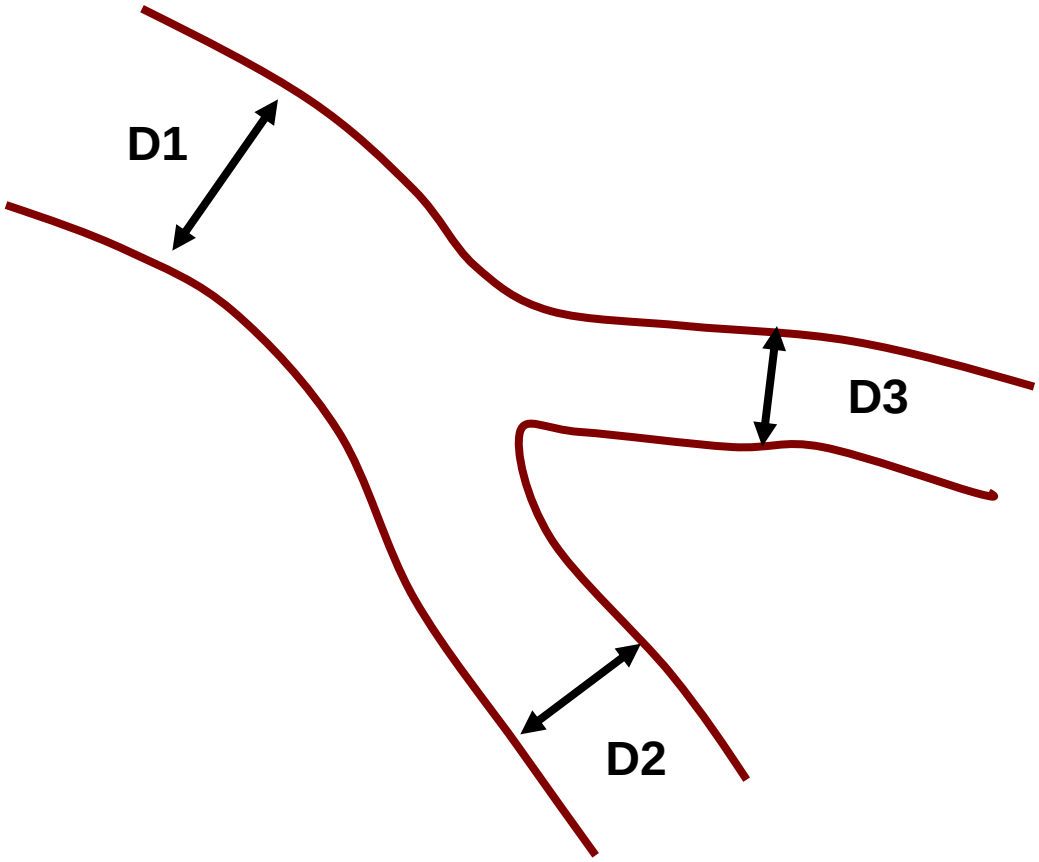
Post-stent Optimization After Bifurcation Stenting: POT and Kissing Balloon

Yves Louvard, ICPS,
Massy, Générale de Santé,
France

Bifurcation branching laws



Murray's law

$$D_1^{\,3} = D_2^{\,3} + D_3^{\,3}$$

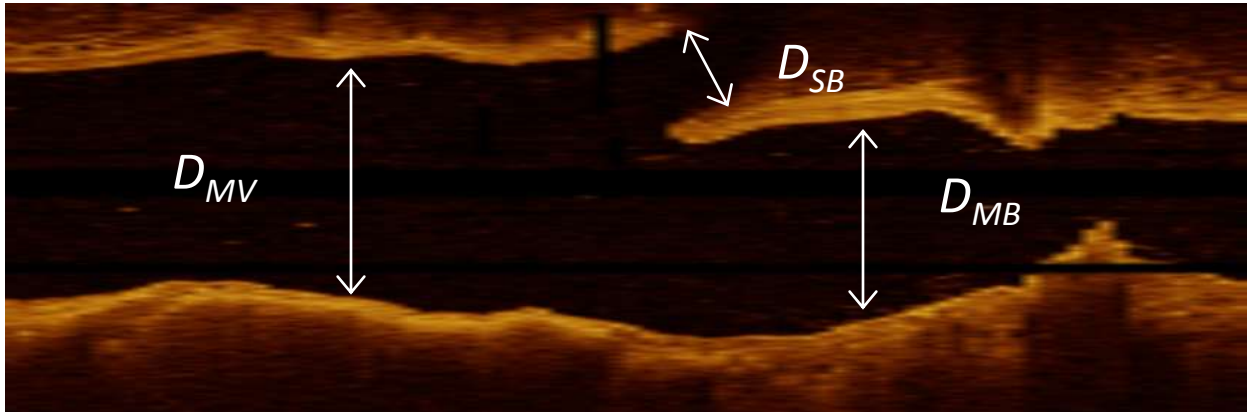
Finet's formula

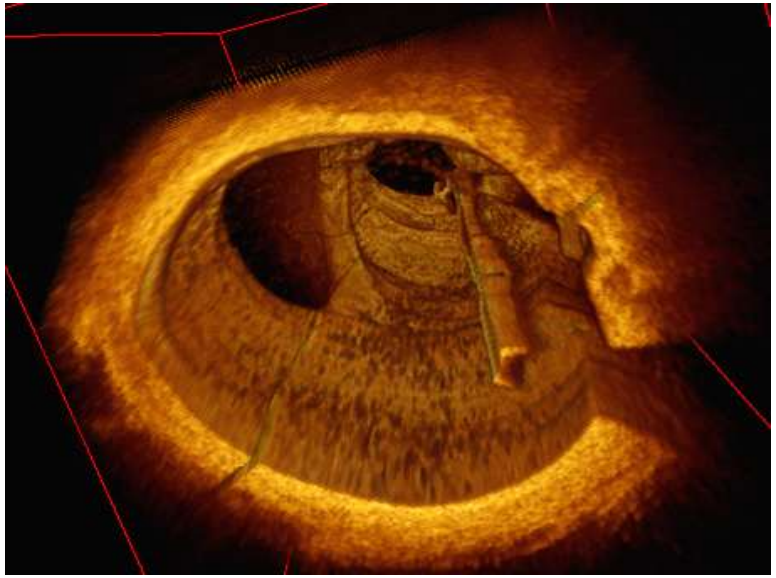
$$D_1 = 0.67(D_2 + D3)$$

Huo-Kassab formula

$$D_1^{\,2.3} = D_2^{\,2.3} + D_3^{\,2.3}$$

Anatomy of Bifurcations





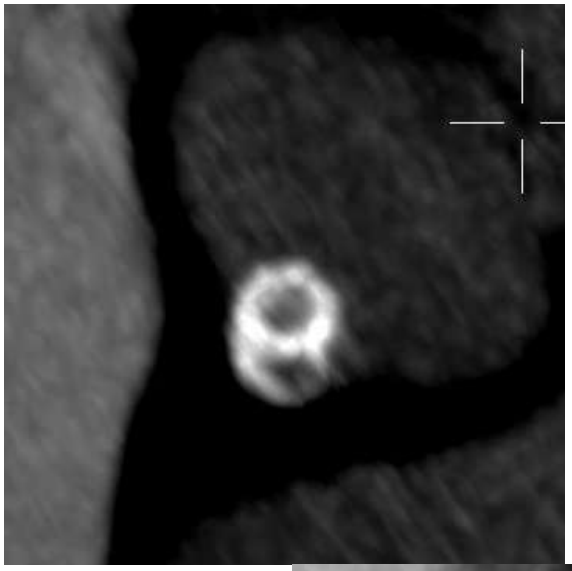
	Principle	Relation	*Ratio Dm/Dd for D_{d1}~ D_{d2}*
Murray's law	Minimum Work	$D_m3 = D_{d1}3 + D_{d2}3$	*1.26*
HK: Huo-Kassab	Minimum Energy	$D_m7/3 = D_{d1}7/3 + D_{d2}7/3$	*1.35*
Flow conservation	$Q_m = Q_{d1} + Q_{d2}$	$D_m2 = D_{d1}2 + D_{d2}2$	*1.4*
Finet	Measurement	$D_m = \underline{0.678}\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

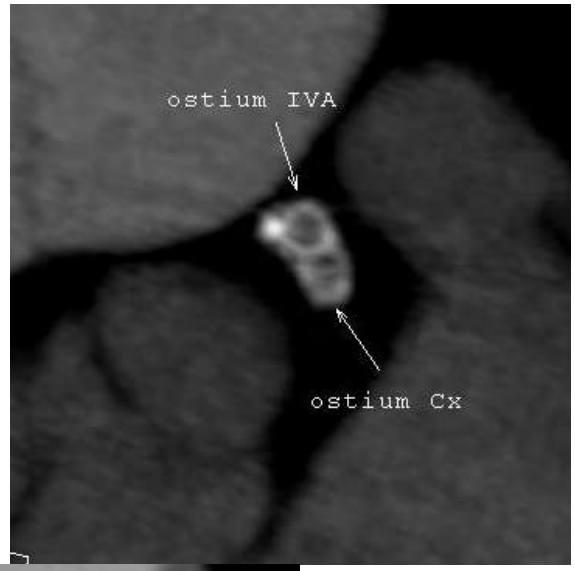
- The larger the SB, the larger the change in MV diameter throughout the bifurcation

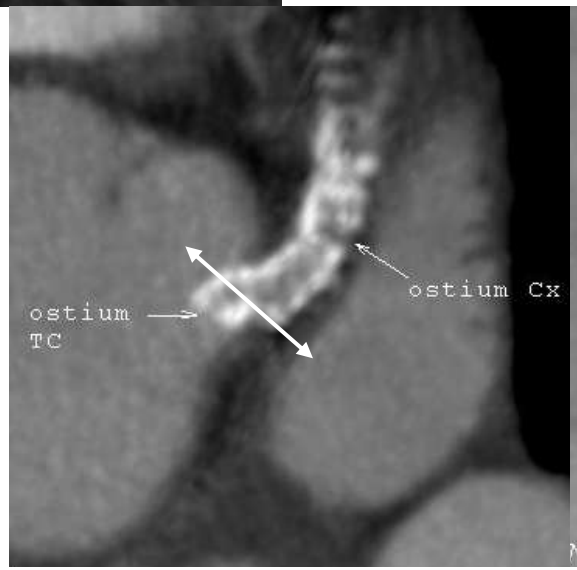
Courtesy of N Foin

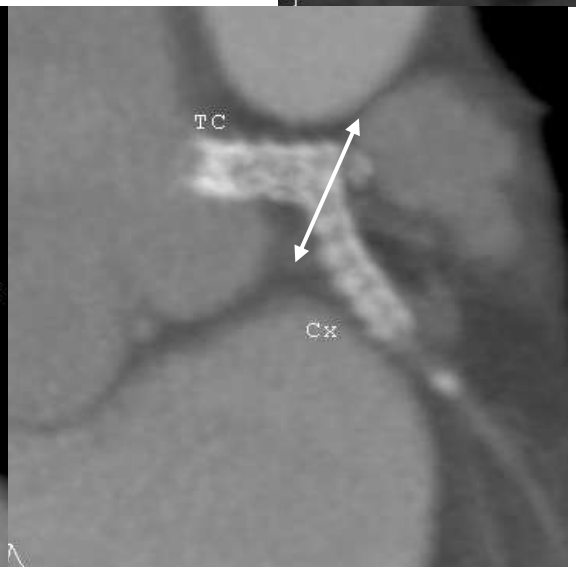
POT: what for ?

- To give 2 « normal » diameters to the cross-over stent
- To avoid wire exchange outside the proximal part of the stent
- To help wire crossing toward the SB through the most distal cell
- To open the access to the provisional SB stenting

