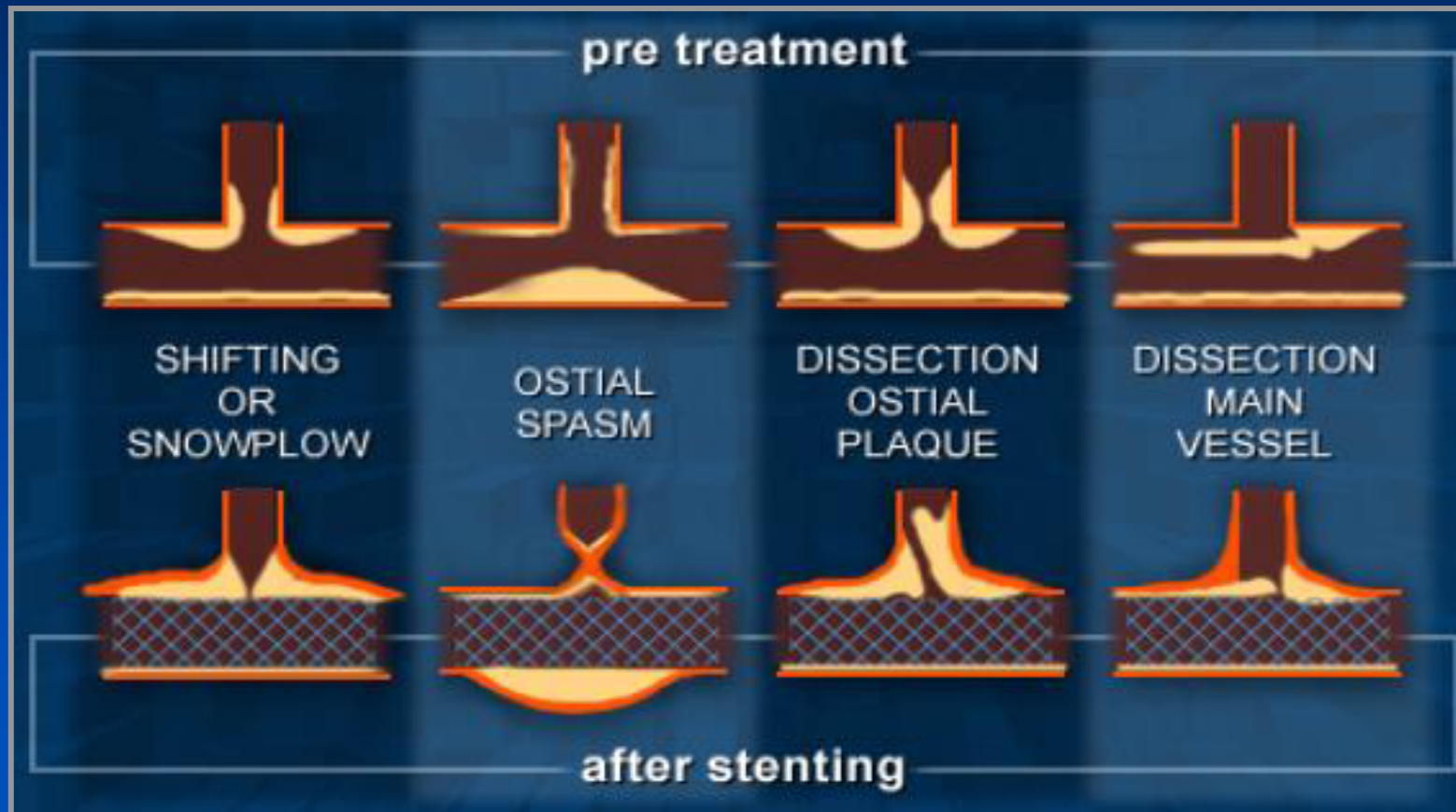


PCI for Bifurcation Lesions



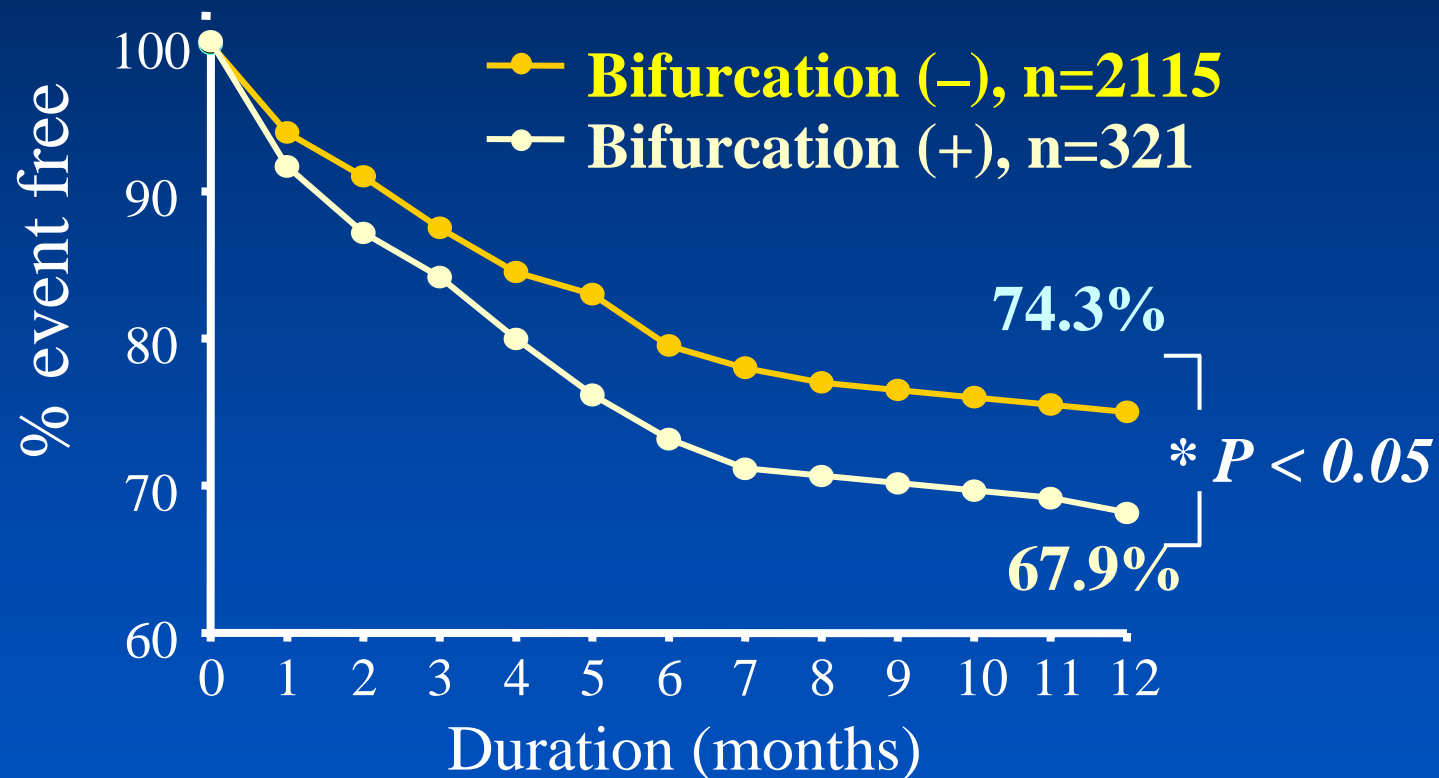
Side Branch Loss

Main Mechanism of Adverse Outcomes



Bifurcation lesion has been a predictor of worse prognosis of PCI.

Event-free survival after BMS implantation in NHLBI Registry



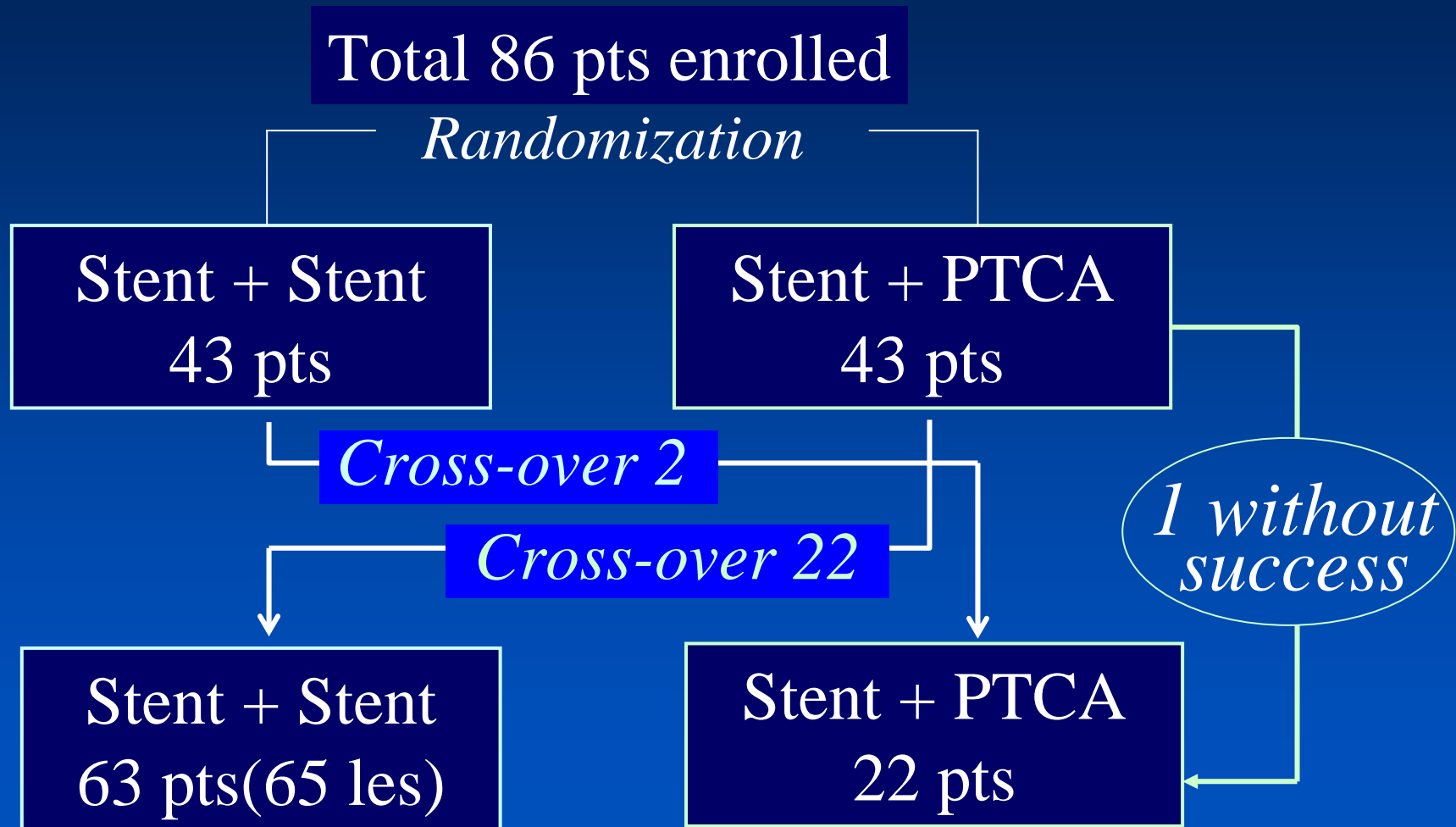
Suwaidi J, et al. AJC 2001;87:1139-44

Is DES a final solution for bifurcation ?



SIRIUS Bifurcation Study

Sirolimus Eluting Stent



A Colombo, et al. Cir 2004;109:1244

Procedural Technique

SIRIUS Bifurcation Study

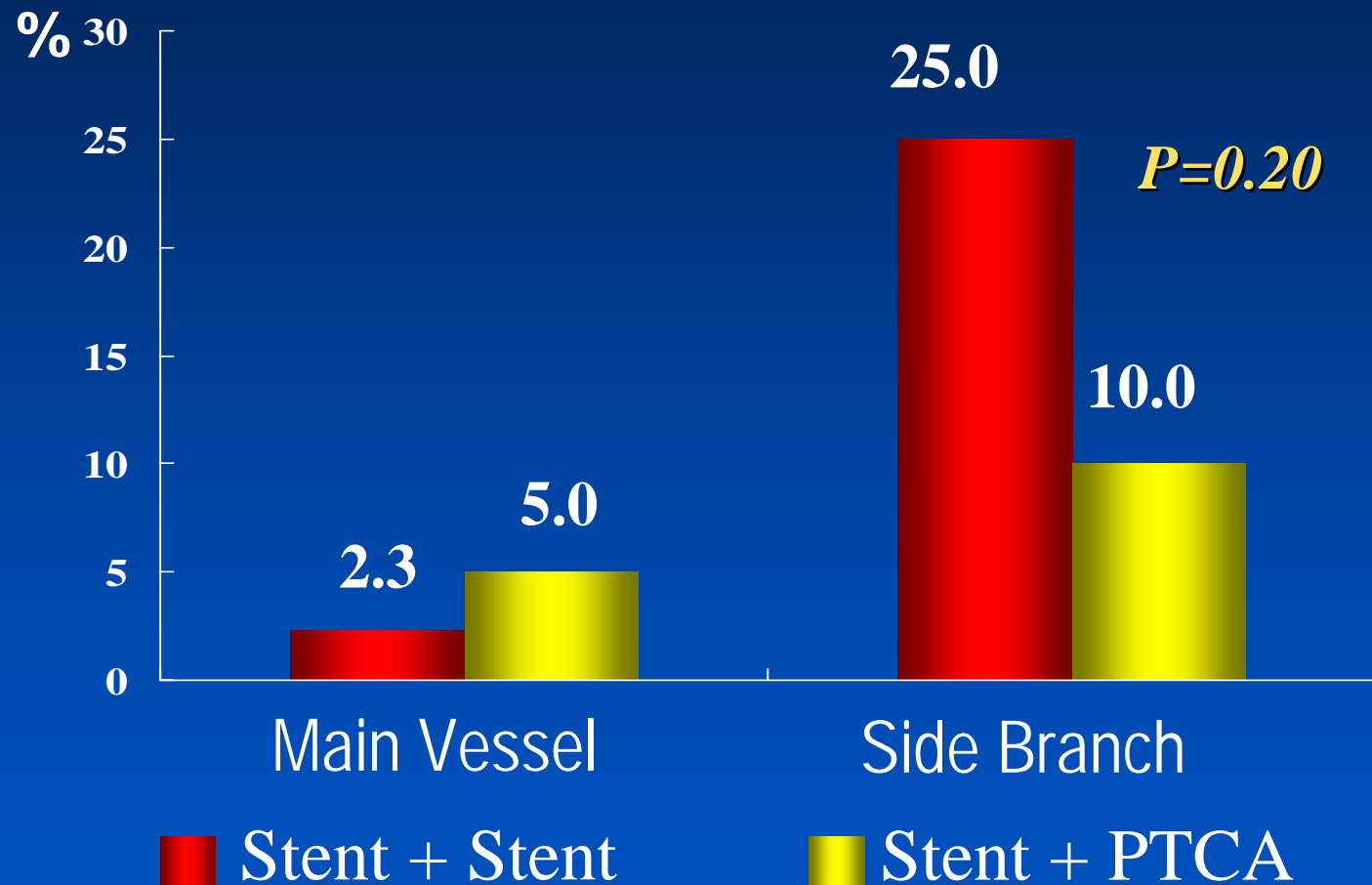
Technique	Stent / Stent (n=63)	Stent / PTCA (n=22)
T- stenting	60	
Side branch first	40	
Main vessel first	20	
V- stenting	1	
Y- stenting	2	
Kissing balloon	60 (95%)	19 (86%)
GPIIb/IIIa inhibitor	27 (43%)	8 (37%)

A Colombo, et al. Cir 2004;109:1244



In-Segment Restenosis

SIRIUS Bifurcation Study



A Colombo, et al. Cir 2004;109:1244

DES is a solution for bifurcation ?

- **Main branch**

Certainly, Yes

- **Side branch**

Not certain, yet

We should focus on the treatment of side branch in bifurcation PCI with DES.

