Consensus Recomandations of the European Bifurcation Club

T. Lefevre

Summit TCT Asia Pacific 2009
April 22-24, 2009, Seoul, Korea
Venue_The Convention Center of Sheraton Grande Walkerhill Hotel

Disclosure Statement of Financial Interest

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

Affiliation/Financial Relationship	Company
Minor Fees	Abbott, Boston, Cordis, Edwards

Objectives of the EBC (1)

- ✓ To gather informations on coronary bifurcation lesions.
- ✓ To define lesions and treatment techniques, standardize assessment methods and develop a common terminology.
- ✓ To promote and support research in this field.

Objectives of the EBC (2)

- ✓ To interact with industry.
- ✓ To offer the interventional cardiology community not the absolute truth but a regularly updated consensus.
- ✓ To teach the assessment and treatment techniques developed (bifurcation workshops).

Methods

« Think tank »

- ✓ « Experts » in the field of bifurcation lesions
- ✓ « Witnesses » (experienced interventional cardiologist and researchers)

EBC 1

EUROPEAN
BIFURCATION CLUB

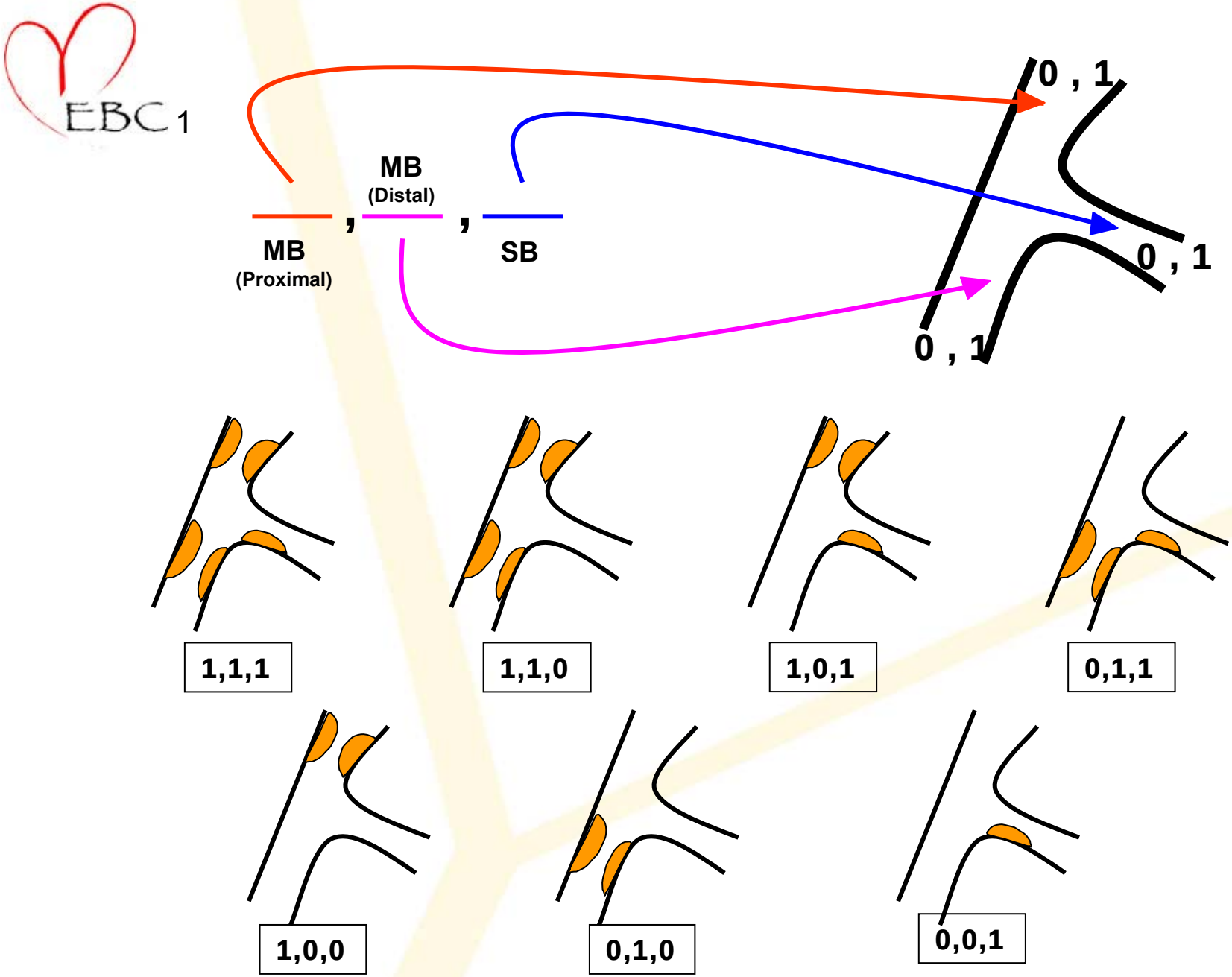
European Bifurcation Club

1st Meeting, Bordeaux,
September 15-16, 2005

Organised by:

Olivier Darremont, Thierry Lefèvre, Yves Louvard,
Goran Stankovic, Remo Albiero, Manuel Pan

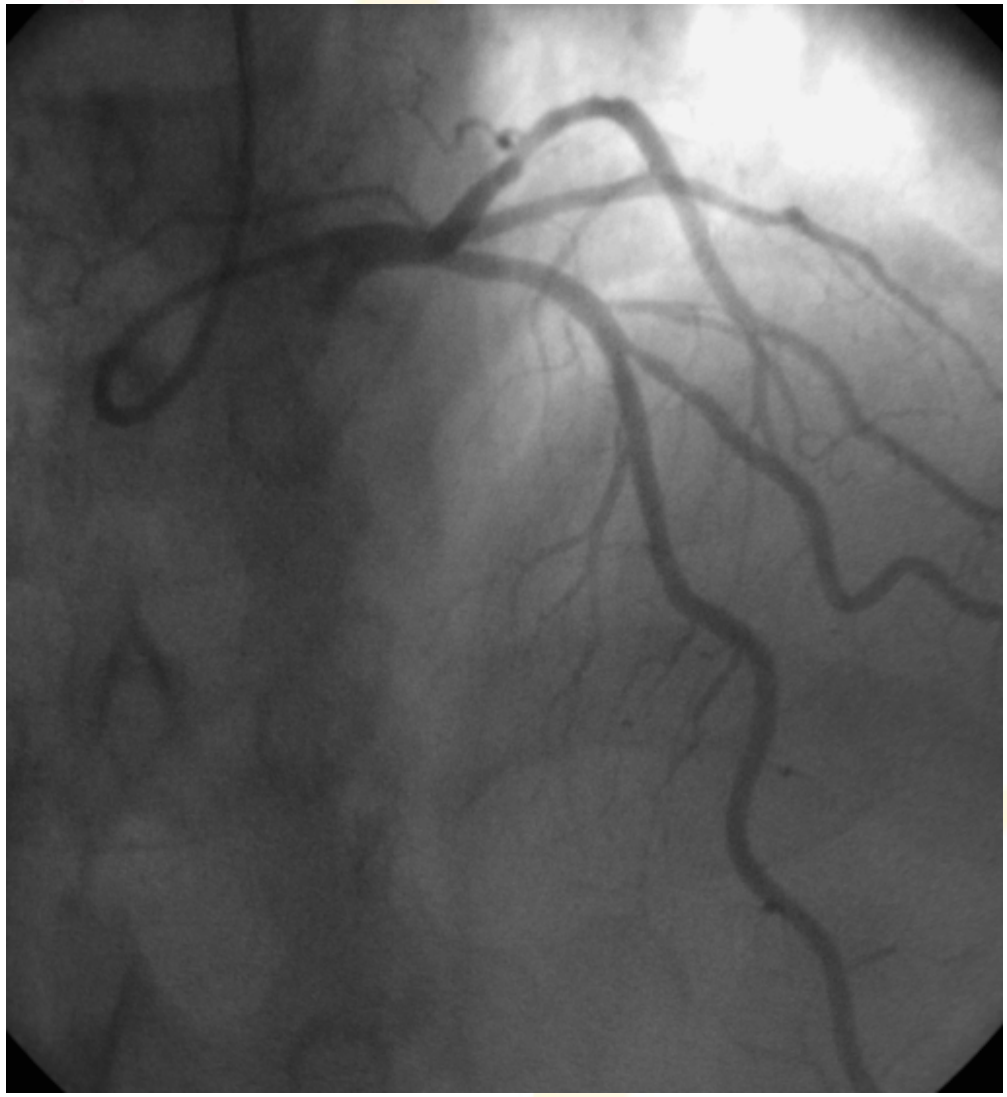
- ✓ Medina
- ✓ Murray's law
- ✓ Bench
- ✓ Kiss after crush
- ✓ Efficacy of DES
- ✓ Safety



Medina et al, Rev. Esp. Cardiol. 2006; 59 (2): 183-4

Structure-Function Scaling Laws of Vascular Trees

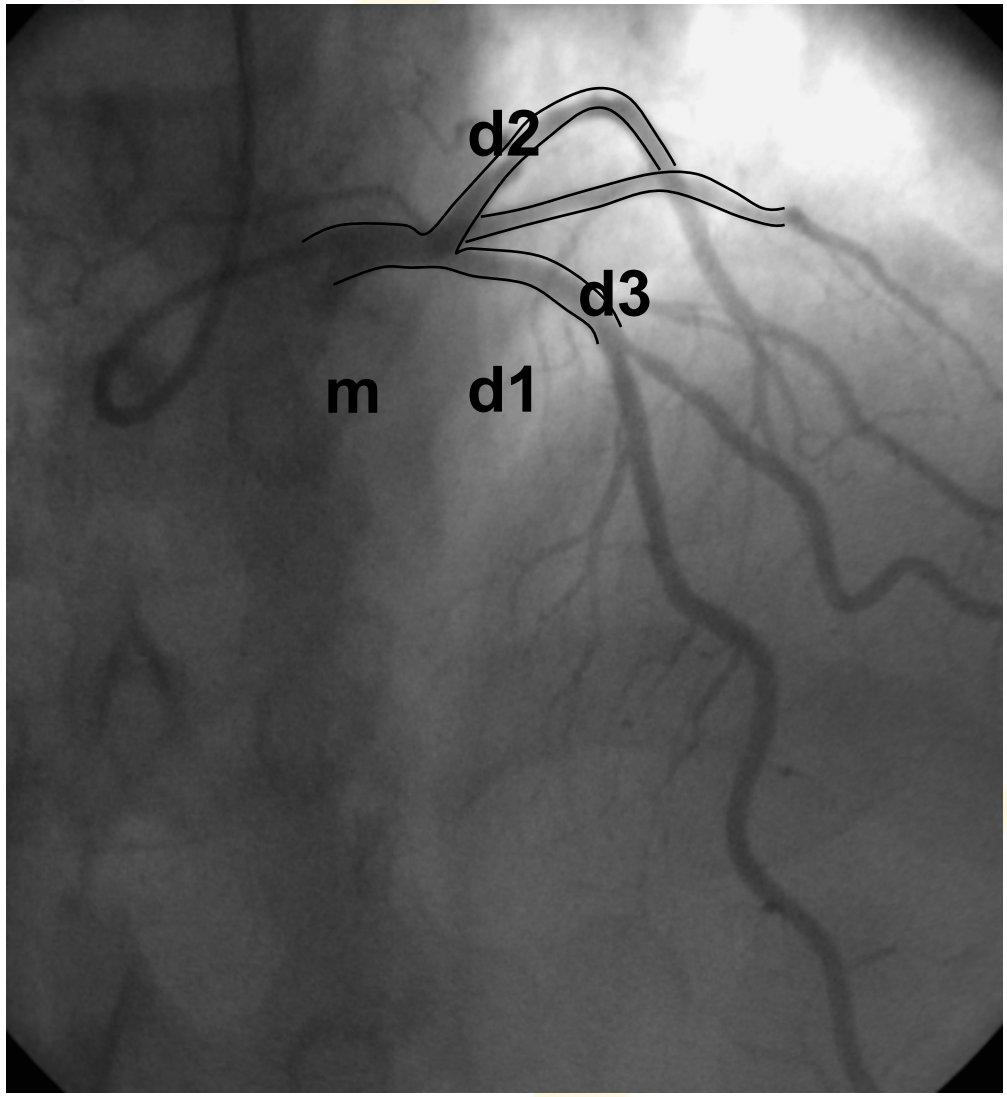
EBC 1



The branching systems in our body (vascular and bronchial trees) and those in the environment (plant trees and river systems) are characterized by a fractal nature.

Kamiya and Takahashi. J Appl Physiol March 2007

Structure-Function Scaling Laws of Vascular Trees



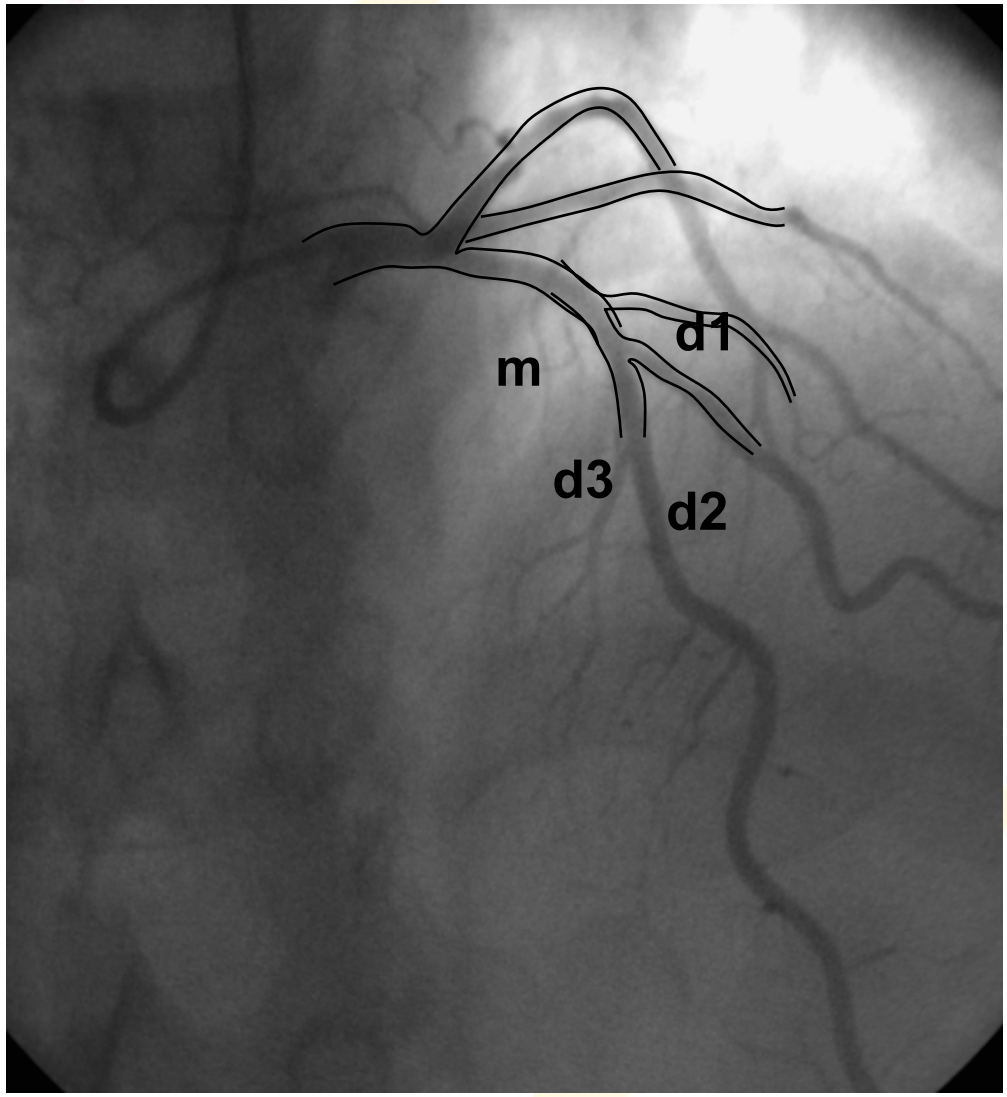
$$D_{mother}^{3} = D_{daughter\ 1}^{3} + D_{daughter\ 2}^{3} + \ldots$$

Murray's law

Murray CD. The physiological principle of minimum work. Proc Natl Acad Sci 1926

Yifang Zhou et al. Phys. Med. Biol. 1999; 44: 2929–2945.

