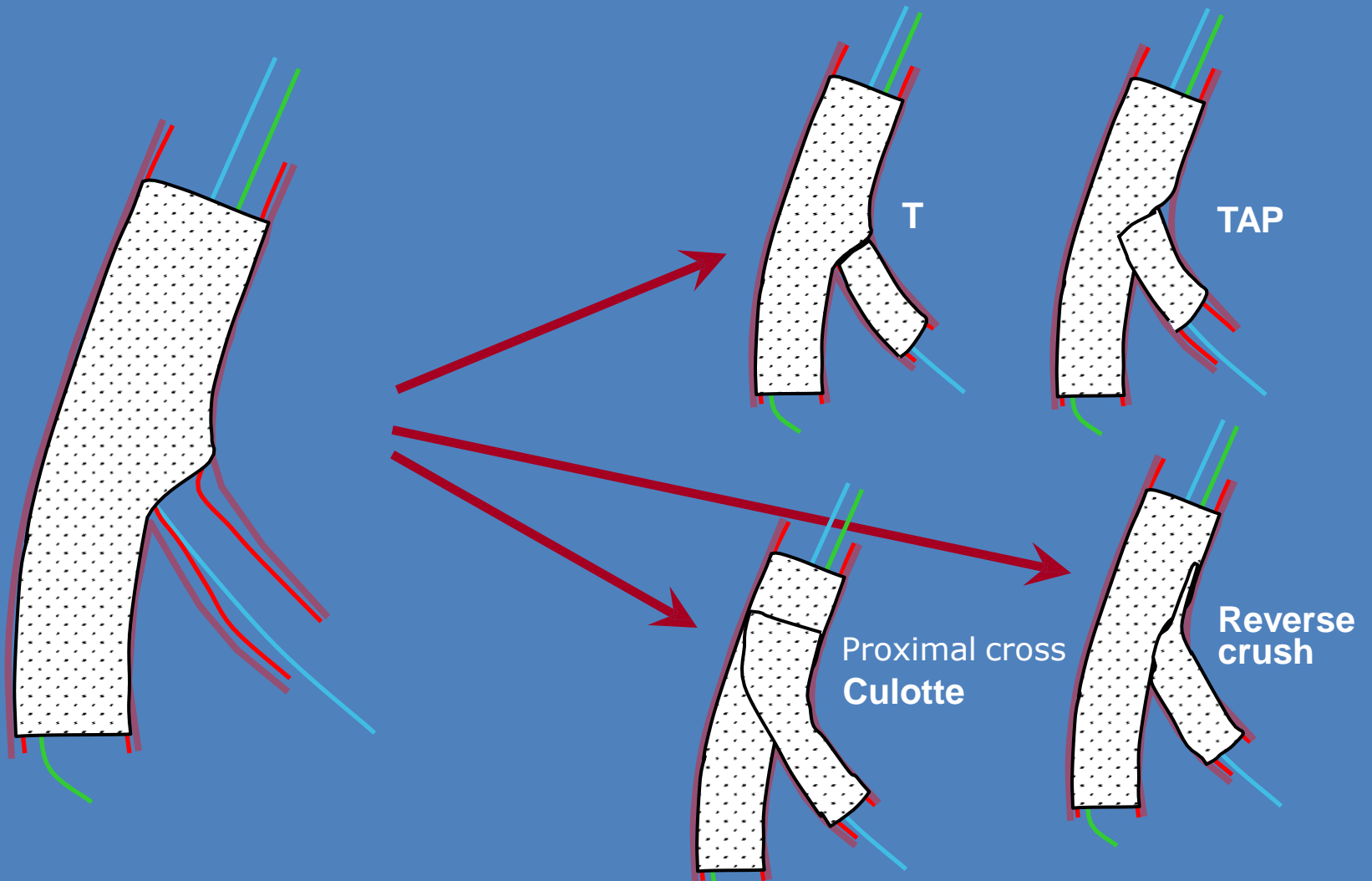


# Final result



- **Second scenario** : Culotte bail out

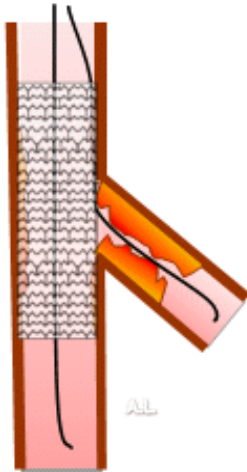
# Provisional Side-Branch Strategies Requiring a Bailout Two Stent Strategy