Then, Simple vs. Complex



Simple Stenting Technique

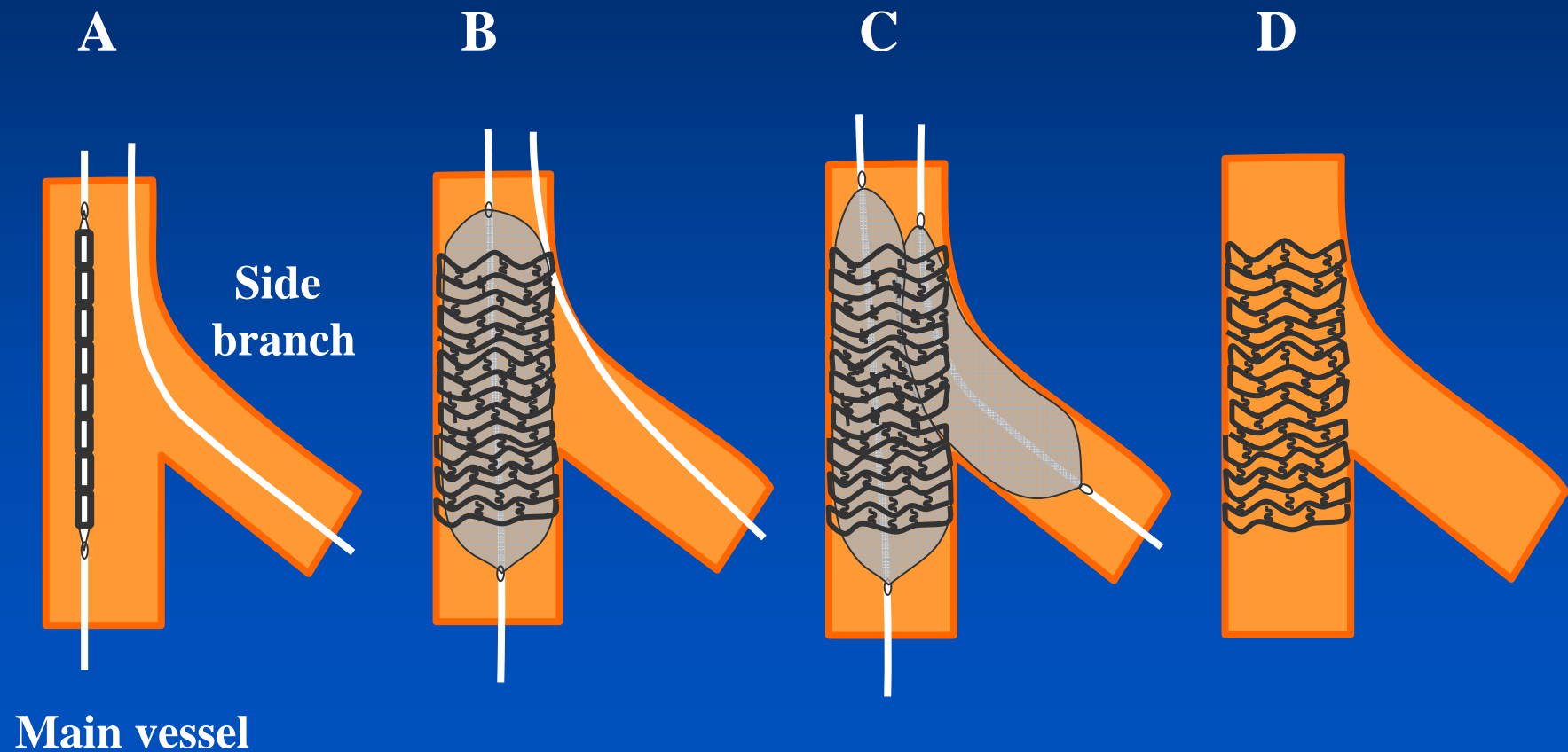
1. Stent placement in the main branch only

And

- 1) Optional kissing balloon inflation**
- 2) Provisional T stenting**
- 3) Provisional reverse Crush technique**

Stenting Crossing Side Branch With Optional Kissing Balloon Inflation

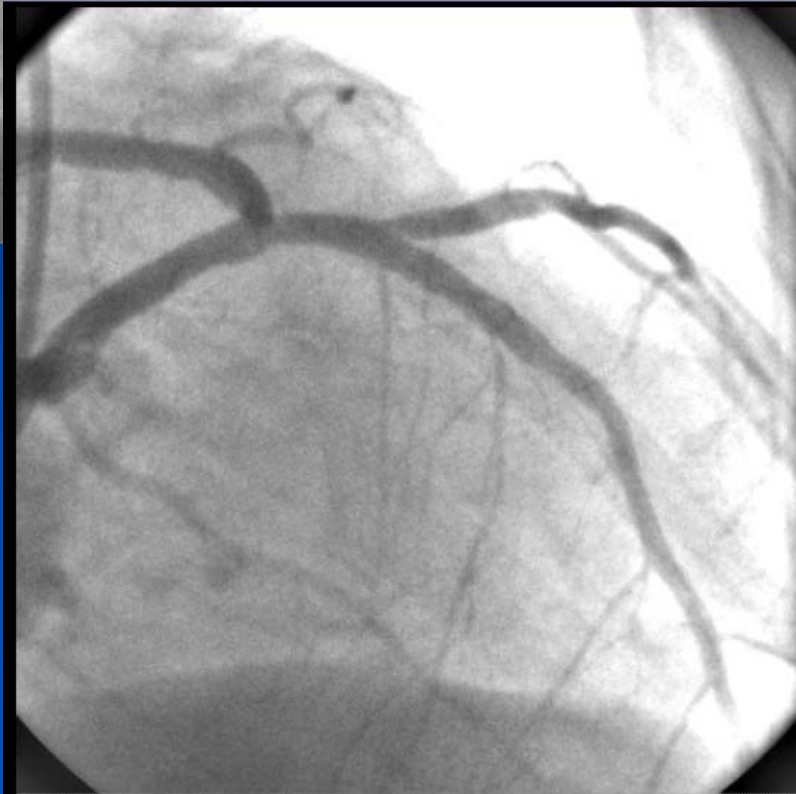
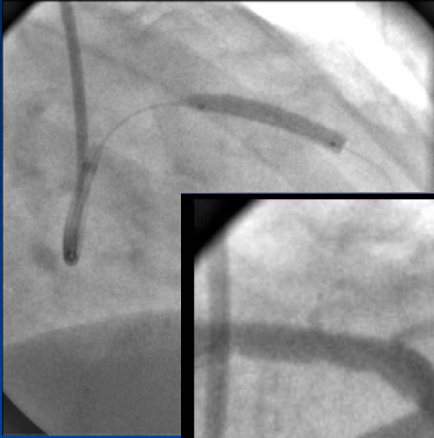
Normal or diminutive side branch ostium



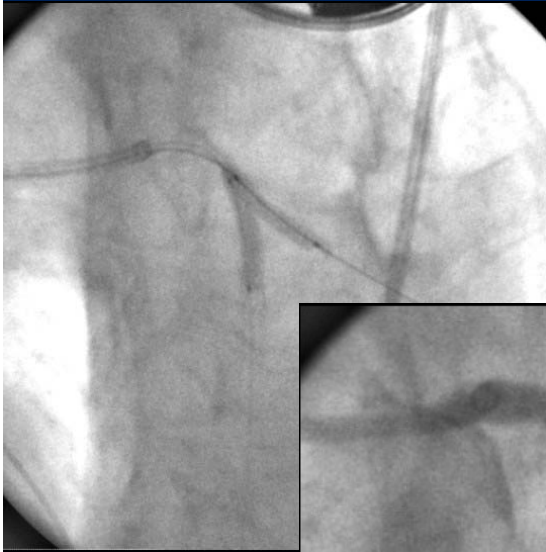
LAD Bifurcation Lesion with Normal Diagonal Ostium



Jailed Diagonal Branch after Cypher (3.5 23mm) Implantation

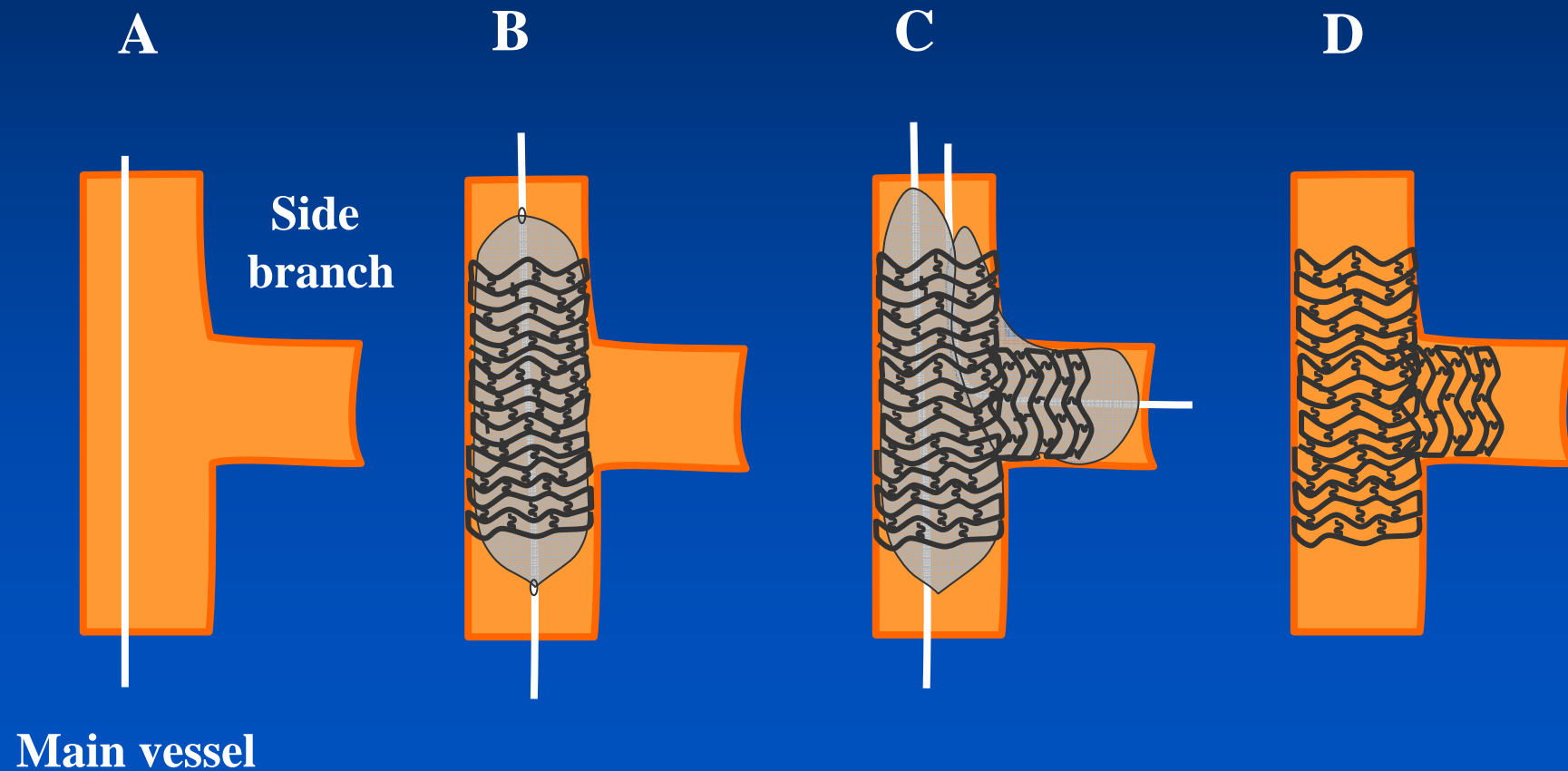


Kissing Balloon Inflation and Good Result



Provisional T Stenting

In cases with significant narrowing of side branch after main branch stenting



Provisional T Stenting

- In extremely angulated lesions, it is difficult to place the second stent in the side branch.
- Deployment of side branch stent before final kissing inflation should be performed with high pressure (14-18atm) to achieve optimal scaffolding.
- Kissing balloon inflation during placement of the second stent in the side branch is very important to prevent distortion of the main branch stent.

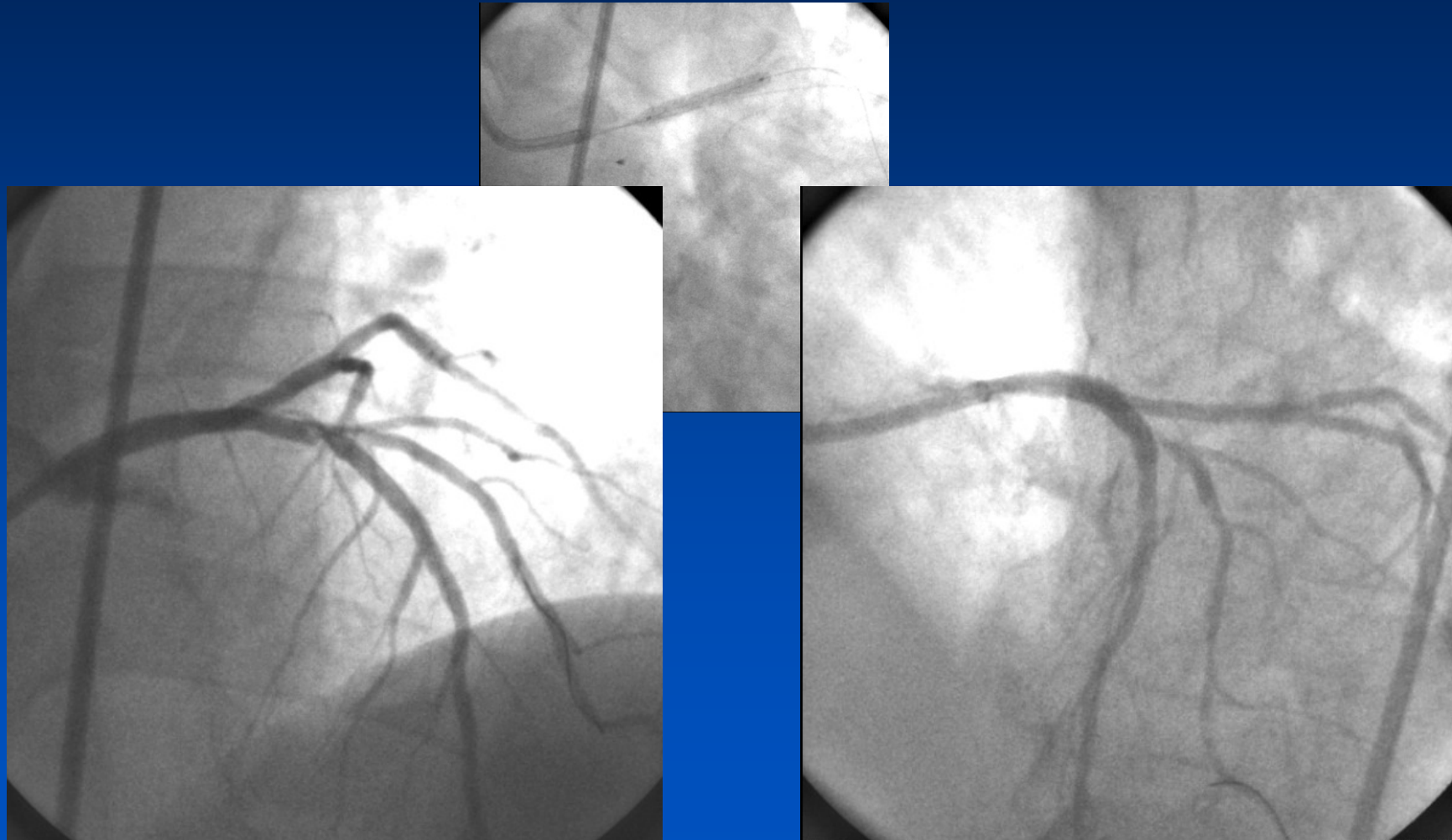
Provisional T Stenting

- Optimal scaffolding of the side branch ostium was generally ensured when the stent strut opened towards the side branch is distal and closer to the carina.
- To achieve complete lesion coverage, put the second stent in the side branch slightly protruding to the main branch.

