

Percutaneous Intervention of Unprotected Left Main Disease

Technical feasibility and Clinical outcomes

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Unprotected Left Main Stenting

- Primary stenting in the setting of AMI
- Bail-out unprotected left main stenting
- Elective unprotected left main stenting
- In the era of drug-eluting stent

Unprotected Left Main Stenting

- Primary stenting in the setting of AMI

Primary Stenting for AMI patients with Left Main Coronary Artery Occlusion

2003 AMC Data

Primary LMCA Stenting

Background

- Primary angioplasty or stenting have emerged as a valuable reperfusion strategy for management of AMI
- However, the issue of best approach to LMCA disease during AMI is controversial

Primary LMCA Stenting

Previous Pilot Studies

	Year	Balloon / Stent	In-hospital mortality	Long-term mortality
Quigley	1993	4/0	100%(4/4)	-
Chauhan	1997	6/0	83% (5/6)	-
ULTIMA	2001	23/17	55%(22/40)	57%
Yip	2001	8/10	33% (6/18)	56% (8/18)
Neri	2002	5/17	50%(11/22)	59%(13/22)
Luca	2003	10/14	58%(14/24)	63%(15/24)

Primary LMCA Stenting

Predictors of Survival

- Dominant RCA
- Good intercoronary collaterals (≥ 2)
- Post TIMI 3 flow
- Cardiogenic shock (negative predictor)

Baseline Demographics

n=18

Age,yrs	59±12
Men	16 (89%)
Diabetes	3 (17%)
Hypertension	4 (22%)
Current smoker	10 (56%)
Hypercholesterolemia	7 (39%)

Primary LMCA Stenting

Baseline Demographics

Prior MI	1 (6%)
Cardiogenic shock	14 (78%)
Ventilator support	7 (39%)
Abxicimab	12 (67%)
IABP support	14 (78%)

Primary LMCA Stenting

Angiographic Findings

Lesion location	
Ostium	1 (6%)
Body	7 (38%)
Bifurcation	10 (56%)
Lesion length	13±7
Ref vessel diameter (mm)	3.9±0.3

Primary LMCA Stenting

In Hospital Outcomes

	n=18
Angiographic success (TIMI \geq 2, DS<30%)	17 (94%)
Emergency CABG	2 (11%)
Elective CABG	2 (11%)
Other lesion stenting	6 (33%)
Death	8 (44%)

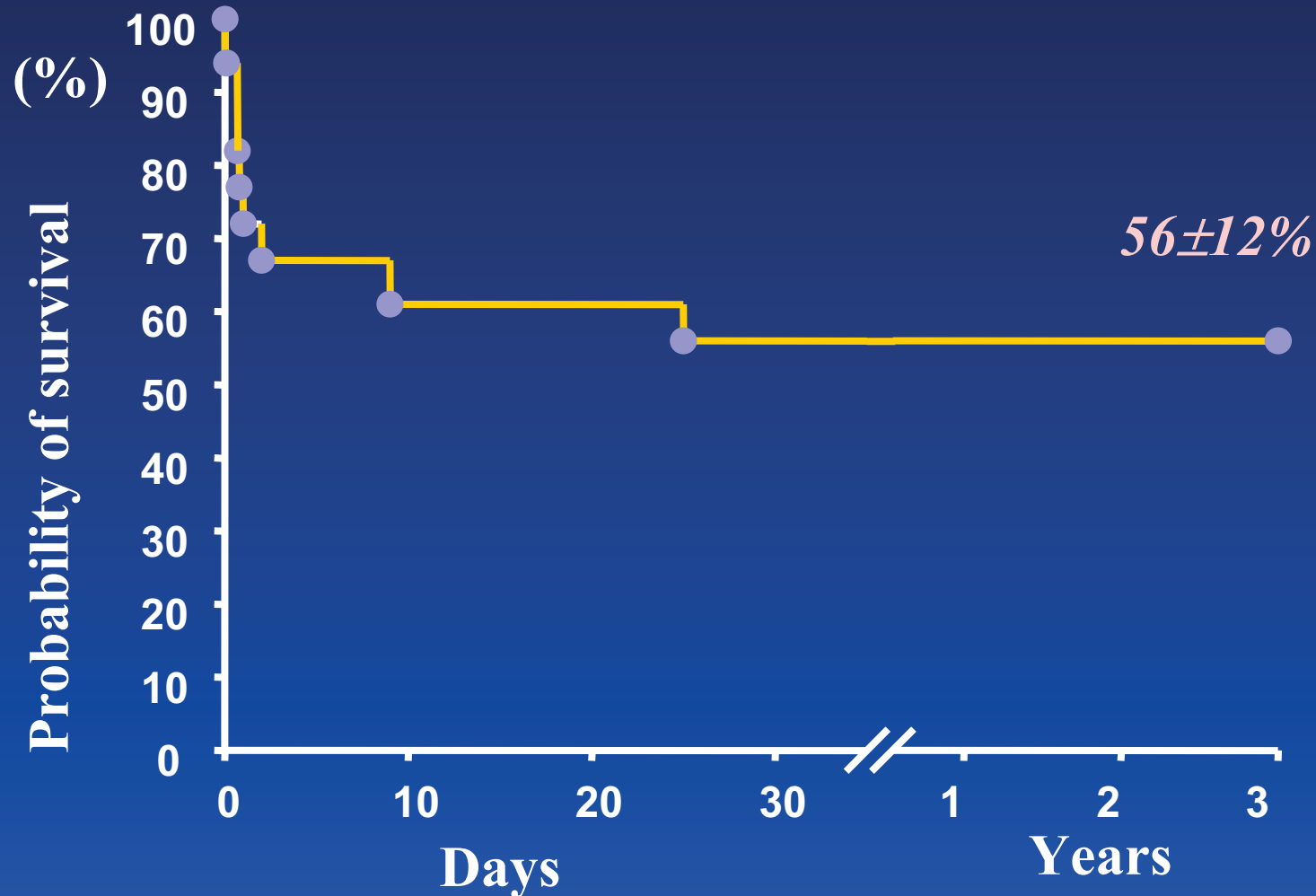
Primary LMCA Stenting

Long-term Outcomes

	n=18
Follow-Up (months)	39±22
TLR(CABG)	1 (6%)
Reinfarction	0
Death	0

Primary LMCA Stenting

3-year Survival



Primary LMCA Stenting

Prognostic Determinants

	Alive (n=10)	Dead (n=8)
✓ Initial TIMI ≥ 2	7(70%)	1(13%)*
Dominant RCA	3(30%)	4(50%)
Collaterals ≥ 2	1(10%)	1(13%)
Final TIMI flow =3	9(90%)	4(50%)
Cardiogenic shock	6(60%)	8(100%)

* $p < 0.05$

Unprotected Left Main Stenting

- Primary stenting in the setting of AMI
 - ✓ Primary stenting of left main during AMI is technically feasible and appropriate therapeutic option
 - ✓ Good initial TIMI flow (≥ 2) is important predictor of survival
 - ✓ Long term clinical outcomes of patients surviving was favorable after hospital discharge

Unprotected Left Main Stenting

- Primary stenting in the setting of AMI
- Bail-out unprotected left main stenting

Bail-out Stenting for Left Main
Coronary Artery Dissection during
Coronary Angioplasty;

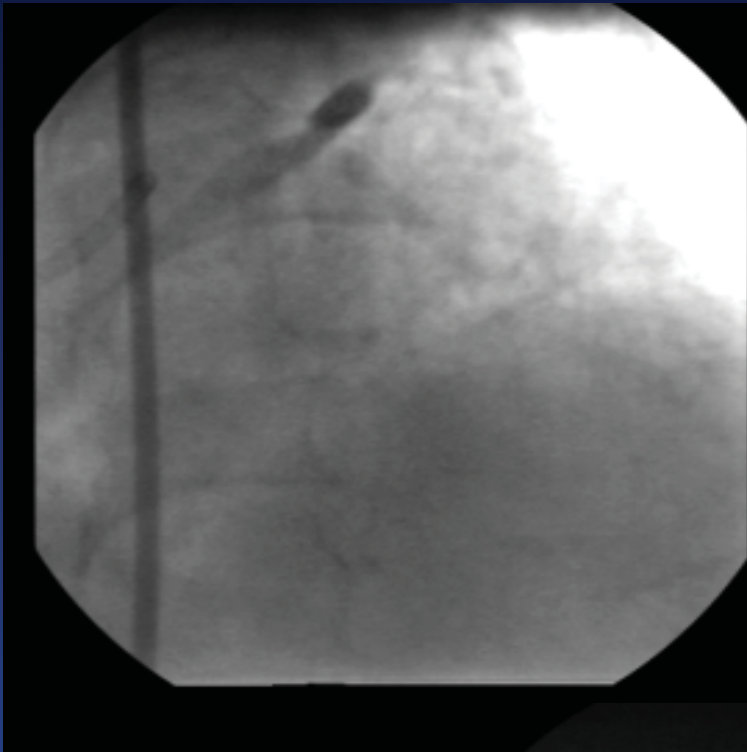
**Acute and Long-term
Results**

2003 AMC Data

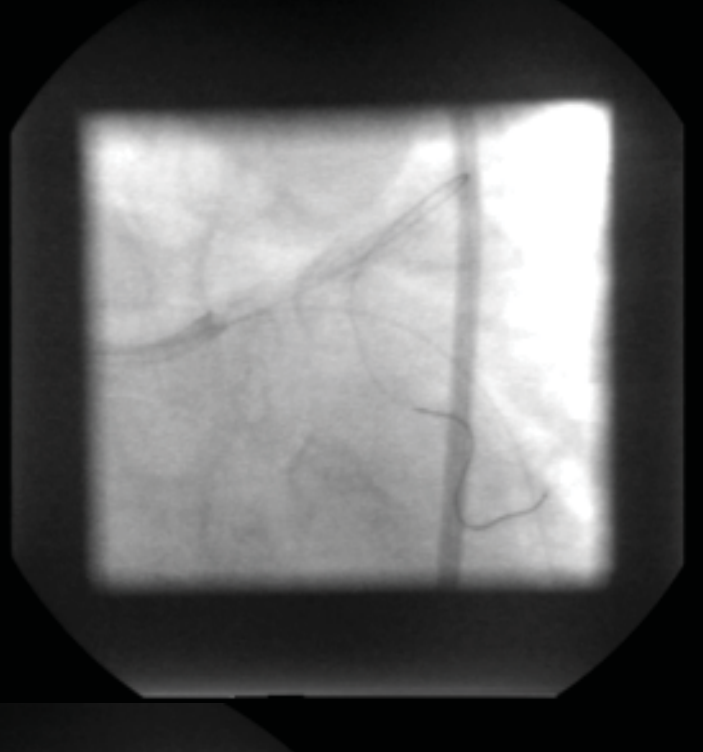
Bail-out LMCA Stenting

Background

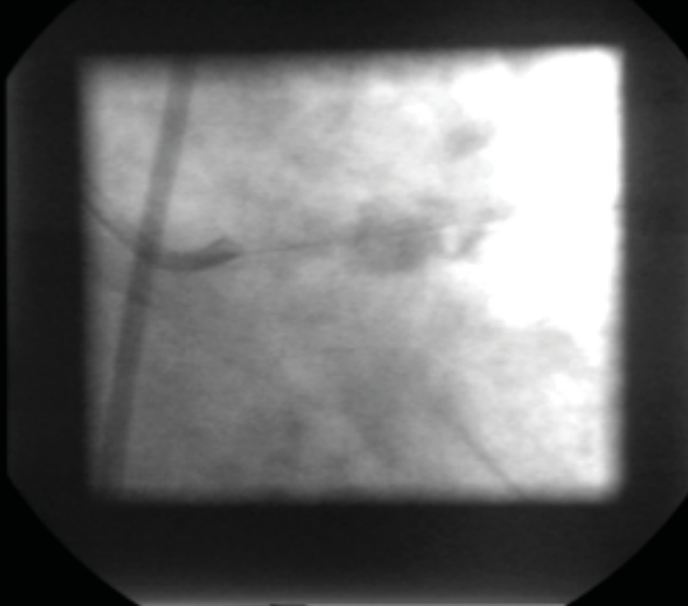
- Stenting is the fastest technique in repairing the LM dissection and stabilization of hemodynamics
- However, the long-term effectiveness of bail-out stenting on the LM has not been clearly defined



Diffuse LAD
Ostial lesion



LM ostial
dissection



Bail-out
Stenting

Bail-out LMCA Stenting

Long-term (3 year) Clinical outcome

n=10

Technical Success	100 %
Follow-Up (Months)	31±25
Restenosis	0
Death	0
TLR	0

Unprotected Left Main Stenting

- Primary stenting in the setting of AMI
- Bail-out unprotected left main stenting

Prompt recognition of LMCA dissection and bail-out stenting save the life and provide excellent acute and long-term results.

Unprotected Left Main Stenting

- Primary stenting in the setting of AMI
- Bail-out unprotected left main stenting
- Elective unprotected left main stenting
 - ✓ Immediate and Late outcomes ?
 - ✓ Role of Debulking ?
 - ✓ Role of IVUS ?
 - ✓ Bifurcation left main intervention ?

Subject

310 Patients

(M/F=209/101, Age: 56years)

- Elective Stenting in Patients with Normal LV function 258
- Follow-up angiogram at 6 month 178/220 (86%)

2003 AMC

Unprotected Left Main Stenting

Inclusion Criteria

- **Good Candidate for Surgery**
(Diameter stenosis $\geq 50\%$ involving both a LMCA and/or the ostium of LAD or LCX with Objective Ischemia)
- **Normal LV function**

2003 AMC



Procedural Success Rate: 99%

In-Hospital Clinical Courses

Acute closure	0
Subacute thrombosis	1 (0.5%)
Death	0
Q-MI	0
Emergent CABG	0

Unprotected Left Main Stenting 6 month Angiographic Restenosis Rate

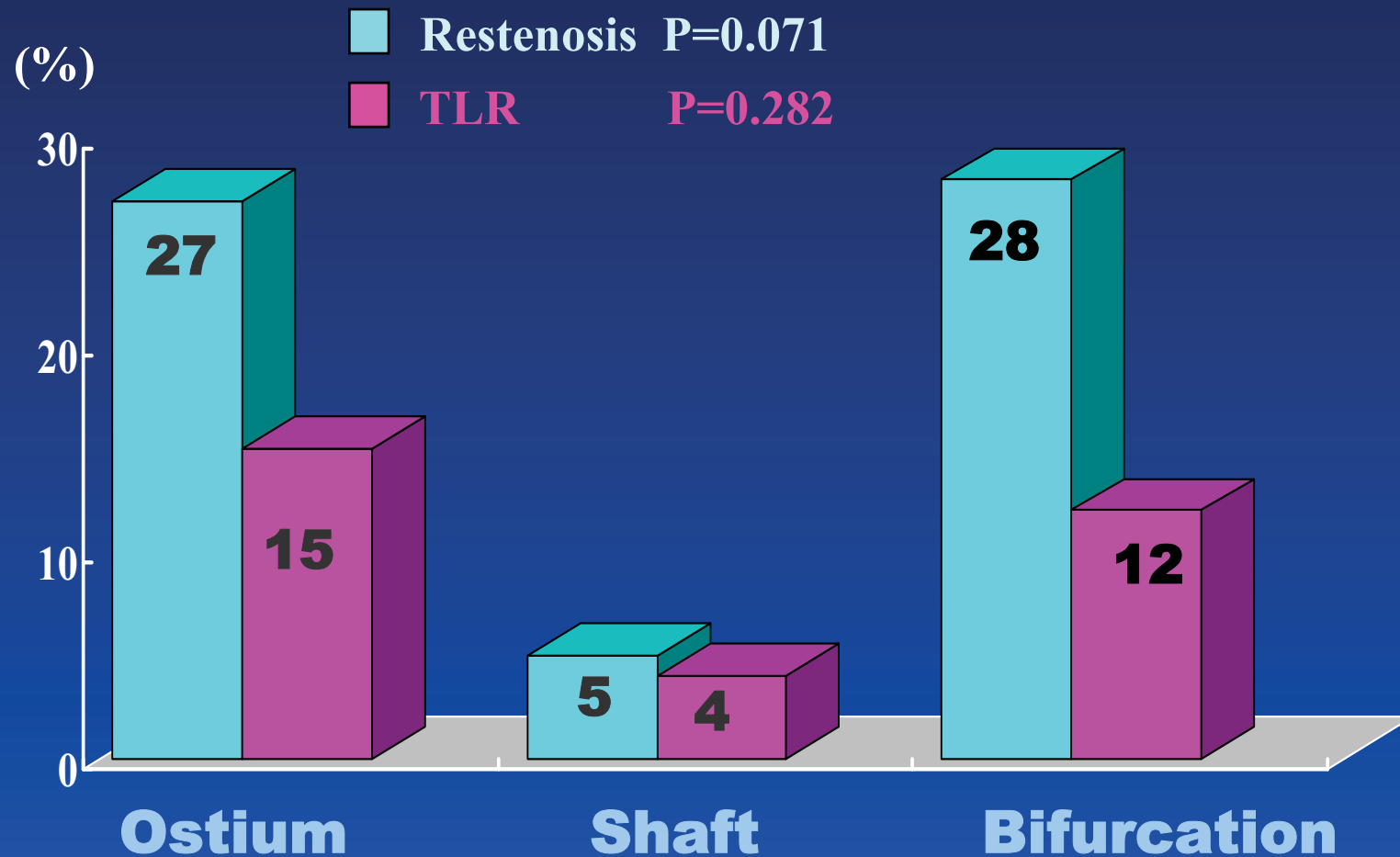
Angiographic follow-up rate:

178/220 eligible patients (86%)

42/178 (23.1%)

Unprotected Left Main Stenting

Restenosis Rate & TLR at overall



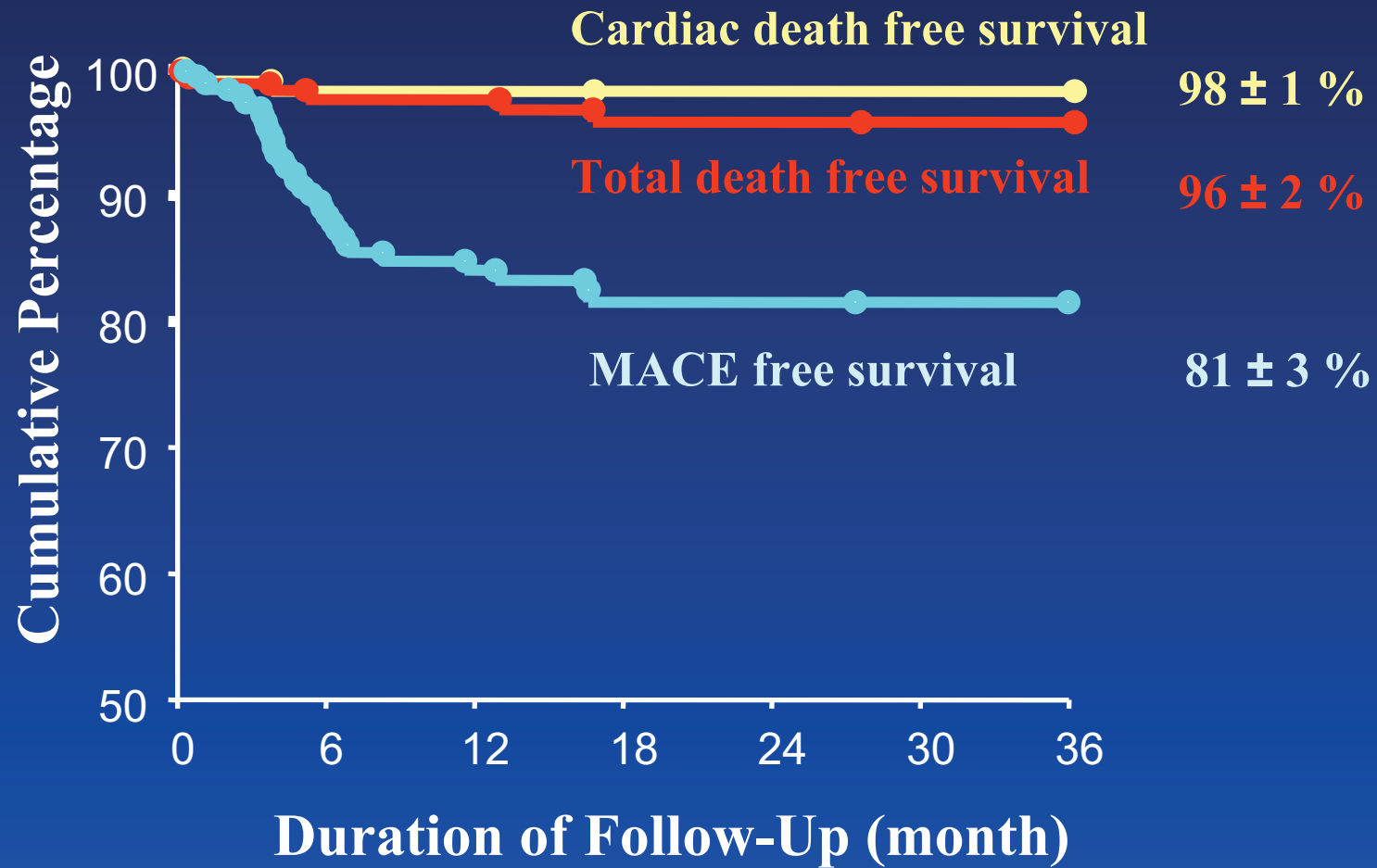
Unprotected Left Main Stenting

4 Year Clinical Follow-up

Mean Duration 42.7 ± 55.7 months

- Symptom Recurrence 22 (10%)
- Death 6 (2.7%)
 - 3 in cardiac, 3 in non-cardiac

Unprotected Left Main Stenting Survival Curve



Subjects

- 101 consecutive patients with unprotected LM PCI
- Clinical follow up at 6-months in 96 cases
- Pre and post QCA analysis, in 61 cases
- AMI was excluded