Structure-Function Scaling Laws of Vascular Trees



$$D_{mother}^{3} = D_{daughter\ 1}^{3} + D_{daughter\ 2}^{3} + \dots$$

Murray's law

$$D_{mother} = 0.67 * (D_{daughter\ 1} + D_{daughter\ 2} + \dots)$$

G. Finet

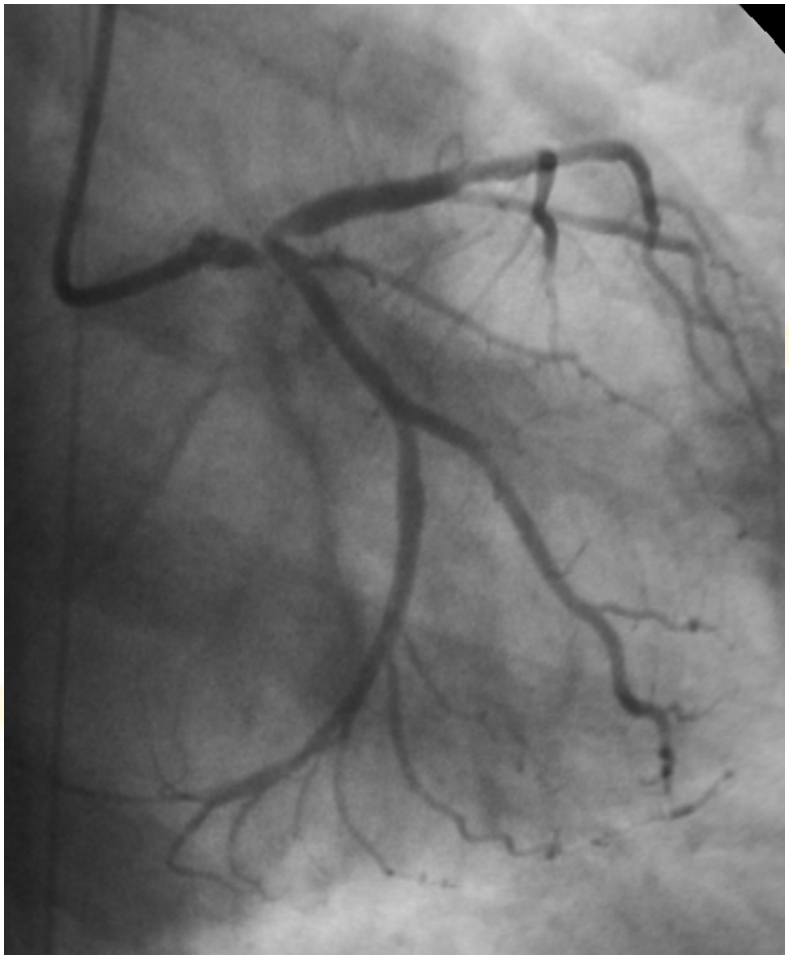
Finet et al. Eurointervention 2007; 490-8

Fractals and Self-Similarity of the Coronary Tree

Murray's law:

$$\text{Ref.} = (\text{MB} + \text{SB}) \times 0.67$$

$$\text{Ref.} = (3.6 + 3.1) \times 0.67 = 4.49 \text{ mm}$$



EBC 1

Percutaneous coronary intervention for bifurcation disease. A consensus view from the first meeting of the European Bifurcation Club

Martyn Thomas[1*], David Hildick-Smith[2], Yves Louvard[3], Remo Albiero[4], Olivier Darremont[5], Goran Stankovic[6], Manuel Pan[7], Victor Legrand[8], Bernard DeBruyne[9], Thierry Lefèvre[3]

1. Kings College Hospital, London, United Kingdom; 2. Sussex Cardiac Centre, Brighton, United Kingdom; 3. Institut Cardiovasculaire Paris Sud, Institut Jacques Cartier, Massy, France; 4. Columbus Hospital, Milan, Italy; 5. Clinique Saint Augustin, Bordeaux, France; 6. Invasive Cardiology Unit, San Raffaele Institute, Milan, Italy; 7. Servicio de Cardiologia, Hospital Reina Sofia, Universidad de Córdoba, Córdoba, Spain; 8. Centre Hospitalier Universitaire Sart Tilman, Liege, Belgium; 9. Cardiovascular Center, OLV Clinic, Moorselbaan, Aalst, Belgium

Bifurcation coronary lesions are commonplace, but present a difficult challenge to the interventional cardiologist, with a high complication rate in both the long and short term[1]. Major adverse cardiac events (MACE) are significantly higher in bifurcation versus non-bifurcation lesions[2] and this is chiefly attributable to target vessel revascularisation rather than death or myocardial infarction[3].

The first meeting of the European Bifurcation Club took place on 15th to 16th of September, 2005 in Bordeaux and was organised by Drs. Thierry Lefèvre, Yves Louvard, Remo Albiero, Olivier Darremont, Manuel Pan and Goran Stankovic. The aim was to bring together an invited faculty of European cardiologists involved in this field to discuss optimal strategies for treating bifurcation coronary artery disease and also to interact with the industry. After 36 hours of discussions an attempt was made to reach a consensus view, and this manuscript reflects the results of these discussions.

The following topics were considered:
- Definitions
- Pharmacology
- Imaging and QCA of bifurcation lesions
- Plaque modification
- Technique
- Lesion location
- Philosophy
- Physiology
- Dedicated bifurcation devices

Definitions

Definition and classification of bifurcation coronary disease is not straightforward. A general consensus exists that if a branch vessel is large enough to be stented, then the coronary division merits the term "bifurcation". This does not take account of any difference in relative size of the two vessels in question, but does have the advantage of uniformity. In practice, therefore, divisions where branch vessels of ≥ 2.25 mm diameter emerge are considered to represent bifurcations. The pattern of disease at the bifurcation may be further classified into "true" bifurcations (where the lesion involves both the main and side vessels to a significant degree – ICPS types 1 and 4) and "false" bifurcations (where only the main or side vessel is significantly involved – ICPS types 2, 3, 4a, 4b) at a bifurcation. The relative value of distinguishing between true and false bifurcations has not been established.

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EuroIntervention 2006

EBC 2

EUROPEAN
BIFURCATION CLUB

2nd European Bifurcation Club

ROME, September 29-30, 2006

Organised by:

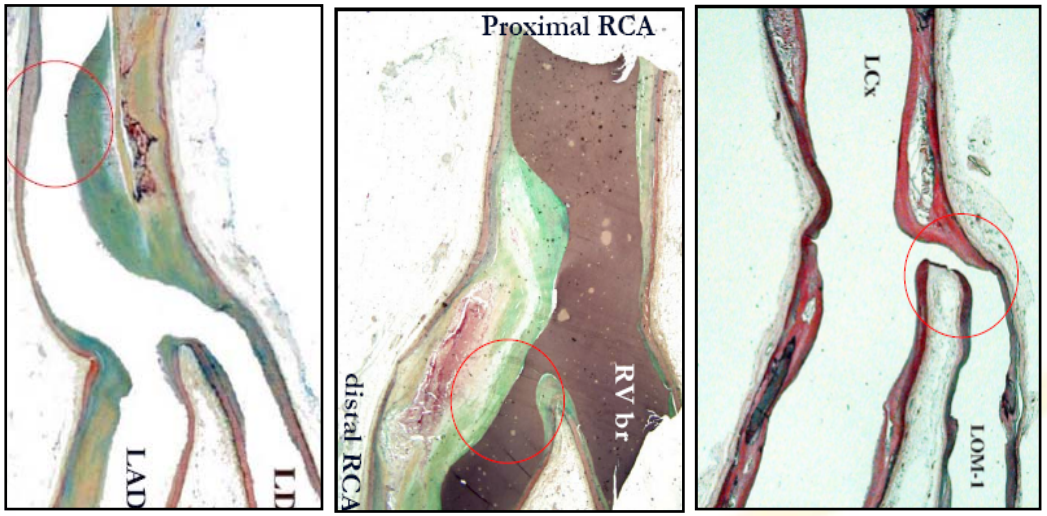
Remo Albiero, Olivier Darremont, David Hildick-Smith,
Thierry Lefèvre, Yves Louvard, Manuel Pan, Goran Stankovic

- ✓ Epidemiology
- ✓ Anatomy
- ✓ Physiology
- ✓ Treatment Classification
- ✓ QCA

Types of Involvement of Coronary Bifurcations by Atherosclerosis

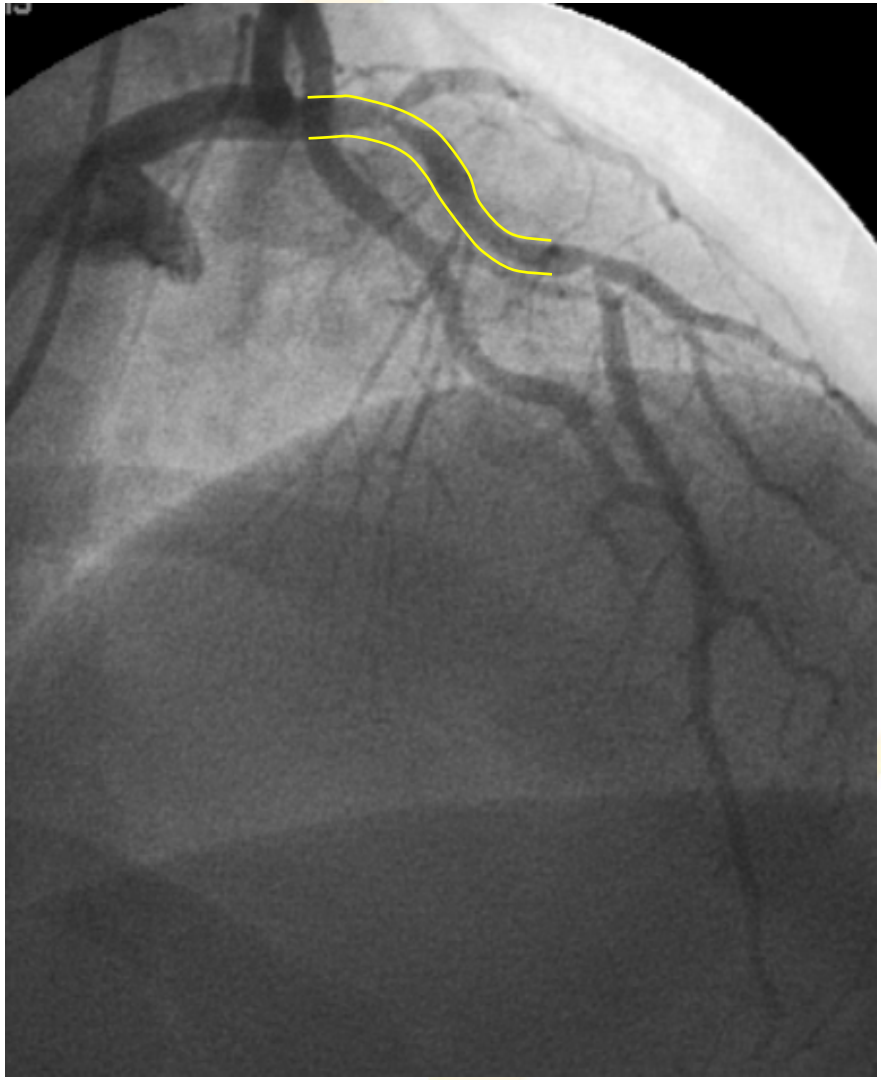
✓ Atherosclerosis occurs predominantly close to bifurcation

✓ Carinal involvement by atherosclerosis is extremely unusual.

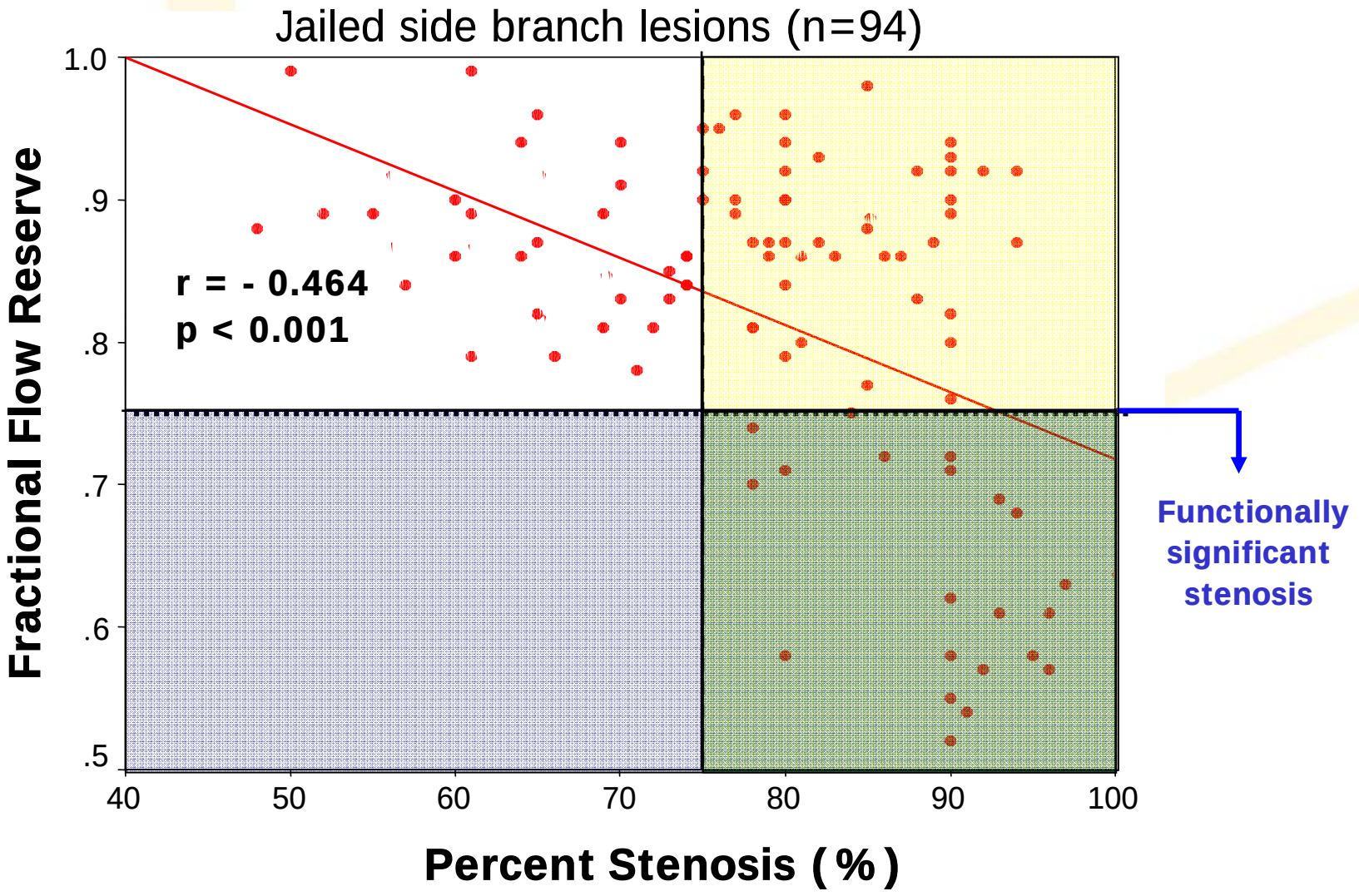


Renu Virmani

Lumen vs Plaque



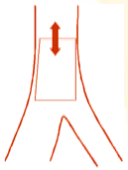
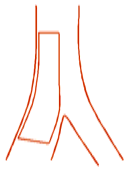
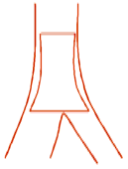
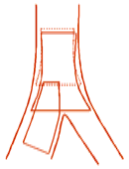
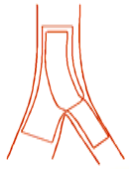
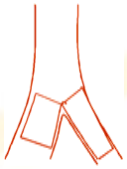
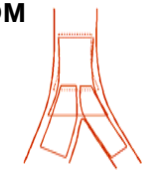
Physiology vs Angiography



