PCI for Small Vessel Disease

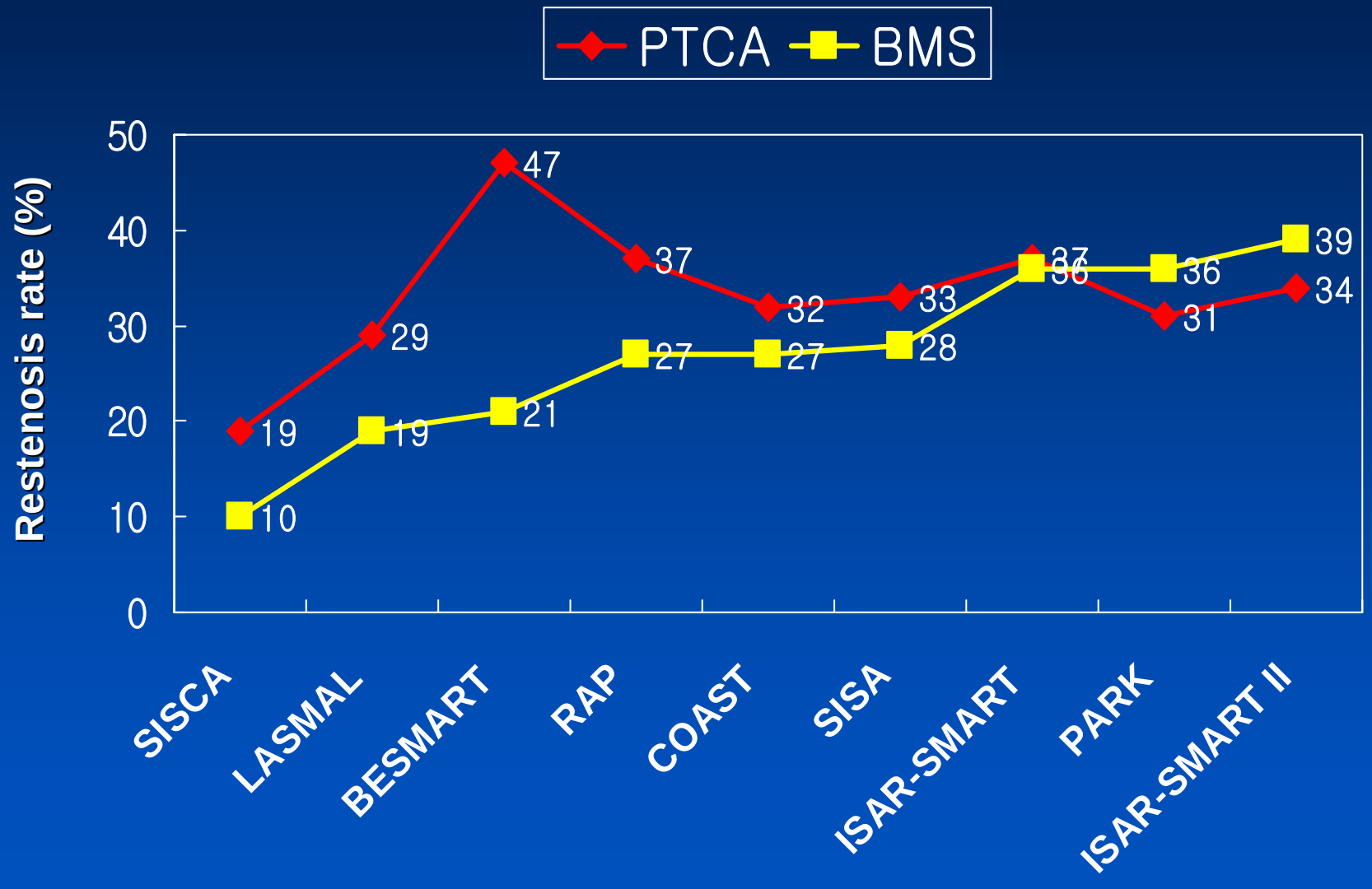
Small Vessel Disease

BMS vs. PTCA

Randomized Trials of BMS vs. PTCA in Small Vessel Disease

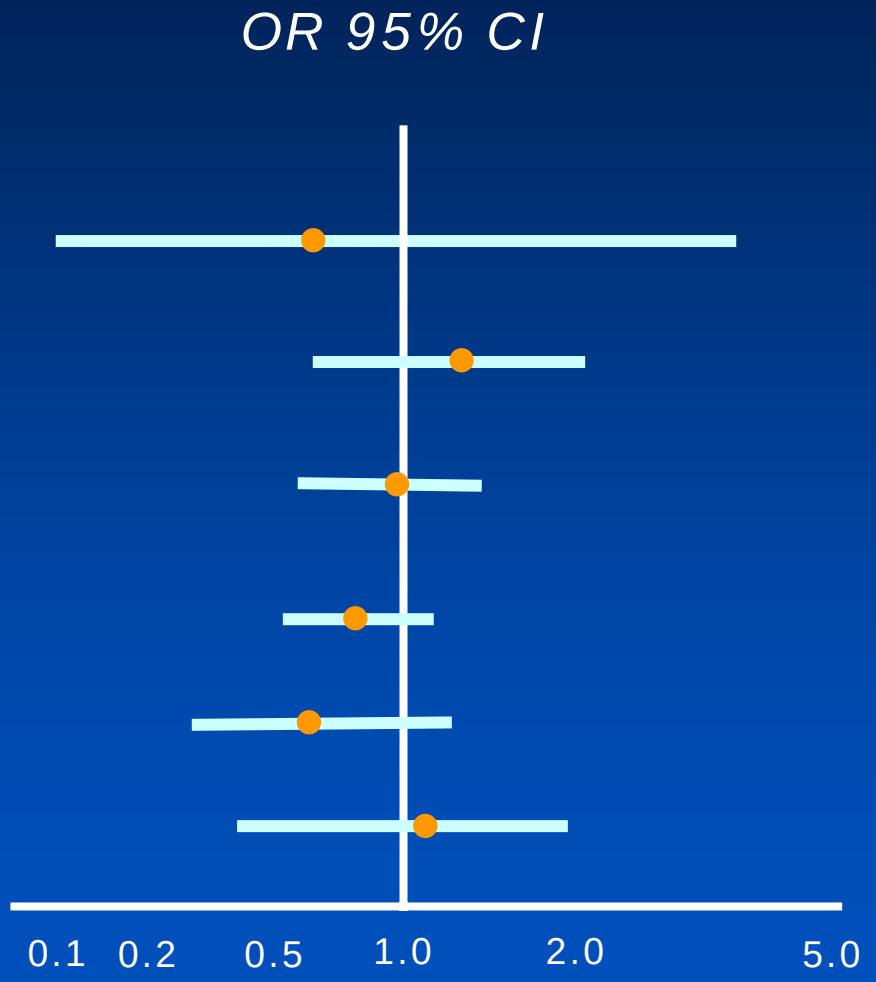
Trial	Stent type	Numbers
ISAR-SMART	Multi-Link	381
N/A	NIR	120
BESMART	BeStent	381
SISA	BeStent	351
SISCA	BeStent	145
RAP	BeStent	426
LASMAL	BiodivYsio	246
COAST	JoStent	588
ISAR-SMART II	BiodivYsio	502

Restenosis Rate of BMS vs. PTCA in Small Vessel Disease



TLR Rate at 8 Months

TRIALS	Stent	PTCA
Park SW, et al.	2/60	3/60
ISAR-SMRT	41/204	33/200
ISAR-SMRT II	51/253	51/249
COAST	42/393	28/195
LASML	19/124	25/122
LASML II	17/111	16/109



Agostoni P. Eur Heart J 2005;26:881

Small Vessel Disease in BMS Era

- The results of trials comparing BMS to PTCA were discordant compared to the other coronary lesions.
- Clinical and angiographic restenosis rates remain relatively high with either strategy.

Small Vessel Disease

DES vs. BMS

PCI for Small Vessels in the DES Era

- For complete lesion coverage in the DES era, the number of PCI for small coronary lesions has been increased despite of small perfusion territory and unfavorable long-term outcomes.

Evidences
DES in Small Vessels

- Subgroups of randomized studies
  - RAVEL, SIRIUS, New-SIRIUS (SES vs. BMS)
  - TAXUS (PES vs. BMS)
- Randomized studies
  - E-SIRIUS (SES vs. BMS)
  - SES-SMART (SES vs. BMS)
- Registries
  - SVELTE (SES vs. BMS)
  - REVOLUTION (thin strut SES)
  - SIRIUS 2.25
  - RESEARCH & T-SEARCH (SES vs. PES)
  - ISAR-SMART 3 (SES vs. PES)
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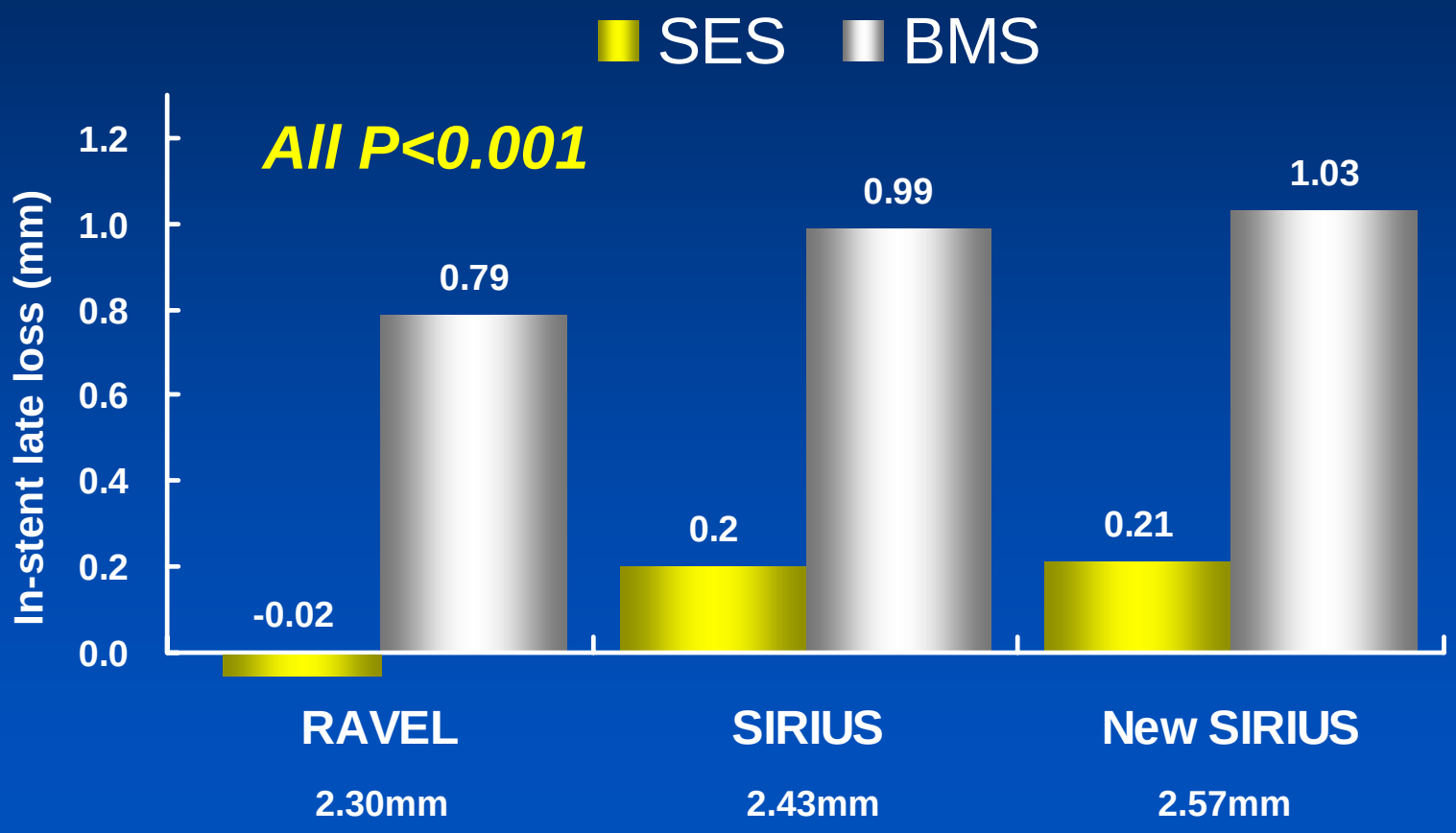
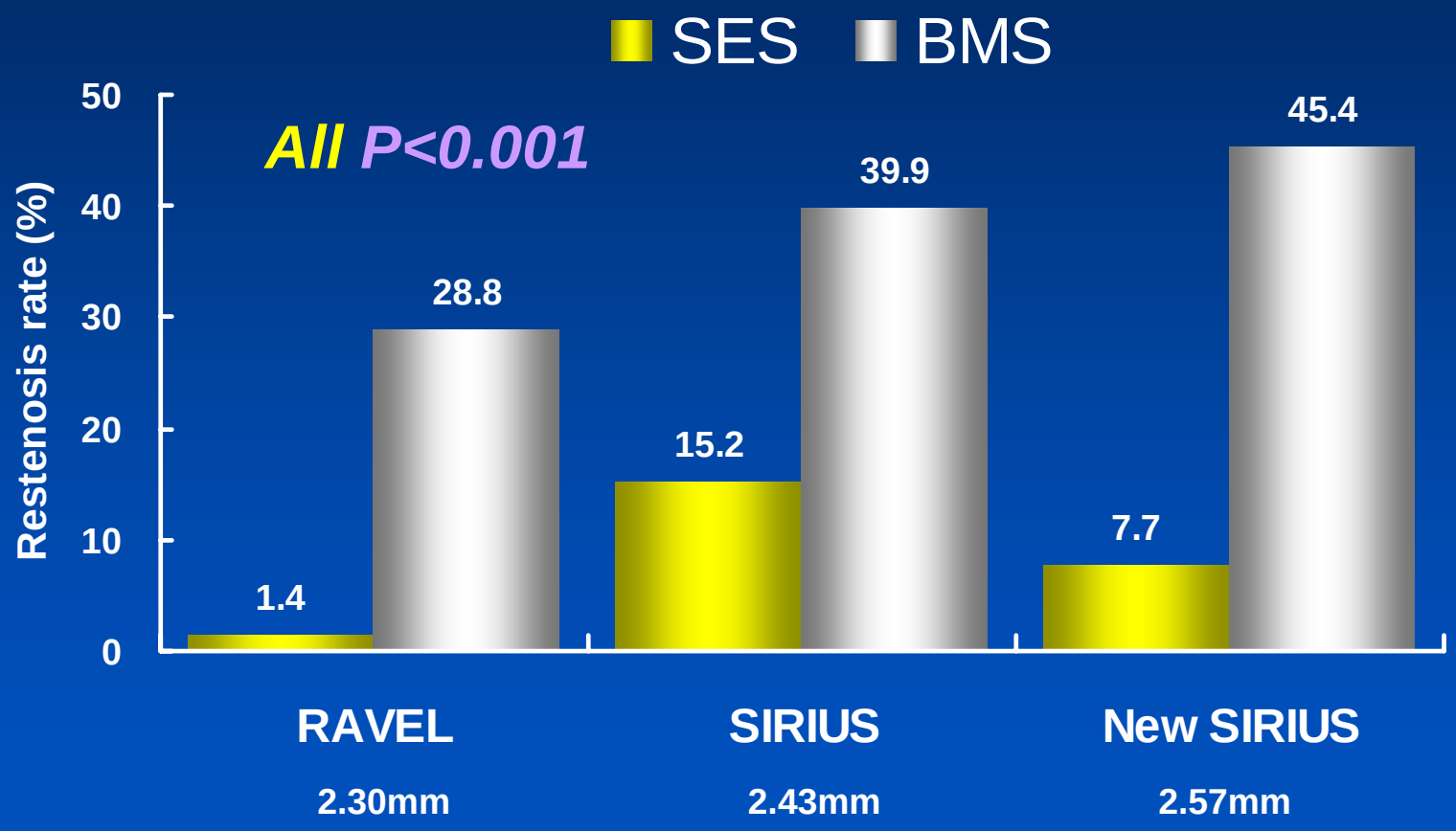
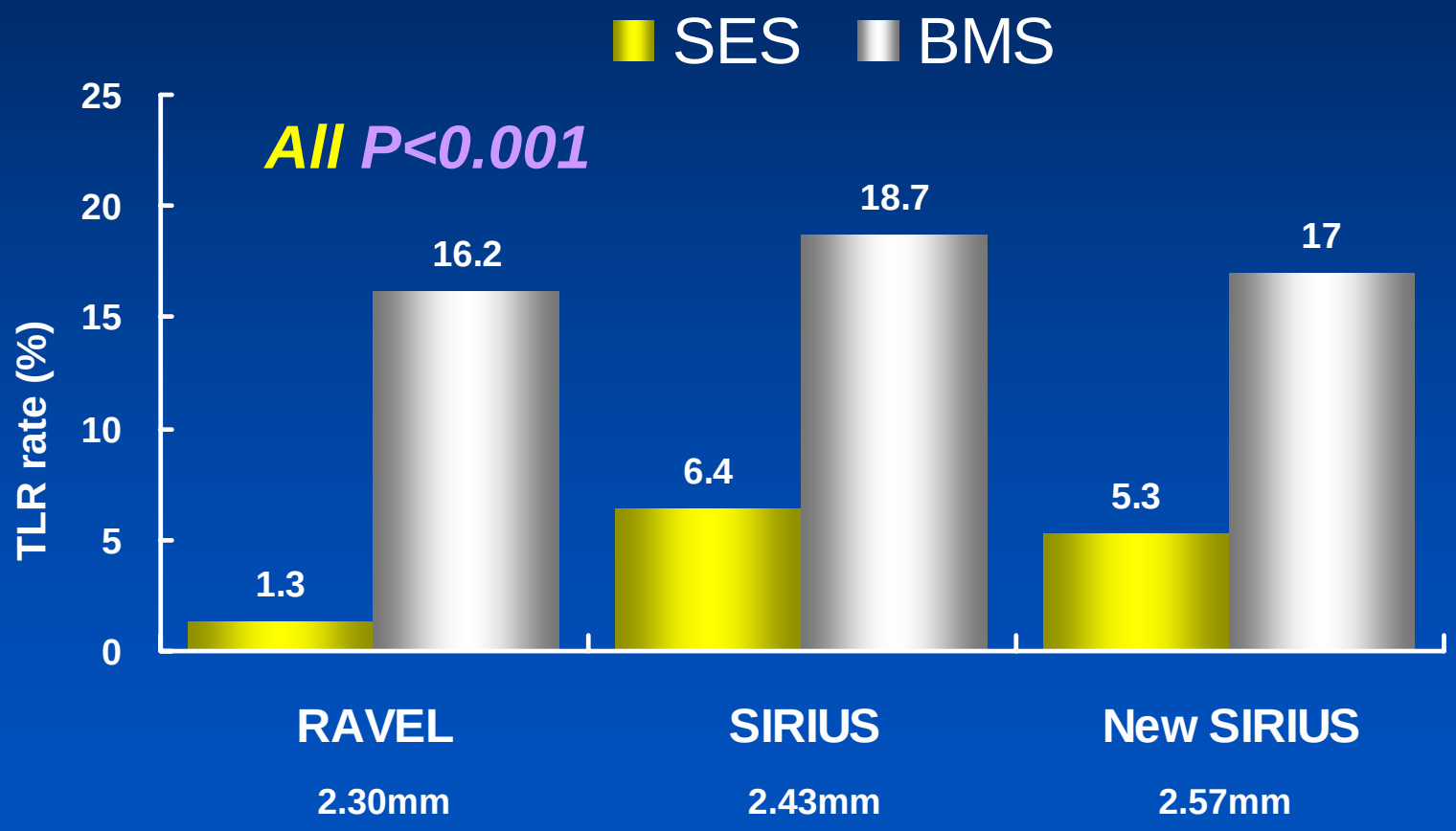
In-Stent Late Loss
SES vs. BMS in RVD<2.75mm



In-Segment Restenosis
SES vs. BMS in RVD<2.75mm



Nine-Month TLR Rates
SES vs. BMS in RVD<2.75mm



Clinical Results

SES vs. BMS in SVD < 2.75mm

	SES (909)	Control (631)	*P*-value
Death	1.0%	0.7%	0.6326
MI: Q-wave	0.8%	0.3%	0.2593
MI: Non-Q-wave	1.9%	2.9%	0.1825
TVR (non-TLR)	2.8%	3.4%	0.4416
TLR	3.5%	17.1%	<0.0001
MACE	6.4%	19.4%	<0.0001