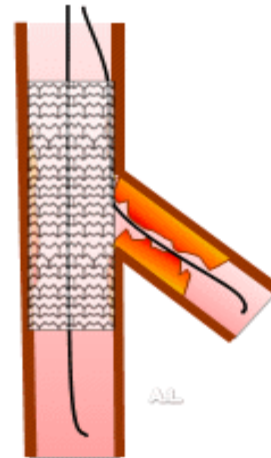
Courtesy: T. Lefevre, R. Albiero

# Provisional requiring second stent

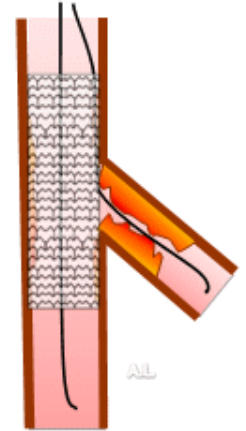
TAP



Reverse crush



culotte



**BUT**

**Complete coverage  
of ostium**

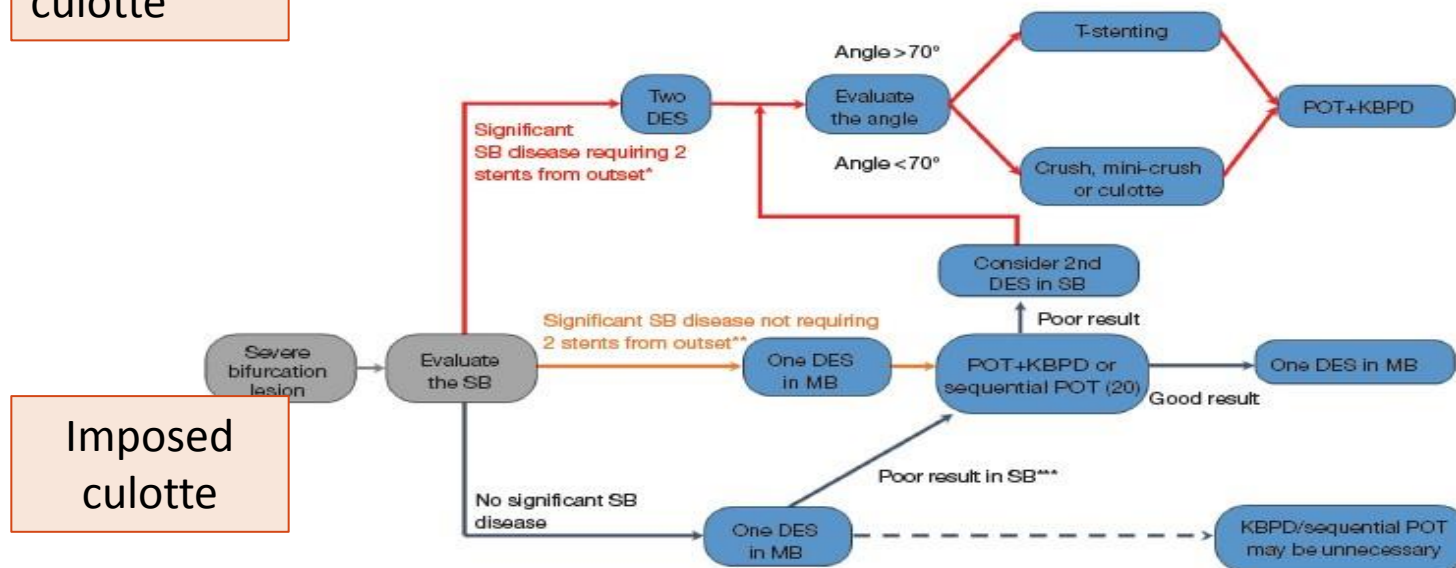
**More difficult rewiring  
Of both branches  
Double stent layer**



# Coronary bifurcation lesions: is less more?

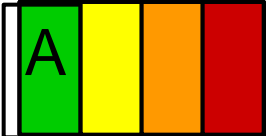
Classic culotte

Bennett and Dubois. Coronary bifurcation lesions: is less more?




**Figure 1** Proposed contemporary approach to treatment of severe bifurcation lesion (20). \*, typically a large SB (>2.5 mm) supplying a large territory of myocardium with significant ostial disease extending over a long segment into the SB; \*\*, typically a smaller SB (<2.5 mm) with focal involvement of the ostium; \*\*\*, presence of important dissection or < TIMI 3 flow in SB. SB, side branch; DES, drug-eluting stent; MB, main branch; POT, proximal optimization technique; KBPD, kissing balloon post-dilatation.