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

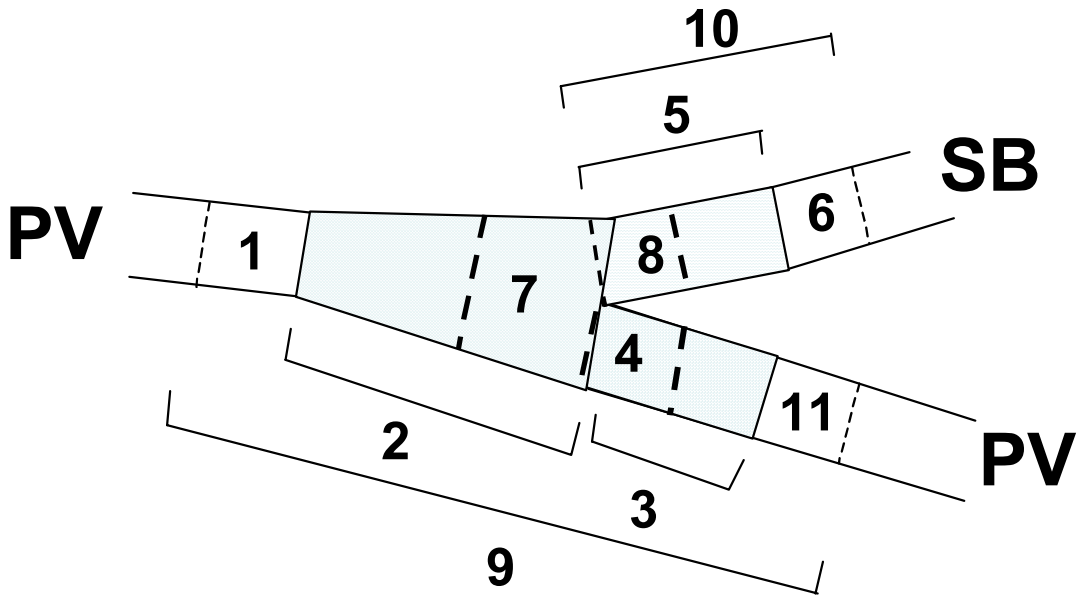
“Universal” Treatment Classification

EBC 2

	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 et al. CCVI 2007

QCA Methods for Bifurcation Lesions



1 – Proximal Edge
2 – Proximal Stent
3 – Distal PV Stent*
4 – Ostium of distal PV (5mm)
5 – SB Stent*

6 – Distal Edge of the SB Stent*
7 – Carina
8 – Ostium of the SB (5mm)
9 – PV In-Lesion
10 – SB In-Lesion
11- distal edge PV Stent

Post EBC II Consensus

EBC 2

Focus article

EuroIntervention

Percutaneous coronary intervention of bifurcation lesions: state-of-the-art. Insights from the second meeting of the European Bifurcation Club

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1. Centre Hospitalier Universitaire Sart Tilman, Liège, Belgium; 2. Kings College Hospital, London, United Kingdom; 3. Klinika kardiologie IKEM, Prague, Czech Republic; 4. Cardiovascular Center, OLV Clinic, Moorselbaan, Aalst, Belgium; 5. Interventional Cardiology, Bad Soden, Germany; 6. Department of Cardiology, University Hospital of Tromsoe, Norway; 7. Sussex Sussex Cardiac Centre, Brighton, United Kingdom; 8. Colombus Hospital, Milan, Italy; 9. Clinique St-Augustin, Bordeaux, France; 10. Institute for Cardiovascular Diseases, Clinical Center of Serbia, Belgrade, Serbia; 11. Servicio de Cardiologia, Hospital Reina Sofia, Universidad de Cordoba, Cordoba, Spain; 12. Department of Cardiology B. Skejby Hospital, University Hospital of Aarhus, Aarhus, Denmark; 13. Institut Cardiovasculaire Paris Sud, Institut Hospitalier Jacques Cartier, Massy, France

None of the authors have any conflict of interest to declare.

Introduction

Percutaneous coronary intervention (PCI) in bifurcation lesions remains complex in many respects. Part of the complexity relates to the variety of situations, definitions, treatment and outcomes which are related to this anatomical configuration. In order to develop a consensual view on the many aspects of coronary bifurcation lesions, the European Bifurcation Club (EBC) was created in 2005. The first EBC meeting took place in Bordeaux and some consensus emerged[1].

Briefly, the participants agreed that: a) the Medina classification should be adopted[2], b) with bare metal stents, a stepwise provisional T-stent strategy is the gold standard, c) with bare metal stents, deliberate double-stenting may be an inferior technique, d) with drug-eluting stents, the optimal strategy is under development and ongoing the second EBC meeting which was held in Rome on September 29th to 30th, 2006. This manuscript highlights the discussions, disputes and consensus which emerged from this meeting.

Definitions

A simple description of the treated lesion, stenosis quantification and PCI technique is not straightforward. Following the first and second EBC meetings, a general consensus emerged and led to the publication of a paper which describes the classification of coronary artery bifurcation lesions and treatments[3]. Figure 1 describe the Medina classification (lesion description) and Figures 2 and 3 the MADS classification (treatment description) which are unanimously accepted by the EBC. These classifications may need some refinements, however, and take into consideration the angle between the

EuroIntervention 2007

EBC 2

Interventional Rounds

Quantitative Angiographic Methods for Bifurcation Lesions: A Consensus Statement from the European Bifurcation Group

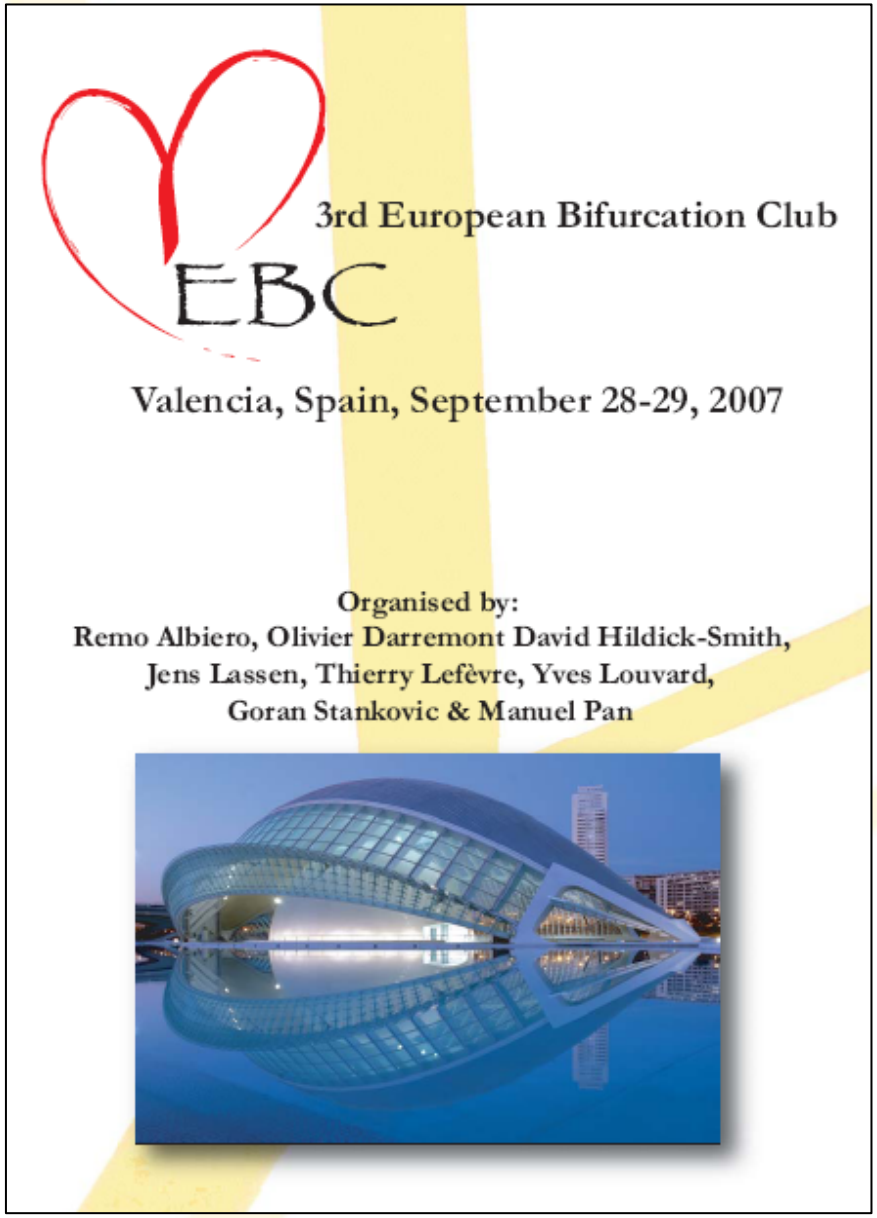
Alexandra Lansky,[1]* Joan Tuinenburg,[2] Marco Costa,[3] Micheal Maeng,[4] Gerhard Koning,[2] Jeffrey Popma,[5] Ecatarina Cristea,[1] Laurence Gavit,[6] Ricardo Costa,[7] Andrei Rares,[2] Gerritt-Ann Van Es,[8] Thierry Lefevre,[9] Hans Reiber,[2] Yves Louvard,[9] and Marie-Claude Morice,[9] on behalf of the European Bifurcation Angiographic Sub-Committee

The treatment of bifurcation lesions is complex and increasingly common. A growing number of dedicated bifurcation devices are under clinical evaluation, but no standardized methodology exists. Specifically, the angiographic analysis of bifurcation lesions is not standardized and current QCA packages are not designed for bifurcation lesions. This consensus statement outlines the limitations of conventional QCA in the bifurcation application, and outlines a new standard approach for the analysis and reporting of the angiographic results of the bifurcation lesion allowing for future trial and device comparisons and mechanistic insight into location and modes of treatment failure.

Key words: quantitative coronary angiography; diagnostic cardiac catheterization; percutaneous coronary intervention

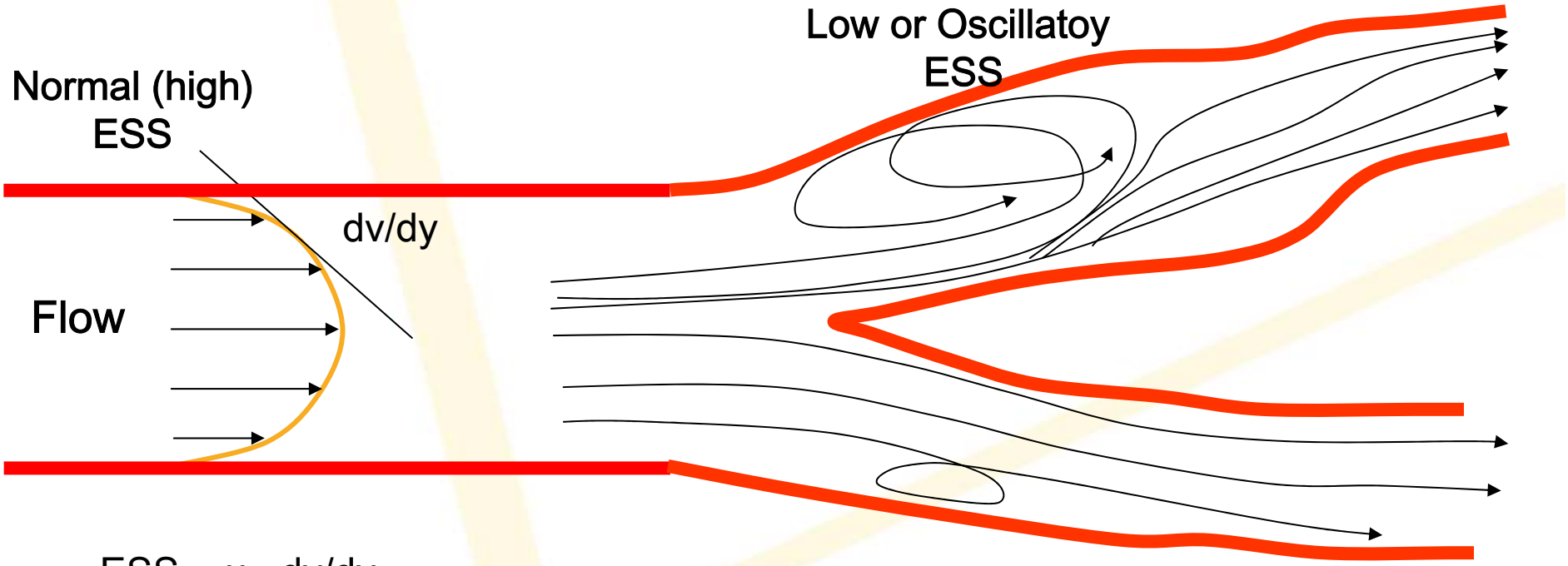
CCVI 2008

EBC 3



- ✓ Anatomy, Rheology
- ✓ Stent thrombosis
- ✓ Role of the angle
- ✓ Role of the Bench
- ✓ Dedicated devices