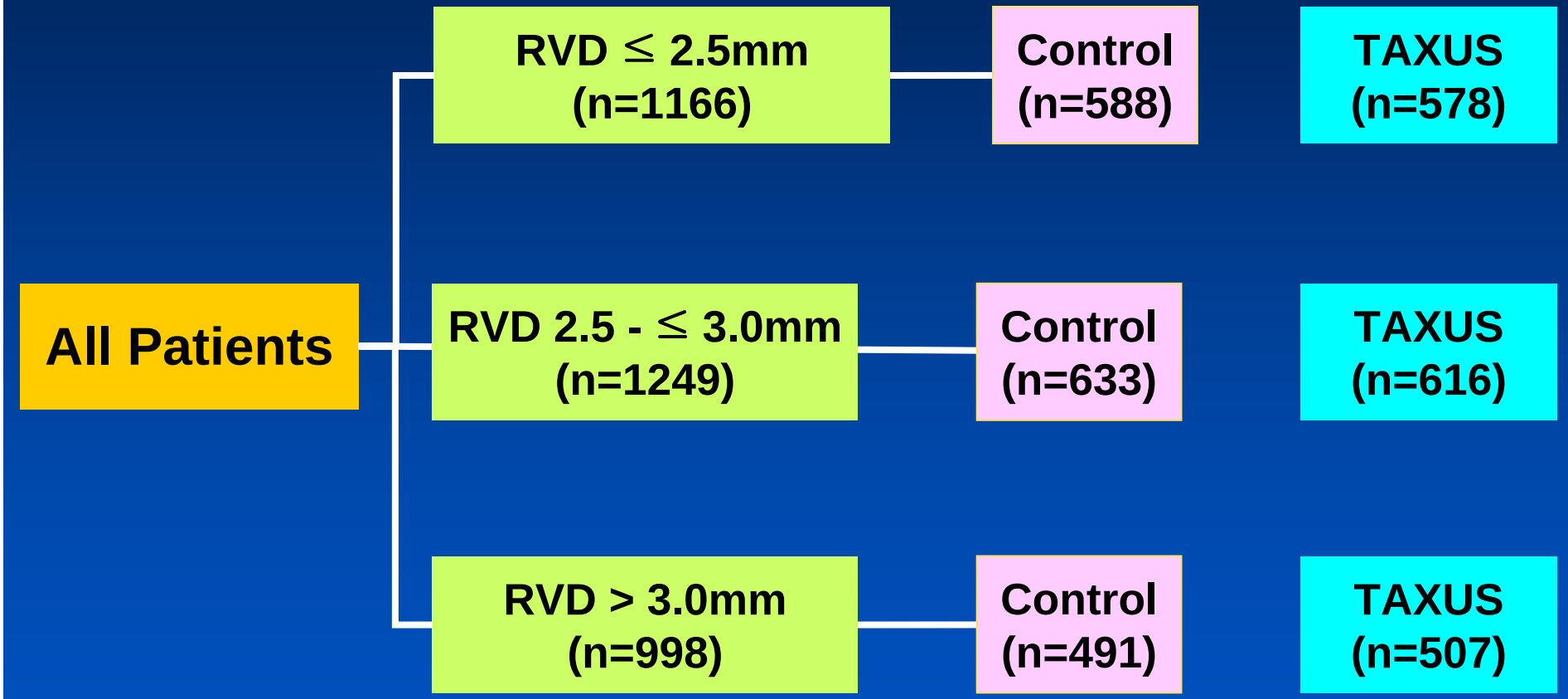
Angiographic Results

SES vs. BMS in SVD

	SES (909)	Control (631)	*P*-value
In-stent late loss (mm)	0.18	1.02	<0.0001
In-lesion late loss (mm)	0.21	0.81	<0.0001
In-stent restenosis (%)	3.2%	38.5%	<0.0001
In-lesion restenosis (%)	6.9%	39.8%	<0.0001

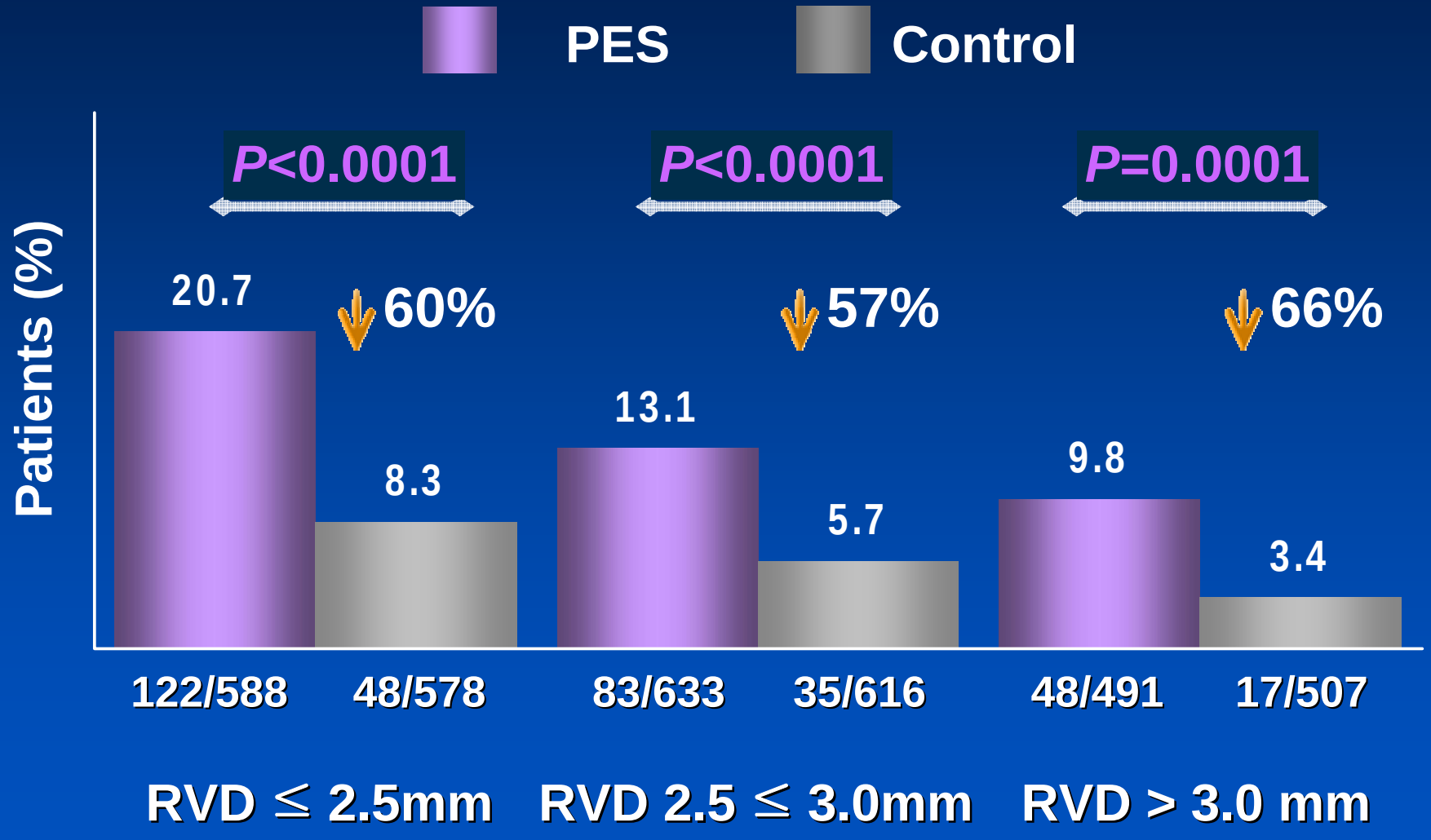
Subgroup Analysis by QCA

TAXUS II, IV, V, VI MetaAnalysis



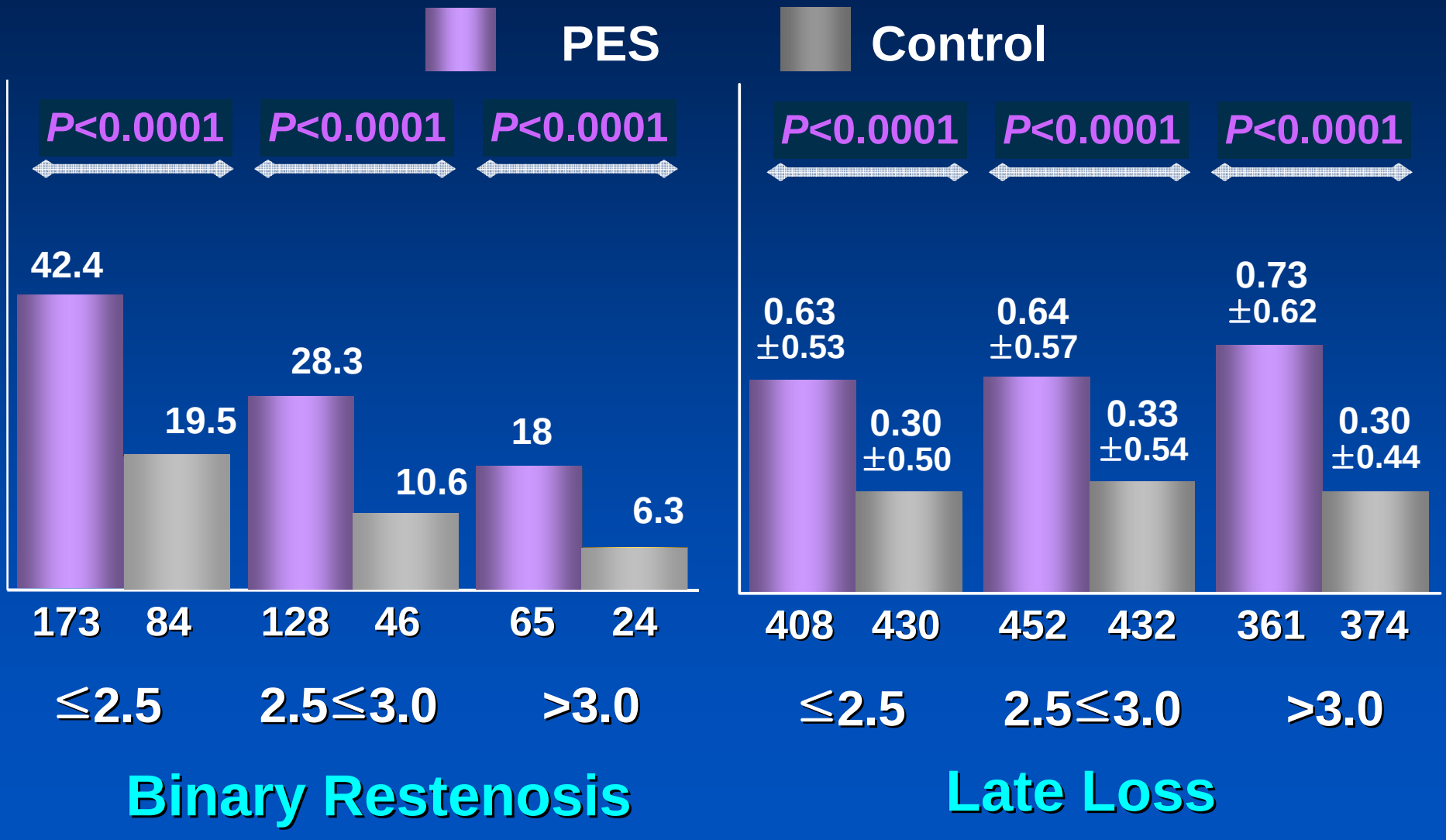
Effect of Vessel Size on 9-Month TLR

TAXUS II, IV, V, VI MetaAnalysis



Effect of Vessel Size on 9m QCA

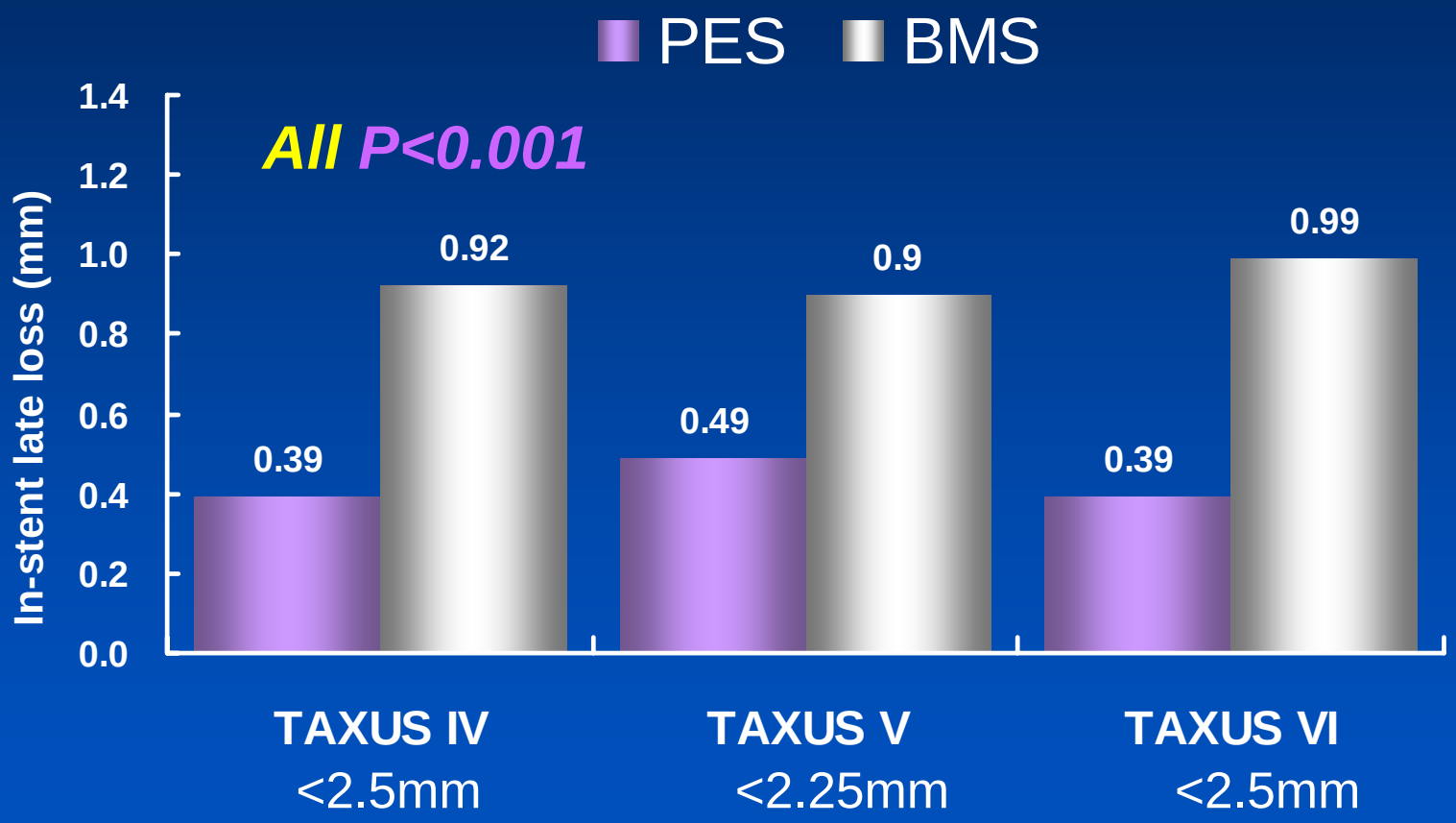
In-Segment, TAXUS II, IV, V, VI MetaAnalysis



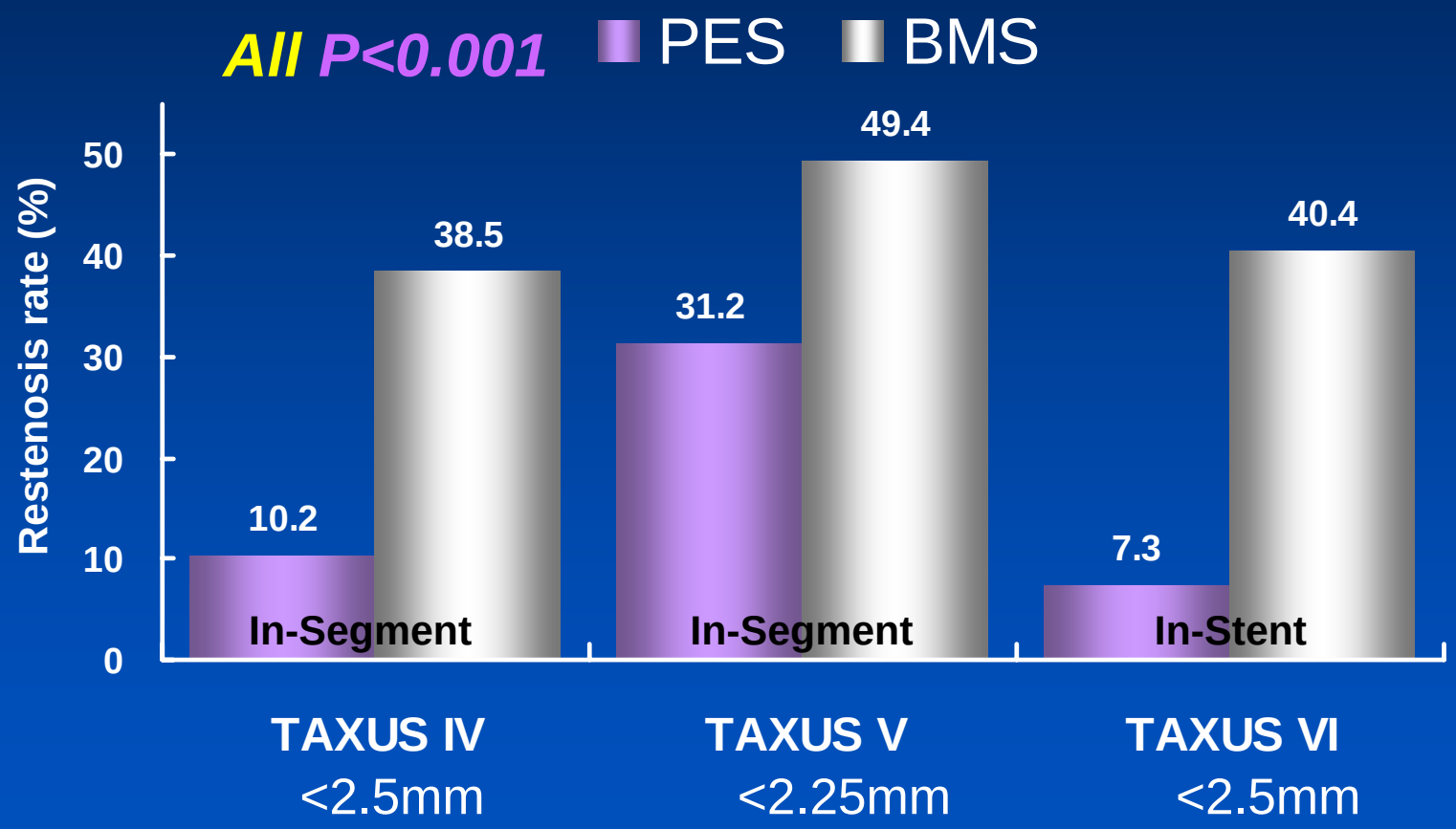
Paclitaxel-Eluting Stent
Taxus IV vs. V vs. VI

	TAXUS IV	TAXUS V	TAXUS VI
No of patients	1,314	1,156	446
Lesion length (mm)	14.4	17.3	20.6
Stent length (mm)	21.9	28.7	33.4
AHA/ACC type C lesions (%)	20.3	36.8	55.6
Small vessels (<2.5mm) (%)	32.1	18.7	27.8
Overlapping stent (%)	Not permit	29.1	27.8
Non-target vessel intervention (%)	20.8	NA	23.5
Diabetes mellitus (%)	23.4	31.7	20.0

