Yes, Selection of the Best Stenting Technique Is Important!

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Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

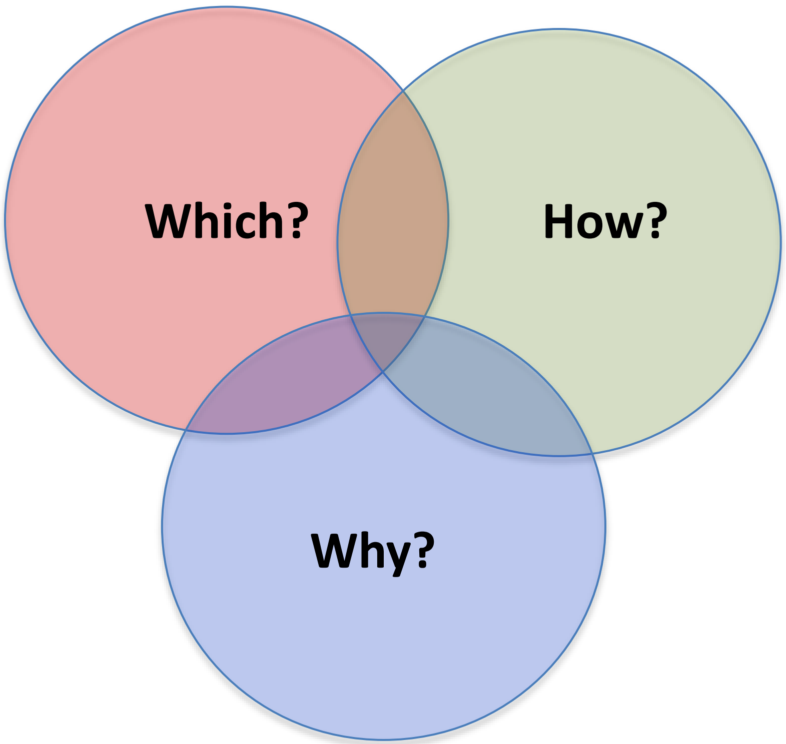
Affiliation/Financial Relationship	Company
Grant/Research Support	Abbott Vascular, Boston Scientific
Consulting Fees/Honoraria	Abbot Vascular, Biosensors, Biotronik, Boston Scientific, Cordis J&J, Medtronic
Major Stock Shareholder/Equity	
Royalty Income	
Ownership/Founder	
Intellectual Property Rights	
Other Financial Benefit	

Questions before making a decision how to treat?

- How large is the SB (diameter, vessel length, and myocardial territory supplied)
- Is the SB ostium diseased? If yes, what is the severity and length of the lesion?
- Is there severe disease in the SB beyond the ostium?
- What is the angle of the SB takeoff? Is it difficult to wire/rewire?
- What is the severity and distribution of the MV lesion?
- What will happen to the SB after MV stenting (mild or significant compromise or occlusion)?
- What are the clinical consequences of SB occlusion (depends on the territory supplied)?

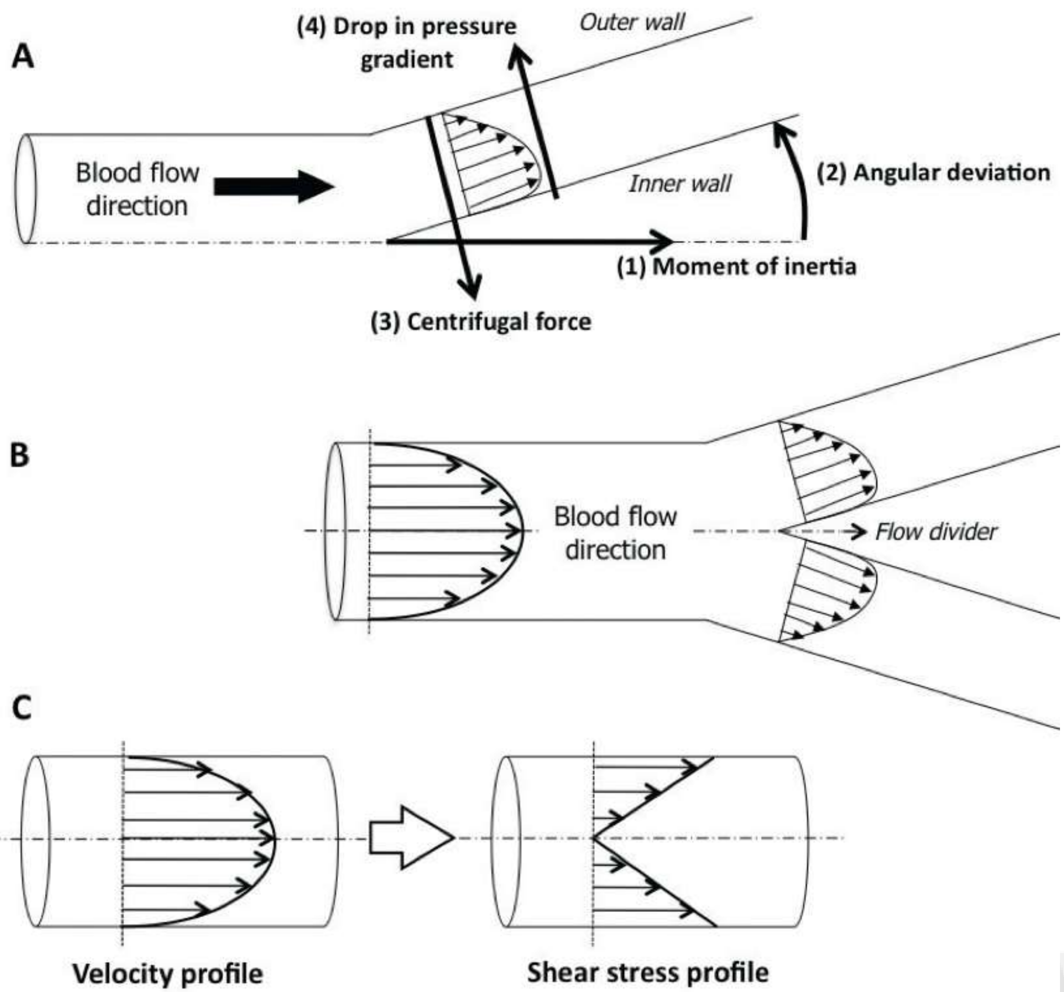
Issam D. Moussa. Catheterization and Cardiovascular Interventions 77:537–545 (2011)

Questions after the decision to use double stenting strategy?



- Which technique?
  - How to choose among the various techniques?
    - Anatomy and physiology
    - Intravascular imaging, FFR
- How to perform?
  - How to optimally perform the procedure?
    - Guide catheter selection
    - Plaque preparation
    - Stent deployment
    - Optimization
    - FFR guidance, IVUS/OCT guidance and optimization
  - How easy is the technique?
  - Operator experience and preferences?
- Why?
  - Is there an evidence-base for decision making?