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Subjects

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Total No (n)	101
No of lesions vessels (n)	
0 (LMCA alone)	7 (7%)
1	19 (19%)
2	34 (33%)
3	41 (41%)
Lesion location (n)	
Ostium	19 (19%)
Body	8 (8%)
✓ Bifurcation	74 (73%)
Calcification (n)	53 (53%)
Diffuse (>20mm) (n)	19 (19%)

In-Hospital Outcome

Total No (n)	101
✓ Clinical success	99 (99%)
Cardiac death (n)	1 (1%)
Non-cardiac death (n)	1 (1%)
Q MI	0
Urgent CABG	1 (1%)

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6-Mo Clinical Outcome

✓ Total No (n)	61
✓ Cardiac death (n)	1 (1.6%)
Non-cardiac death (n)	2 (3.3%)
MI	0
CABG	1 (1.6%)
Re-PCI	20 (32.8%)
✓ TLR	10 (16.4%)

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Longterm Outcomes of Unprotected Left Main Stenting in Selected Patients with Normal LV Function

-Multicenter Registry Data-
Japan and Korea
(N=280)

2003 Am J Cardiol



Multicenter Registry Data

Procedural Success Rate: 98.2%

In-Hospital Clinical Courses

Acute closure	0
Subacute thrombosis	3 (1.1%)
Death	0
Q-MI	3 (1.1%)
Emergent CABG	3 (1.1%)

Multicenter Registry Data

**6 month Angiographic
Restenosis Rate**

Angiographic follow-up rate:

247 / 280 eligible patients (88.2%)

51 / 247 (20.6%)

Multicenter Registry Data

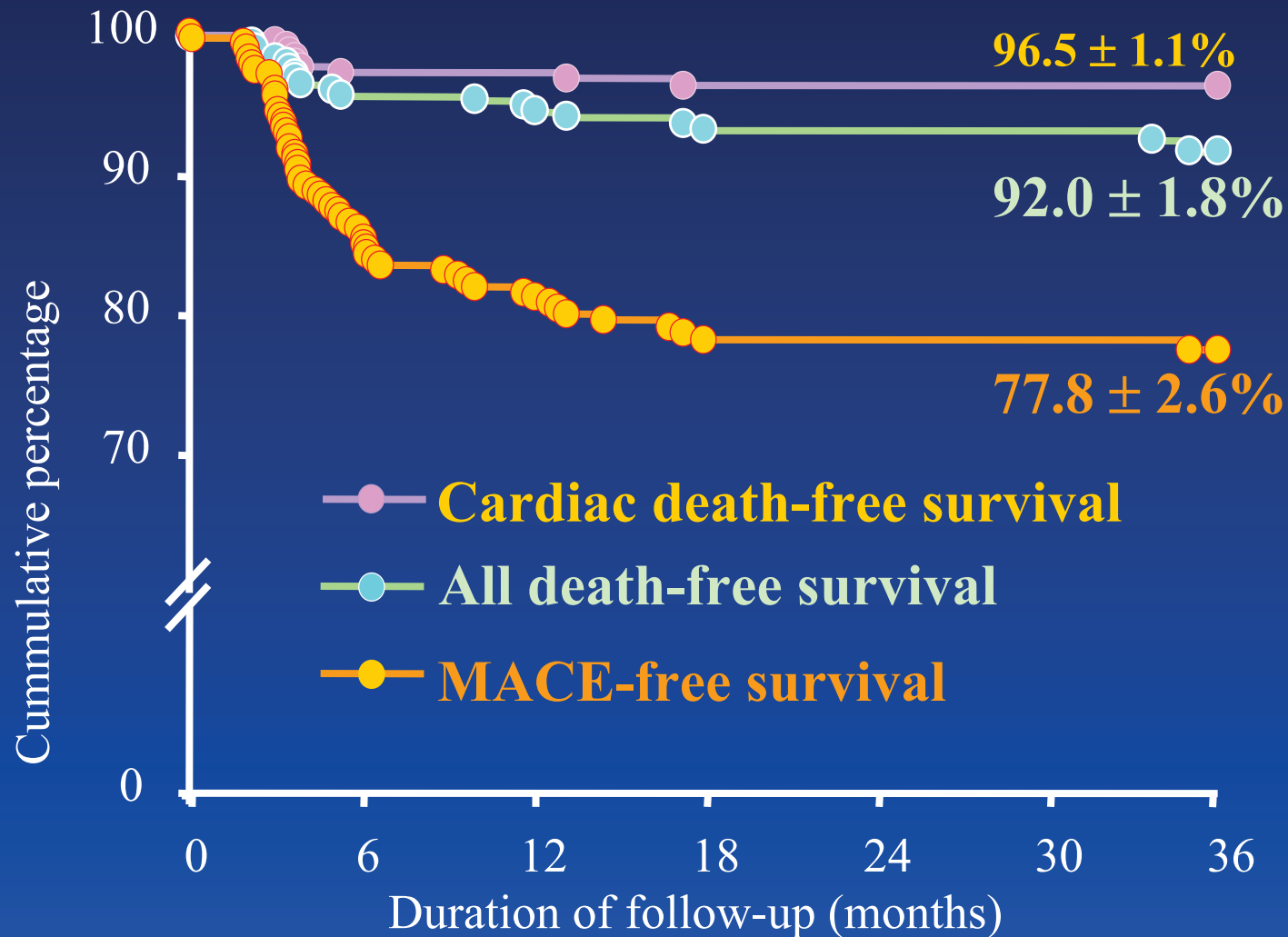
3 Year Clinical Follow-up

- Symptom Recurrence 32 (11.4%)
- Death 22 (7.9%)

9 cardiac, 12 non-cardiac

Multicenter Registry Data

Survival Curve



Multicenter Registry Data

Determinants of MACE-free Survival

Univariate	OR	95% CI	P
Age	1.03	1.01~1.05	0.008
Reference size	0.45	0.29~0.69	<0.001
Combined CAD	1.84	1.11~3.06	0.017
Post-MLD	0.48	0.33~0.69	<0.001
Multivariate			
Combined CAD	0.50	0.34~0.72	<0.001
Post-MLD	1.82	1.08~3.05	0.024

Immediate Outcomes ?

Unprotected left main stenting in selected patients with normal LV function.

- Technical success rate was 98-99 %
- No procedure related mortality
- SAT rate was 0.5 - 1.0 %

It is Safe !

Late Outcomes ?

Unprotected left main stenting in selected patients with normal LV function.

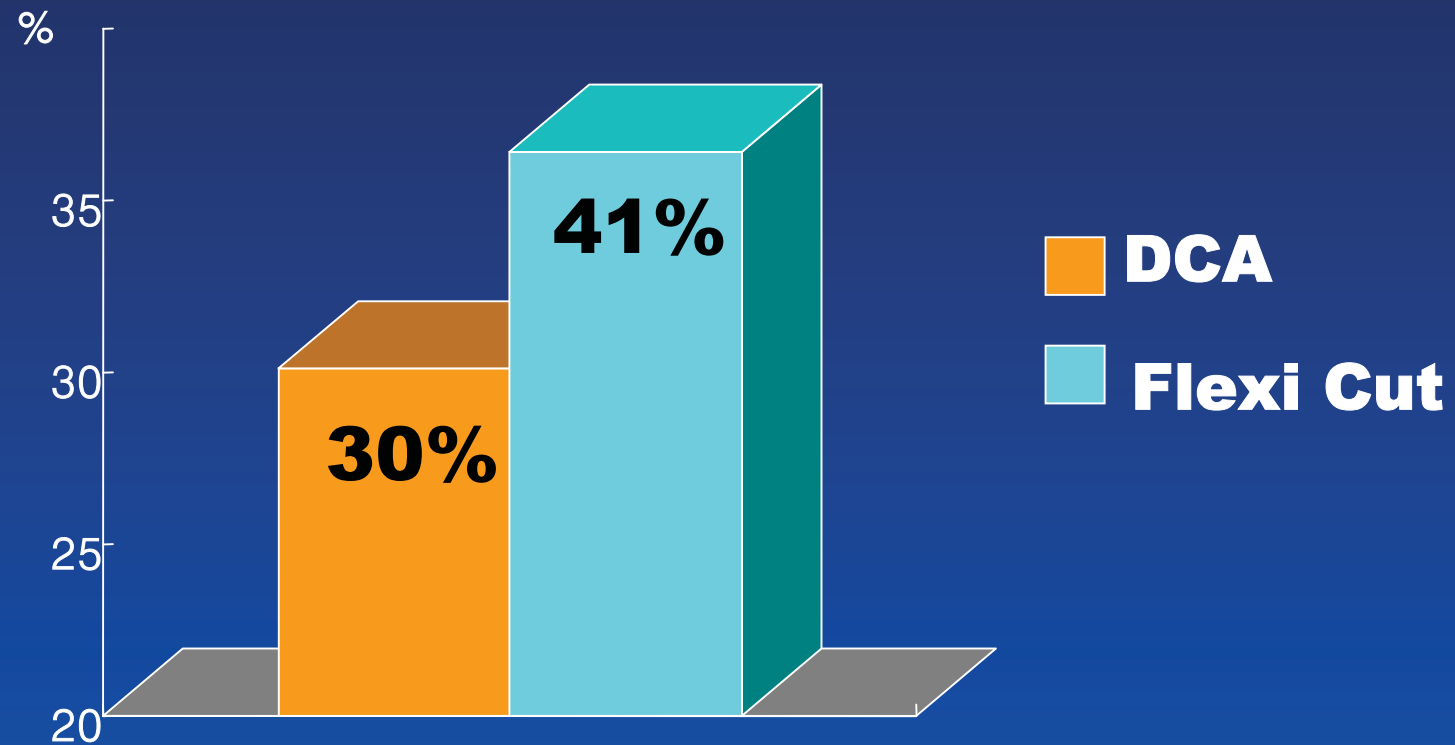
- Restenosis rate was 20-25%, TLR 12-16%
- All death free survival was 92-96%,
MACE free survival was 78-82%
during 4 year clinical follow-up period

Good Long-term Outcome !

Unprotected Left Main Stenting

- Primary stenting in the setting of AMI
- Bail-out unprotected left main stenting
- Elective unprotected left main stenting
 - ✓ Immediate and Late outcomes ?
 - ✓ Role of Debulking ?

Unprotected Left Main Stenting Reduction of Plaque Burden



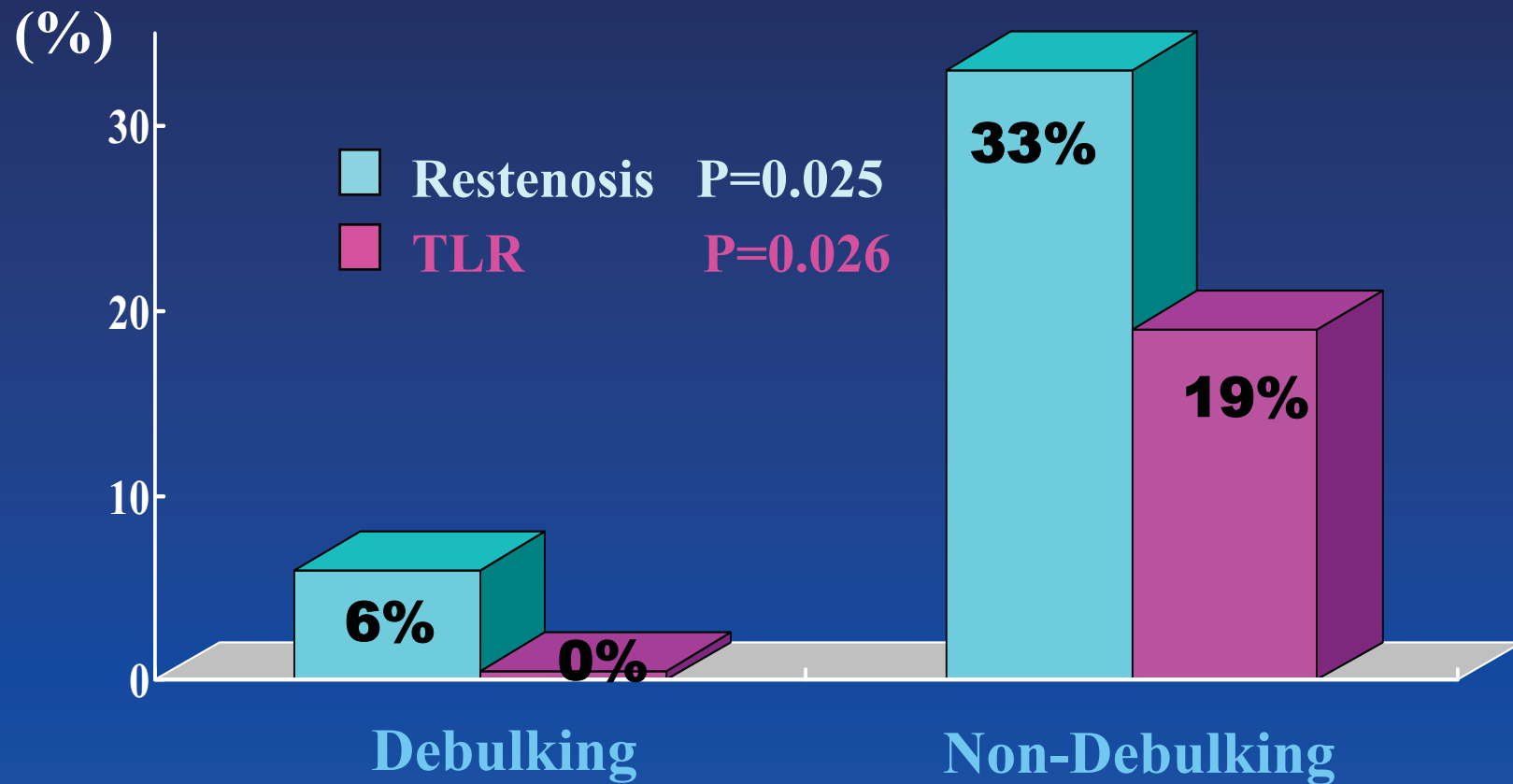
Angiographic Findings and Clinical Results

Debulking

	DCA + stent	Stent alone	P
Reference vessel DM (mm)	4.12 ± 0.62	3.92 ± 0.67	0.029
MLD (mm)			
Pre-intervention	1.16 ± 0.45	1.23 ± 0.565	0.338
Post-intervention	4.23 ± 0.57	4.05 ± 0.57	0.022
Follow-up	2.95 ± 0.91	2.65 ± 1.13	0.076
Pressure (atm)	14.8 ± 2.94	14.8 ± 2.74	0.343
Angiographic follow-up (%)	89	81	0.781
<i>Restenosis rate (%)</i>	16.4	29.4	0.071