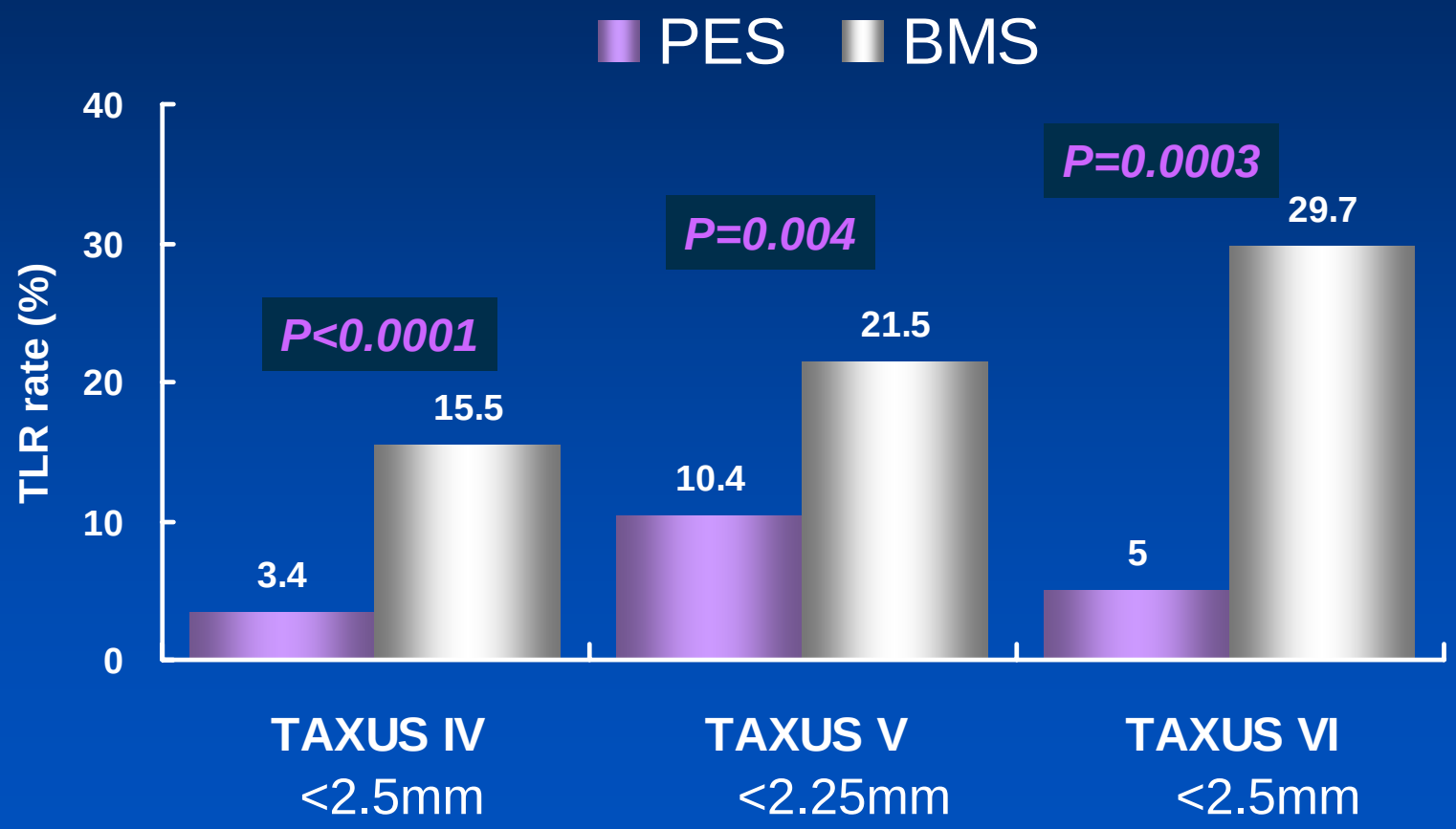
In-Stent Late Loss at 9 Mo
PES vs. BMS



Restenosis at 9 Mo
PES vs. BMS



TLR Rates at 9 Mo
PES vs. BMS



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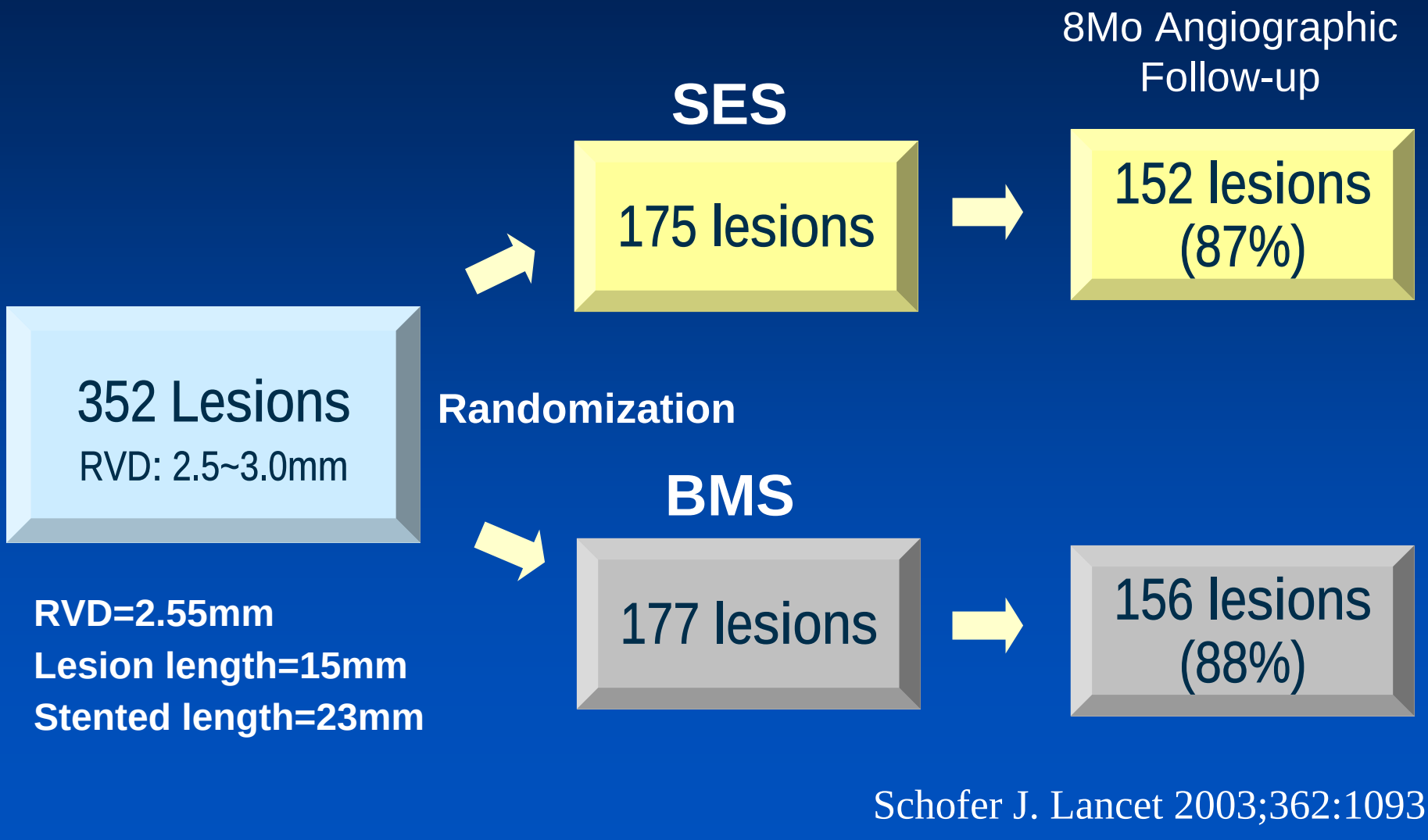
E-SIRIUS Study

2.5~3.0mm



Schofer J. Lancet 2003;362:1093

Angiographic Outcomes at 8 Mo

	SES (n=175)	BMS (n=177)	*P*-value
Reference size, mm	2.61±0.34	2.48±0.32	0.0006
In-stent MLD, mm	2.22±0.48	1.33±0.63	<0.0001
In-segment MLD, mm	1.97±0.48	1.29±0.61	<0.0001
In-stent late loss, mm	0.20±0.38	1.05±0.61	<0.0001
In-segment late loss, mm	0.19±0.38	0.80±0.57	<0.0001
In-stent restenosis	6/152 (3.9%)	65/156 (41.7%)	<0.0001
In-segment restenosis	9/152 (5.9%)	66/156 (42.3%)	<0.0001

Schofer J. Lancet 2003;362:1093

Clinical Outcomes at 9 Mo

	SES (n=175)	BMS (n=177)	*P*-value
Death	2 (1.1)	1 (0.6)	0.62
MI	8 (4.6)	4 (2.3)	0.26
Q-MI	2 (1.1)	0 (0)	0.25
Non Q-MI	6 (3.4)	4 (2.3)	0.54
CABG	0 (0)	3 (1.7)	0.25
TLR	7 (4.0)	37 (20.9)	<0.0001
Total	14 (8.0)	40 (22.6)	0.0002

Data are shown as the number (%)

Schofer J. Lancet 2003;362:1093

SES-SMART Study
≤ 2.75 mm

8Mo Angiographic Follow-up

SES

129 lesions → 123 lesions (95%)

257 Lesions
RVD ≤ 2.75mm

Randomization

BMS

128 lesions → 113 lesions (88%)

RVD=2.20mm
Lesion length=11.8mm
Stented length=16mm
Diabetes=24.9%

Ardissino D. JAMA 2004;292:2727

Angiographic Outcomes at 8 Mo

	SES (n=123)	BMS (n=113)	*P*-value
In-stent MLD, mm	2.01±0.43	1.20±0.64	<0.001
In-segment MLD, mm	1.70±0.48	1.09±0.60	<0.001
In-stent late loss, mm	0.16±0.38	0.90±0.62	<0.001
In-segment late loss, mm	0.16±0.46	0.69±0.61	<0.001
In-stent restenosis, %	4.9	49.1	<0.001
In-segment restenosis, %	9.8	53.1	<0.001

Data are shown as the number (%)

Ardissino D. JAMA 2004;292:2727

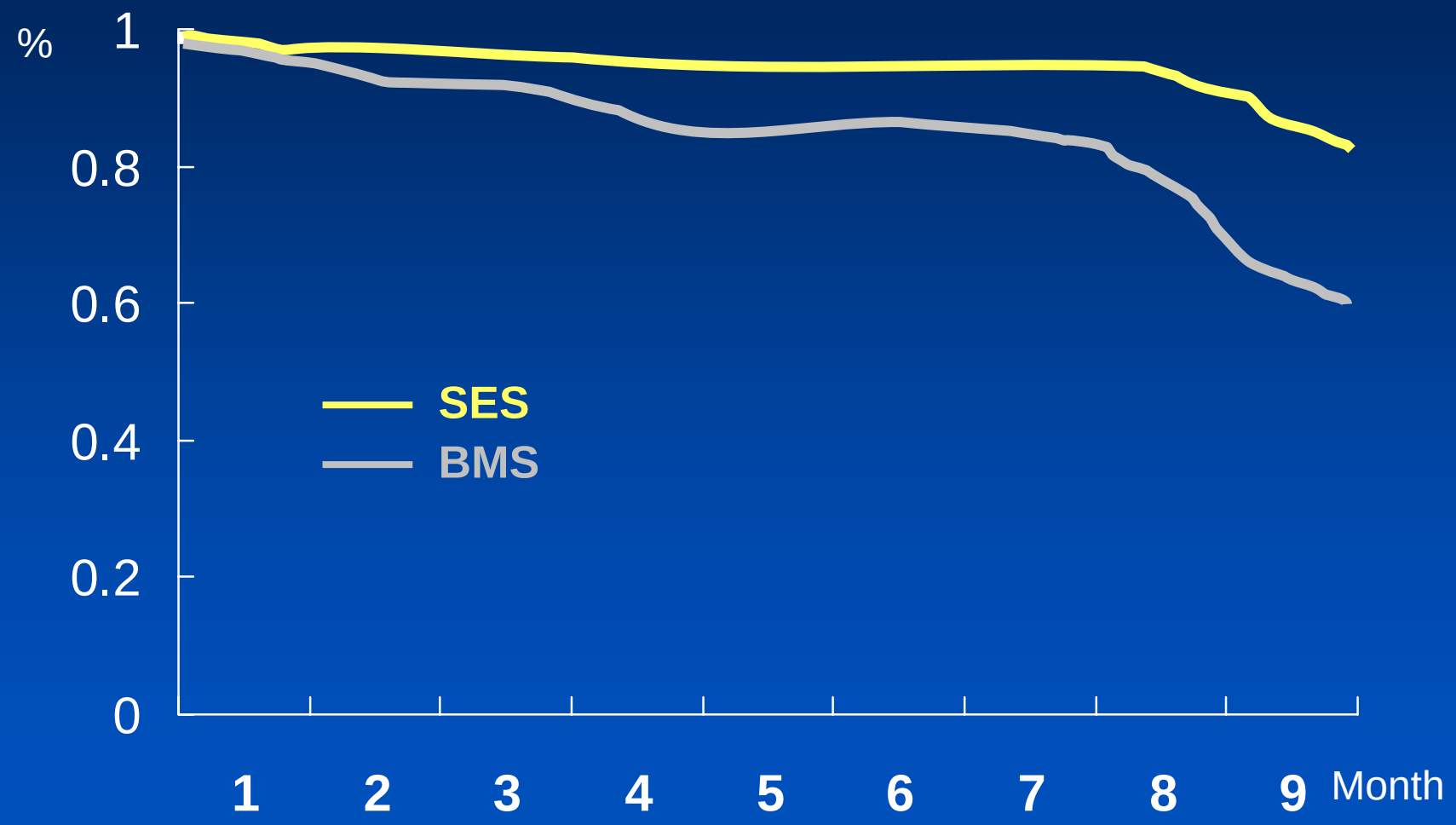
Clinical Outcomes at 8 Mo

	SES (n=129)	BMS (n=128)	*P*-value
Death	0	2 (1.6)	0.24
MI	2 (1.6)	10 (7.8)	0.04
Q-MI	0	2 91.6)	0.24
Non Q-MI	2 (1.6)	8 (6.3)	0.06
CVA	1 (0.8)	1 (0.8)	>0.99
TLR	9 (7)	27 (21.1)	0.002
Total	12 (9.3)	40 (31.3)	<0.001

Data are shown as the number (%)

Ardissino D. JAMA 2004;292:2727

Event-free Survival at 9 Mo

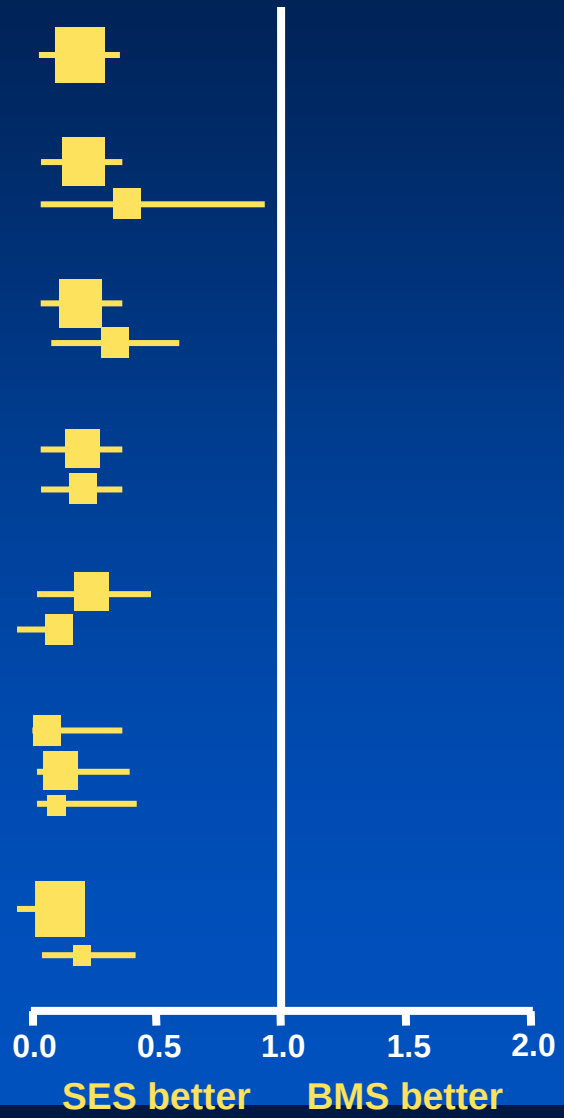


QCA – In-Segment

Variable	SES (n=123)	BMS (n=113)	*P*-value
Binary restenosis (%)	9.8	53.1	< 0.001
Minimal luminal diameter (mm)			
Before procedure	0.73 ± 0.23	0.71 ± 0.23	
After procedure	1.84 ± 0.36	1.79 ± 0.34	
After 8 months	1.7 ± 0.48	1.09 ± 0.6	< 0.001
Stenosis (% luminal diameter)			
Before procedure	66.88 ± 9.52	66.83 ± 10.35	
After procedure	22.39 ± 9.62	22.93 ± 10.32	
After 8 months	29.26 ± 15.84	50.78 ± 25.83	< 0.001
Late lumen loss (mm)	0.16 ± 0.46	0.69 ± 0.61	< 0.001
Loss index	0.11 ± 0.5	0.68 ± 0.68	< 0.001

SES-SMART Study

SES-SMART



GROUP	Number of patients	Sirolimus stent %	Uncoated stent %	Odds Ratios (95 % CI)
All	236	9.8	53.1	0.10 (0.05,0,19)
Gender				
- male	168	6.4	55.4	0.05 (0.02,0.14)
- female	68	20.7	48.7	0.27 (0.03,0.82)
Diabetes				
- no	167	5.3	47.2	0.06 (0.02,0.17)
- yes	69	25.0	63.4	0.19 (0.07,0.56)
Clinical presentation				
chronic stable angina or silent ischemia	136	9.2	47.9	0.11 (0.04,0,29)
acute coronary syndrome	100	10.7	56.4	0.09 (0.03,0.27)
Left anterior descending coronary artery				
- no	149	11.3	47.4	0.14 (0.06,0.33)
- yes	87	8.7	65.7	0.04 (0.01,0.15)
Stent diameter				
- 2.25 mm	62	3.6	51.5	0.03 (0.00,0.29)
- 2.50 mm	128	10.8	50.8	0.12 (0.05,0.30)
- 2.75 mm	46	13.8	64.7	0.09 (0.02,0.37)
Stent length				
- 8 - 13 – 18 mm	203	7.2	50.0	0.08 (0.03,0.18)
- 23 - 28 – 33 mm	33	19.2	100.0	0.19 (0.09,0.42)

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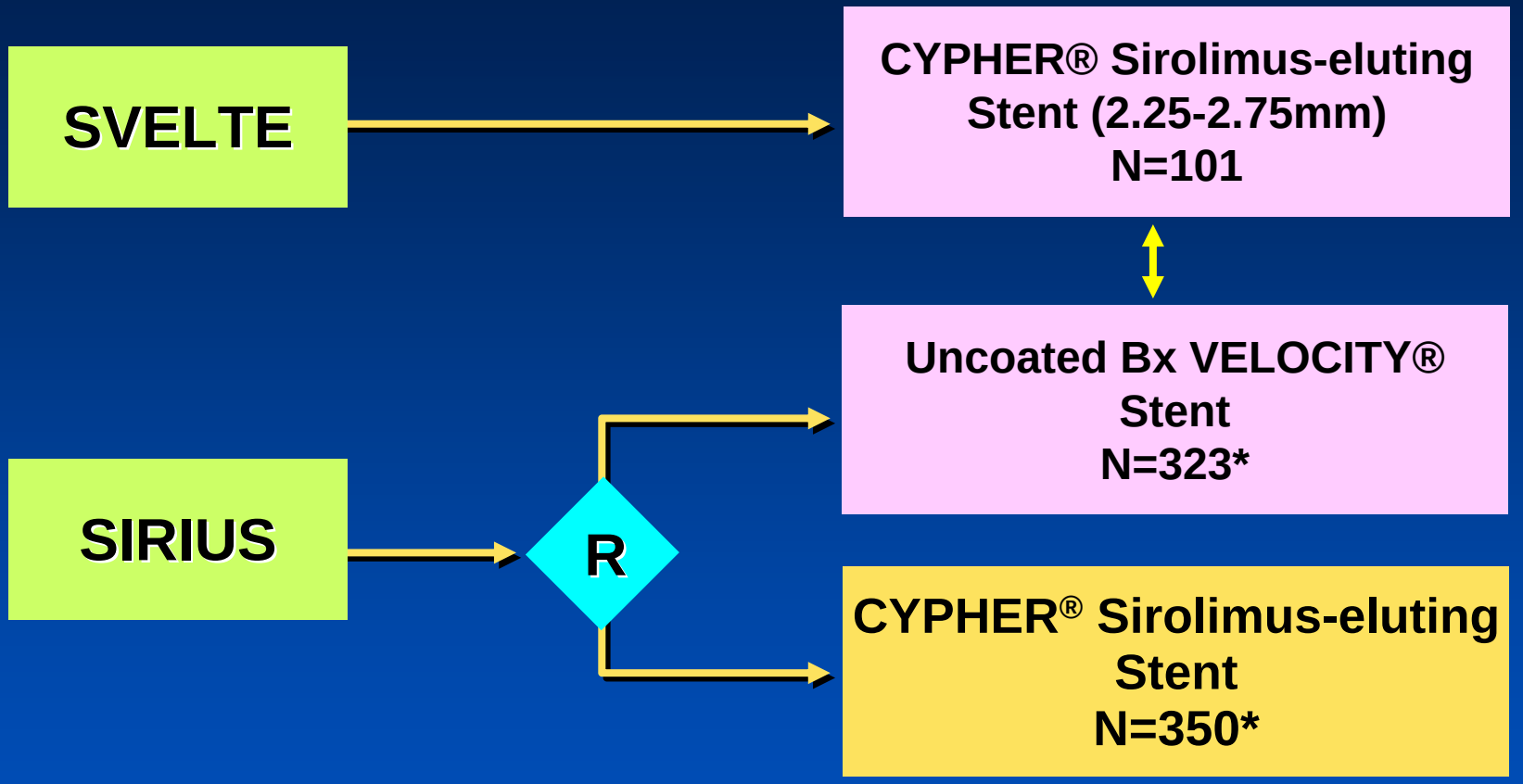
SVELTE – Study Design