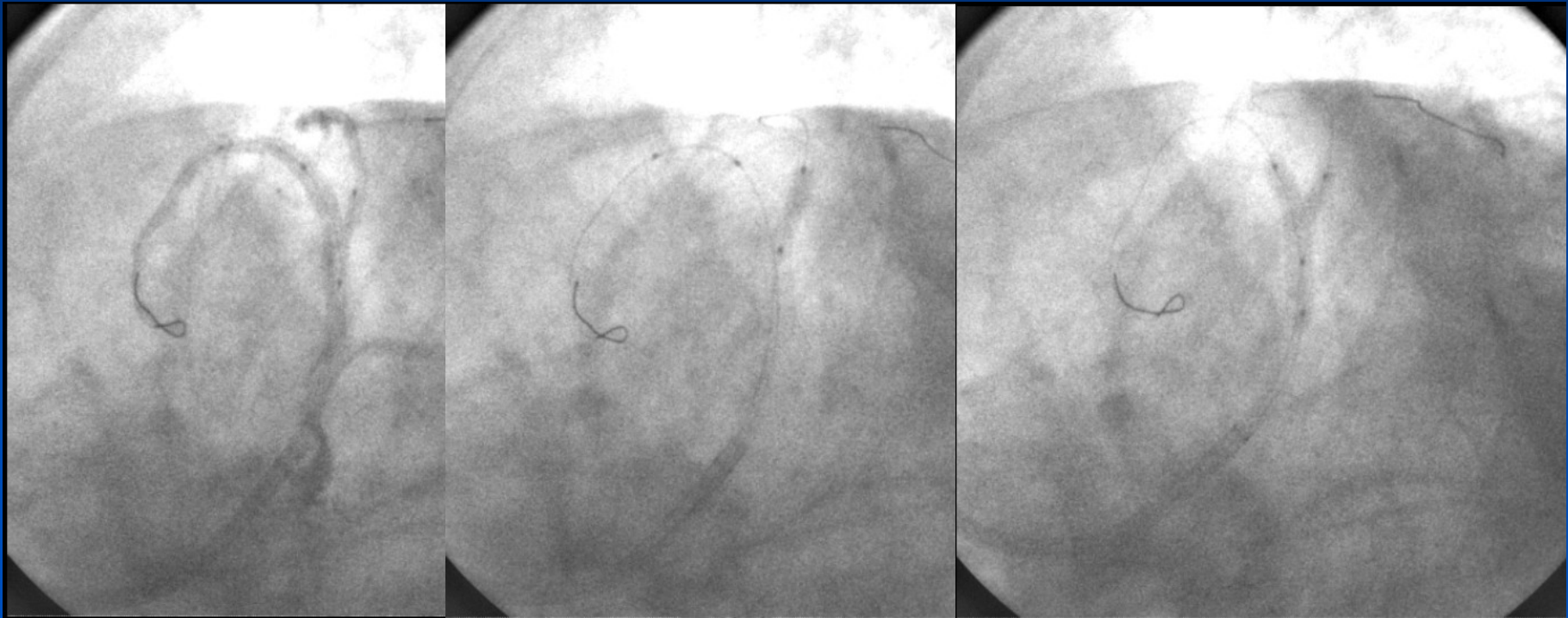
True LAD Bifurcation Stenosis



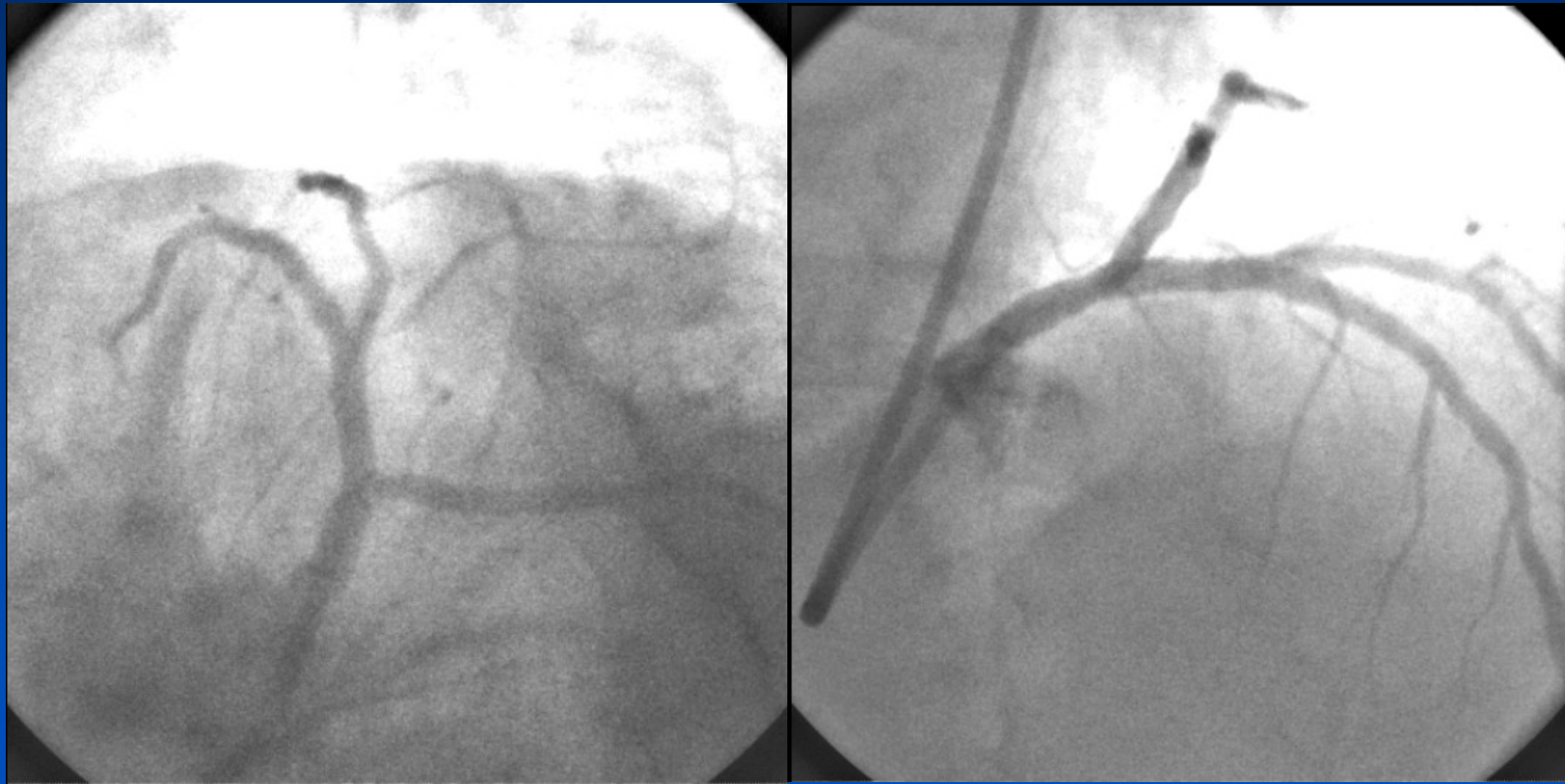
Cypher Stenting (3.5×23mm) and Kissing Balloon Inflation. However....



Side Branch Stenting with a Cypher (2.75 × 13mm) and Kissing Balloon

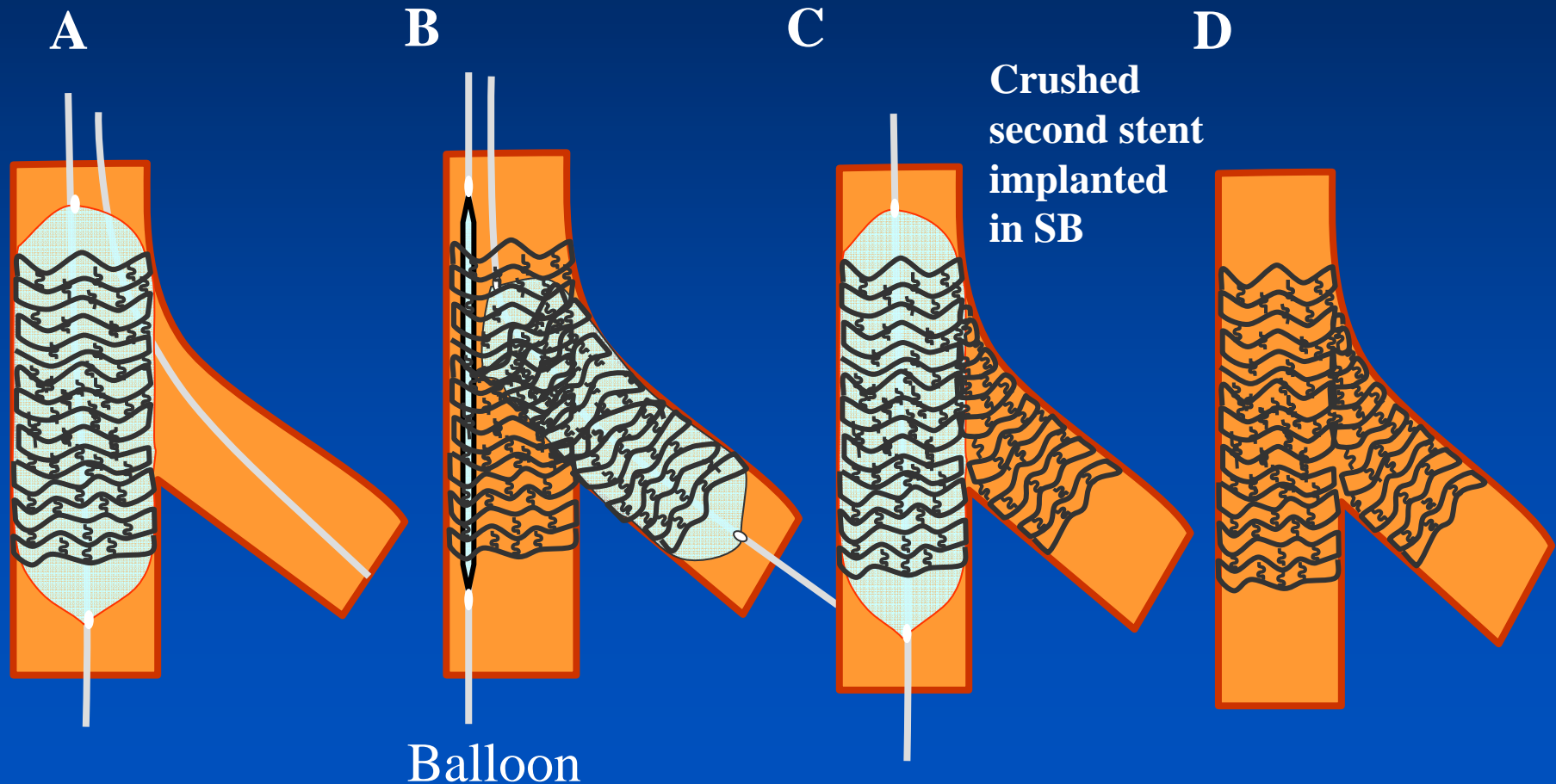


Good Result



“Internal” or “Reverse” Crush

allows provisional SB stenting with full ostial coverage



“Internal” or “Reverse” Crush

- This technique allows provisional stenting of the side-branch with a fall-back strategy that delivers coverage of the side-branch ostium without gaps.
- Final kissing balloon inflation may be difficult because a balloon should be crossed through the crushed stent segment in the side branch ostium.

AMC Experience

DES For Bifurcation



Stenting Technique

- **Complex stenting technique : SES**
implantation at the main vessel and the side branch
- **Simple stenting technique : SES**
implantation only at the main vessel with
balloon angioplasty at the side branch

Simple Strategy in 61%

Patients (n = 213) with de novo
coronary bifurcation lesions except LM (n =213)
[Jan 2003 ~ Dec 2004]

Complex Stenting
[Group A, n=60]

Simple stenting
[Group B, n=153]

Eligible Patients (n = 167)
[Jan 2003 ~ Jul 2004]

Clinical (n=159) and
Angiographic (n=112)
follow up

Baseline QCA Characteristics

	Complex Stenting (N=60)	Simple Stenting (N=153)	<i>P</i>
Reference diameter, mm			
MB	2.86 ± 0.43	2.92 ± 0.44	0.44
SB	2.35 ± 0.39	2.30 ± 0.42	0.49
MLD, mm			
MB	0.93 ± 0.52	0.87 ± 0.55	0.51
SB	0.91 ± 0.32	1.23 ± 0.72	0.004
Diameter stenosis, %			
MB	66.9 ± 16.8	70.8 ± 17.2	0.20
SB	56.9 ± 13.3	52.1 ± 27.4	0.52
Lesion length, mm			
MB	29.6 ± 16.6	26.0 ± 13.7	0.16
SB	15.3 ± 9.7	7.4 ± 4.4	<0.001

MB= Main Branch; SB= Side Branch



Procedural Findings

	Complex Stenting (N=60)	Simple Stenting (N=153)	<i>P</i>
MB			
Balloon size, mm	3.84 ± 0.39	3.66 ± 0.51	0.09
Balloon/artery ratio	1.23 ± 0.23	1.20 ± 0.16	0.37
SB			
Balloon size, mm	3.07 ± 0.43	2.98 ± 0.32	0.42
Balloon/artery ratio	1.21 ± 0.26	1.19 ± 0.18	0.40
Success Rate*, %	99.2	94.3	0.75
Kissing balloon %	86.7	78.5	0.36

QCA after Procedure

	Complex Stenting (N=60)	Simple Stenting (N=153)	<i>P</i>
MLD, mm			
MB	2.69 ± 0.36	2.73 ± 0.43	0.51
SB	2.27 ± 0.38	1.55 ± 0.53	<0.01
Diameter stenosis, %			
MB	3.9 ± 13.0	5.5 ± 12.6	0.48
SB	14.8 ± 15.6	31.5 ± 21.0	0.01
Acute gain, mm			
MB	1.73 ± 0.48	1.87 ± 0.58	0.18
SB	1.33 ± 0.43	0.78 ± 0.59	<0.01

MB= Main Branch; SB= Side Branch

In-Hospital Outcomes

	Complex Stenting	Simple Stenting	P
Patients	60	153	
Death	0	2*	...
MI			
Q MI	0	0	...
Non-Q MI	4 (6.7%)	6 (3.9%)	0.47
Stent thrombosis	0	0	...
TLR	0	0	1.0

MB= Main Branch; SB= Side Branch; * Due to gall bladder cancer and traffic accident, respectively.



QCA at 6 Months

	Complex Stenting (N=49)	Simple Stenting (N=114)	<i>P</i>
Angiographic F/U rate	81.7%	74.5%	0.32
MLD, mm			
MB	2.25 ± 0.76	2.53 ± 0.60	0.71
SB	2.02 ± 0.68	1.52 ± 0.48	0.20
Late loss, mm			
MB	0.17 ± 0.67	0.09 ± 0.56	0.50
SB	0.36 ± 0.62	0.01 ± 0.50	0.03
Restenosis			
MB	7 (14.2%)	6 (5.3%)	0.40
SB	9 (18.4%)	2 (1.7%)	0.03
Overall	13 (26.5%)	6 (5.7%)	0.09

Clinical Outcomes at 9 Months

	Complex Stenting (n=58)	Simple Stenting (n=145)	P
Death	0	2*	...
MI	0	0	...
Stent thrombosis	0	0	...
TLR	4 (6.9%)	3 (2.1%)	0.46
MACE	4 (6.9%)	5 (3.4%)	0.43

* Due to gall bladder cancer and traffic accident, respectively.

Simple vs. Complex Stenting

- Simple stenting technique crossing the side branch should be preferred in bifurcation lesions with non-diseased side branch.
- Final kissing balloon dilatation improves immediate outcome of the side branch.
- Provisional T stenting can be used when the side branch narrowing was deteriorated after stenting in the main branch.

Simple Stenting vs. Complex Stenting

**Make the procedure simple
if possible !**

Complex Stenting Techniques

Inevitable in certain cases..

Golden Rules of Bifurcation Stenting with DES

1. Complete lesion coverage

- especially at the side branch ostium

2. Optimal stent apposition

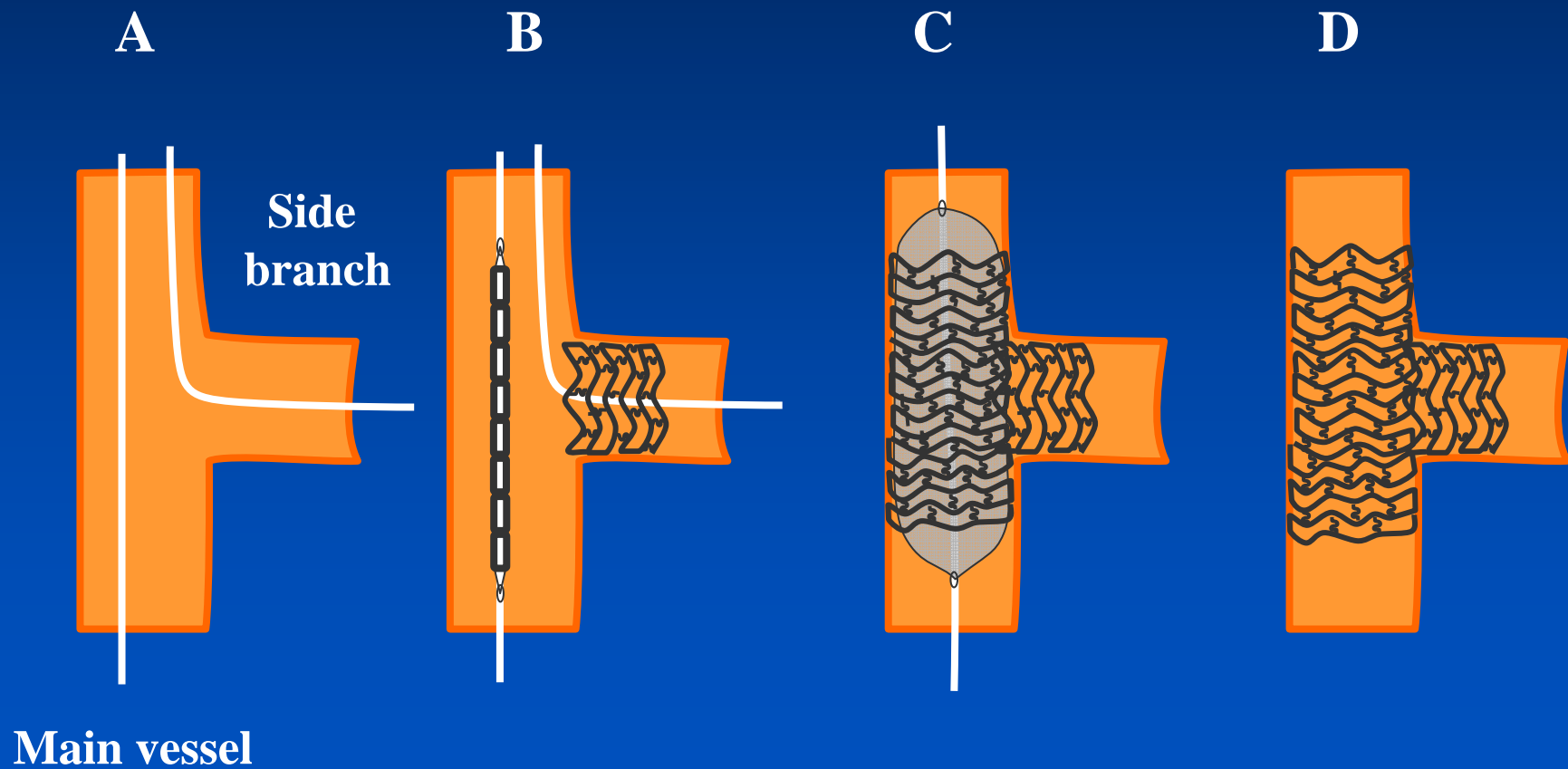
- all the stented segments in the main and side branch

Complex Stenting Techniques

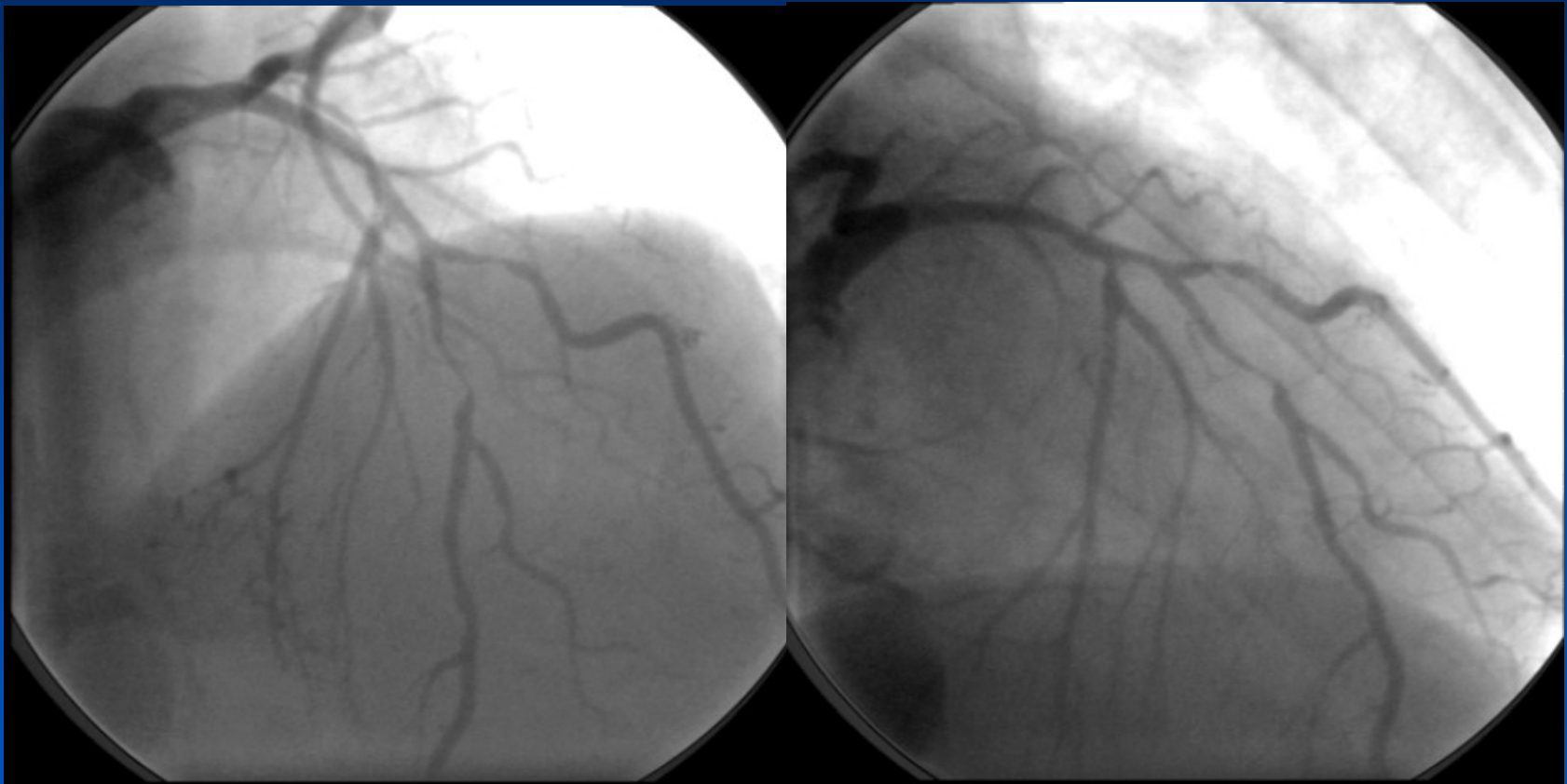
that can fulfill two rules...