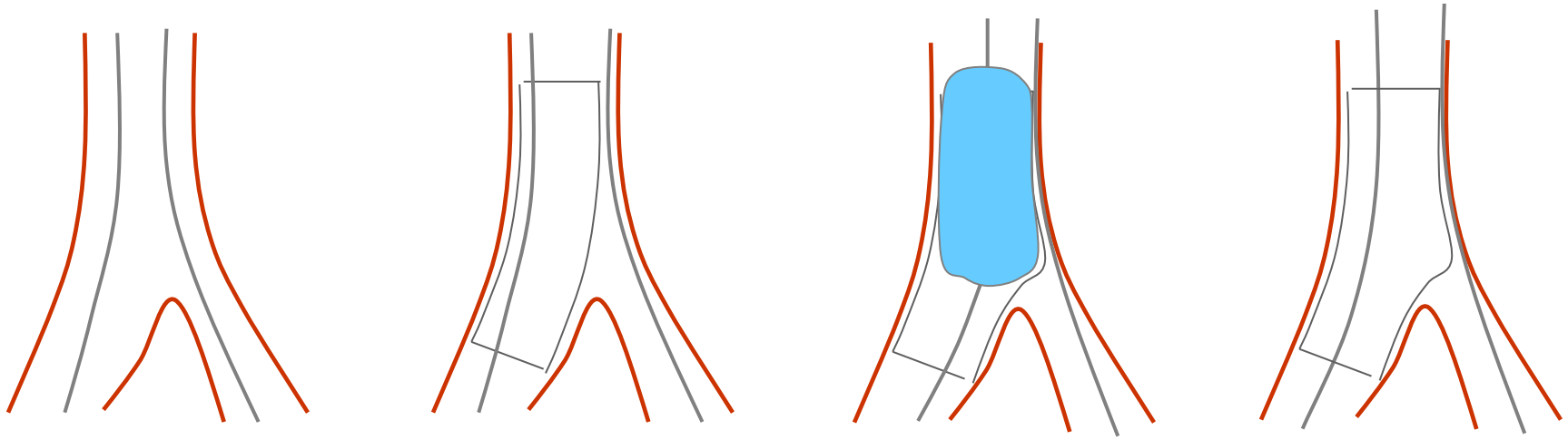


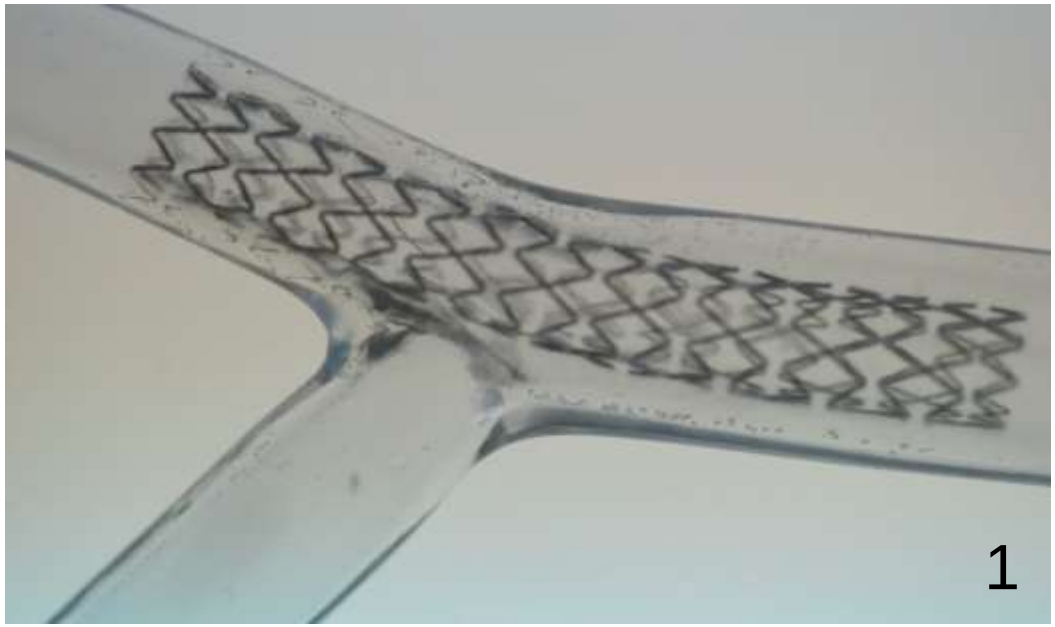

ostium IVA
ostium Cx

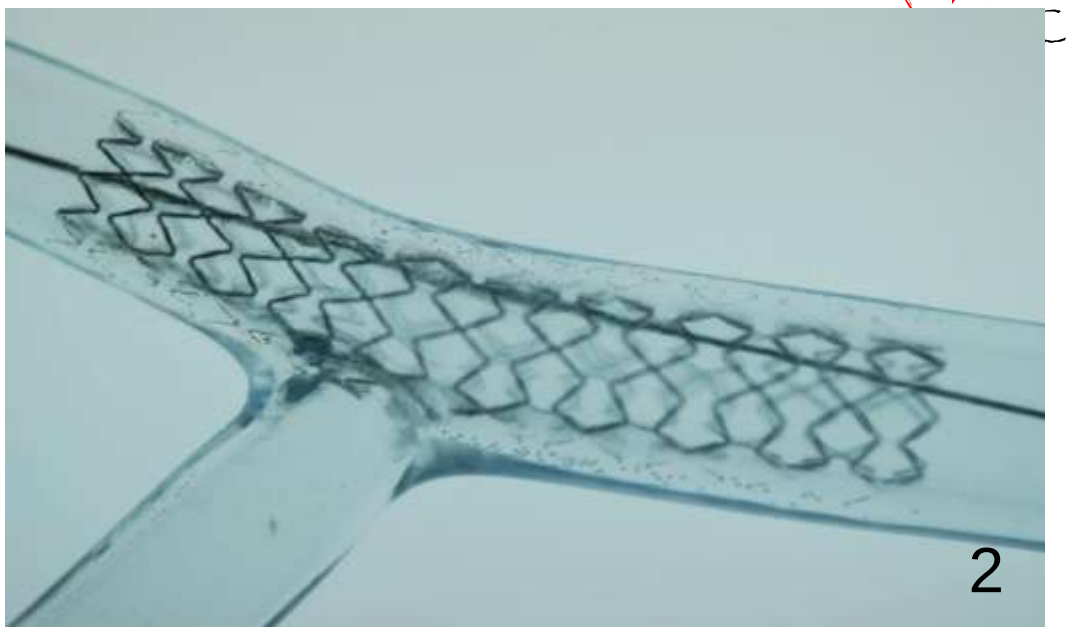

ostium
TC
ostium Cx


TC
Cx

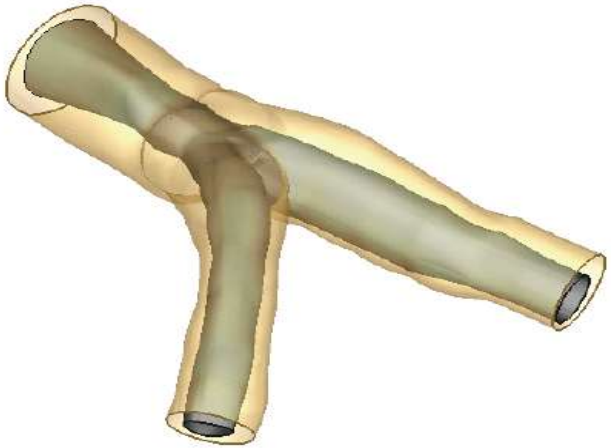
Provisional Side Branch Stenting: Step-by-step procedure

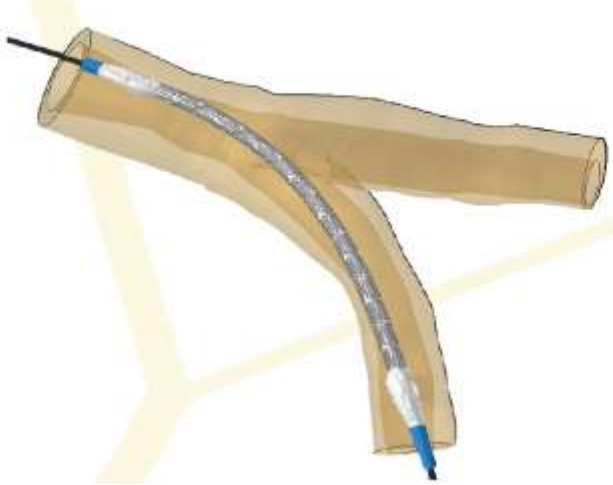


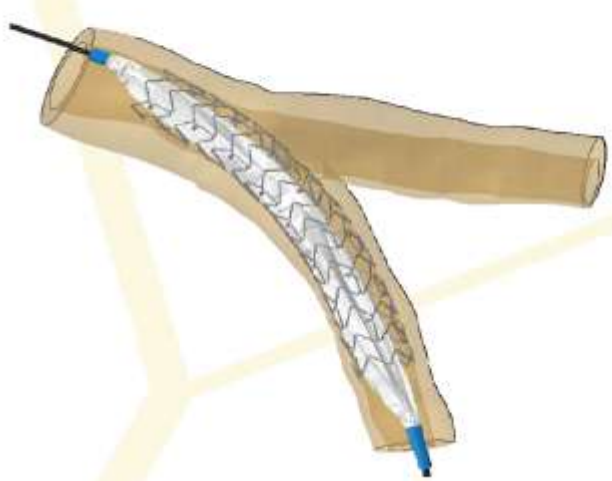

1

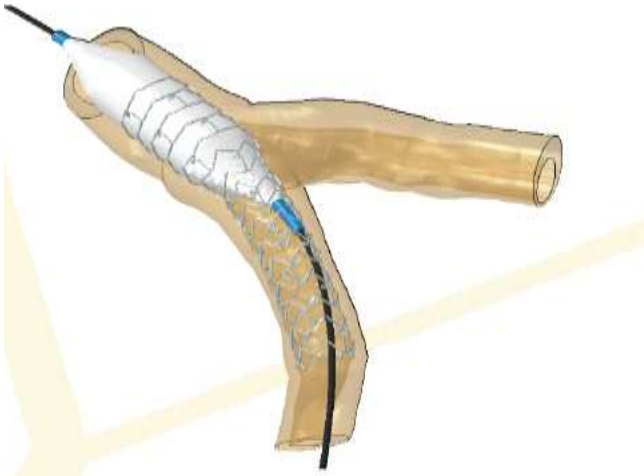

2

Patient's specific stenting simulation (Xience Prime)







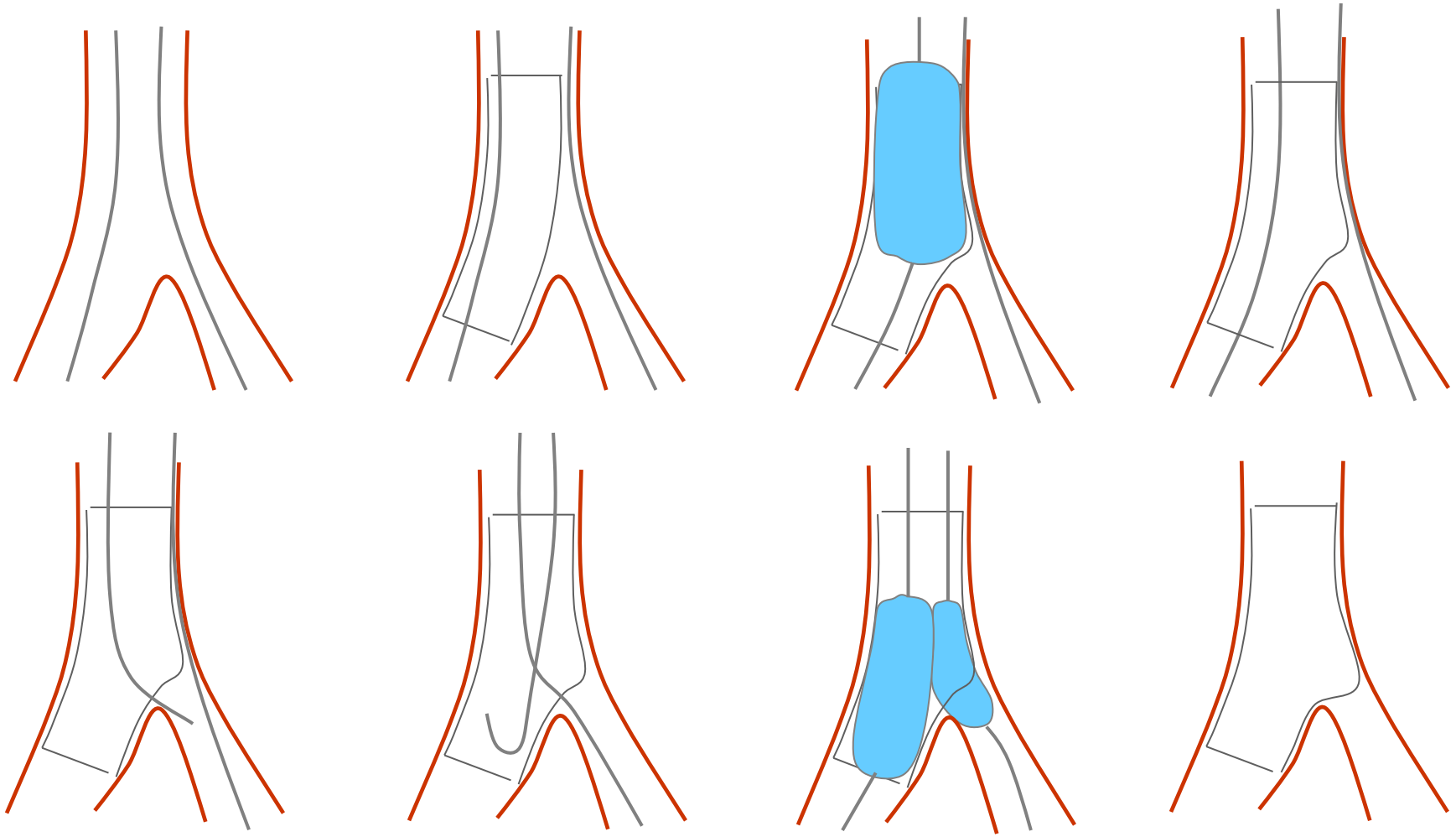


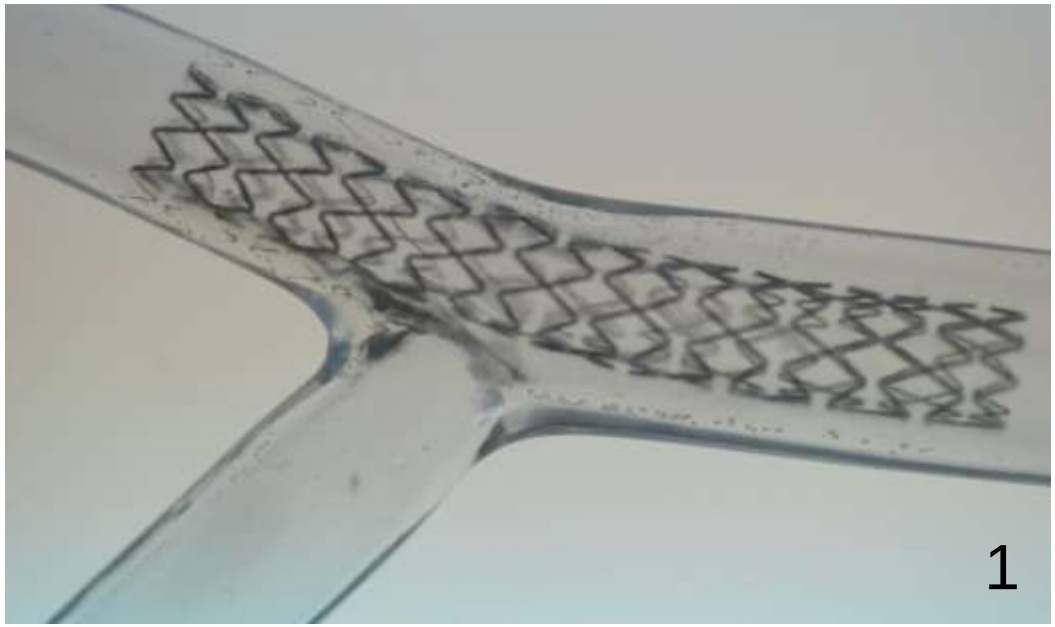
From J. Wentzel, P. Mortier

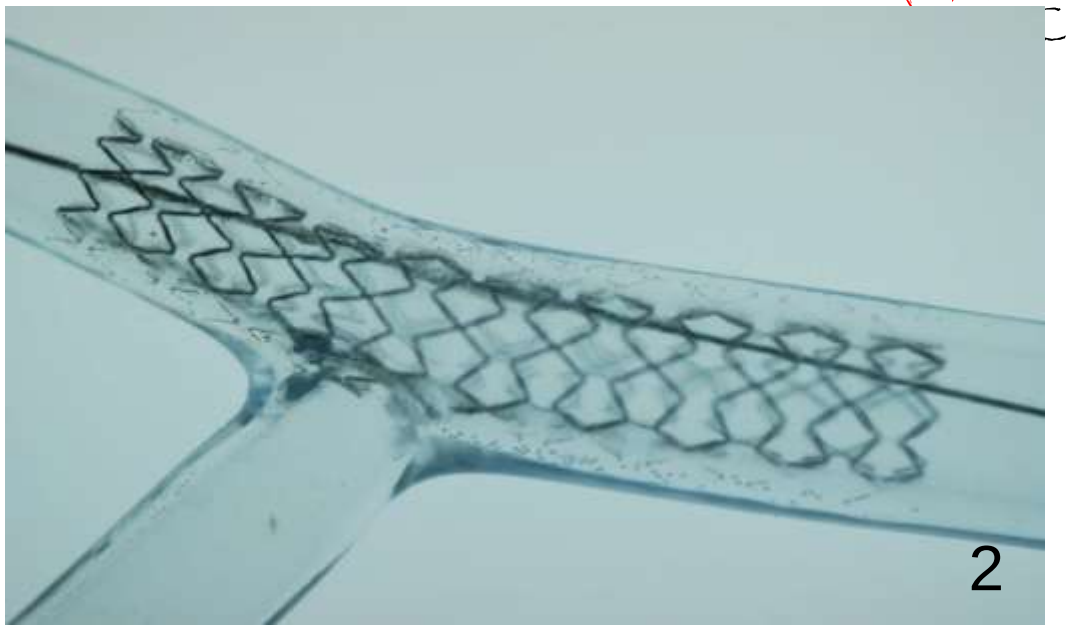
Final kissing balloon: what for ?