Primary endpoint: in-lesion late lumen loss @ 8 months

* Angiographic f/u cohort matched by propensity score on RVD, lesion length & diabetes

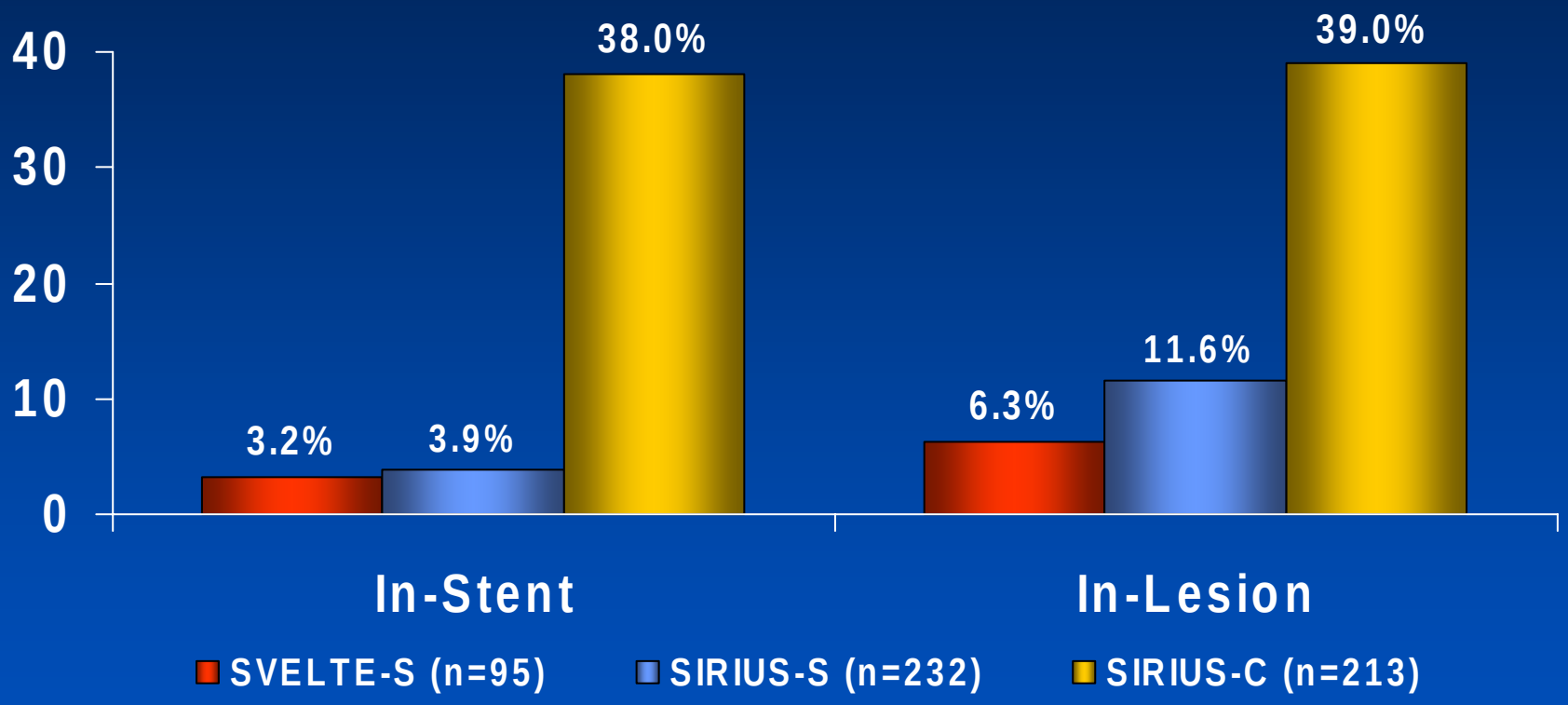
SVELTE

Lesion Characteristics

	SVELTE–S (n=101)	SIRIUS–C (n=323)	*P*-value	SIRIUS–S (n=350)
Lesion length (mm)	*14.5 (n=101)*	14.4 (n=323)	0.5876	14.6 (n=350)
RVD (mm)	*2.36 (n=101)*	2.42 (n=323)	<0.0001	2.41 (n=350)
Diameter stenosis (%)	69.3 (n=101)	66.3 (n=323)	0.0217	66.0 (n=350)
Pre-dilatation (%)	98.0%(n=101)	96.9%(n=323)	0.4612	97.7% (n=350)
Max. pressure (bar)	10.2 (n=99)	9.1 (n=313)	0.0042	9.6 (n=342)
Max. Implant. pressure (bar)	14.1 (n=101)	13.6 (n=320)	0.1535	13.8 (n=348)
Post-dilatation (%)	31.7%(n=101)	53.6%(n=323)	<0.0001	49.7 (n=350)
Max. pressure (bar)	16.2 (n=32)	14.8 (n=173)	0.0380	14.7 (n=174)
Post-procedural IVUS (%)	75.2% (n=101)	18.6% (n=323)	<0.0001	21.4 (n=350)
Mean No. of stents / patient	1.15 (n=101)	1.43 (n=323)	<0.0001	1.48 (n=323)

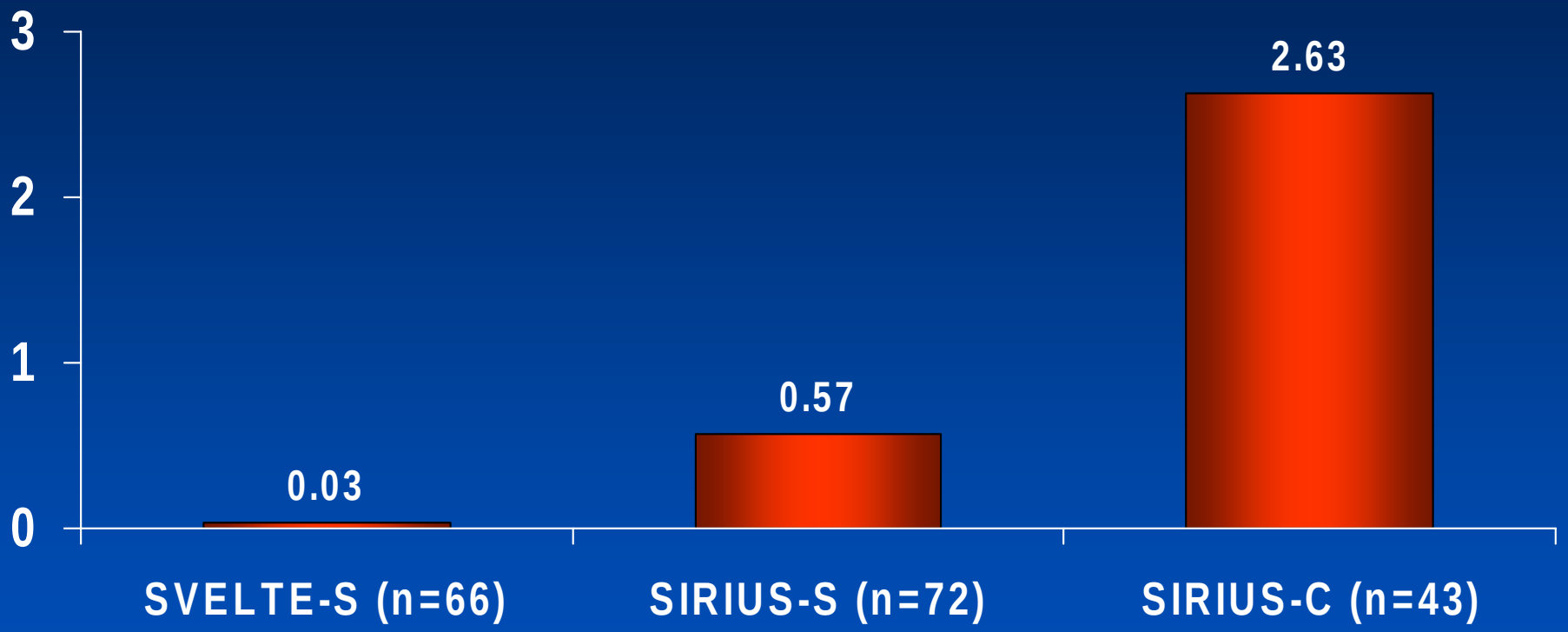
S: Sirolimus-eluting stent - C: Control

Binary Restenosis (QCA), 8 Mo



S: Sirolimus-eluting stent - C: Control

Neointimal Hyperplasia (IVUS), 8M



S: Sirolimus-eluting stent - C: Control

MACE, 8 Mo

	SVELTE–S (n=101)	SIRIUS–C (n=323)	*P*-value	SIRIUS–S (n=350)
MACE (overall)	5.0 (5/101)	14.9 (48/323)	0.0080	7.7 (27/350)
Death	2.0 (2/101)	0.9 (3/323)	0.5204	0.9 (3/350)
MI	3.0 (3/101)	2.8 (9/323)	0.7907	3.1 (11/350)
Q-Wave MI	1.0 (1/101)	0.3 (1/323)	0.1309	0.6 (2/350)
Non-Q-Wave MI	2.0 (2/101)	2.5 (8/323)	0.7700	2.6 (9/350)
TLR	*0 (0/101)*	12.7 (41/323)	0.0001	4.6 (16/350)
TLR-PCI	*0 (0/101)*	12.1 (39/323)	0.0002	4.0 (14/350)
TLR-CABG	*0 (0/101)*	1.5 (5/323)	0.1652	0.6 (2/350)

S: Sirolimus-eluting stent - C: Control

EVOLUTION Study
2.0-2.5mm

Multicenter registry
52 patients

- RVD= 2.0 ~ 2.5 mm
- Lesion length < 18mm
- SES heparin coated cobalt-Cr stent

6-Month Angiographic FU

Follow-up- 6 mos	N=50
In-stent restenosis	4 (8.0%)
In-lesion restenosis	5 (10.0%)
In-stent late loss	0.30±0.44
In-lesion late loss	0.28±0.45

Volumetric IVUS Analysis

	6 month Follow-up N=35
Stent volume (mm^3)	67.79 ± 20.74
Lumen volume (mm^3)	66.23 ± 20.96
NIH volume (mm^3)	1.61 ± 2.29
Obstruction (%)	2.49 ± 3.50

Clinical FU, 12 Mo

	N=52
Death (cardiac)	1 (1.9%)
MI: Q-Wave	0 (0.0%)
Non-Q	1 (1.9%)
TLR	7 (13.5%)
TL-CABG	0 (0.0%)
TL-PCI	7 (13.5%)
MACE	9 (17.3%)

Clinical follow-up available in 100% of patients

The SIRIUS-2.25 mm Trials

- To assess the safety and the efficacy of the 2.25mm SES in patients with de novo native coronary lesions
- Prospective, non-randomized study including 100 patients at 12 centers in the US

Moses. TCT 2006

Inclusion & Exclusion Criteria

- Inclusion Criteria
  - Stable or unstable angina
  - De novo lesion
  - Reference vessel diameter 2.0 to 2.5mm by visual estimation
  - Lesion length < 20mm
  - TIMI flow ≥1
- Exclusion Criteria
  - Unprotected LM stenosis
  - Acute MI within the preceding 24 hours
  - Ostial lesion location
  - Visible thrombus
  - LVEF ≤ 25%
  - Serum creatinine > 3.0 mg/dl

Moses. TCT 2006

Endpoint

- Primary Endpoint
  - In-lesion binary angiographic restenosis at 6 months by QCA

- Secondary Endpoints
  - At 6-month Follow-up
    - In-stent BAR, in-stent MLD, & in-lesion MLD
  - At 6-and 9-month follow-up:
    - TLR, TVR, TVF
  - MACE at 30 days, 6, 9, and 12 months and years 2-5
  - Stent lumen and stent volume obstruction by IVUS both post-procedure and at 6 months in subset of patients

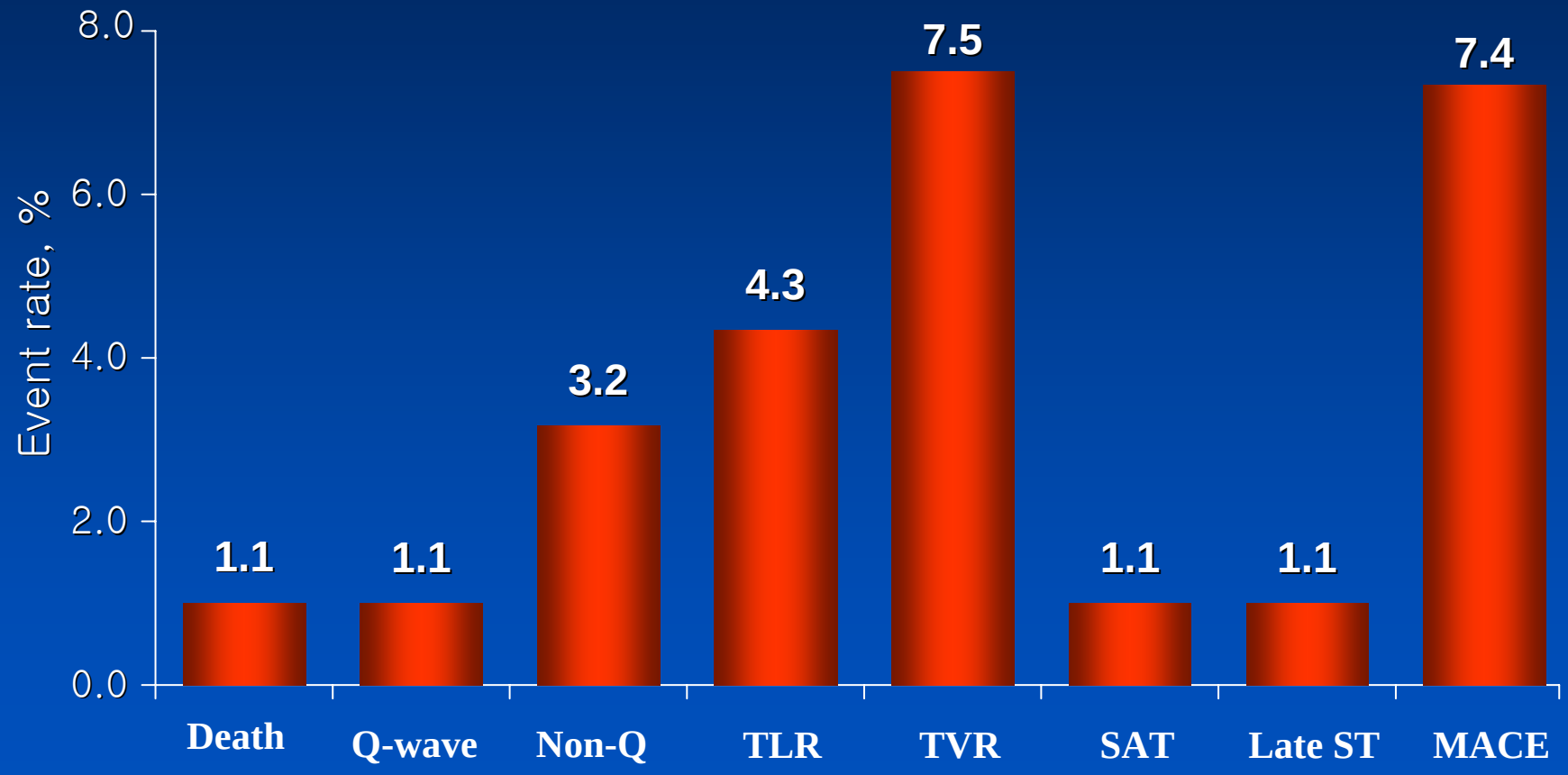
Moses. TCT 2006

Baseline Clinical Characteristics

2.25mm Sirolimus-Eluting Bx Velocity TM, N=100	
Age, mean±SD (years)	63.4±9.9
Male gender	64.0%
Diabetes mellitus	40.0%
Hyperlipidemia	86.0%
Hypertension	84.0%
History of CVA/TIA	8.0%
Prior MI	35.1%
Prior CABG	29.0%
Smoking within 30 days	20.2%
Unstable angina	17.0%

Moses. TCT 2006

Six-month Clinical Follow-up



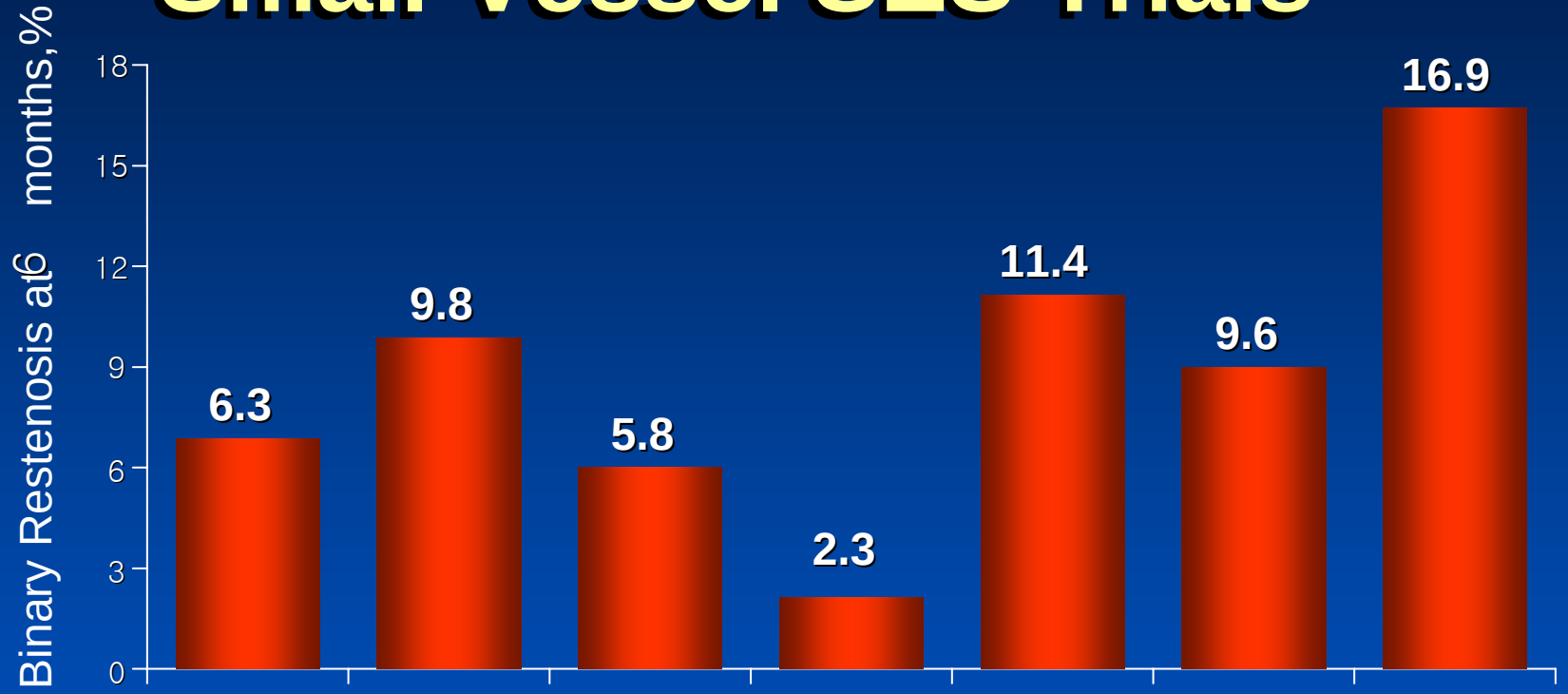
Moses. TCT 2006

Multivariate Predictors of 6-Month Binary Restenosis

Variable	Odds Ratio	*P*-value
In-stent binary restenosis		
Total stent length implanted	1.21	0.001
In-lesion binary restenosis		
Number of implanted stents	10.4	0.002