1. Modified T stenting
2. Crush technique
3. Y stenting
4. V stenting
5. Kissing stenting

Modified T Stenting



LAD and Diagonal Stenosis



Diagonal Stenting First with a Cypher (Cypher 2.5×13mm)

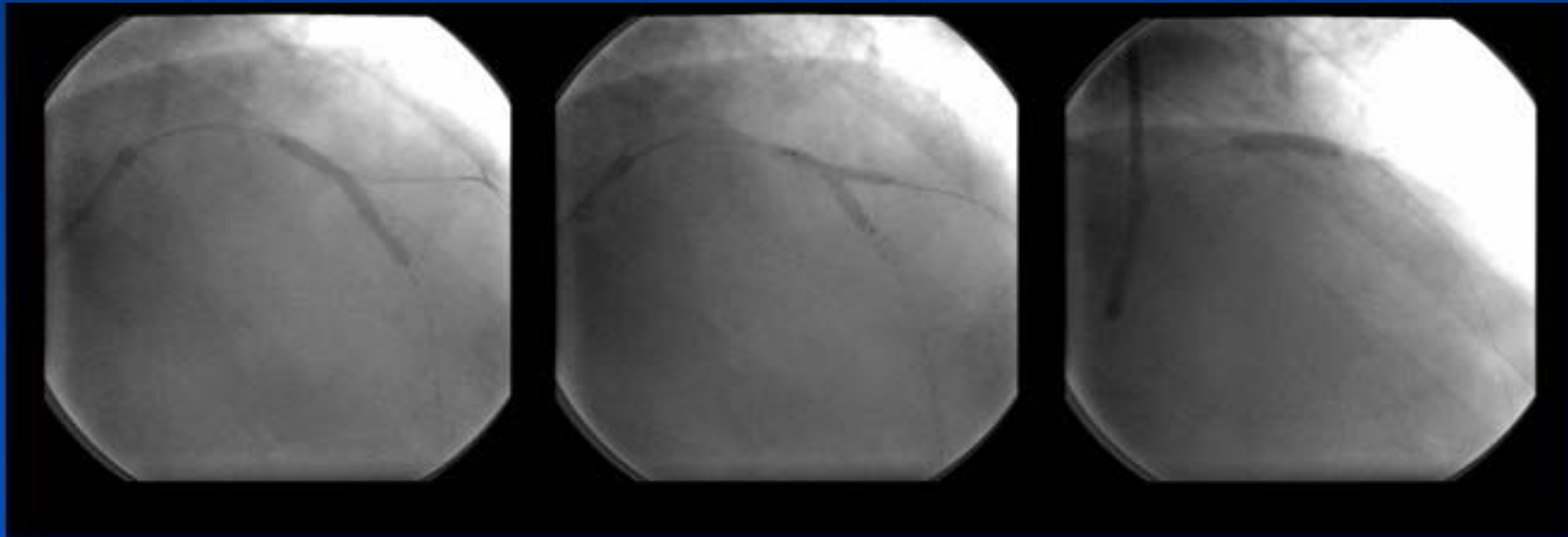


LAD Stenting with Two Cyphers

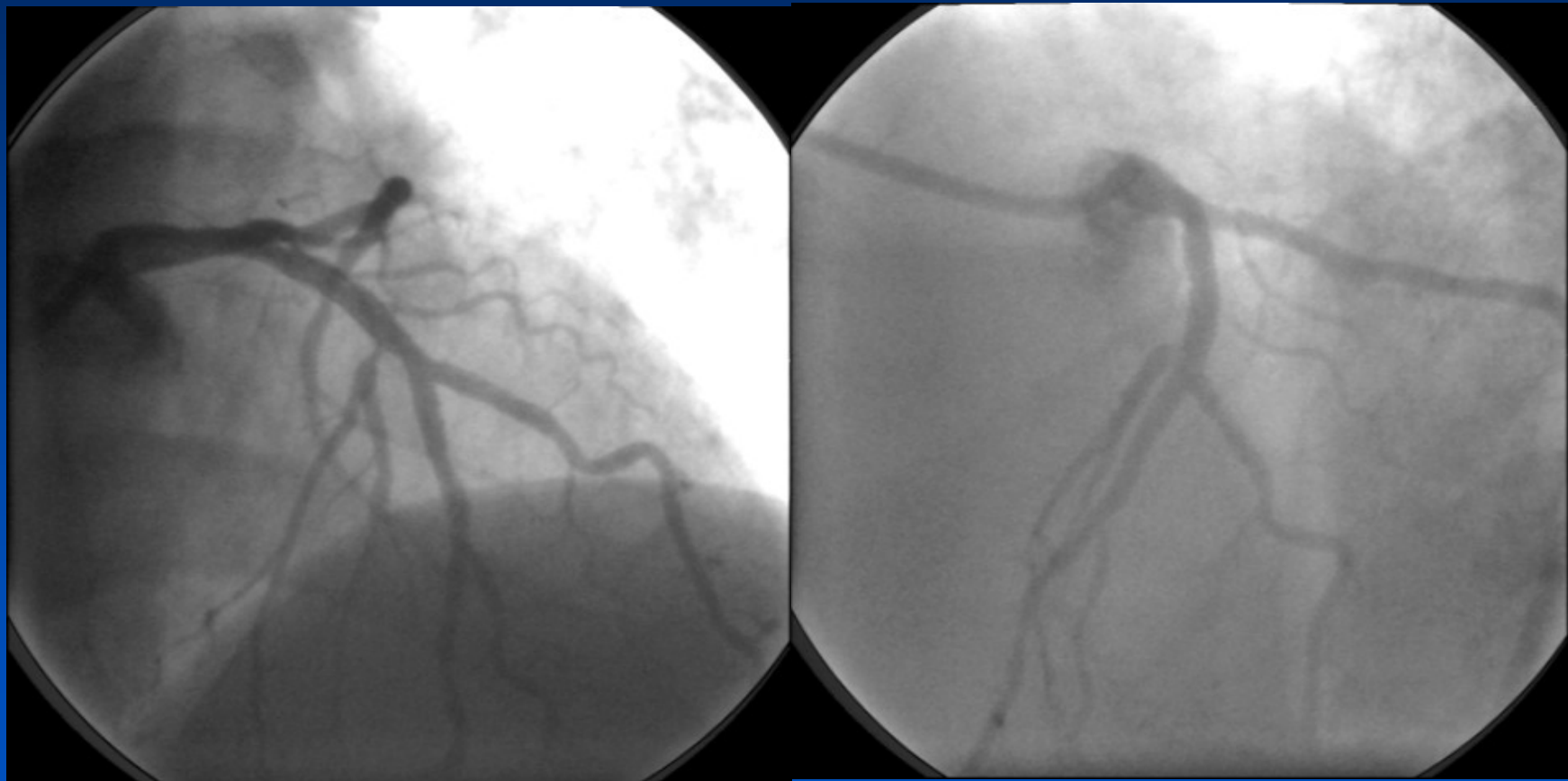
3.0×28mm

Kissing balloon

3.0×18mm

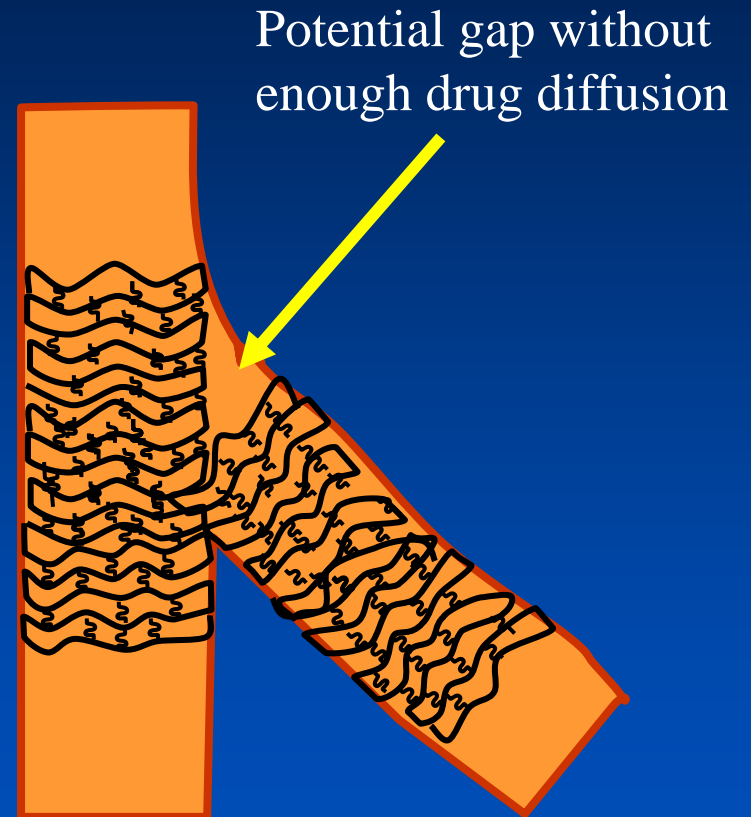
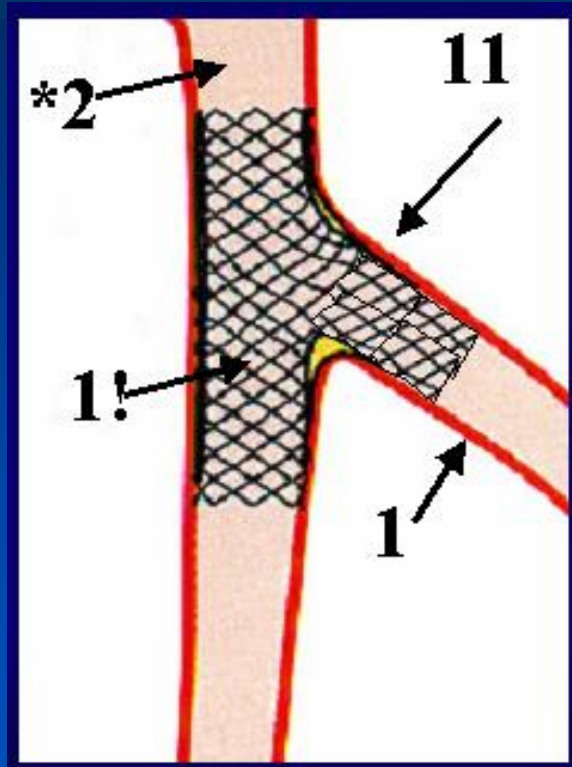


Final Results



Limitation of Modified T Stenting

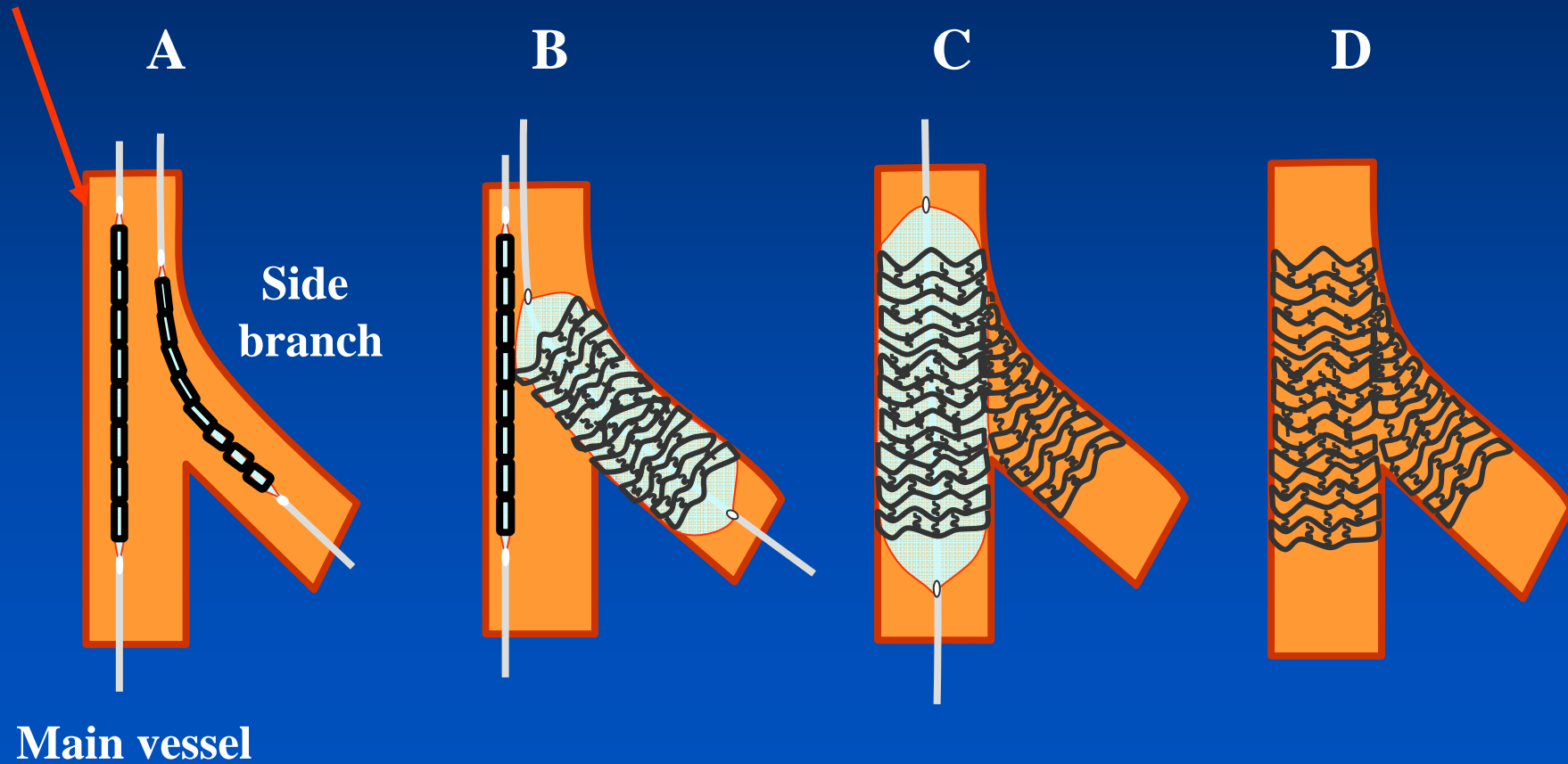
Restenosis site of T stenting in SIRIUS bifurcation



To prevent potential gap at the ostial side branch, the first stent should cover the entire surface of the side branch.

