**Samsung Medical Center**
Sungkyunkwan University
School of Medicine

# IVUS: Postintervention

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# Disclosure

- Grant support
  - Korean Society of Interventional Cardiology
  - National Strategic Coordinating Center for Clinical Research
  - Sungkyunkwan University Foundation for Corporate Collaboration
  - Abbott Vascular, Boston Scientific, Biotronik, Biometrics, and Medtronic
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  - Abbott Vascular, Astra Zeneca, Biotronik, Biometrics, Daiichi Sankyo, Pfizer, and Sanofi-Aventis

# Contents

- Stent expansion
- Full lesion coverage
- Assessment of acute problems
  - Dissection
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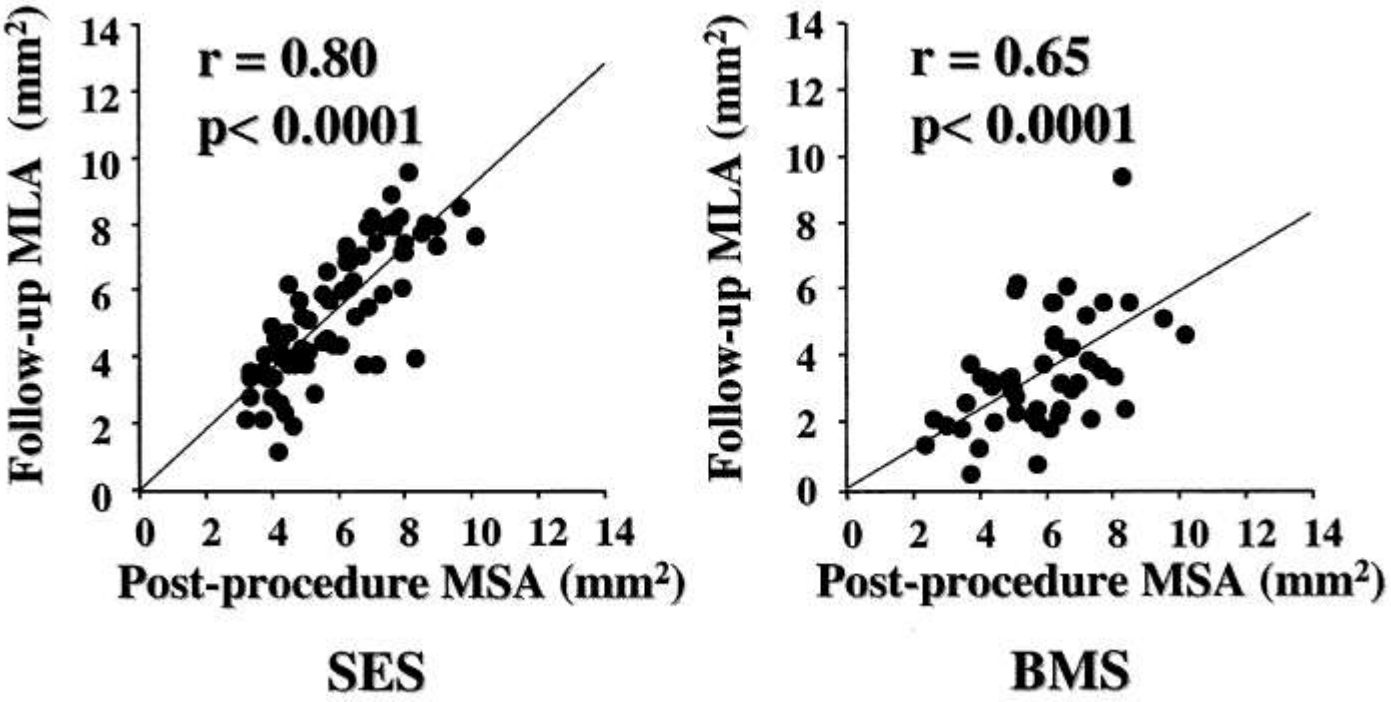
# Mechanism of in-stent restenosis (ISR)