Moses. TCT 2006

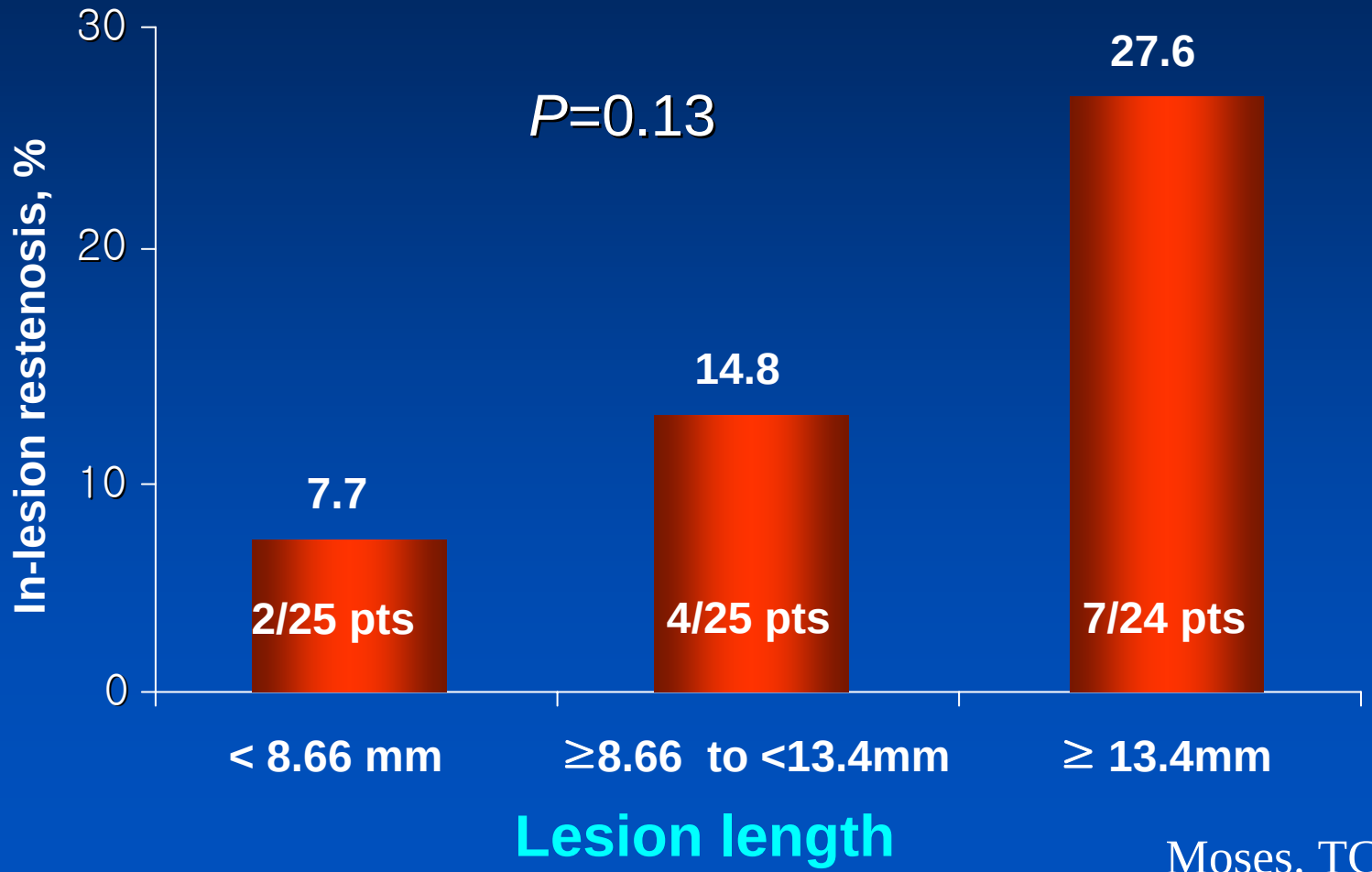
Six-month Binary Restenosis in Small-Vessel SES Trials



Mean RVD, mm	2.37	2.20	2.59	2.65	2.44	2.40	2.04
Mean length,mm	14.8	13.0	14.8	14.5	12.9	17.0	12.1
Diabetes, %	27%	19%	19%	24%	0%	27%	40%

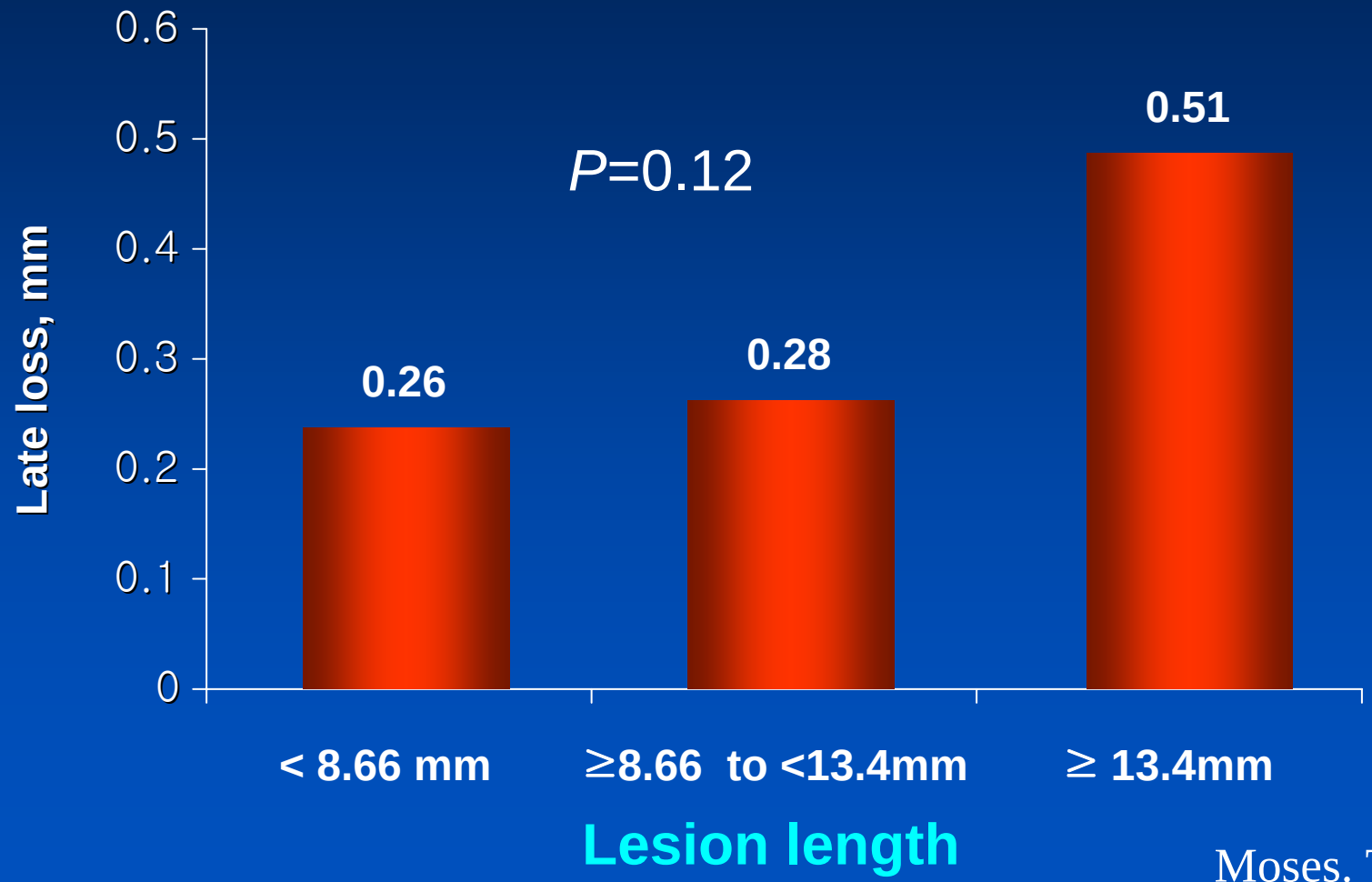
Moses. TCT 2006

Primary Endpoint: In-lesion Binary Restenosis



Moses. TCT 2006

In-Stent Late Loss in Relation to Lesion Length



Moses. TCT 2006

Six-month Clinical Outcomes

	1st tertile	2nd tertile	3rd tertile	*P*-value
Death (%)	1 (3.6%)	0 %	0%	
Myocardial infarction (%)	1 (3.6%)	2 (6.3%)	1 (3.0%)	0.76
TLR	0%	0%	4 (12.6%)	0.024
TVR	1 (3.6%)	0%	6 (18.9%)	0.013
TVF	2 (7.1%)	2 (6.3%)	6 (18.9%)	0.23
Stent Thrombosis	1 (3.6%)	0%	1 (3.0%)	0.74

Moses. TCT 2006

Conclusion

- The SES is effective in reducing restenosis compared with bare metal stents, even in smaller vessels treated with the small 2.25mm SES, but the use of multiple stents may still be an important predictor of restenosis and repeat revascularization.

- A larger clinical trial in patients with longer lesions is warranted to determine if the effects of lesion length have a disproportionate effect in patients with smaller vs. larger vessels.

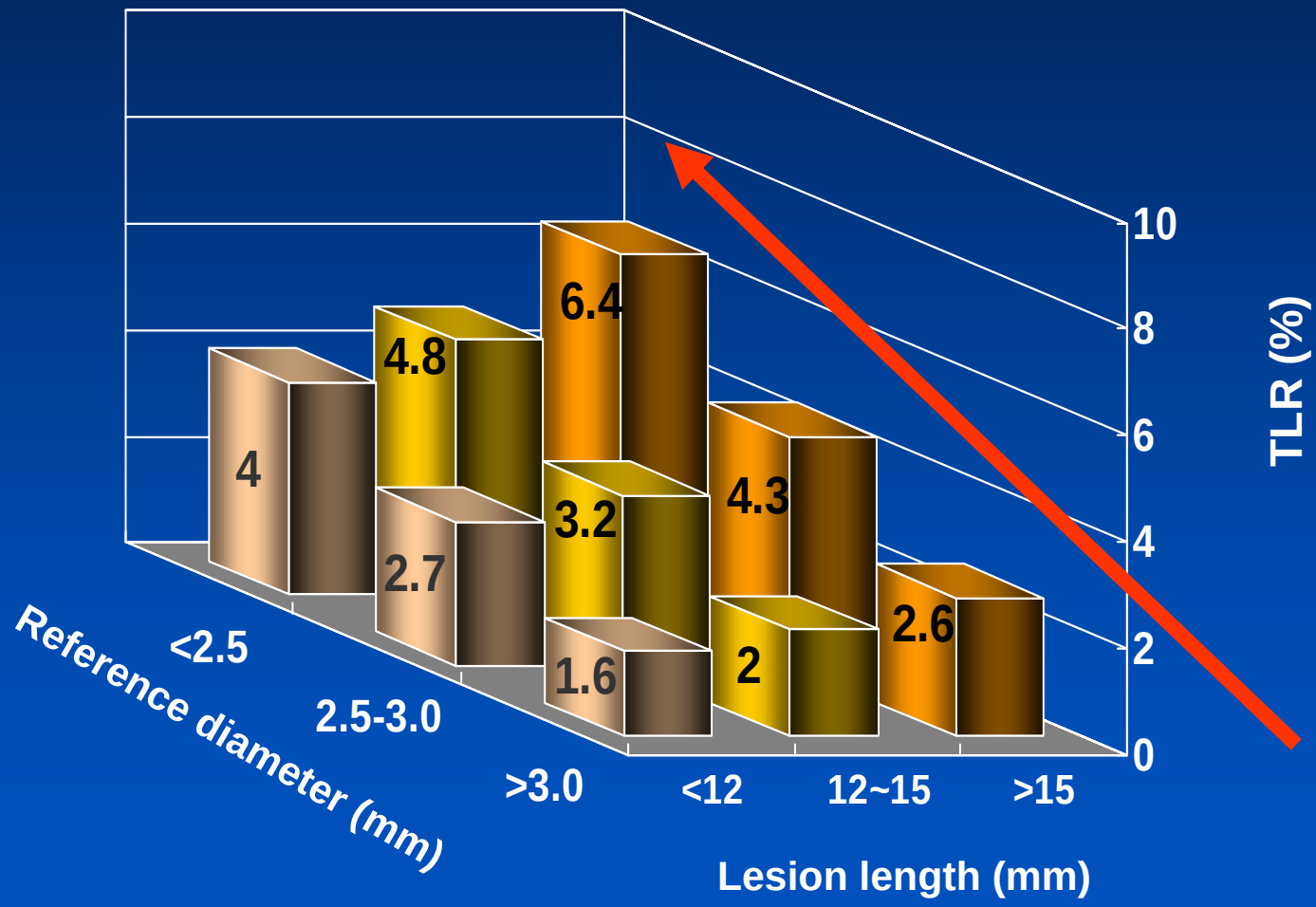
Moses. TCT 2006

DES in Small Coronary Lesions

Impact of Small Diameter

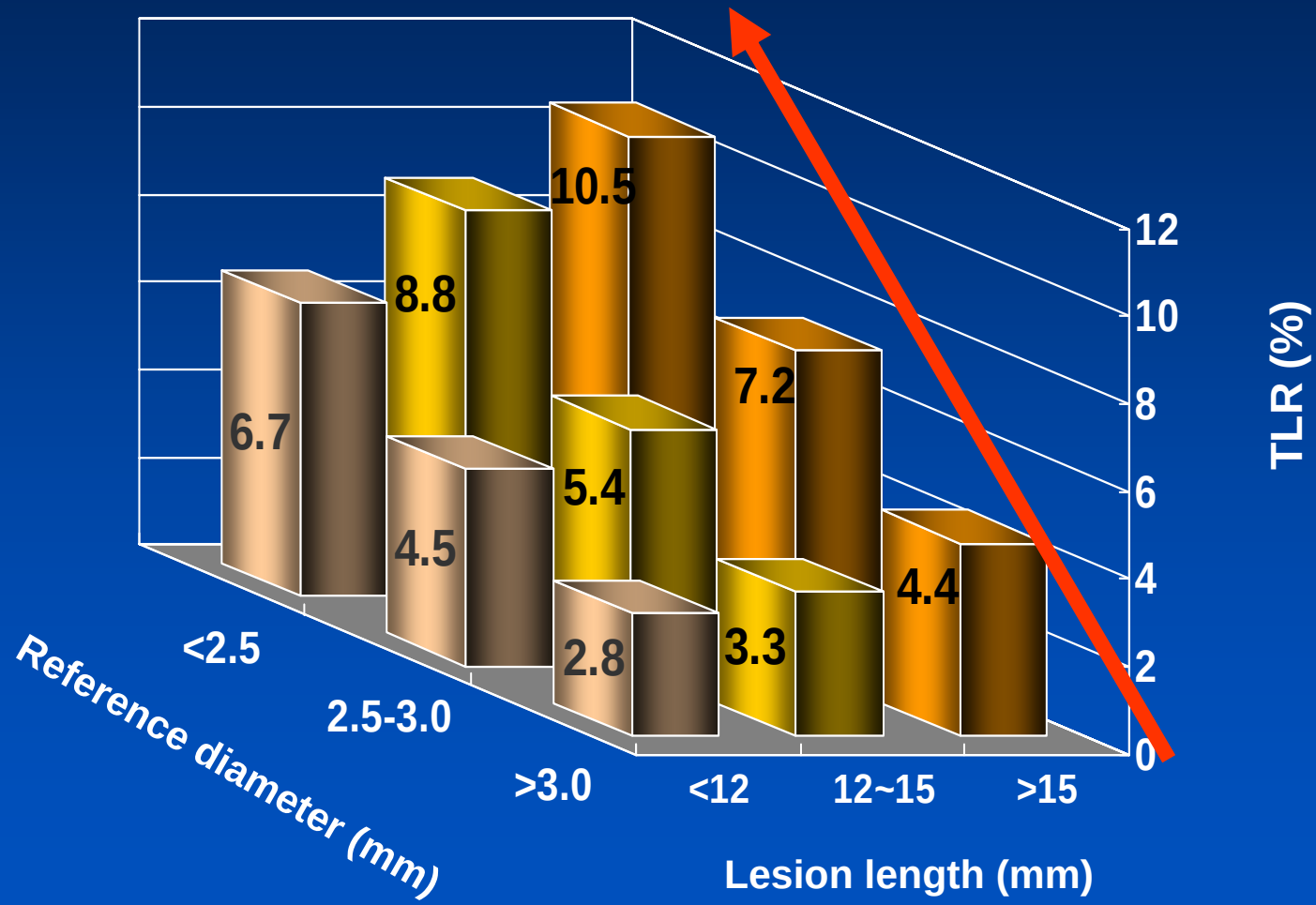
Predictors of TLR

In non-diabetics from Ravel, Sirius, New-Sirius, Direct and Svelte



Predictors of TLR

In diabetics from Ravel, Sirius, New-Sirius, Direct and Svelte



DES vs. BMS in Small Vessels

- In patients with small coronary lesions, the treatment with DES (either Cypher or Taxus), compared to the BMS, is associated with a dramatic reduction of angiographic and clinical events as the other coronary lesion subsets.
- However, the small coronary vessel remains an independent predictor of angiographic restenosis even in the DES era.