Bifurcation impact on fluid dynamics



A) *Laminar flow in an artery induces a force of inertia (1) in the direction of flow; a sudden change in direction characterised by an angular deviation (2) induces a centrifugal force (3) which creates a pressure gradient at the exit from the change in direction.*

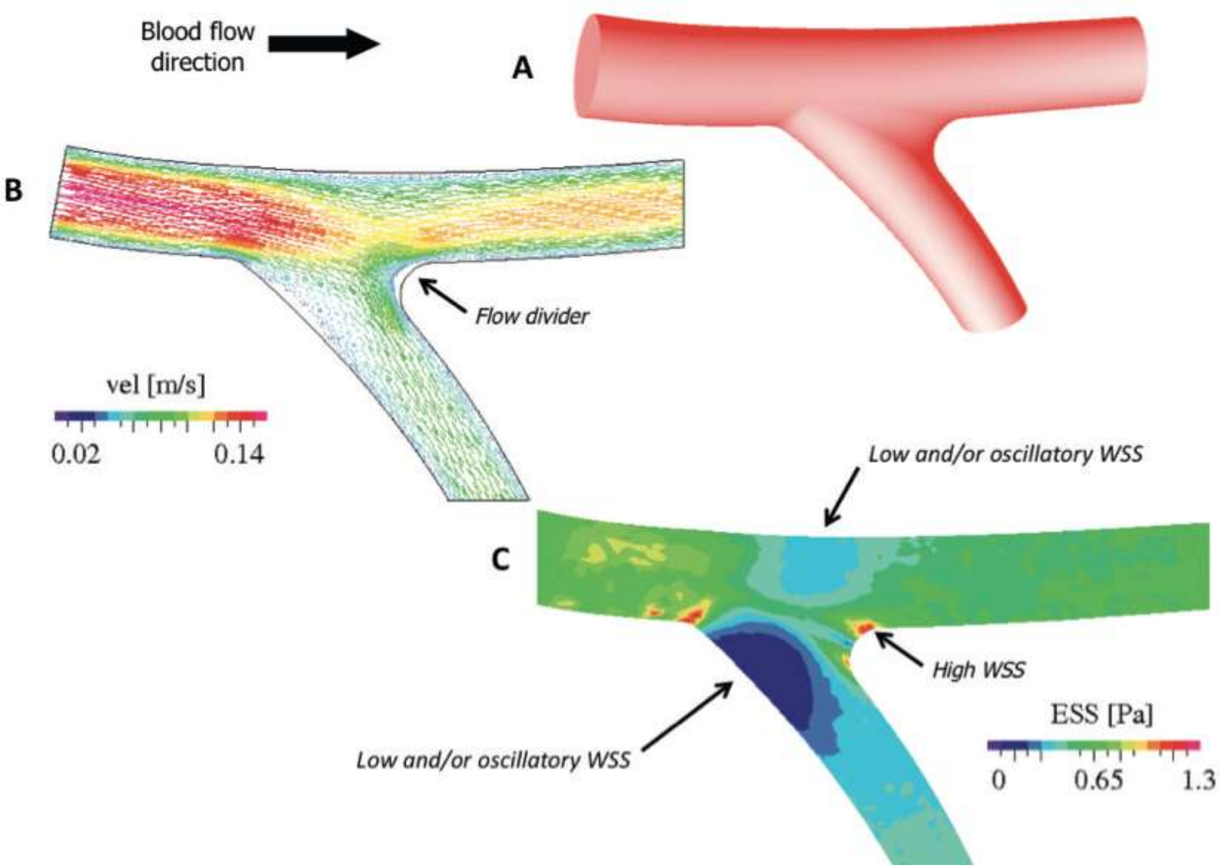
B) *Description of fluid dynamics changes from symmetric laminar flow before the bifurcation to asymmetric flow gradients after division of the flow.*

C) *The flow velocity profile is associated with a shear stress profile, corresponding to the derivative of the velocities from their radial position.*

Which?

Finet G et al. *EuroIntervention.* 2010;6 Suppl J: J10-J15

Wall shear stress in bifurcations

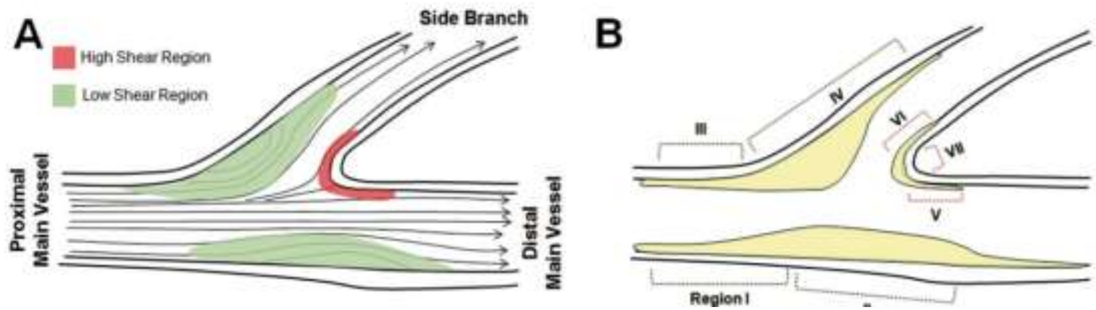


A) *The coronary bifurcation model respects a fractal geometry.*
B) *Map of velocity profile, showing the preferential route towards the flow divider induced by the force of inertia.*
C) *Map of wall shear stress (WSS) showing two contrasting regions at the flow divider where WSS is low, regions where flow is very slow and/or oscillatory.*

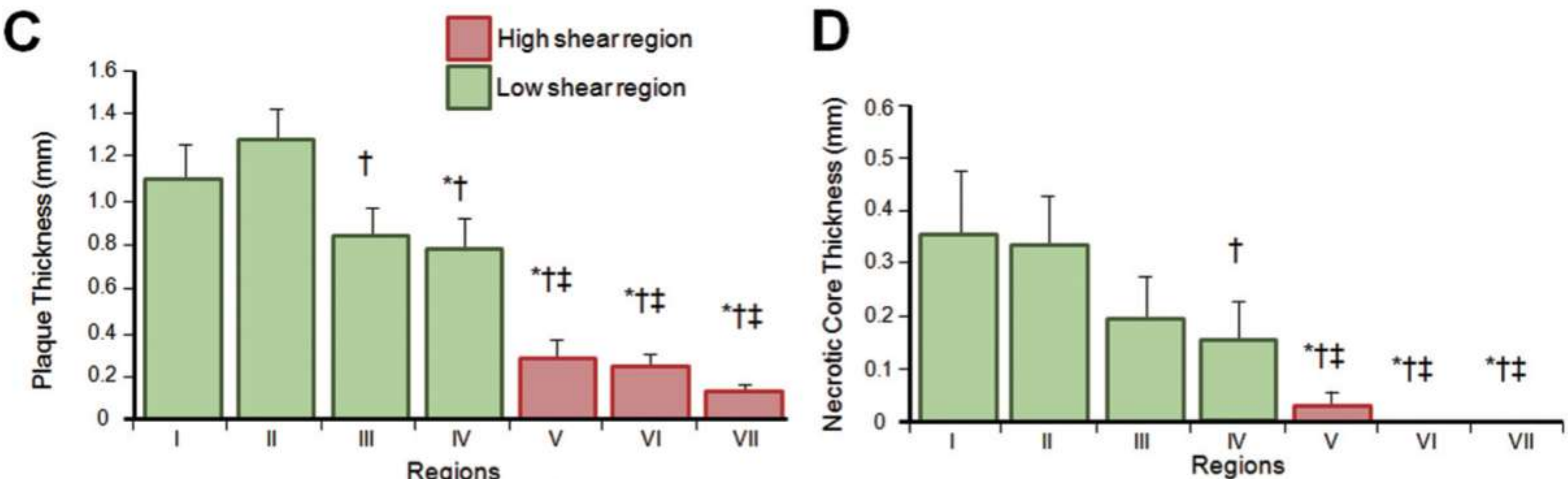
Which?