- Stent underexpansion
- Neointimal hyperplasia



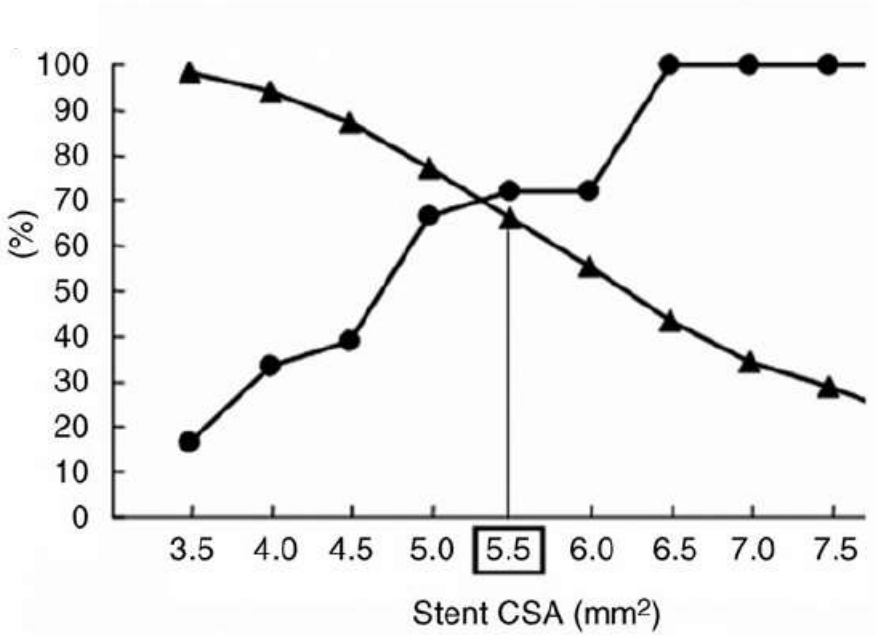
# Independent predictors of ISR

990 lesions treated by SES, ZES, and EES

| Variable | Odds Ratio | 95% CI | P-value |
|---|---|---|---|
| **Univariable analysis** | | | |
| Diabetes mellitus | 0.981 | 0.449-2.144 | 0.002 |
| Smoker | 2.241 | 0.997-5.037 | 0.051 |
| Multi-vessel disease | 0.608 | 0.297-1.248 | 0.608 |
| intravascular ultrasound-minimal stent area, post-intervention | 0.710 | 0.569-0.887 | 0.002 |
| intravascular ultrasound-minimal vessel area, post-intervention | 0.929 | 0.853-1.013 | 0.095 |
| Reference vessel diameter, pre-intervention | 0.404 | 0.180-0.907 | 0.028 |
| In-stent minimal lumen diameter, post-intervention | 0.535 | 0.268-1.065 | 0.075 |
| **Multivariable analysis** | | | |
| intravascular ultrasound-minimal stent area, post-intervention | 0.722 | 0.581-0.897 | 0.003 |