Small Vessel Disease

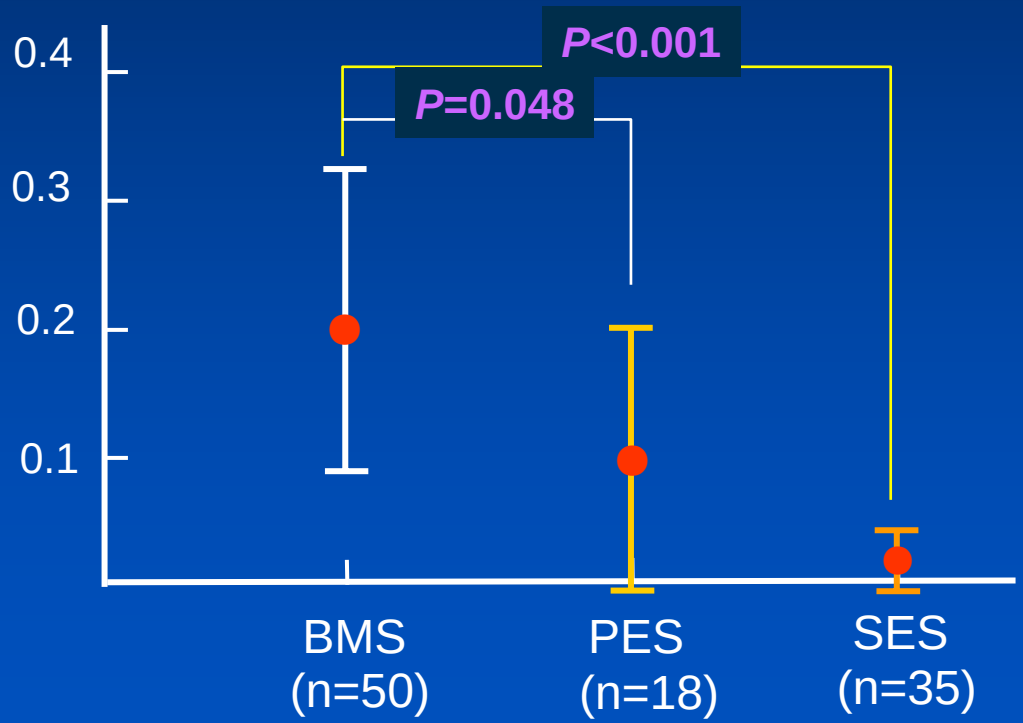
DES vs. BMS

IVUS Comparison of IH

BMS (Multi-Link) vs. PES (ACHIEVE) vs. SES

LL: 11.7mm, RVD: 2.6mm, DS:68.3%

6Mo Intimal Hyperplasia Thickness

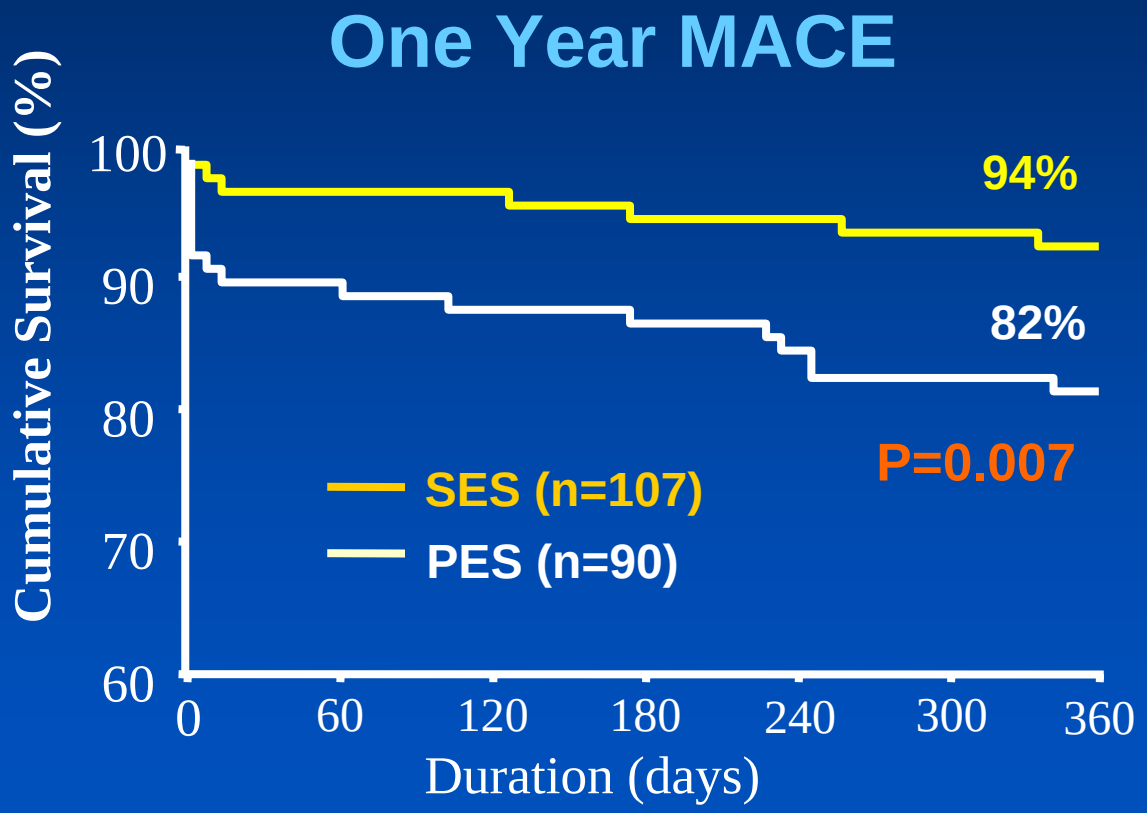


Hoffmann R. Am J Cardiol 2004

Comparison of Very Small Vessels in RESEARCH vs. T-SEARCH Registries

2.25mm SES and PES stents

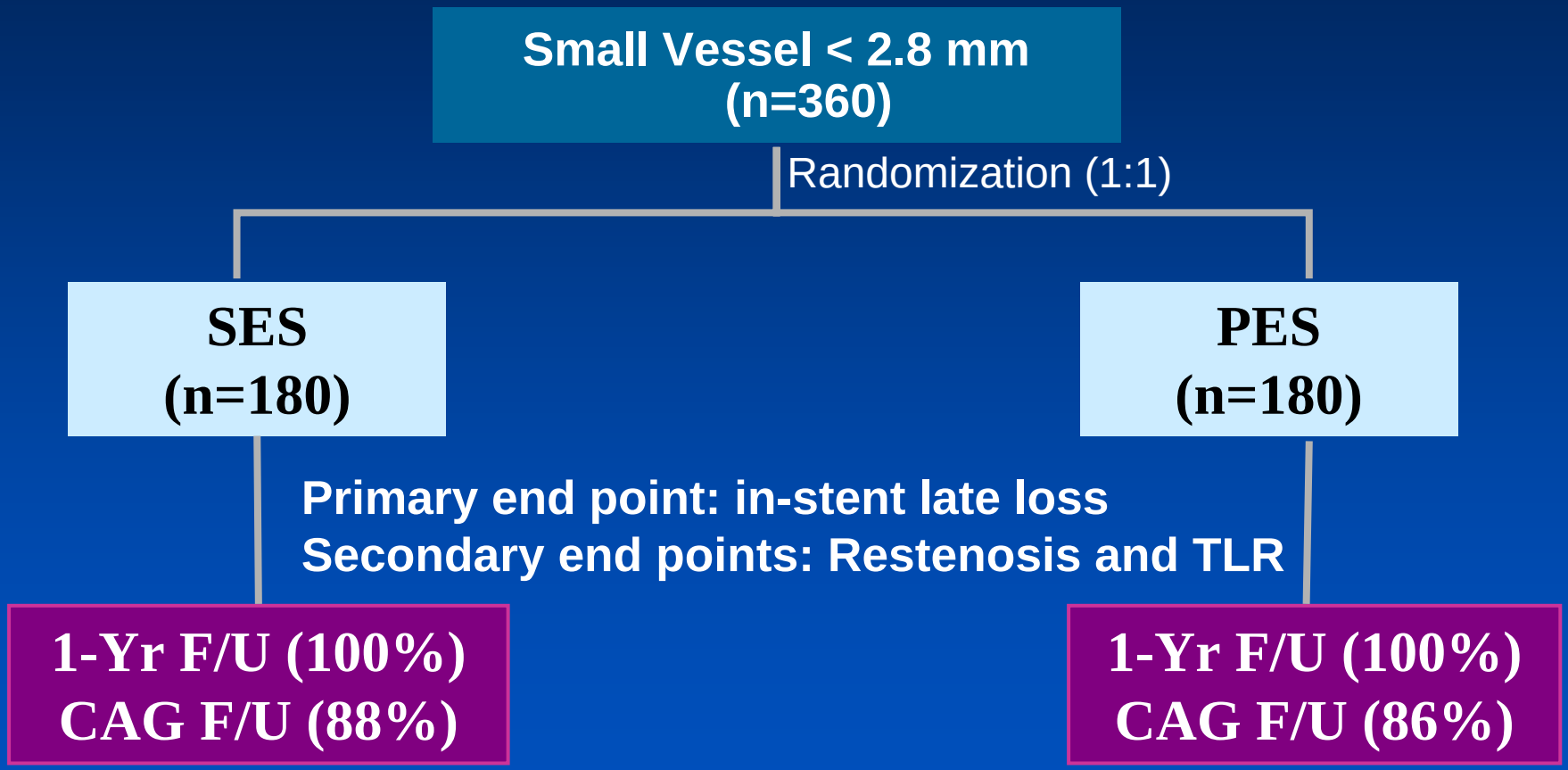
RVD: 1.90mm, MLD: 0.52mm, DS:72.4%, Stent length: 17.8mm



Rodriguez-Granillo GA. J Invasive Cardiol 2005

SES vs PES for Small Vessels

ISAR-SMART 3 study



Mehilli J. Eur Heart J 2006;27:260

Angiogrpahy before Procedure

	PES (n=204)	SES (n=198)	*P*-value
Vessel size (mm)	2.40±0.38	2.44±0.38	0.34
Lesion length (mm)	11.7±6.7	12.9±8.0	0.12
MLD (mm)	10.3±0.39	0.99±0.40	0.33
DS (%)	57.2±14.4	59.4±15.3	0.15
Type B2/C lesions, n (%)	151 (74)	142 (72)	0.60

Mehilli J. Eur Heart J 2006;27:260

Angiogrpahy after Procedure

	PES (n=204)	SES (n=198)	*P*-value
Length of stent (mm)	21.0±7.8	21.4±9.8	0.65
MLD			
in-stent (mm)	2.44±0.37	2.44±0.36	0.80
in-segment (mm)	2.00±0.47	2.04±0.47	0.41
DS			
in-stent (%)	6.3±7.7	5.6±7.5	0.36
in-segment (%)	18.5±7.2	16.7±7.7	0.05

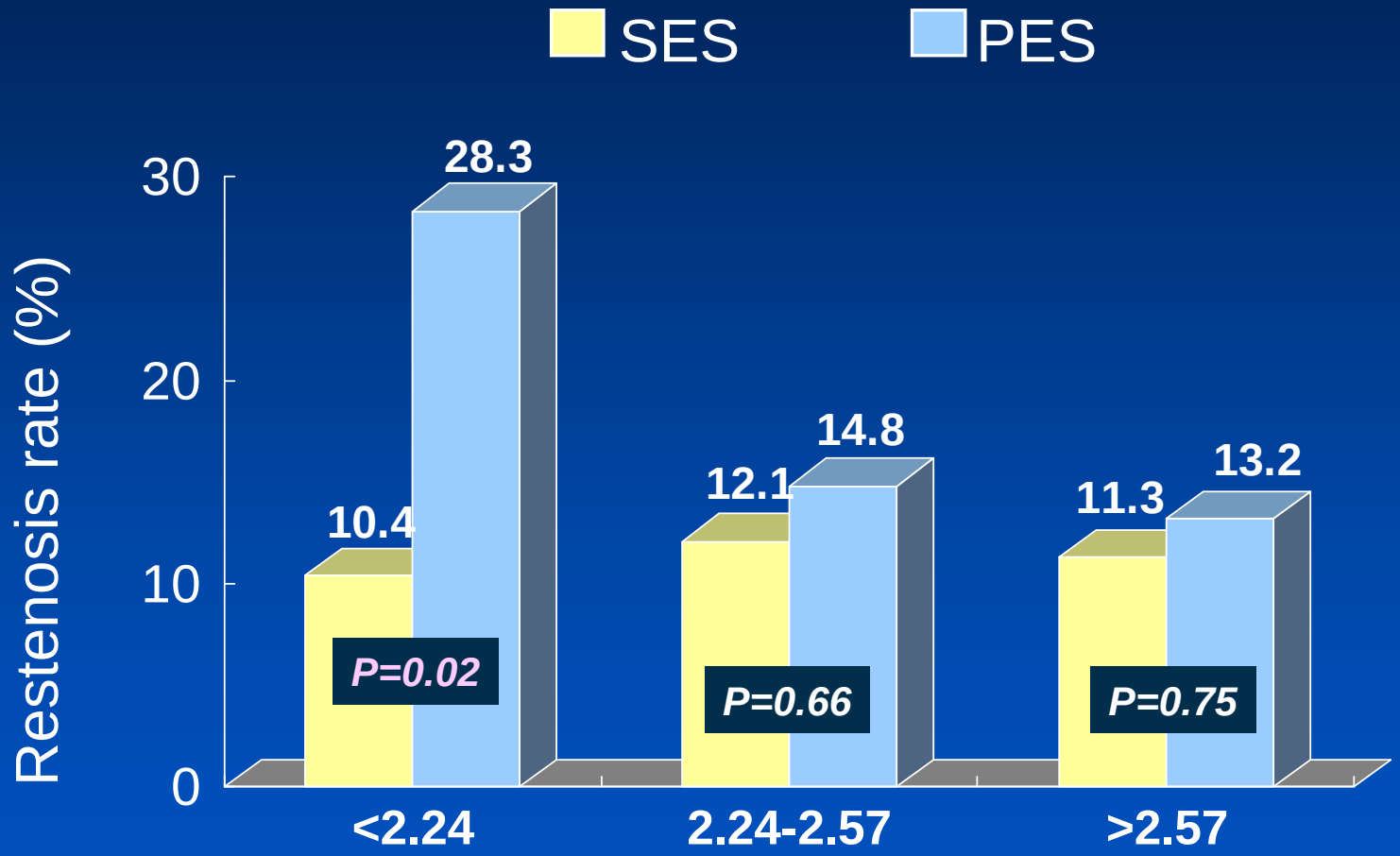
Mehilli J. Eur Heart J 2006;27:260

Angiogrpahy at Follow-up

	PES (n=204)	SES (n=198)	*P*-value
MLD			
in-stent (mm)	1.88±0.67	2.21±0.66	<0.001
in-segment (mm)	1.67±0.63	1.91±0.61	<0.001
Late lumen loss			
in-stent (mm)	0.56±0.59	0.25±0.55	<0.001
in-segment (mm)	0.34±0.57	0.13±0.56	<0.001
Binary restenosis			
in-stent, n (%)	26 (14.9)	14 (8.0)	0.04
in-segment, n (%)	33 (19.0)	20 (11.4)	0.047

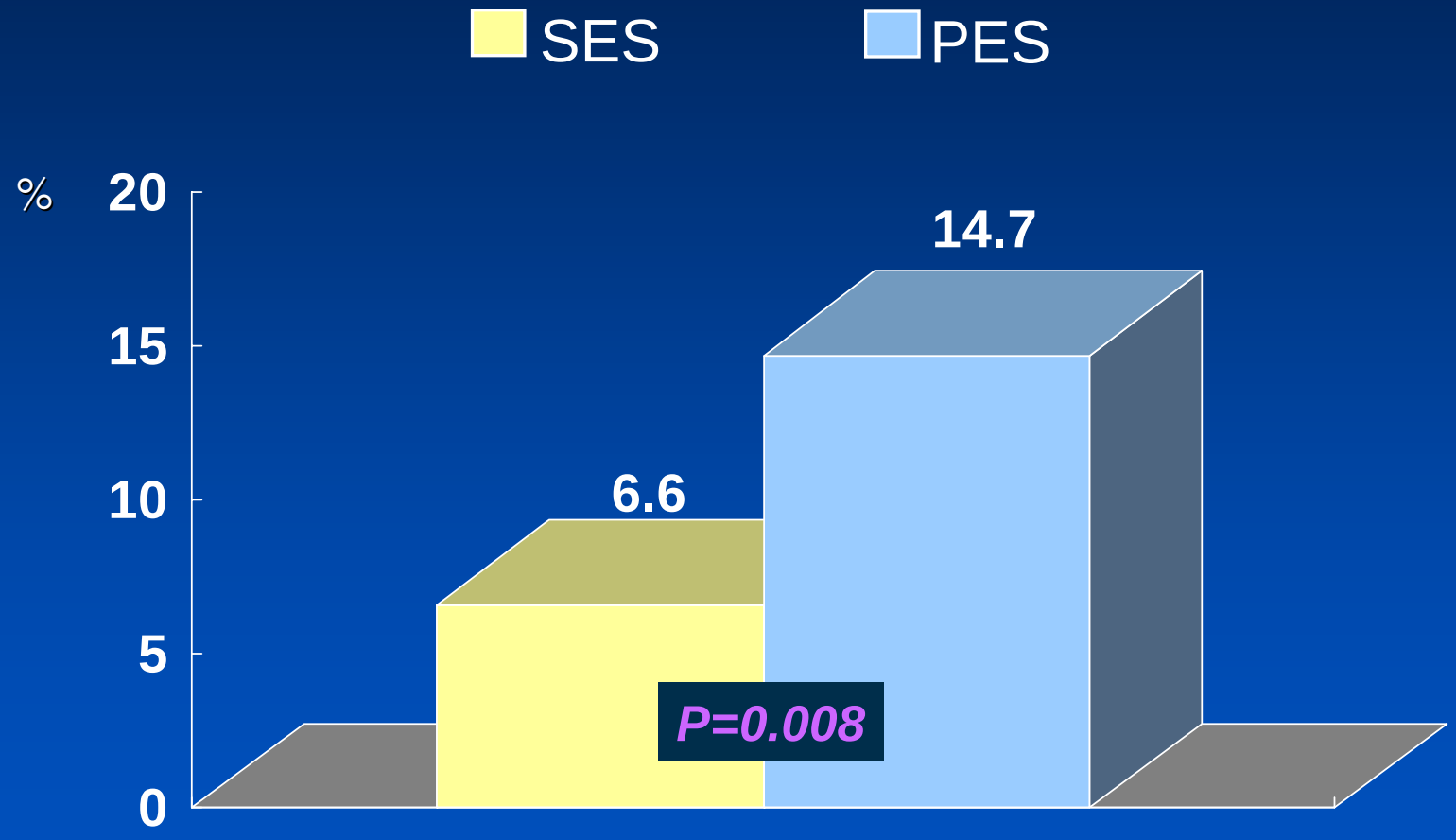
Mehilli J. Eur Heart J 2006;27:260

Impact of Vessel Size on Restenosis



Mehilli J. Eur Heart J 2006;27:260

Target Lesion Revascularization



Mehilli J. Eur Heart J 2006;27:260

AMC Experience in Small Vessel Disease

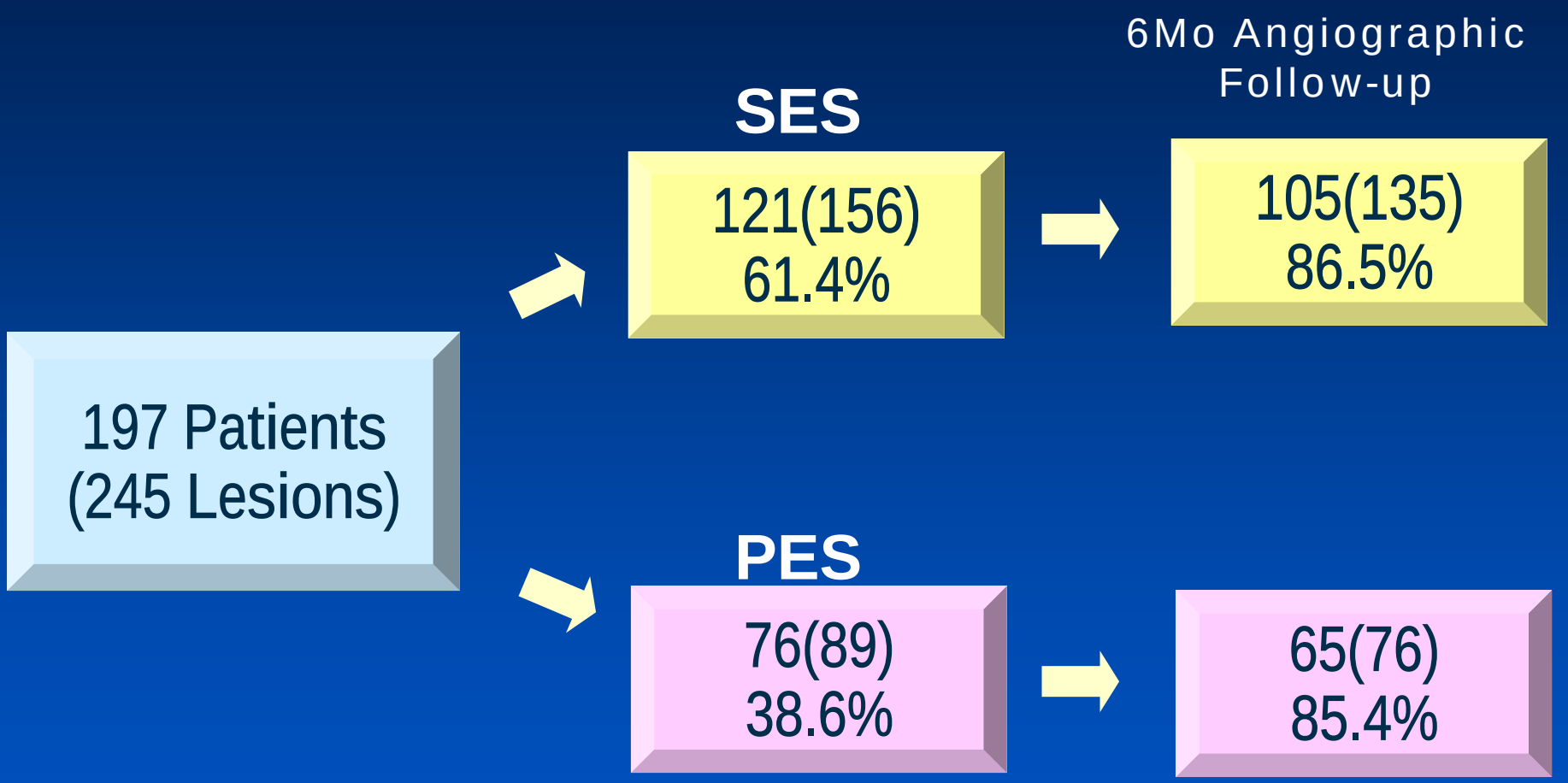
Subjects

- Between June 2003 and July 2004
- Inclusion criteria
  - Reference diameter ≤ 2.75mm
  - Diameter stenosis ≥ 70%
- Exclusion criteria
  - AMI within 48 hrs
  - LVEF ≤ 40%
  - LM, Bifurcation, CTO and ISR lesions
  - History. of PCI or CABG

Park KH. Catheter Cardiovasc Interv 2006;67:589

AMC

Subjects
≤ 2.75 mm



Park KH. Catheter Cardiovasc Interv 2006;67:589

AMC

Baseline Characteristics

	SES (n=121)	PES (n=76)	*P*-value
Age, yrs	61.0±8.6	59.210.6	0.22
Male, n (%)	76 (62.8)	54 (71.0)	0.28
LVEF, %	59.1±8.5	58.8±7.6	0.79
Hypertension, n (%)	62 (51.2)	34 (44.7)	0.38
Diabetes mellitus, n (%)	39 (32.2)	21 (24.5)	0.53
Current smoker, n (%)	35 (28.9)	28 (36.8)	0.21
Hypercholesterolemia, n (%)	39 (32.2)	30 (39.5)	0.36
ACS	61 (50.4)	33 (43.3)	0.20