Impact of flow on atheroma in bifurcation

Flow behavior with low shear regions in the lateral walls and high shear regions at the carina.



Regions: I - Proximal MV, II - Distal MV on the lateral wall, III - Proximal MV on the SB, IV - Distal SB on the lateral wall, V - Distal MV on the flow divider side, VI - Distal SB on the flow divider side, VII – Carina.



P<0.05, vs. I (*) , vs. II (†), vs. III & IV (‡)

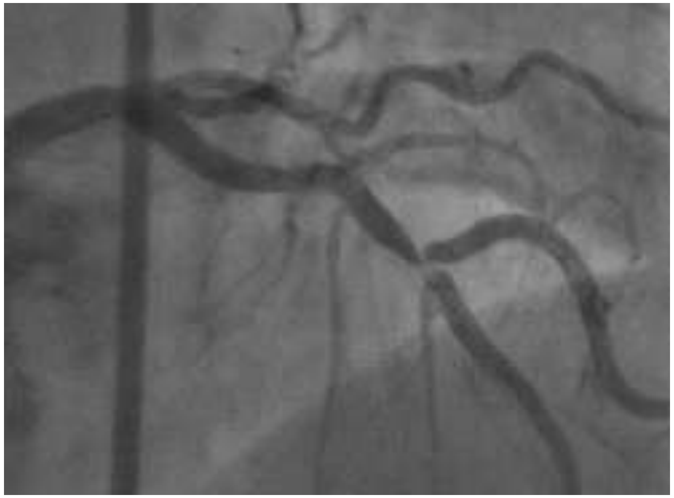
C: Plaque thickness was greater in regions of low shear as compared to high shear.

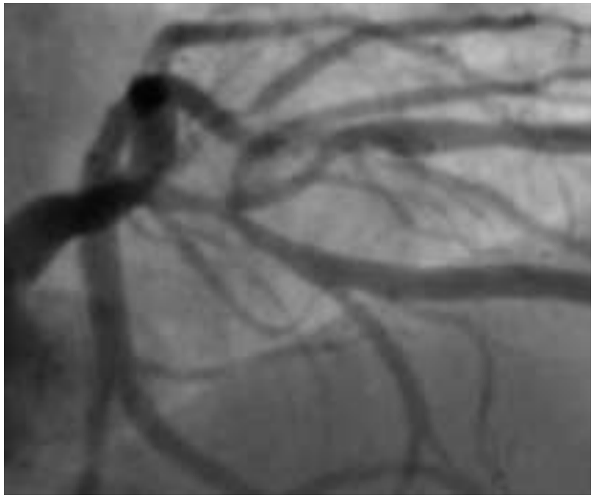
D: Necrotic core thickness was significantly greater in low shear regions as compared to high shear with absent of necrotic core at the carinal region (VII)

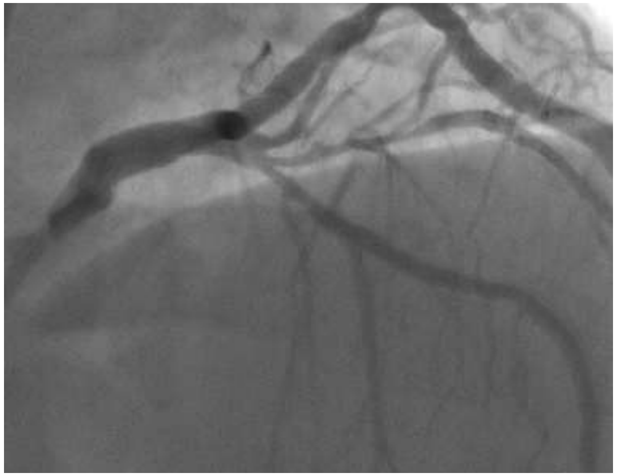
Which?