# The Guidelines

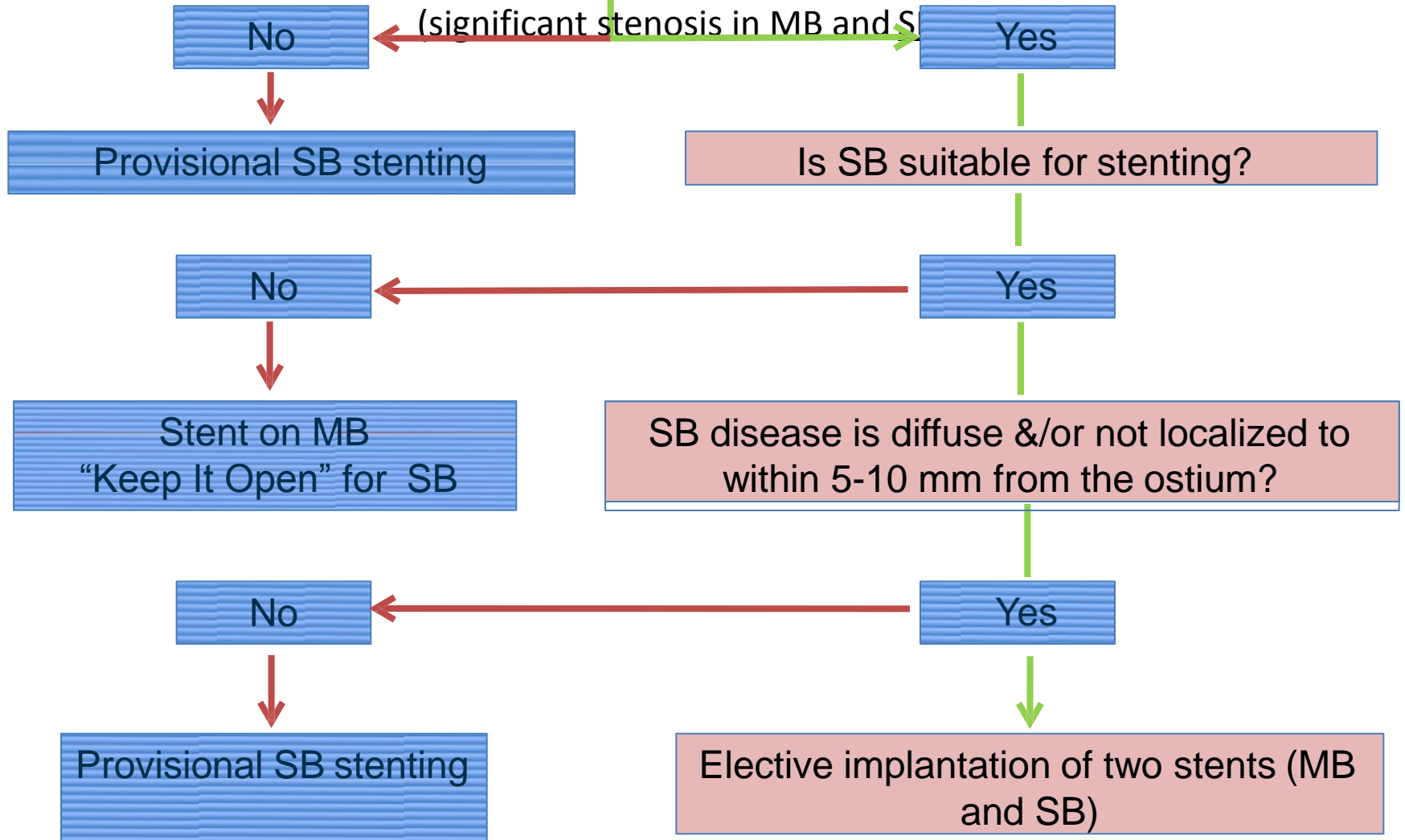


Provisional side-branch stenting should be the initial approach in patients with bifurcation lesions when the side branch is not large and has only mild or moderate focal disease at the ostium



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

# True Bifurcations



## True Bifurcations

No

(significant stenosis in MB and SB)

Yes

Provisional SB stenting

Is SB suitable for stenting?

Approach is dictated by the  
Side Branch!

No

Provisional SB stenting

Yes

Elective implantation of two stents (MB and SB)

# Factors Influencing 2-Stent Approaches

- Size of SB @ to MB
  - Important discrepancy: Avoid Culotte
    - T-Stenting
    - Crush/DK-Crush
- Bifurcation Angle
  - $>70^\circ$ : T-stent, or T and Protrusion (TAP)
  - $<70^\circ$ : Culotte, Crush, DK Crush
- Operator experience and expertise
- Life-threatening / Shock presentation

# Two Stent Strategies-How Do You Decide?

*When to perform? Which technique*

Technique	SIZE daughter branches	Angle	Provisional	Complexity
Culotte	SB $\approx$ MV	wide range ( $<55^\circ$ preferred)	suitable	2 rewiring 5 steps (+1-3 POT)
T-Stenting (TAP)	SB $\ll$ MV	$\approx 90^\circ$	suitable	1 rewiring 3 steps (1-2 POT)
DKCrush (mini-crush)	SB $<$ MV	$< 90^\circ$	no	2 rewiring 6 steps (1-2 POT)
SKS	SB $\approx$ MV	wide range	no	no rewiring 1 step (no POT)

# Indications

# Two stents required for large SB *with diffuse disease?*

## EBC consensus:

– Main vessel (MV) stenting with provisional SB treatment, if needed, is recommended as the preferred technique for the majority of bifurcation lesions.