Shear Stress



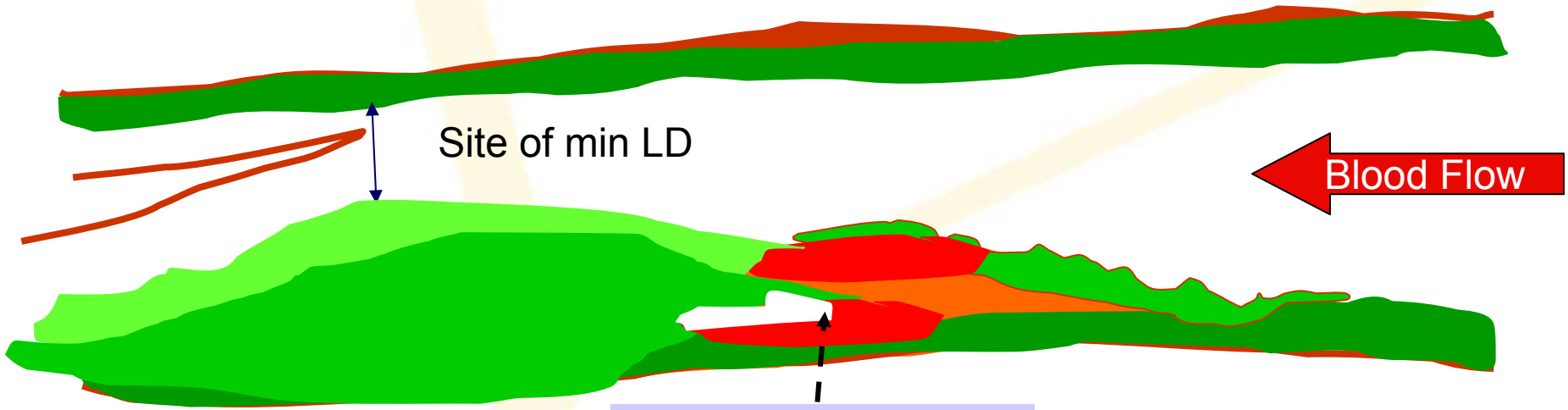
ESS = μ . dv/dy

μ = viscosity
dv/dy = spatial gradient of blood velocity at the wall

Adapted from Y S Chatzisisis et al JACC 2007

Anatomy / rheology

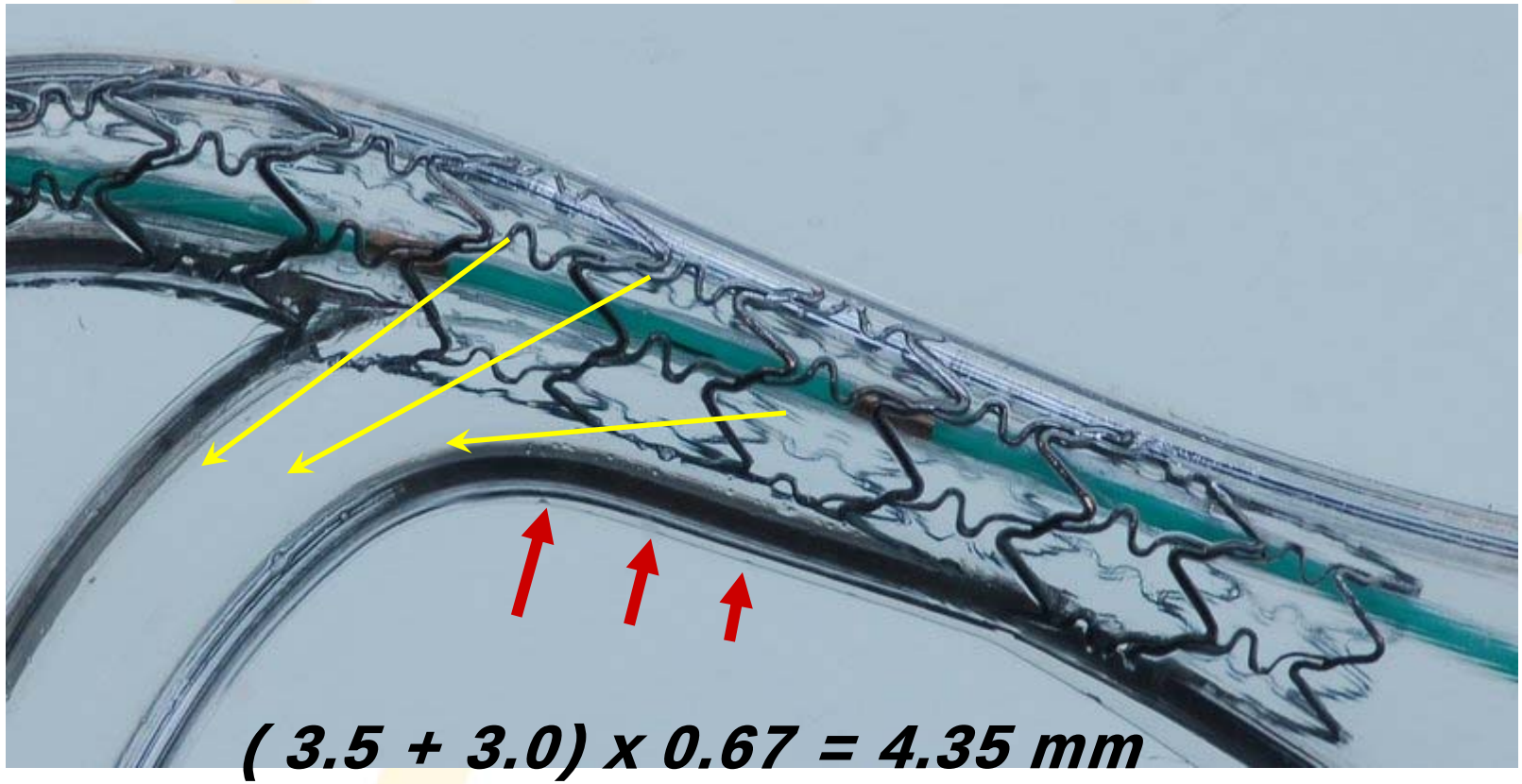
- ✓ Plaque (necrotic core) proximal extension is under-estimated by angio (VH).
- ✓ Spot stenting or bifurcation refusal may miss the plaque.



R. Virmani, CVPath and
P. Margolis, Volcano Corp.

Proximal Optimization Technique

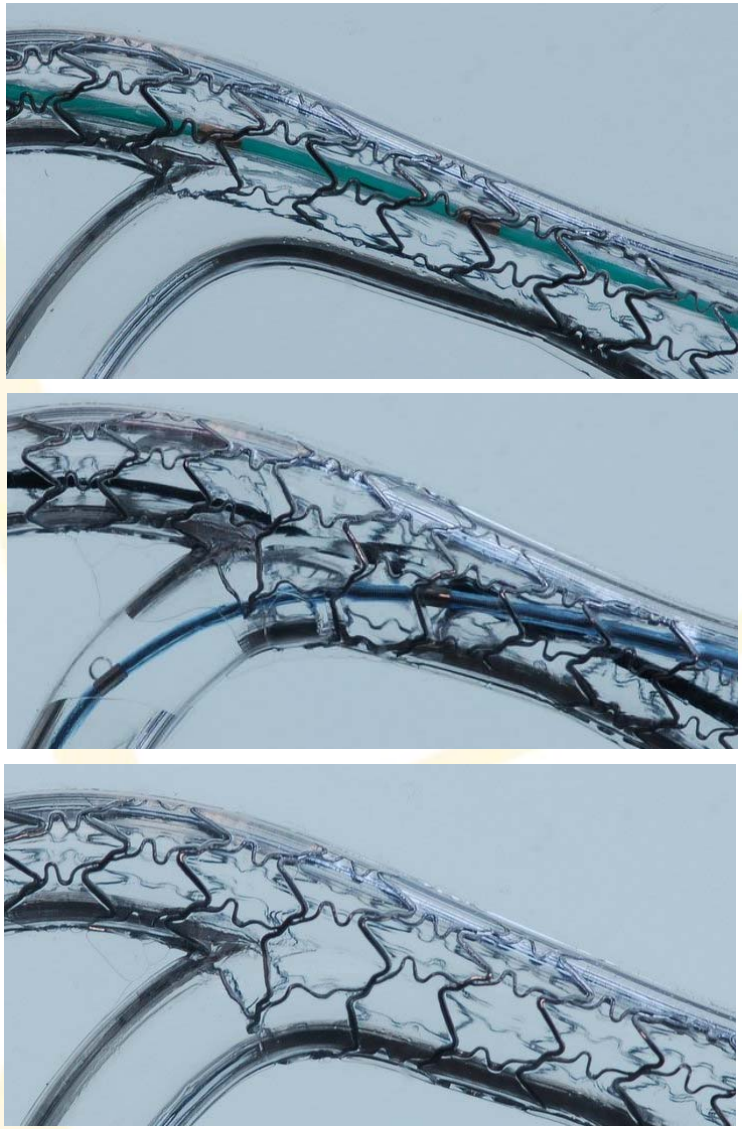
Cypher Select 3.5 x 23mm



Proximal Optimization Technique
Cypher Select 3.5 x 23mm

Darremont et al. EBC 2007

Proximal Optimization Technique
Cypher Select 3.5 x 23mm



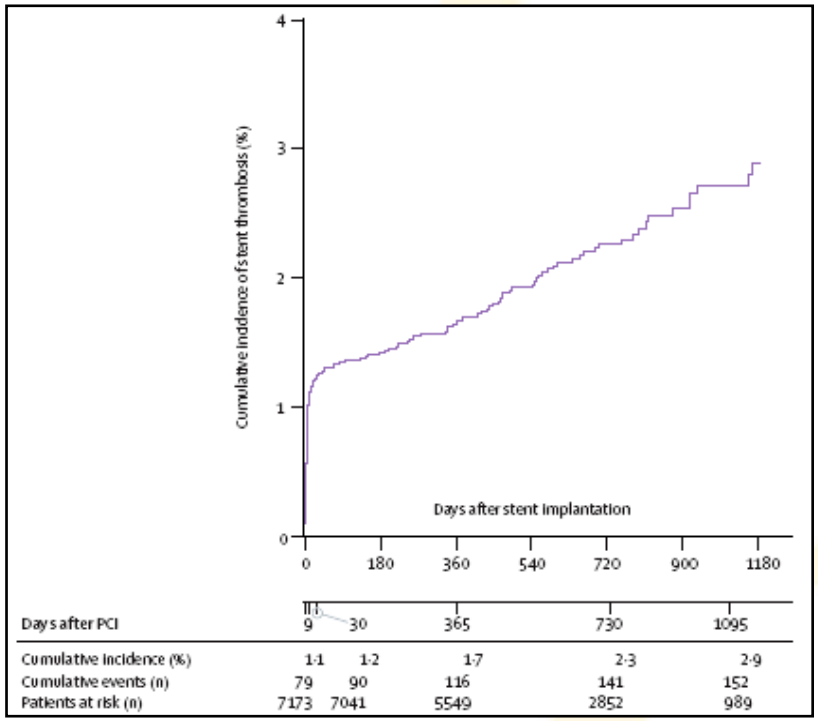
Darremont et al. EBC 2007

Bifurcation as a Potent, Independent Risk Factor for Stent Thrombosis

	n	RR	95% CI	FU
Iakovou et al JAMA 2005	2229	5.96	1.90 - 18.68	Subacute
	2229	8.11	2.50 - 26.26	Late
Ong et al JACC 2005	1017	3.00	1.30 - 6.80	6 mo
Kuchulakanti et al Circulation 2006	2974 4.40	1.96 - 10.00		12 mo
Hwang + Koo TCT 2006		10.21	4.75 – 21.92	Late

Bifurcation as a Potent, Independent Risk Factor for Stent Thrombosis

Bern-Rotterdam registry (n=8146 patients)

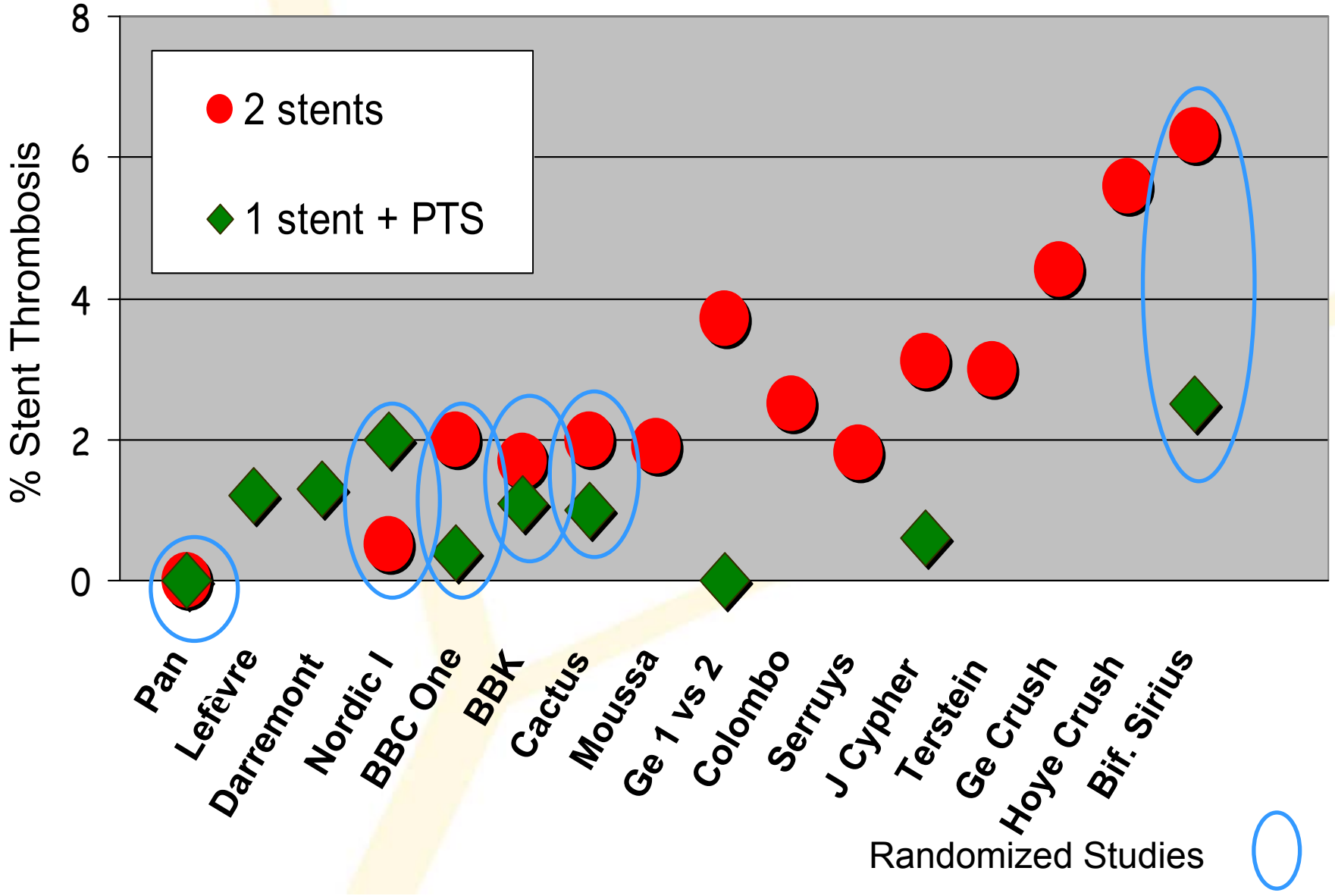


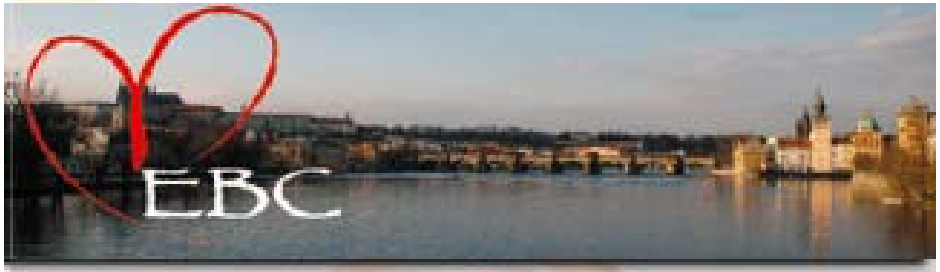
Multivariate Cox proportional hazards model to identify the presence of a bifurcation lesion as an independant predictor of stent thrombosis

Early ST	2.52	(1.26-5.02)
Late ST	0.22	(0.03-1.71)
Overall ST	1.47	(0.79-2.72)