Unprotected Left Main Stenting Restenosis Rate & TLR

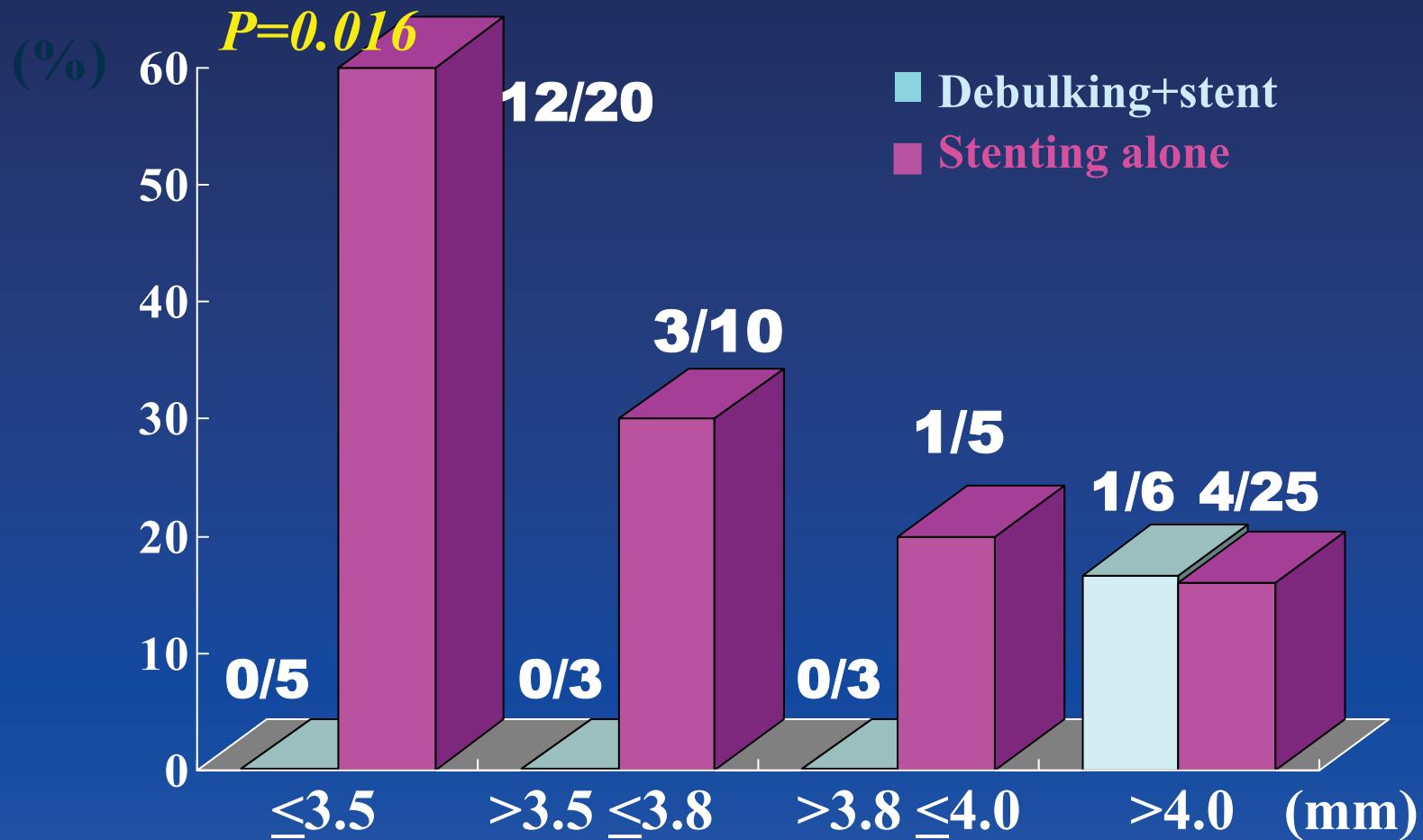
at Ostial lesion



Restenosis Rate

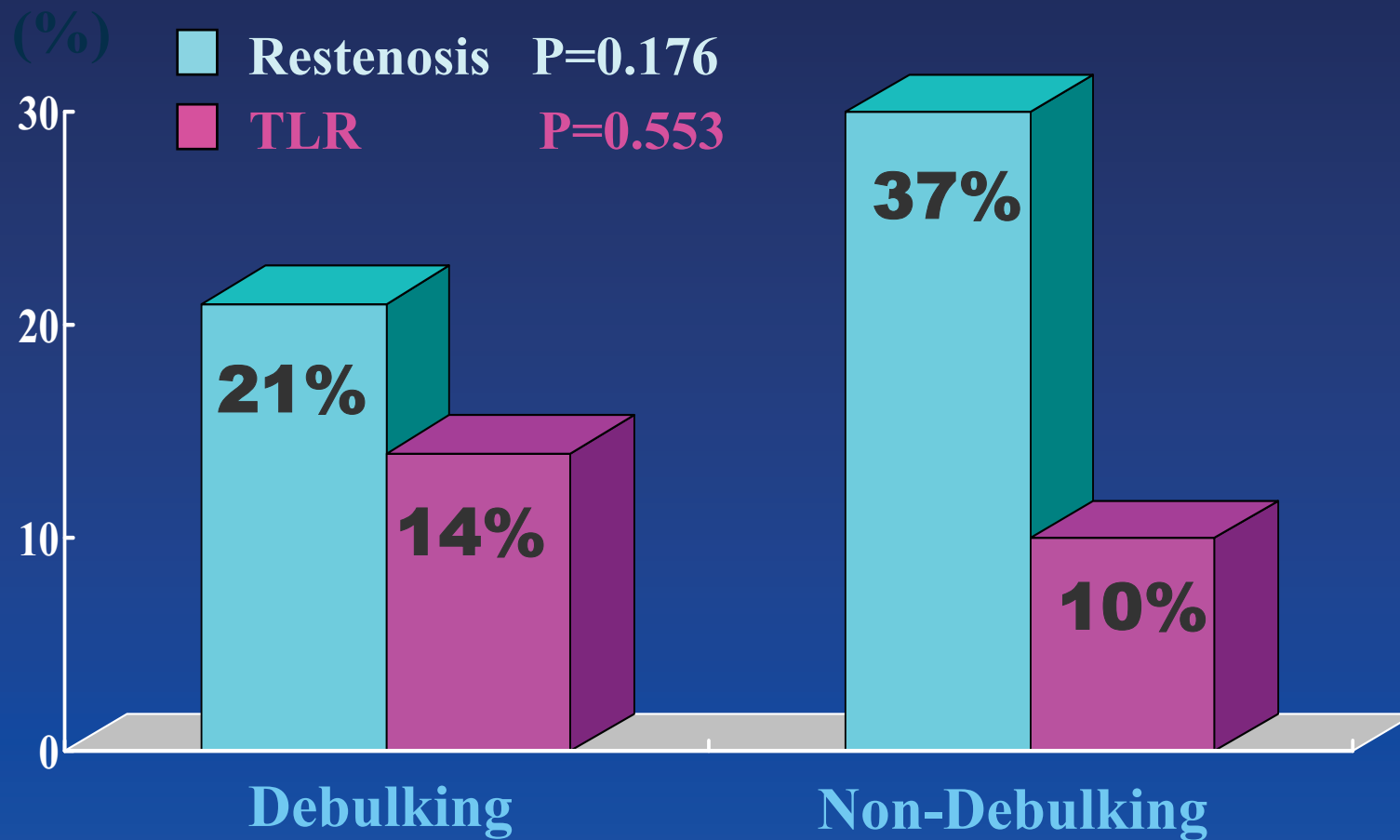
Ostial lesion

according to reference vessel size



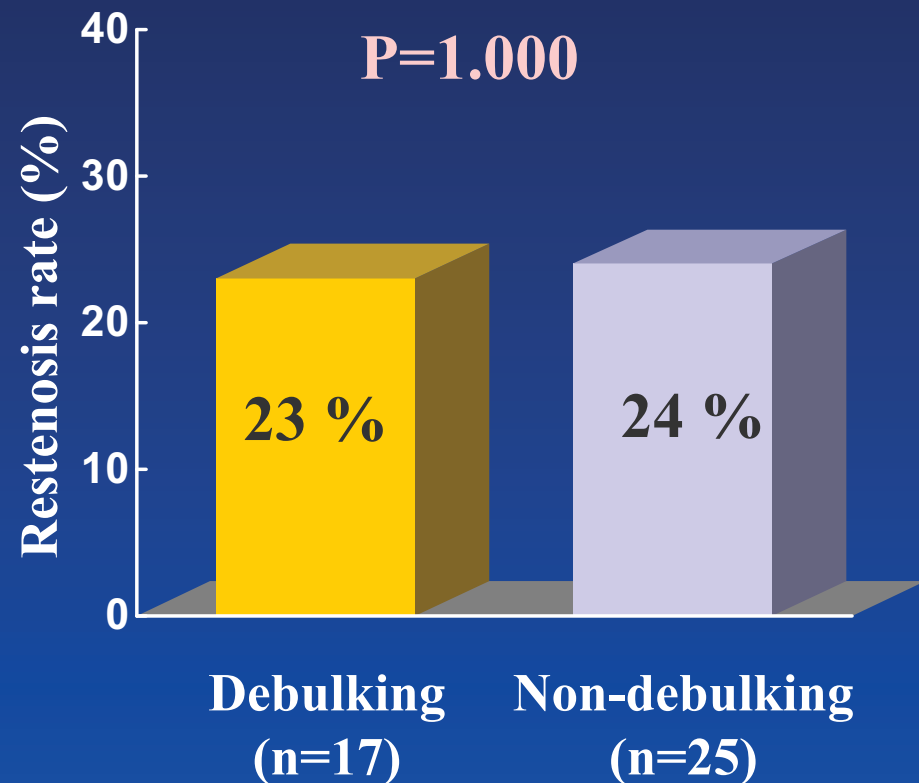
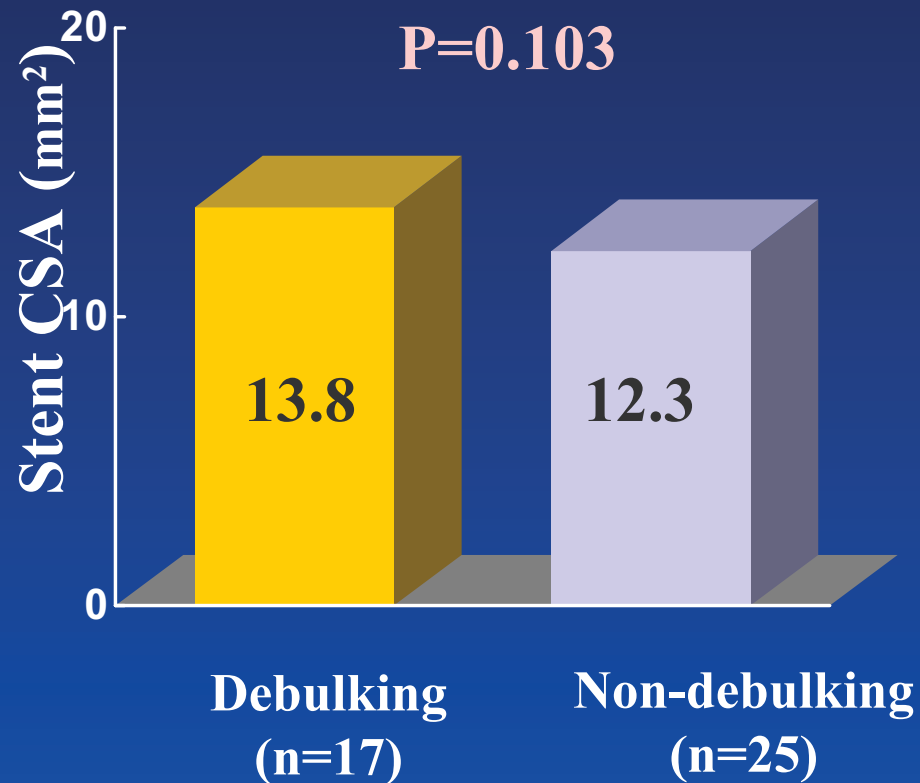
Effect of Debulking ...

at Left Main Bifurcation



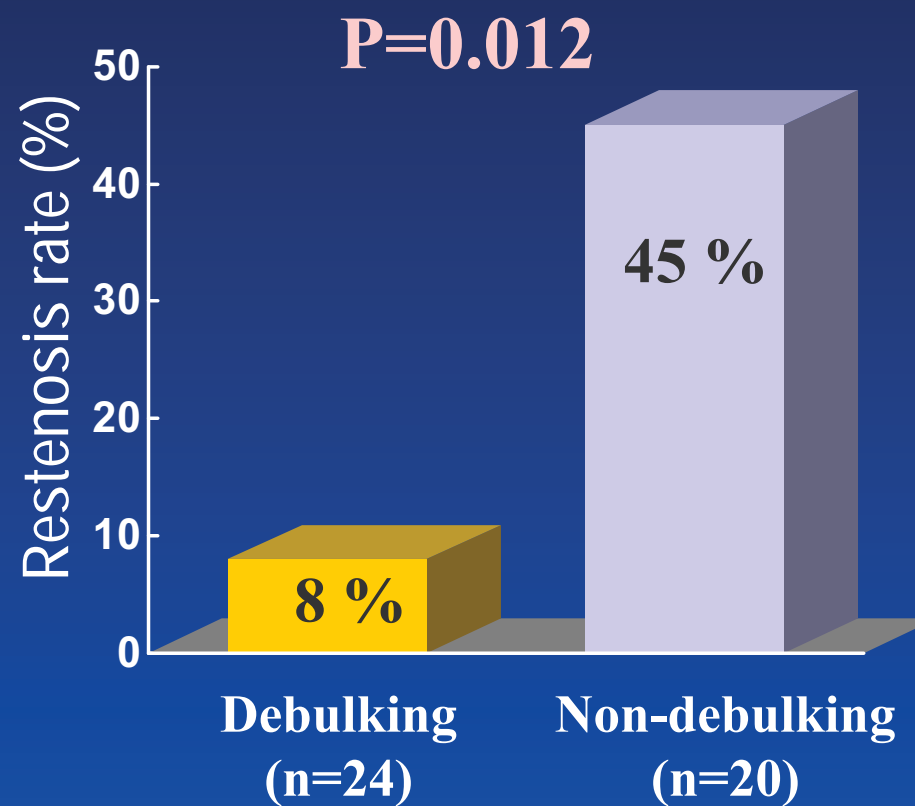
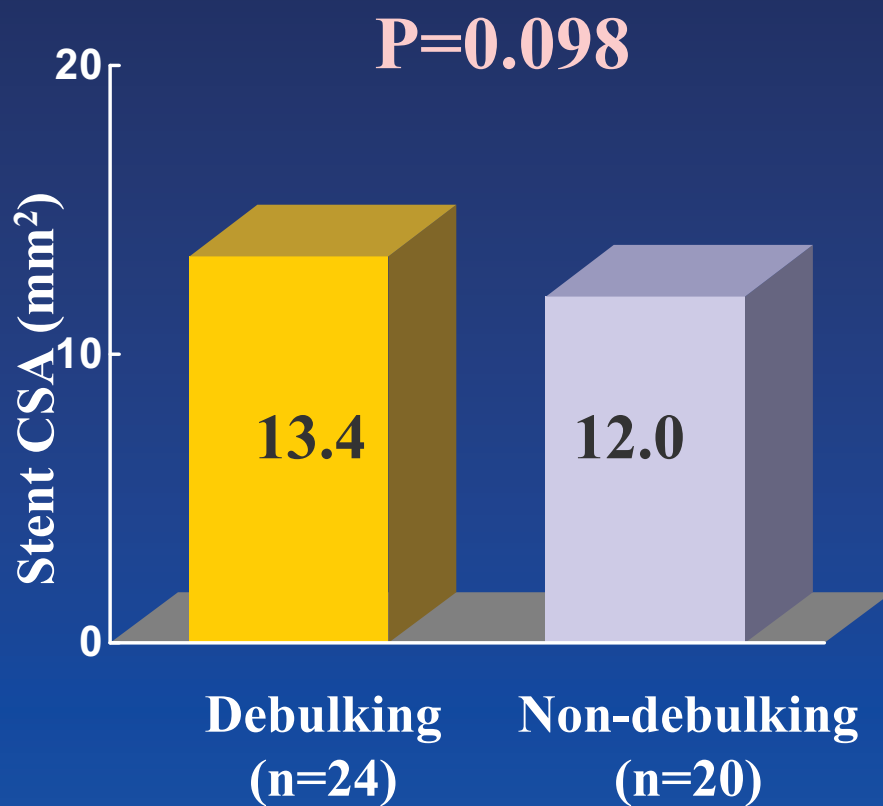
Effect of Debulking