– Large SBs with significant ostial disease extending further into the SB are likely to require a two-stent strategy.

– Larger SBs whose access is particularly challenging should be secured by stenting once accessed. *EuroIntervention 2014;10:545-560.*

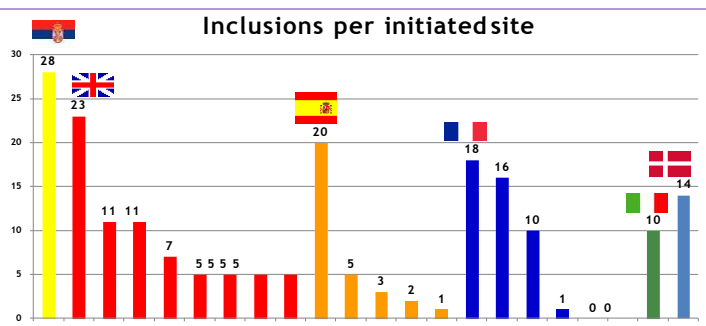


# Two stents required for large SB

## *with diffuse disease?* *Nordic-Baltic Bifurcation Study IV PCR 2015*



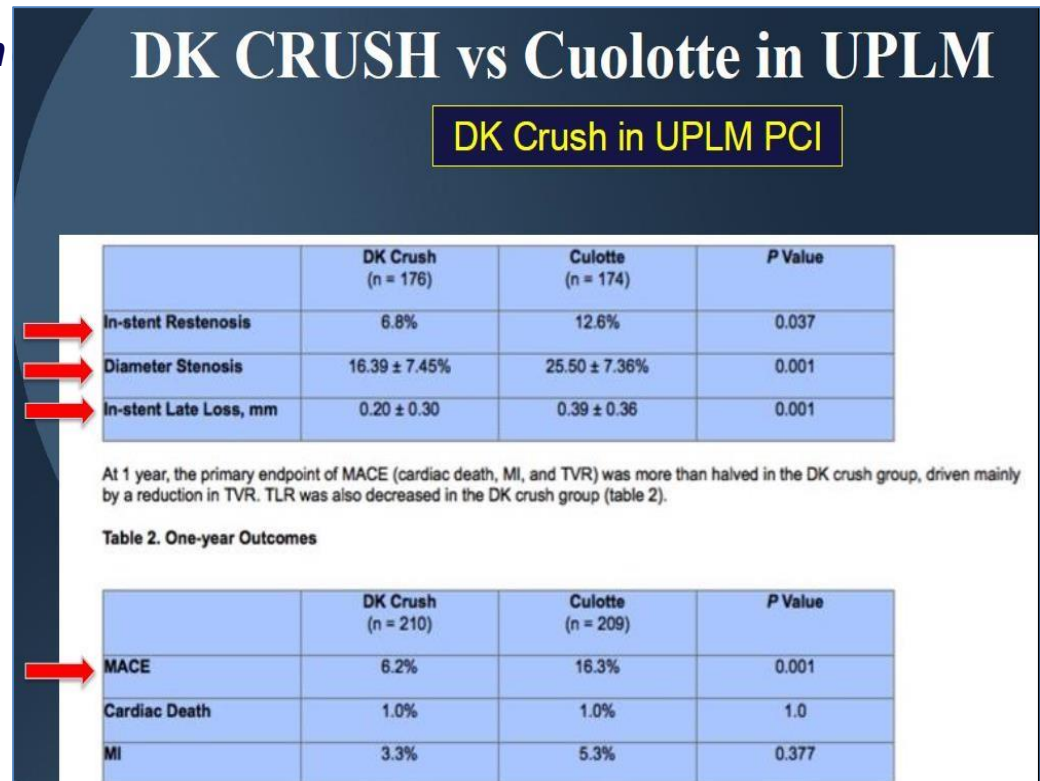
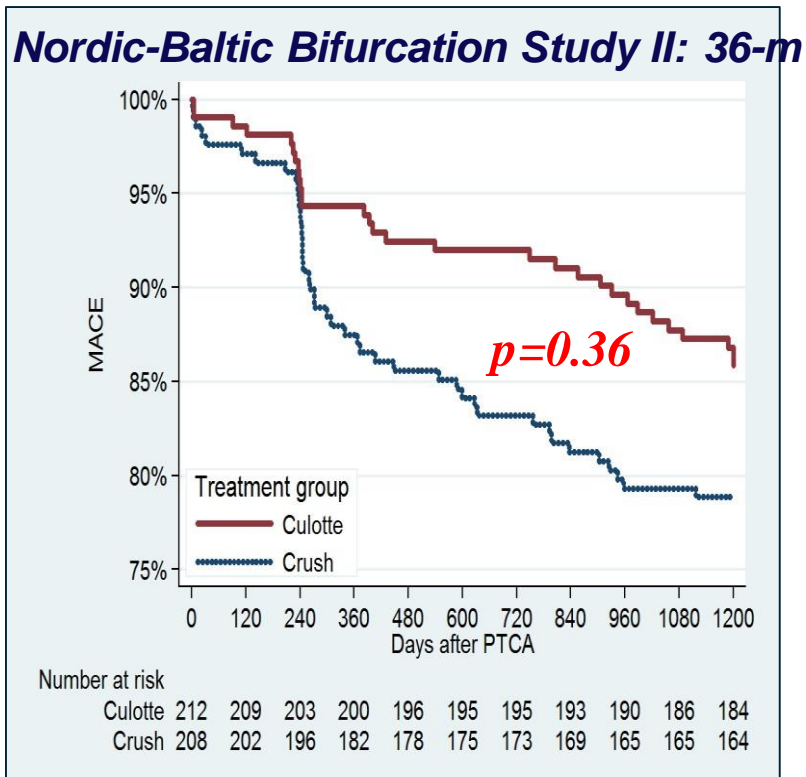
- After 2 years, two-stent techniques for treatment of true bifurcation lesions with a large side branch showed no significant difference in MACE rate compared to provisional side branch stenting