Crush Technique

Proximal location of the stent in the main vessel

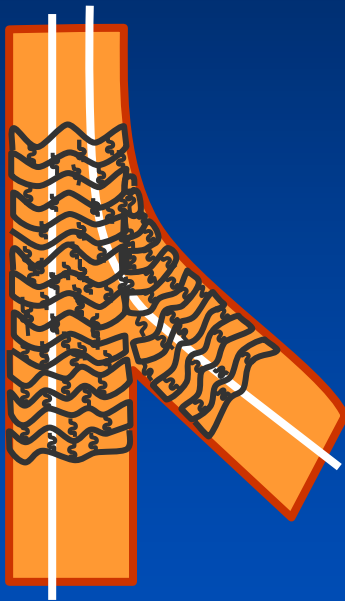


One More Step of Crush Technique

Final Kissing Balloon Dilatation

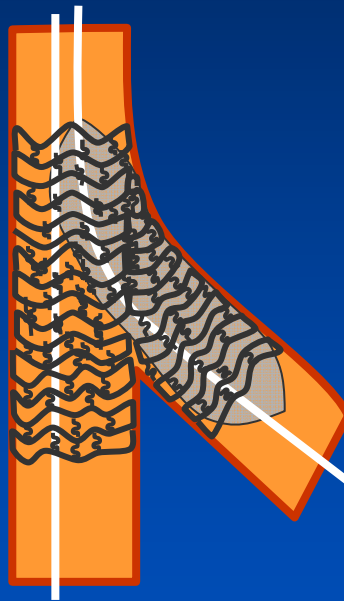
for side branch re-opening and stent optimization

E



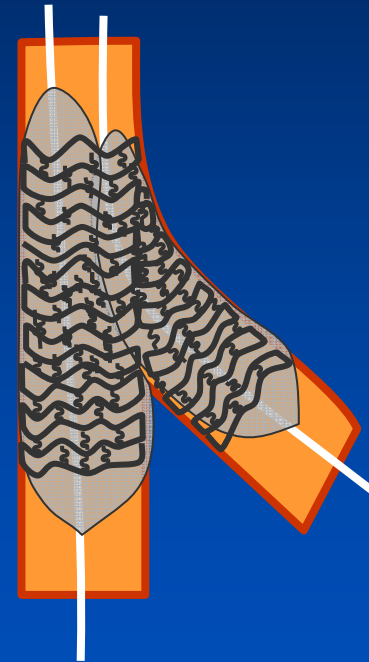
Re-advancement of
wire into the side
branch

F



Opening of the
side branch ostium

G



Final kissing
balloon inflation

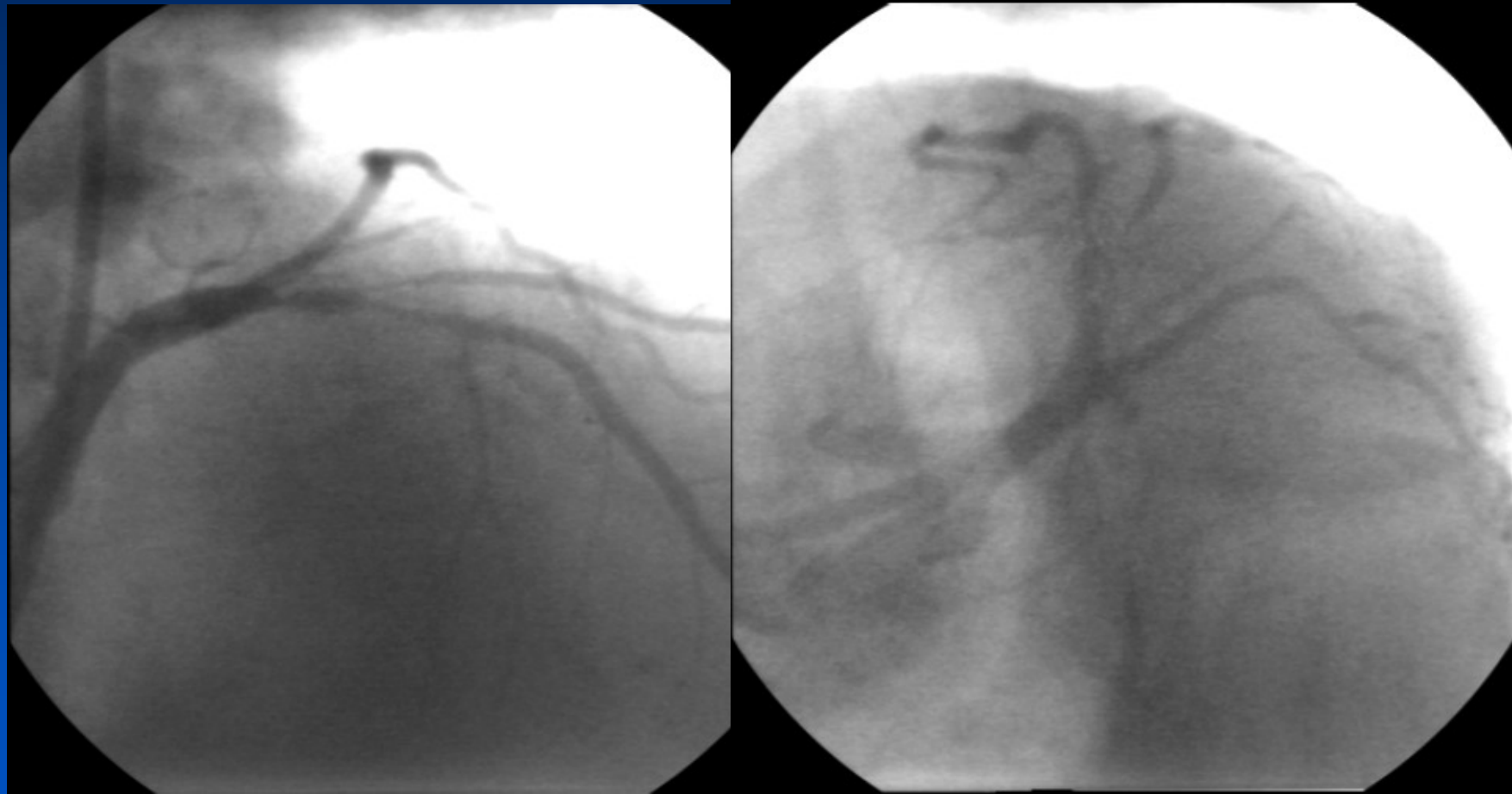
Advantages of Final kissing balloon inflation

- Fully expand the stent in the side-branch ostium.
- Wide the gaps between stent struts covering the side branch.
- Eliminate main branch distortion.

Tips of Final Kissing Ballooning

- Guiding catheter with good back-up support
- Use of hydrophilic wire
- Low profile balloon
- Crush the side branch stent completely by high pressure balloon dilatation of the main vessel stent before wire re-crossing
- Stepwise size increment of balloon from 1.5~2.0mm
- Postdilatation of the main vessel with a balloon of narrower diameter than the deploying balloon caused main-branch stent distortion.

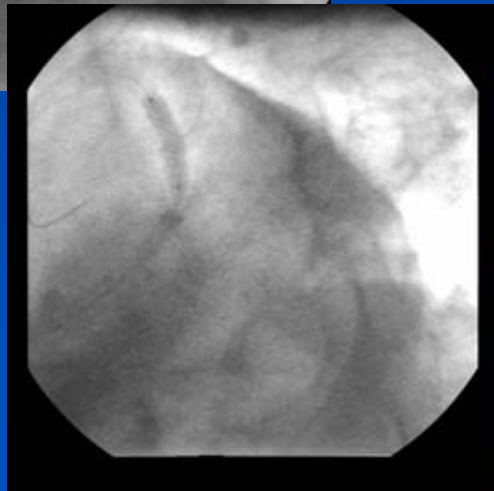
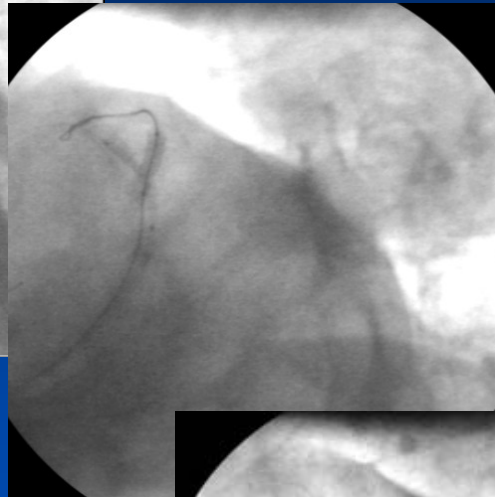
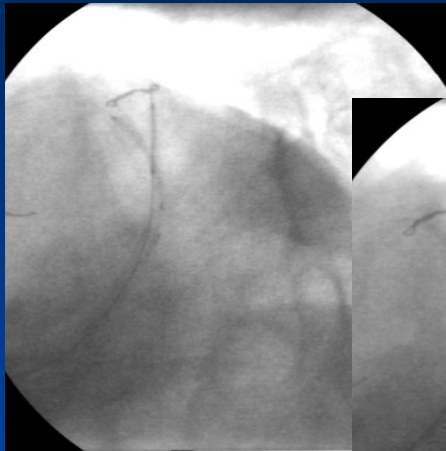
True LAD Bifurcation Stenosis



Predilation and middle LAD Stenting with a Cypher (3.5×23mm)



Crushing with two Cyphers (3.5×23mm in LAD & 2.5×18mm in Diag)



Balloon Dilatation in Diag & Final Kissing Balloon Inflation

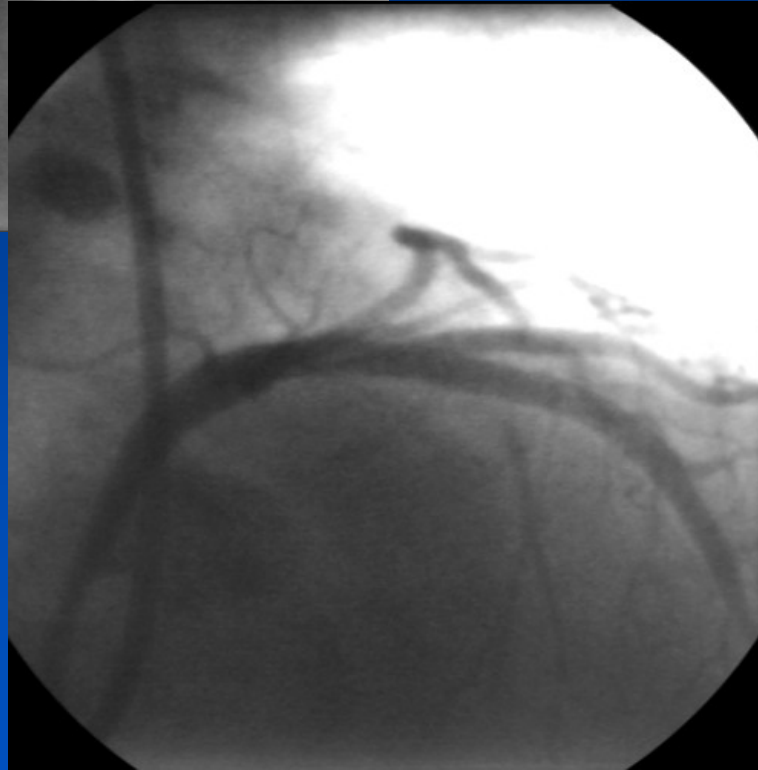
Maverick 2.5×20mm balloon



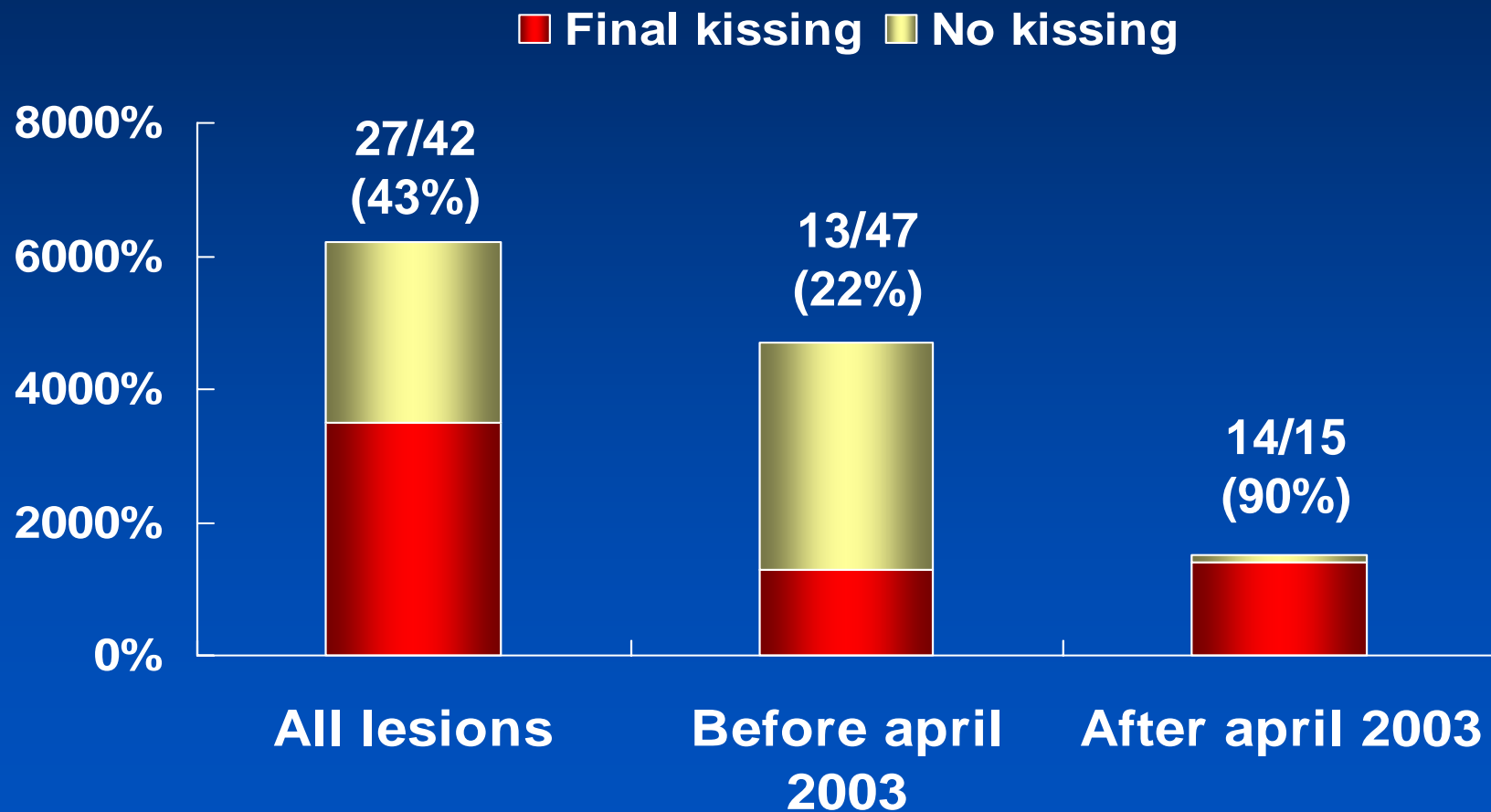
Maverick 2.5×20mm
Stent balloon 3.5×25mm



Final Results



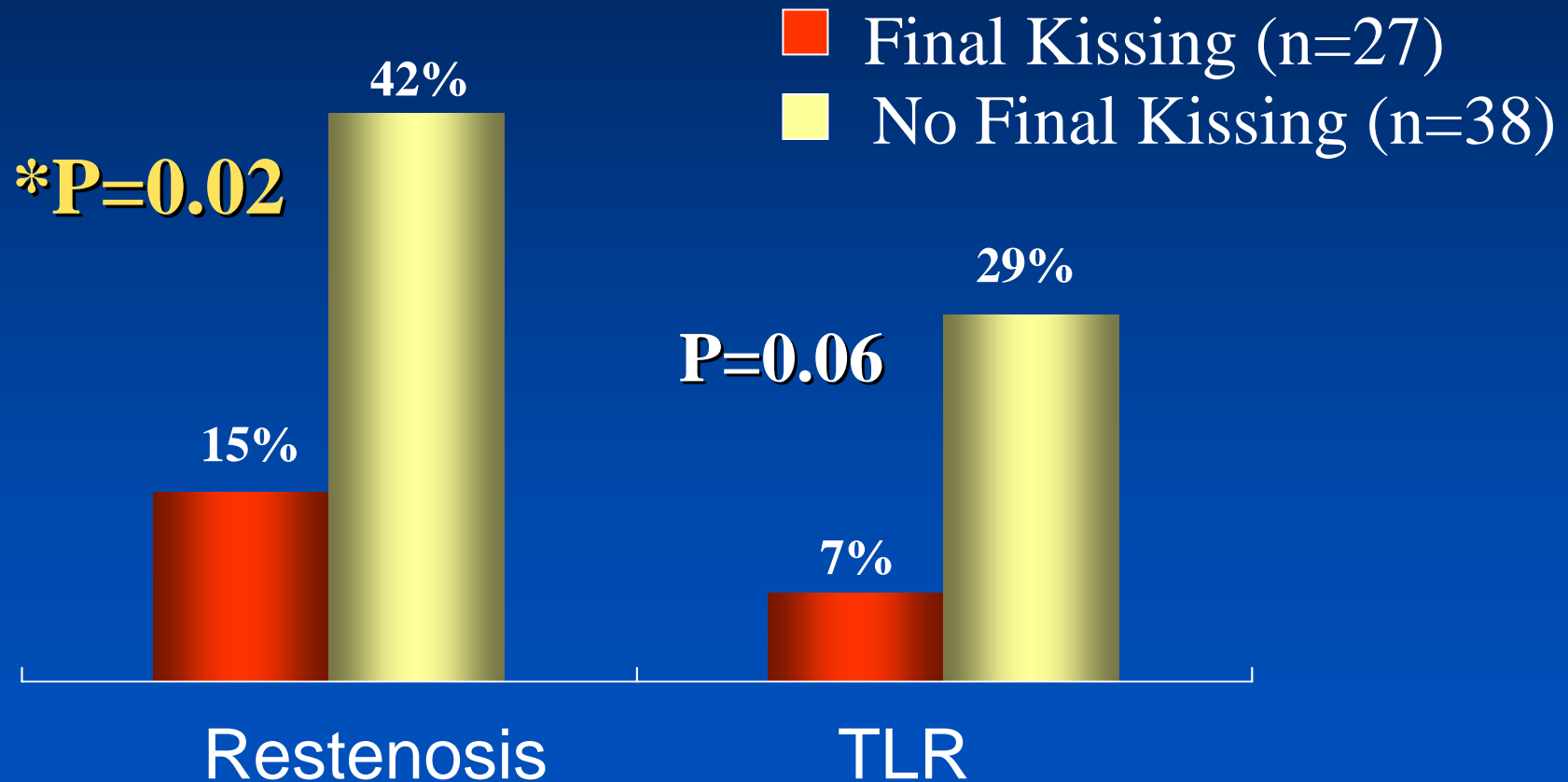
Progression of Crush Technique Milan Experience