In Negative Vascular Remodeling



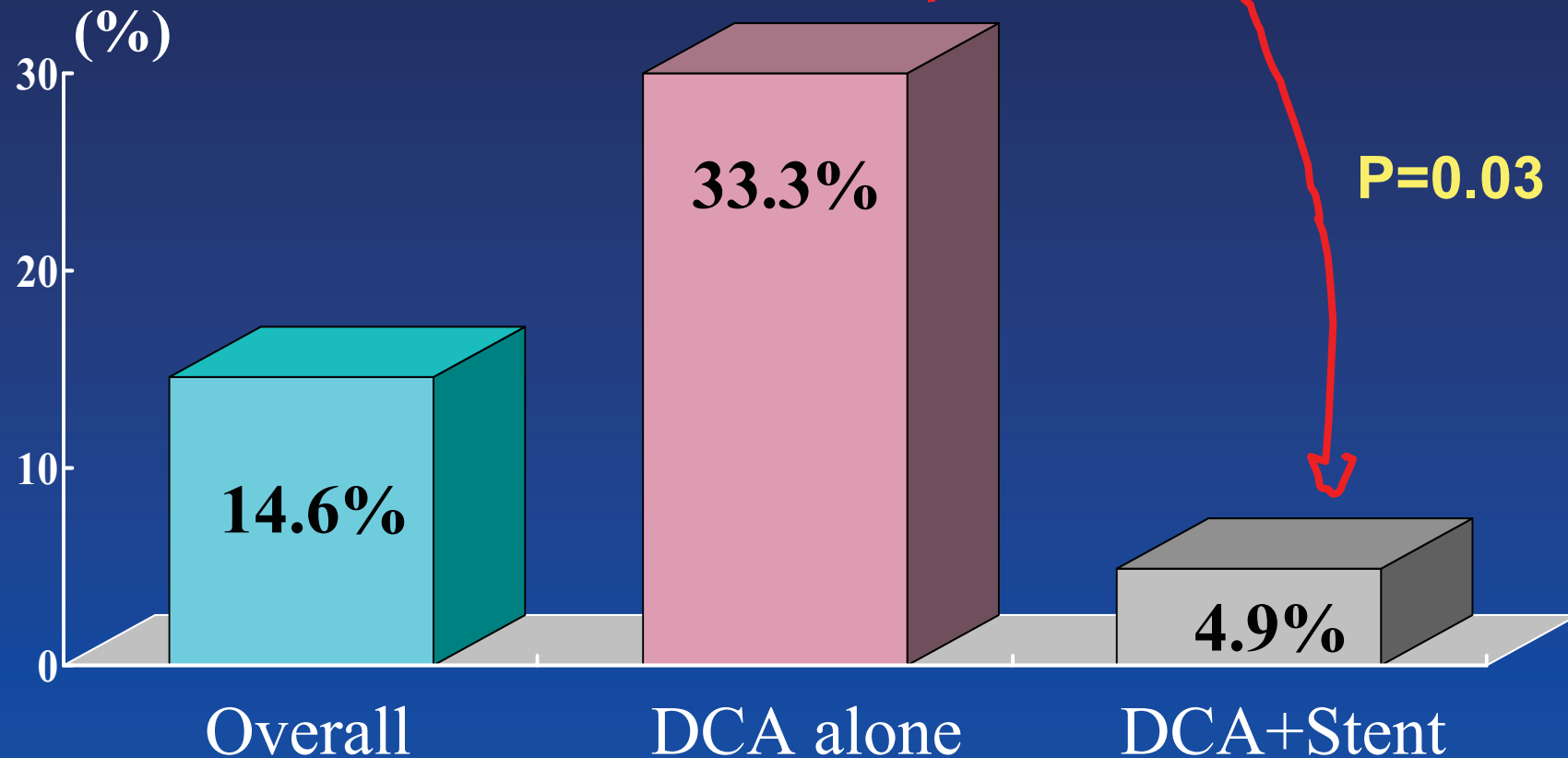
Effect of Debulking

In Non-negative Vascular Remodeling



DCA alone vs. DCA+ Stent

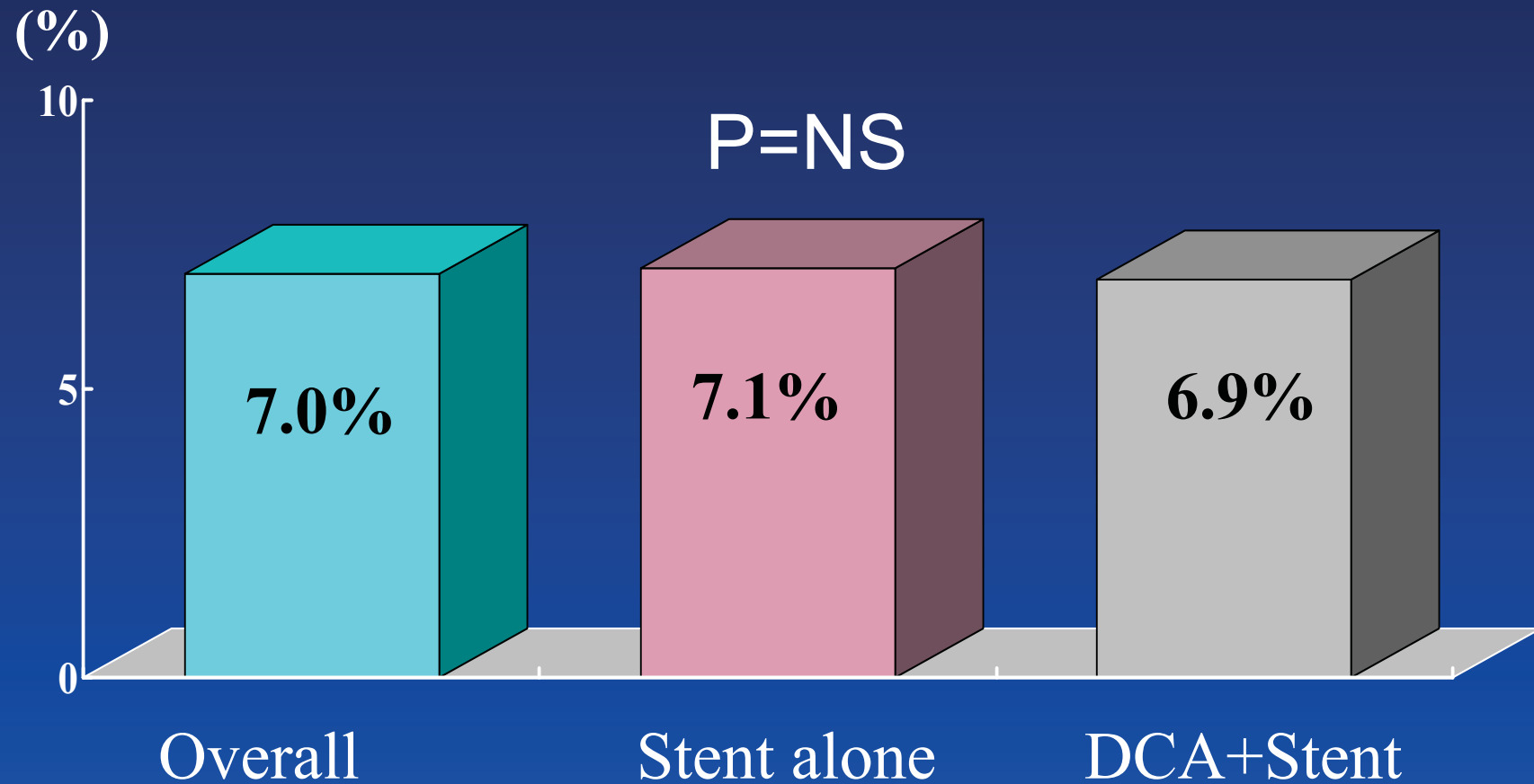
TLR



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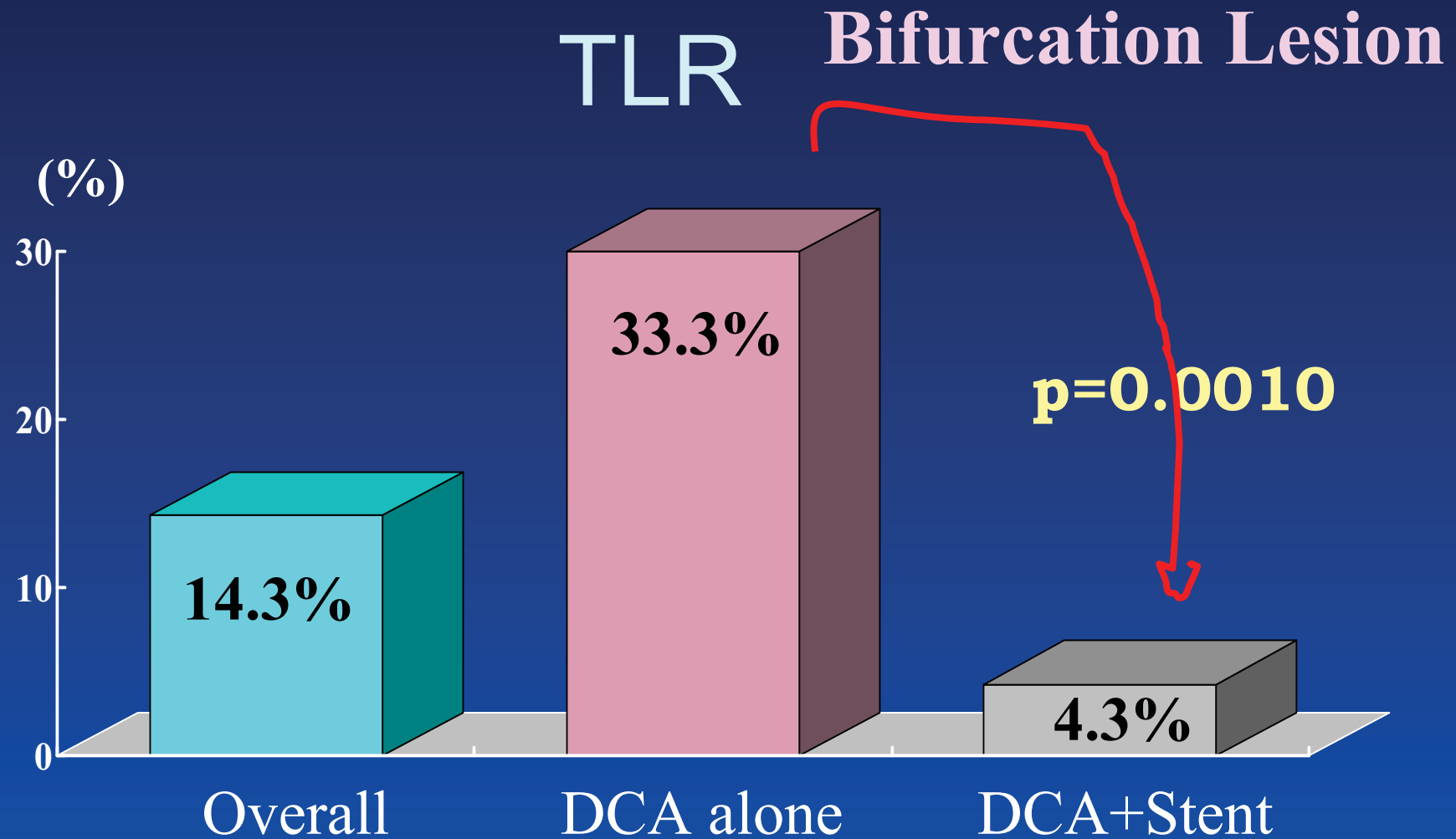
Stent vs. DCA+ Stent

TLR



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DCA alone vs. DCA+ Stent

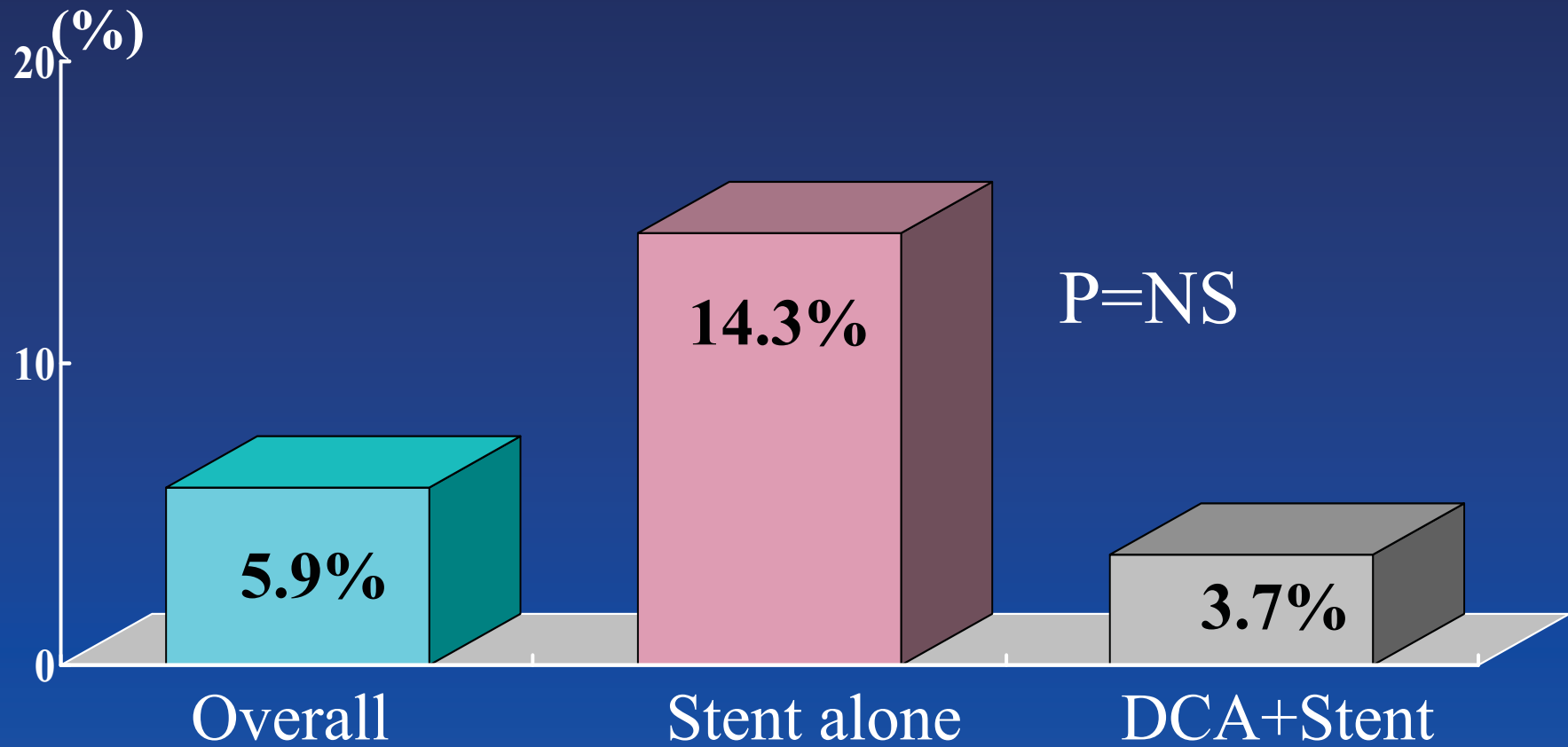


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Stent vs. DCA+ Stent

TLR

Bifurcation Lesion



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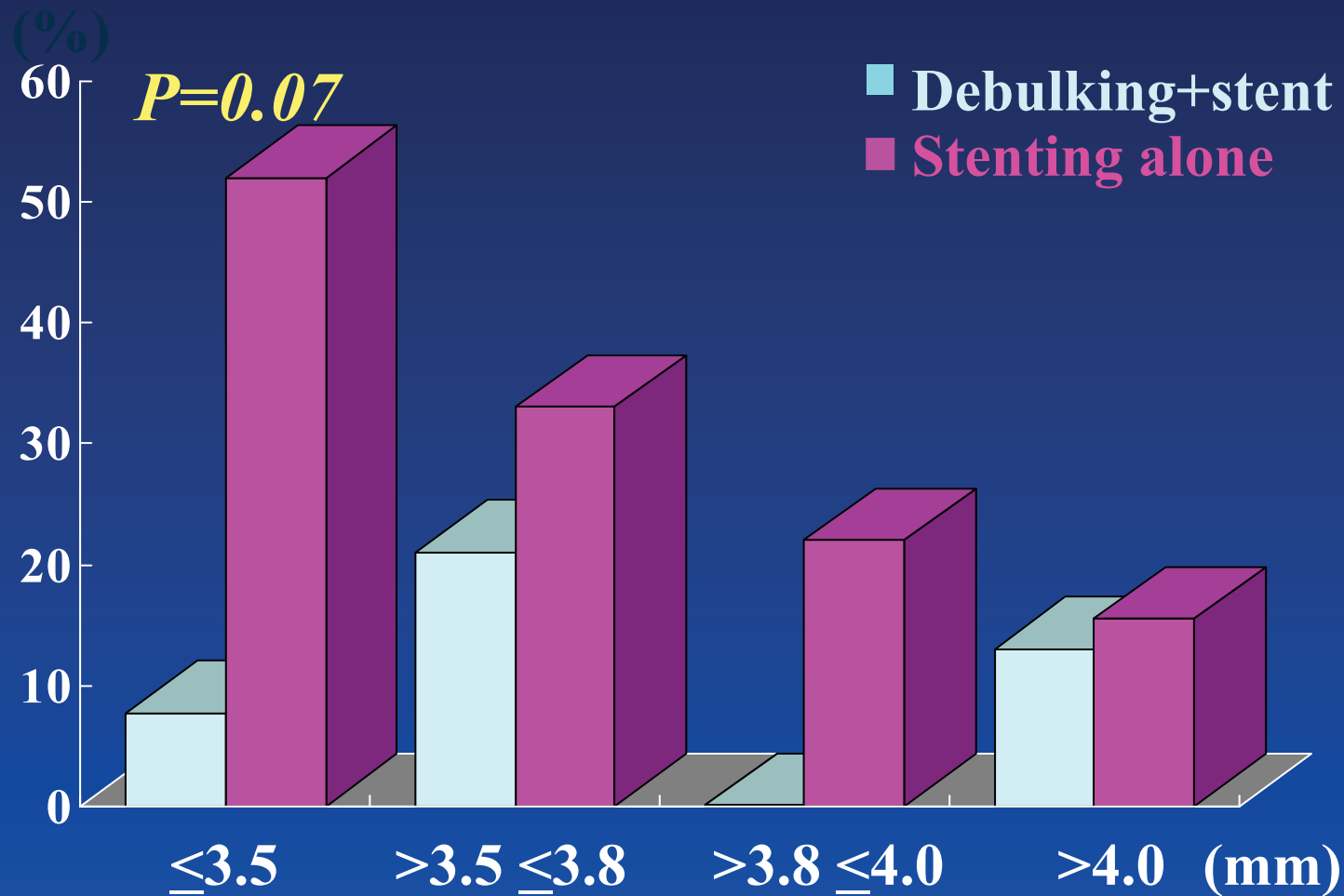
Unprotected Left Main Stenting

- Elective unprotected left main stenting
 - Immediate and late clinical outcomes
 - Role of Debulking ?

Restenosis Rate

Overall

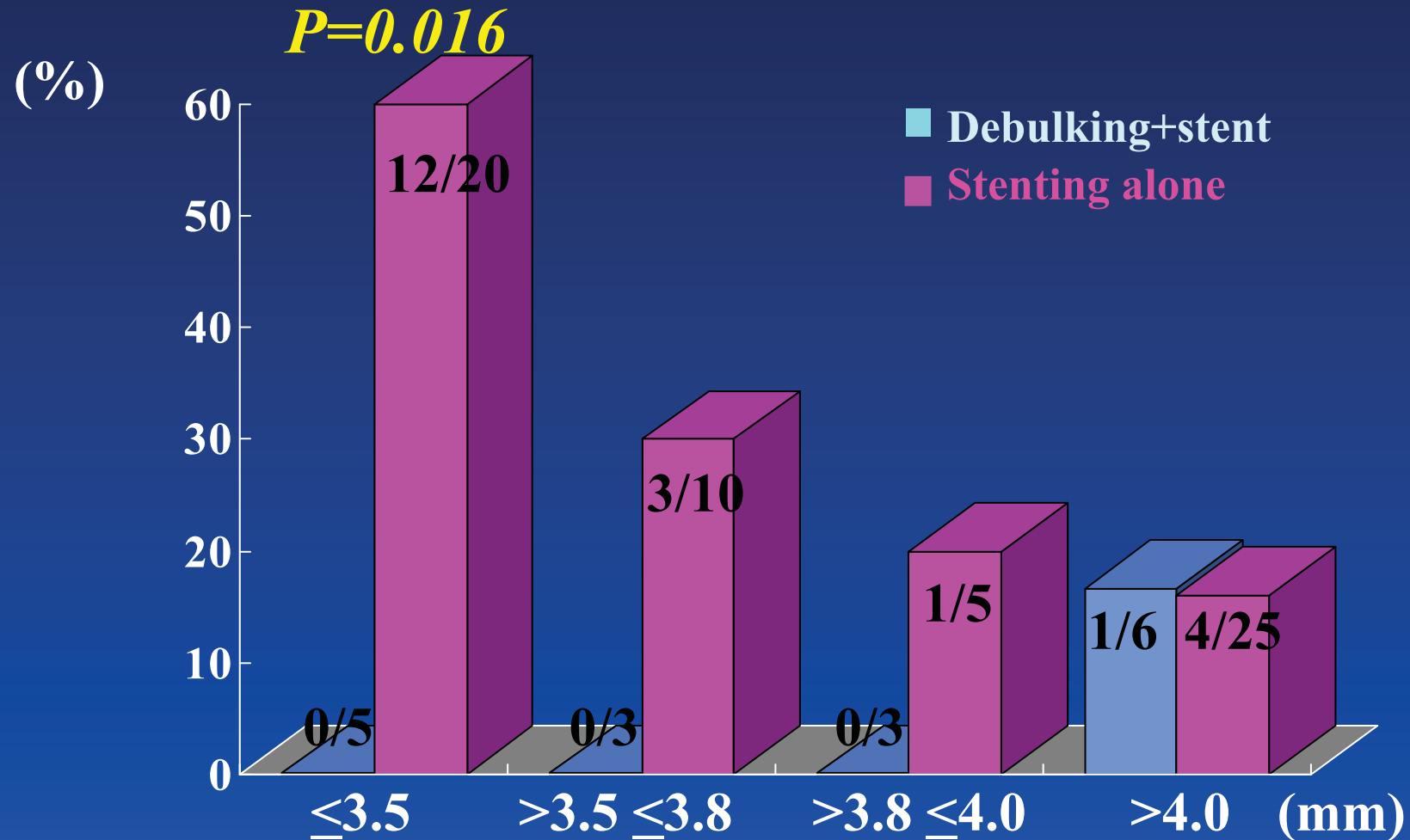
according to reference vessel size



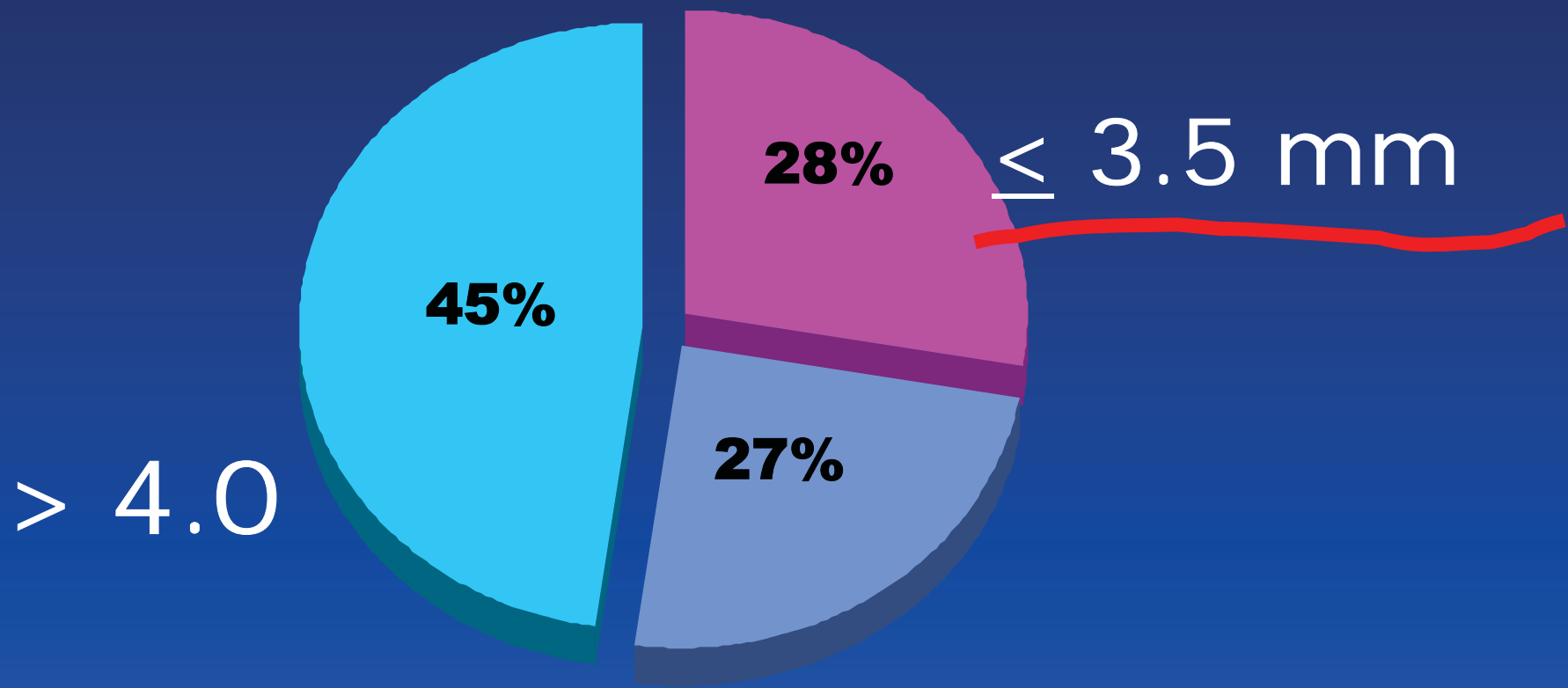
Restenosis Rate

Ostial lesion

according to reference vessel size



DCA seems to be beneficial in small reference vessel with non-negative remodeling lesions



Unprotected Left Main Stenting

- Elective unprotected left main stenting
 - ✓ Immediate and late clinical outcomes
 - ✓ Role of Debulking ?