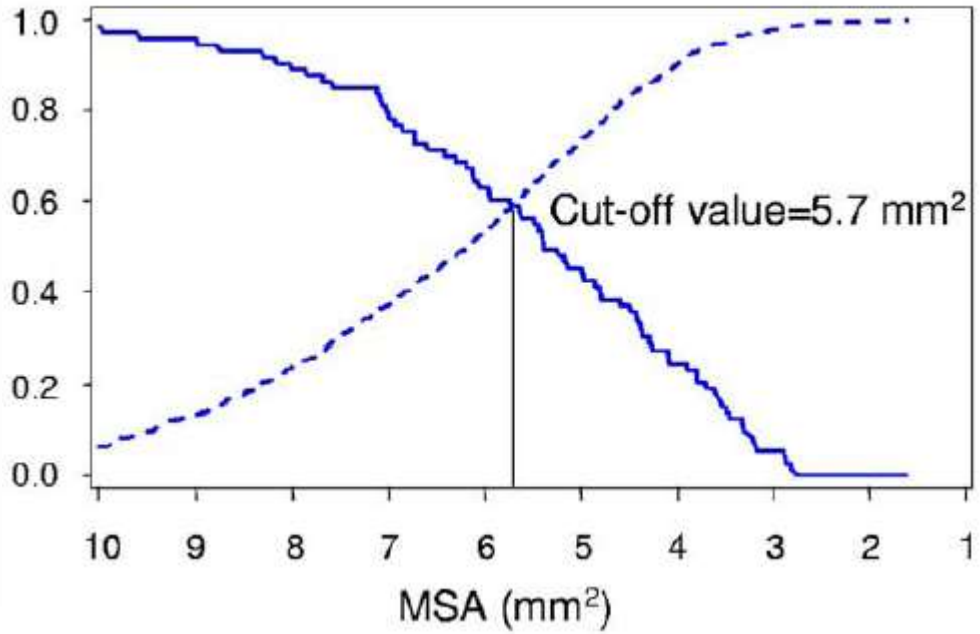
# Cutoff value for angiographic restenosis in 1st generation DES

SES




Hong MK et al. Eur Heart J 2006.