Daemen et al, Lancet 2007

Bifurcation as a Potent, Independent Risk Factor for Stent Thrombosis





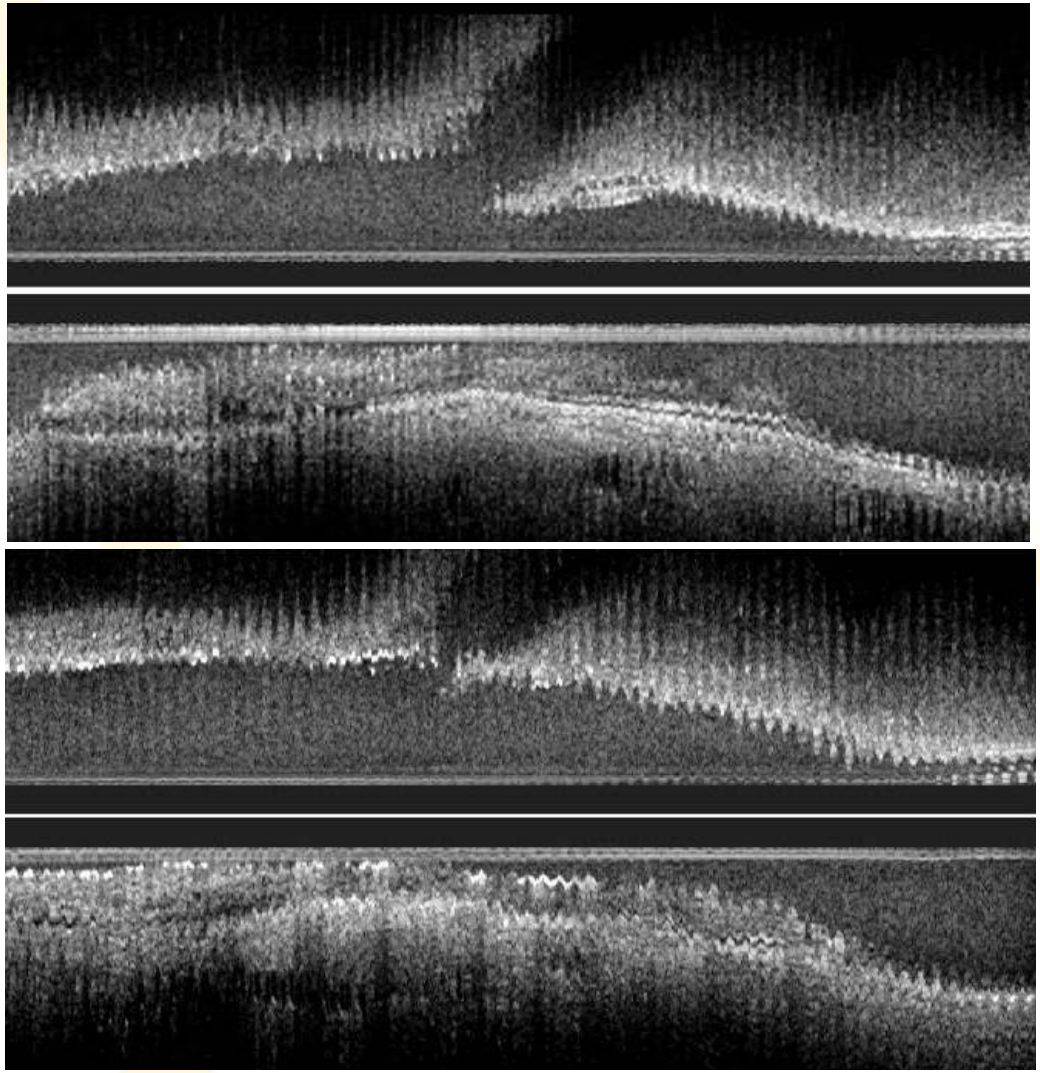
IV European Bifurcation Club Meeting

PRAGUE - 26-27 September 2008

EBC

- ✓ Carena shifting
- ✓ Optimal Technique
- ✓ Stent Design
- ✓ Role of the angle

Carena Shifting

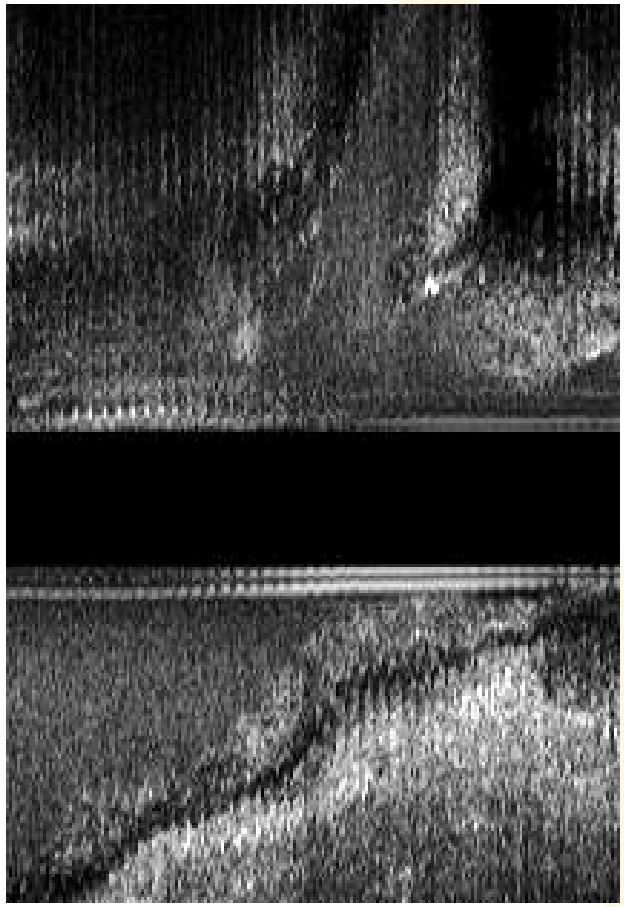


Before

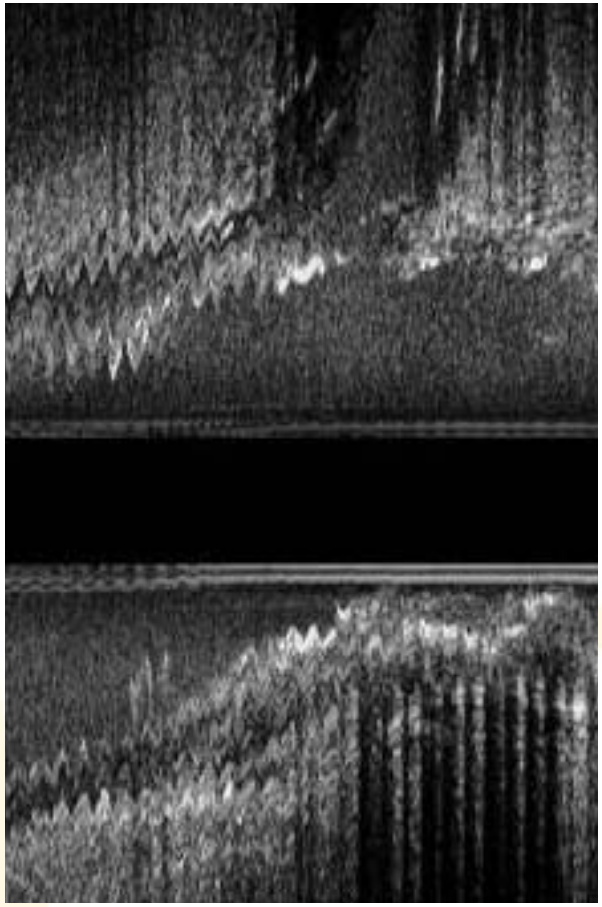
After stent

Koo et al EBC 2008

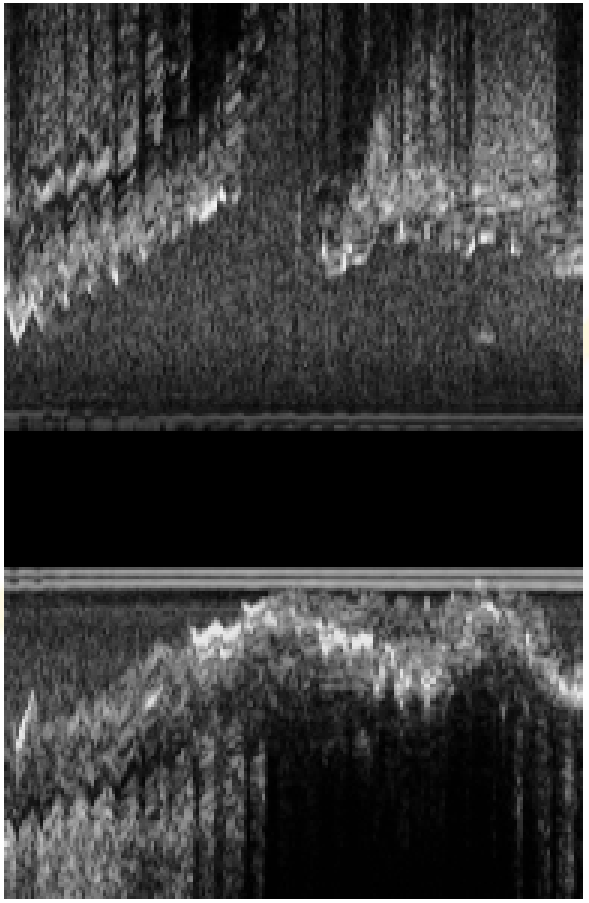
Carena Shifting



Pre-intervention

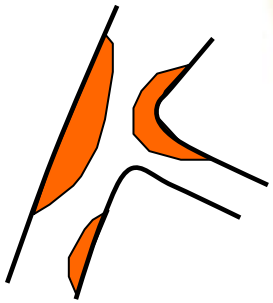


MB stenting

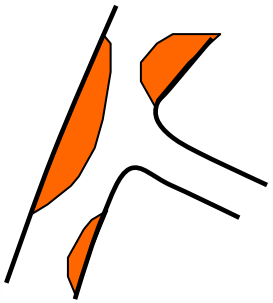


Kissing balloon

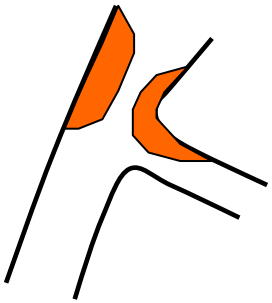
New Medina Classification



1,1,1

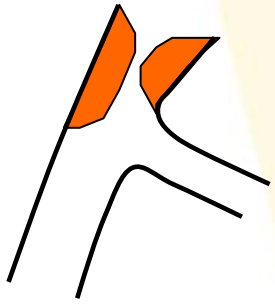


1,1,0

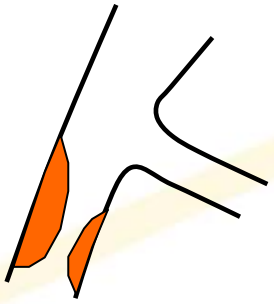


1,0,1

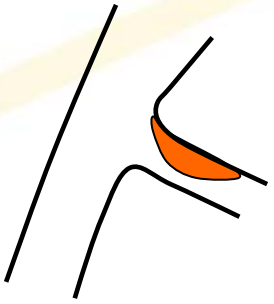
0,1,1



1,0,0



0,1,0



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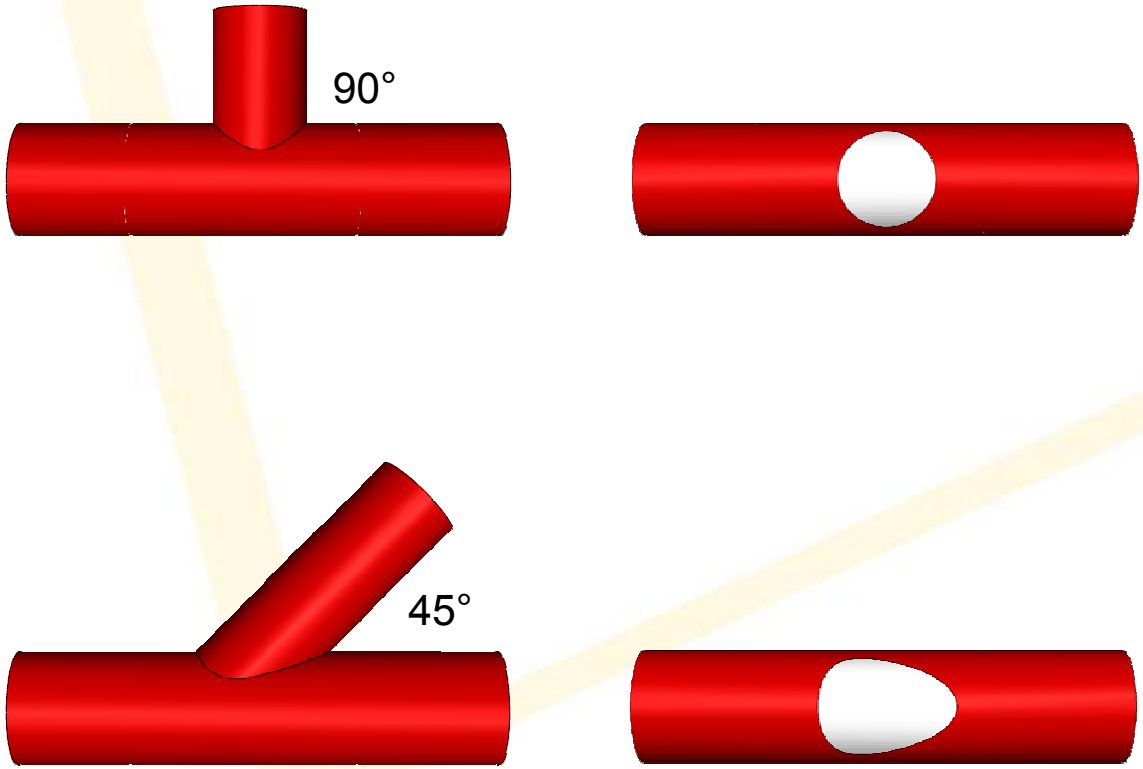
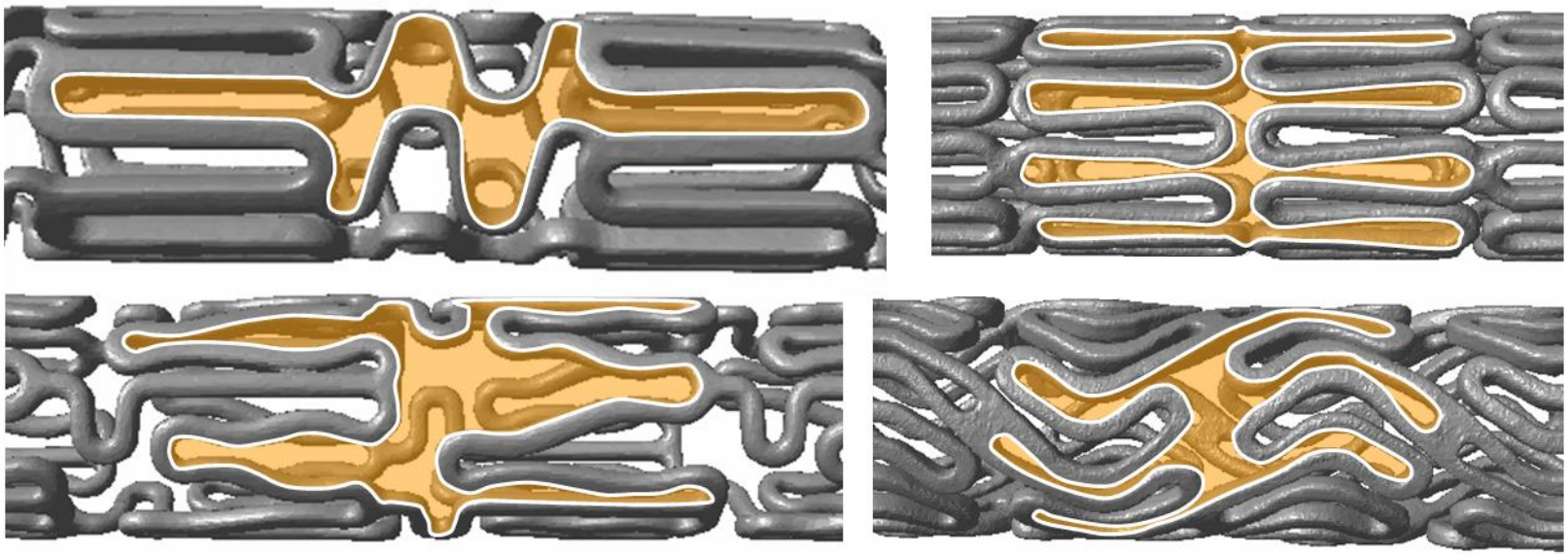
Size of the ostium



From Mortier et al. EBC IV, Prague 2008

Size of stent cell



From Mortier et al. EBC IV, Prague 2008

Cell Sizes Differ Considerably

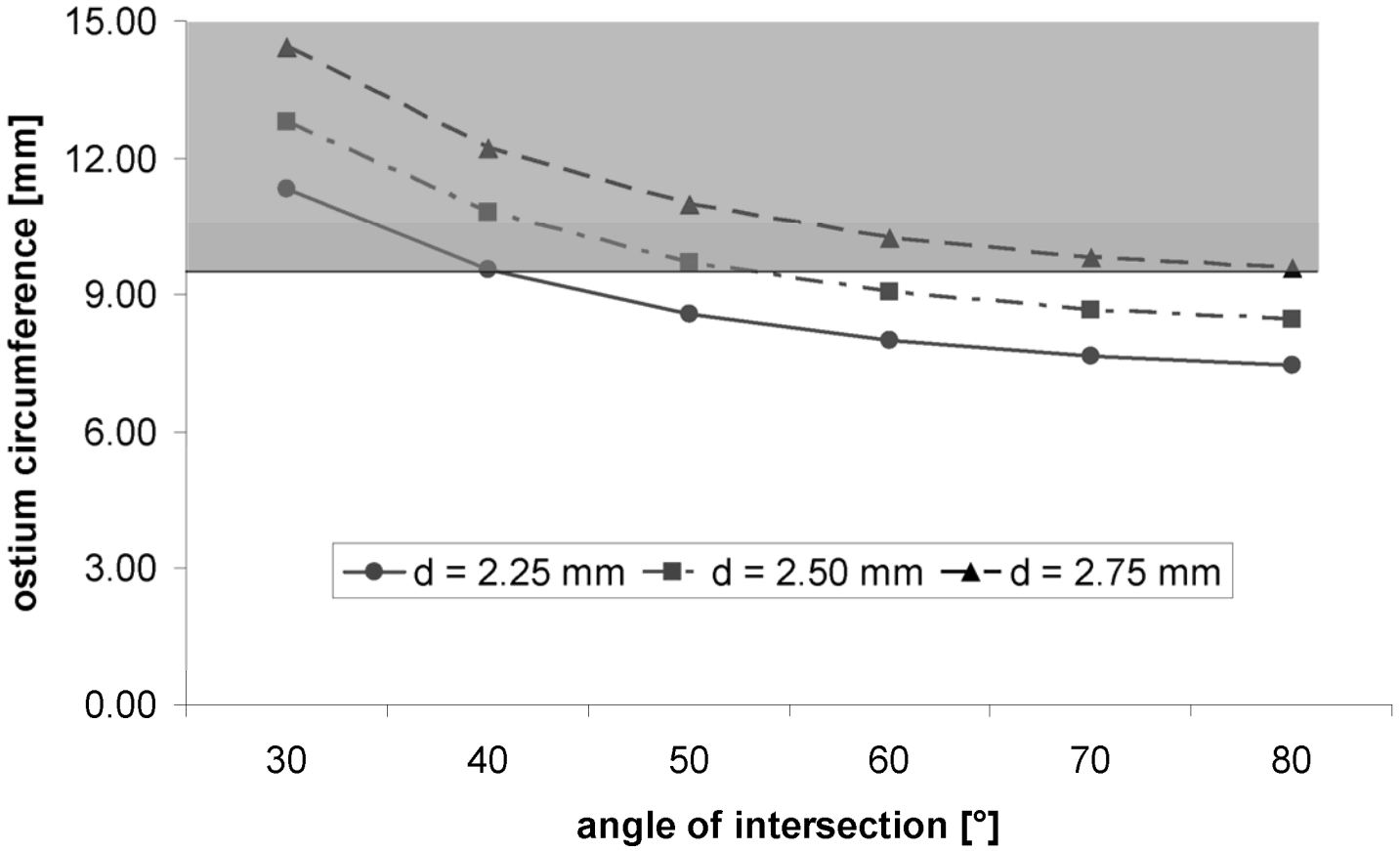
All stents have a nominal diameter of 3 mm