How much plaque burden
should be removed ?

Unprotected Left Main Stenting

Only Predictor of Restenosis

-Multivariate Analysis-

- Reference vessel size

Ref. MLD by QCA and IVUS

OR=0.39, 95% CI (1.17-0.87) P=0.021

Ref. CSA by IVUS

OR=0.65, 95% CI (0.44-0.97) P=0.033

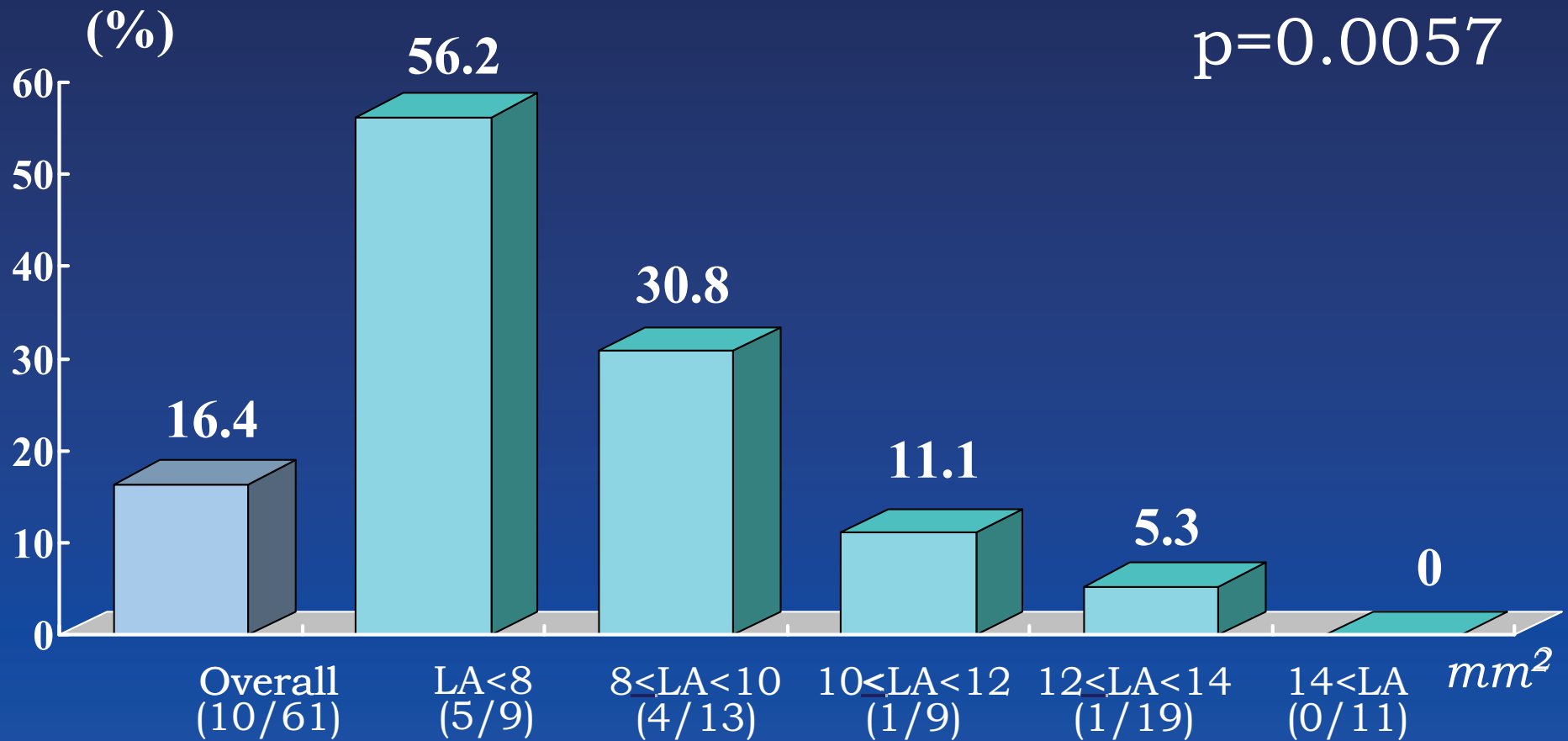
Conclusion

- In PCI for ULM bifurcation lesion, larger lumen size can be expected to bring better chronic outcome.
- In order to achieve that, combination of DCA and stenting is an effective strategy

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Post - LA vs. TLR

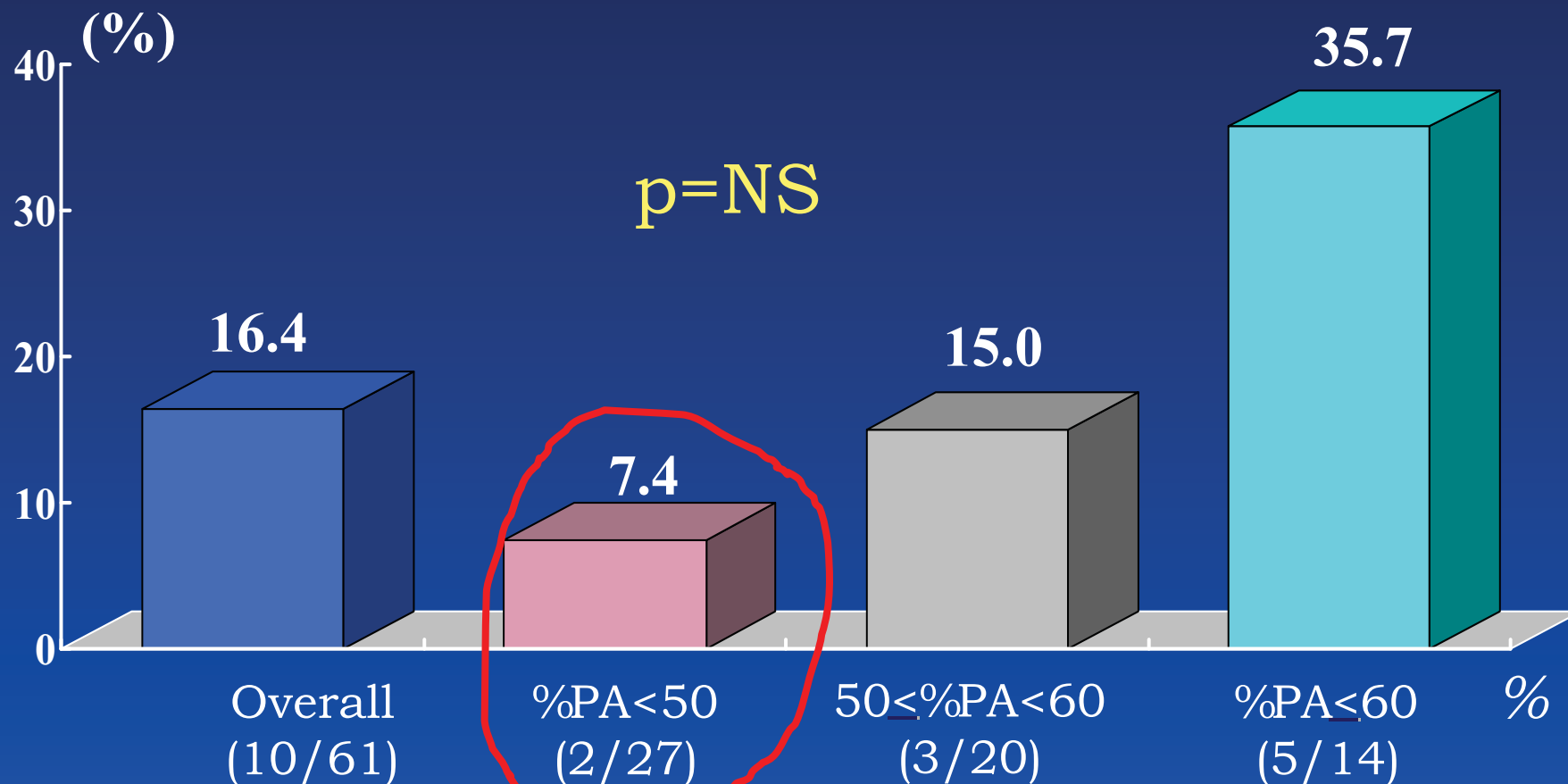
TLR



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Post - % PA vs. TLR

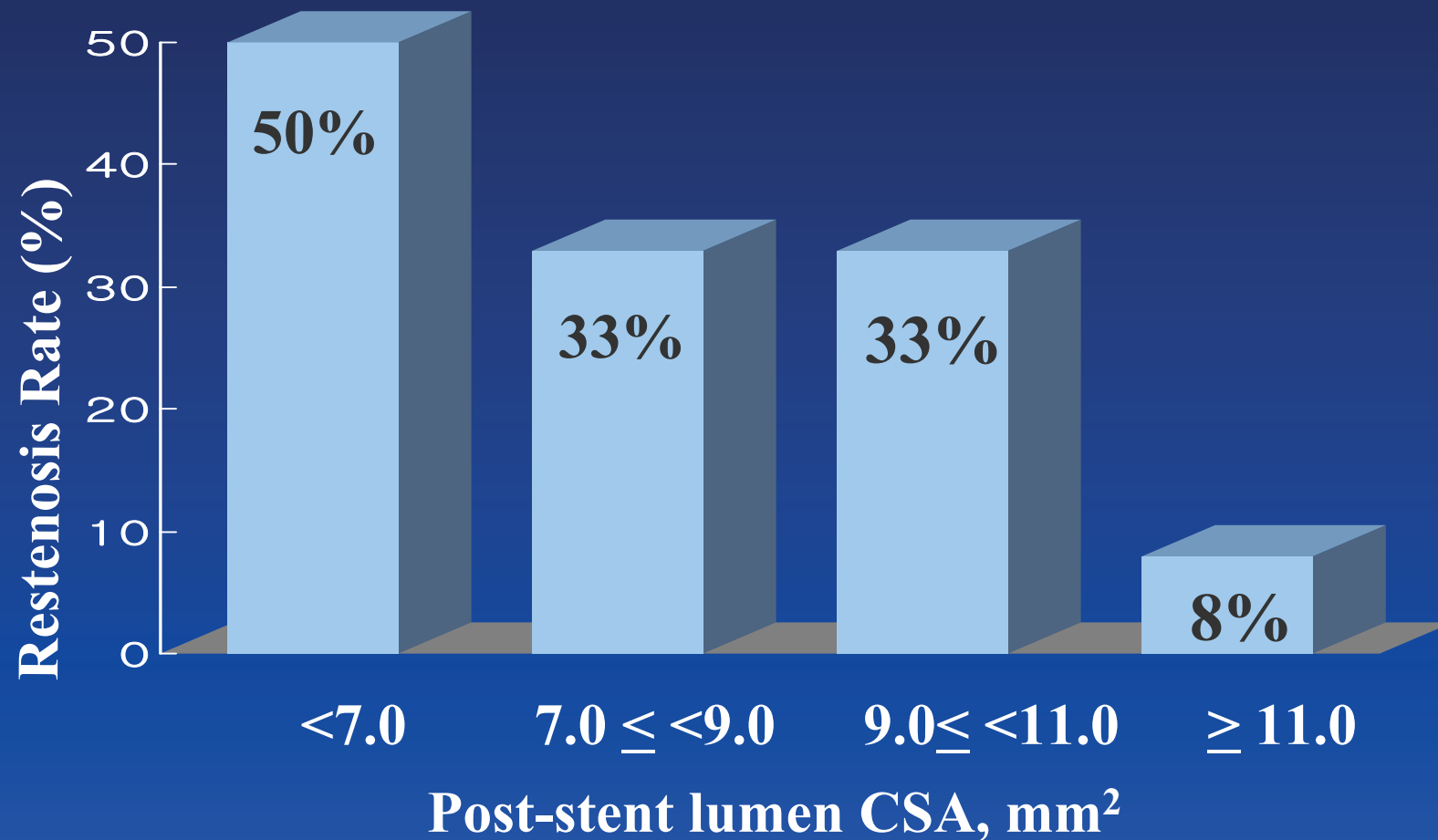
TLR



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Restenosis Rate

According to Stent Lumen CSA



How much plaque burden should be removed ?

- Residual Plaque burden < 50%
- Post-stent CSA >11 mm²

Unprotected Left Main Stenting

- Primary stenting in the setting of AMI
- Bail-out unprotected left main stenting
- Elective unprotected left main stenting
 - ✓ Immediate and Late outcomes ?
 - ✓ Role of Debulking ?
 - ✓ Role of IVUS ?

Angiographic Findings and Clinical Results

IVUS-guided

	IVUS-guided	Angio-guided	P
Number of lesions	133	83	
Lesion site			
Os	72 (54)	35 (42)	
Body	24 (18)	4 (5)	
Bifurcation	37 (28)	44 (53)	
Debulking before stenting	54 (41)	17 (21)	0.002
Reference vessel DM (mm)	4.1 ± 0.7	3.8 ± 0.6	0.005
MLD (mm)			
Pre-intervention	1.3 ± 0.5	1.1 ± 0.5	0.011
Post-intervention	4.2 ± 0.6	4.0 ± 0.6	0.002
Follow-up	2.8 ± 1.1	2.6 ± 1.1	0.160
Restenosis Rate (%)	24/105 (23)	12/52 (23)	0.980

IVUS findings

of Left Main Disease

- Soft plaque 63 %
- Fibrous Calcific 18 %
(Mean calcification : 147°)
- Eccentricity index 6.5 ± 6.2
- Negative Remodeling in Ostial Lesions
47/72 (65%)
(Mean NRI : 0.91 ± 0.25)

Unprotected Left Main Stenting IVUS-guiding is Necessary

- **Clinical outcomes may be not different**
- **Assess unusual lesion morphology (severe negative remodeling, calcium, thrombi, etc)**
- **We can change treatment strategy**
- **Optimized final results**

Unprotected Left Main Stenting

- Primary stenting in the setting of AMI
- Bail-out unprotected left main stenting
- Elective unprotected left main stenting
 - ✓ Immediate and Late outcomes ?
 - ✓ Role of Debulking ?
 - ✓ Role of IVUS ?
 - ✓ Bifurcation left main intervention ?

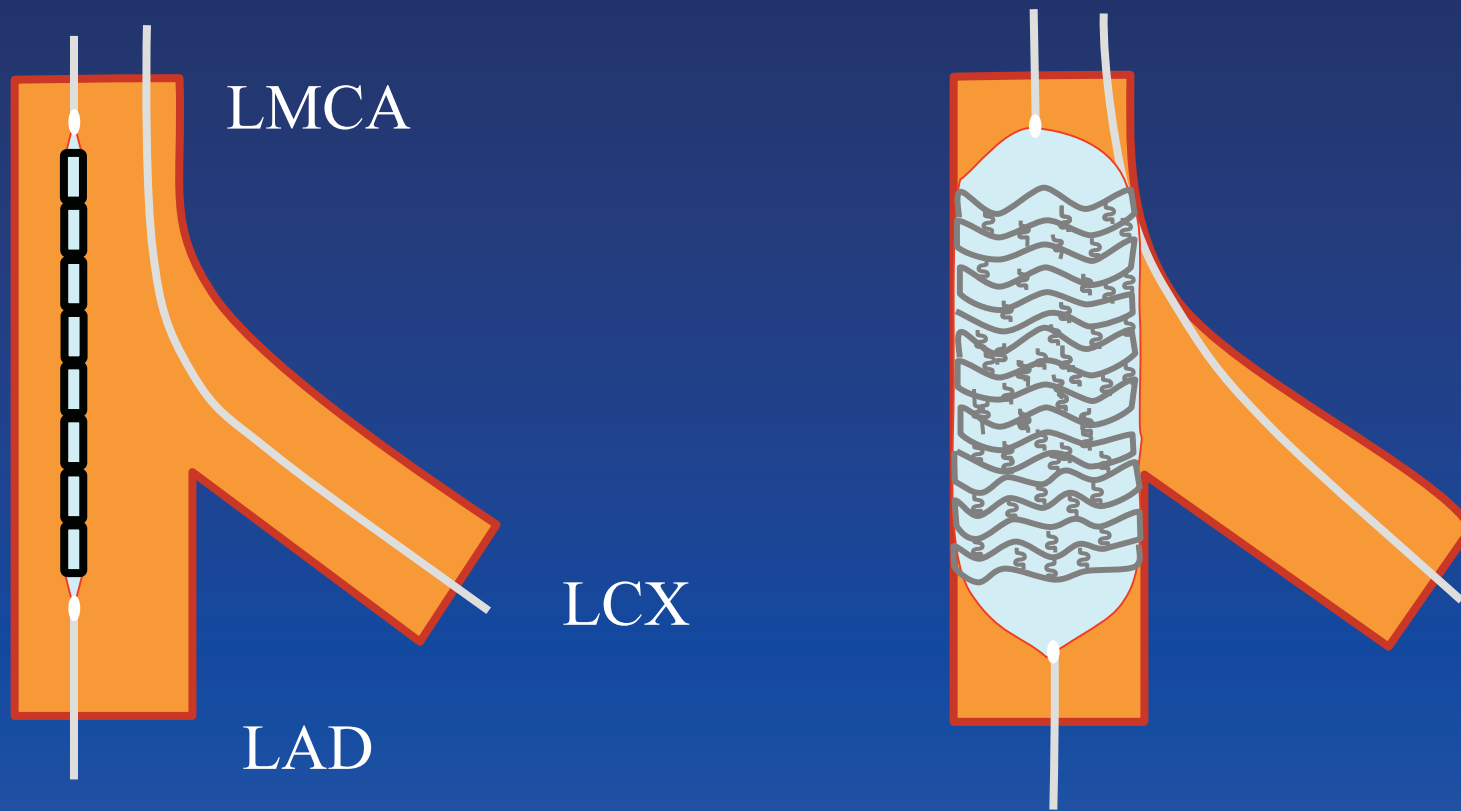
PCI Strategy

for LM Bifurcation lesion

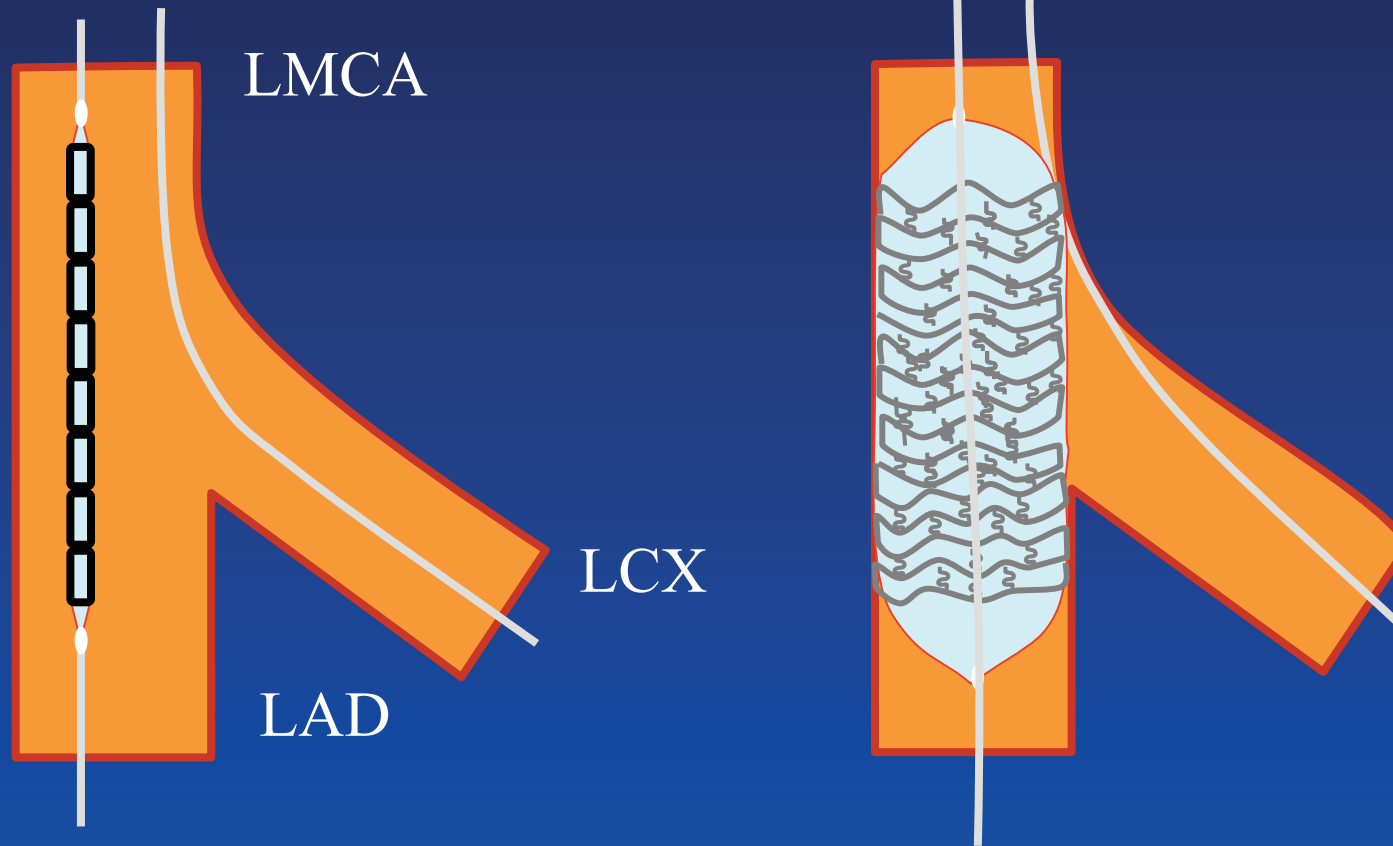
1. Stenting cross over LCX with optional kissing balloon inflation
2. T-stent technique
3. Kissing stent technique
4. Bifurcation stent (SLK-View stent)