Yazdani SK, Virmani R et al. *EuroIntervention.* 2010;6 Suppl J: J24-J30

Medina 1,1,1 and Medina 1,1,1

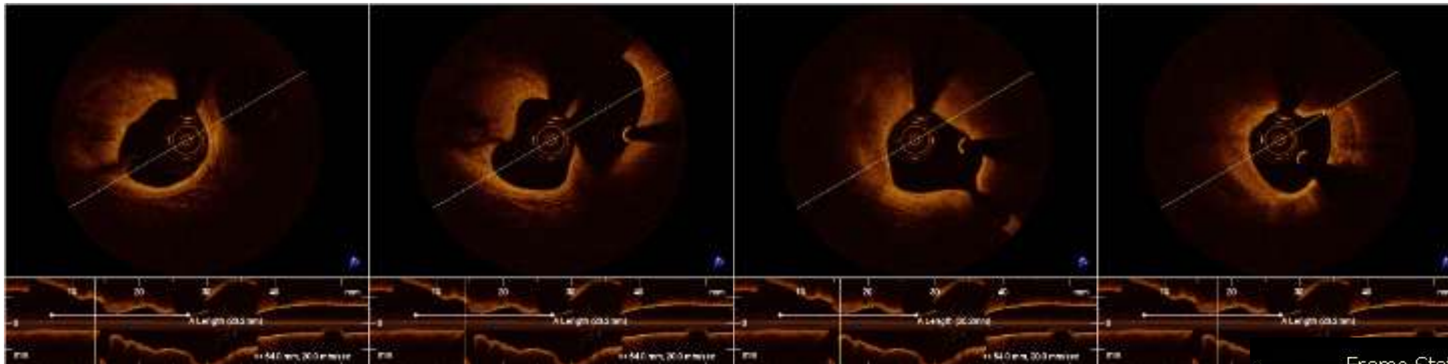


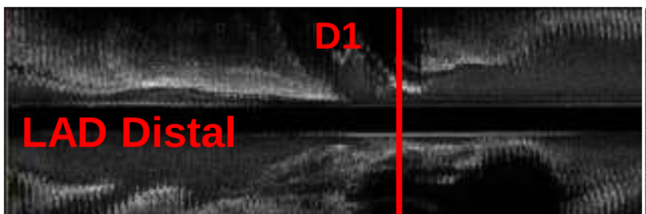


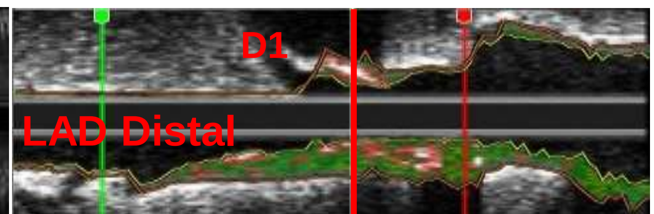


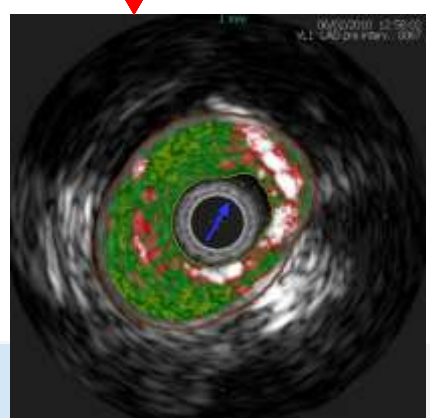
Which?

LAD Bifurcation evaluation with IVUS, OCT or VH

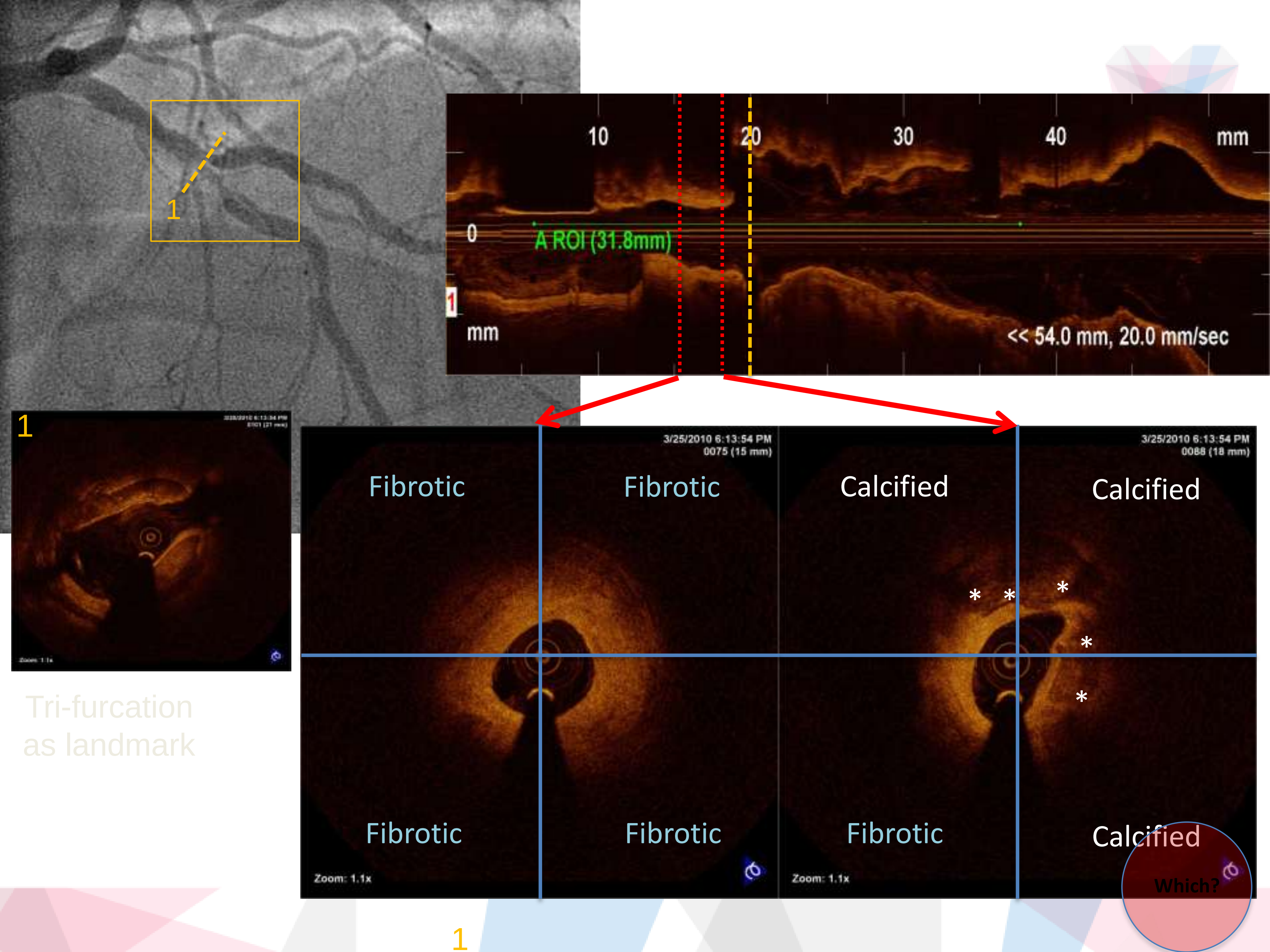








Which?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Which?
1

Impact of flow on arterial healing after stenting

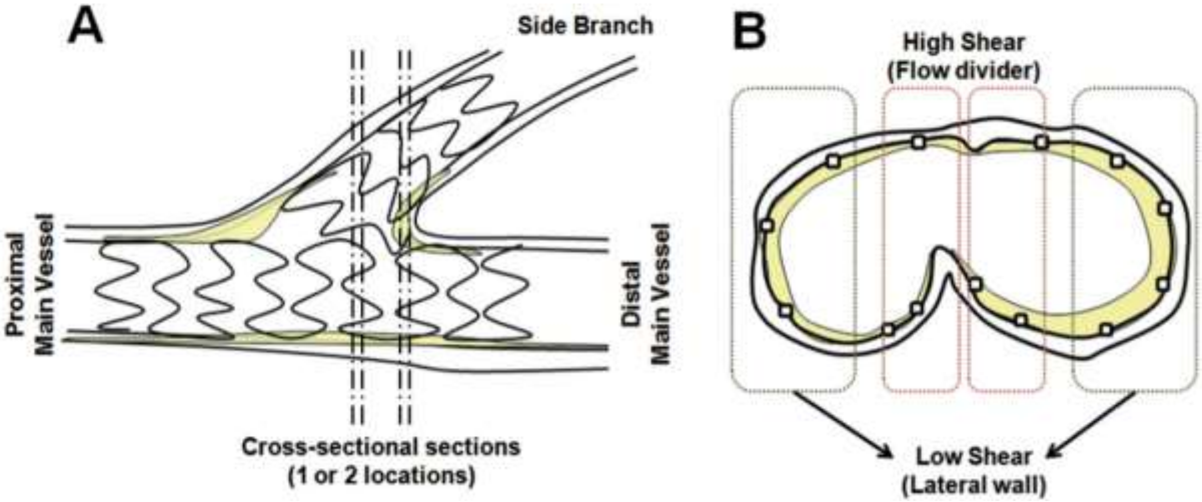


Table 2. Morphometric comparison between high shear vs. low shear regions in DES and BMS.