## *EBC TWO: Circ. Interv 2016*

- When treating coronary bifurcation lesions with large side branches incorporating significant length of ostial disease, there is no difference between a provisional T stent strategy and a systematic two-stent culotte strategy MACE rate revascularization at 12 months.

# Either TAP, culotte or DK crush could be used as a two stent technique



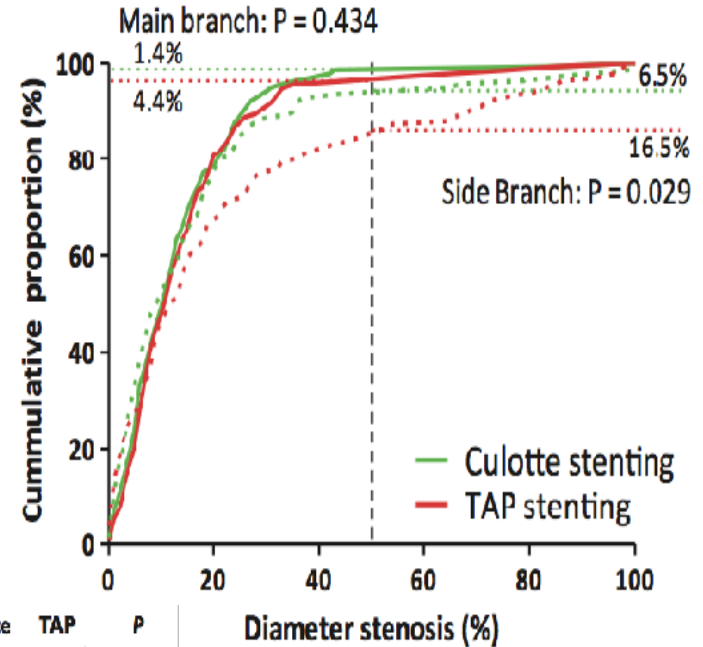
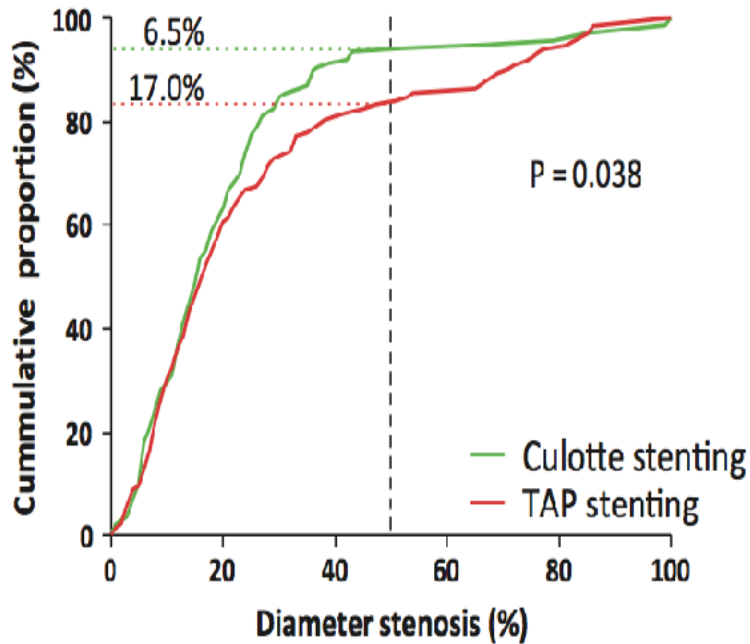
Chen SL. *J Am Coll Cardiol*. 2013 Apr 9;61(14):1482-8  
 Kervinen K. *JACC Cardiovasc Interv*. 2013 Nov;6(11):1160-5