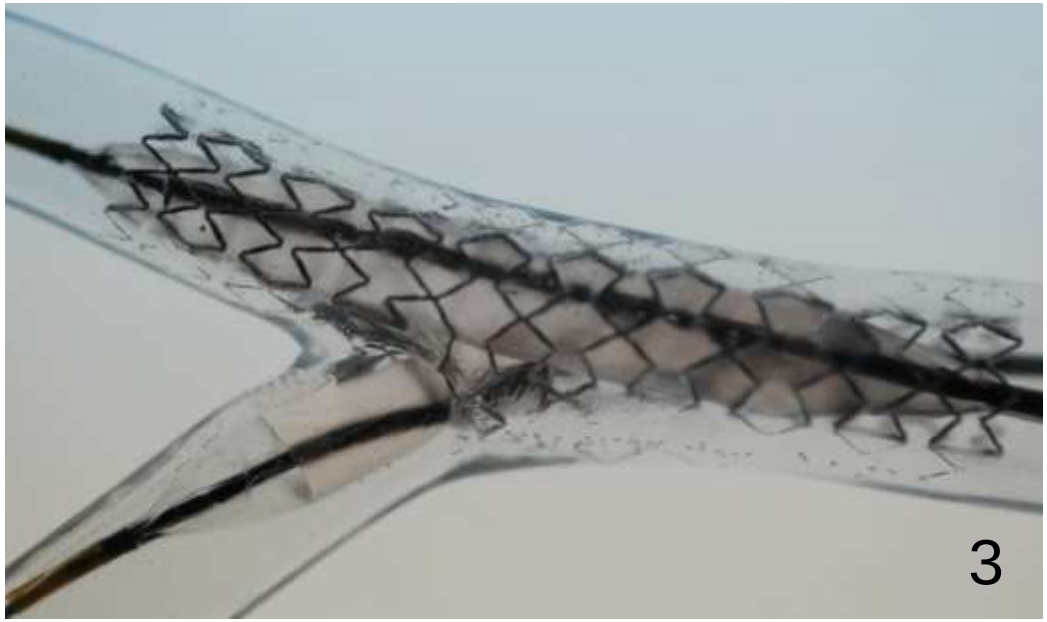
- To treat an ostial SB stenosis / carena-plaque shift
- To open the stent jail
- To place the carena in its proper position for flow sharing

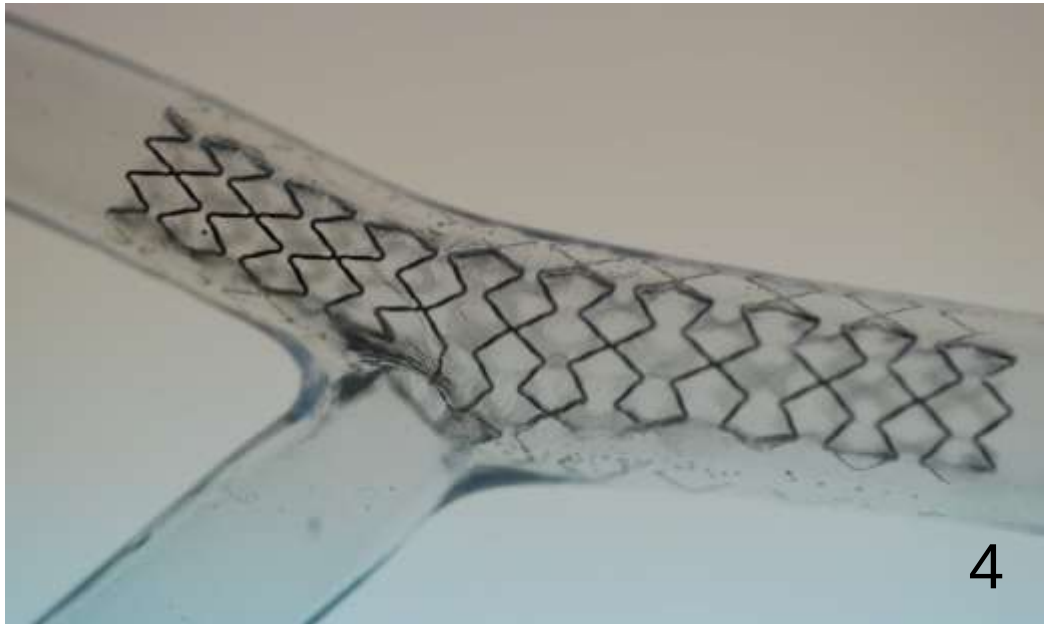
Provisional Side Branch Stenting: Step-by-step procedure



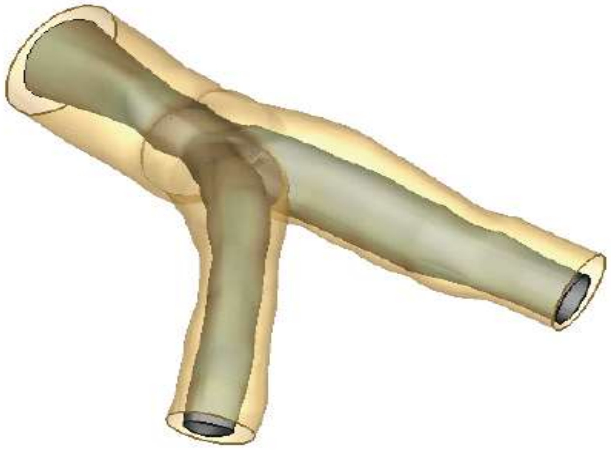

1

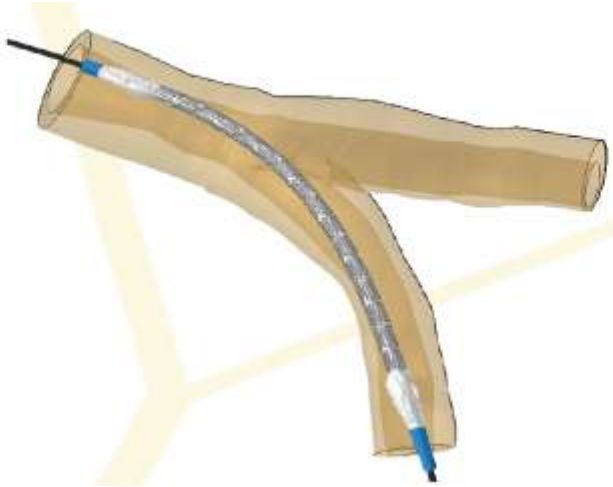

2

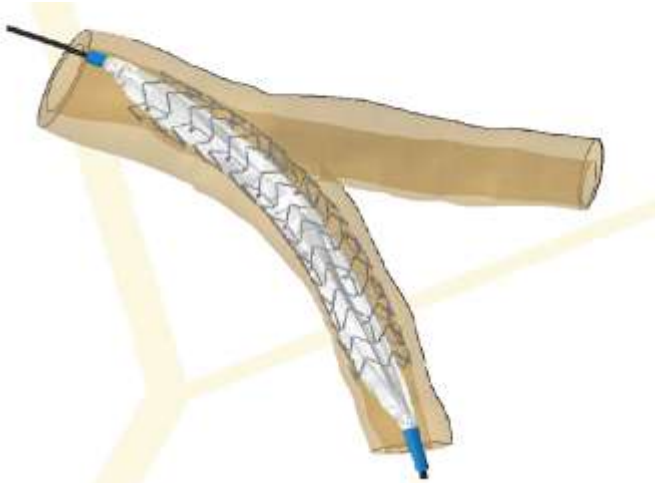

3

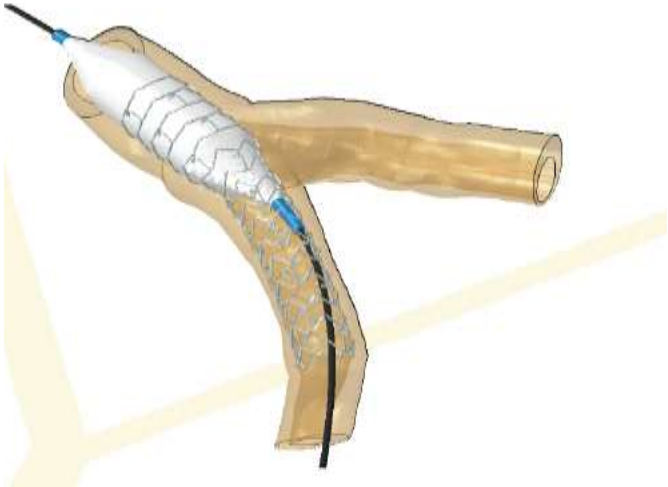

4

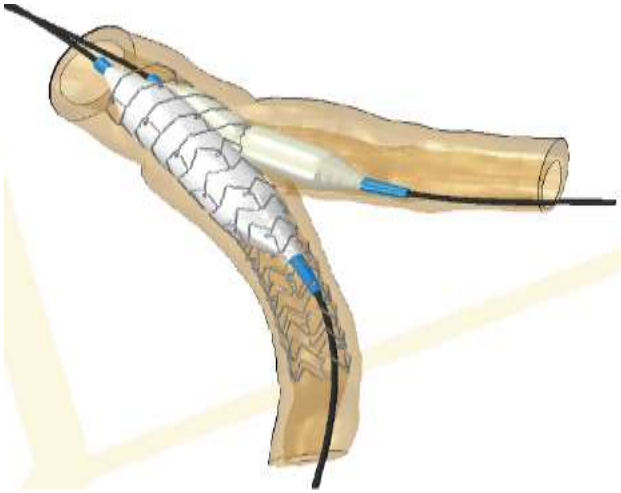
Patient's specific stenting simulation (Xience Prime)