	DES (12 lesion, 17 stents)		p value	BMS (14 lesion, 18 stents)		p value	P value for DES vs. BMS	
	High shear (flow divider)	Low shear (lateral walls)		High shear (flow divider)	Low shear (lateral walls)		High shear	Low shear
Neointimal thickness (mm)	0.07 [0.03, 0.15]	0.17 [0.09, 0.23]	0.001	0.26 [0.16, 0.73]	0.44 [0.17, 0.67]	0.25	0.0002	0.004
Fibrin deposition (%Struts)	60 [21, 67]	17 [0, 55]	0.01	8 [0, 33]	3 [0, 21]	0.21	0.008	0.19
Uncovered struts (%Struts)	40 [16, 76]	0 [0, 15]	0.001	0 [0, 21]	0 [0, 0]	0.10	0.004	0.38

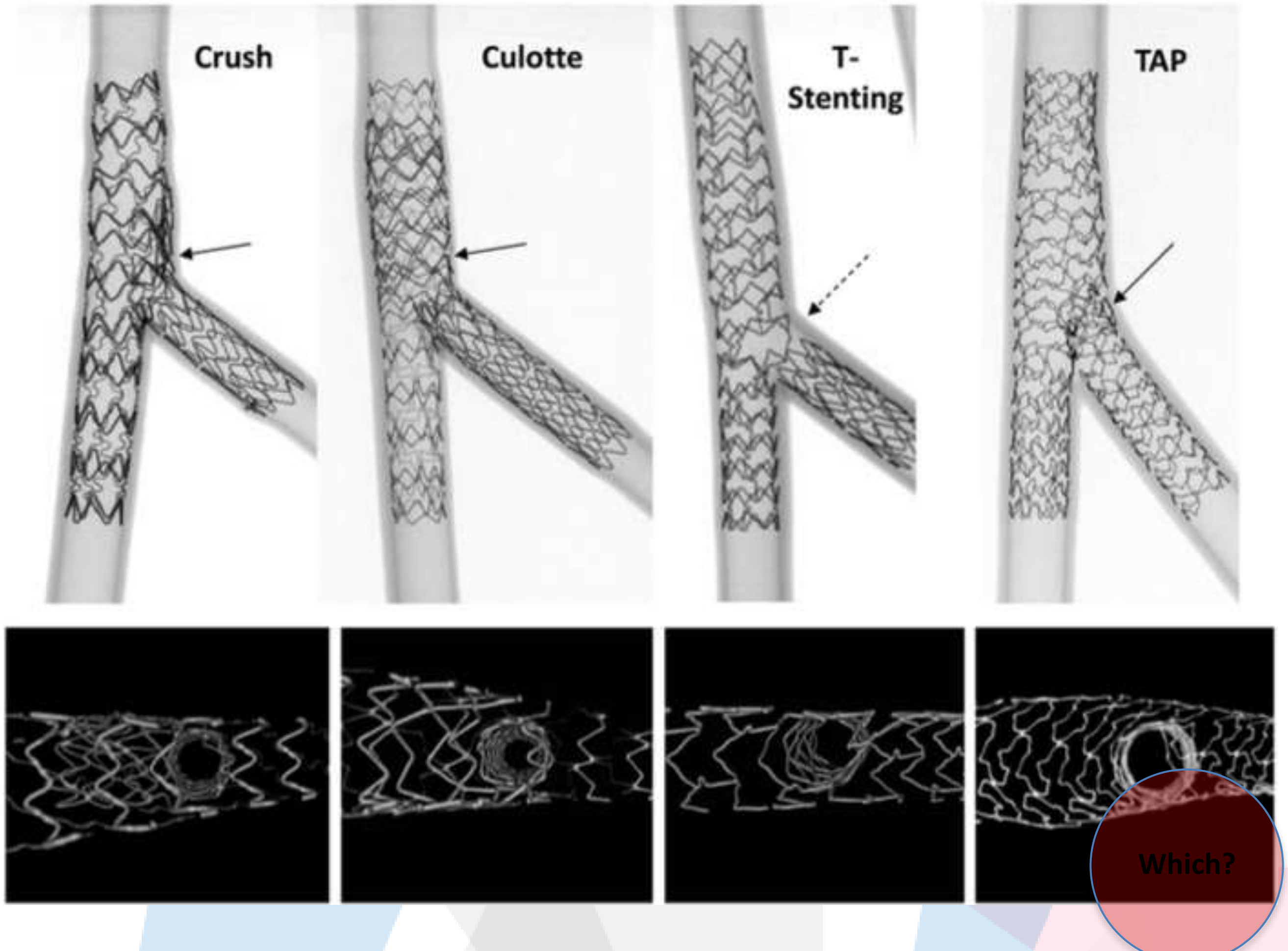
DES: drug-eluting stent; BMS: bare metal stent; Values are expressed as median and interquartile range

Which?

Yazdani SK, Virmani R et al. *EuroIntervention.* 2010;6 Suppl J: J24-J30

Insights From In Vitro Experiments and Micro-Computed Tomography

Overlapping layers of struts proximal to the SB in the Crush and Culotte techniques (arrow) increase the metallic presence and the rate of malapposition proximal to the SB. T-stenting technique can leave a gap in stent scaffolding between the main vessel stent and the SB stent (dashed arrow), whereas TAP provides scaffolding of the ostium with minimal strut overlap and malapposition in the proximal vessel.