Lassen JF. *EuroIntervention*. 2014 Sep;10(5):545-60  
 Hildick-Smith D. *EuroIntervention* 2010;6(1):34-8

# BBK 2

- TAP VS CULOTTE

# Randomized comparison: BBK II study



	Culotte stenting n = 150	TAP stenting n = 150	P
Target lesion revascularization n, (%)	9 (6.0)	18 (12.0)	0.069
TLR only in side branch n, (%)	7 (4.7)	13 (8.7)	0.16
Target lesion failure n, (%)	10 (6.7)	18 (12.0)	0.11
Death, any cause n, (%)	3 (2.0)	4 (2.7)	0.70
Cardiac n, (%)	1 (0.7)	1 (0.7)	1.0
Non-cardiac n, (%)	2 (1.3)	3 (2.0)	0.65
Target vessel myocardial infarction n, (%)	2 (1.3)	1 (0.7)	0.56
ARC definite/probable Stent thrombosis n, (%)	1 (0.7)	0 (0)	0.32

**Bifurcation Angle (p=0.03)**  
**57.8 ± 29.9 vs 51.5 ± 19.6**

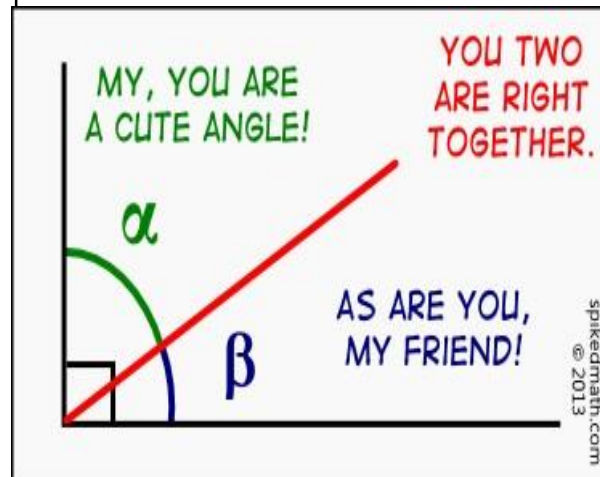
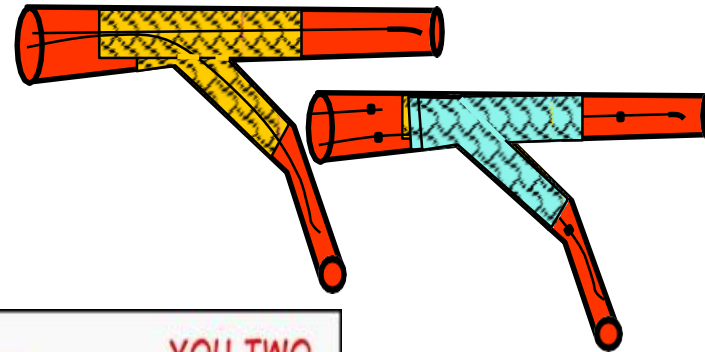
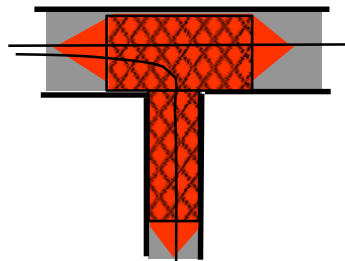
# TAP vs Culotte stenting, JUST an angle issue?