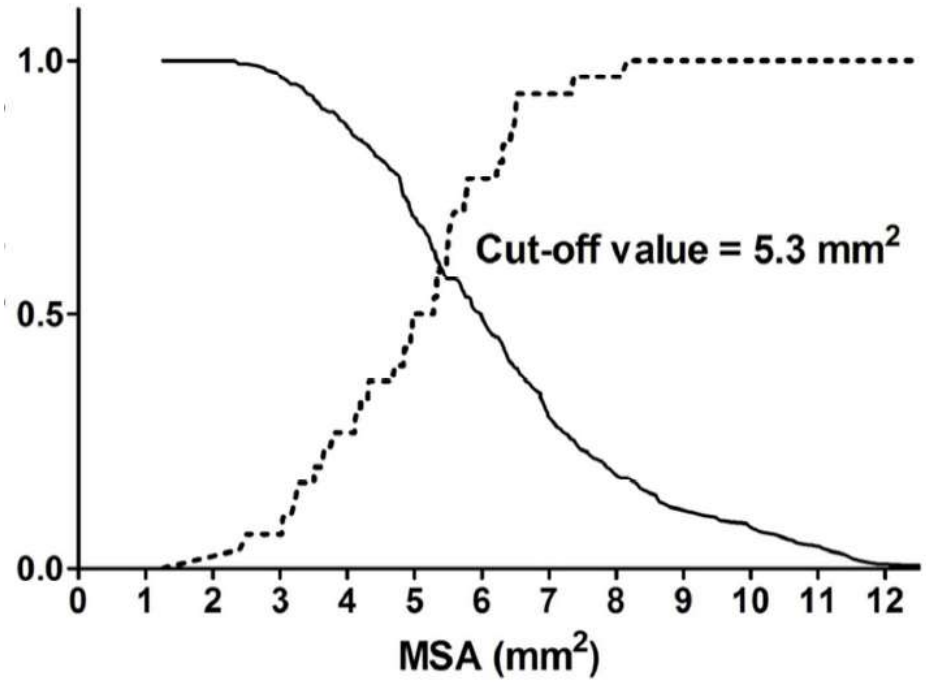
PES



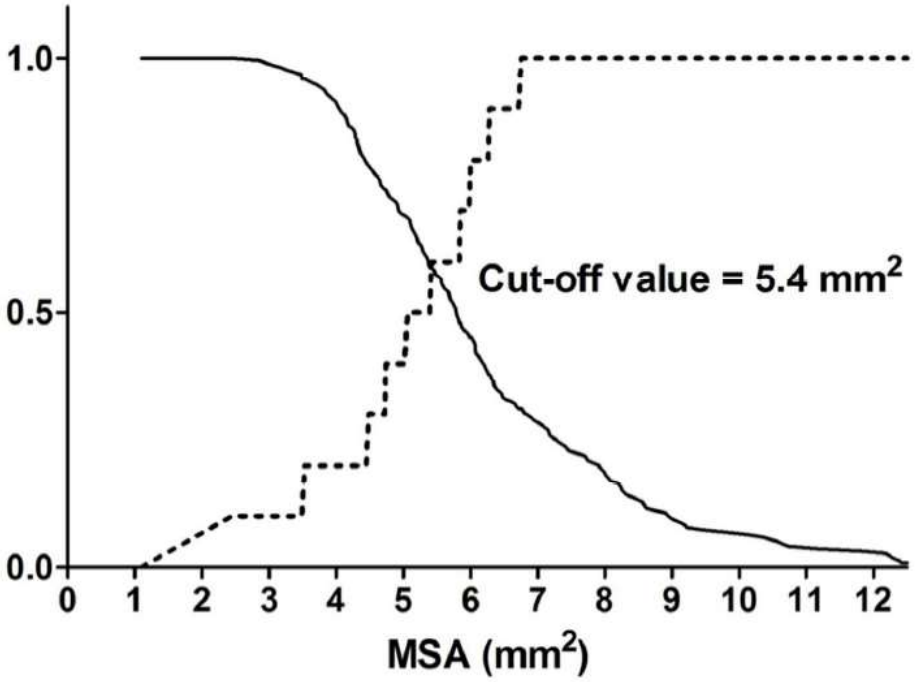

Doi H et al. J Am Coll Cardiol Intv 2009.

