Angiographic Assessment of Bifurcation Lesions

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Disclosure

- Nothing to disclose related with this presentation

CVRF
Clinical Trial Center

President

Business Department
(Budget, Billing, Contracts)

Independent Angiographic
And IVUS Analysis

CTA
(Clinical Trial Assistant)

IVUS/QCA Core Lab

Bifurcation Angiographic Analysis

- Qualitative assessment
- Quantitative assessment

Bifurcation Angiographic Analysis

- **Qualitative assessment**
- Quantitative assessment

Qualitative Assessment

- General morphology of MB or SB
  - Calcification
  - TIMI grade flow
  - Tortuosity
  - Calcification
  - Restenosis
  - Restenosis pattern
- Bifurcation classification: MEDINA class
- Bifurcation angle
- etc

SYNTAX SCORE

Search...

Welcome to the SYNTAX Score website. The SYNTAX Score is a unique tool to score complexity of coronary artery disease. However, it is very important to use this new scoring tool correctly, hence, it is strongly recommended to complete the tutorial first.

TUTORIAL

Knowledge of definitions is vital. Please use the tutorial prior to first calculator use.

Start tutorial...

CALCULATOR

Start using the calculator when you have successfully completed the tutorial.

Start calculator...

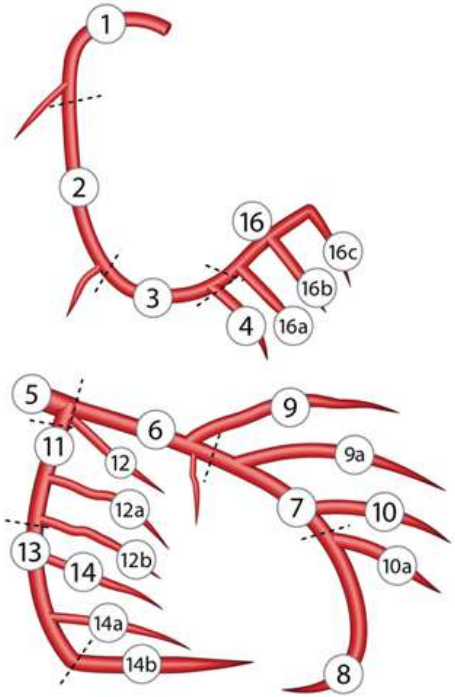
SYNTAX Trial: Two-year outcomes

EUROPEAN SOCIETY OF CARDIOLOGY®

Pieter Kappetein, MD, PhD presented the two-year results of the SYNTAX trial at the European Society of Cardiology Meeting, Barcelona on September 2nd, 2009. SYNTAX was featured in a Clinical Trial webcast. Key findings included:

- In the SYNTAX randomized patients, 2-year MACCE rates remained significantly higher for PCI than CABG, mainly driven by higher repeat revascularization in the PCI arm.
- MACCE rates at 2 years not significantly different for patients with a low (0-22) or intermediate (23-32) baseline SYNTAX Score treated with either PCI or CABG; for patients with high SYNTAX Scores (≥33), MACCE continued to be increased at 2 years in patients treated with PCI compared with CABG
- In the predefined subgroups of patients with either 3VD or LM disease:
  - In the LM group, safety outcomes and MACCE rates were similar for PCI and CABG, but the 2-year revascularization rate was lower in the CABG group.
  - Safety outcomes (death/CVA/MI) in the 3VD group were similar for PCI and CABG, but the 2-year revascularization and MACCE rates favored CABG.

The full presentation can be viewed or downloaded here:



3. Specify which segments are diseased for lesion 1.

Click on the coronary tree image to select or unselect segments.

		Lesion:	1
	Segments:		
RCA	RCA proximal	1	☐
	RCA mid	2	☐
	RCA distal	3	☐
	Posterior descending	4	☐
	Posterolateral from RCA	16	☐
	Posterolateral from RCA	16a	☐
	Posterolateral from RCA	16b	☐
	Posterolateral from RCA	16c	☐
LM	Left main	5	☐
LAD	LAD proximal	6	☐
	LAD mid	7	☐
	LAD apical	8	☐
	First diagonal	9	☐
	Add. first diagonal	9a	☐
	Second diagonal	10	☐
	Add. second diagonal	10a	☐
LCX	Proximal circumflex	11	☐
	Intermediate/anterolateral	12	☐
	Obtuse marginal	12a	☐
	Obtuse marginal	12b	☐
	Distal circumflex	13	☐
	Left posterolateral	14	☐
	Left posterolateral	14a	☐
	Left posterolateral	14b	☐

next

Click here for segment definitions

Bifurcation

≥ 1.5 mm

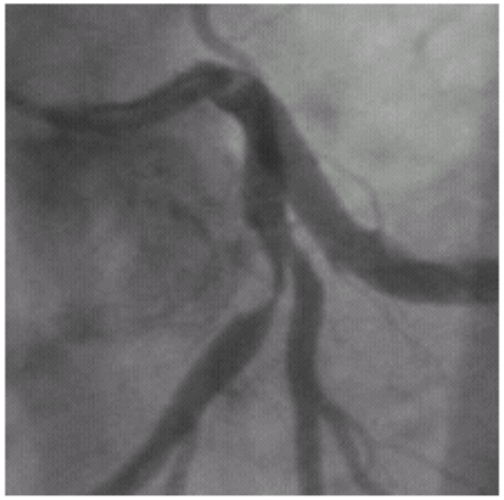
A bifurcation is a division of a main, parent, branch into two daughter branches of at least 1.5mm. Bifurcation lesions may involve the proximal main vessel, the distal main vessel and the side branch according to the Medina classification. The smaller of the two daughter branches should be designated as the 'side branch'. In case of the main stem either the LCX or the LAD can be designated as the side branch depending on their respective calibres.
Bifurcations are only scored for the following segment junctions: 5/6/11, 6/7/9, 7/8/10, 11/13/12a, 13/14/14a, 3/4/16 and 13/14/15.

No septal branch

'Specify which segments are diseased for lesion X': one should fill out only those segment numbers of the bifurcation that have a Diameter Stenosis ≥50% in direct contact with the bifurcation.

≥ 50% stenosis

Example 1



SB = small daughter branch

- One lesion
- one segment number involved/diseased (= segment: 7).
- Bifurcation 'Yes'
- Medina class: 0, 1, 0

TIMI Flow

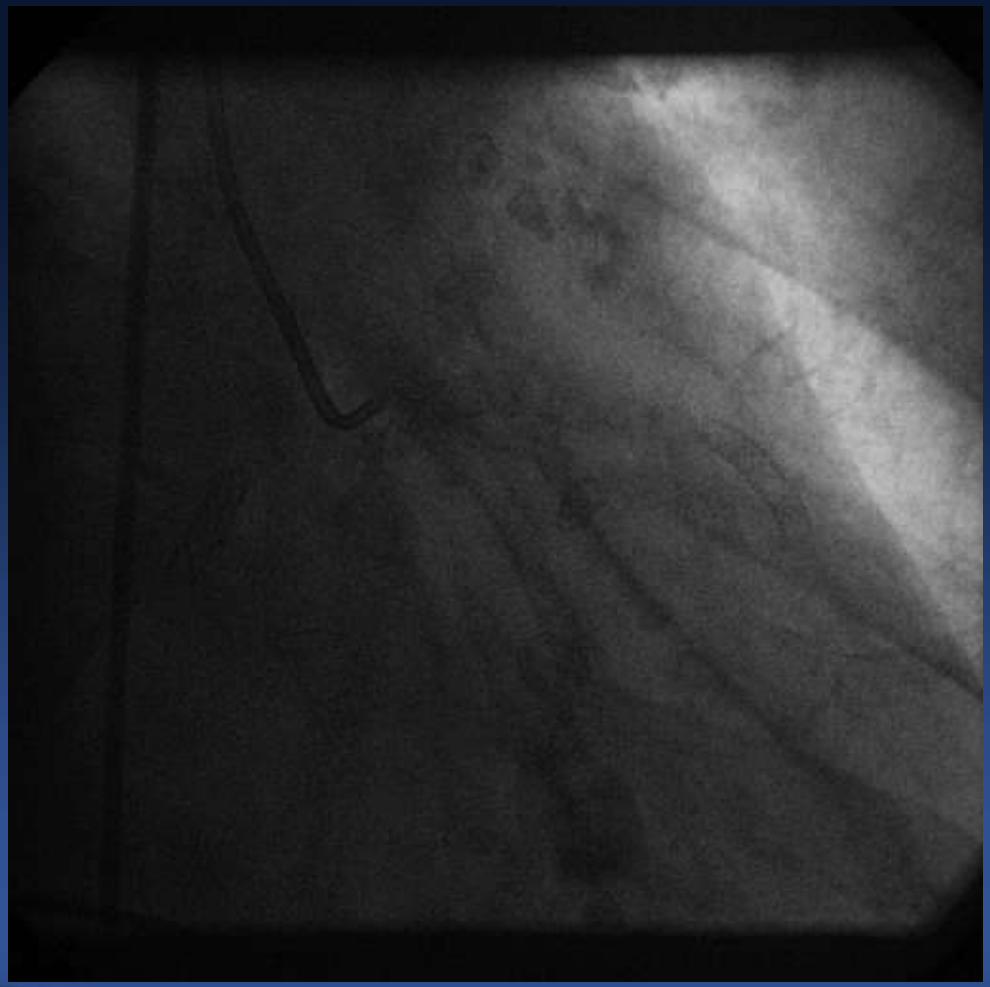
Grade 0 No flow beyond the point of occlusion (total occlusion).

Grade 1 Contrast passes the point of obstruction but only trickles distal.

Grade 2 Contrast opacifies the entire coronary bed distal to the stenosis with complete filling of the artery and it's major and minor branches after more than 3 full cardiac cycles.

Grade 3 Complete perfusion of the epicardial vessel artery and it's major and minor branches within 3 full cardiac cycles.