about 90° angle

< 70° angle

**T/TAP-Stent**

**Mini Crush/Culotte**



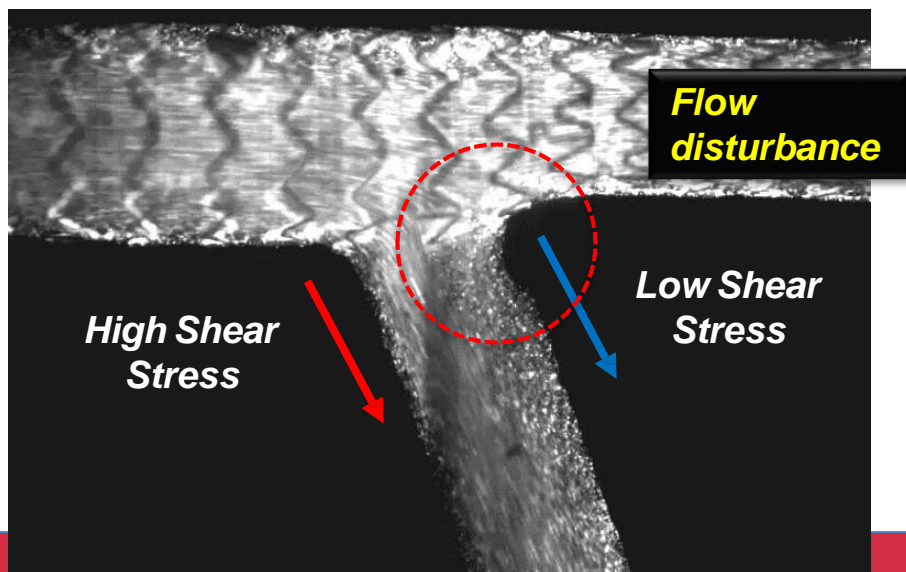
COMPLIMENTARY ANGLES

# FKB AND TWO STENTS STRATEGY CULOTTE

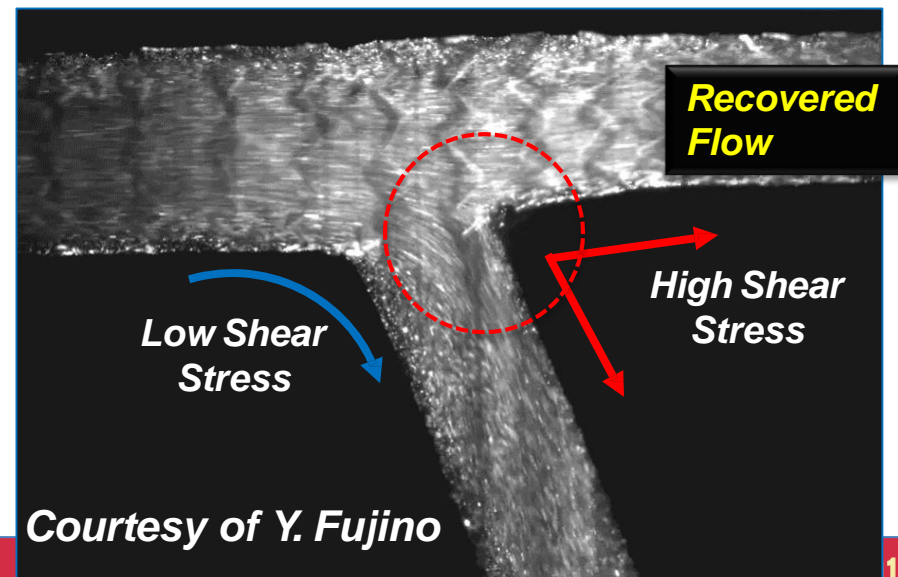
# How to perform optimal Final Kissing?

- Optional for provisional, **mandatory for complex techniques**;
- Short & NC balloons, size according to distal reference;
- *Side* branch first
- Simultaneous deflation;
- Longer inflation (at least 20-30 seconds);