Park KH. Catheter Cardiovasc Interv 2006;67:589

Angiographic and Procedural Results

	SES (n=156)	PES (n=89)	*P*-value
Multivessel, n (%)	62 (76.0)	63 (82.8)	0.51
Lesion location			0.21
LAD, n (%)	52 (52.6)	53 (59.6)	
LCX, n (%)	50 (32.0)	20 (22.4)	
RCA, n (%)	24 (15.3)	16 (18.0)	
Total stent length (mm)	31.4±17.5	32.8±14.4	0.69
Maximal pressure (atm)	15.9±3.0	15.1±2.9	0.09
Maximal device diameter (mm)	2.91±0.2	3.0±0.22	0.23

Park KH. Catheter Cardiovasc Interv 2006;67:589

Baseline QCA

	Cypher (n=156)	Taxus (n=89)	*P*-value
Baseline			
Lesion length (mm)	25.2±14.7	27.1±12.7	0.34
Reference (mm)	2.47±0.21	2.44±0.25	0.19
MLD (mm)	0.86±0.33	0.81±0.42	0.31
Diameter stenosis (%)	65.4±13.0	67.5±16.0	0.22
After procedure			
MLD (mm)	2.52±0.33	2.42±0.35	0.45
Diameter stenosis (%)	3.7±7.1	5.8±8.3	0.06
Stent length (mm)	31.4±17.5	32.8±14.4	0.69

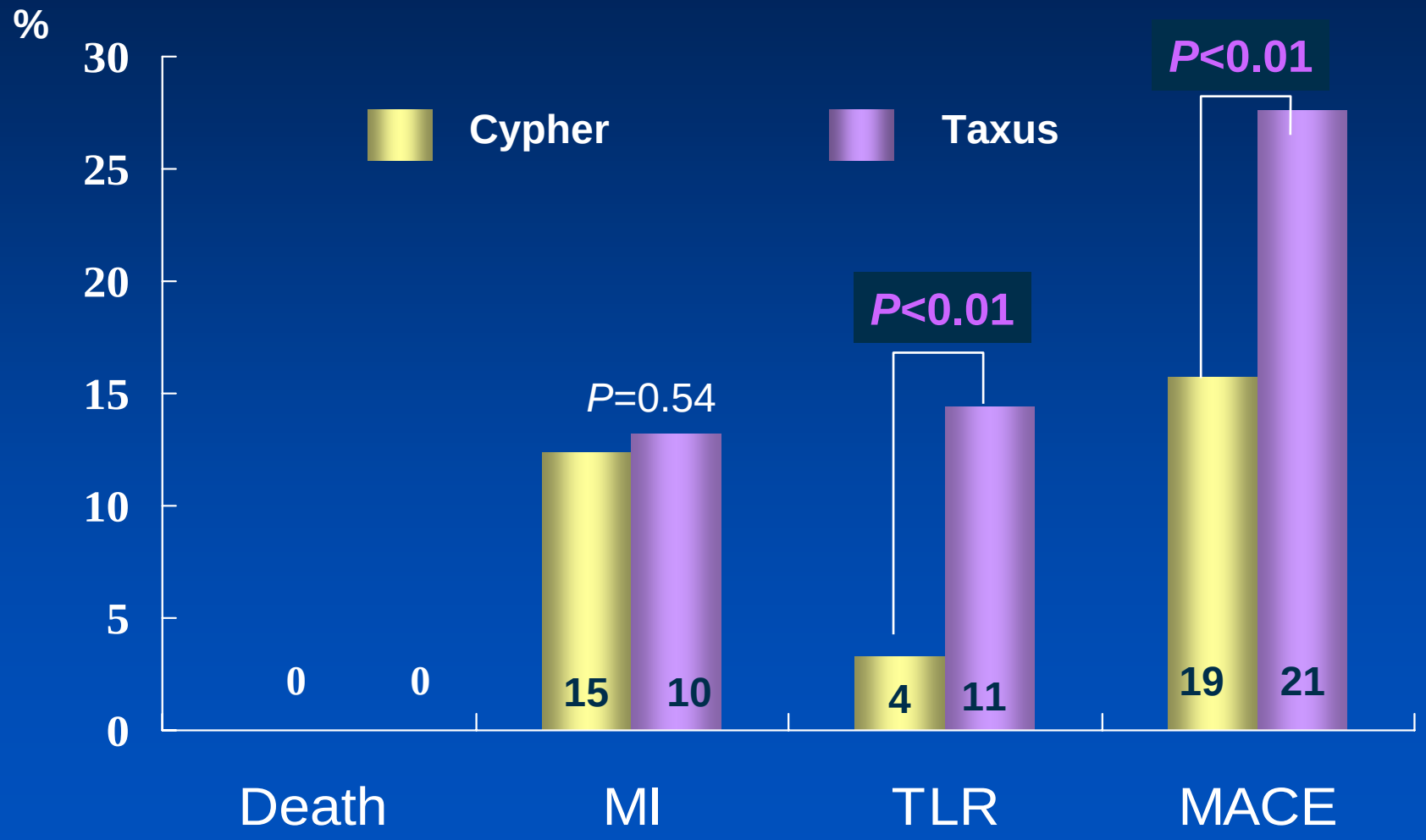
Park KH. Catheter Cardiovasc Interv 2006;67:589

QCA at 6 months

	Cypher (n=156)	Taxus (n=89)	*P*-value
Lesions, n (%)	135 (86.5)	76 (85.4)	0.85
Reference (mm)	2.46±0.28	2.43±0.39	0.54
MLD (mm)	2.32±0.56	1.77±0.77	<0.001
DS (%)	5.38±22.5	31.7±34.9	<0.001
Late loss (mm)	0.29±0.42	0.69±0.62	<0.001
Restenosis, n (%)	9 (6.7)	21 (27.7)	<0.001

Park KH. Catheter Cardiovasc Interv 2006;67:589

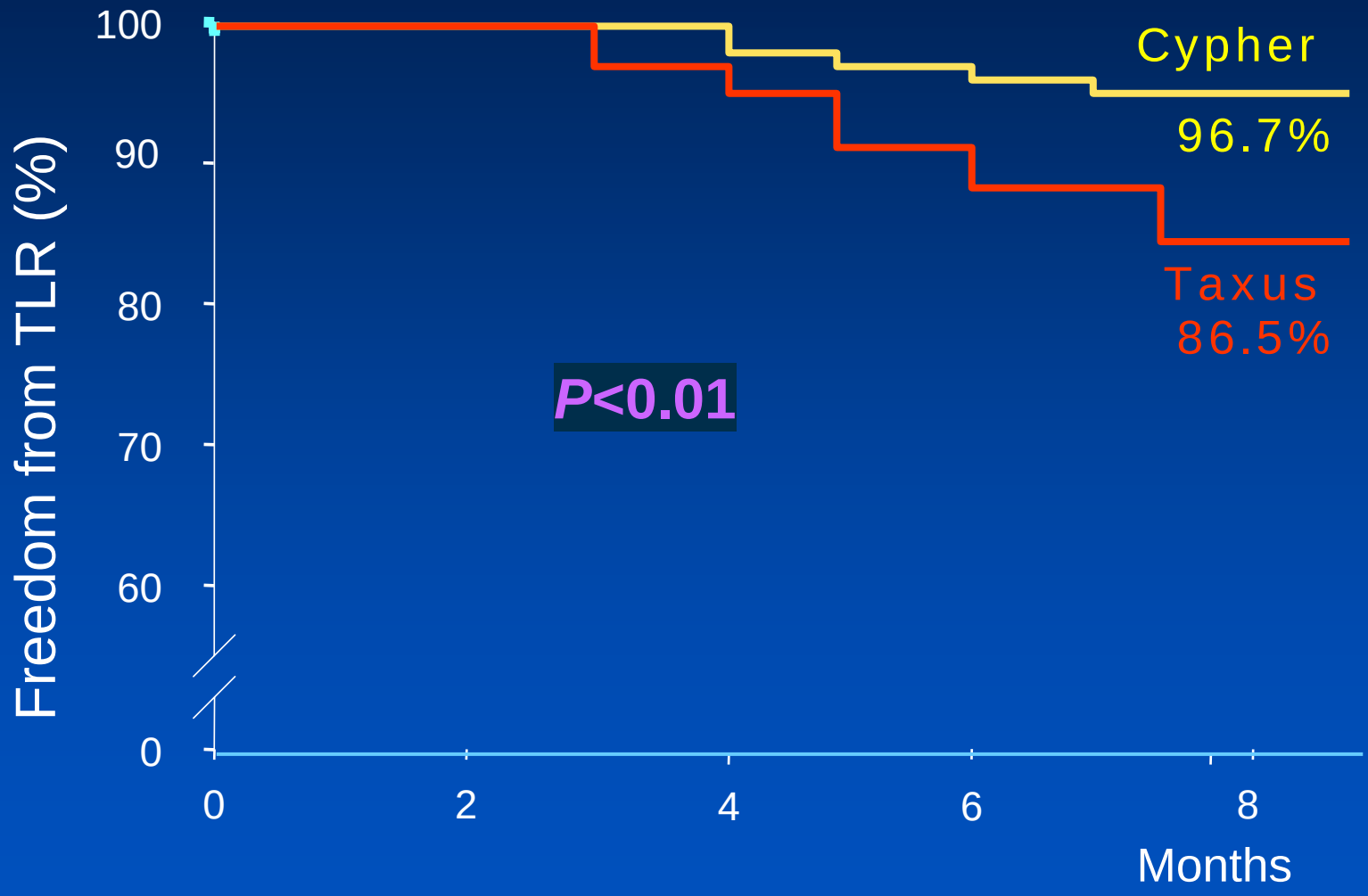
Clinical outcomes at 9Mo



Park KH. Catheter Cardiovasc Interv 2006;67:589

AMC

Freedom from TLR at 9Mo



Park KH. Catheter Cardiovasc Interv 2006;67:589

Predictive Factors of Restenosis after SES Implantation

Lee CW, Catheter Cardiovasc Interv. In Press

Methods

- Prospectively investigated predictable factors for cardiac events and restenosis
- Between February 2003 and September 2005
- Reference vessel size ≤ 2.8 mm
- 1,092 patients treated with Sirolimus-eluting stent(SES)
- Follow-up angiography was done at 6 months later

Lee CW, Catheter Cardiovasc Interv. In Press

Clinical Characteristics

Characteristic	N=1,092
Age(years)	60.8 ± 9.9
Men/Women	752/340
Current smoker	367 (33.6%)
Diabetes mellitus	361 (33.1%)
Total s-cholesterol ≥200mg/dl	232 (21.2%)
Hypertension	569 (52.1%)
Clinical presentation	
Stable angina pectoris	491 (45.0%)
Unstable angina pectoris	307 (28.1%)
Acute myocardial infarction	115 (10.5%)
Previous myocardial infarction	88 (8.1%)
Previous percutaneous coronary intervention	229 (21.0%)
Previous coronary bypass surgery	21 (1.9%)
Multivessel coronary disease	538 (49.3%)

Lee CW, Catheter Cardiovasc Interv. In Press

Lesion characteristics

Target coronary vessel	
LAD	763 (60.1%)
LCx	276 (21.7%)
RCA	230 (18.1%)
Type B2/C lesions	957 (75.4%)
CTO	86 (6.8%)
Ostial lesion	60 (4.7%)
Bifurcation	173 (13.6%)
ISR	141 (11.1%)
Infarct-related artery	97 (7.4%)

Lee CW, Catheter Cardiovasc Interv. In Press

Angiographic Characteristics

Lesion length(mm)	2.77 ± 15.2
RVD(mm)	2.47 ± 0.24
Pre-intervention	
MLD(mm)	0.75 ± 0.46
DS(%)	70.0 ± 16.8
Post-intervention	
MLD(mm)	2.52 ± 0.36
DS(%)	-1.0 ± 13.2
Acute gain	1.74 ± 0.52

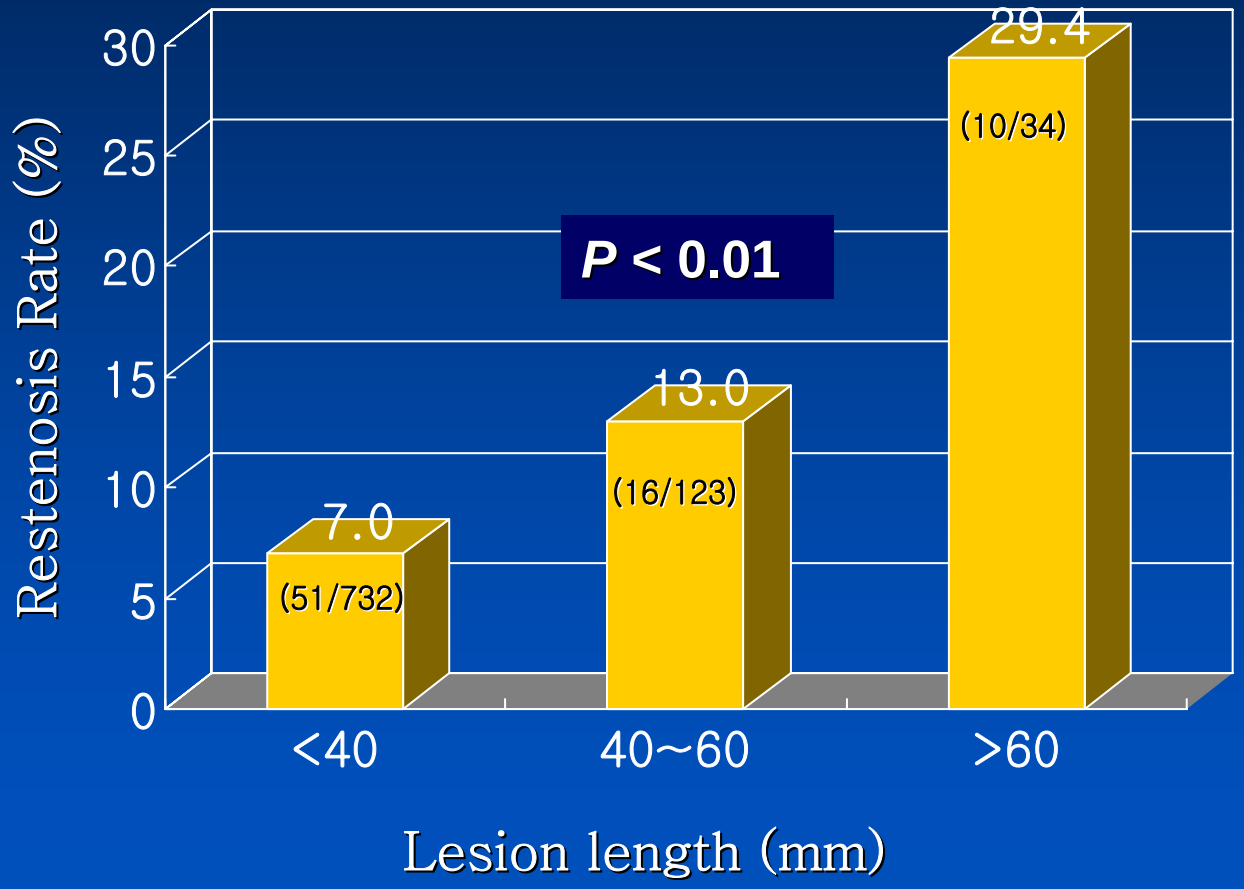
Lee CW, Catheter Cardiovasc Interv. In Press

Procedural Characteristics

Balloon to artery ratio	1.31 ± 0.16
Maximal inflation pressure(atm)	15.5 ± 3.6
Stents per lesion	1.4 ± 0.7
Stented length per lesion(mm)	34.8 ± 19.2

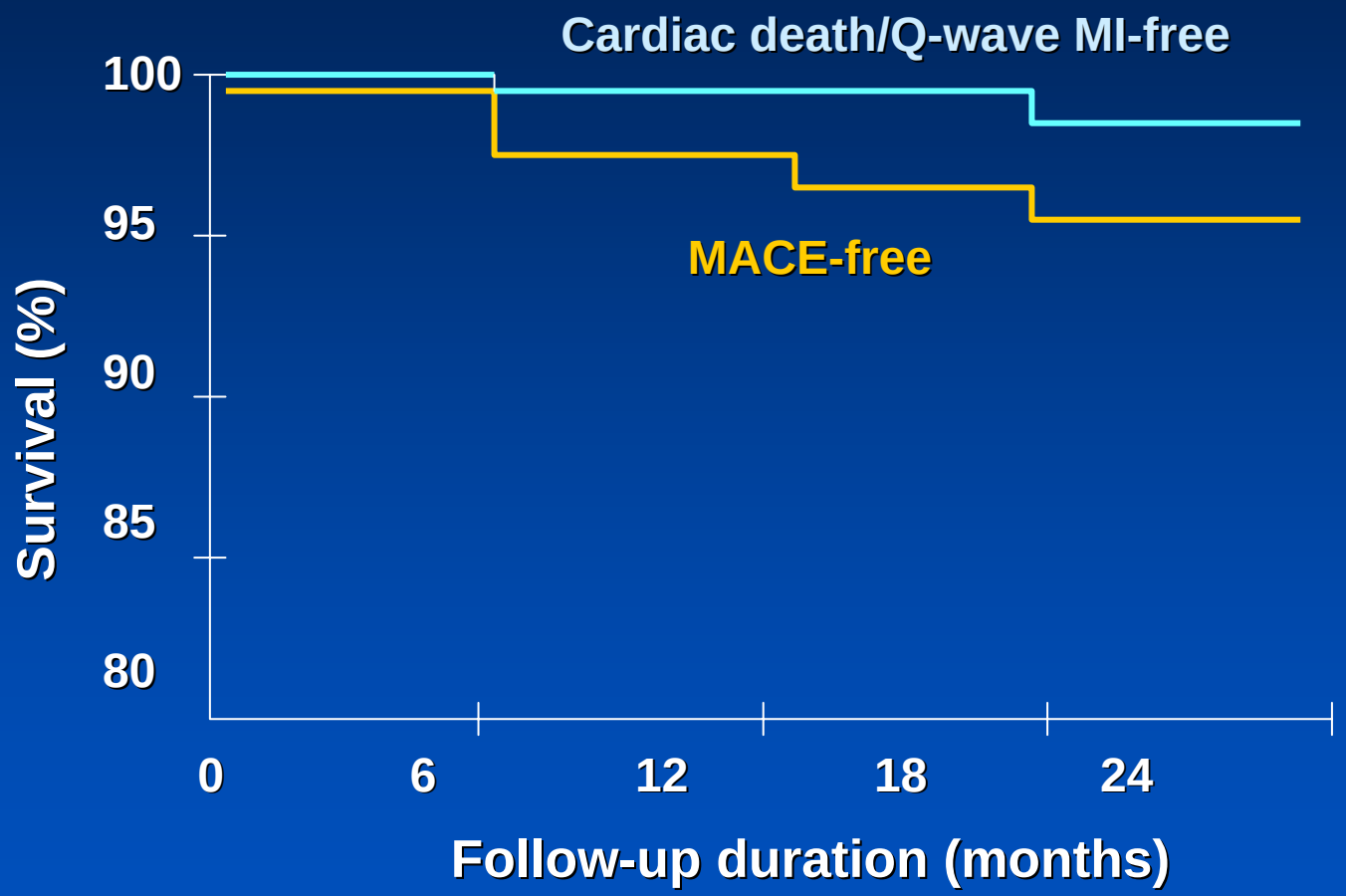
Lee CW, Catheter Cardiovasc Interv. In Press

Effects of lesion length on restenosis rate



Lee CW, Catheter Cardiovasc Interv. In Press

Event-free survival curves



Lee CW, Catheter Cardiovasc Interv. In Press

Conclusion

- Lesion length was a powerful predictor of restenosis and MACE
- Multiple overlapping stents in lesion length ≥ 60 mm was associated with SES failure
- The risk of complication and restenosis is increased by diffuse vessel disease and diabetes mellitus
- The risk of SES failure in ISR lesions was higher than in native coronary lesions