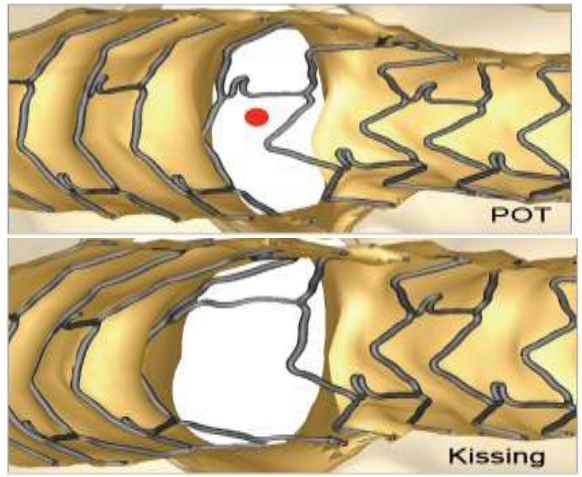






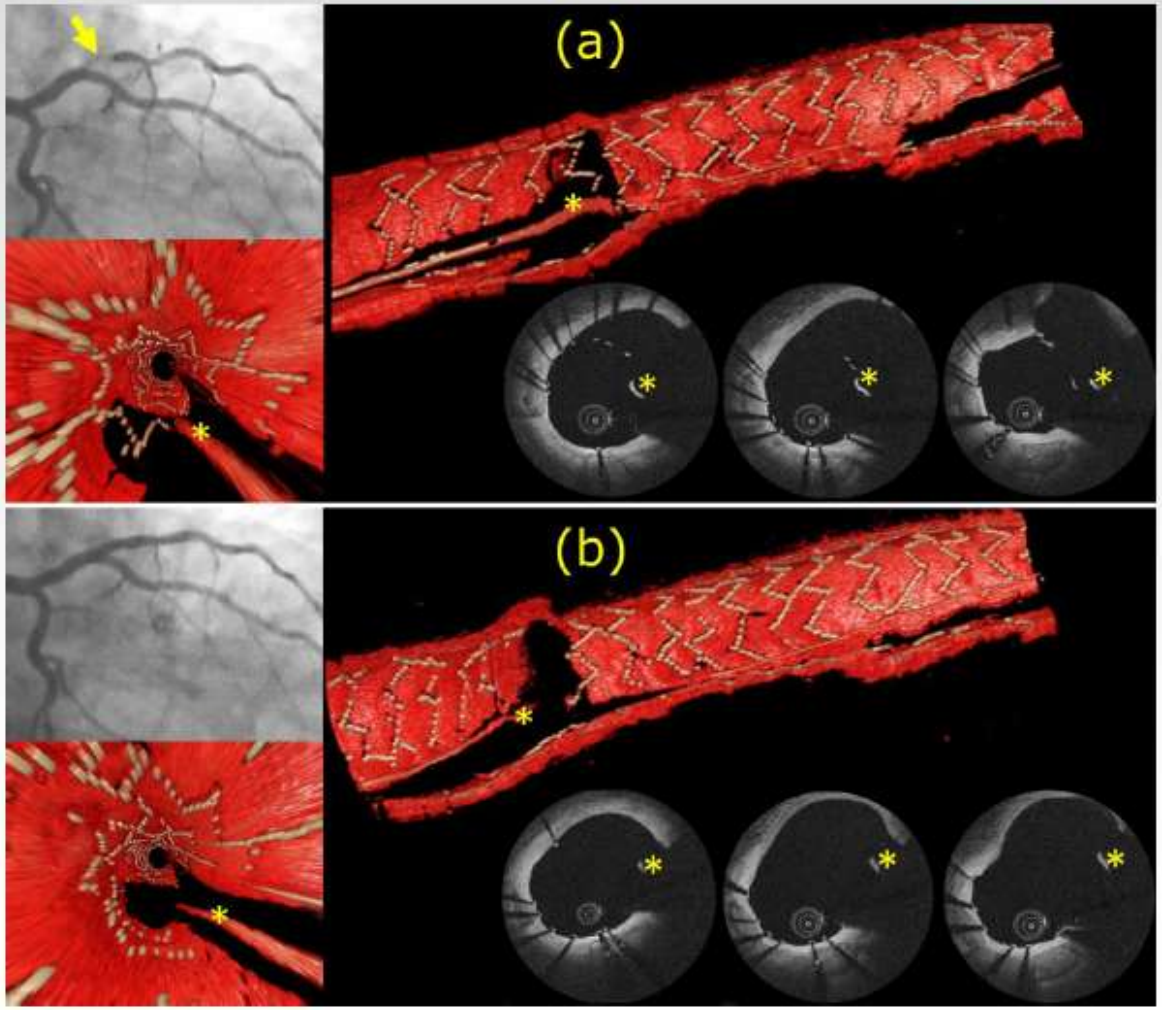






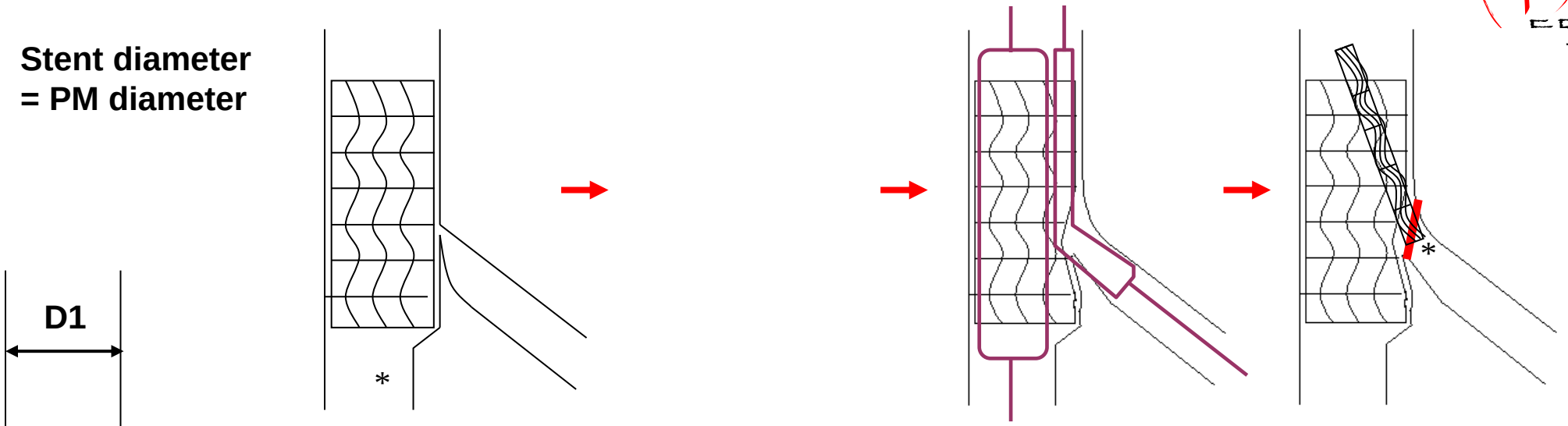
From J. Wentzel, P. Mortier

2D vs. 3D OCT assessment of wire re-crossing



Ughi et al. Eur Heart J Cardiovasc Img 2013

Stent diameter
= PM diameter



Stent diameter
= DM diameter

POT

EBC

Datas:
POT ? FKB ?

Randomized Comparison of Final KB Dilatation Versus No Final KB Dilatation in Patients With Coronary Bifurcation Lesions Treated With Main Vessel Stenting. The Nordic-Baltic Bifurcation Study III

Individual Components of MACEs and Clinical Outcomes at 6 Months

	No FKBD (n=239), n (%)	FKBD (n=238), n (%)	*P*
Noncardiac death	0 (0)	1 (0.4)	0.49
Cardiac death	0 (0)	2 (0.8)	0.24
Index lesion MI*	3 (1.3)	1 (0.4)	0.62
TLR	4 (1.7)	3 (1.3)	1.00
CCS class ≥2 angina	29 (12.0)	28 (11.7)	1.00
Stent thrombosis	1 (0.4)	1 (0.4)	1.00

Niemela, Circulation. 2011;123:79-86

Randomized Comparison of Final KB Dilatation Versus No Final KB Dilatation in Patients With Coronary Bifurcation Lesions Treated With Main Vessel Stenting. The Nordic-Baltic Bifurcation Study III

	True Bifurcation Subgroup			Nontrue Bifurcation Subgroup		
Variable	FKBD (n=92)	No FKBD (n=80)	*P*	FKBD (n=72)	No FKBD (n=82)	*P*
In-segment MV						
DS, %	22±15	22±15	0.85	22±14	21±12	0.90
≥50% DS, n (%)	3 (3.8)	2 (2.2)	0.67	3 (4.2)	1 (1.2)	0.34
Ostial 5 mm of the SB						
MLD, mm	1.71±0.42	1.50±0.53	0.005	1.79±0.54	1.77±0.61	0.79
DS, %	25±14	32±21	0.009	23±15	27±19	0.21
≥50% DS, n (%)	7 (7.6)	16 (20)	0.024	6 (8.3)	9 (11)	0.79

Niemela, Circulation. 2011;123:79-86

Long-Term Clinical Results and Predictors of Adverse Outcomes After DES Implantation for Bifurcation Lesions in a Real-World Practice– The COBIS Registry –

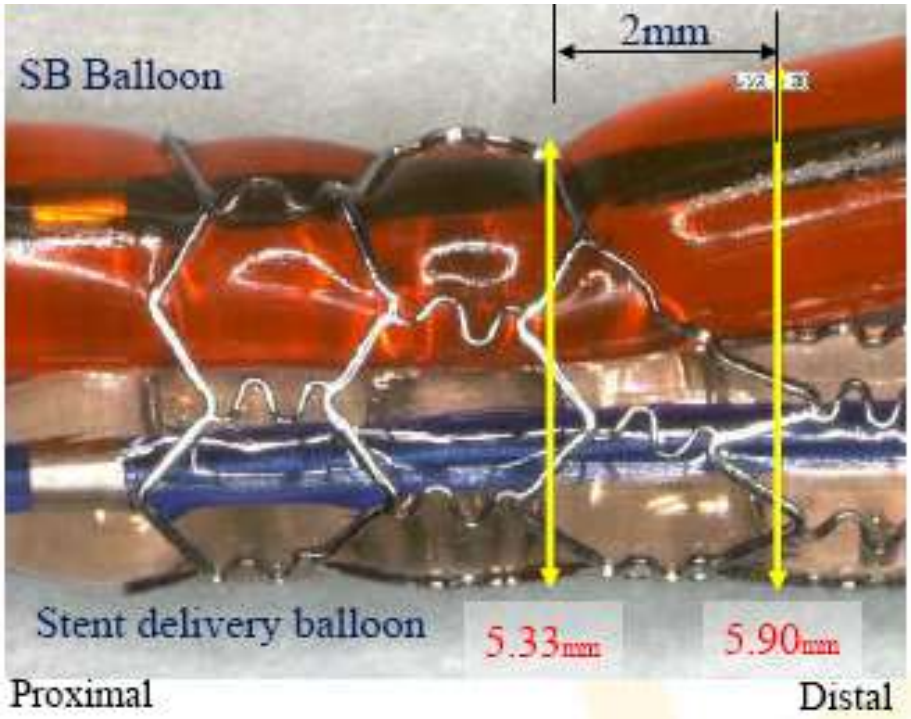
Independent Risk Factors for MACE and TLR

	HR (95%CI)	P value
MACE		
Final kissing ballooning	2.01 (1.29–3.13)	0.002
Use of paclitaxel-eluting stent	1.98 (1.34–2.92)	0.001
Stent length in the main vessel	1.02 (1.001–1.03)	0.03
TLR		
Final kissing ballooning	3.09 (1.84–5.16)	<0.001
Use of paclitaxel-eluting stent	2.28 (1.45–3.59)	<0.001
Stent length in the main vessel	1.02 (1.01–1.04)	0.01
Stent diameter in the main vessel	0.42 (0.20–0.89)	0.02

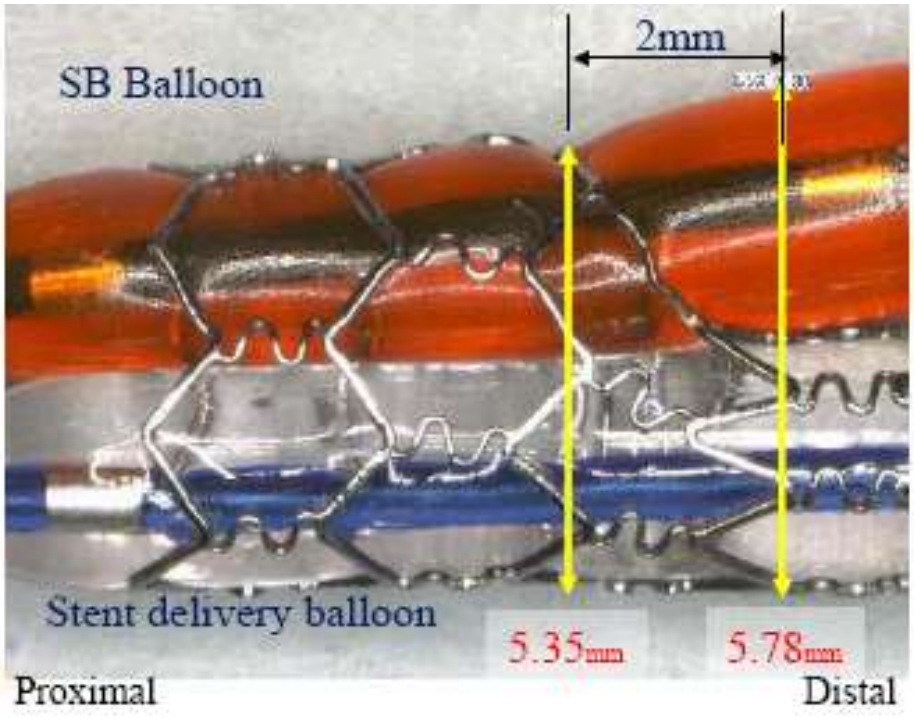
Gwon Circ J 2010 Sept 28

How to kiss ?

Non compliant high pressure balloons for kissing



Semi-Compliant Balloon
(Ryujin Plus, Terumo)



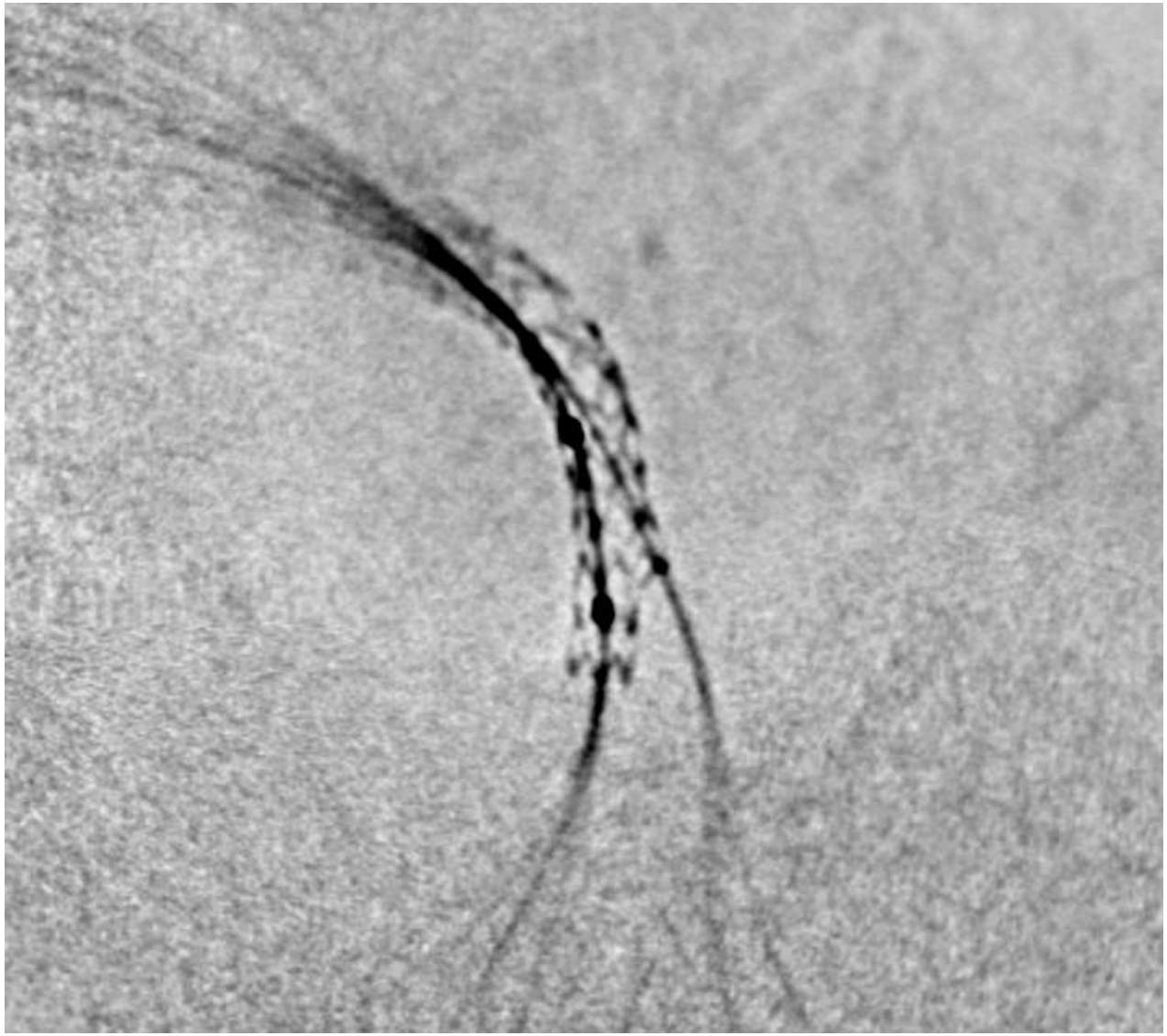
Non-Compliant Balloon
(Hiryu, Terumo)

Kinoshita, EBC 2009

Kissing With NC Balloons
Toulouse Rangueil / Massy Pilot Study (StentBoost)