# Cutoff value for angiographic restenosis in the 2nd generation DES

ZES-R

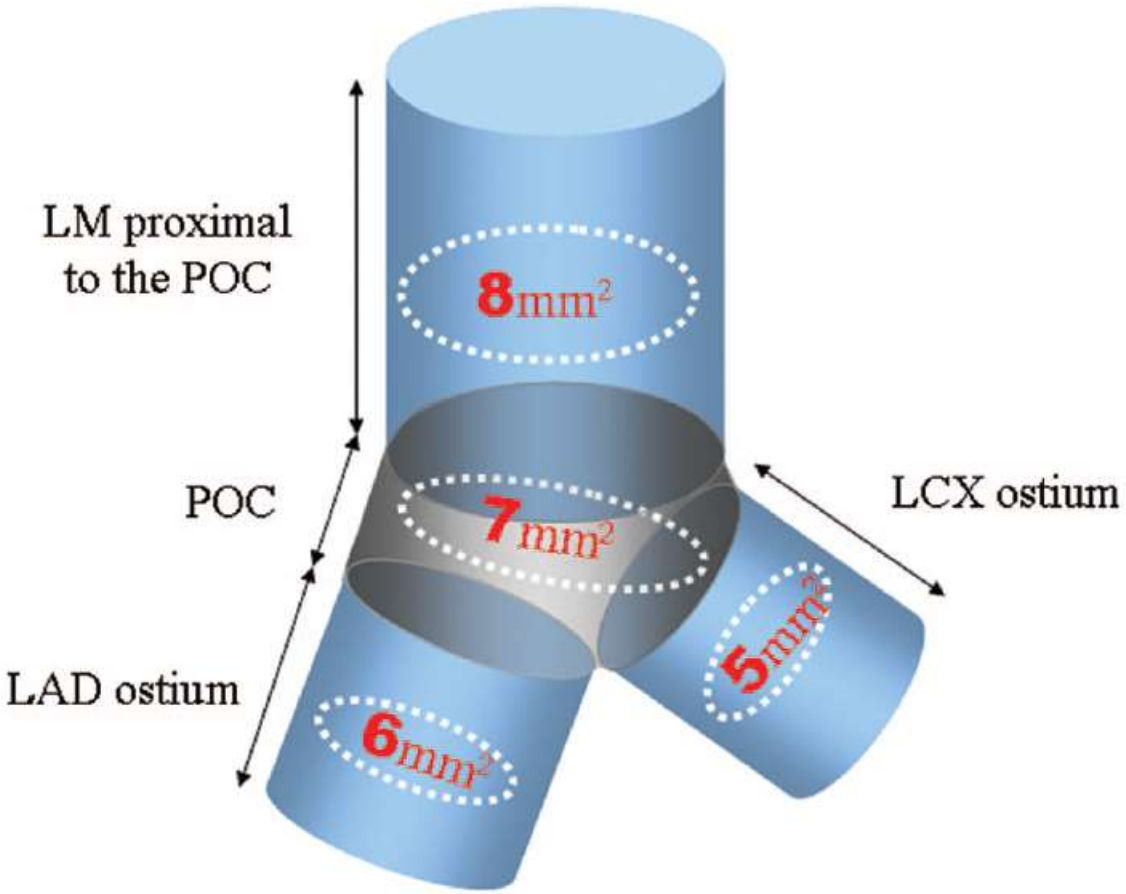



EES



# Left main lesions