Lee CW, Catheter Cardiovasc Interv. In Press

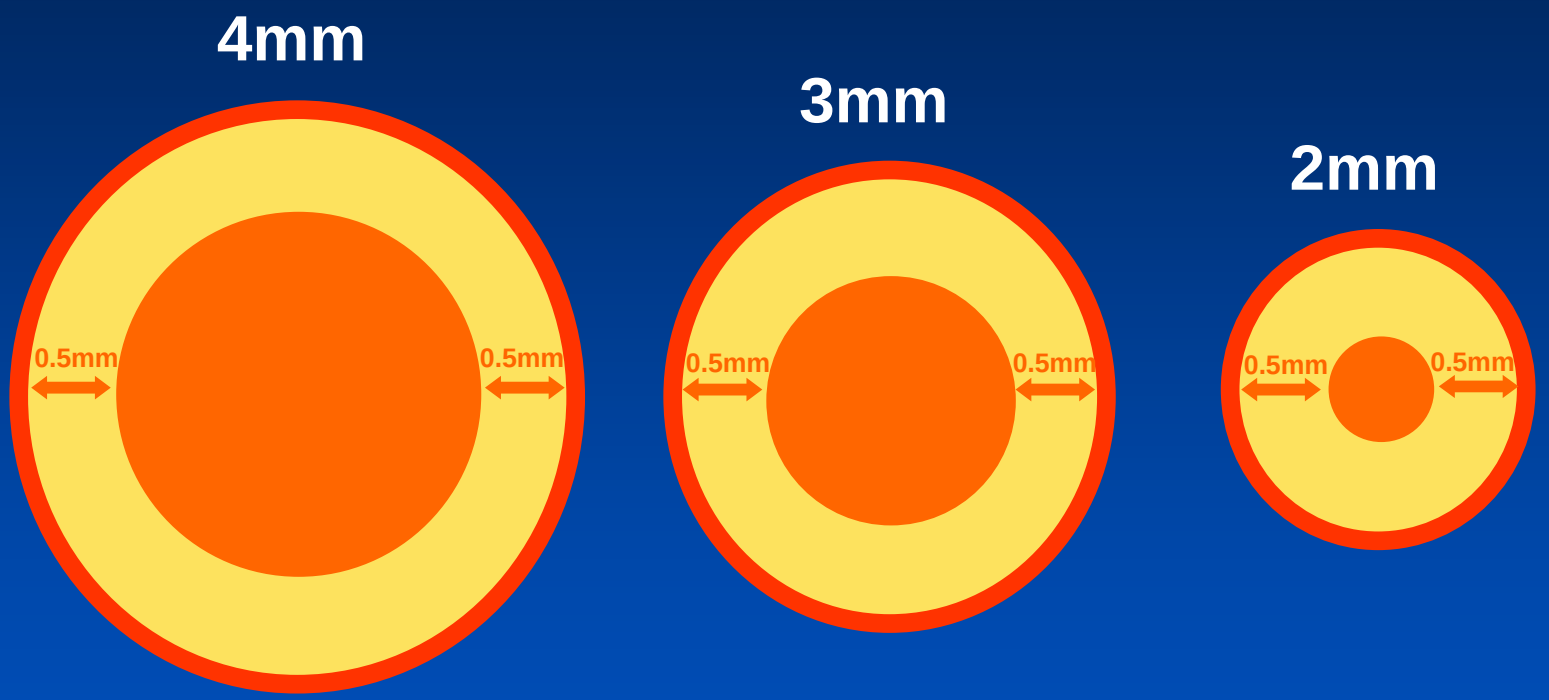
SES vs. PES in Small Vessels

- In patients with small vessels, use of the SES appears to be associated with a decrease in the extent of late luminal loss, angiographic restenosis, and the need of target lesion revascularization, as compared to use of the PES.
- Our finding in the AMC registry was in line with the recent randomized studies comparing the efficacy of SES versus PES.
- However, a randomized study for small coronary lesions is warranted to verity this registry result.

New DES for Small Vessels

Greater impact of late loss in small vessel

Late Loss 1mm



	4mm	3mm	2mm
%DS	25%	33%	50%
%Decrease in CSA	44%	56%	75%

ISAR-STEREO-2

BMS Study

611 Lesions

Lesion length: 14.0mm
RVD: 2.92mm
DS: 69.5%

Randomization (1:1)

Multilink

309 Lesions (50um)

6Mo Angiographic Follow-up

229 Lesions 77%

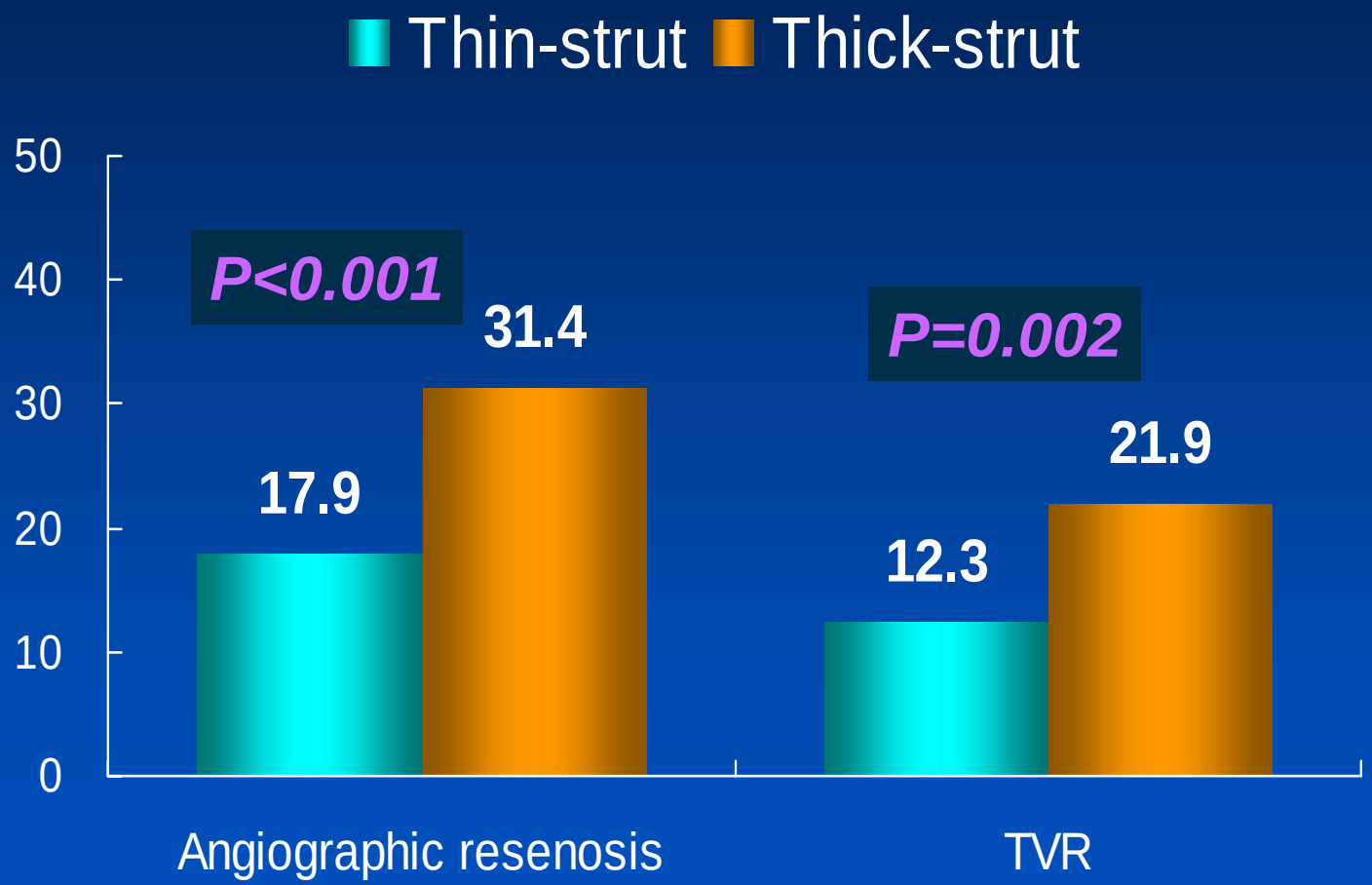
Bx Velocity

302 Lesions (140um)

236 Lesions 80%

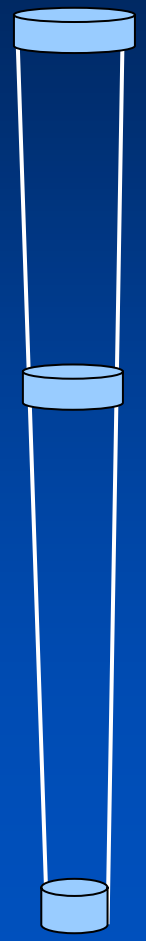
Pache J. JACC 2003;41:1283

Angiographic and Clinical Outcomes



Pache J. JACC 2003;41:1283

Thin Strut BMS vs. DES ?



μm		
0.200	Jo-Graft stent	
0.150	S 670	
0.140	Bx Velocity	Cypher / Taxus
0.130	Multilink Tetra	
0.120		
0.100	NIR	
0.090	Biodivysio	
0.080	Tsunami	
0.075	BeStent	
0.070	Driver / Vision	
0.062		
0.055		
0.050	ACS Multilink	

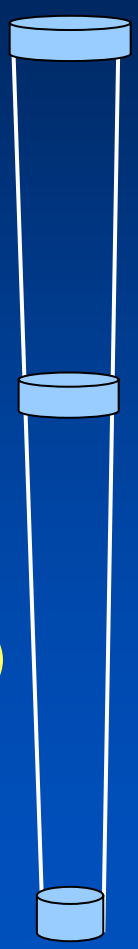
Strut Thickness and Restenosis in Small Vessel Disease

Thin-strut BMS (BeStent; 76µm) vs Thick-strut DES (Cypher; 140µm)

	Cypher	BeStent	*P*-value
Entire group (n=409)	9.0	22.5	<0.001
> 2.8mm (n=235)	7.0	34.2	<0.001
≤ 2.8mm (n=174)	10.0	13.1	0.52

Pache J. Eur Heart J 2005

However, Thin-Strut DES ?



μm

0.200 Jo-Graft stent

0.150 S 670

0.140 Bx Velocity

0.130 Multilink Tetra

Cypher

Taxus

0.120

0.100 NIR

0.090 Biodivysio

0.080 Tsunami

0.075 BeStent

0.070 Driver

Vision

0.062

0.055

0.050 ACS Multilink

Thin DES

New DES in Small Vessels

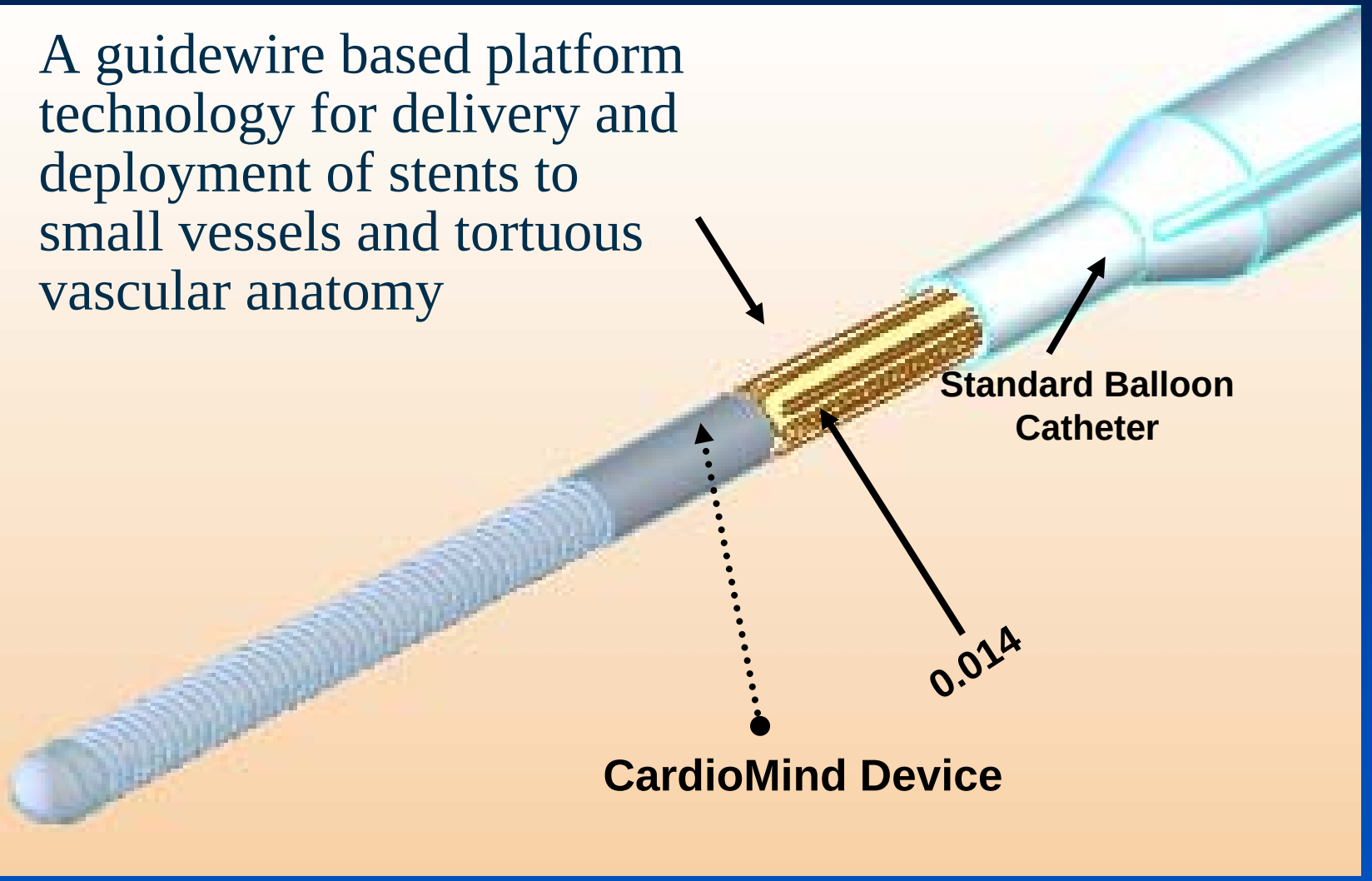
- In the studies with BMS, thinner strut has been shown to decrease neo-intimal hyperplasia.
- However, a recent randomized study failed to observe a similar efficacy of the thin-strut BMS compared to that of the SES in small coronary lesions.
- Nonetheless, a more smart DES stent platform with better conformability, trackability, and thinner stent strut is being investigated to improve the outcomes of small coronary interventions.

Need for Specific Designs

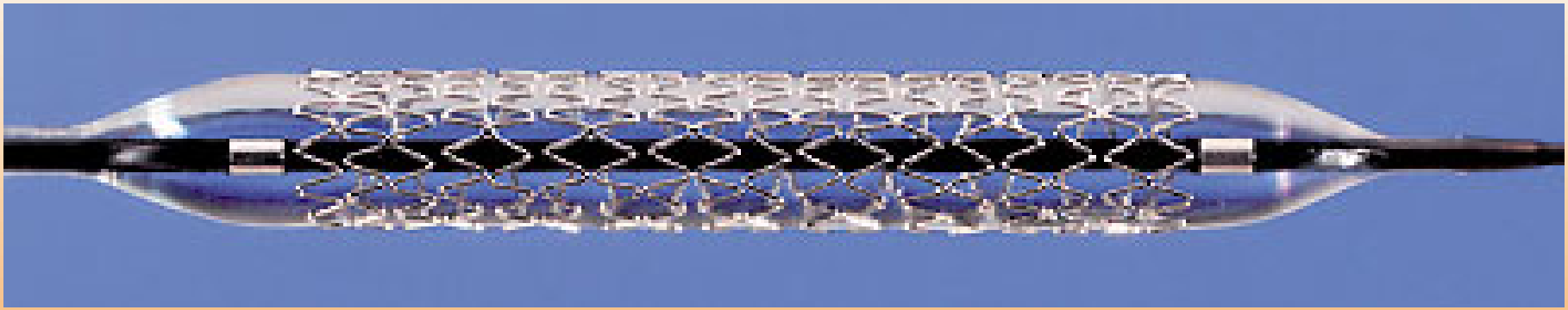
- Current balloon expandable stents are difficult to deliver to distal or tortuous sites
- Current stents are not designed to address unique needs of small vessel anatomy

CardioMind's New Platform

A guidewire based platform technology for delivery and deployment of stents to small vessels and tortuous vascular anatomy



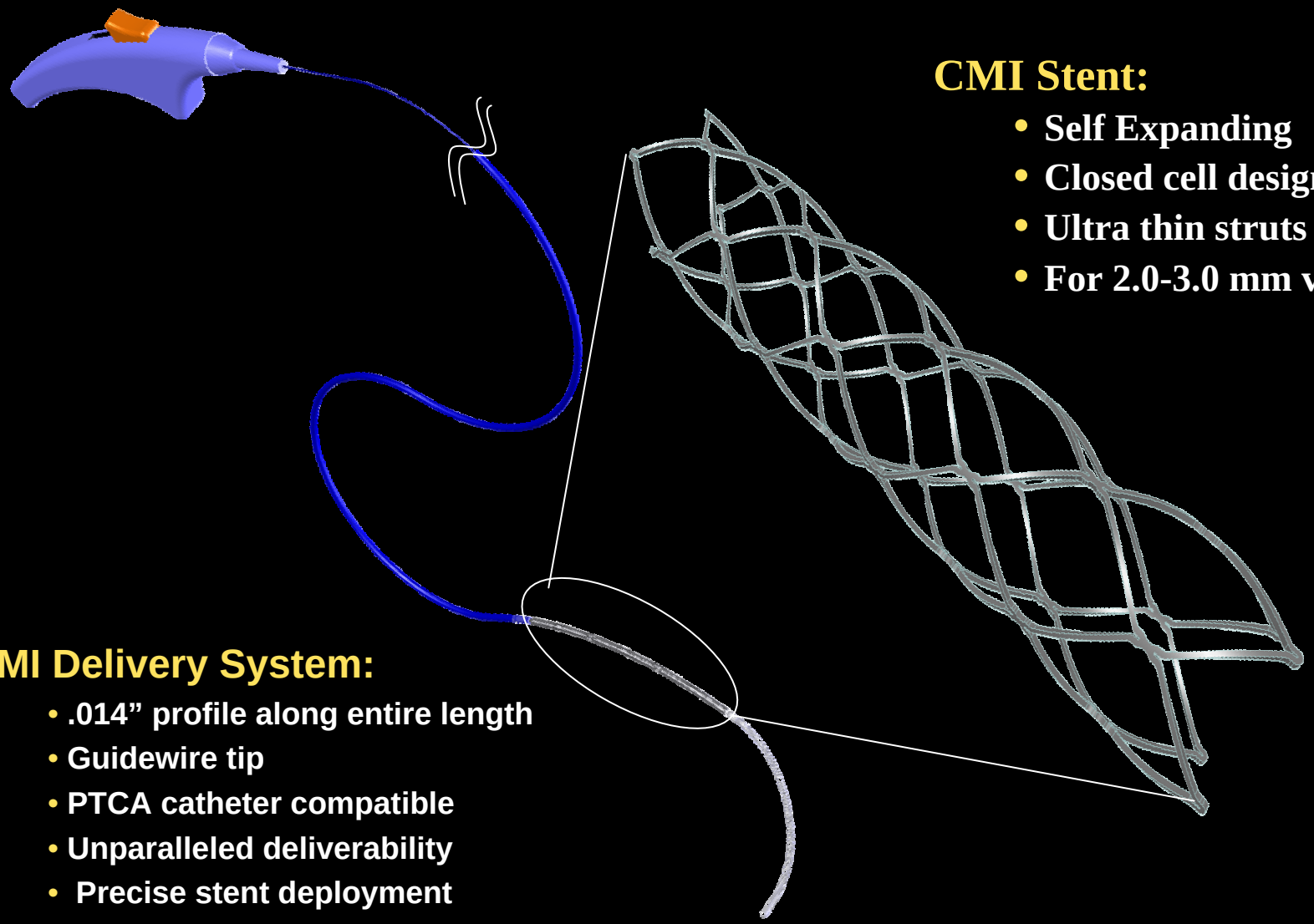
A New System That Shifts Stent Delivery From Over-the-Balloon To In-the-Wire



.014” CMI System

.014” Guidewire

The CardioMind System



CMI Stent:

- Self Expanding
- Closed cell design
- Ultra thin struts
- For 2.0-3.0 mm vessels

CMI Delivery System:

- .014” profile along entire length
- Guidewire tip
- PTCA catheter compatible
- Unparalleled deliverability
- Precise stent deployment

Caution: Investigational Device; Not available for sale in the United States

Acute Animal Study Experience

- 10+ acute studies in the pig model
- > 50 deployments of 2.0-3.5 mm stents in coronary vessels of pigs
- Full range of stent lengths from 8 to 28 mm
- Bare wire and through the lumen deliveries

Chronic Animal Study Results

- CMI stents are well tolerated within the coronary vasculature
- Minimal inflammatory response and favorable lumen area maintained by favorable remodeling of the vascular wall at both 28 and 90 days in porcine model

RCA 28 day

Courtesy of the C. Rogers, A. Groothuis, and P. Seifert, ECI Laboratory, Brigham and Women's Hospital