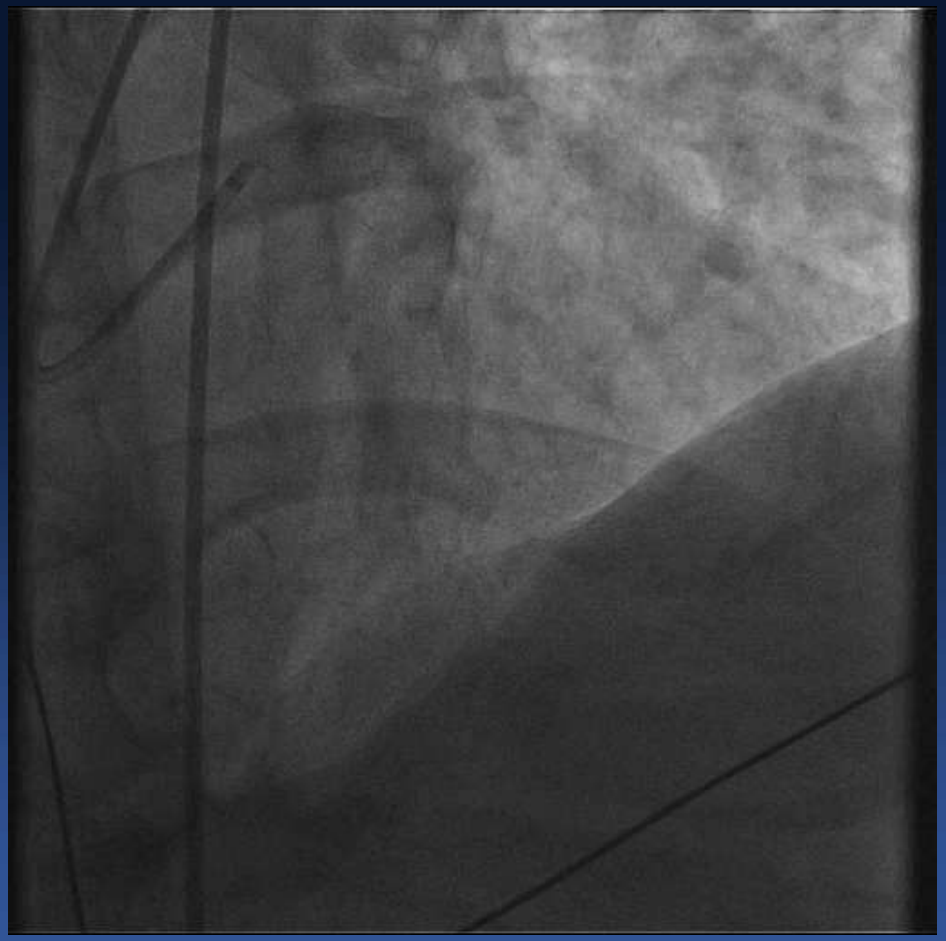
TIMI 1 Flow with Collaterals



Grade 0 No flow beyond the point of occlusion (total occlusion).

Grade 1 Contrast passes the point of obstruction but only trickles distal.

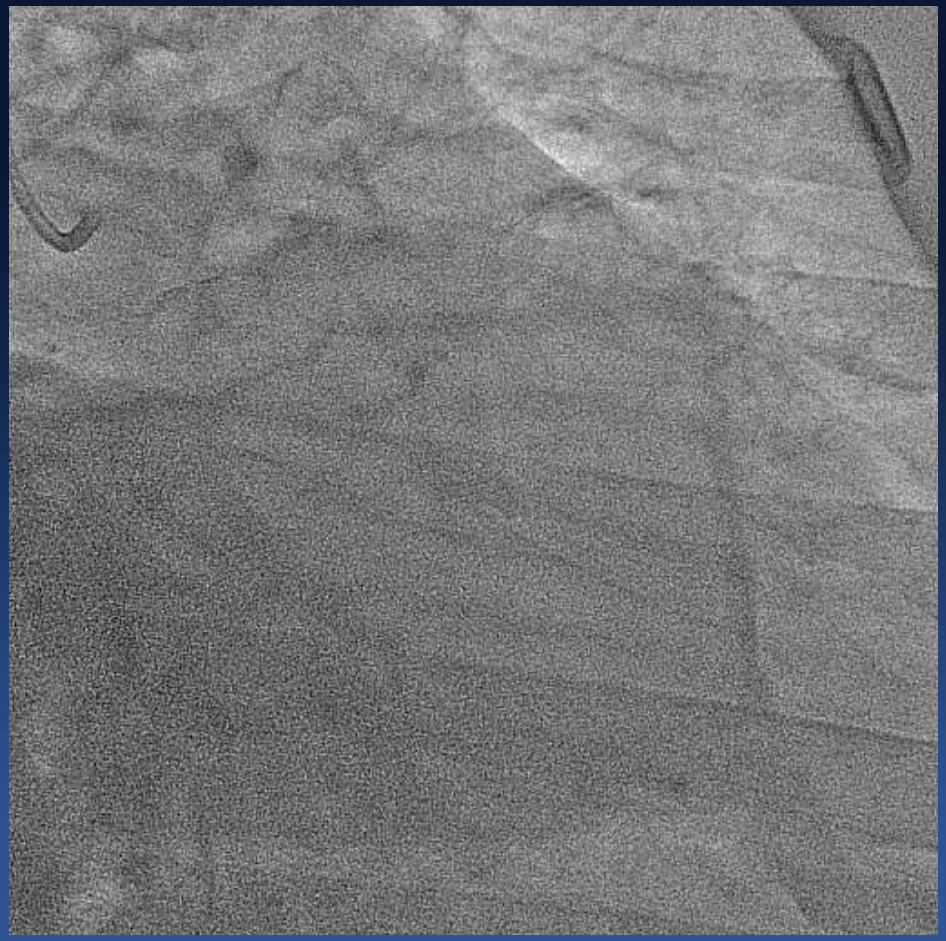
TIMI-2 Flow



Grade 2 Contrast opacifies the entire coronary bed distal to the stenosis with complete filling of the artery and it's major and minor branches after more than 3 full cardiac cycles.

Grade 3 Complete perfusion of the epicardial vessel artery and it's major and minor branches within 3 full cardiac cycles.

TIMI-3 Flow



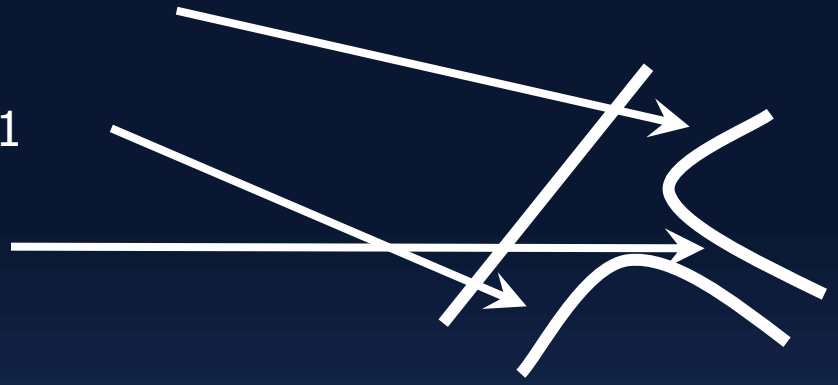
Grade 3 Complete perfusion of the epicardial vessel artery and it's major and minor branches within 3 full cardiac cycles.