A Colombo, ACC 2004

Benefit of Final Kissing Inflation

Clinical Outcome at 6 Months



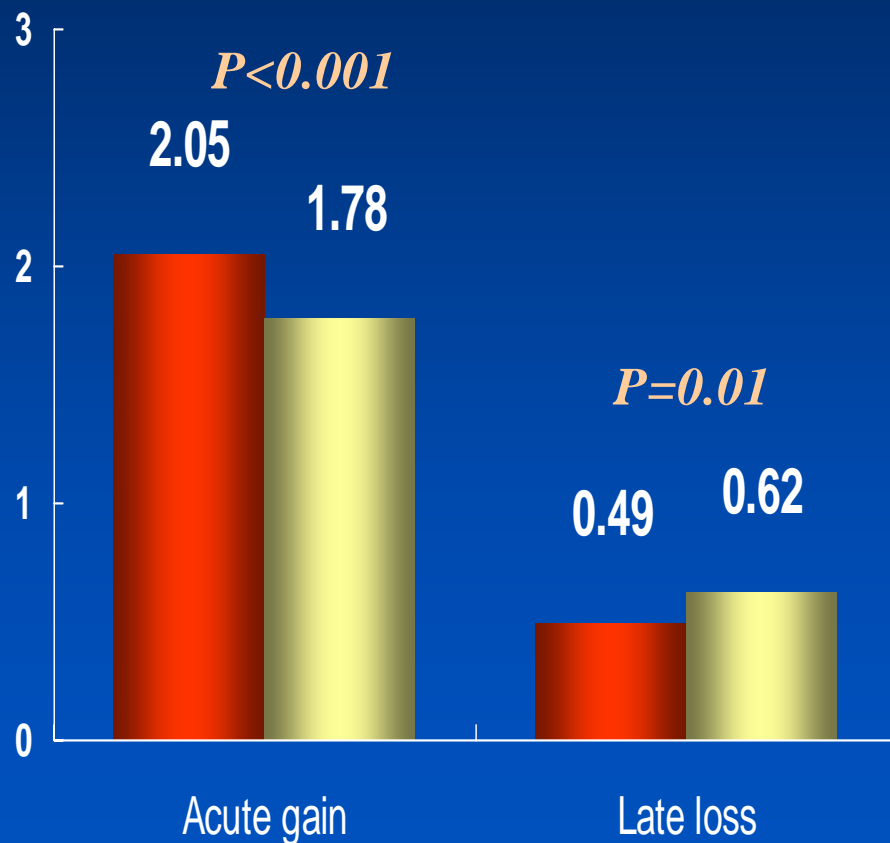
A Colombo, ACC 2004



QCA Results at 6 Months

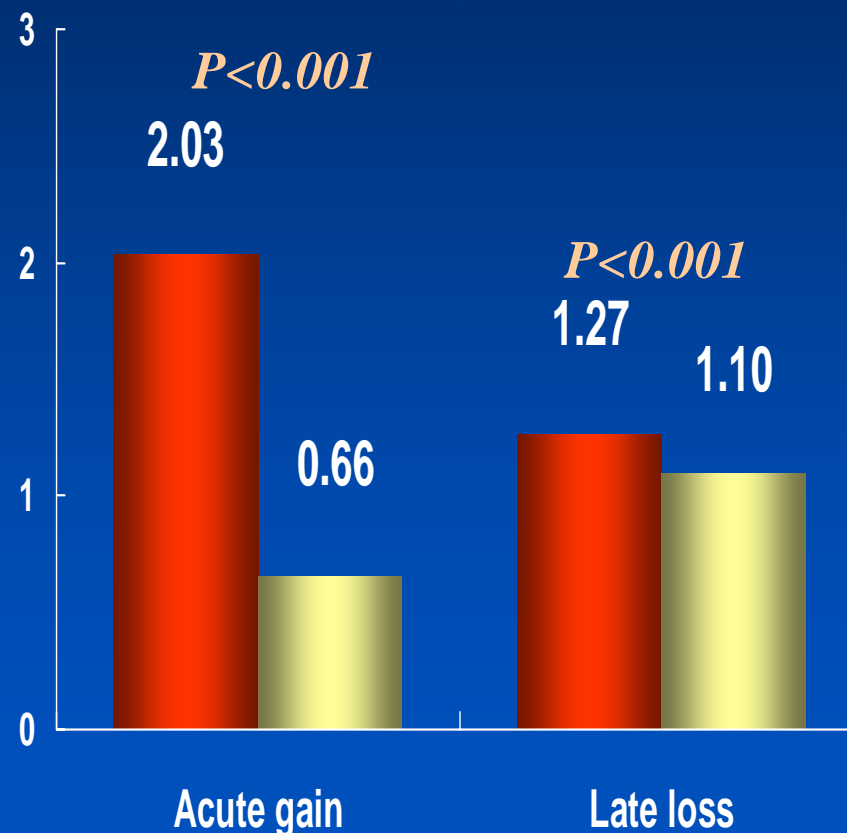
Main vessel

Final kissing



Side branch

No final kissing



A Colombo, ACC 2004

Crush and Kissing Balloon with Cypher in MATRIX Registry

108 patients, April 2003 ~ Nov. 2003

In- hospital events

- No death, MI, CABG, urgent TLR

30- day outcome

- No death
- Stent thrombosis 1.9 % (2/108)

Intermediate- term clinical outcome

- No death, MI
- TLR 12 % (9/108)