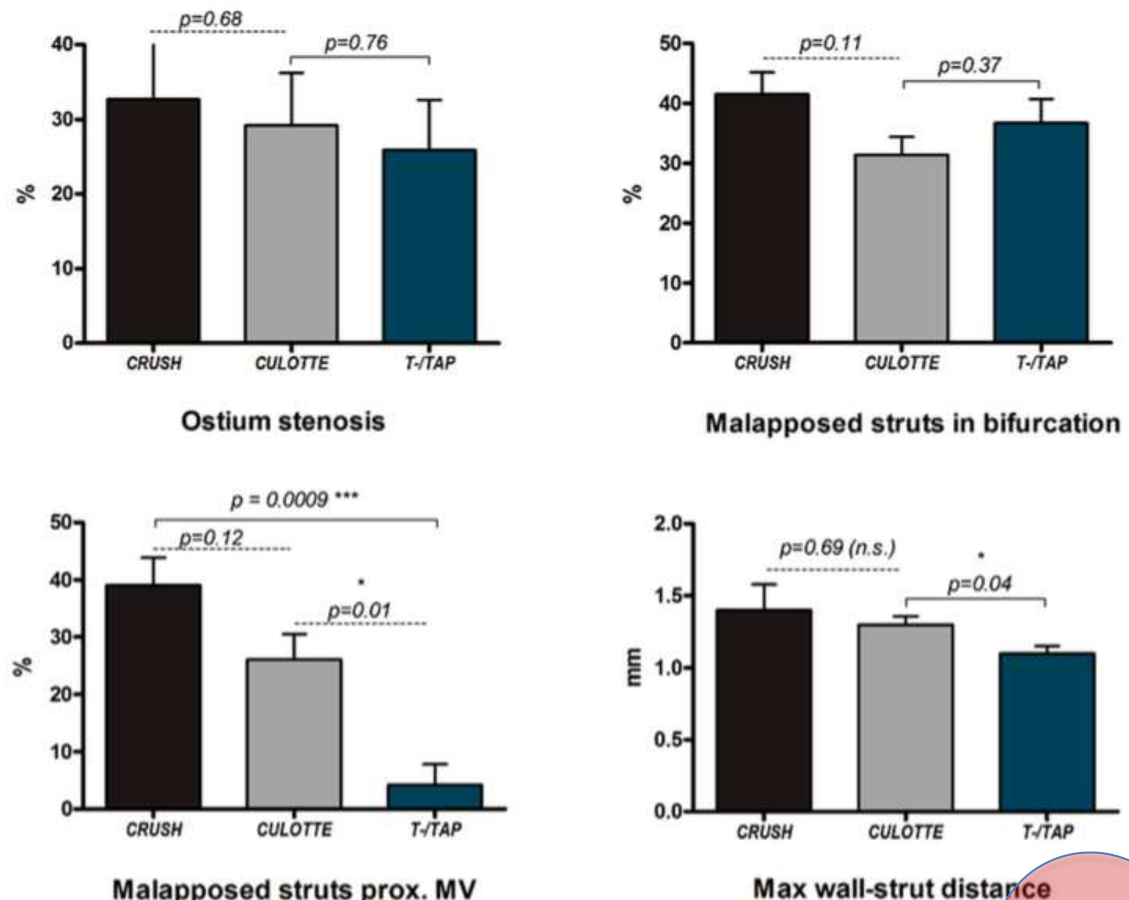


Foin N et al. *Circ J* 2013; **77:** 73 – 80

Insights From In Vitro Experiments and Micro-Computed Tomography

Non-significant trend toward a lower rate of malapposition within the bifurcation with culotte and T-/TAP techniques compared to the crush technique.
In the proximal MB, overlapping layers of struts after the crush and culotte stenting lead to a significantly higher rate of strut malapposition than with the T-/TAP technique.

The authors concluded that the crush technique resulted in a higher risk of malapposition than the culotte or T-/TAP technique



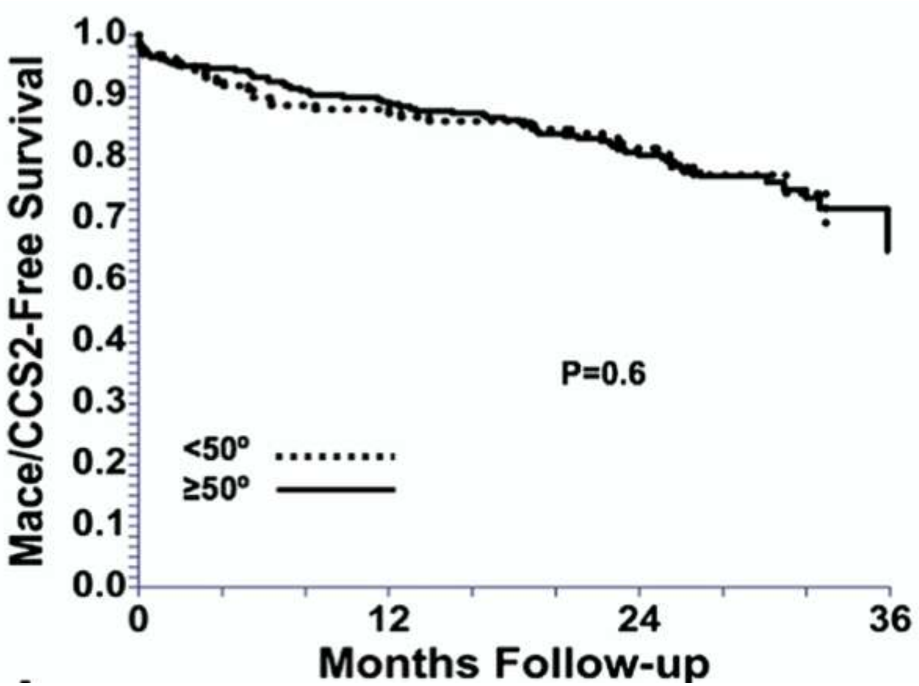
Which?