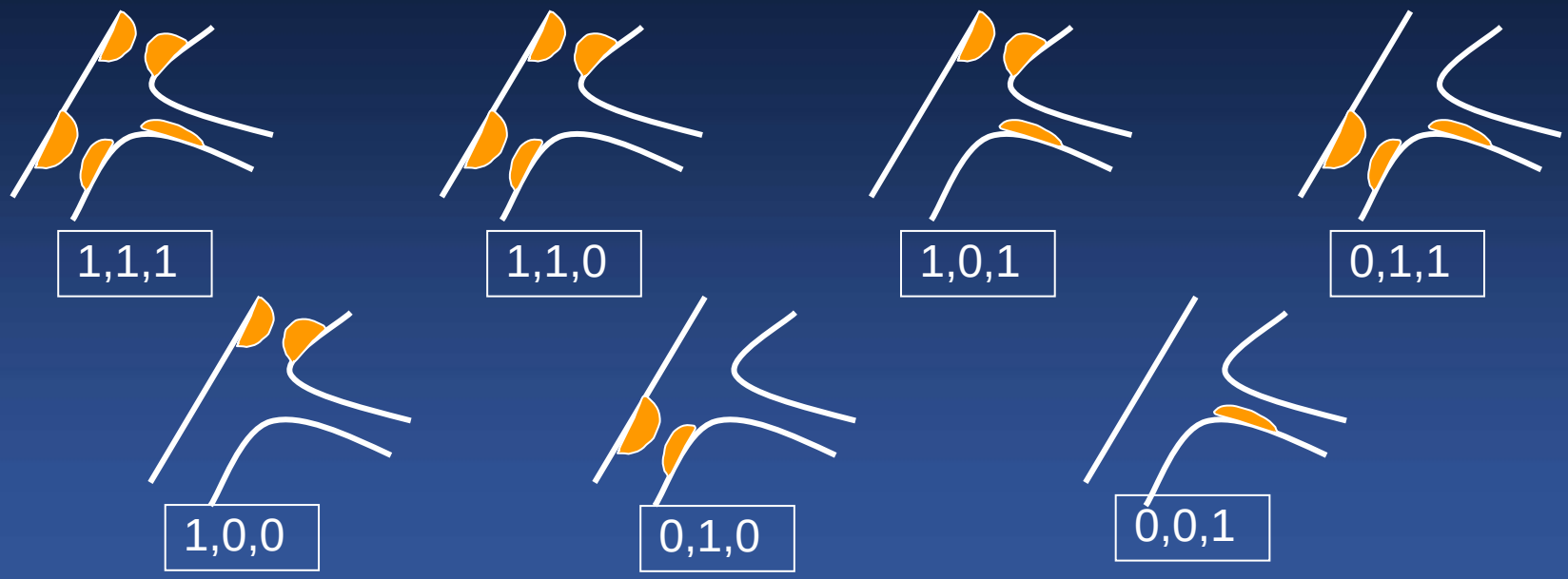
Classification of Bifurcation Stenosis

1. Prox PV > 50%: 0 or 1

2. Distal PV > 50%: 0 or 1

3. SB > 50%: 0 or 1





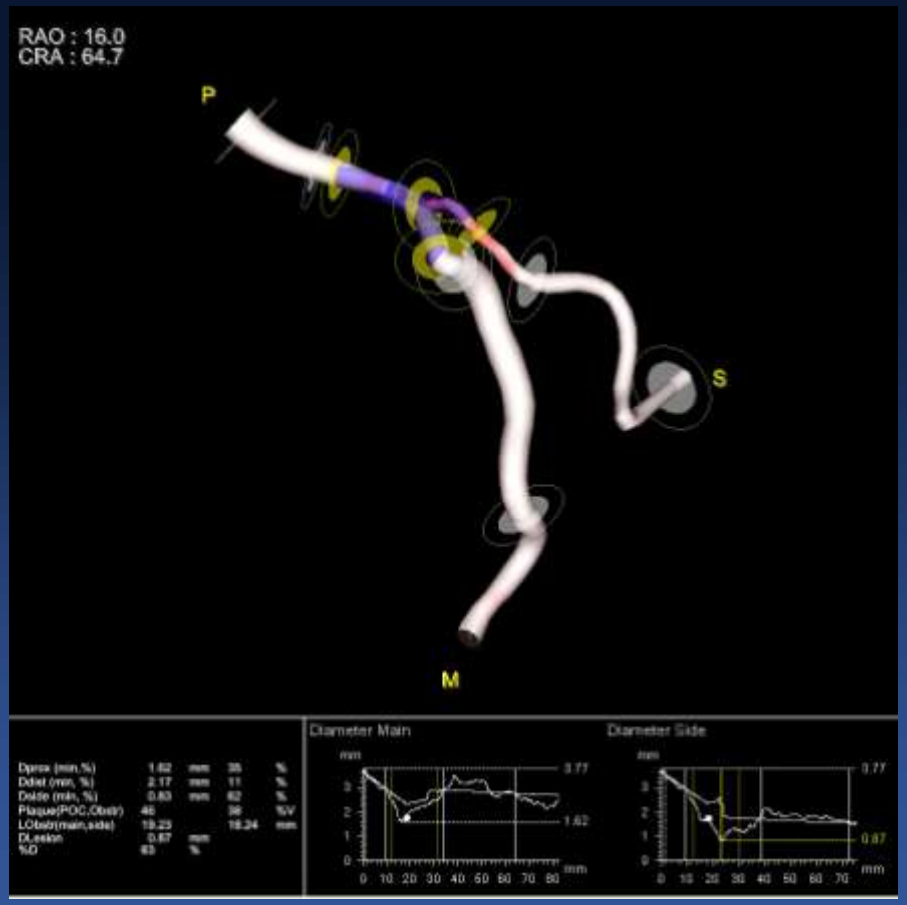
Medina A.Rev Esp Cardiol. 2006;59:183

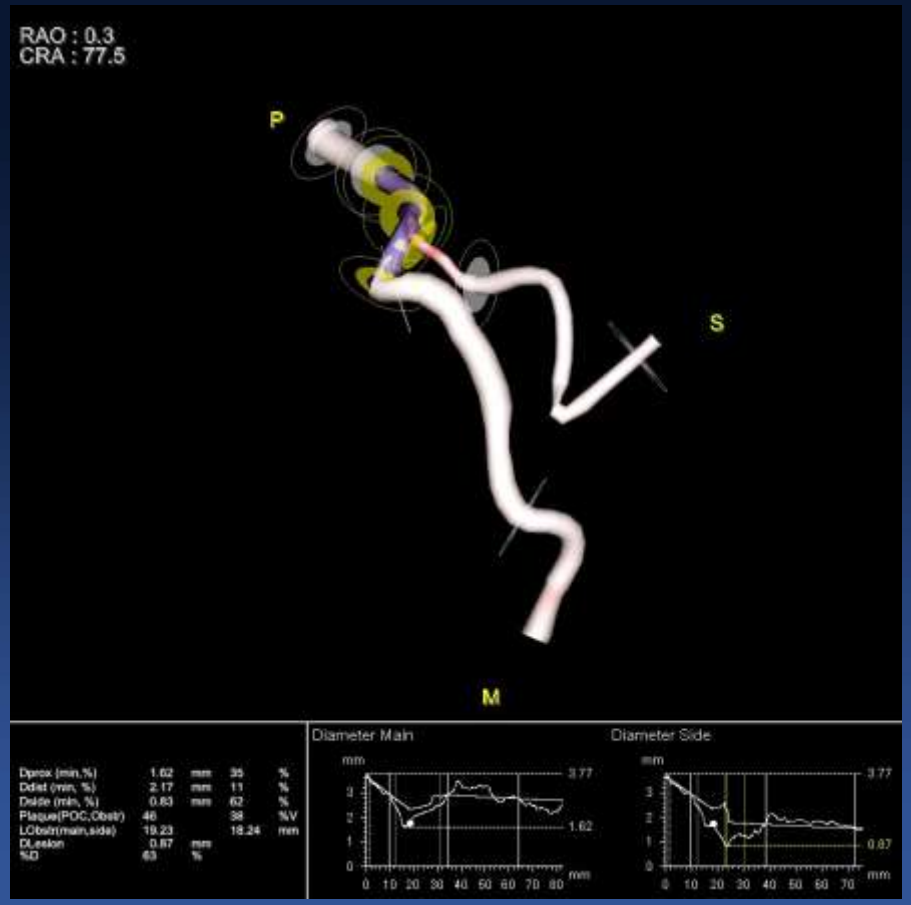
Bifurcation Angle Measures

Angle between Prox PV and SB

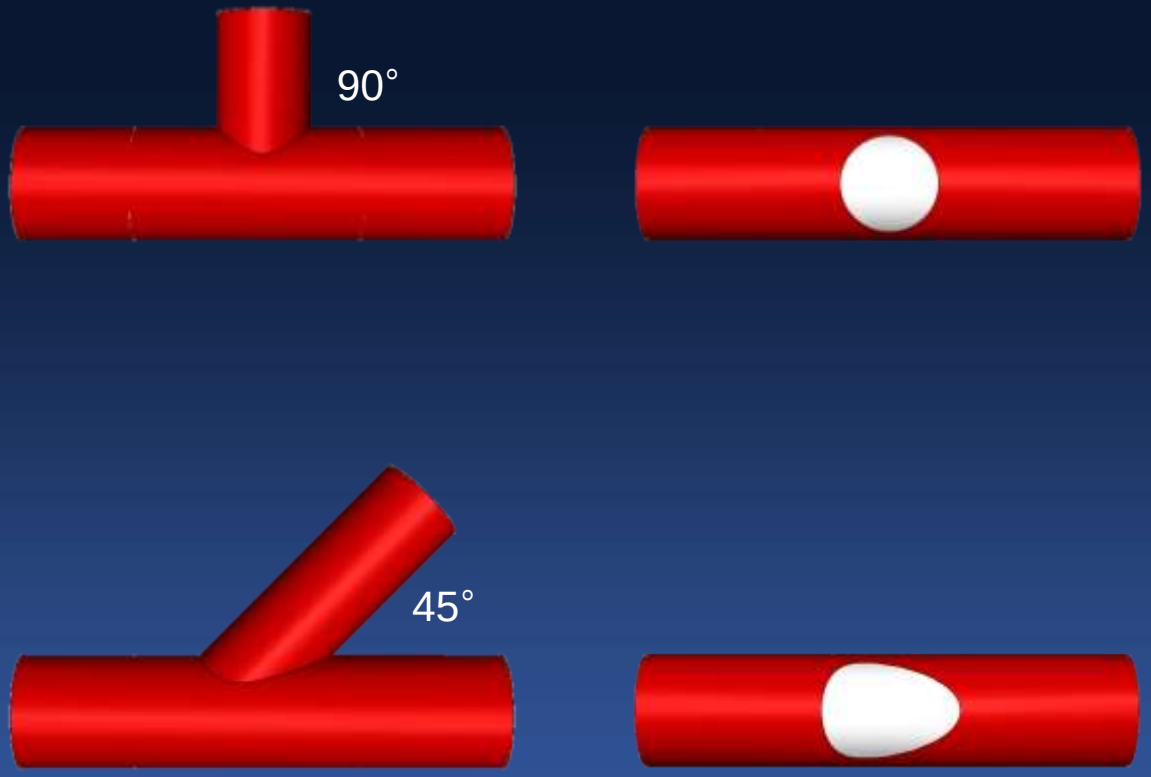
Angle between Distal PV and SB

3-D Angle Measurement





Size of the ostium changes with the angle of bifurcation



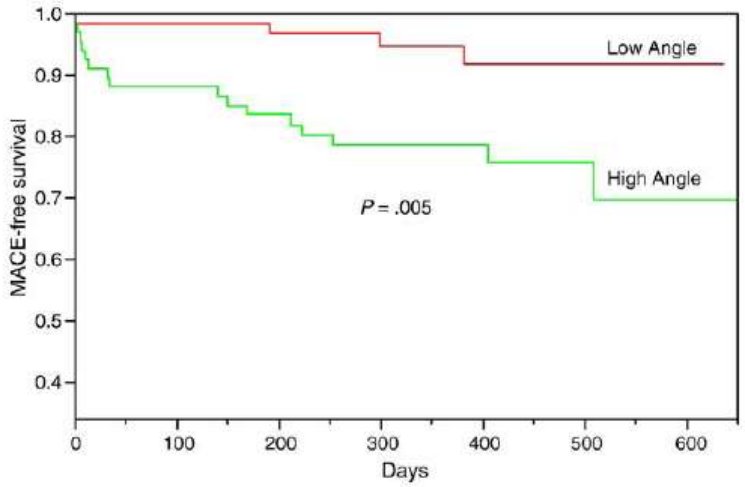
Courtesy P Mortier et al

Greater Bifurcation Angle associated with higher mortality and MACE with Crush Technique

133 pts undergoing crush stenting:

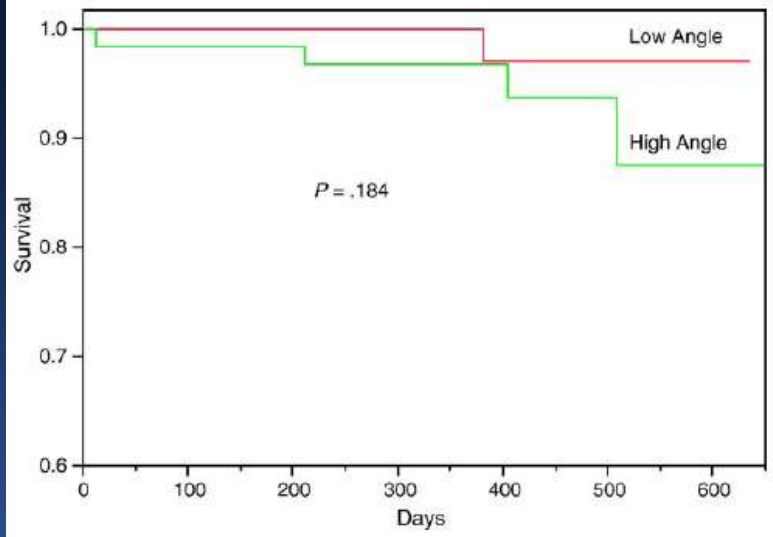
- 66 pts with low angle (<50 degrees)
- 67 pts with high angle (>50 degrees)

Figure 3 **MACE**



Kaplan-Meier plot comparing MACE-free survival up to 648 days between the low-angle group (BA <50° and high-angle group (BA ≥50°).

Figure 4 **Survival**



A Kaplan-Meier plot indicating survival up to 648 days in the low-angle (BA <50°) and high-angle group (BA ≥50°).