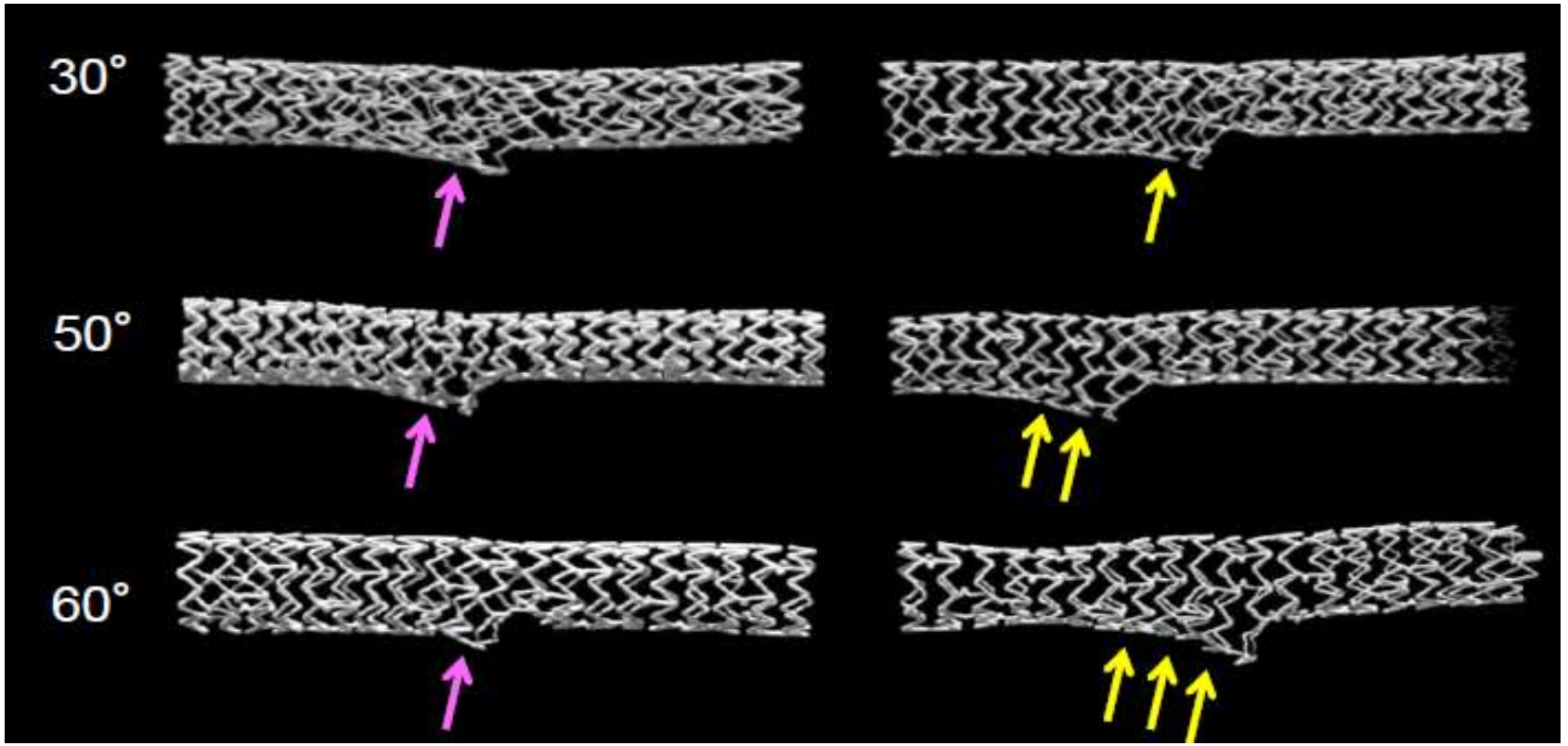
Bifurcation lesions (n)	100
FKB success (%)	100
FKB success without SB opening (%)	97
Metal projection in SB (%)	89
Need for SB stenting (%)	7
In-hospital MACE (%)	0

Mylotte.EuroIntervention. 2012 Feb;7(10):1162-9.



Optimal FKB in The Bench

Minimal overlaping **Long overlaping**



Murasato et al. PCR 2010

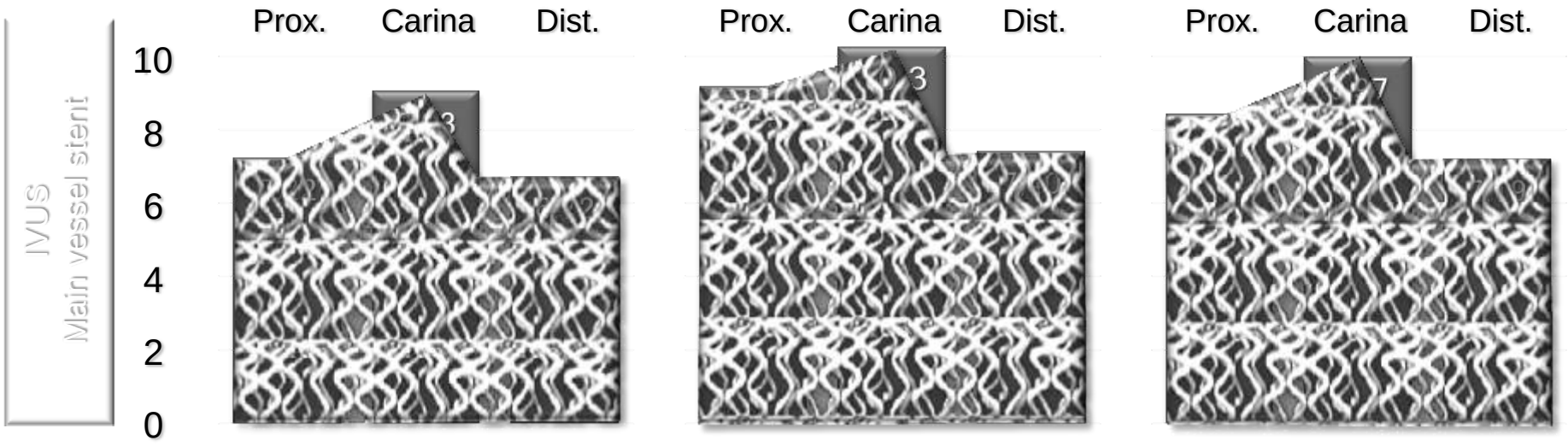
Optimal FKB in The Bench

Simultaneous

MV balloon First

SB balloon First

CSA (mm^2)



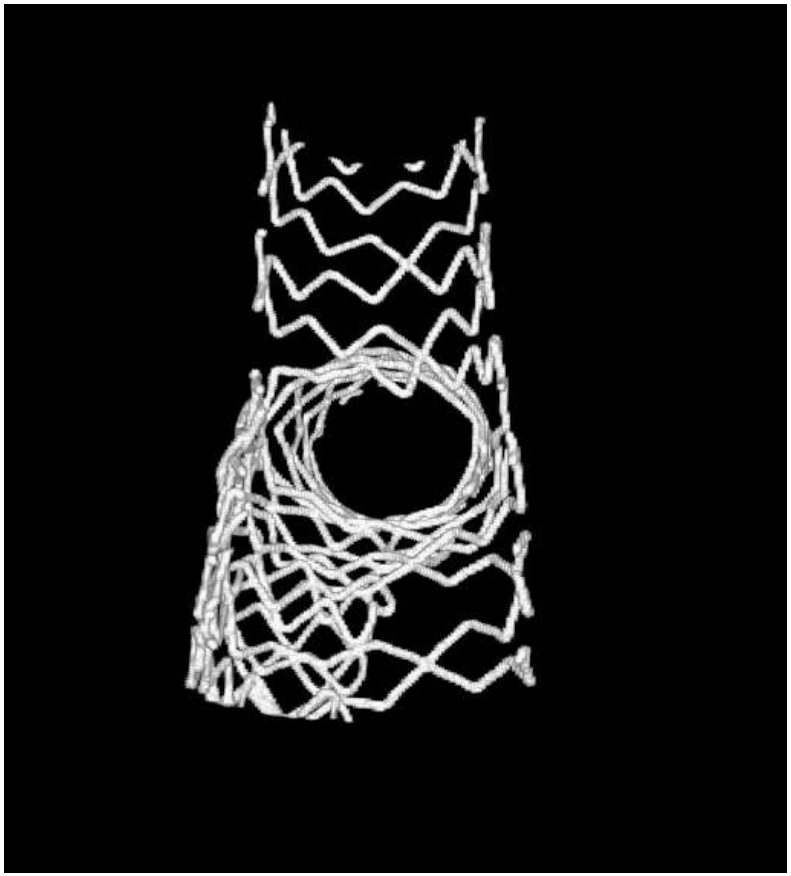
* p<0.05 vs. Simultaneous,

† p<0.02 vs. Simultaneous

Sung-Jin Oh et al. PCR 2010

Optimal FKB in The Bench

12atm*60sec

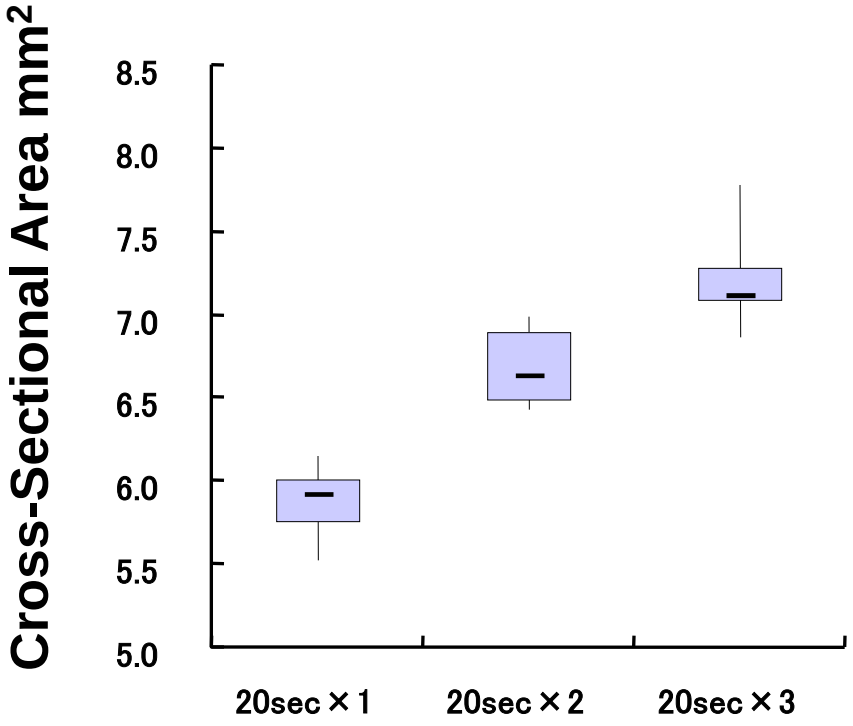


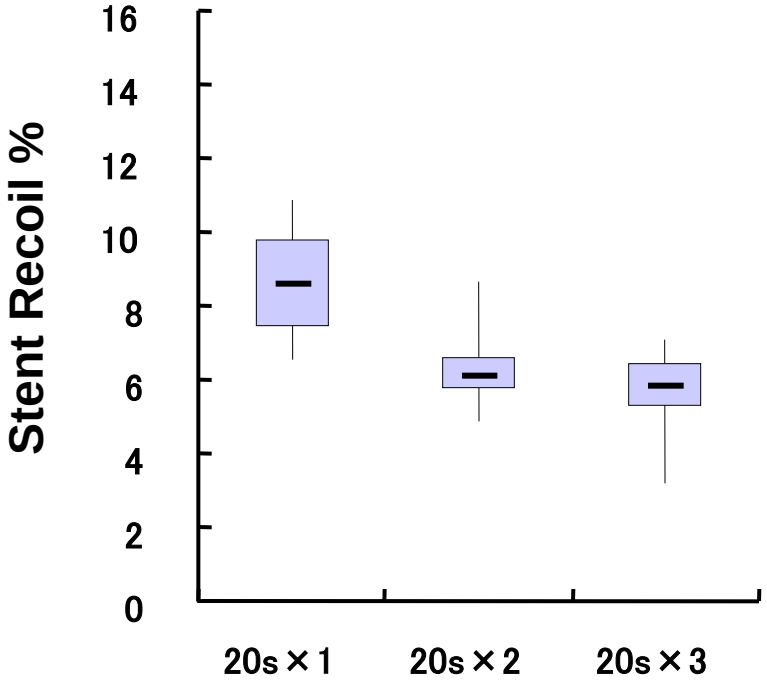
12atm*5sec

Hikichi et al. EBC 2009

Optimal FKB in The Bench

20 seconds of inflation is not enough





Hikichi et al. EBC 2009

Alternatives to kissing ?

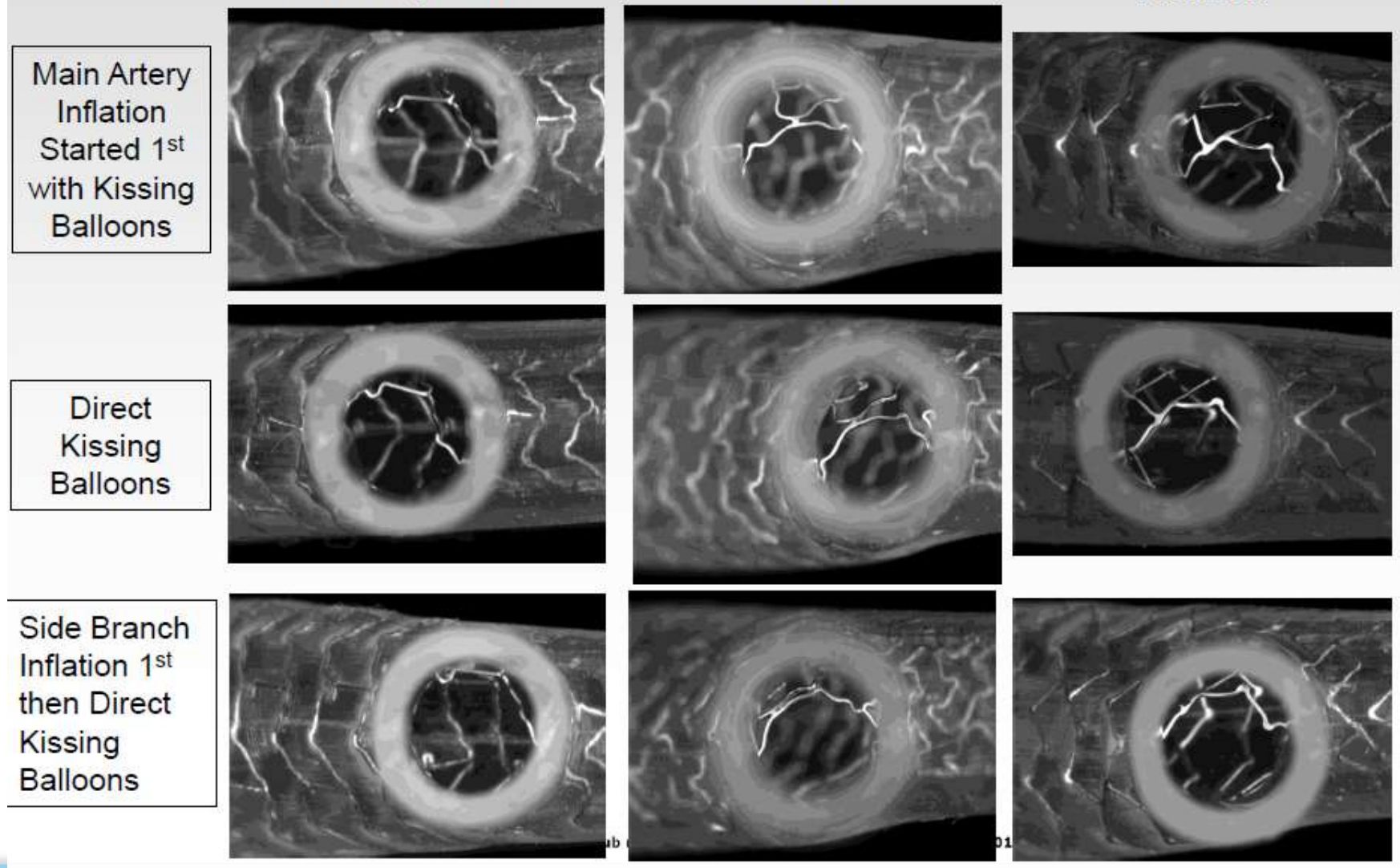
Kissing Balloon inflation technique : bench test analysis with BSCI stents