Stenting Cross Over

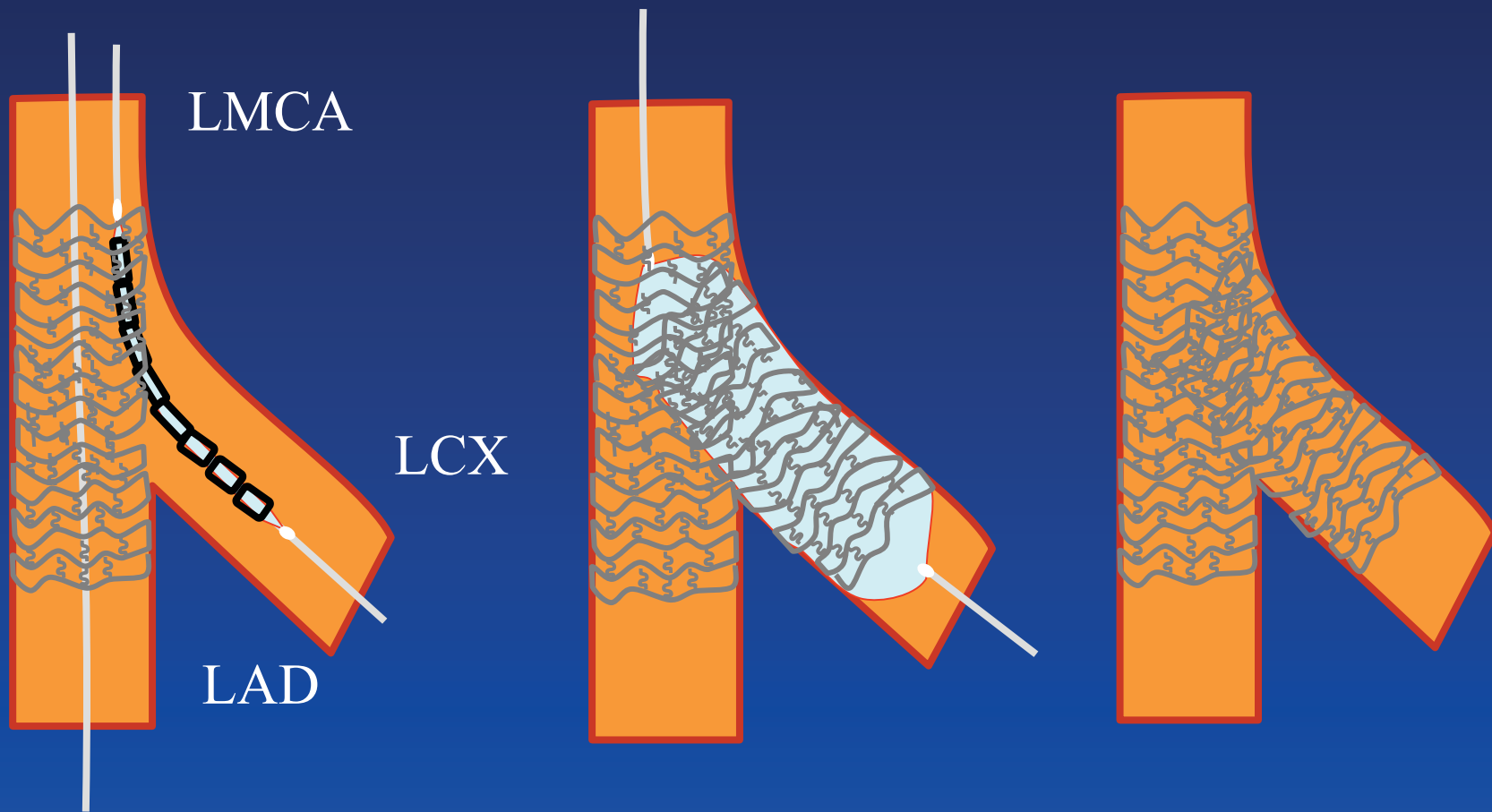
Tube stenting cross over LCX with optional kissing balloon dilatation



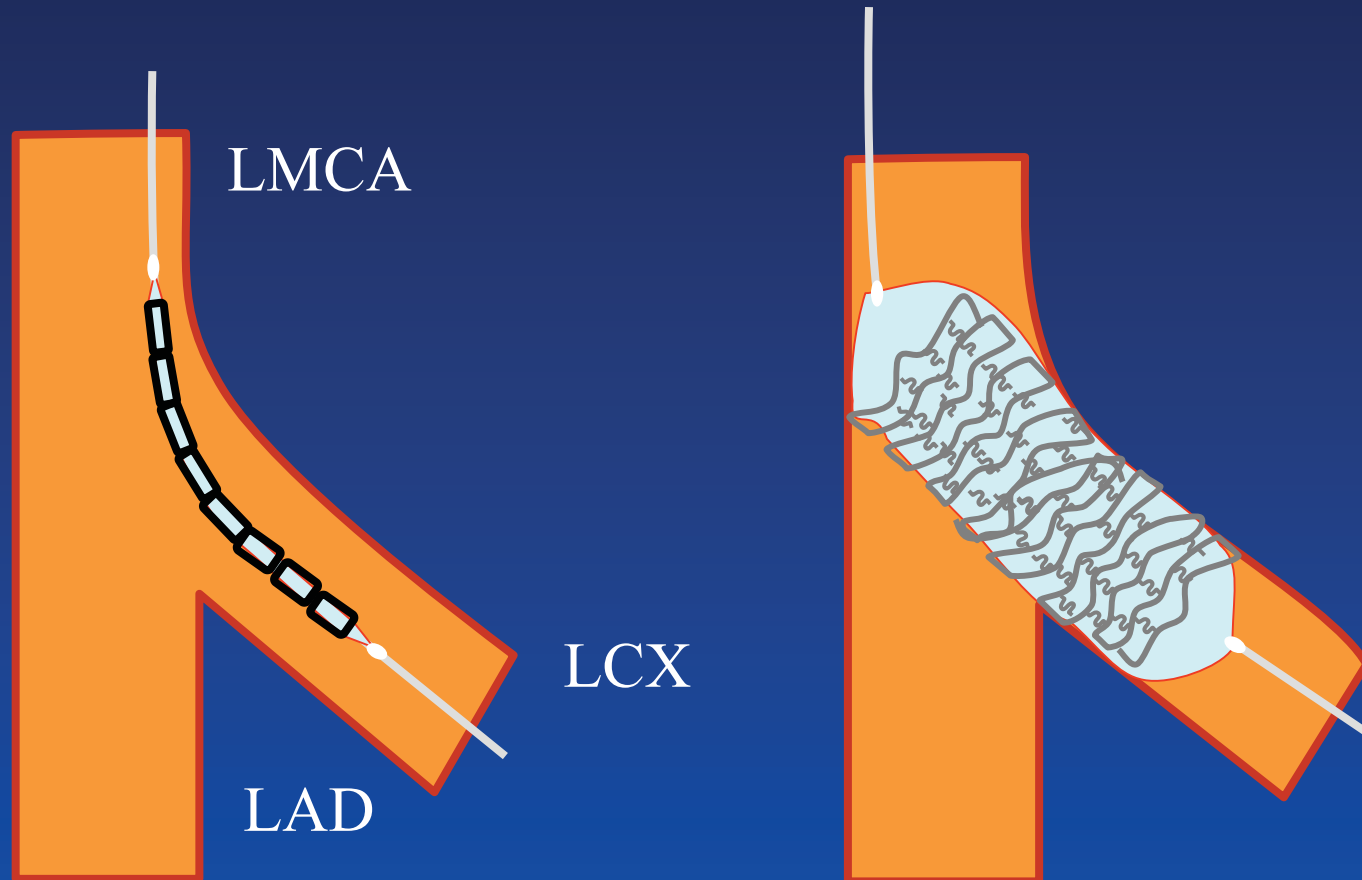
T Stenting



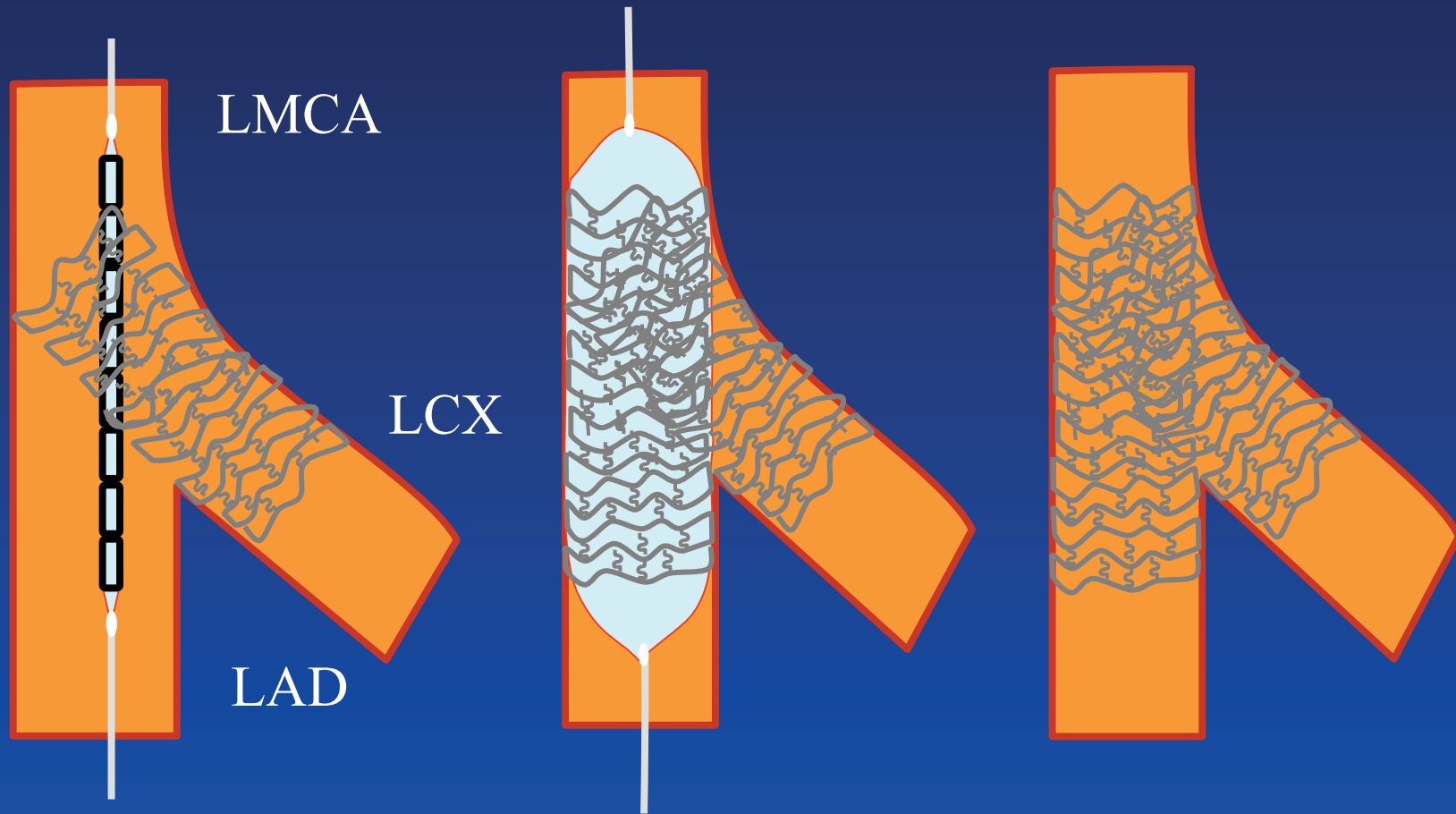
T Stenting



Y (Culotte) Stenting

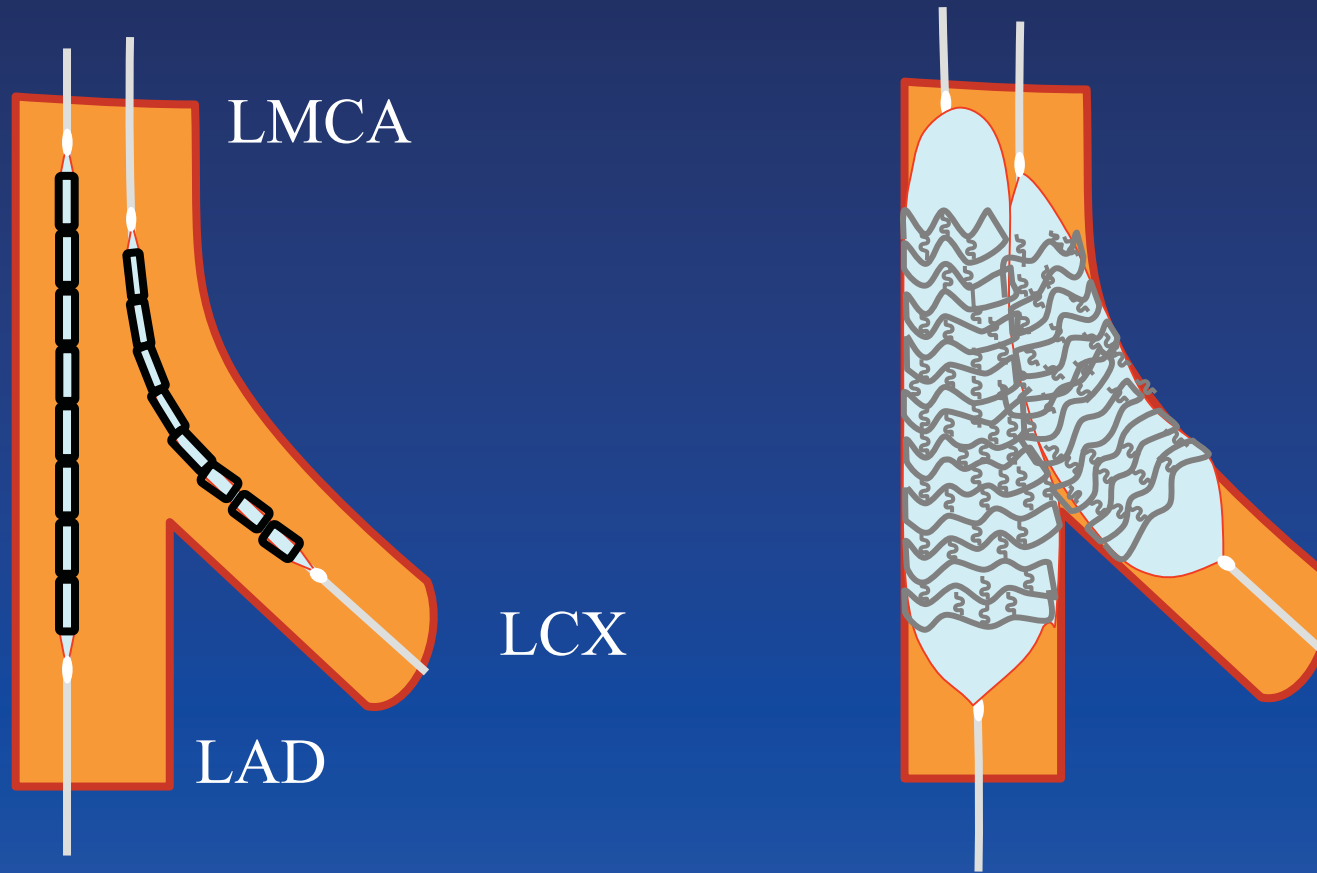


Y (Culotte) Stenting



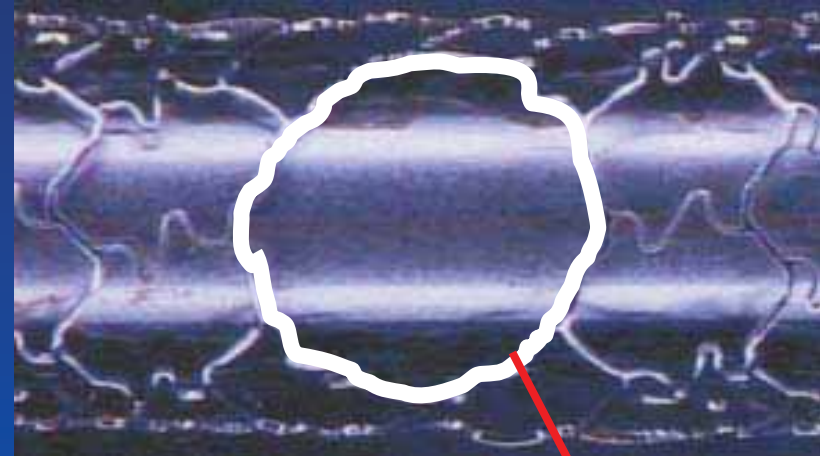
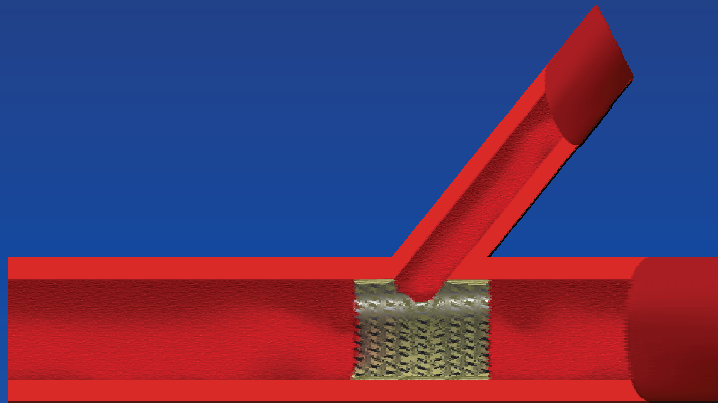
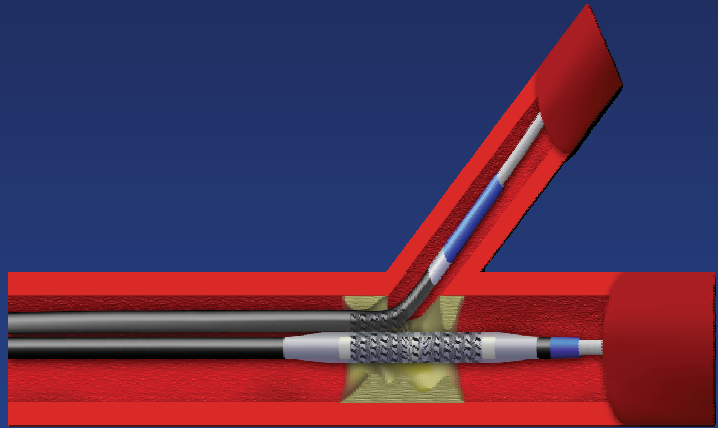
Kissing Stenting