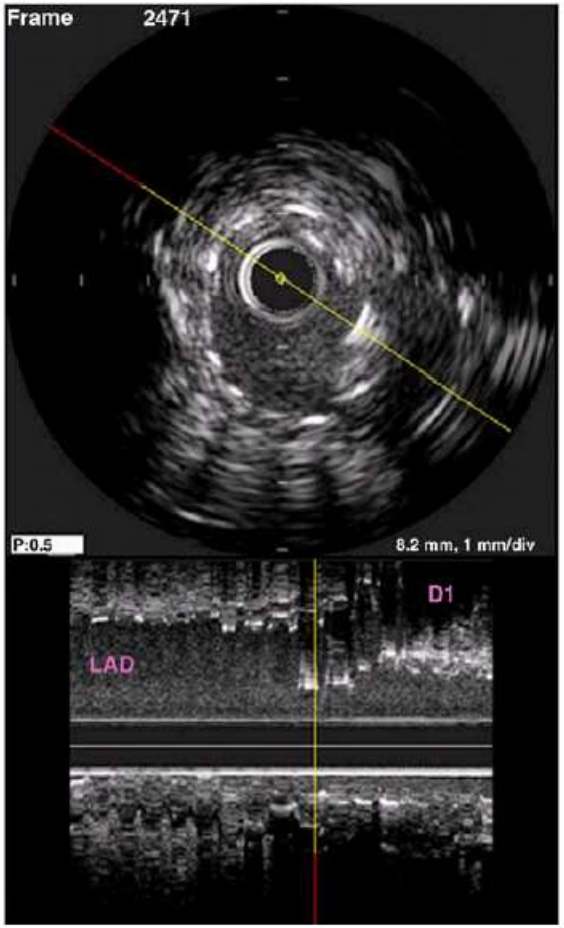
403 patients with SES



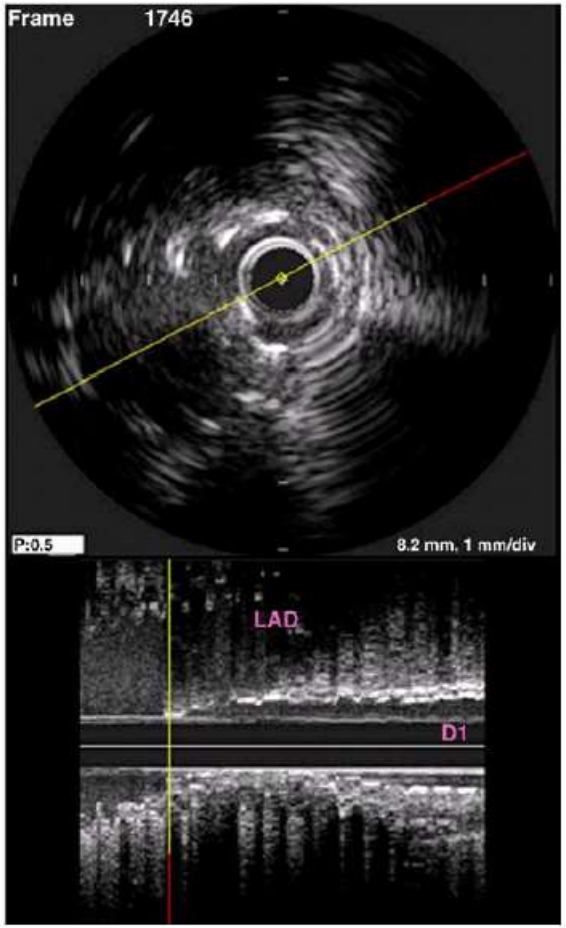

Kang SJ et al. Circ Cardiovasc Interv. 2011.