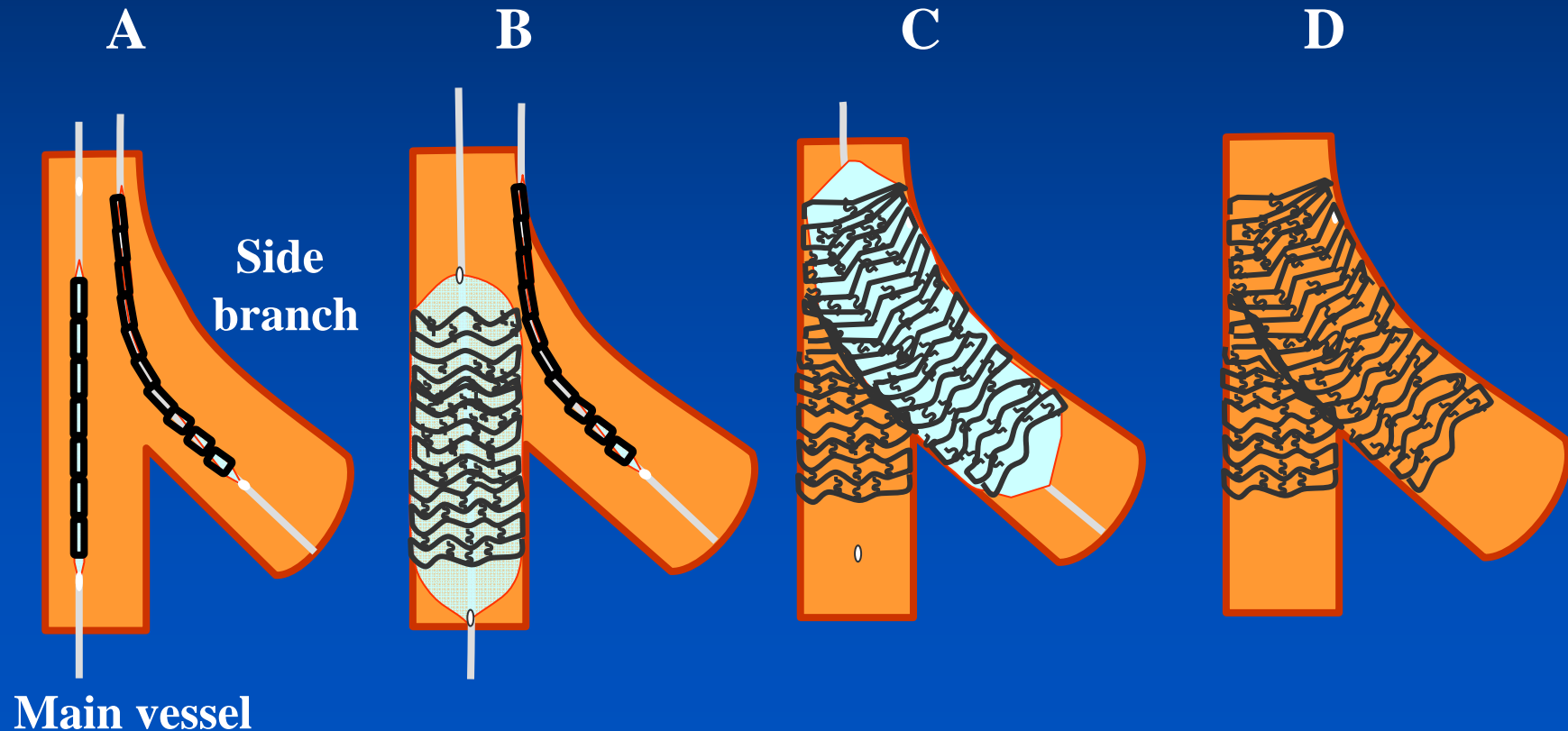
I Moussa, ACC 2004



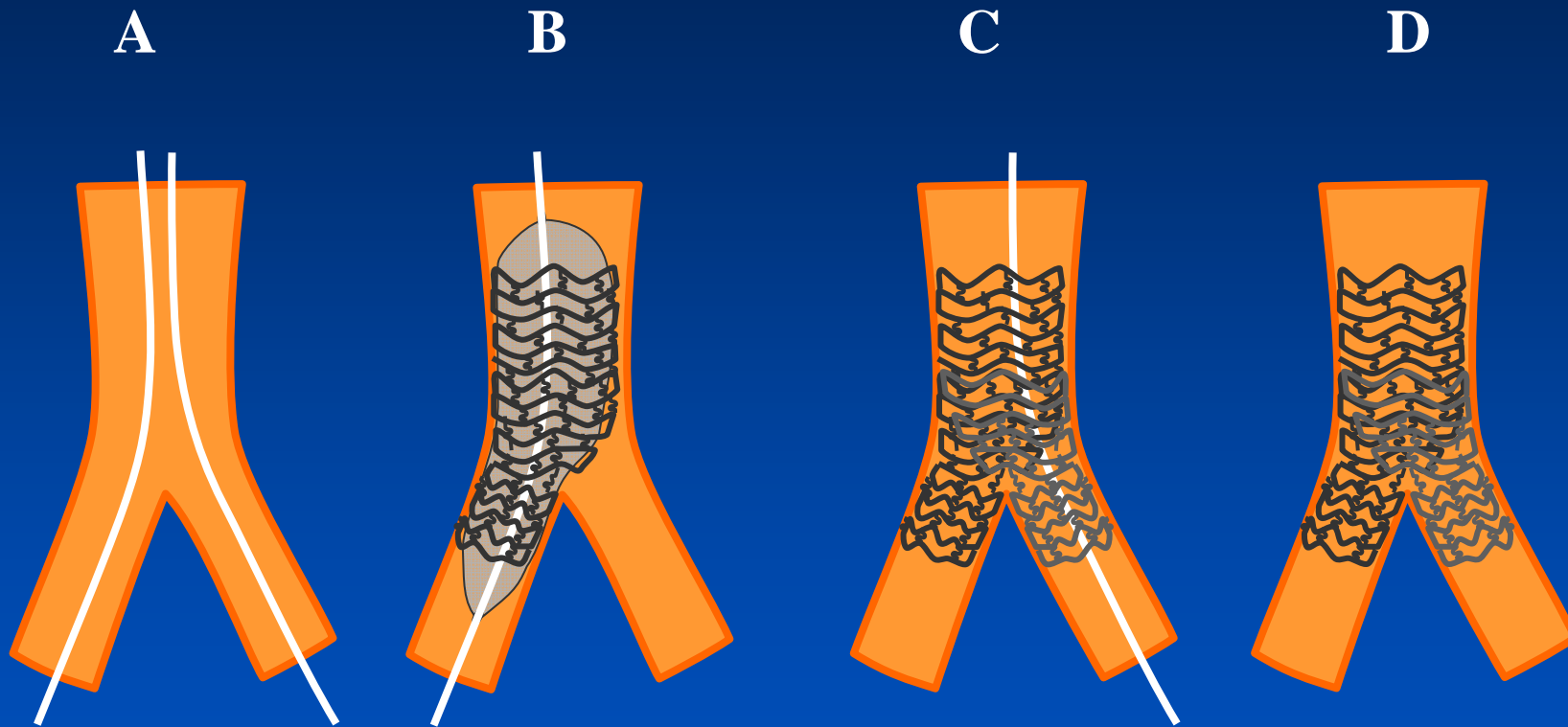
Inverted Crush

Modification in big side branch

Proximal location of the stent in the side branch



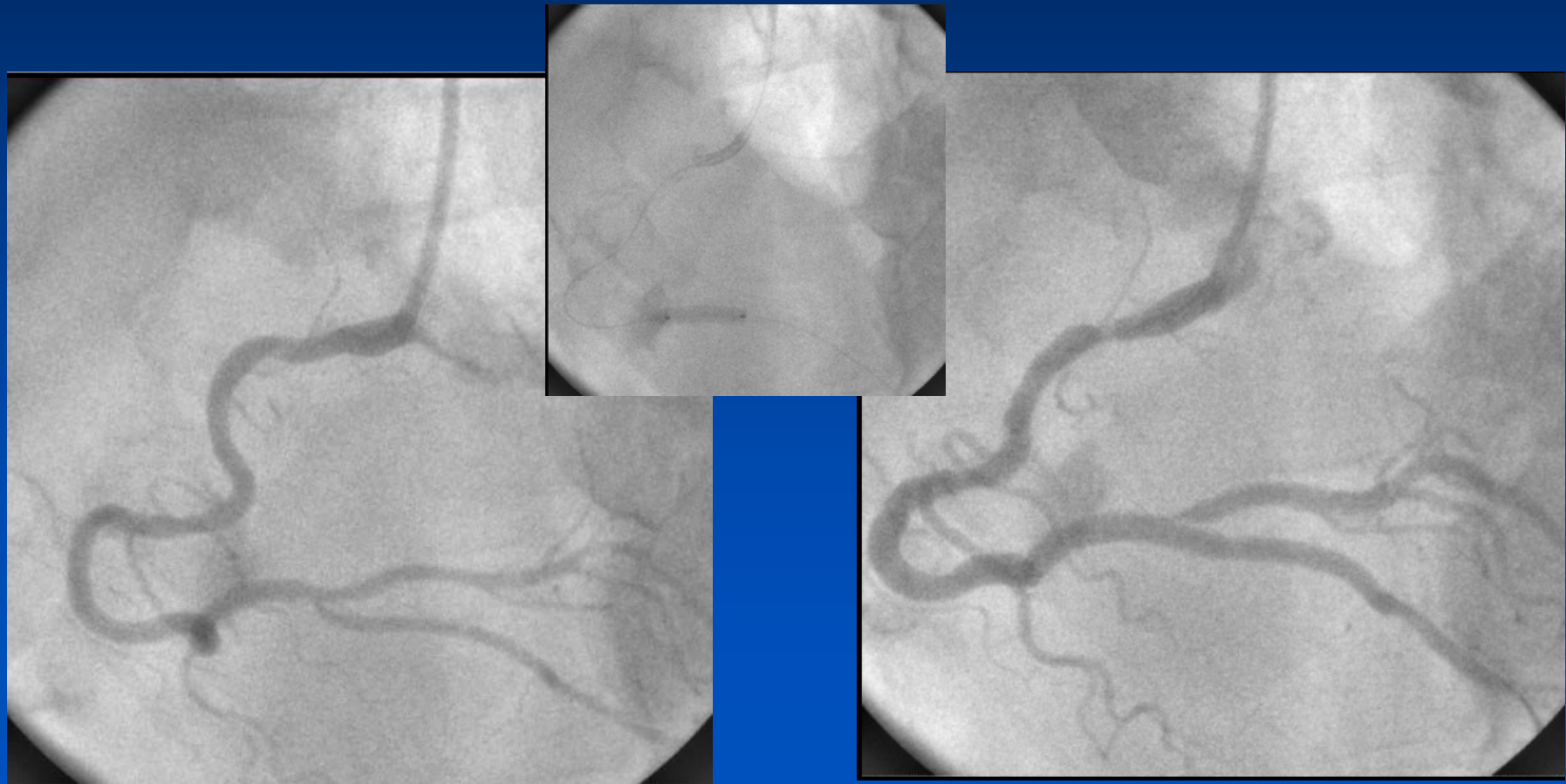
Y Stenting



- Complete lesion coverage
- Too much stent overlap at the proximal segment

Distal RCA Bifurcation Lesion

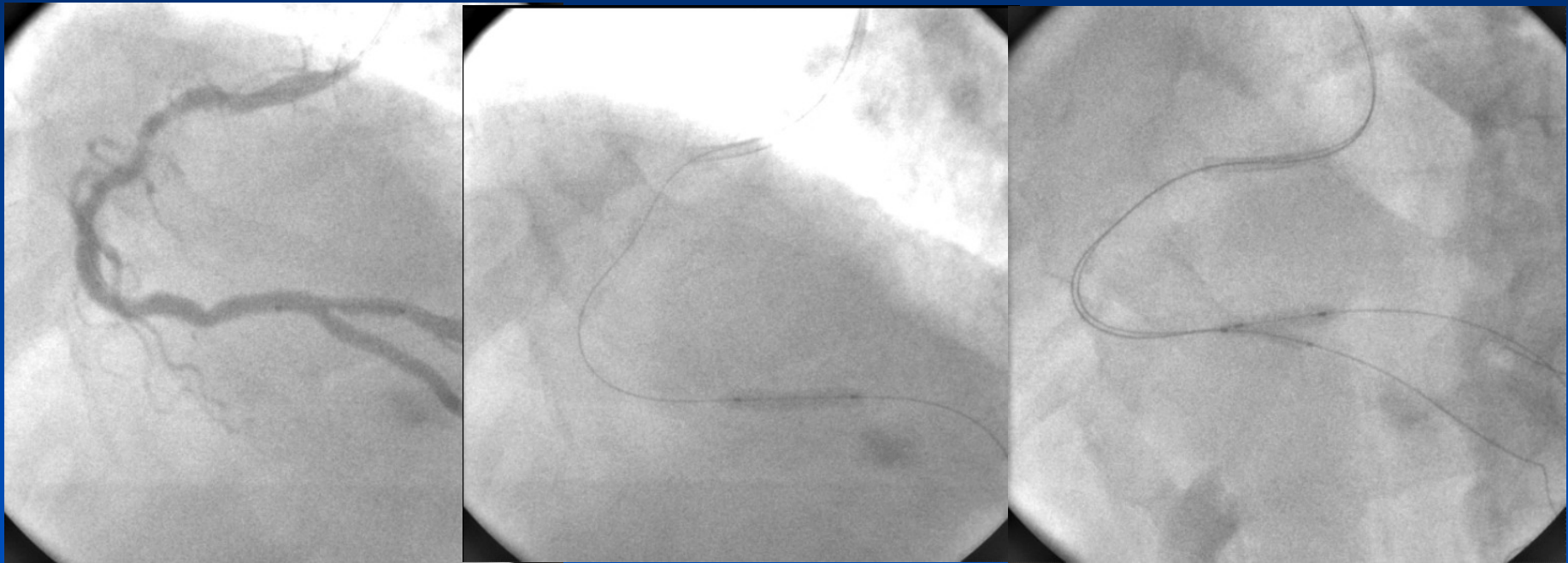
ArthosPICO Stent (3.5×14mm) at PDA



Suboptimal at PL Branch after Kissing Balloon Inflation



PL Stenting with a Cypher (3.0×18mm) & Repeat Kissing Ballooning

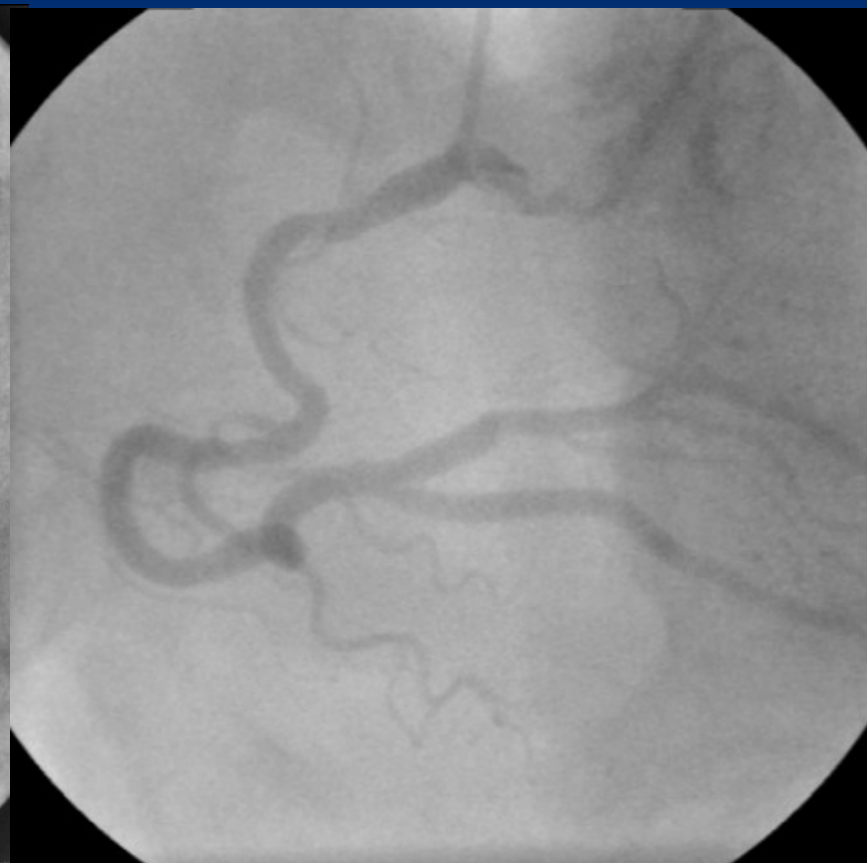


Final Result & 6-Month F/U

After procedure



6-month Follow-up



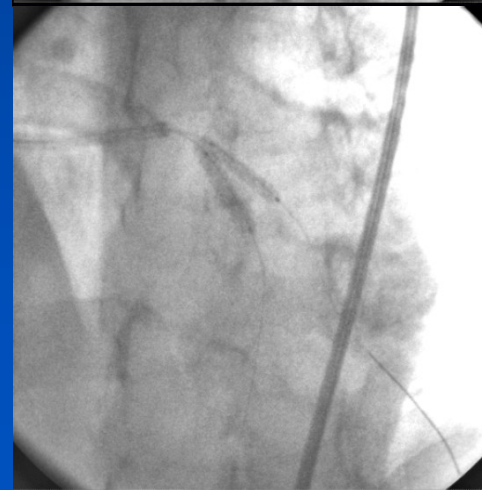
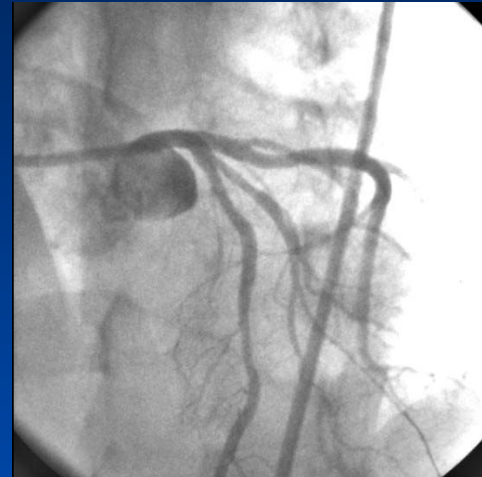
V Stenting

- Very short left main
- Bifurcation without stenosis proximal to the bifurcation



LAD and Diagonal Stenosis with Normal Proximal Reference

V stenting with two Cyphers (3.5×18mm in LAD and 2.75×18mm in Diag)

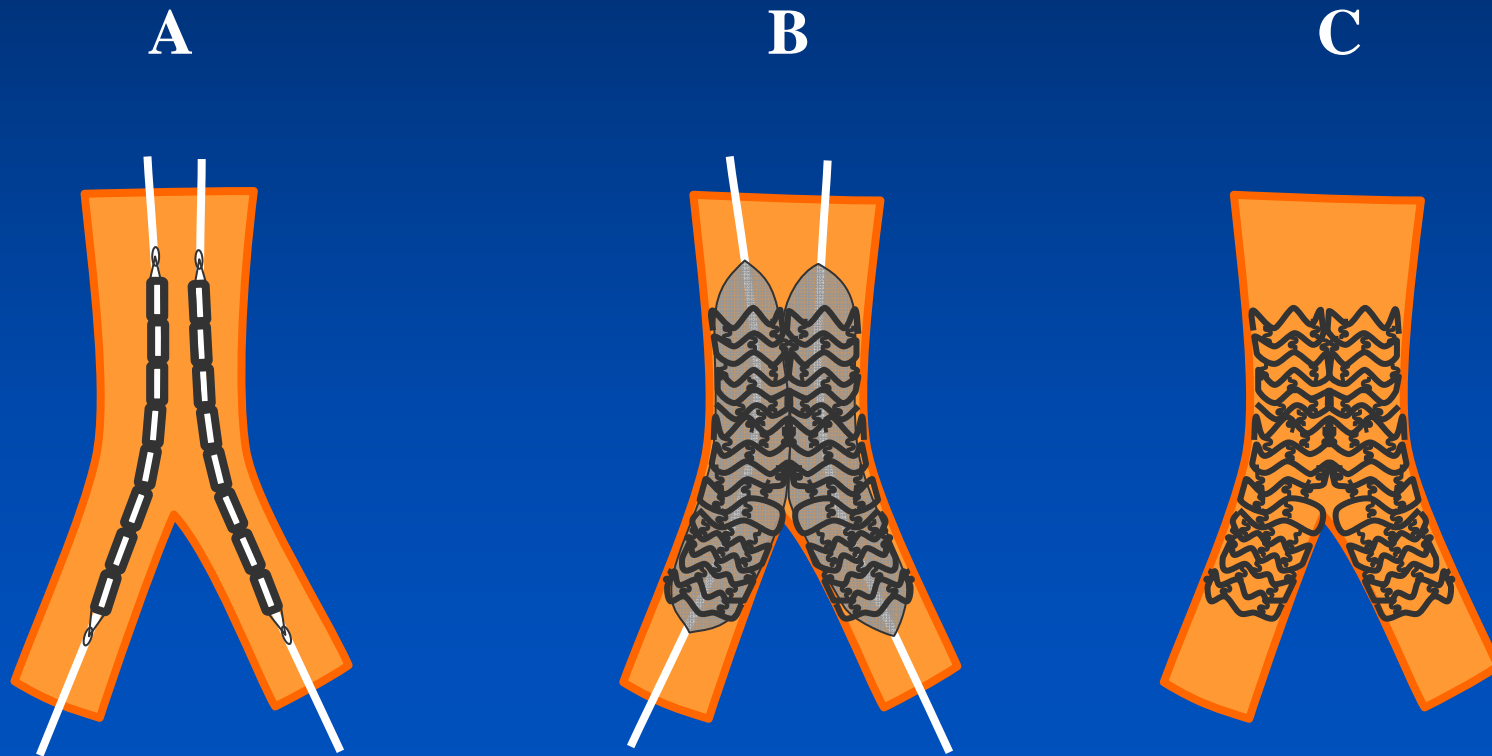


Final Results

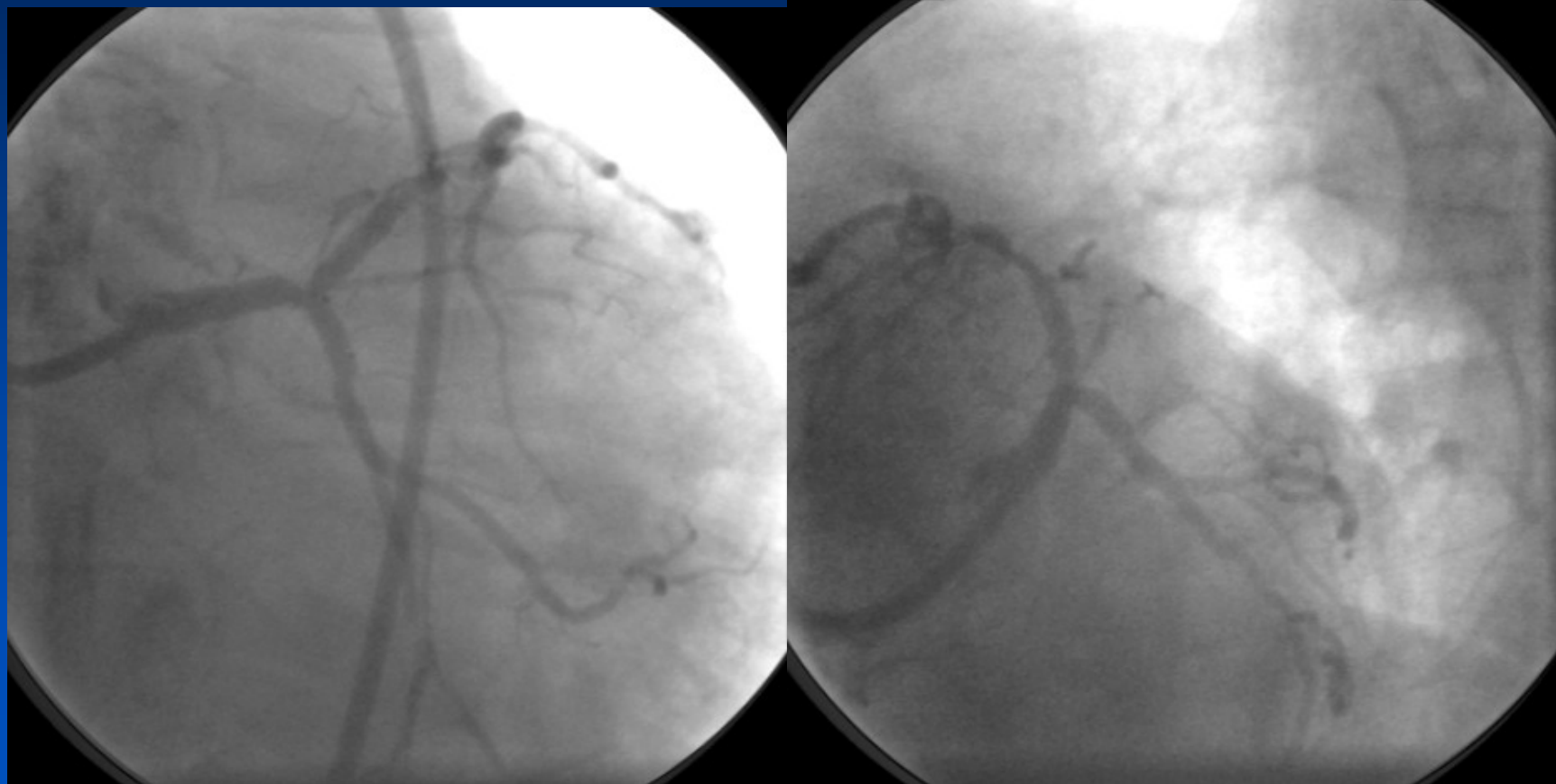


Kissing Stenting

- Large proximal reference
- Bifurcation with stenosis proximal to the bifurcation



LMCA bifurcation stenosis

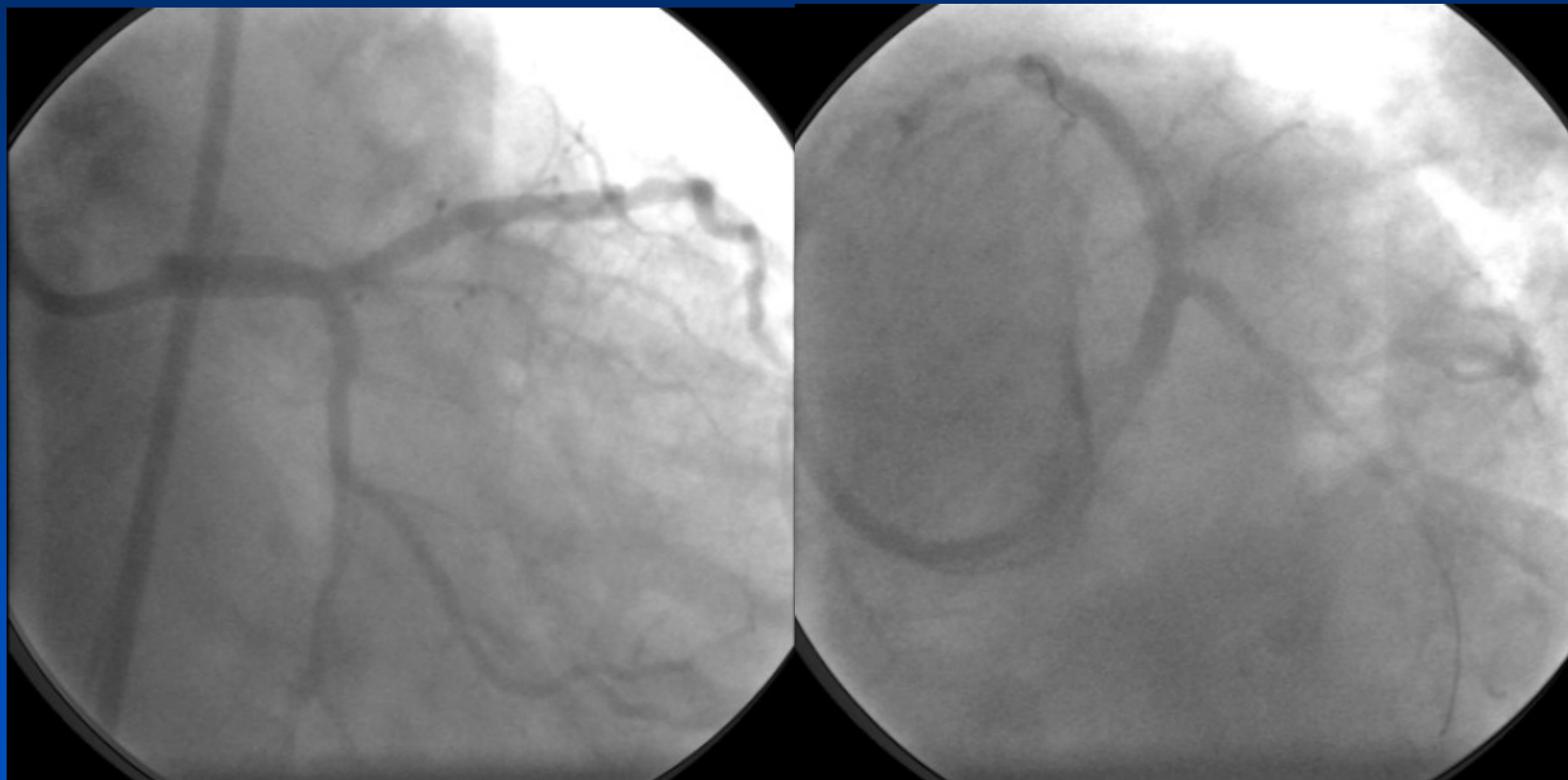


Kissing Balloon and Kissing Stenting

LAD: 3.0×23 mm, LCX: 3.0×18 mm



Successful Results



Patent at 6-month F/U



What is best in various complex stenting ?