Stent	Company	Cell circumference [mm]	Equivalent diameter [mm]
Cypher	Cordis	**9.5**	3.0
Endeavor	Medtronic	**19.8**	6.3
PRO-Kinetic	Biotronik	10.8	3.4
Promus	Boston Scientific	12.6	4.0
Taxus Liberté	Boston Scientific	12.6	4.0

From Mortier et al. EBC IV, Prague 2008

Cypher stent

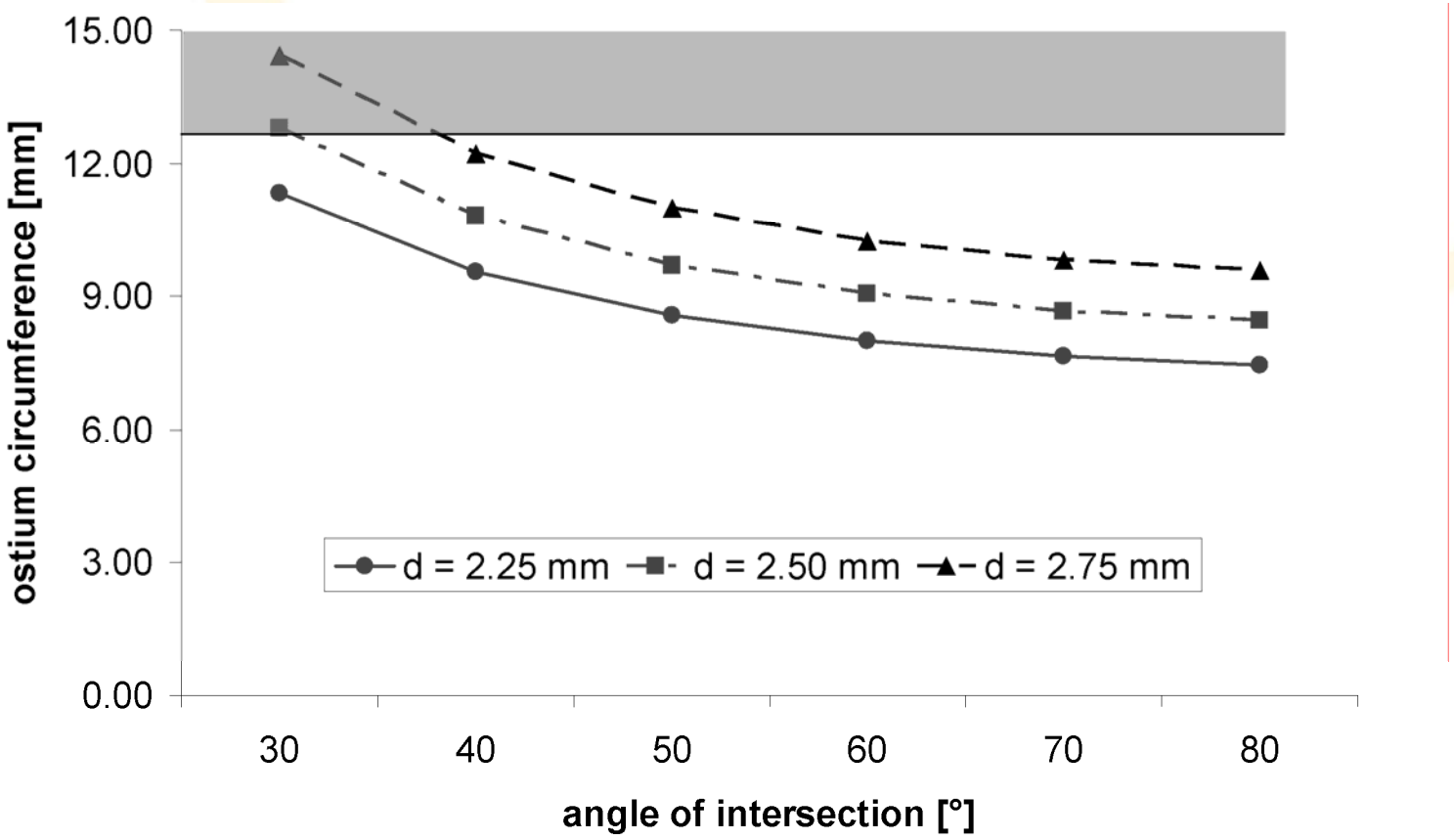
For a 3 mm main branch



From Mortier et al. EBC IV, Prague 2008

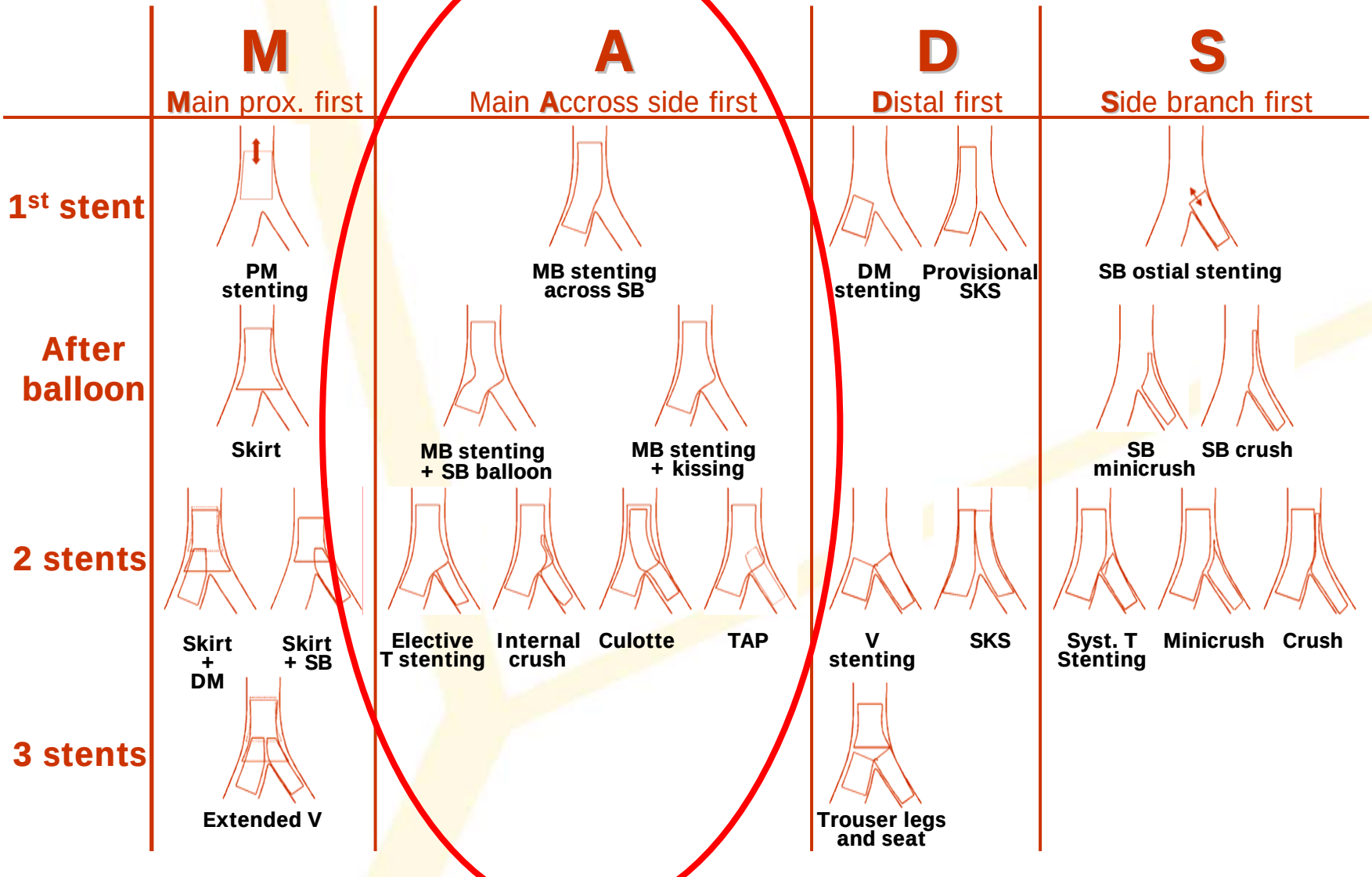
Taxus Liberté

For a 3 mm main branch



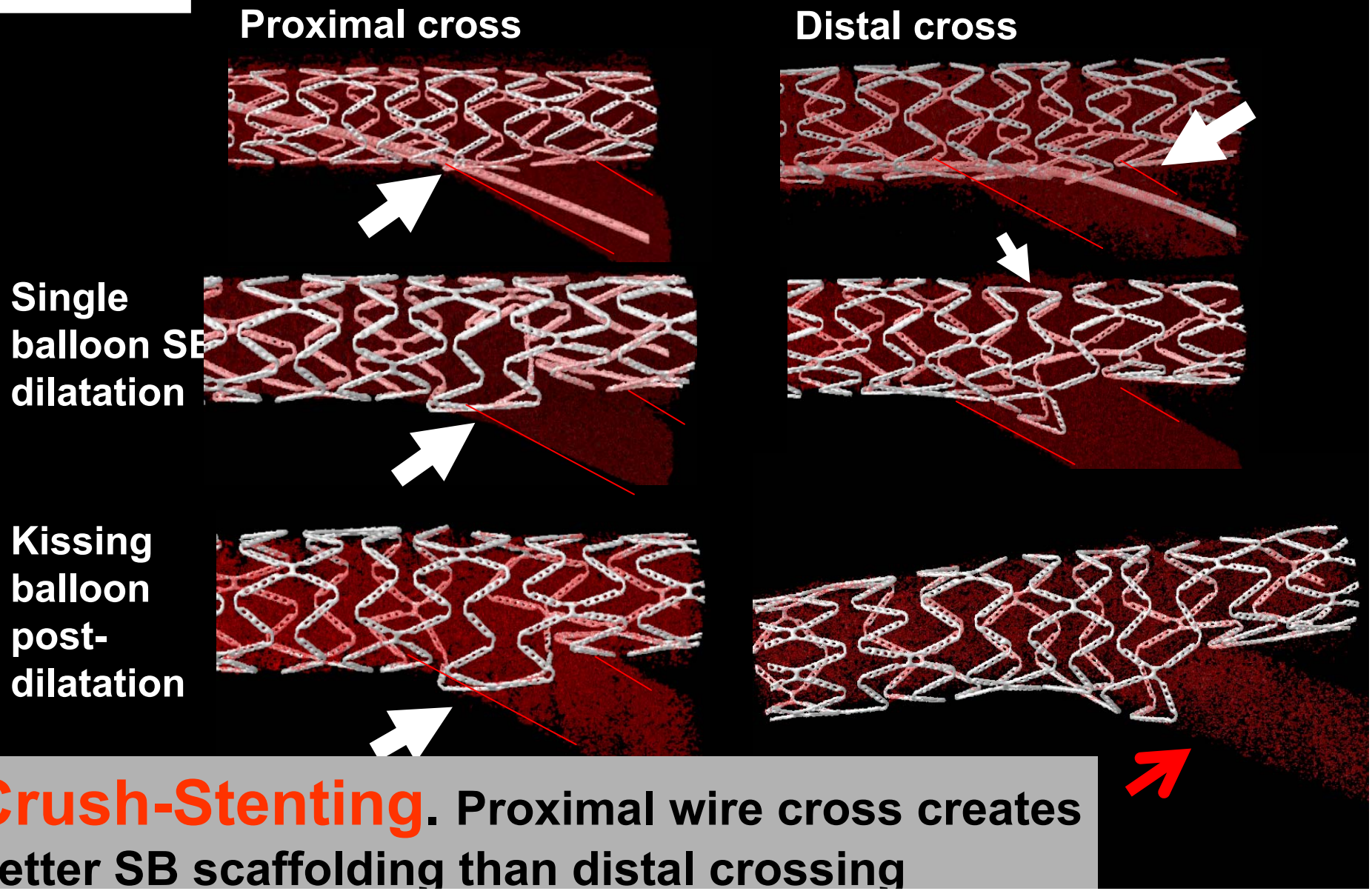
From Mortier et al. EBC IV, Prague 2008

Stenting Techniques



EBC4

Stenting MV across the SB. Distal wire cross creates better SB scaffolding than prox



Crush-Stenting. Proximal wire cross creates better SB scaffolding than distal crossing

How to do a Provisional T Stenting

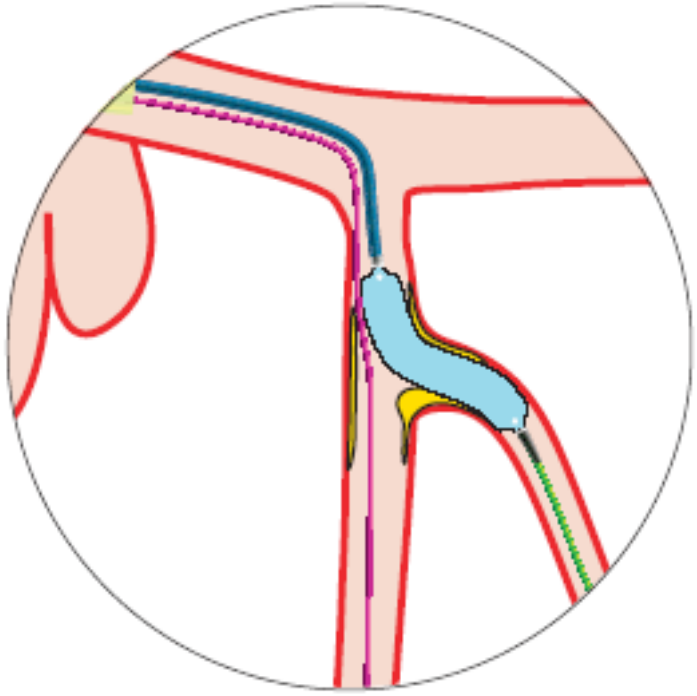
Should we use the jailed wire technique?