Bifurcation angle was an independent predictor of MACE

Dzavik V et al. Am Heart J. 2006

Bifurcation Angiographic Analysis

- Qualitative assessment

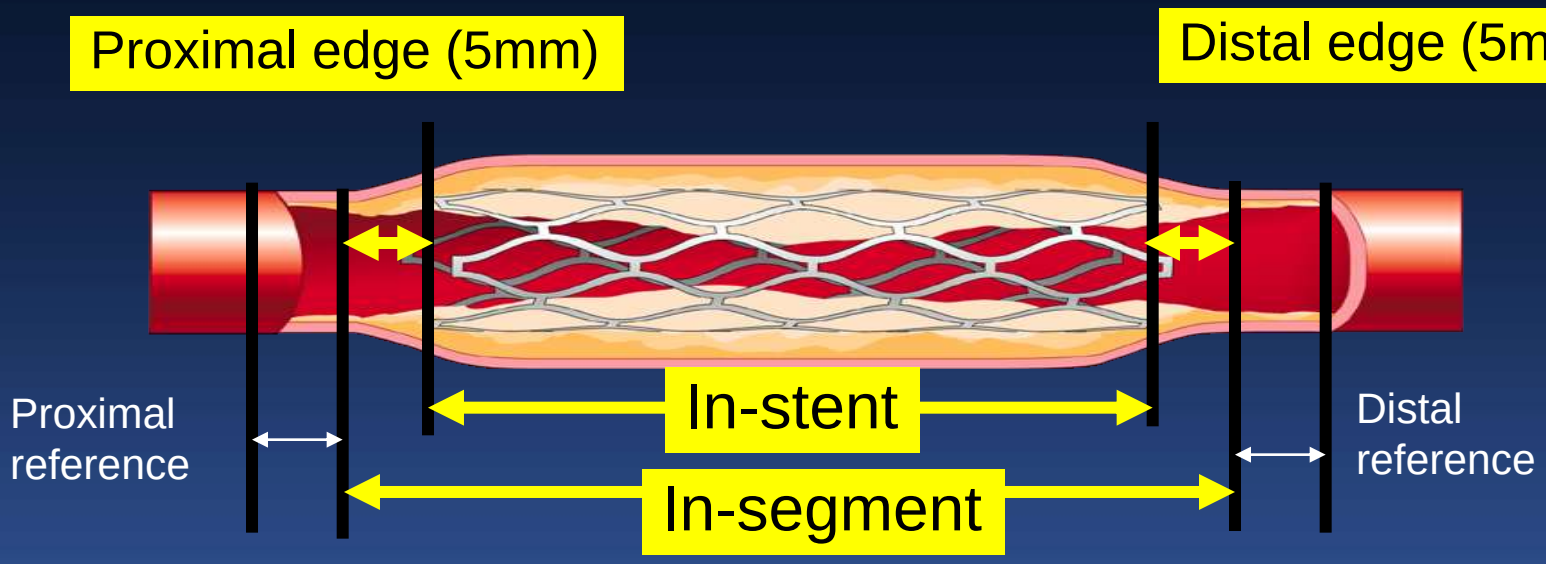
- **Quantitative assessment**

Quantitative Assessment

- Separated assessment
  - Main branch (proximal and distal)
  - Side branch

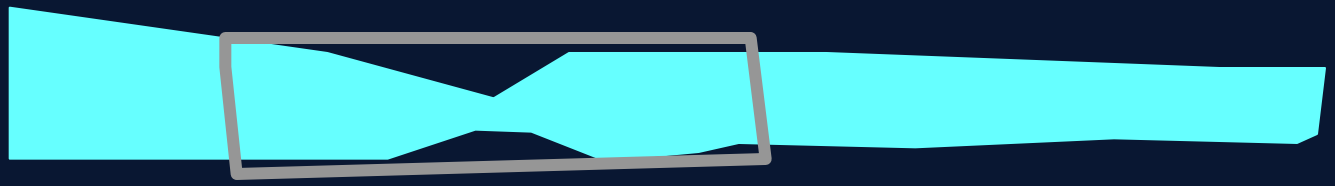
- General information on MB and SB
  - Reference diameter, proximal and distal
  - Minimal lumen diameter
  - Diameter stenosis
  - Late loss

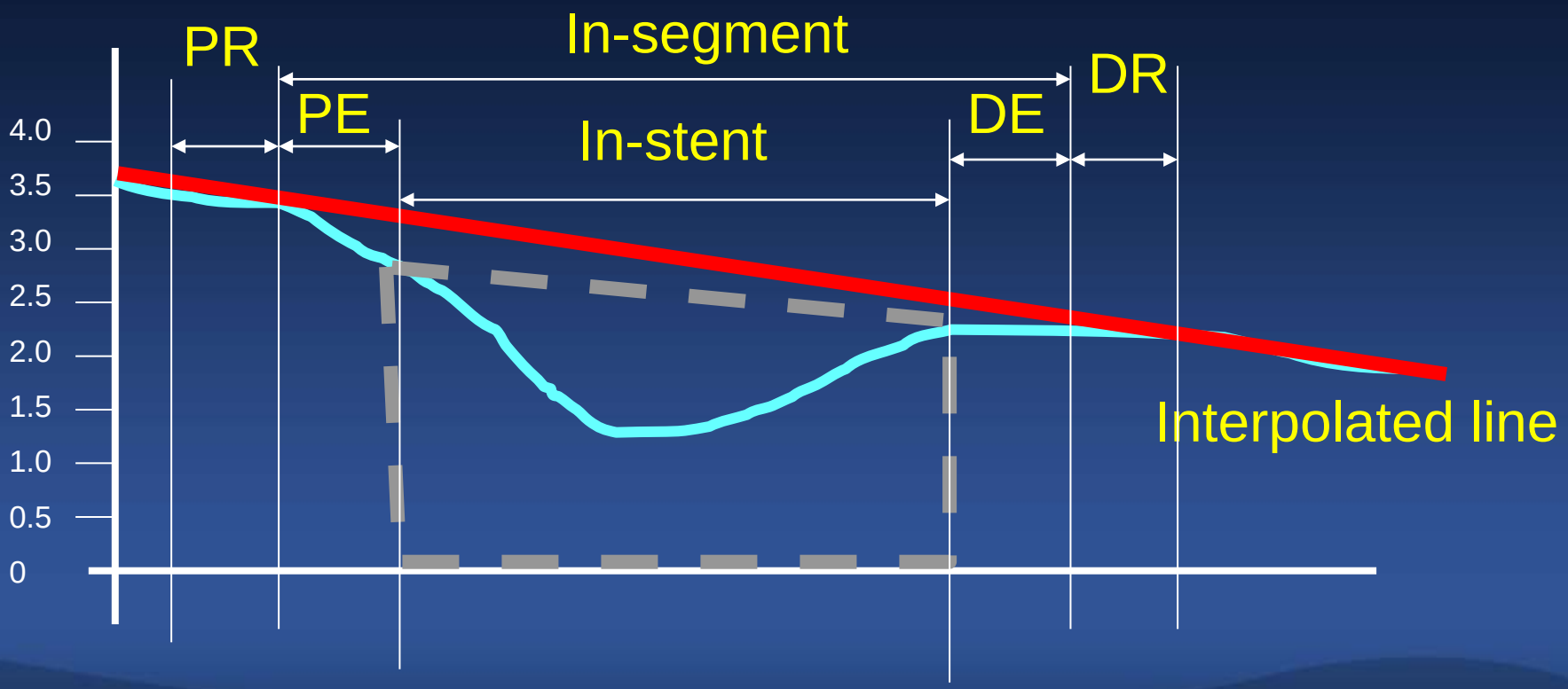
Standard DES Measurement



Automatic Border Detection for QCA

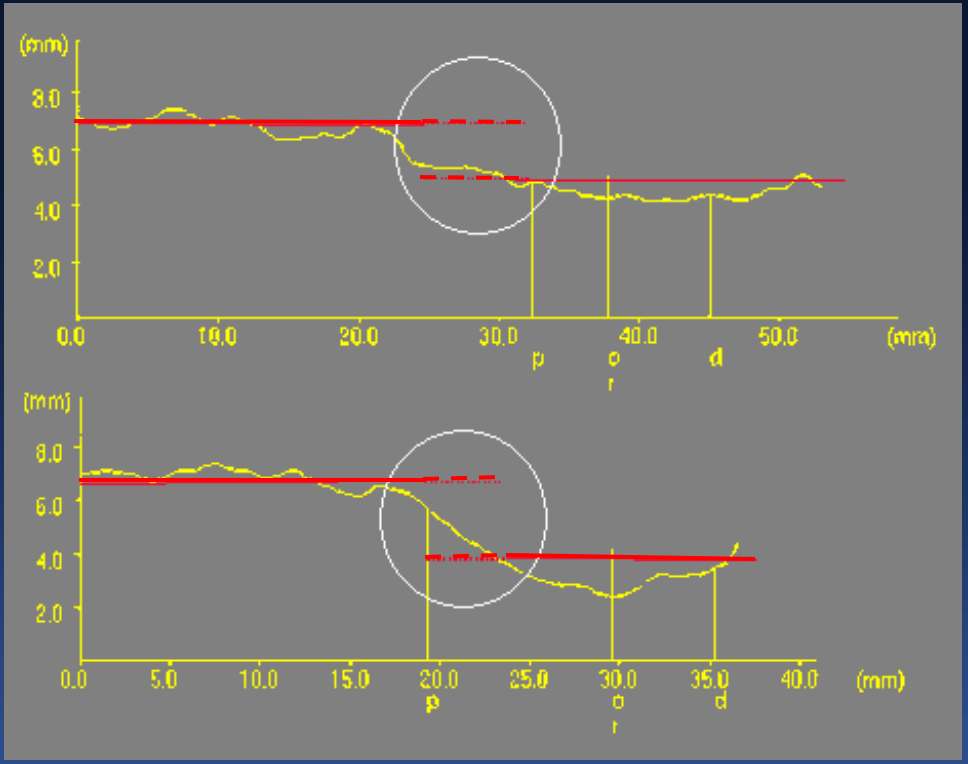
Interpolated reference line is the index.