RESEARCH Bifurcation

SES (n=127) or PES (n=72)

- **Subacute thrombosis** 2.5 %
- **TLR** 7 %
- **TVR** 9 %
- **Binary Restenosis**
 - Main vessel** 9 %
 - Side branch** 14 %

Serruys et al, ACC 2004

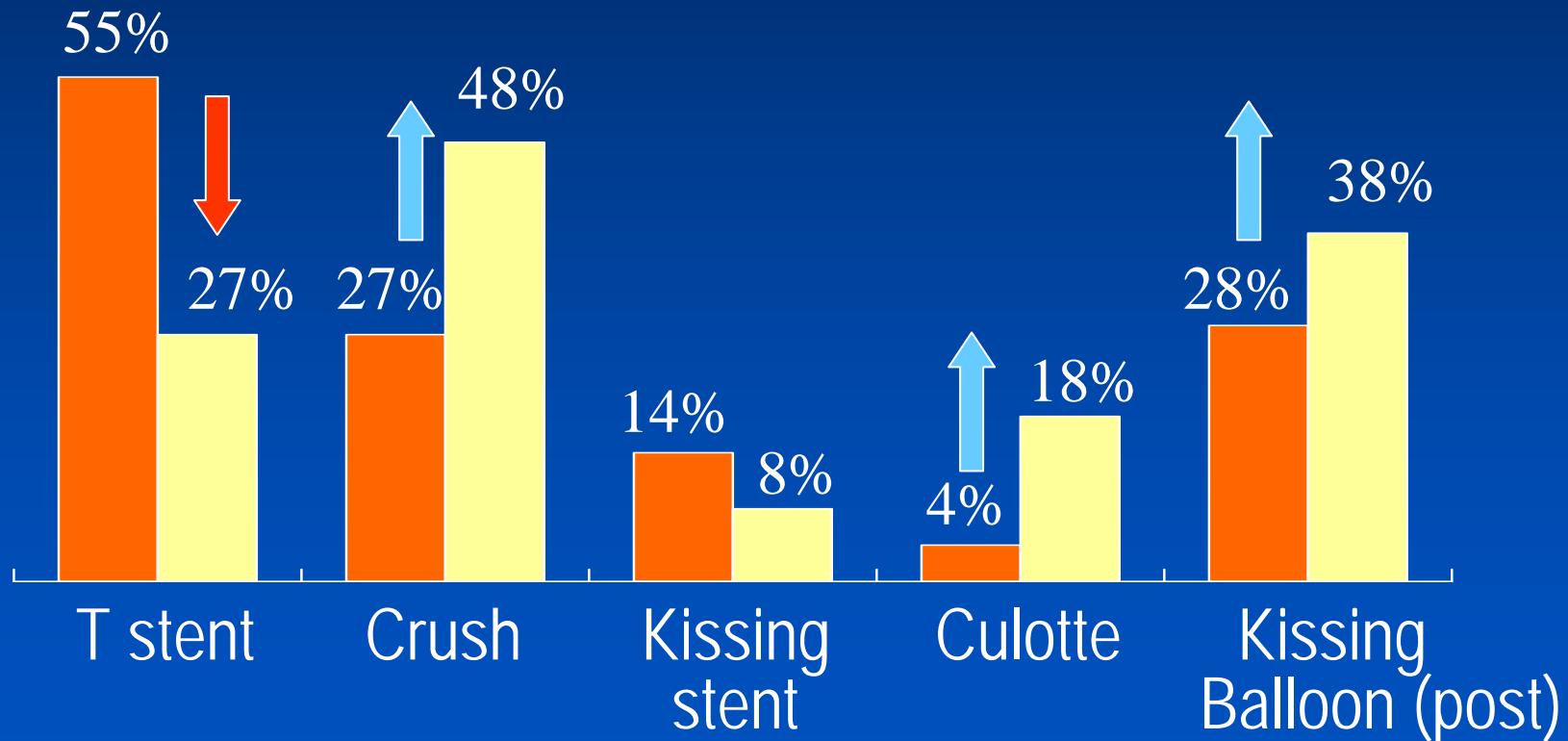


Stenting Technique Used

RESEARCH

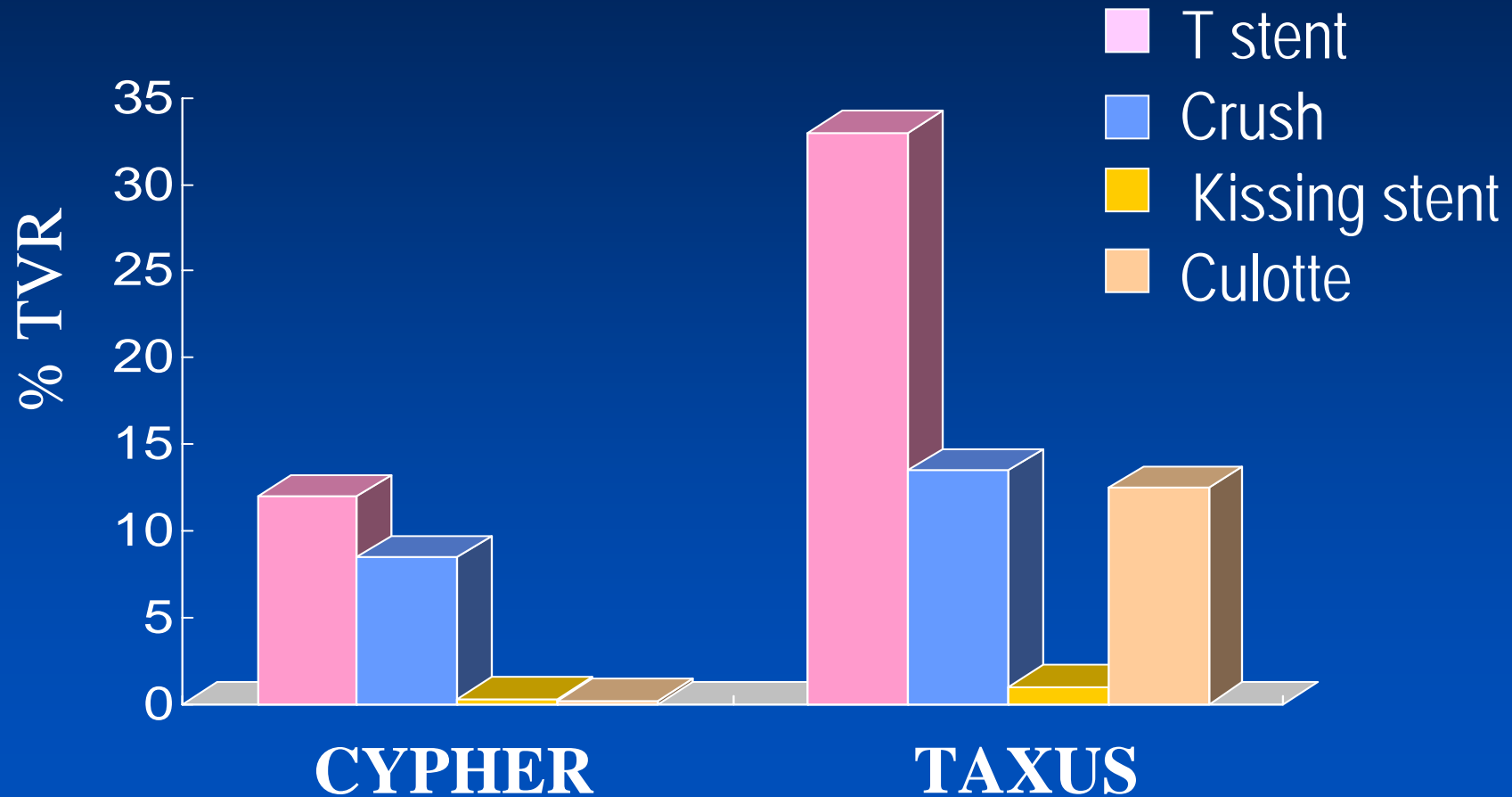
■ **CYPHER** (n=123)
April 2003 ~ April 2004

■ **TAXUS** (n=71)
Mar. 2004 ~ Sep. 2004



Serruys et al, ACC 2004

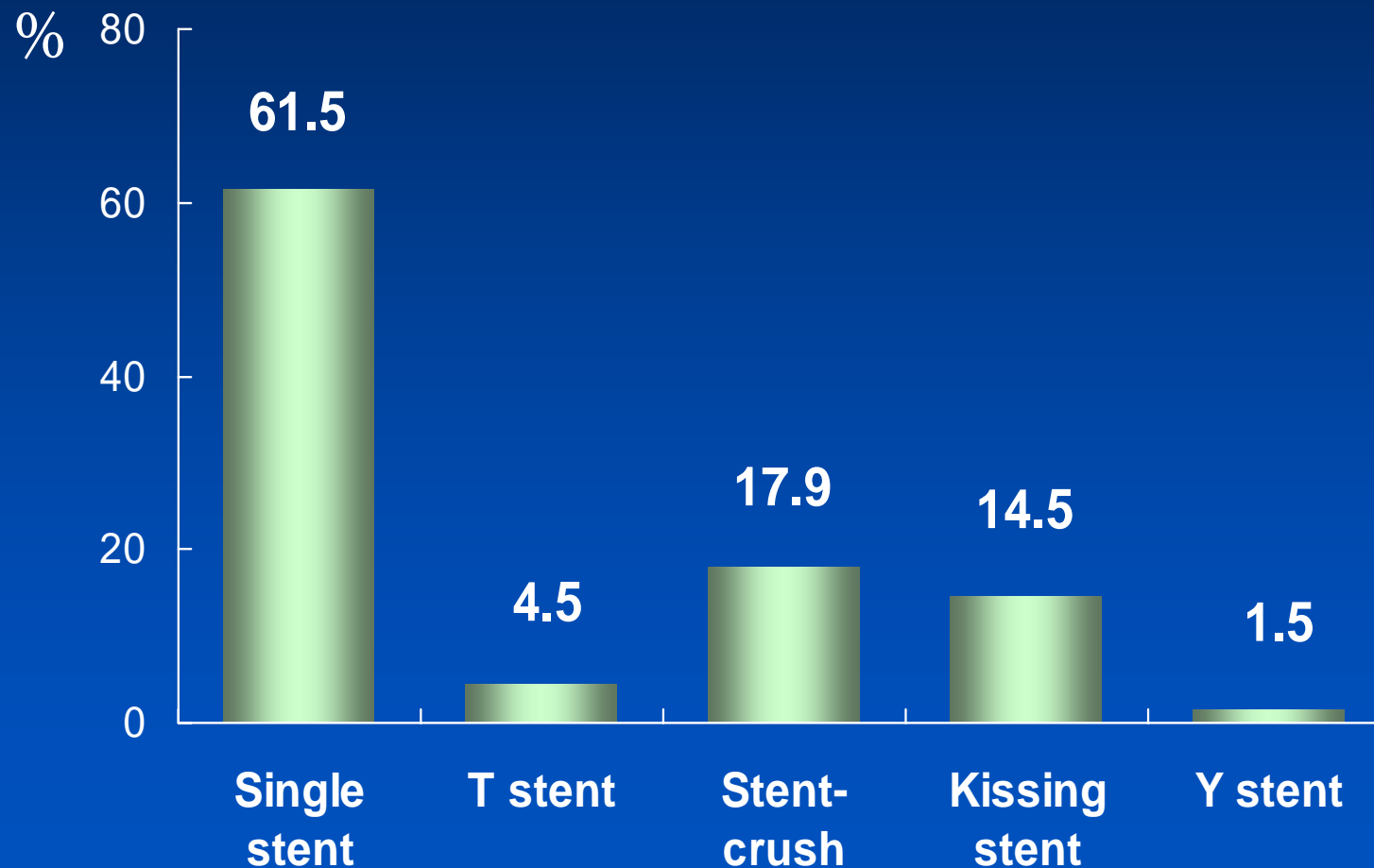
Target Vessel Revascularization RESEARCH



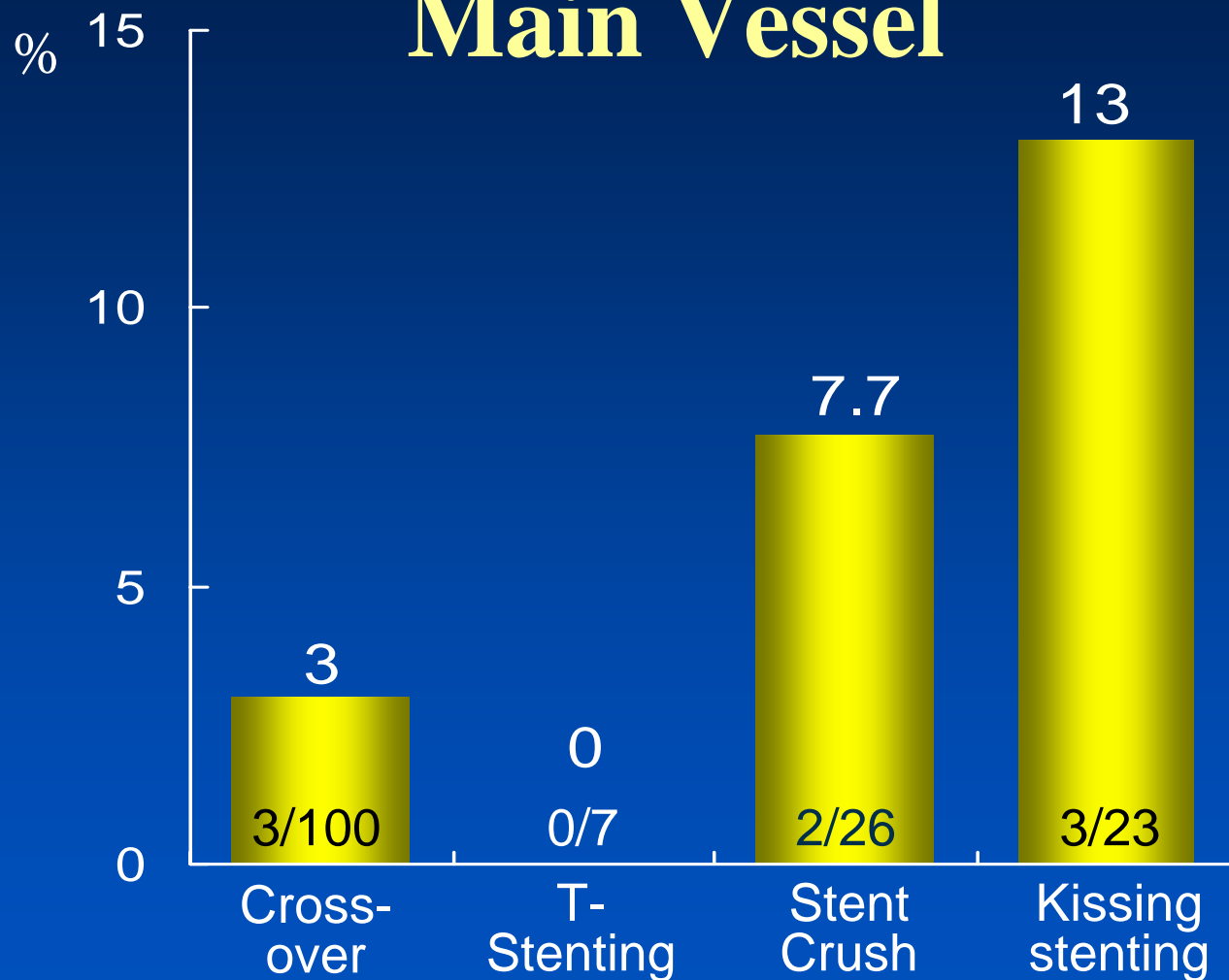
Serruys et al, ACC 2004

Bifurcation Lesions in AMC

Total 330 lesions with side branch $\geq 2.0\text{mm}$



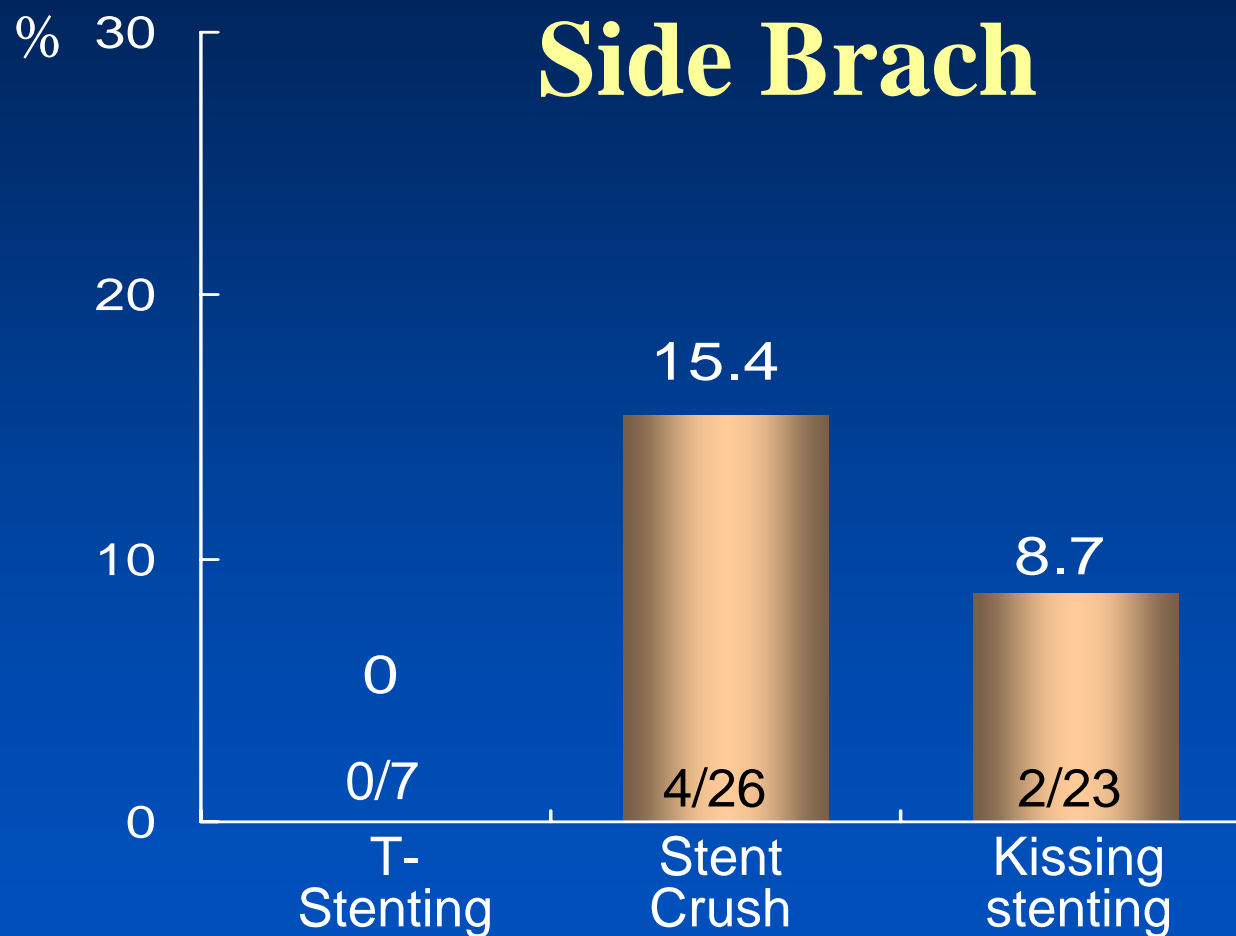
Restenosis Rate : 5.3 % Main Vessel



* Bifurcation including LMCA

Restenosis Rate

Side Branch



* Bifurcation including LMCA

Conclusions

- DES implantation has dramatically improved long-term outcome of the main vessel in the bifurcation lesions.
- However, restenosis at the side branch remains a problem.
- Until now, no statement can be made regarding the most appropriate technique with DES for bifurcation lesions.
- Therefore, treatment decision should depends on each patient and each lesion.