Yes

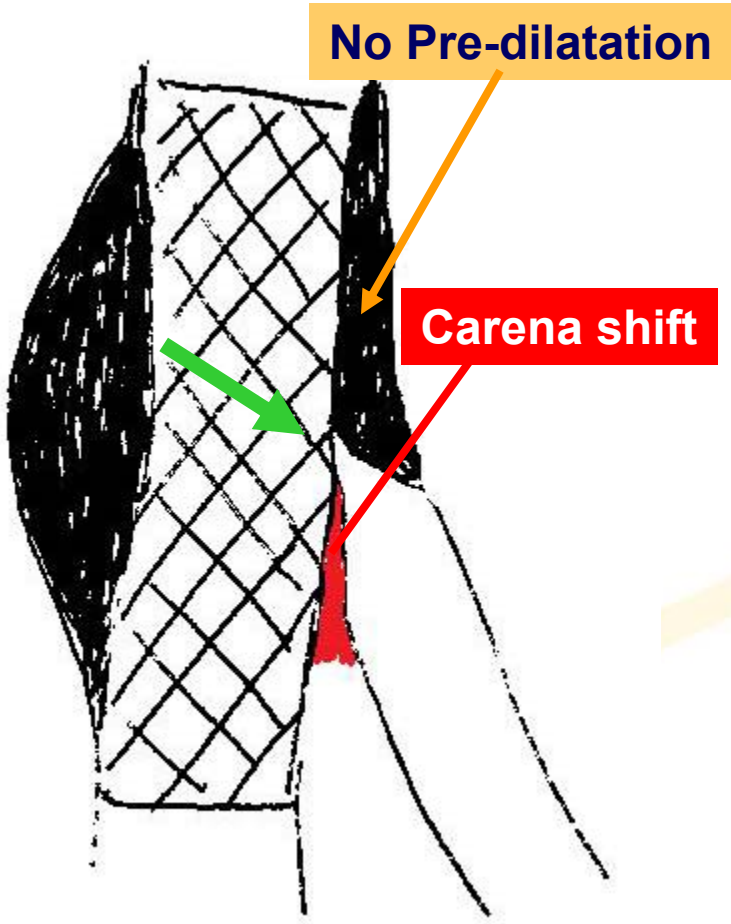
- ✓ Modifies favorably the angle between both br.
- ✓ Keeps the side branch open
- ✓ Is a good marker of SB
- ✓ Is a predictor of SB success

How to do a Provisional T Stenting

Should we Predilate the Side Branch?



Why We Should Not Predilate the Side Branch



Post MB stenting

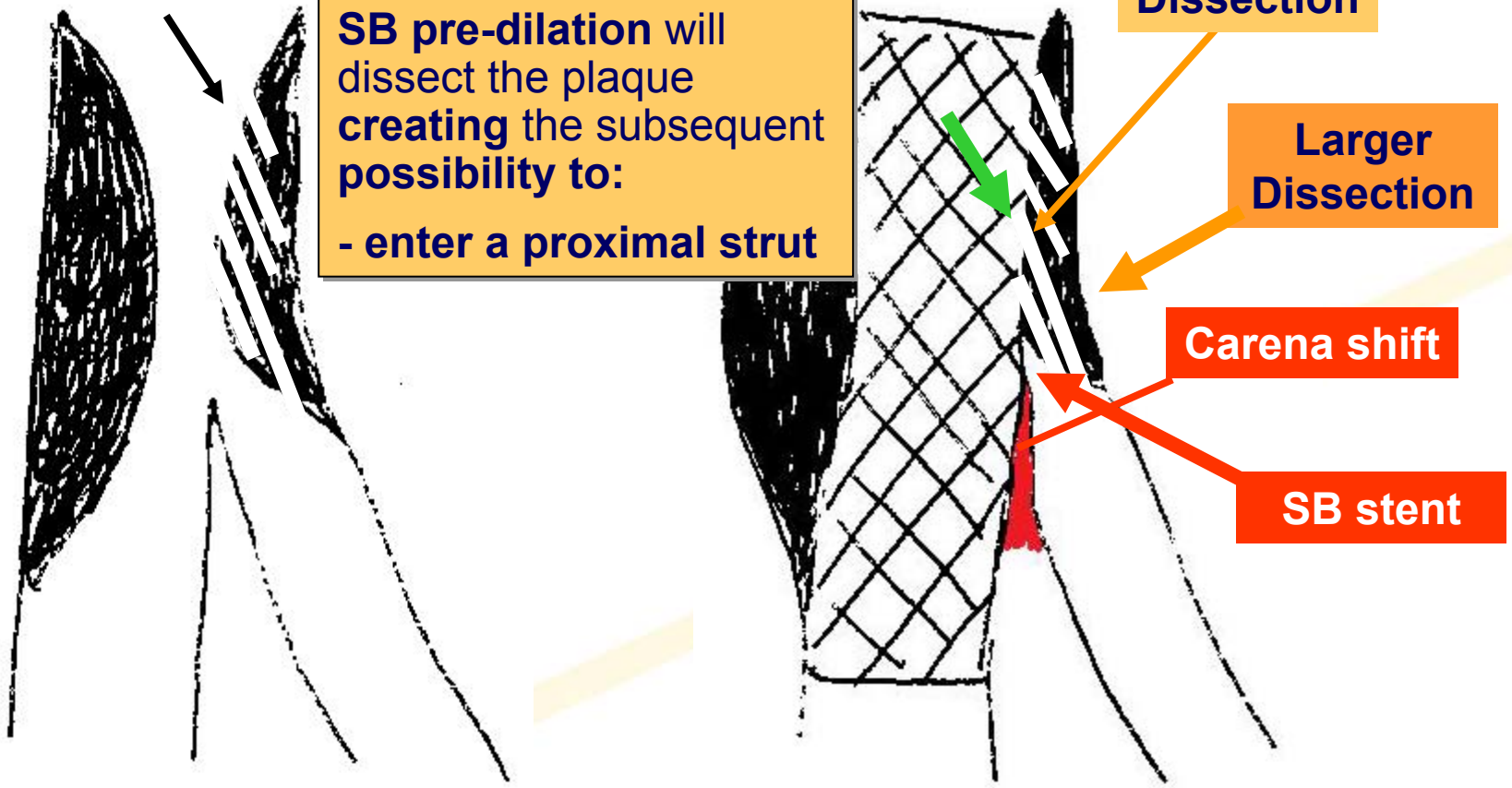
Albiero et al. EBC 2008

Why We Should Not Predilate the Side Branch

Pre-dilatation->Dissection

SB pre-dilation will dissect the plaque **creating** the subsequent **possibility to:**

- enter a proximal strut



Pre **Post MB stenting**

Albiero et al. EBC 2008

Consensus

No need for routine SB predilatation unless lesion in the SB long and/or severely calcified.

Role of Kissing Balloon Inflation

CACTUS trial

Coronary Bifurcation Application of the Crush Technique Using Sirolimus-Eluting stents

	Yes	No	P value
Patients (n)	319	31	
MI (%)	7.5	29.0	<0.0001
Stent Thrombis (%)	0.9	6.5	0.06
Restenosis MB (%)	4.7	16	0.03
Restenosis SB (%)	11.9	36	<0.001

From Flavio Airoldi, EBC IV, Prague 2008

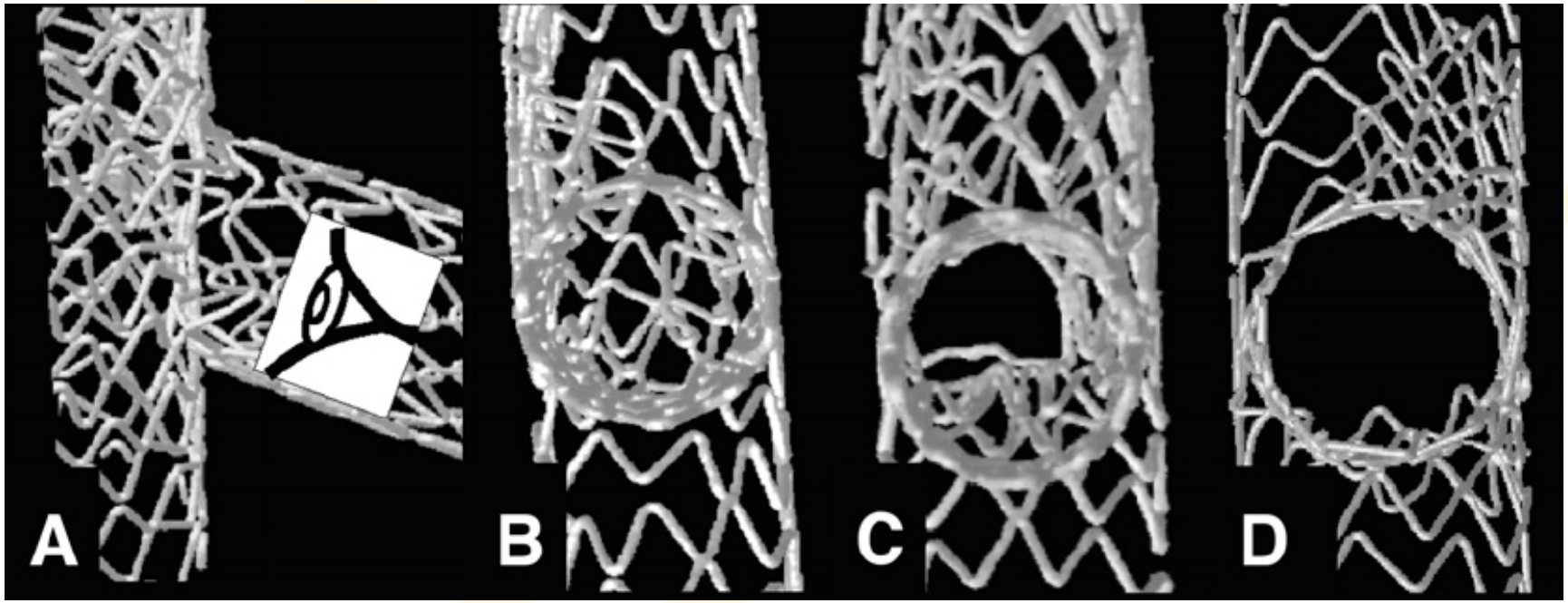
Consensus

Final kissing balloon inflation necessary in complex stenting.

May also improve angiographic and clinical outcome in provisional SB stenting.

Randomized trial is needed (Nordic-KISS)

“Crush” Technique



No Kiss 1 step Kiss 2 steps Kiss

Ormiston et al. J Am Coll Cardiol Intv 2008;1:351–7

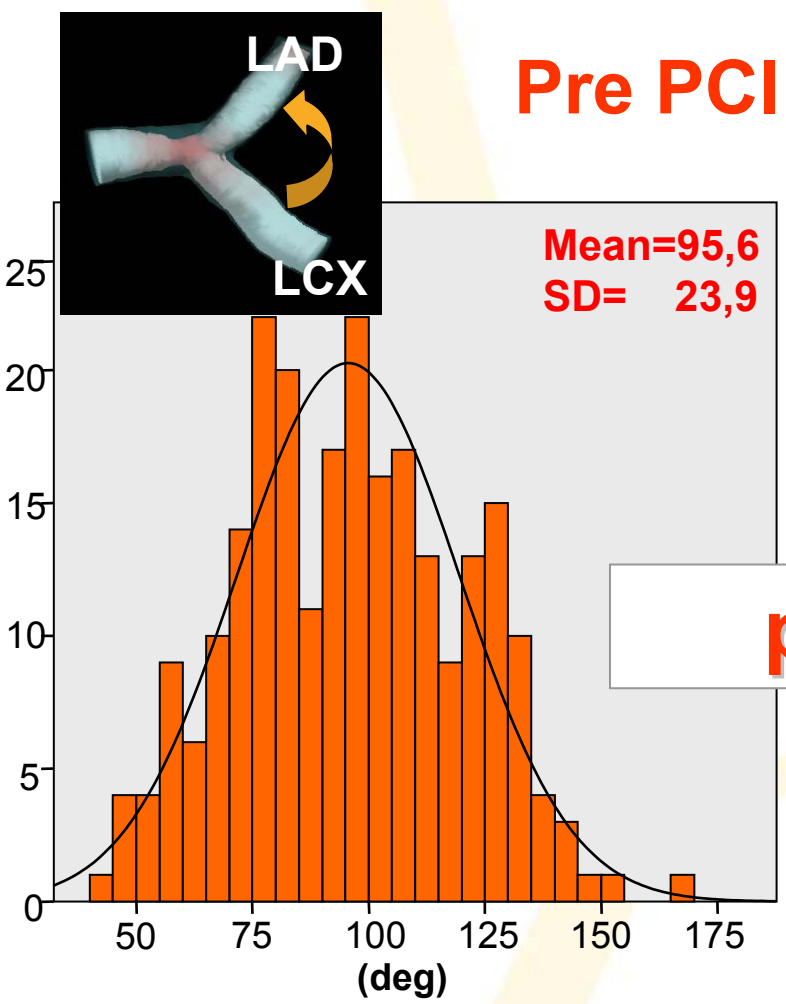
DK-Crush: 8-month f-up

	Crush No Kiss	Crush Final Kiss	DK Crush	P value
# Lesions	39	117	155	-
MACE	35.9	19.7	11.4	0.02
Cardiac death	2.5	2.5	0.6	NS
Q-wave MI	5.1	0.9	1.2	NS
Non-Q-wave MI	10.2	8.1	9.1	NS
TVR	26.5	20.0	10.3	0.03
Stent Thrombosis	5.1	1.7	1.3	NS

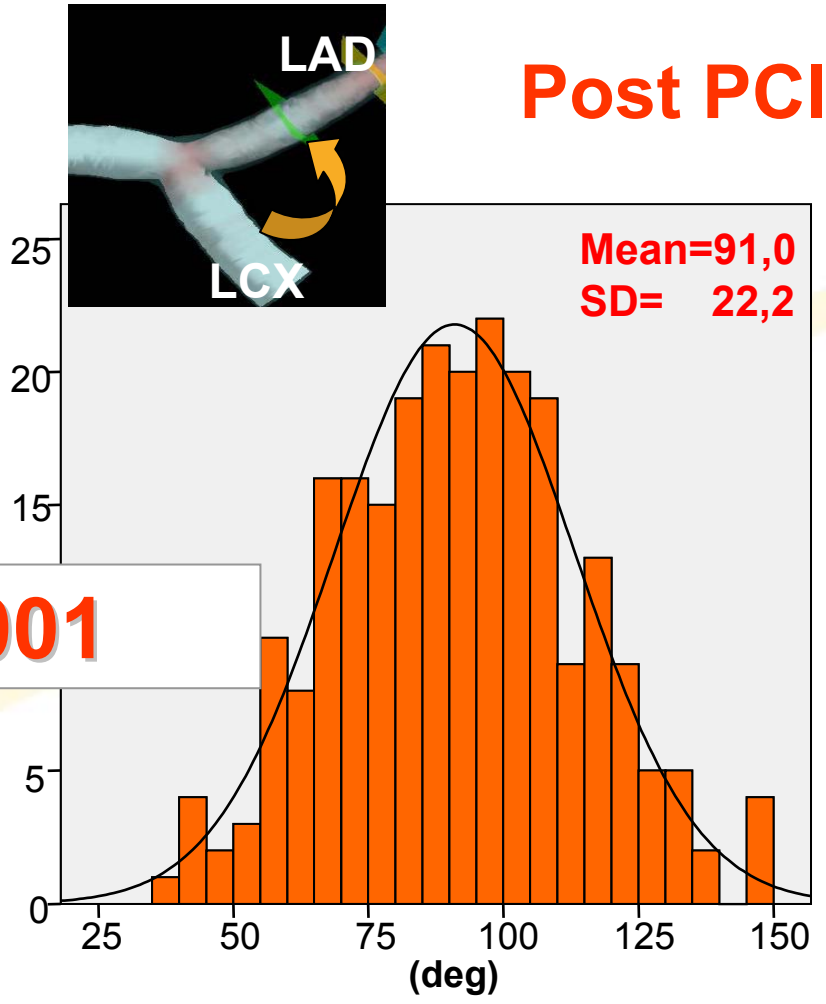
Chen et al. – DKCRUSH-1 Bifurcation Study