T. Mickley, D. Larson

JL. Leymarie, O. Darremont

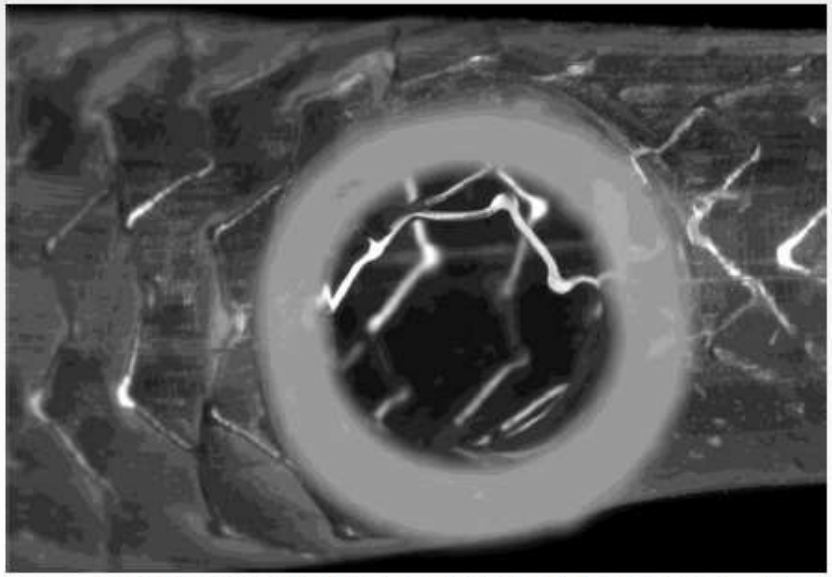
Kissing Balloon Technique Study Results

Inflation of side branch 1st results in less malapposed metal in the side branch

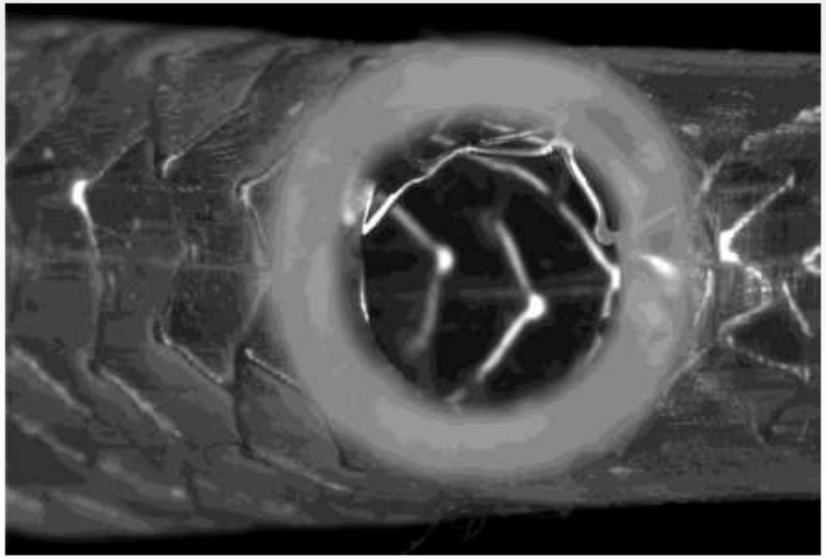


Kissing Balloon Technique Study Results

Side branch 1st with one inflation then kissing balloons



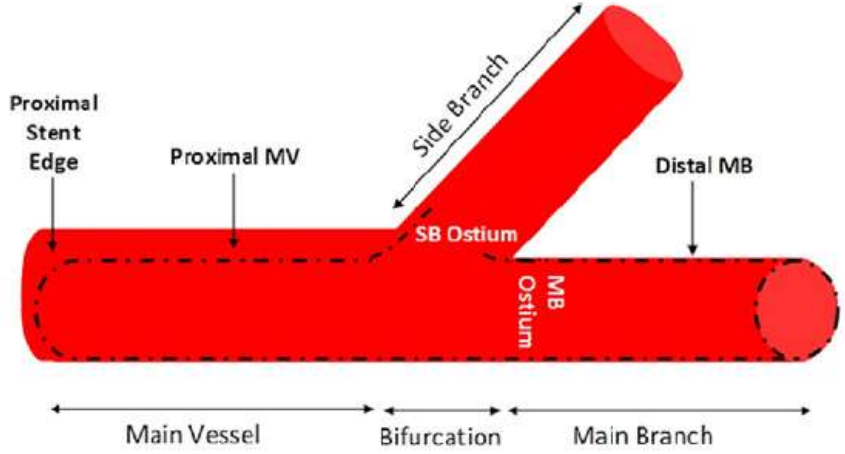
Side branch 1st with three inflations then kissing balloons

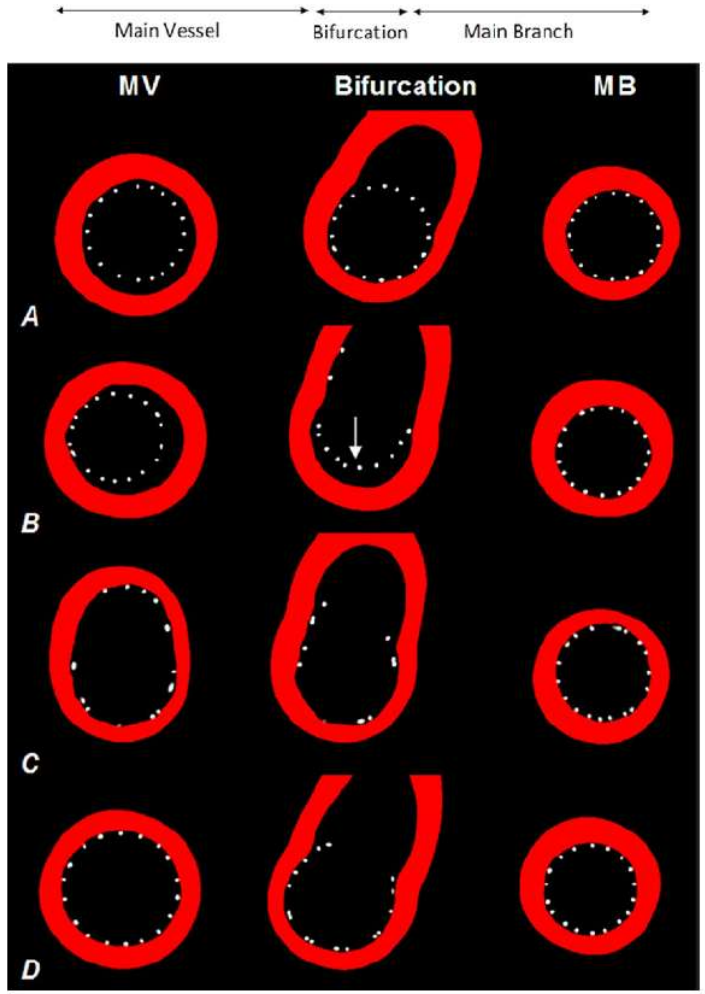


- Further inflation of the side branch (three times versus one time) prior to kissing balloons results in similar to better side branch opening and metal apposition.

Kissing or sequential dilation of the side and main vessel for provisional stenting of bifurcations: Micro-Computed Tomography and Simulations

Stent Apposition in 3 Different MV Cross Sections





5 mm proximal to the SB, in the bifurcation, 5 mm distal to the SB:

(A) MV stenting: Incomplete apposition proximal / SB ostium

(B) SB dilation: malapposition opposite the SB ostium

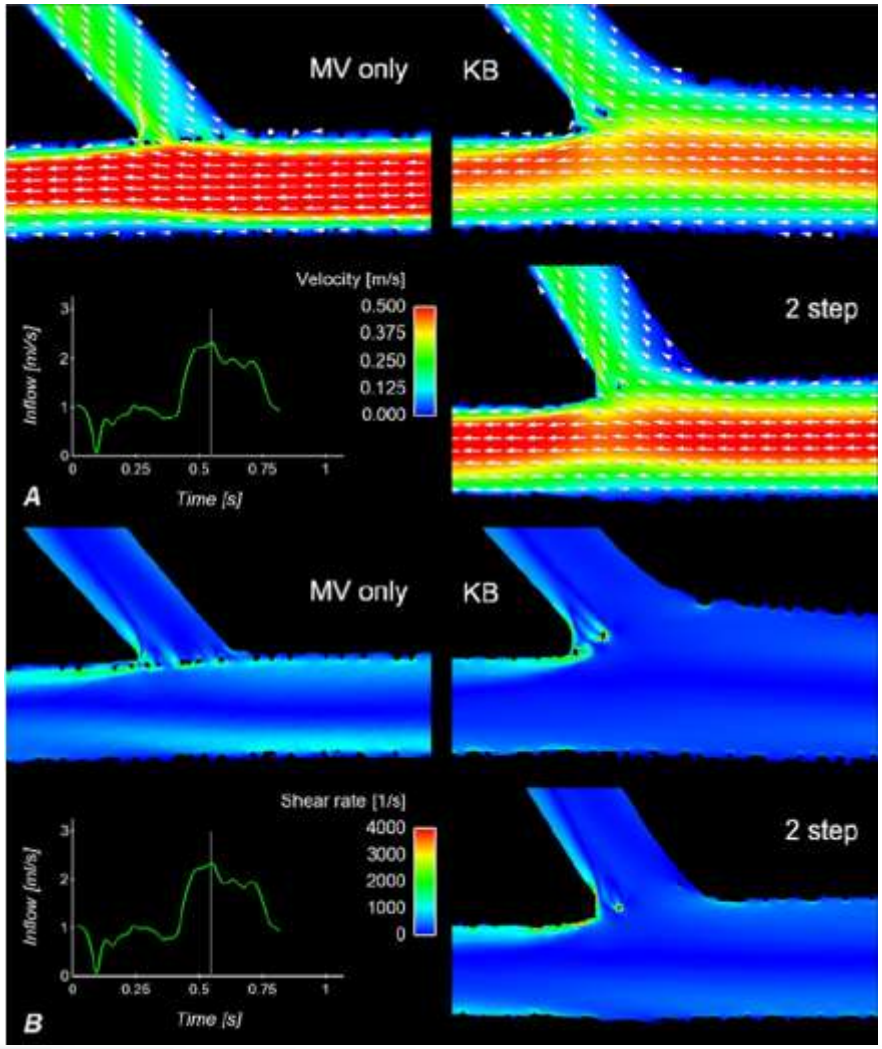
(C) KB: overlapping balloons = distortion in the proximal MV

(D) POT: full circular expansion of the stent in the proximal

Foin, JACC CVINT 2012, 5: 50-56

Kissing or sequential dilation of the side and main vessel for provisional stenting of bifurcations: Micro-Computed Tomography and Simulations

Computational Flow Simulation

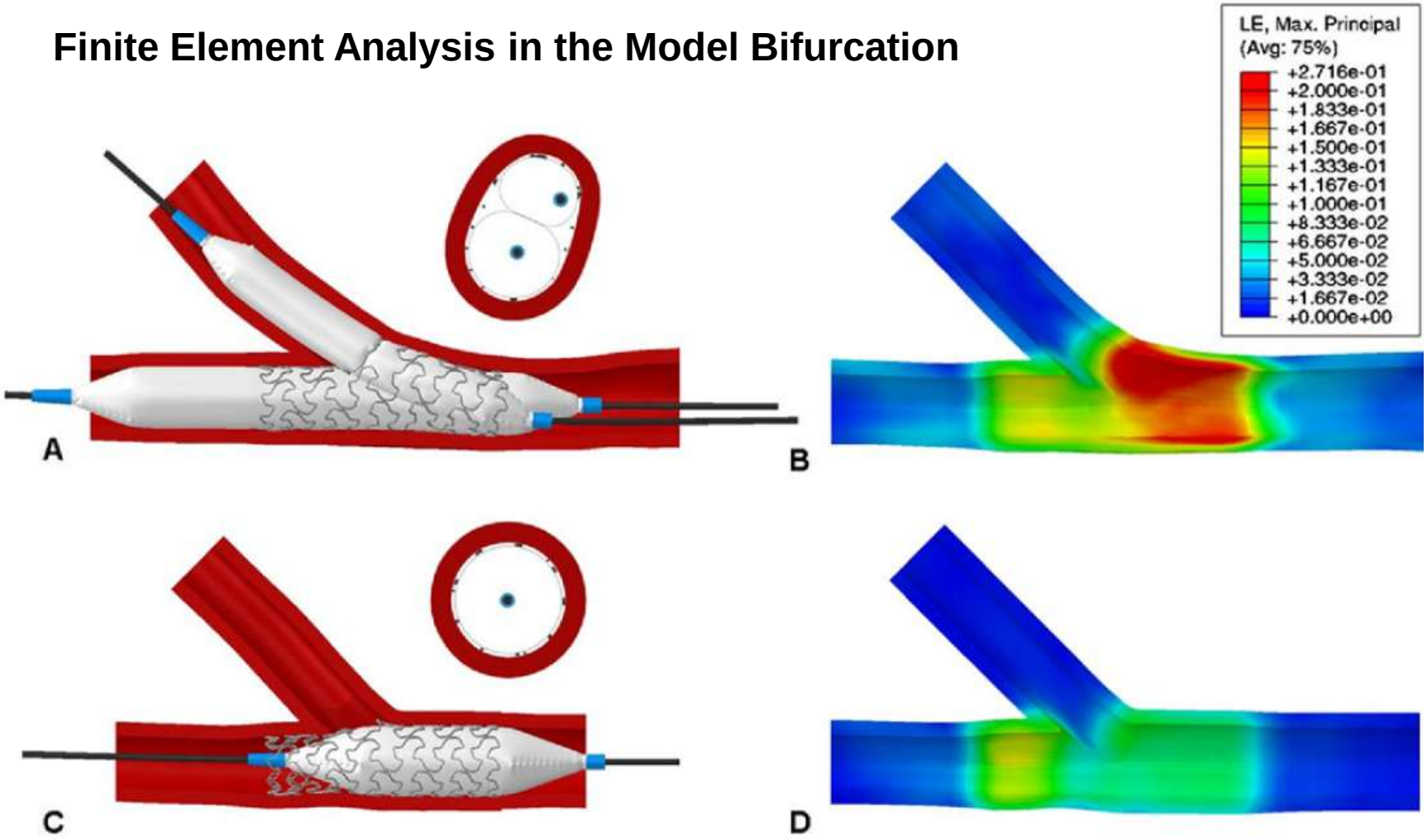


Computational flow simulation of the velocity field **(A)** and shear rate **(B)** in cases representative of provisional technique with MV stenting only and post-dilation with KB or the sequential 2-step SB–MV dilation.