Kissing stents with optional stent on the Main



Bifurcation Stent

SLK-View Stent



Side hole

Unprotected Bifurcation Left Main Stenting Subject

82 patients

(M / F=70/12, Age 59 yrs)

Strategies

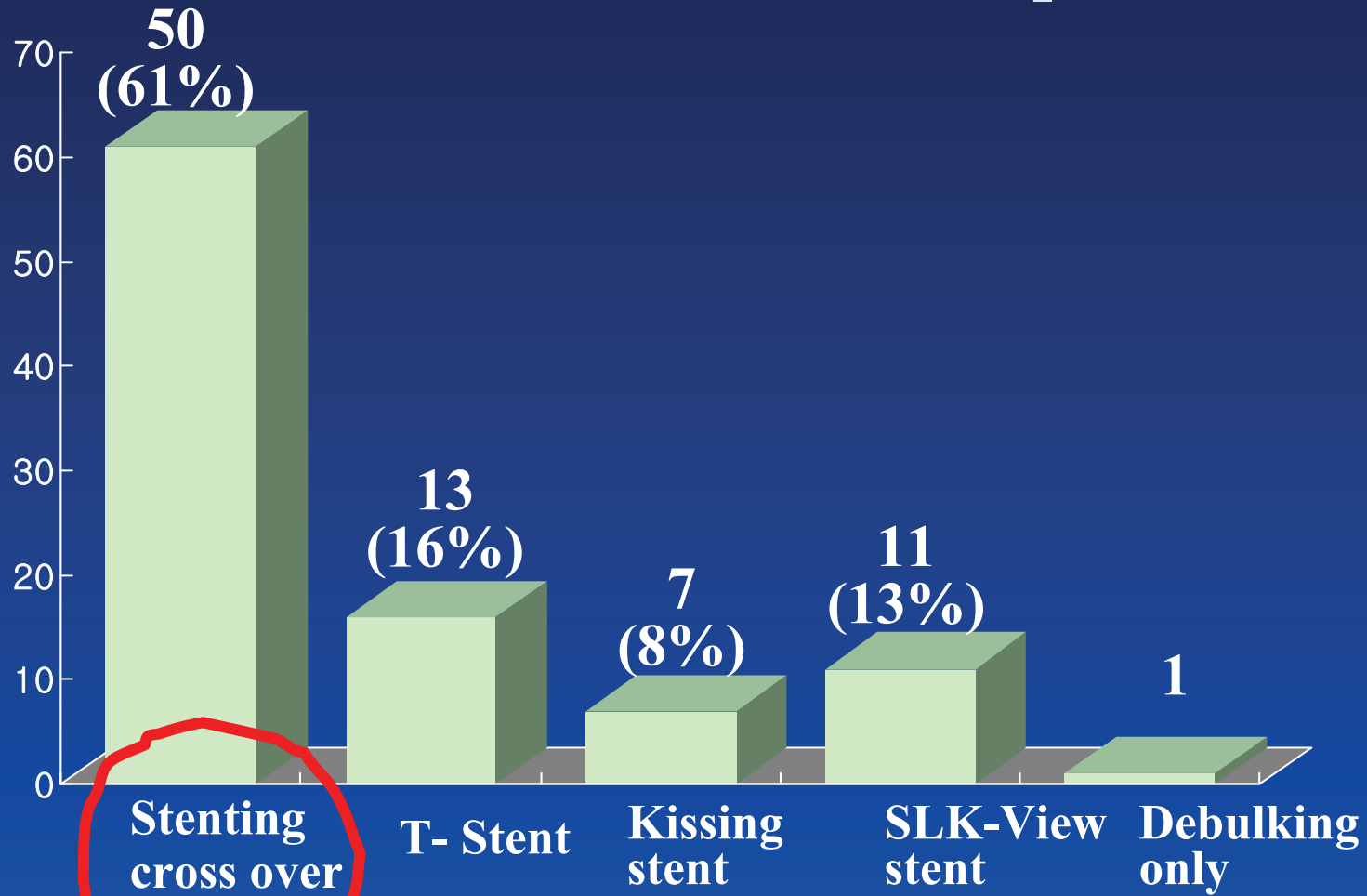
40	Stent Alone
42	DCA + Stent

Unprotected Left Main Bifurcation Stenting

Procedural Success Rate:	100 %
In-Hospital Clinical Complications	0 %
Restenosis Rate	23 %
TLR, 3 year F/U	10 %

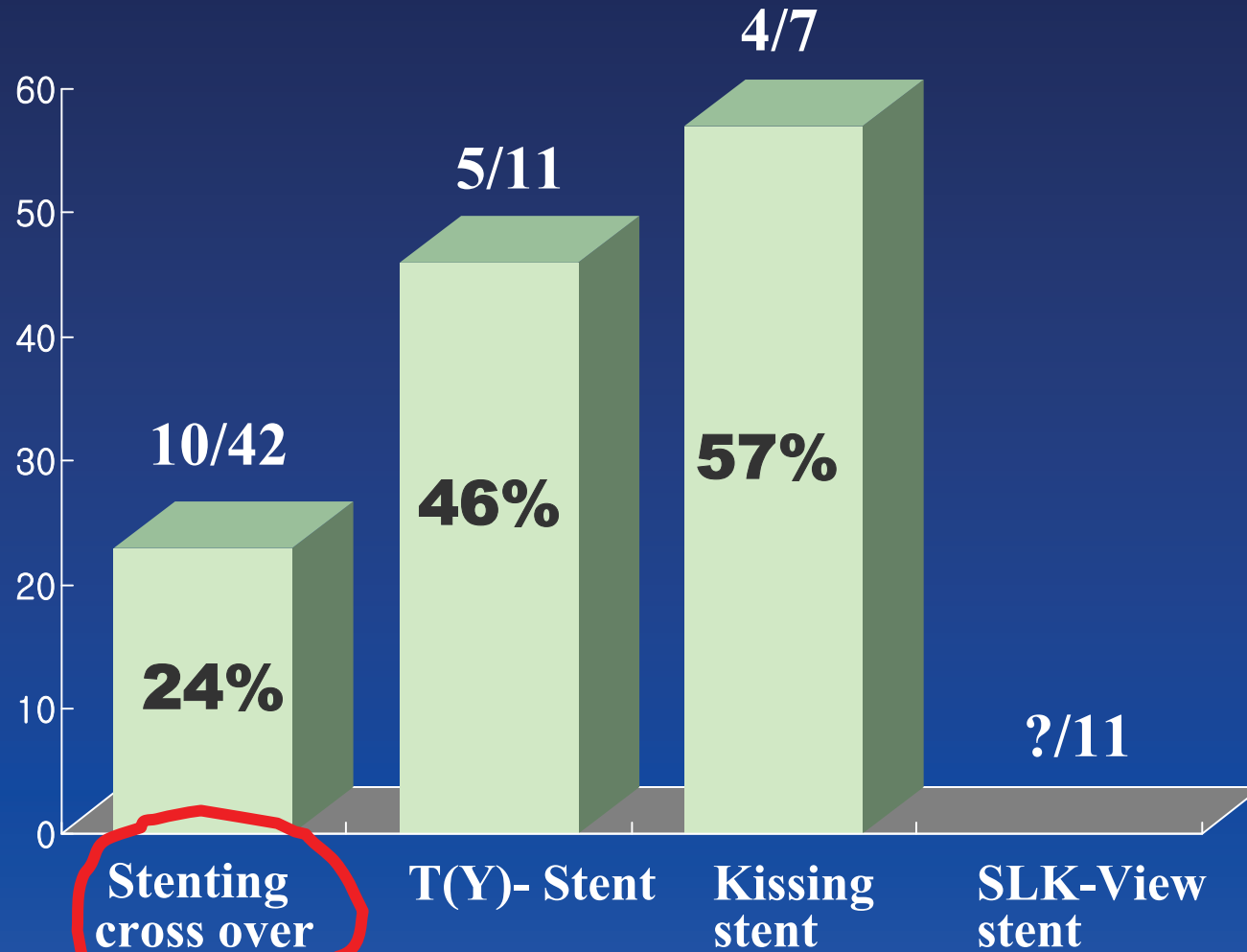
Selection

Different Technique



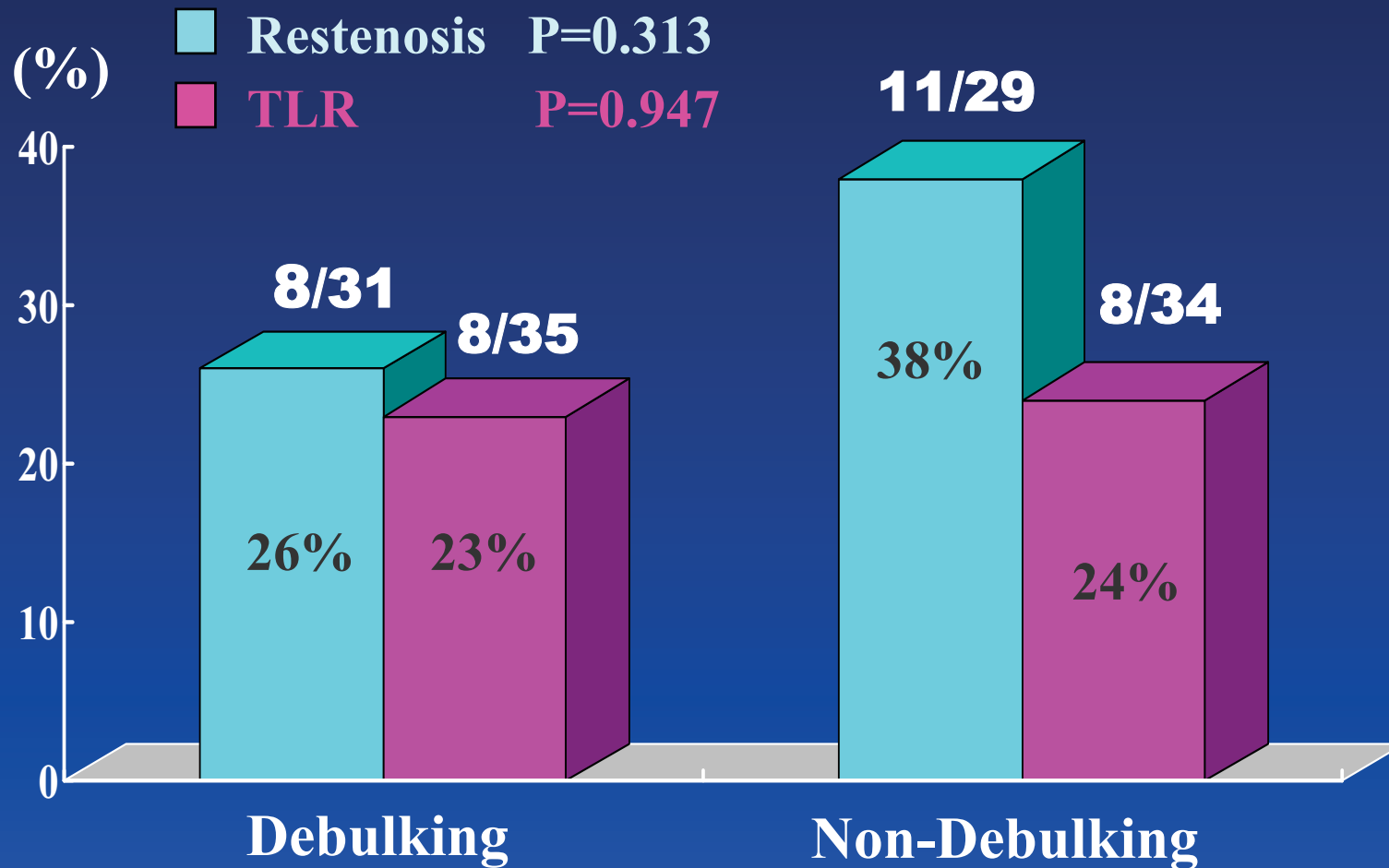
6 month Angiographic Restenosis

According to different strategy



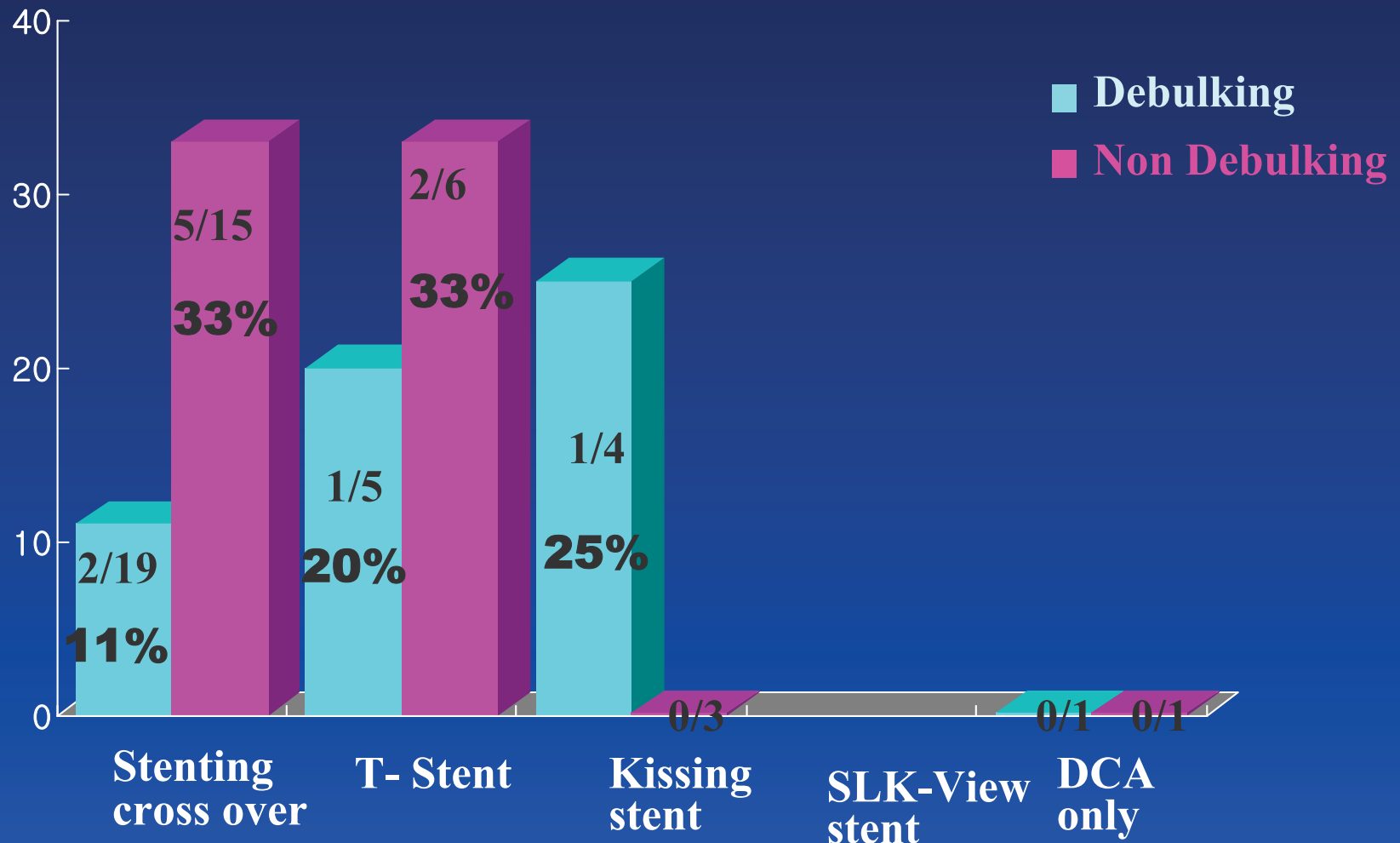
Effect of Debulking ...