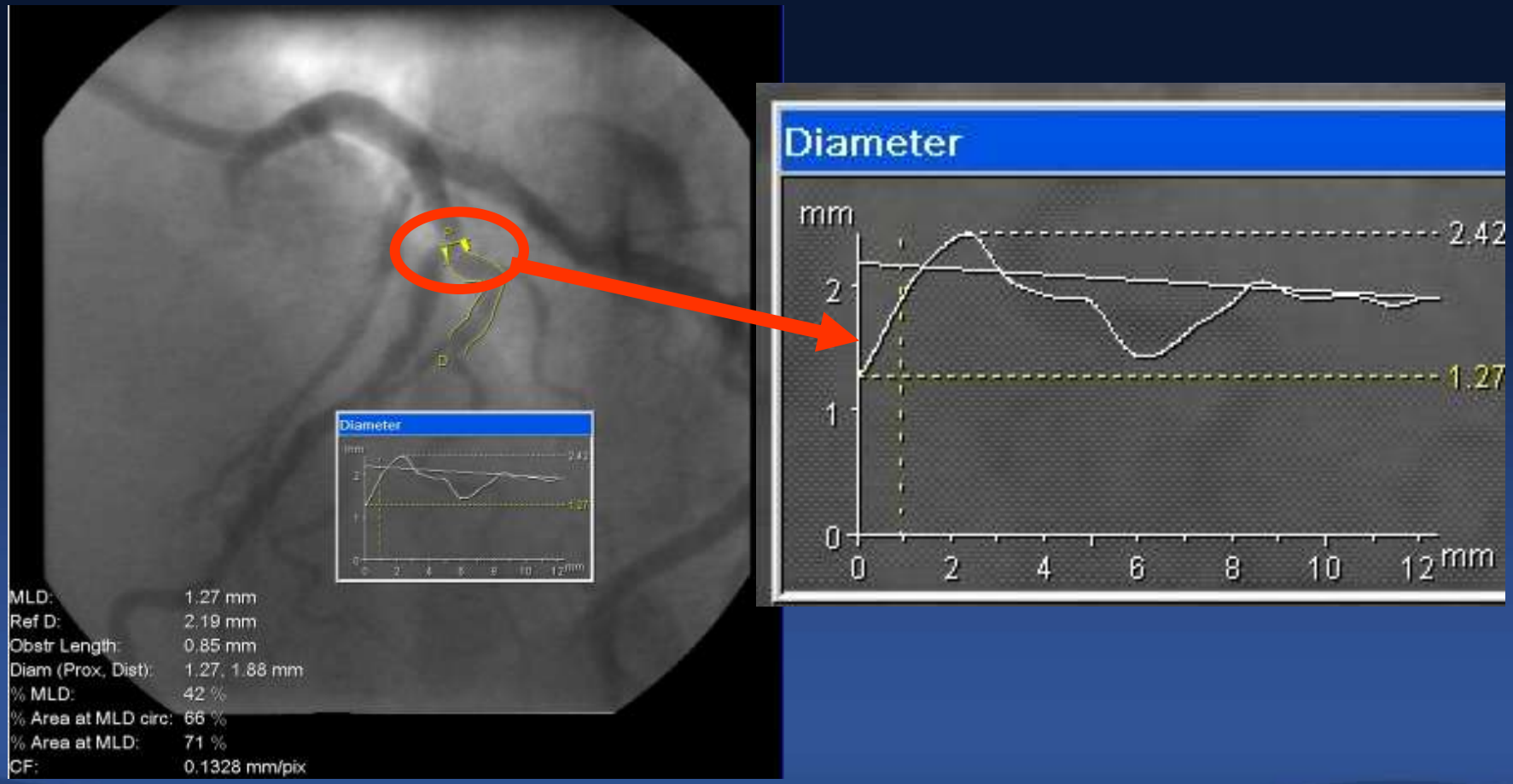
QCA Limitation: Step Down

Method to determine the proper reference diameter for each individual segment

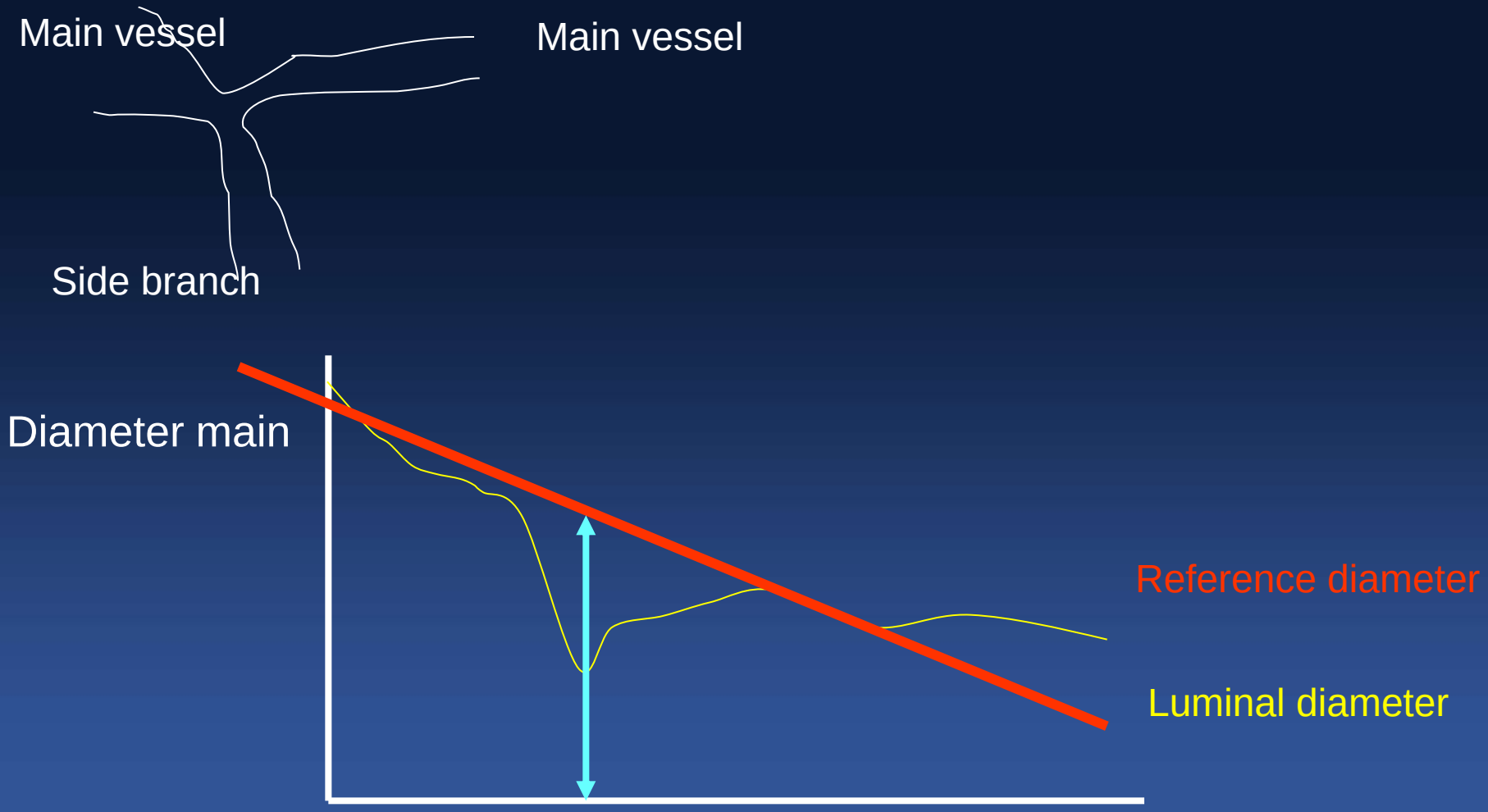


The "Step down" phenomenon is a major limitations of Standard QCA when applied to bifurcation analyses

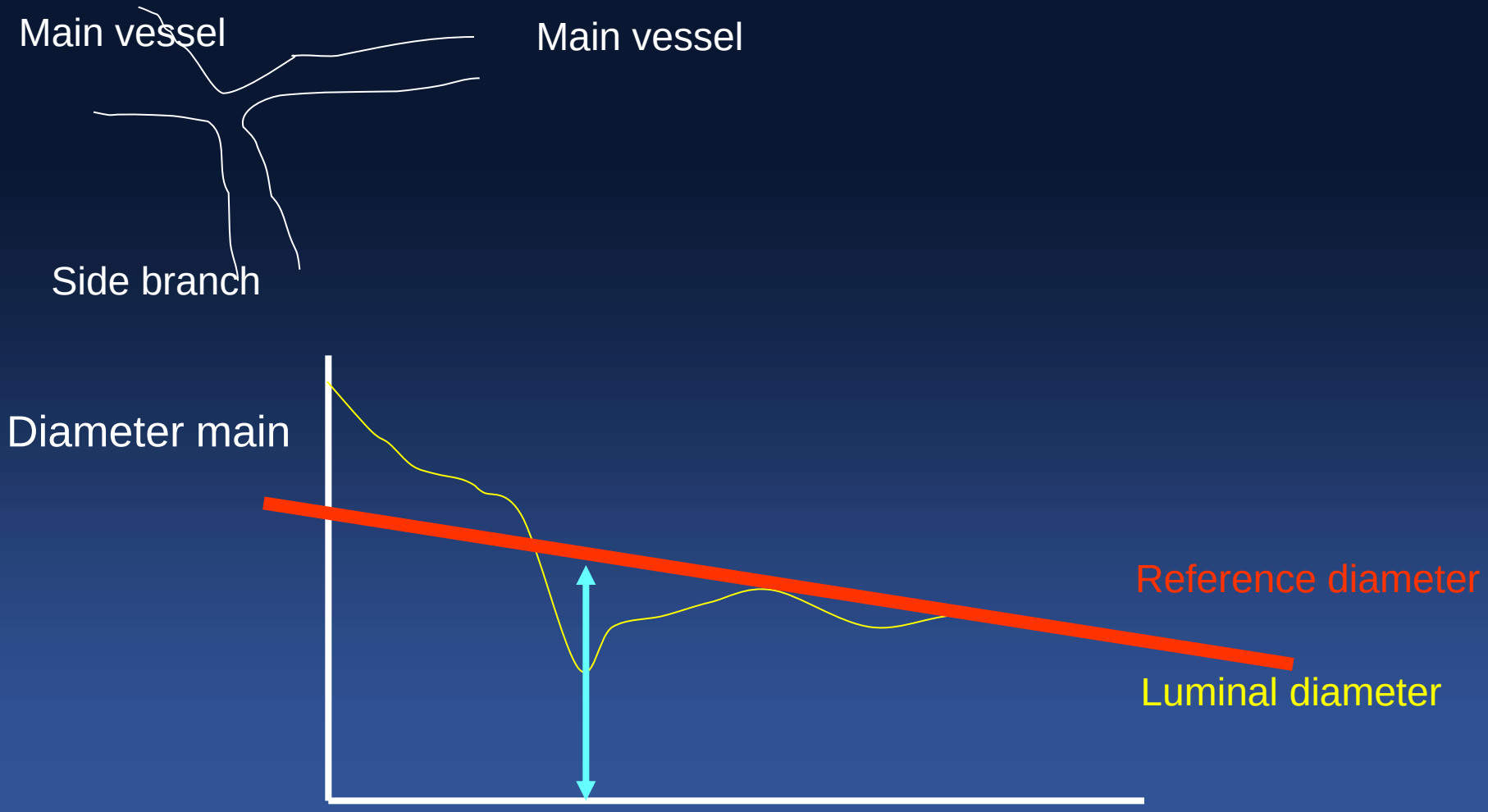
Underestimation of Side Branch Reference



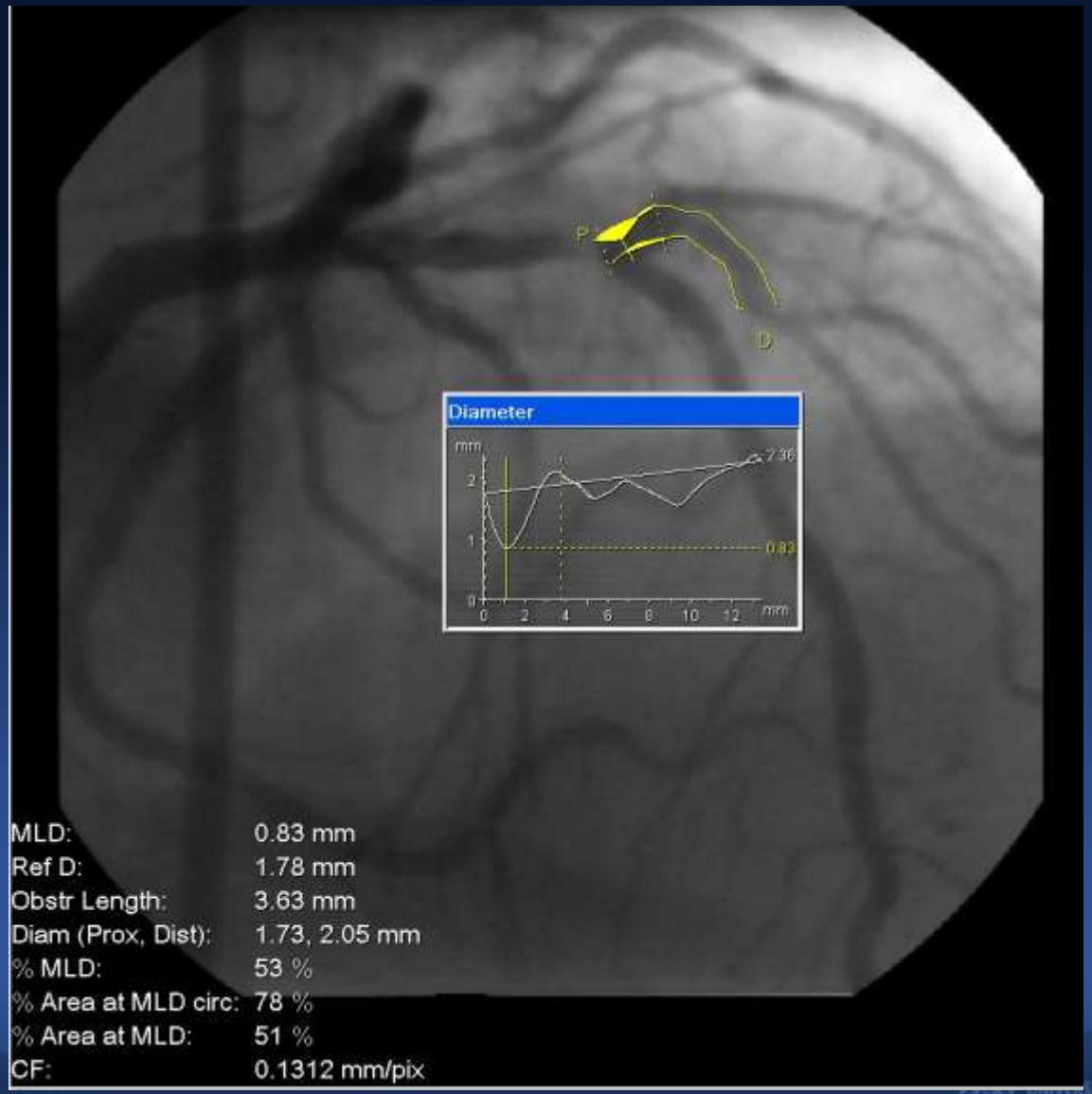
Overestimation of Reference



Underestimation of Reference
If the index is the distal segment.