Foin, JACC CVINT 2012, 5: 50-56

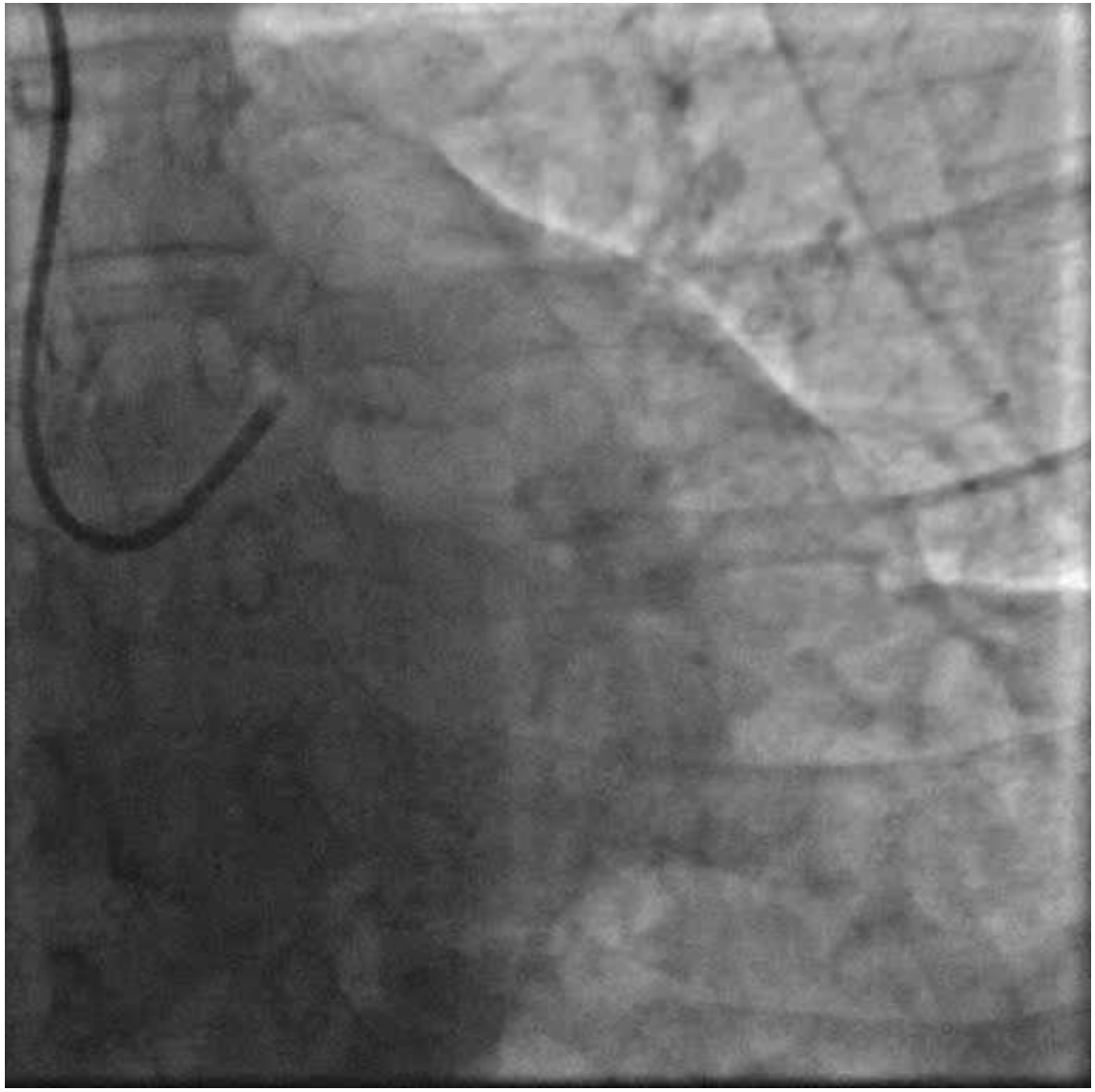
Kissing or sequential dilation of the side and main vessel for provisional stenting of bifurcations: Micro-Computed Tomography and Simulations

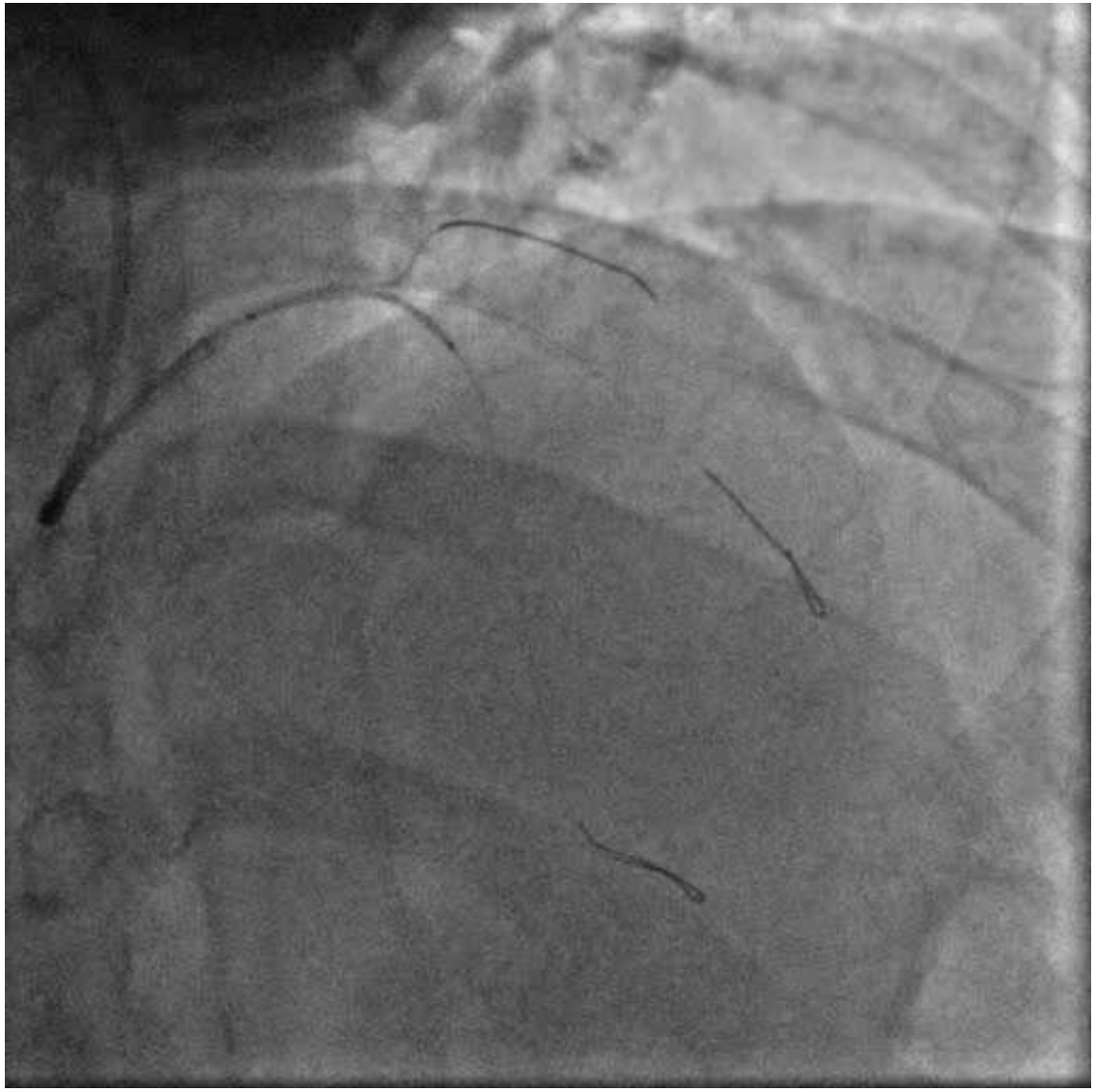
Finite Element Analysis in the Model Bifurcation