at Left Main Bifurcation



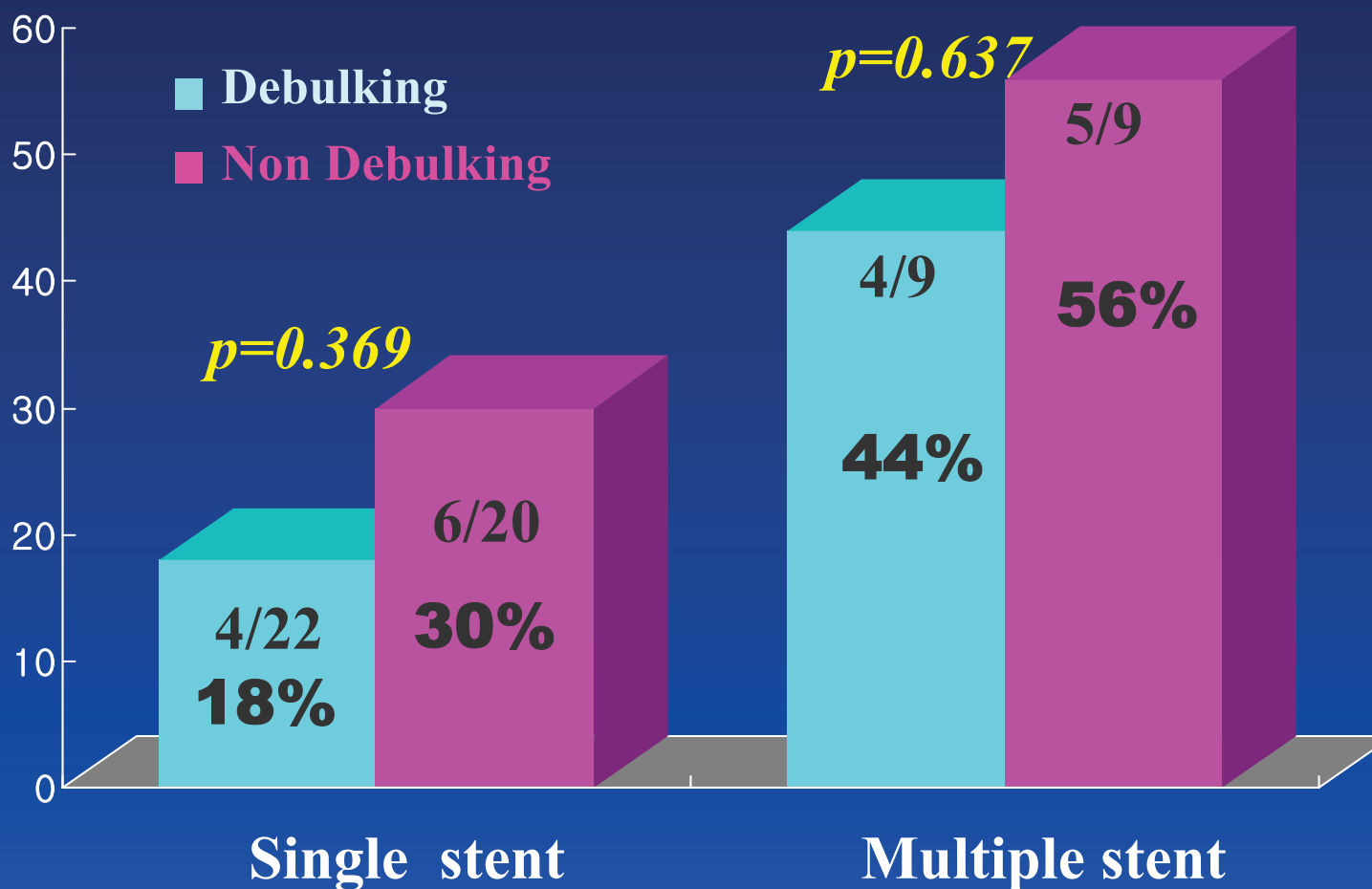
Angiographic Restenosis Rate

depending on the different technique



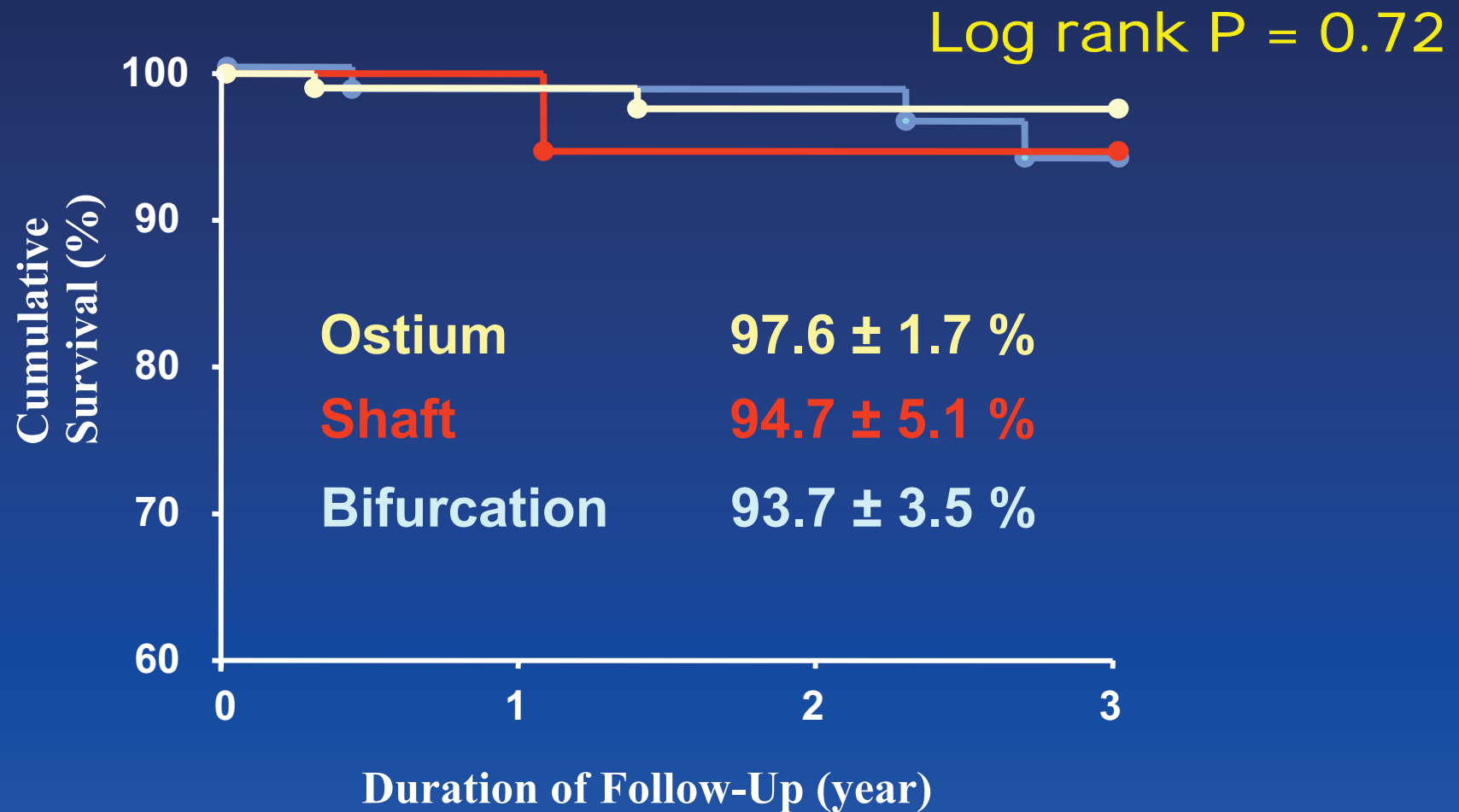
Angiographic Restenosis Rate

depending on number of stents



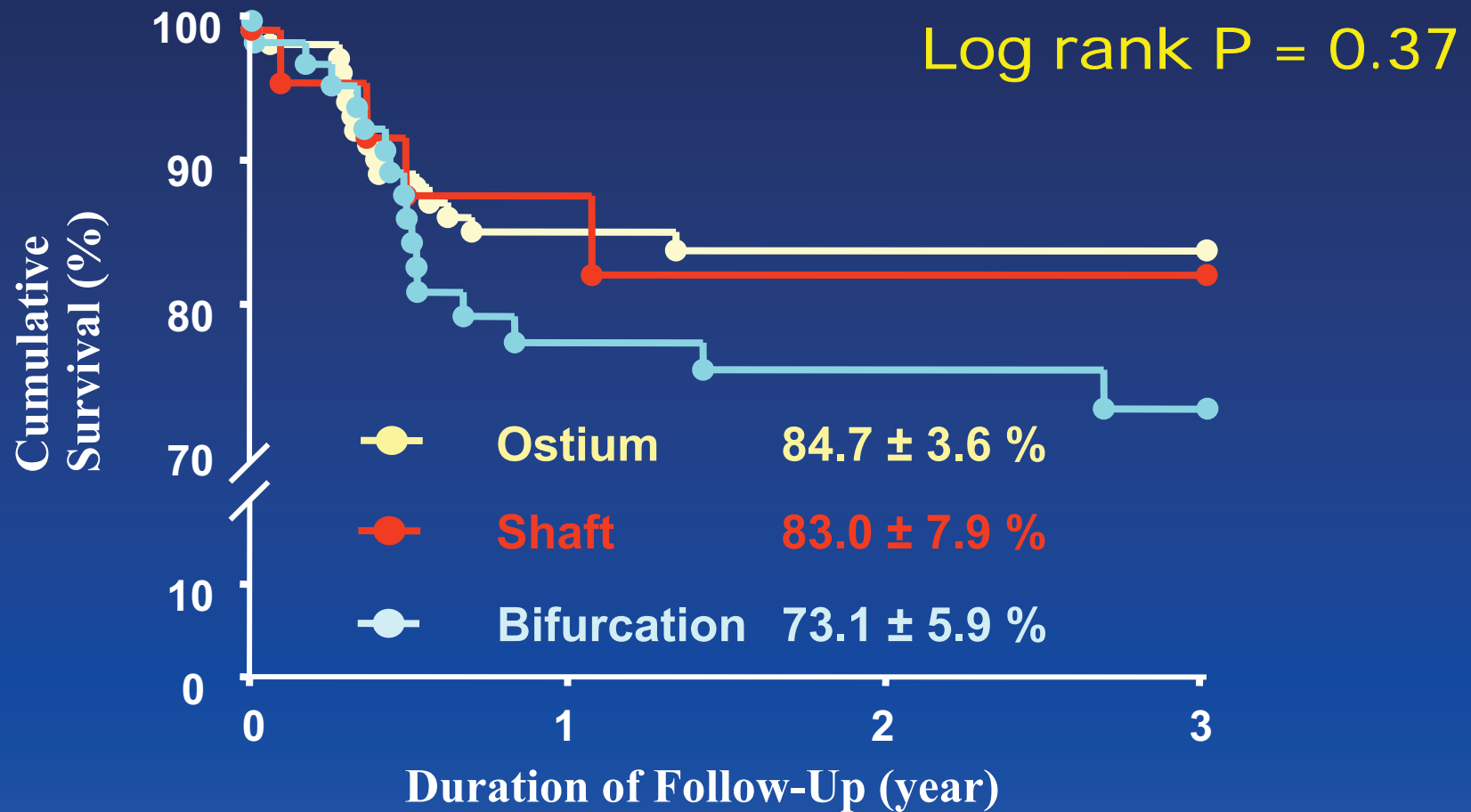
3-Year Survival

According to Lesion Location (AMC data)



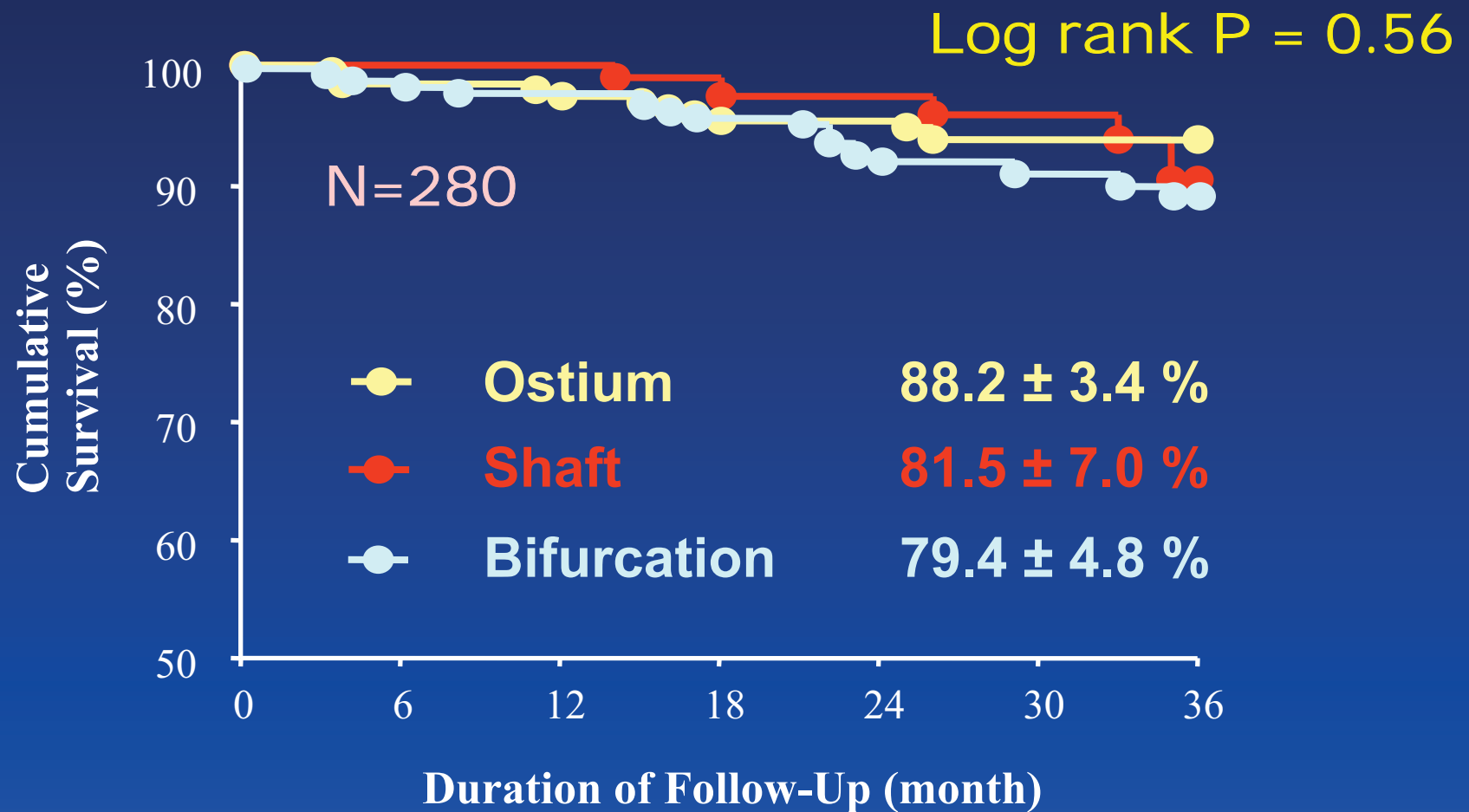
3-Year MACE-Free Survival

According to Lesion Location (AMC)



3-Year TLR-Free Survival

According to Lesion Location (Multicenter)



Unprotected left main Bifurcation stenting

Technical feasibility, safety and outcomes

- Stenting cross over LCX would be the most effective technique
- Debulking seemed to be beneficial
- Could be an alternative to surgery in highly selected patients, but requires meticulous bifurcation technique

Intervention 2003

Era of Drug Eluting Stent



Running to
the New Heights...

Unprotected LM stenting

Era of Drug Eluting Stent



We need more data...

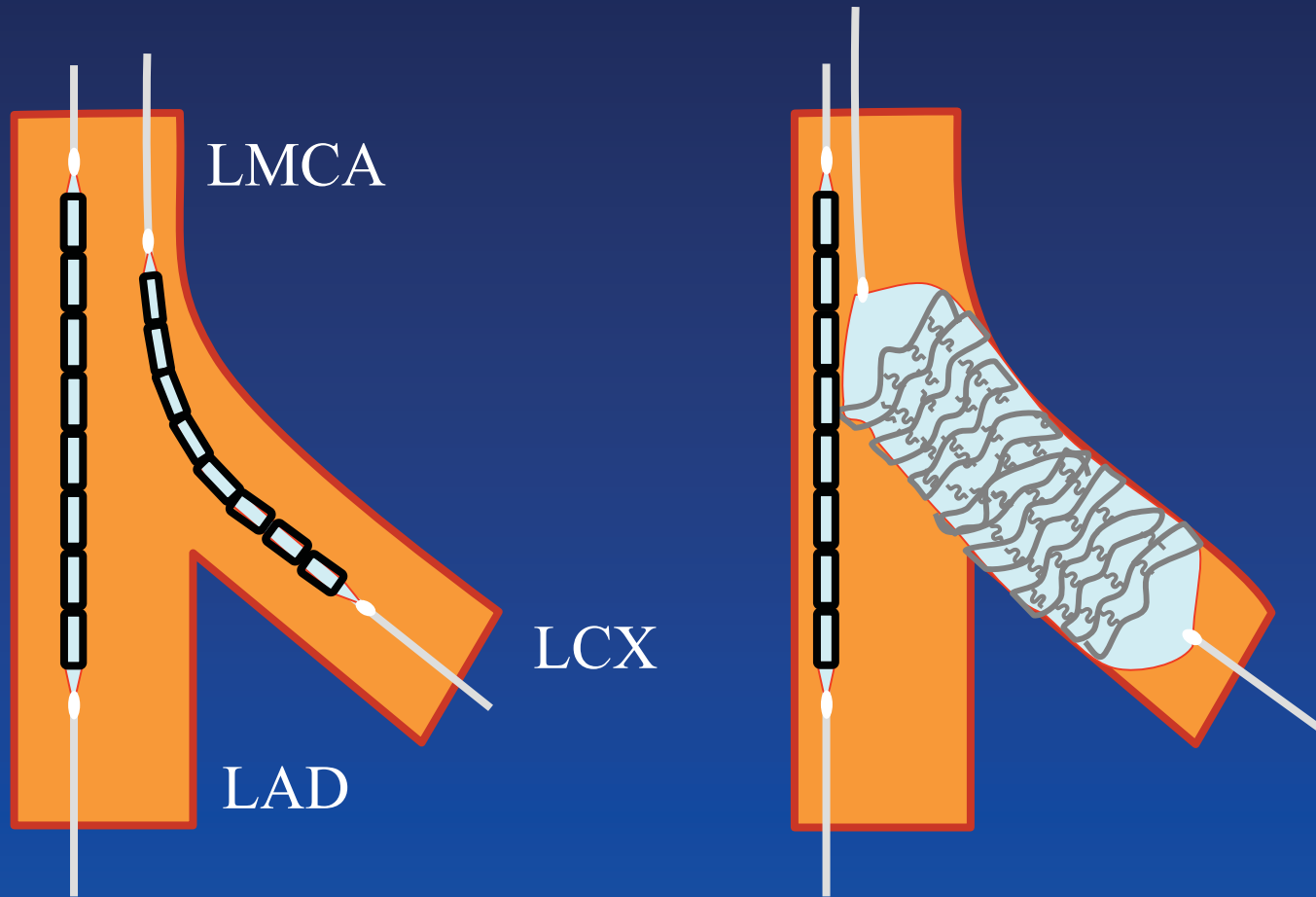
Intervention 2003

Era of Drug Eluting Stent

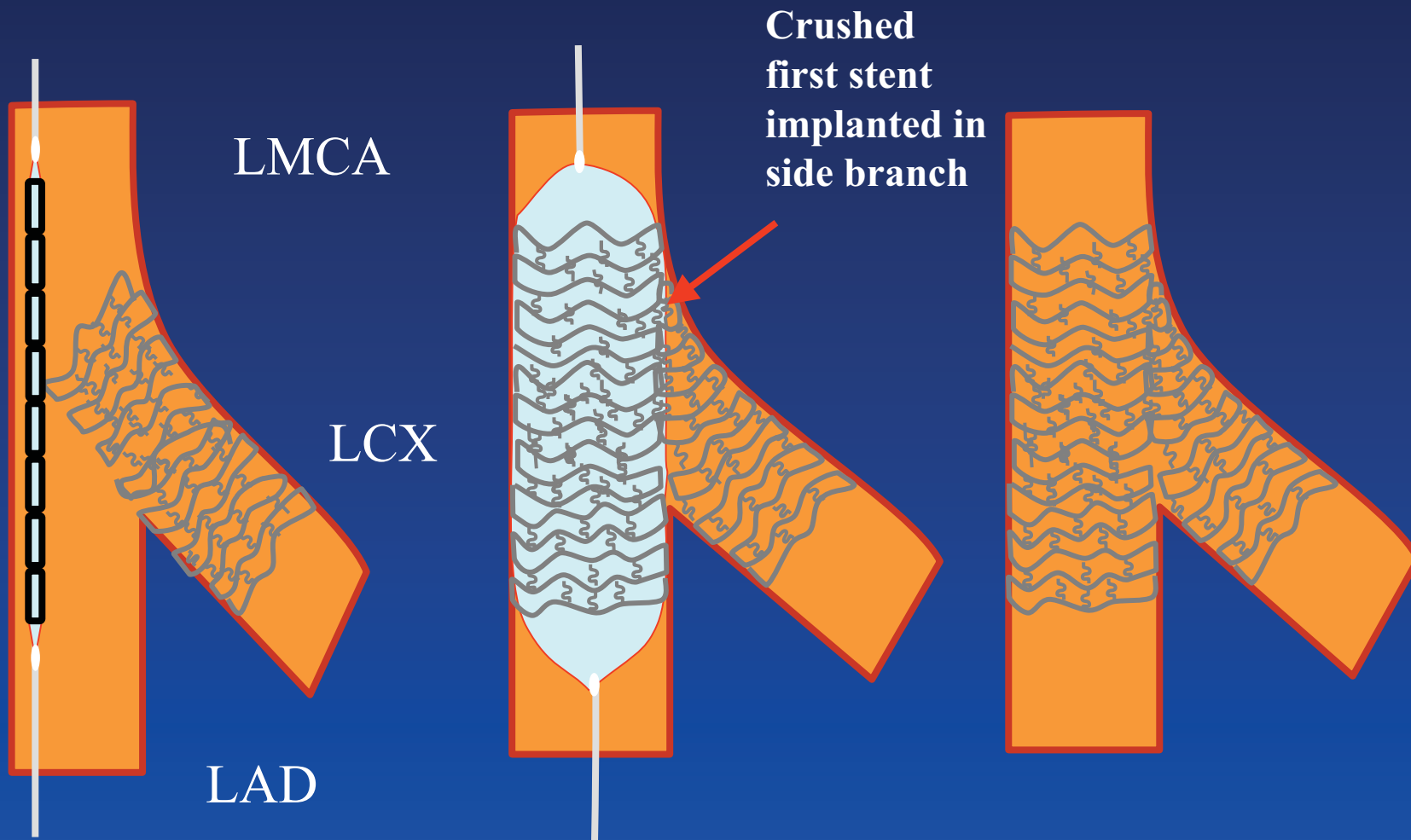
Left main trifurcation lesion,
treated by 3 Cyphers...

Operator: A.Colombo, SJ Park from JIM 2003
Case presentation is shown in <http://summitmd.com>.

Stent - Crush



Stent - Crush



Intervention 2003

Era of Drug Eluting Stent

The procedure of unprotected left
main stenting would be very
simplified
as Just stent it !