Foin N et al. *Circ J* 2013; **77:** 73 – 80

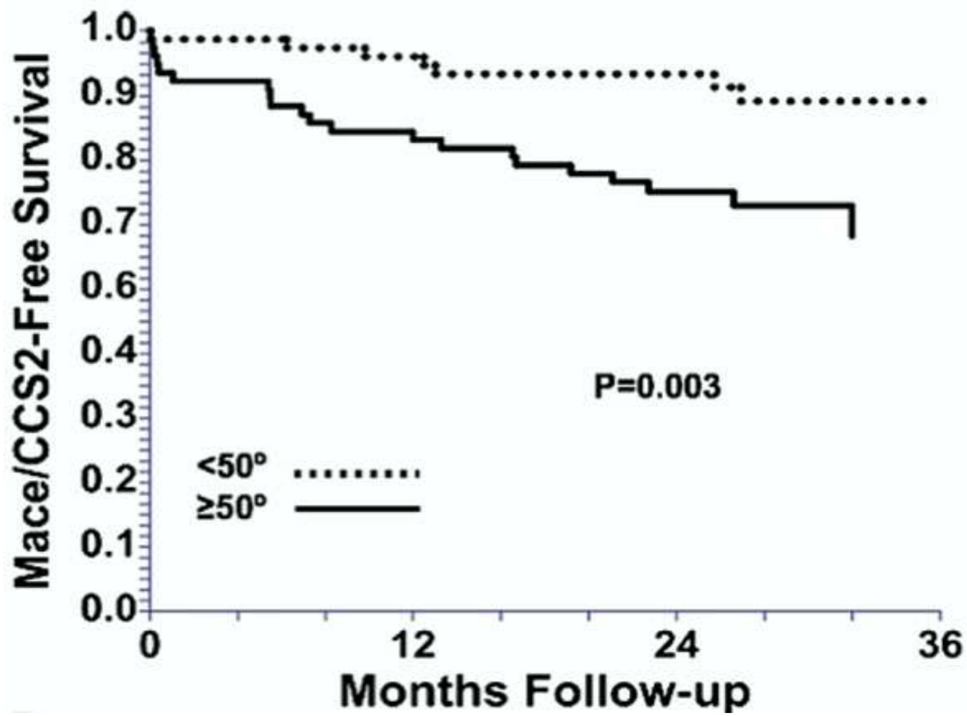
The role of bifurcation angle

Kaplan-Meier curves for MACEs or CCS class ≥2 angina-free survival

MV stenting only



Crush/Culotte stenting



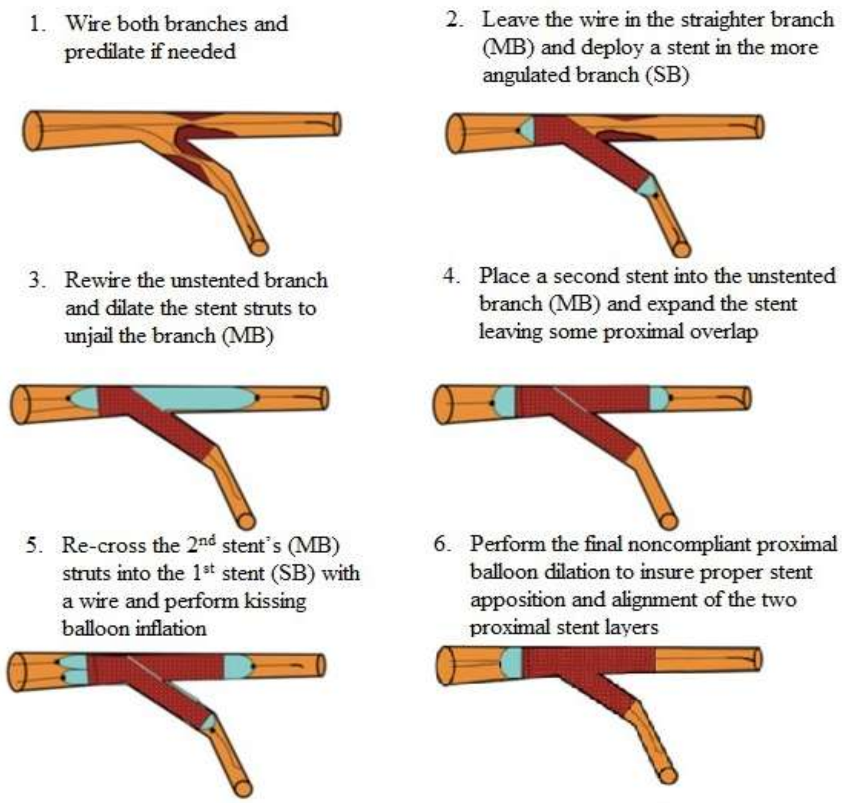
Which?

Collins N et al. *Am J Cardiol* 2008;102:404–410

Step-by-Step Approach

- ≥7F guiding catheter
- Wire both branches and predilate if needed
- Intravascular imaging for PCI guiding
- Plaque modificiation with cutting/scoring balloon/ROTA
- Stenting: new generation DES by default and BVS
- Optimization:
  - Final kissing
  - Proximal optimisation technique (POT)
- Intravascular imaging for final result optimization

Culotte technique



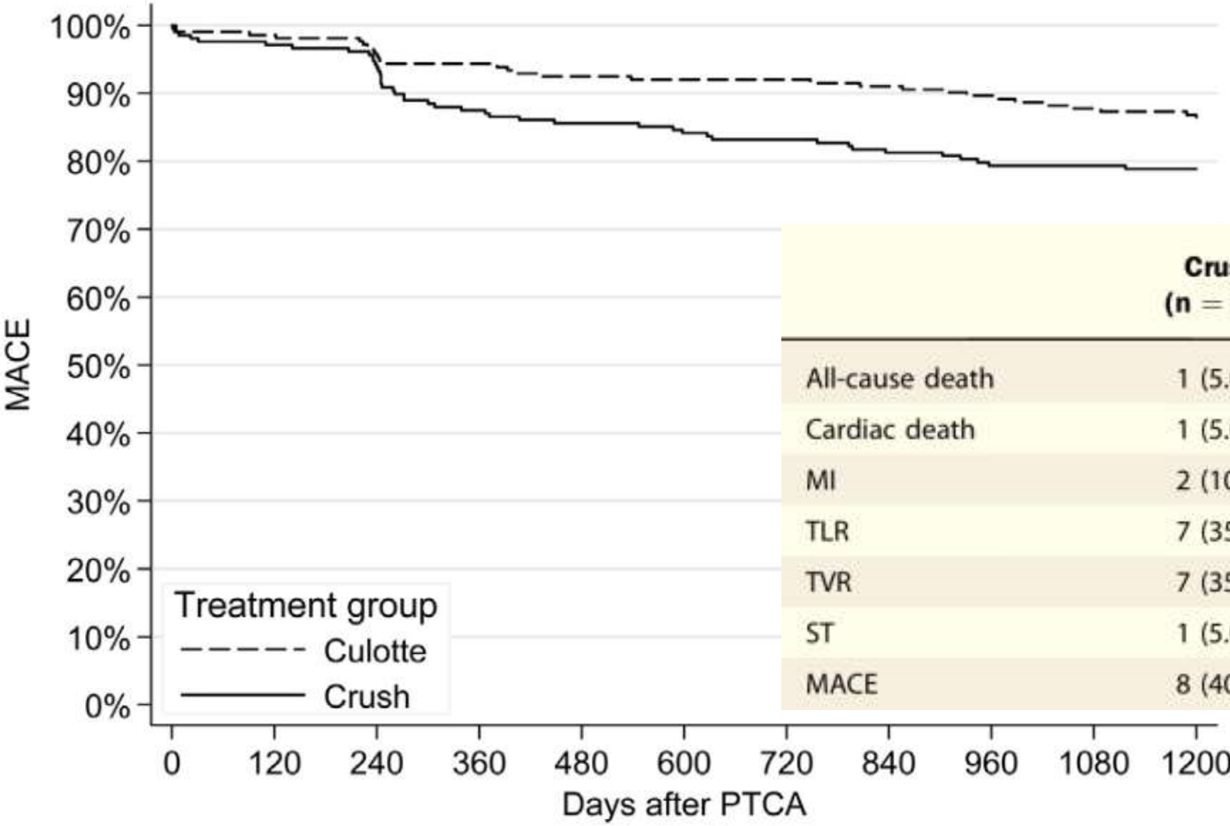
How?