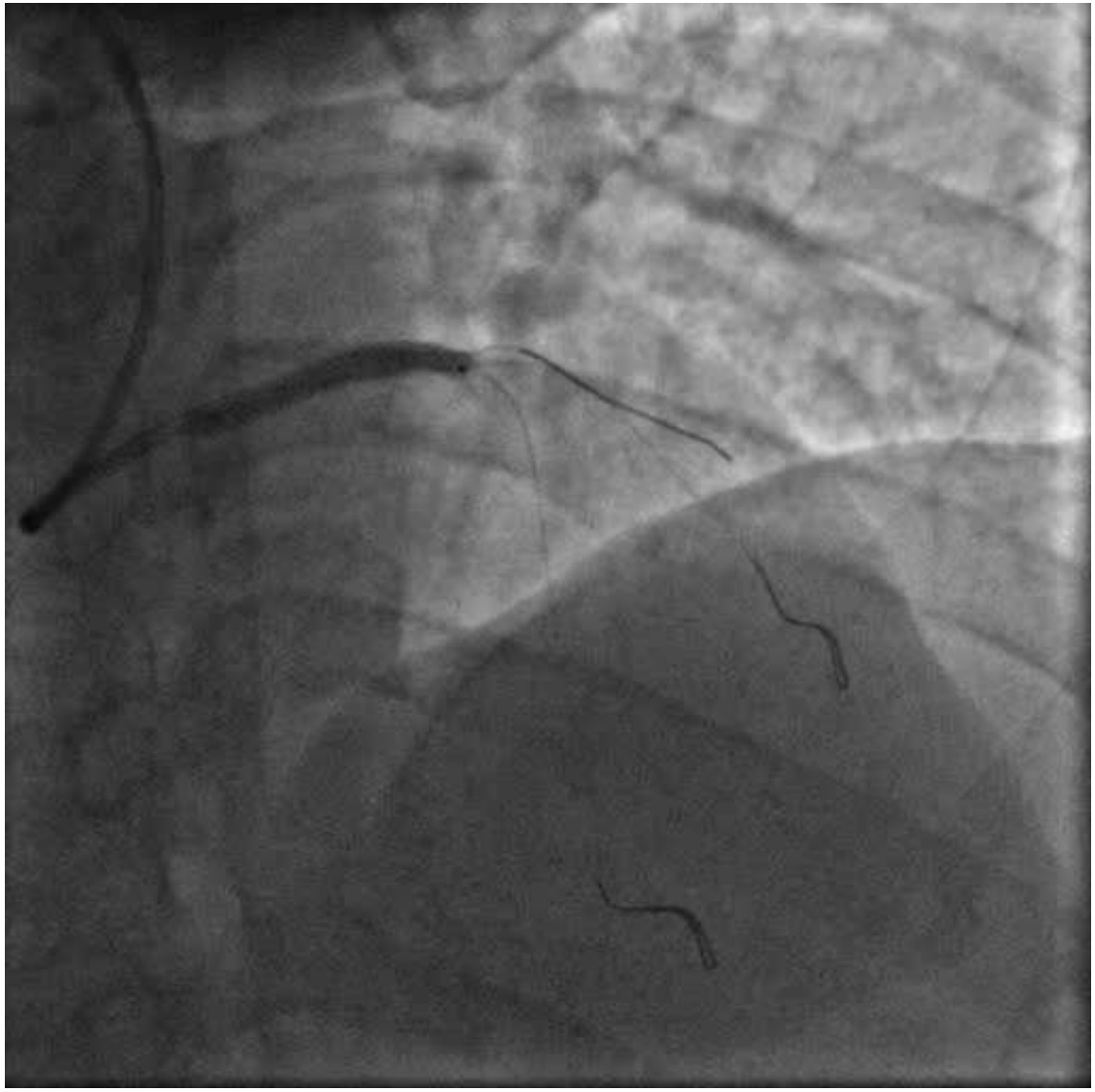


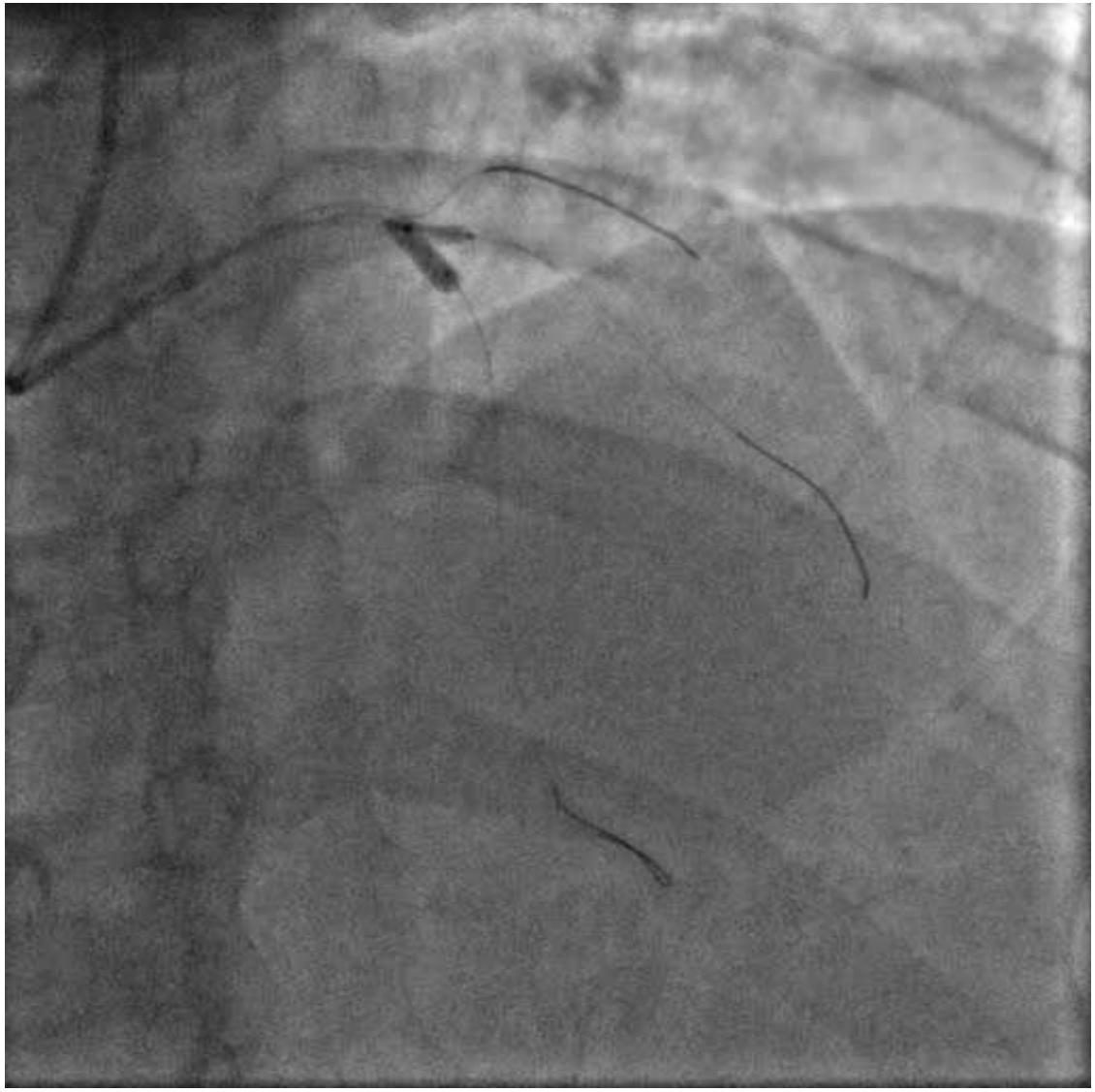
Foin, JACC CVINT 2012, 5: 50-56

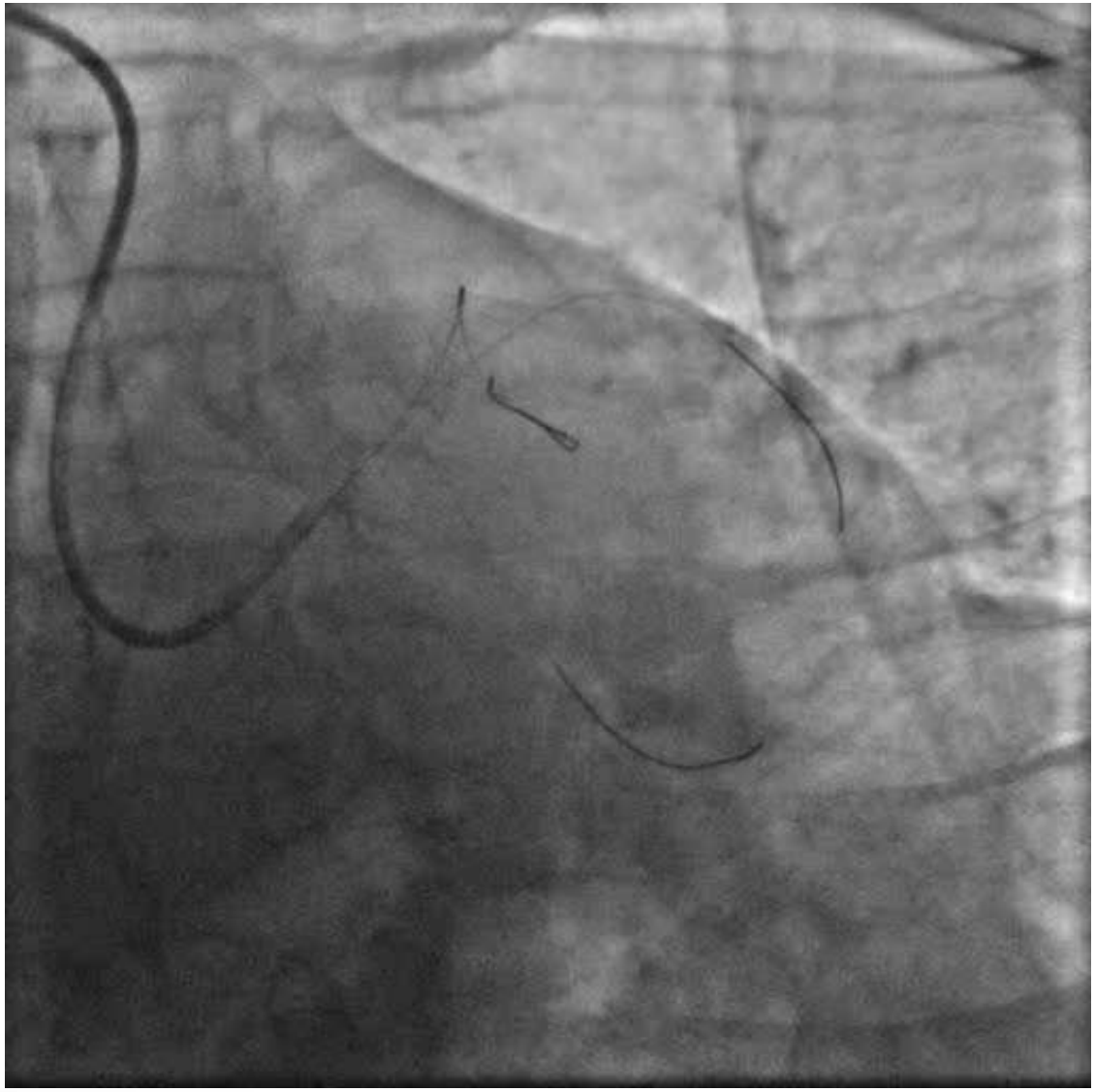
POT and kissing in a LM

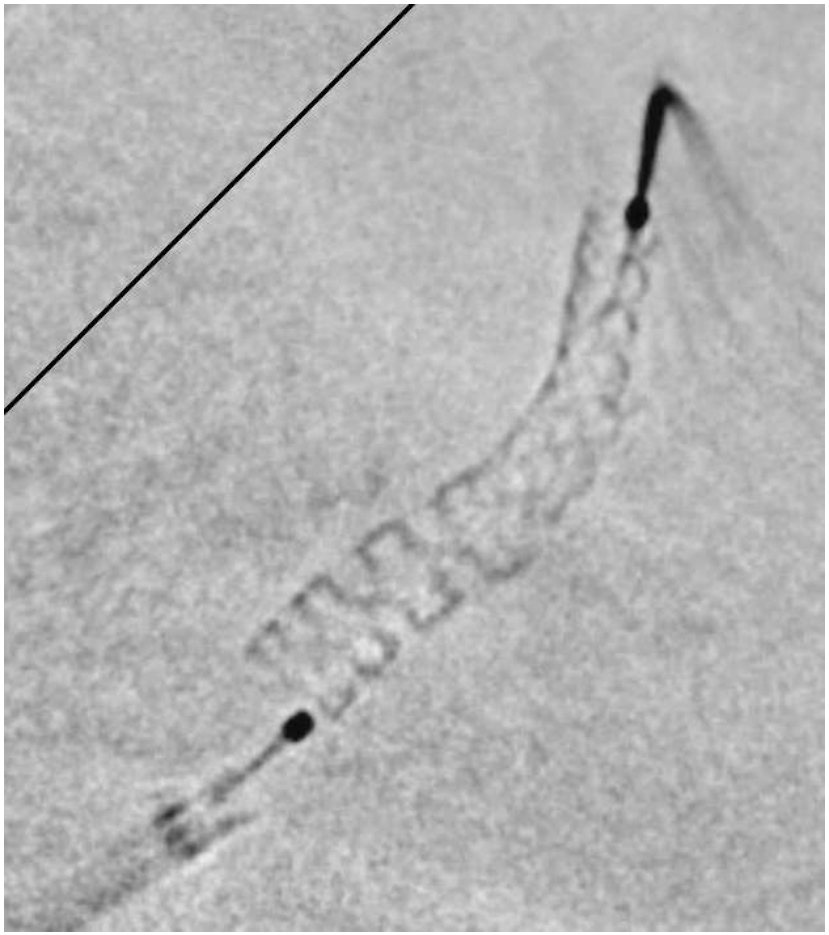


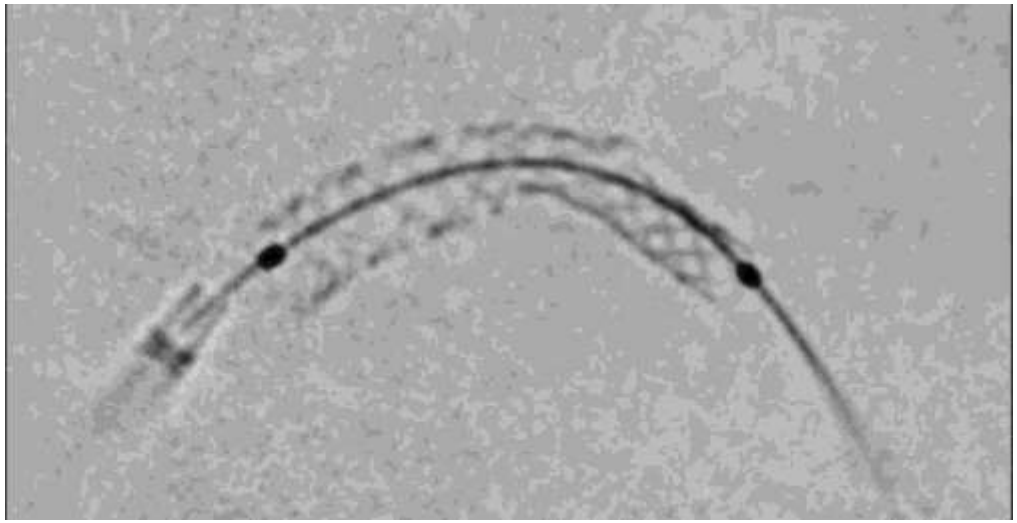


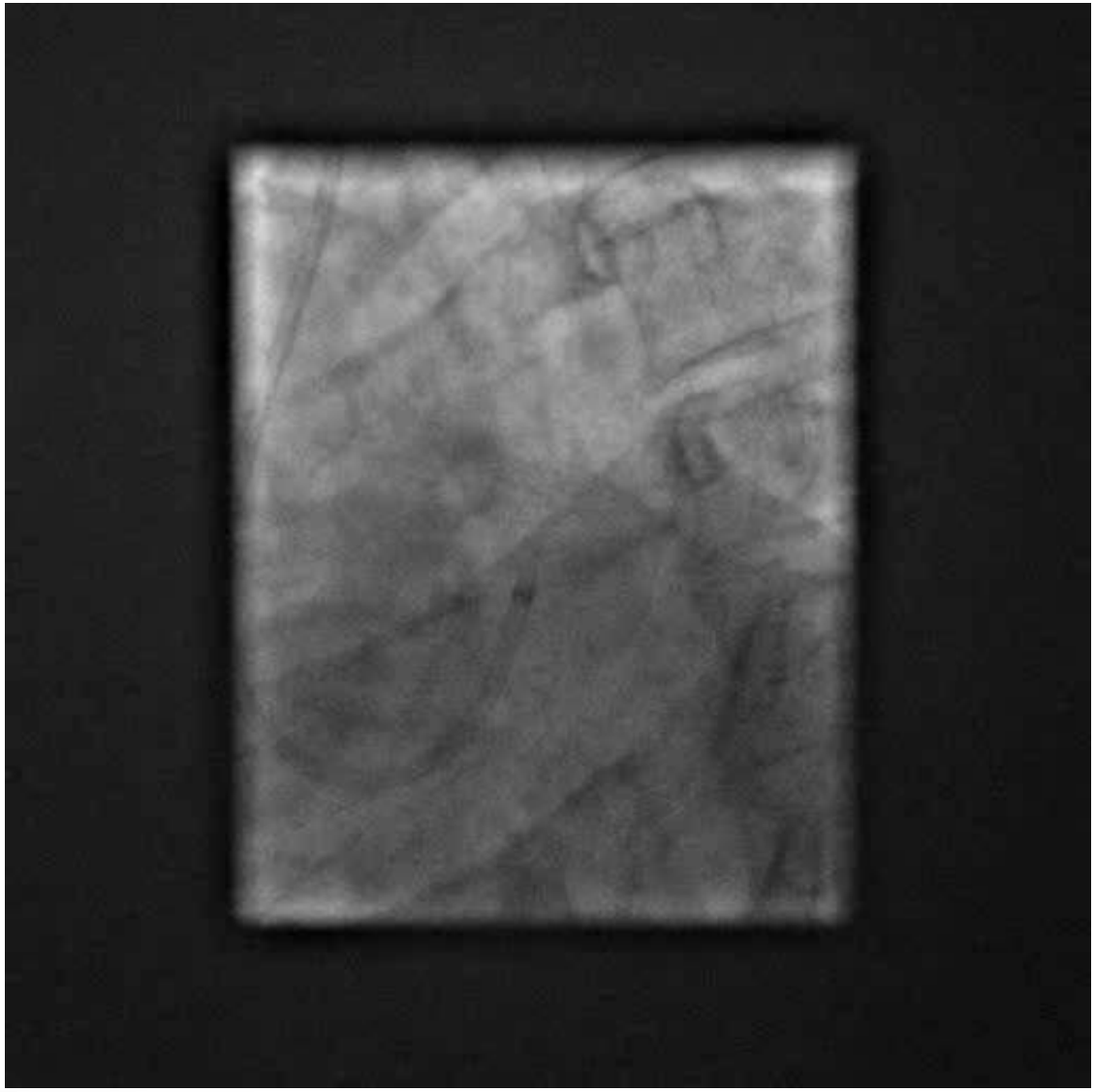












Conclusions

- POT is an important technique for technical (SB access, safe wire exchange) and physiological reasons, and possibly for prevention of restenosis / thrombosis (not only in provisional stenting).

- Kissing balloon inflation is improving poor SB results and release the big jailed SB (future access), without harm if properly performed.

- No demonstration of any clinical short time advantage.

- Kissing ballon inflation is challenged by SB balloon + POT (option for BVS).