Incorrect Measurement



Challenge in measuring Bifurcations

Innovative derivation of RVD in carina segment

arterial contours

reference contours

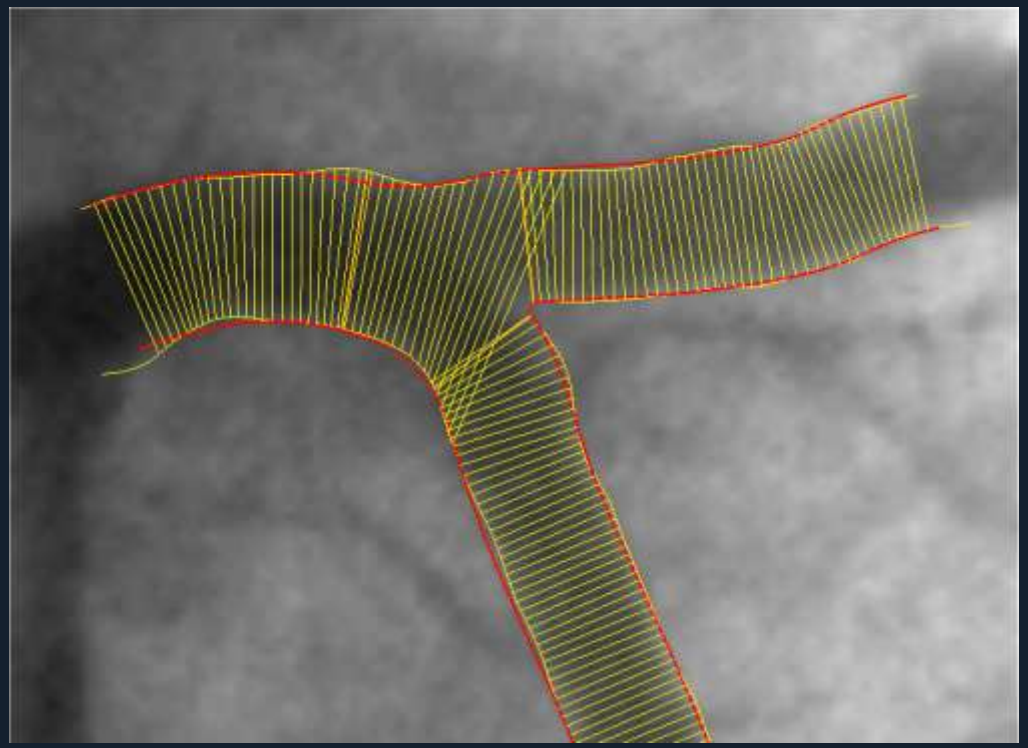
fragment delimiters

arterial diameters in proximal parent and carinal segment

Challenge in measuring Bifurcations

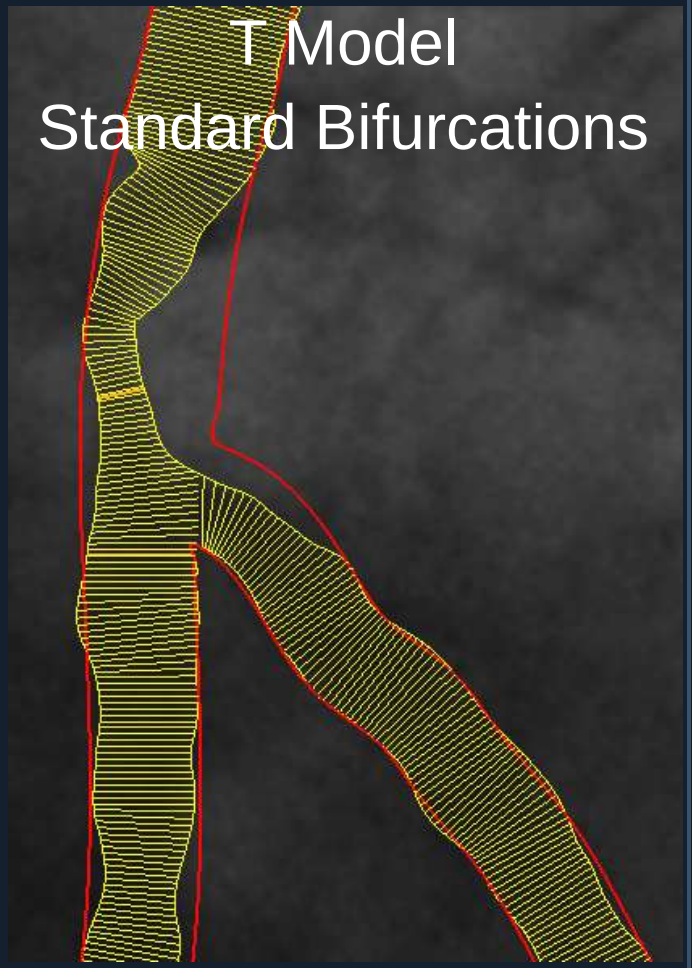
Innovative derivation of RVD in carina segment