Role of the Bifurcation Angle

Distal BA, enddiastolic values (n=266)



p<0.001

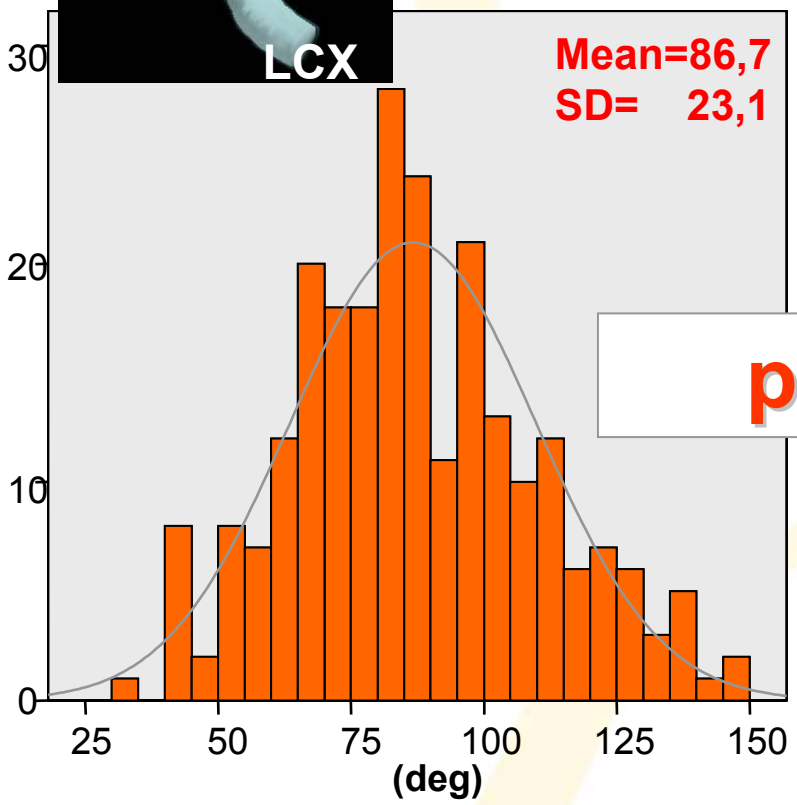


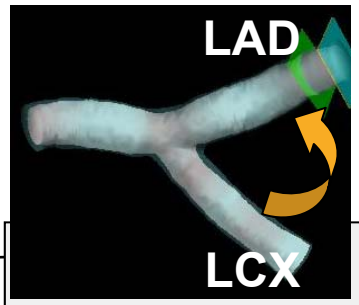
Serruys et al. EBC IV, Prague 2008

Role of the Bifurcation Angle

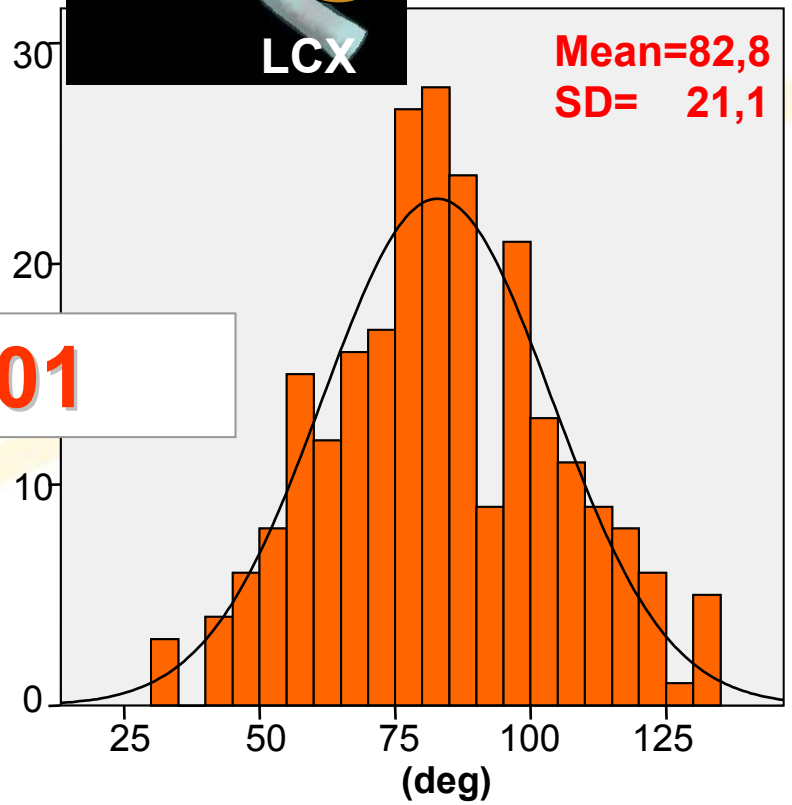
Distal BA, endsystolic values (n=266)

Pre PCI





Post PCI

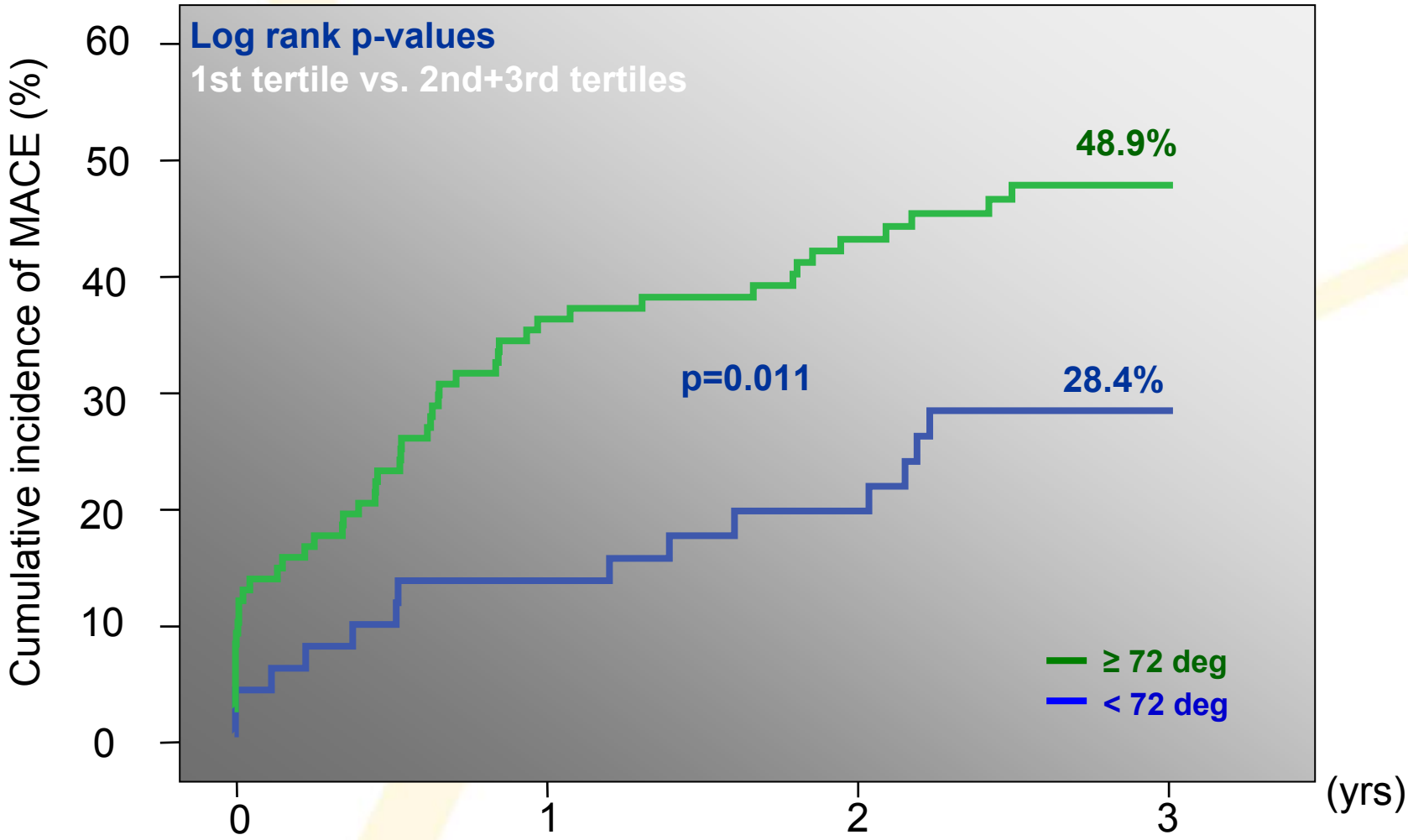


p<0.001

Serruys et al. EBC IV, Prague 2008

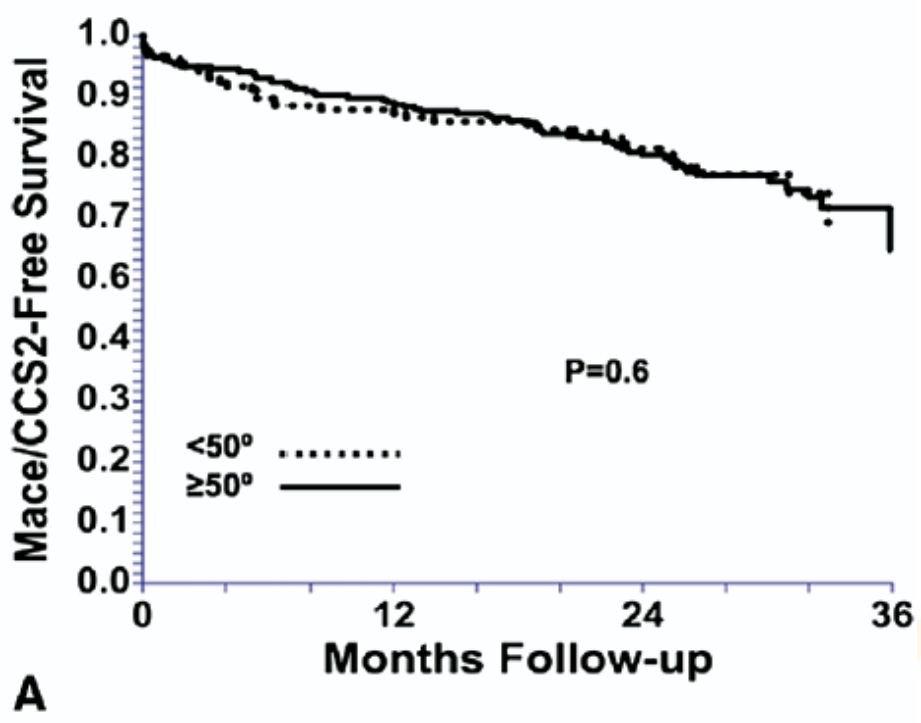
Role of the Bifurcation Angle

MACE at 3 yrs-prePCI systolic BA (n=157)

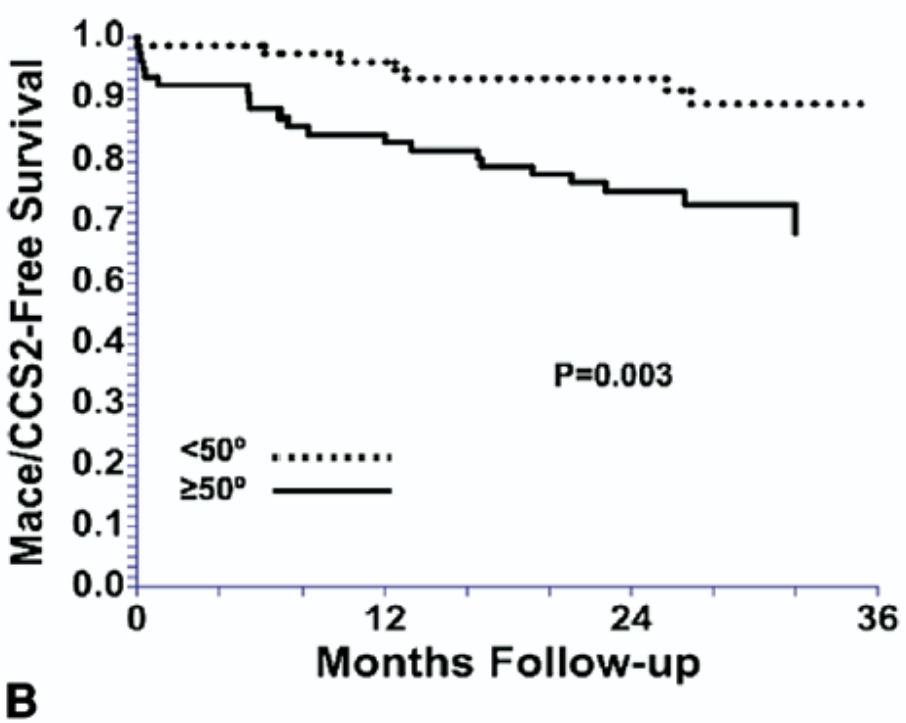


Serruys et al. EBC IV, Prague 2008

Role of the Bifurcation Angle



Main vessel stent only

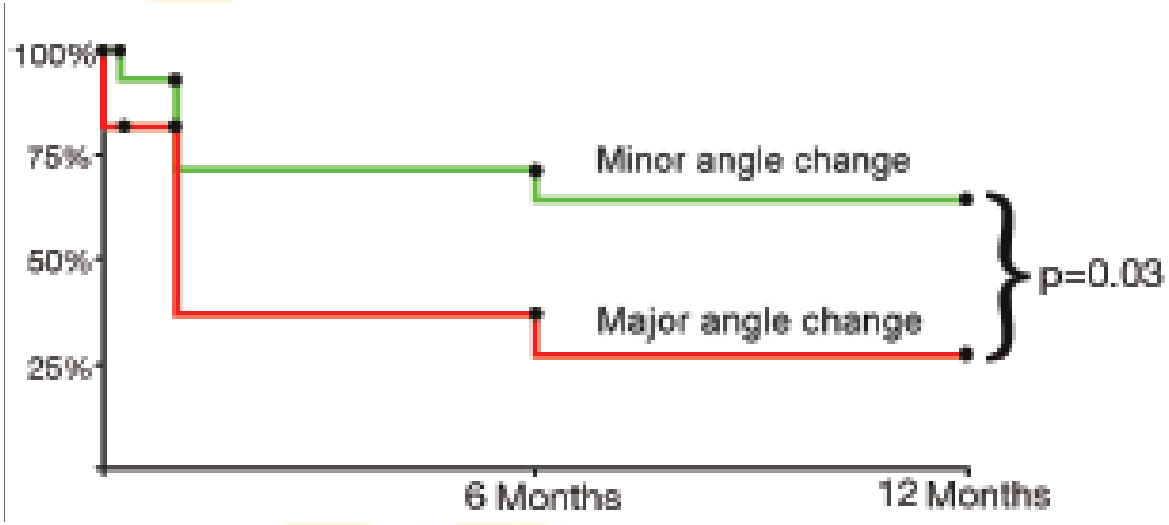


Culotte or crush

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

Role of the Bifurcation Angle

TVR free survival (%) according to absolute angle change after intervention



Major absolute angle change ≥ 20 degrees

Assali et al. EBC IV, Prague 2008

EBC 4

EuroIntervention

Percutaneous coronary intervention for bifurcation lesions: 2008 consensus document from the fourth meeting of the European Bifurcation Club

Goran Stankovic[1]*, MD, PhD, FESC; Olivier Darremont[2], Miroslaw Ferenc[3], David Hildick-Smith[4], Jens Flensted Lassen[5], Yves Louvard[6], Remo Albiero[7], Manuel Pan[8], Thierry Lefèvre[6],

1. Institute for Cardiovascular Diseases, Clinical Center of Serbia, Belgrade, Serbia; 2. Clinique Saint Augustin, Bordeaux, France; 3. Herz-Zentrum Bad Krozingen, Bad Krozingen, Germany; 4. Sussex Cardiac Centre, Brighton and Sussex University Hospitals, United Kingdom; 5. Department of Cardiology B, Skejby Hospital, University of Aarhus, Denmark; 6. Institut Cardiovasculaire Paris Sud, Massy, France; 7. Clinica San Rocco, Brescia, Italy; 8. Hospital Reina Sofia, Cordoba, Spain

Summary

✓ New techniques or devices should be assessed in the bench before human use.

✓ Provisional SB stenting with DES is now the “gold standard” and can be used in the majority of cases.

✓ New dedicated devices should be compared to this reference.

✓ When 2 stents are used, final kissing balloon inflation and minimal overlap is strongly recommended

Summary (cont..)

✓ The use of 2 wires when starting the procedure is usefull and increase procedural success rate.

✓ The Murray's law should be used in routine in order to avoid undersizing of the proximal part of the MB stent.

✓ Optimal antiplatelet treatment probably the same as for non bifurcation lesions.

✓ T-shape angulation is associated with worse outcomes when 2 stents are used.