*Single stent: pre FKBI*



*Single stent: post FKBI*



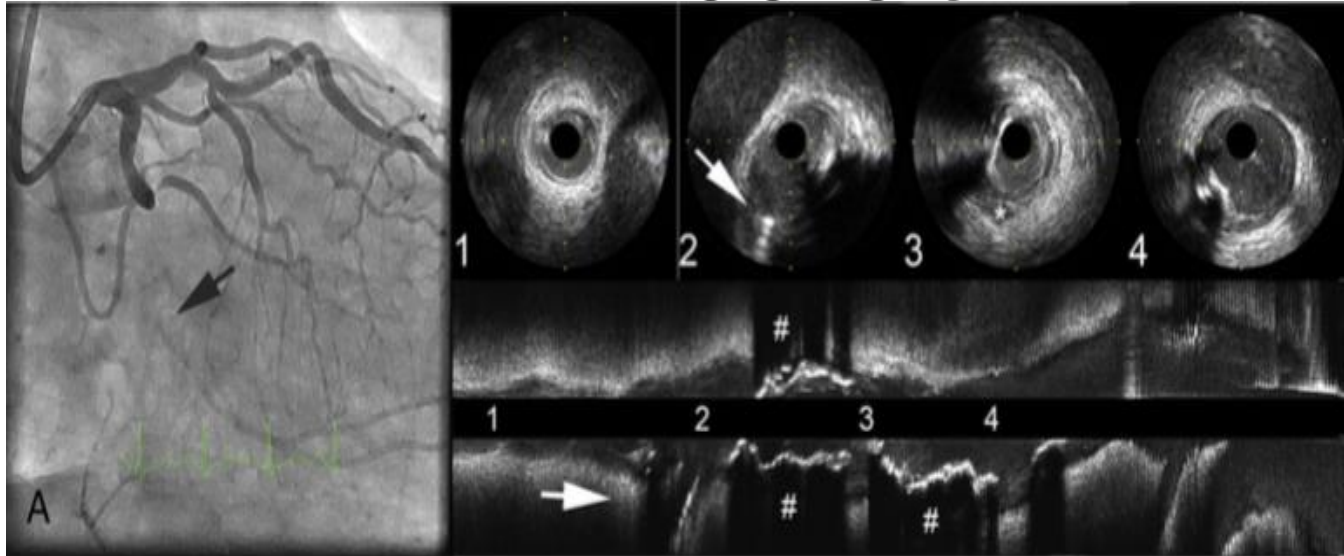
Courtesy of Y. Fujino

# The role of imaging

- ***Intravascular imaging is valuable supplement in bifurcation treatment and is especially useful in complex lesions due to limitations of angiography alone;***
- ***It is strongly recommended to have access to intravascular imaging modalities (IVUS, OCT, OFDI) during elective PCI of LM;***
- IVUS is strongly recommended for LM bifurcation treatment
- OCT may be used with the provision that aorto-ostial assessment is often not possible
- Wire positions in stent recrossing can be evaluated by OCT

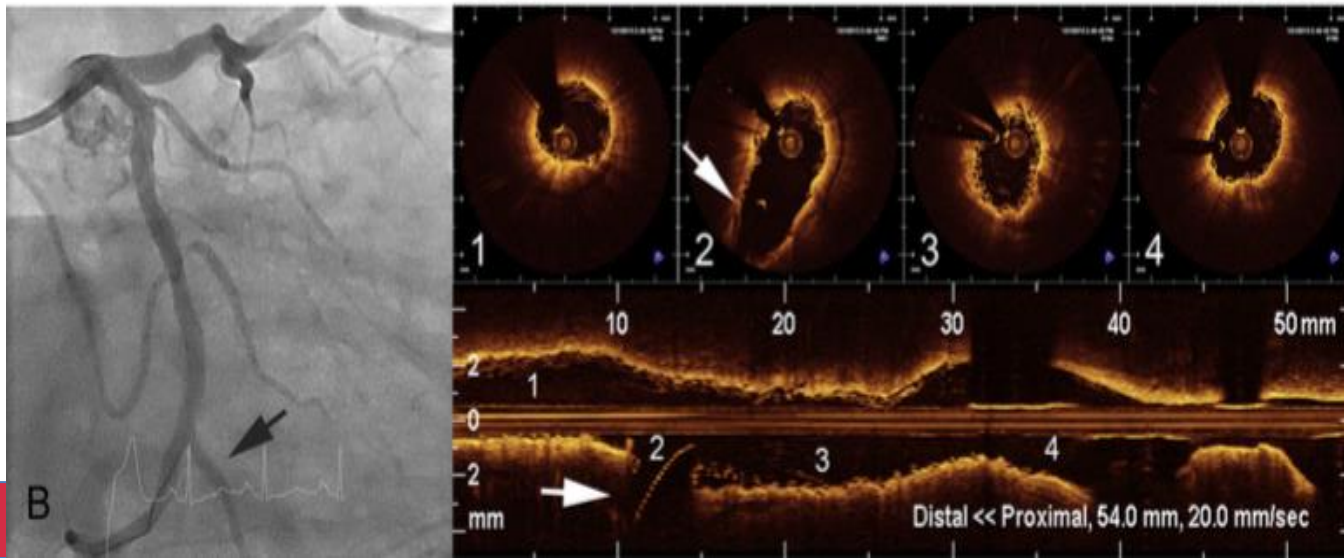


# IVUS-OCT



distal

proximal



# CONCLUSIONS

- Different 2-stent techniques can be used in the same scenario
- Culotte offers better (angio) results than TAP stent – BBK II study
  - Bifurcation angle may be key for the technique selection
  - Suboptimal 2-stent technique can be converted into a different, successful, technique
- Imaging techniques are critical to optimize the result