Y Model: LM



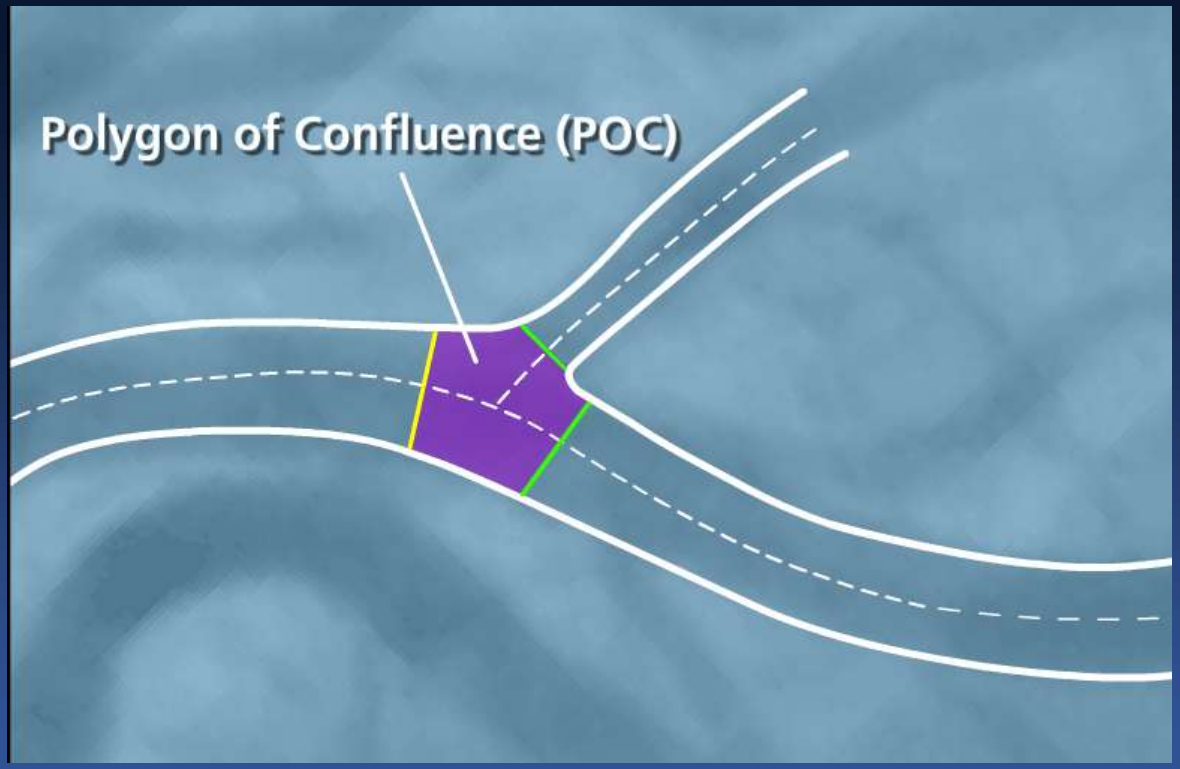
T Model

Standard Bifurcations



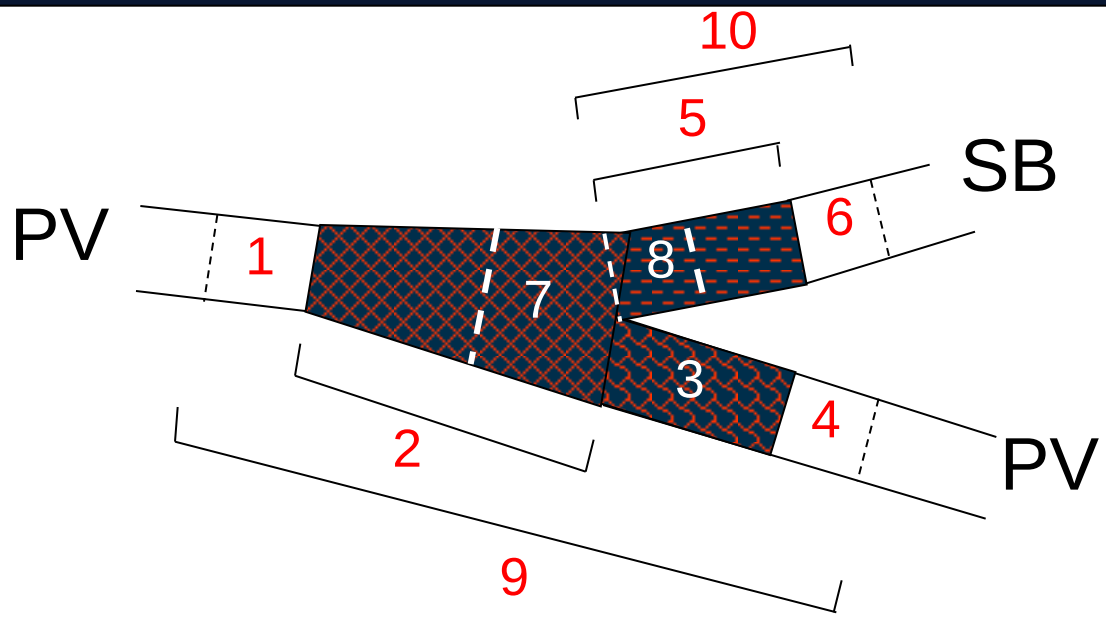
Polygon of Confluence by CASS-QCA

: Innovative Method of Bifurcation QCA



Ramcharritar S et al. Eurointervention 2008;3:553

Separation of Bifurcation Segments

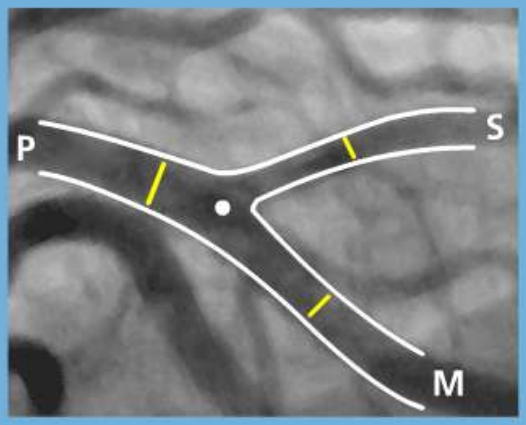


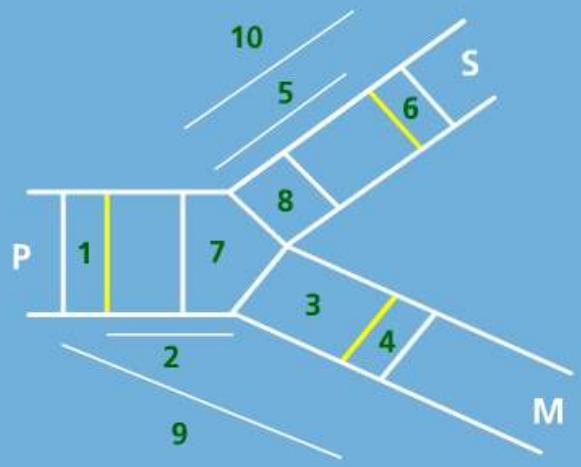
1 – Proximal Edge of the Prox PV Stent
2 – Prox PV Stent
3 – Distal PV Stent*
4 – Distal Edge of the PV Stent
5 – SB Stent*
6 – Distal Edge of the SB Stent*
7 – Carina
8 – Ostium of the SB (5mm)
9 – PV In-Lesion
10 – SB In-Lesion

**if additional stent(s) placed*

Gorktekin O et al. Catheter Cardiovasc Interv 2007;69:172

Description of Bifurcation QCA



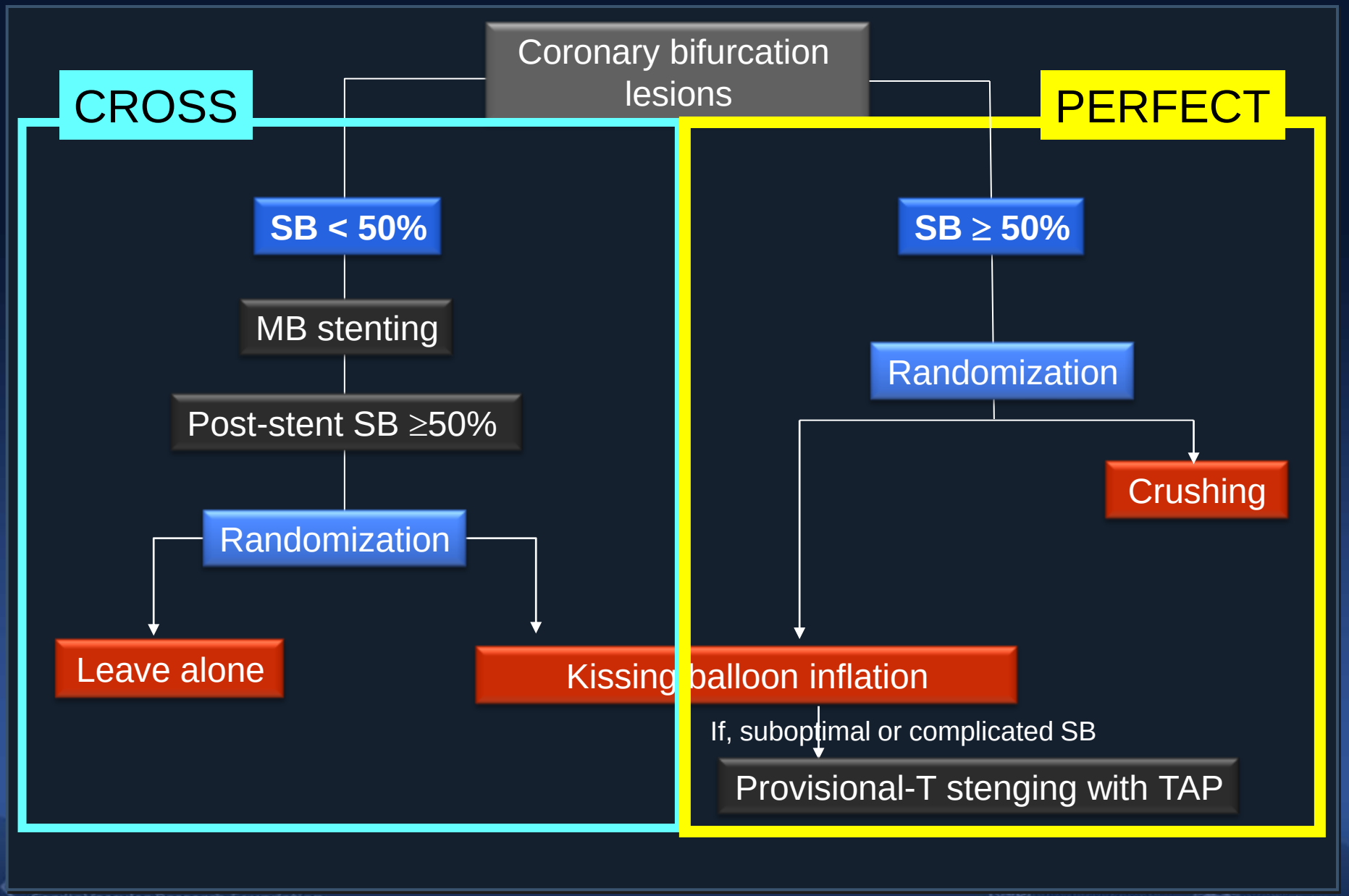


1. Proximal edge (5mm)
2. Proximal main stent
3. Distal main stent
4. Distal edge main (5mm)
5. Side branch stent
6. Distal edge side (5 mm)
7. Polygon of confluence
8. Ostium of side branch (5mm)
9. Main vessel stent + edges
10. Side branch stent + distal edge

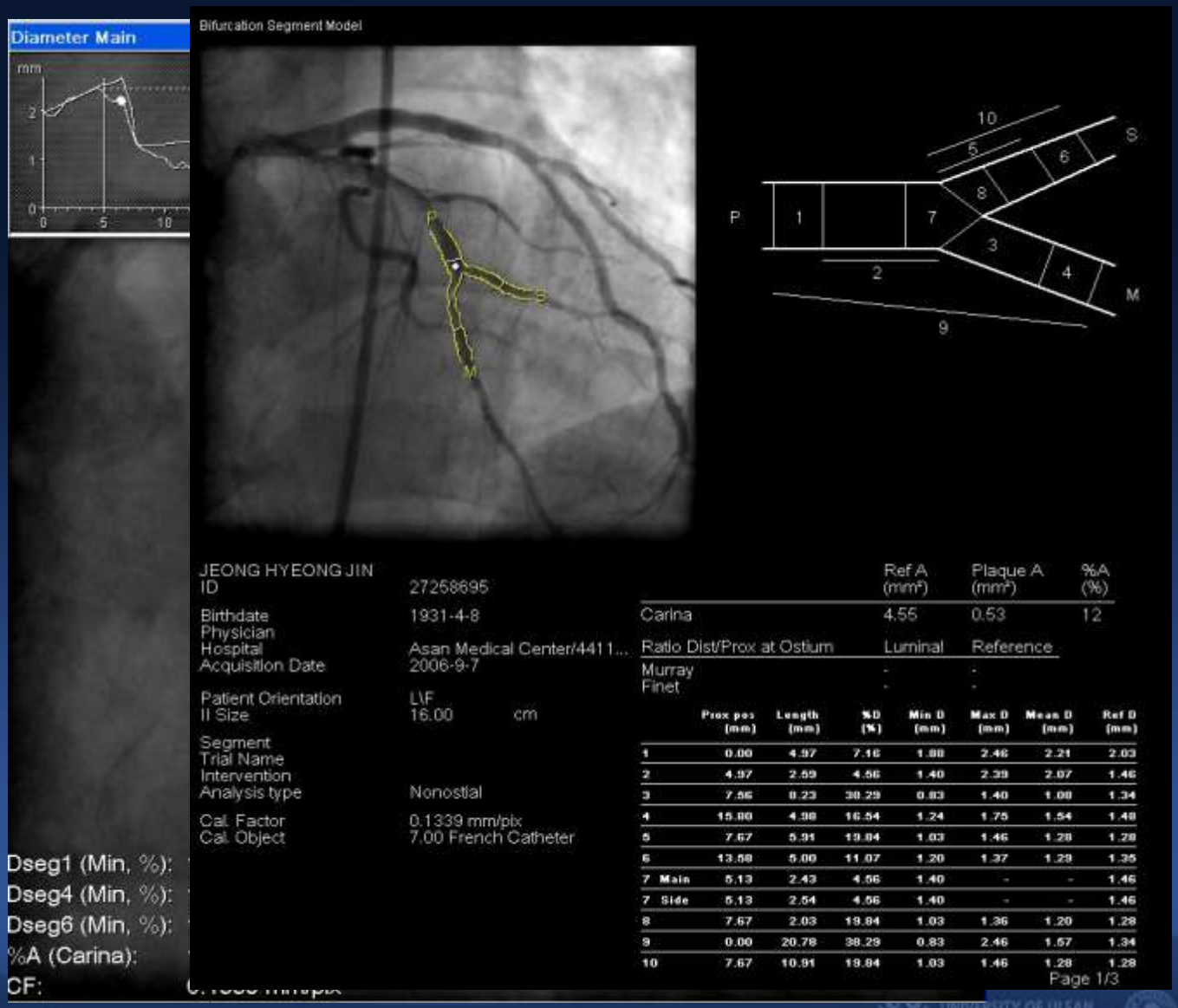
Presenting results in segmental model

- Ramcharritar S et al. Eurointervention 2008;3:553

CROSS & PERFECT Trials



Dedicated Bifurcation QCA



Presentation

Table 3. Angiographic Characteristics of Lesions Before and After Procedure

Variables	CROSS Study			PERFECT Study		
	Routine-FKB (N=151)	Leave-alone (N=155)	P value	Crush (N=213)	Single-stent (N=206)	P value
Baseline						
Medina classification			0.18			0.012
1. 0. 0.	18 (12.2)	15 (9.8)		2 (1.0)	4 (2.0)	
1. 1. 0.	52 (35.1)	74 (48.4)		5 (2.4)	22 (10.9)	
1. 0. 1.	8 (5.4)	4 (2.6)		18 (8.7)	18 (8.9)	
1. 1. 1.	28 (18.9)	24 (15.7)		137 (65.9)	126 (62.4)	
0. 1. 0.	34 (23.0)	25 (16.3)		4 (1.9)	5 (2.5)	
0. 1. 1.	6 (4.1)	4 (2.6)		39 (18.8)	25 (12.4)	
0. 0. 1.	1 (0.7)	3 (2.0)		3 (1.4)	2 (1.0)	
0. 0. 0.	1 (0.7)	4 (2.6)		0	0	
Main branch						
Severe calcification	7 (4.7)	8 (5.2)	0.84	25 (12.0)	25 (12.4)	0.91
Severe tortuosity	1 (0.7)	0	0.49	0	0	-
TIMI flow grade			0.14			0.43
0 or 1	4 (2.7)	5 (3.3)		3 (1.4)	6 (3.0)	
2	4 (2.7)	0		14 (6.7)	10 (5.0)	