# Bifurcation lesions

Main vessel pullback




Side branch pullback

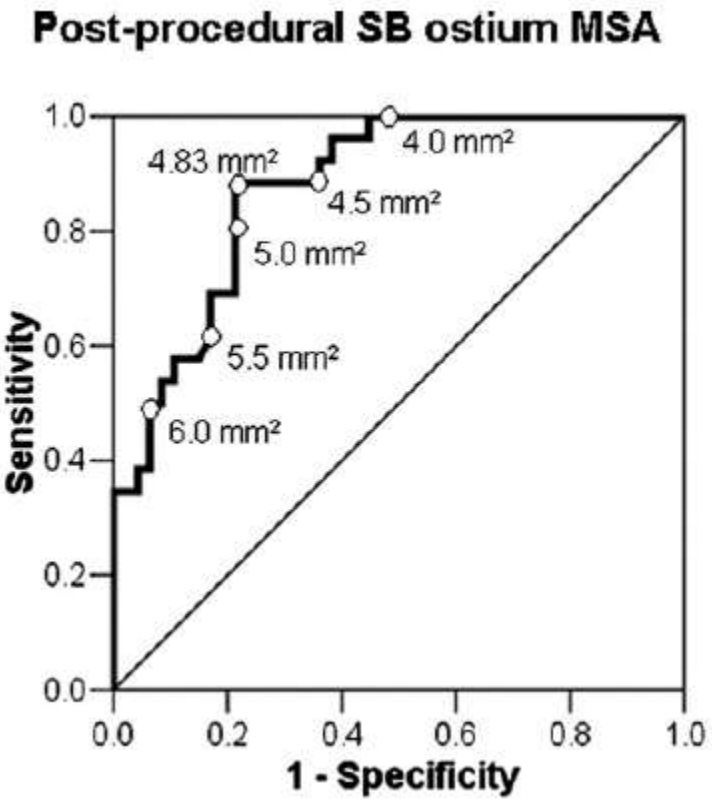


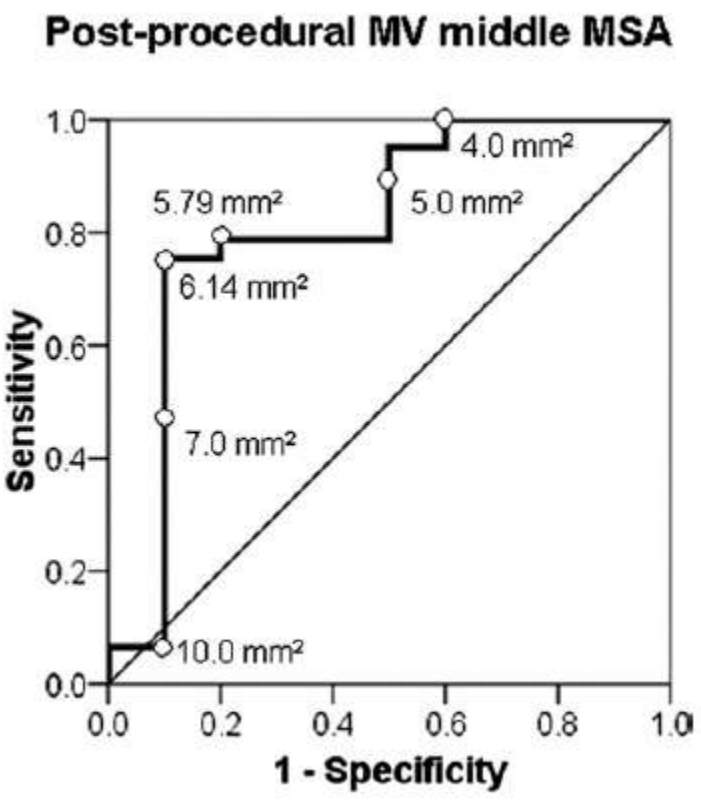

Hahn JY et al. J Am Coll Cardiol 2009.

# Bifurcation lesions

## Cut off value for stent patency

73 bifurcation lesions treated with TAP technique




Hahn JY et al. J Am Coll Cardiol 2009.

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# Lessons from the SIRIUS trial