Nordic II: Nordic Stent Technique Study

MACE-Free Survival at 3-Year Follow-Up

Major adverse cardiac event (MACE)-free survival (cardiac death, myocardial infarction not related to percutaneous coronary intervention, target vessel revascularization)

Nordic Stent Technique Study (NORDIC II): the first randomized clinical and angiographic comparison of the crush and the culotte bifurcation stent techniques



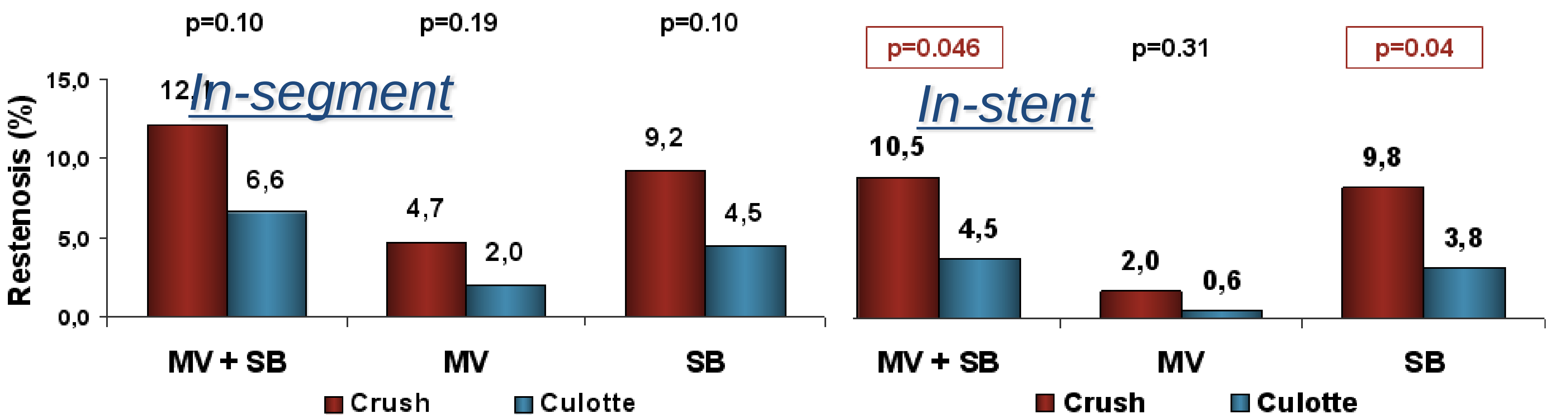
	Crush (n = 20)	Culotte (n = 21)	p Value
All-cause death	1 (5.0)	1 (4.8)	0.51
Cardiac death	1 (5.0)	0 (0.0)	0.49
MI	2 (10.0)	0 (0.0)	0.14
TLR	7 (35.0)	2 (9.5)	0.049
TVR	7 (35.0)	2 (9.5)	0.049
ST	1 (5.0)	0 (0.0)	0.49
MACE	8 (40.0)	3 (14.0)	0.01

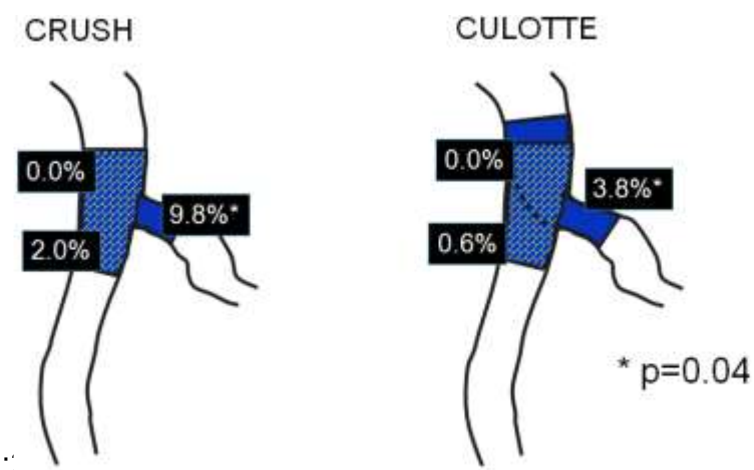
Why?

Kervinen K et al. J Am Coll Cardiol Intv 2013;6:1160–5

Nordic II:
QCA results

There is a trend towards less restenosis of the entire bifurcation lesion because of significantly reduced SB in-stent restenosis in patients treated with the CULOTTE technique (Nordic II)





Why?

Erglis et al, Circ Cardiovasc Interv. 2009;

Consensus from European Bifurcation Club, 2014

Culotte:

- Culotte is recommended for two-stent treatment of bifurcation lesions.
- When using the culotte technique, "mini-culotte" with as less proximal a double layer of stent struts as possible is recommended.
- Anatomic indications: This technique can be used in almost all true bifurcation lesions irrespective of bifurcation angle. We use this technique for treatment of bifurcations in which the MB and the SB have similar diameter .

Crush:

- Crush should be performed as mini-crush to reduce the extent of multiple strut layers in the MV.
- The DK-crush modification may aid rewiring the SB after MV stenting.
- Anatomic indications: This technique can be used in almost all true bifurcation lesions but should be avoided in wide-angle bifurcation

T-stenting:

- T-stenting is appropriate for near 90 degree bifurcations. ,TAP stenting may also be used in smaller angles.
- Anatomic indications: Bifurcation lesions with ～90 degrees angle between the MB and the SB.

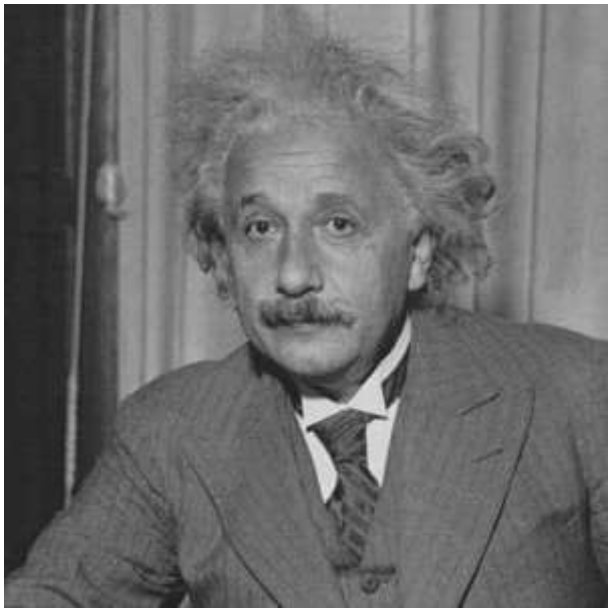
V-stent:

- V-stent technique might be used in appropriate narrow angle bifurcations.
- Anatomic indications: A (0,1,1) bifurcation with large proximal MB and a <90-degree angle between both branches.

SKS technique:

- SKS stenting is not recommended as a routine two-stent technique.

Jens Flensted Lassen et al. EuroIntervention 2014;10:545-560



Albert Einstein (1879-1955)

Make everything as simple as possible, but not simpler

Confucius (c.551-479BC)

Life is really simple, but we insist on making it complicated.