3	140 (94.6)	148 (96.7)		191 (91.8)	186 (92.1)	
Proximal reference diameter, mm	3.5±0.6	3.4±0.5	0.24	3.6±0.4	3.7±0.5	0.039
Distal reference diameter, mm	2.5±0.4	2.5±0.4	0.86	2.6±0.4	2.6±0.4	0.67
Lesion length, mm	28.3±12.9	27.1±12.8	0.42	28.9±14.6	27.8±13.1	0.43
Minimal lumen diameter, mm	1.2±0.4	1.1±0.4	0.20	1.1±0.4	1.1±0.4	0.75
Diameter stenosis, %	60.5±11.8	61.8±13.4	0.36	64.4±12.3	65.9±11.7	0.21
Side branch						
Severe calcification	0	0	-	5 (2.4)	4 (2.0)	1.0
Severe tortuosity	0	0	-	0	1 (0.5)	0.49
TIMI flow grade			0.84			1.0
0 or 1	2 (1.4)	4 (2.6)		1 (0.5)	1 (0.5)	
2	1 (0.7)	1 (0.7)		16 (7.7)	15 (7.4)	
3	145 (98.0)	148 (96.7)		191 (91.8)	186 (92.1)	
Distal reference diameter, mm	2.1±0.4	2.1±0.4	0.069	2.2±0.4	2.2±0.4	0.17
Lesion length, mm	2.3±4.3	1.4±3.1	0.026	10.3±8.2	8.3±7.3	0.009
Minimal lumen diameter, mm	1.6±0.4	1.7±0.4	0.24	1.1±0.4	1.2±0.4	0.25
Diameter stenosis, %	29.4±13.4	29.0±15.7	0.82	57.2±14.5	53.3±16.5	0.012
Post-procedure						
Main branch						
Stent length, mm	31.5±12.0	30.9±11.7	0.66	34.0±13.5	34.7±13.4	0.64
Minimal luminal diameter, mm						
In-stent	2.6±0.4	2.6±0.4	0.68	2.6±0.4	2.7±0.4	0.041
In-segment	2.2±0.4	2.2±0.4	0.53	2.2±0.4	2.3±0.5	0.13
Diameter stenosis, %						
In-stent	11.6±6.6	12.8±7.2	0.12	13.5±7.2	13.0±6.9	0.48
In-segment	20.3±8.7	20.7±8.3	0.70	22.1±10.0	20.7±8.7	0.12
Side branch						
Stent length, mm	15.3±8.1	24.6	0.42	15.4±7.1	16.4±6.6	0.32
Minimal luminal diameter, mm						
Ostium	1.7±0.4	1.6 ± 0.5	0.053	2.3±0.4	1.9±0.6	< 0.001
In-segment	1.6±0.4	1.5 ± 0.4	0.15	1.8±0.4	1.6±0.4	< 0.001
Diameter stenosis, %						
Ostium	25.8±15.0	32.2 ± 18.2	0.001	13.7±11.1	25.7±17.8	< 0.001
In-segment	28.7±13.3	34.2 ± 16.6	0.002	21.0±10.7	31.1±15.0	< 0.001

Values are presented as number (percentages) and mean±SD

Table 4. Angiographic Characteristics of Lesions at Follow-Up

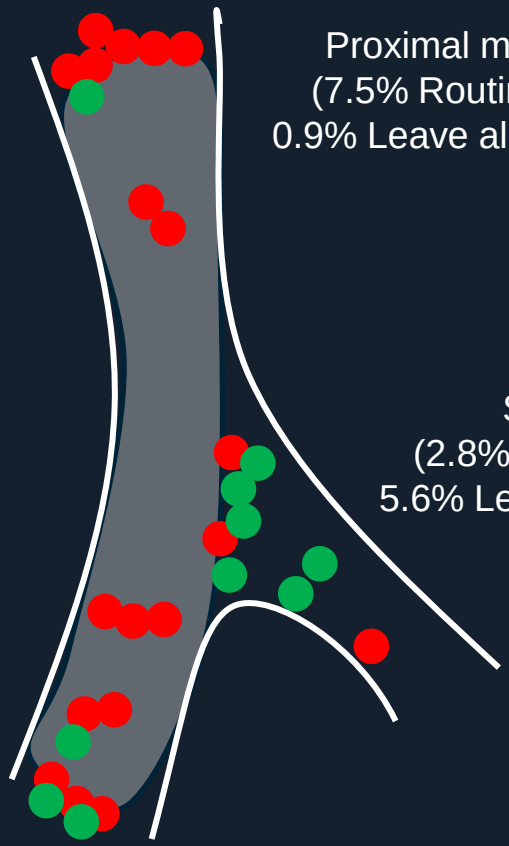
Variables	CROSS Study			PERFECT Study		
	Routine-FKB (N=106)	Leave-alone (N=108)	P value	Crush (N=155)	Single-stent (N=145)	P value
Overall restenosis, % *	19 (17.9)	10 (9.3)	0.064	13 (8.4)	16 (11.0)	0.44
Main branch						
Minimal luminal diameter, mm						
In-stent	2.2±0.6	2.3±0.5	0.32	2.4±0.4	2.4±0.5	1.0
In-segment	1.9±0.6	2.1±0.4	0.071	2.1±0.4	2.2±0.5	0.44
Diameter stenosis, %						
In-stent	22.8±16.2	20.5±13.4	0.24	19.8±10.6	21.3±13.3	0.26
In-segment	29.7±17.3	25.7±13.1	0.064	26.8±13.1	26.1±12.4	0.65
Late luminal loss, mm						
In-stent	0.4±0.5	0.3±0.4	0.13	0.2±0.3	0.3±0.4	0.036
In-segment	0.2±0.5	0.1±0.4	0.094	0.1±0.4	0.2±0.4	0.24
Restenosis						
In-stent	8 (7.5)	1 (0.9)	0.018	2 (1.3)	5 (3.4)	0.27
Proximal edge	6 (5.7)	1 (0.9)	0.064	5 (3.2)	1 (0.7)	0.22
Distal edge	3 (2.8)	2 (1.9)	0.68	1 (0.6)	1 (0.7)	1.0
In-segment	16 (15.1)	4 (3.7)	0.004	8 (5.2)	7 (4.8)	0.90
Restenosis pattern			1.0			1.0
Focal	10 (62.5)	2 (50.0)		5 (62.5)	4 (57.1)	
Diffuse	6 (37.5)	2 (50.0)		3 (37.5)	3 (42.9)	
Side branch						
Minimal luminal diameter, mm						
Ostium	1.6±0.4	1.5±0.5	0.17	2.0±0.4	1.6±0.5	< 0.001
In-segment	1.5±0.4	1.5±0.4	0.73	1.7±0.4	1.4±0.4	< 0.001
Diameter stenosis, %						
Ostium	27.5±15.9	33.3±16.9	0.010	23.2±15.1	34.3±18.9	< 0.001
In-segment †	31.1±14.5	34.9±15.8	0.074	27.7±13.2	37.7±17.1	< 0.001
Late luminal loss, mm						
Ostium	0.1±0.4	0.1±0.4	0.59	0.3±0.4	0.3±0.5	0.15
In-segment	0.1±0.4	0.1±0.4	0.88	0.1±0.3	0.2±0.3	0.36
Restenosis						
Ostium	2 (1.9)	4 (3.7)	0.68	1 (0.6)	4 (2.8)	0.20
In-segment	3 (2.8)	6 (5.6)	0.50	6 (3.9)	12 (8.3)	0.12
Restenosis pattern			0.33			0.52
Focal	2 (66.7)	6 (100)		6 (100)	9 (75.0)	
Diffuse	1 (33.3)	0		0	3 (25.0)	

Values are presented as number (percentages) and mean±SD. * and † were the primary end points of the PERFECT and CROSS studies.

Sites of restenosis

CROSS

Routine-FKB Leave alone



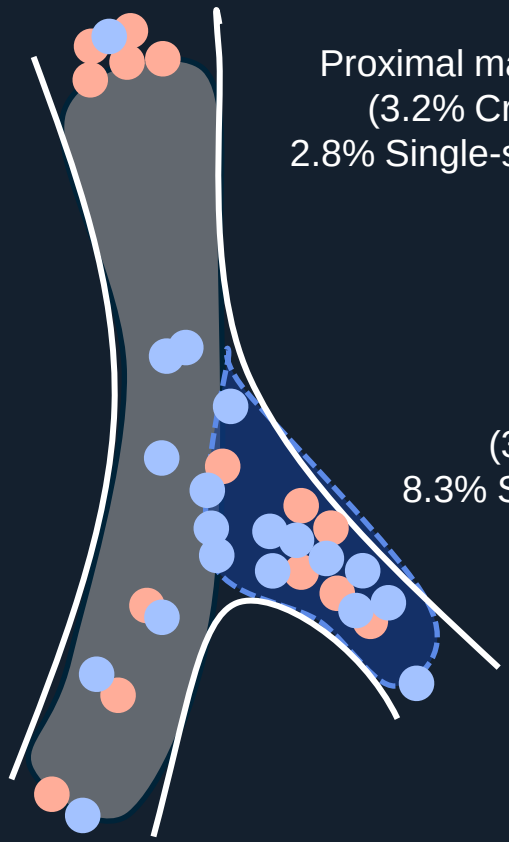
Proximal main branch
(7.5% Routine-FKB vs.
0.9% Leave alone, p=0.018)

Side branch
(2.8% Routine-FKB vs.
5.6% Leave alone, p=0.50)

Distal main branch
(7.5% Routine-FKB vs.
2.8% Leave alone, p=0.11)

PERFECT

Crush Single-stent



Proximal main branch
(3.2% Crush vs.
2.8% Single-stent, p=1.0)

Side branch
(3.9% Crush vs.
8.3% Single-stent, p=0.11)

Distal main branch
(1.9% Crush vs.
2.1% Single-stent, p=1.0)

Conclusions

- In angiographic analysis for bifurcation coronary lesions, both qualitative and quantitative measurements are performed.
- Qualitative assessment includes various morphological evaluations of parent vessel and side branch.
- After PCI, SB ostium is the major site of restenosis after bifurcation stenting. Therefore, careful SB assessment is the key element of bifurcation angiographic analysis.
- In quantitative assessment, ordinary QCA analysis has many limitations in assessing bifurcation lesions.
- Dedicated bifurcation software is useful to accurately represent quantitative parameters of angiography.

Thank you very much