**Table 2. Results of Quantitative Coronary Angiography.***

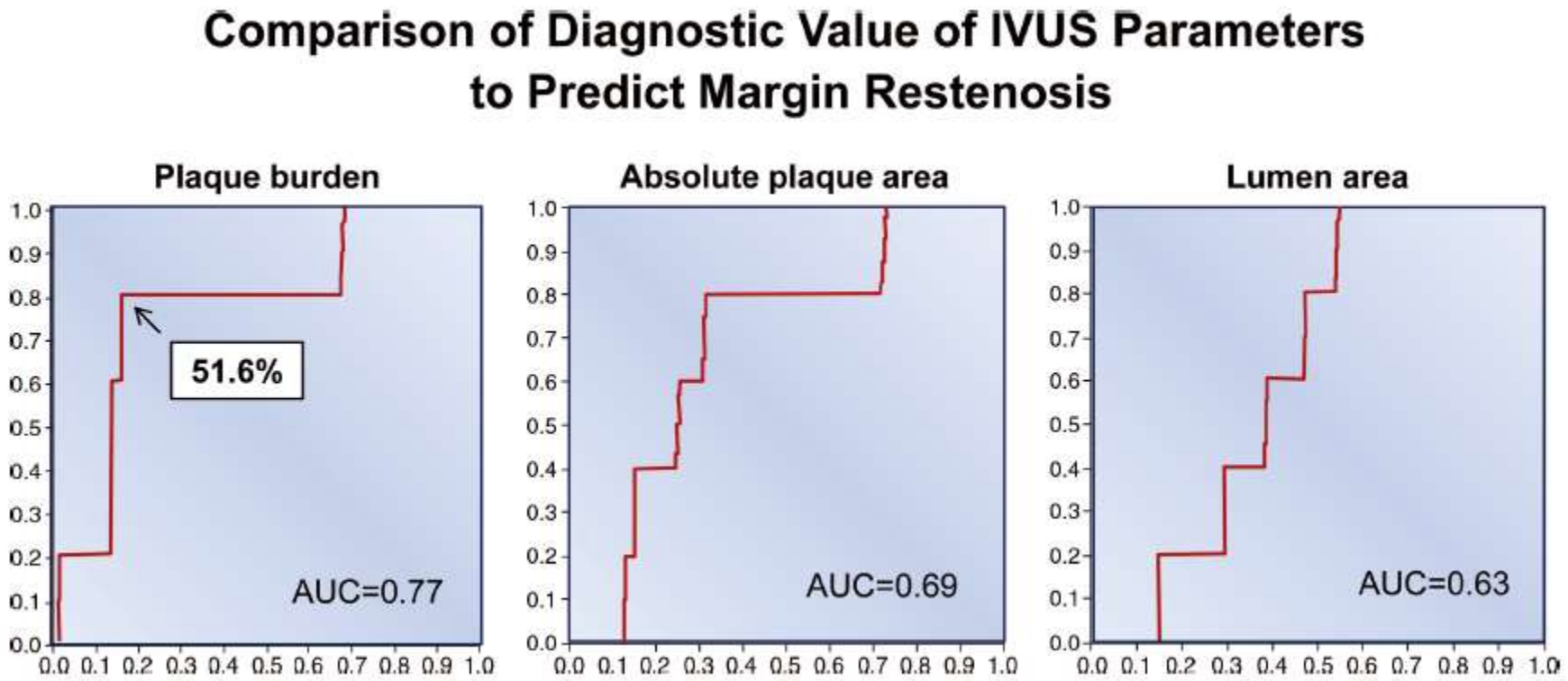
| Variable | In-Stent Zone | | | In-Segment Zone | | |
|---|---|---|---|---|---|---|
| | Sirolimus Stent | Standard Stent | P Value | Sirolimus Stent | Standard Stent | P Value |
| Minimal luminal diameter (mm) | | | | | | |
| Before procedure | 0.98±0.40 | 0.97±0.38 | 0.68 | 0.99±0.40 | 0.97±0.38 | 0.68 |
| After procedure | 2.67±0.40 | 2.68±0.42 | 0.98 | 2.38±0.45 | 2.40±0.46 | 0.63 |
| At 240 days | 2.50±0.58 | 1.69±0.79 | <0.001 | 2.15±0.61 | 1.60±0.72 | <0.001 |
| Stenosis (% of luminal diameter) | | | | | | |
| Before procedure | 65.1±12.6 | 65.6±12.1 | 0.46 | 65.1±12.6 | 65.6±12.1 | 0.46 |
| After procedure | 5.4±8.2 | 6.0±7.9 | 0.22 | 16.1±9.7 | 16.2±8.5 | 0.80 |
| At 240 days | 10.4±16.5 | 40.1±25.3 | <0.001 | 23.6±16.4 | 43.2±22.4 | <0.001 |
| Late luminal loss (mm)† | 0.17±0.45 | 1.00±0.70 | <0.001 | 0.24±0.47 | 0.81±0.67 | <0.001 |
| Restenosis (% of patients)‡ | 3.2 | 35.4 | <0.001 | 8.9 | 36.3 | <0.001 |

- Late lumen loss
  - In-segment zone > in-stent zone

- Restenosis rate:
  - proximal margin > the distal margin or the body of the stent.

# Predictors of edge restenosis

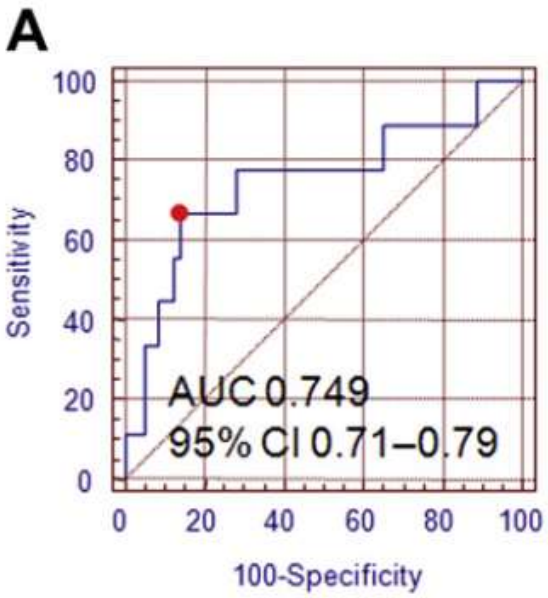
## SES




Circ J 2010; 74: 1609 – 1616

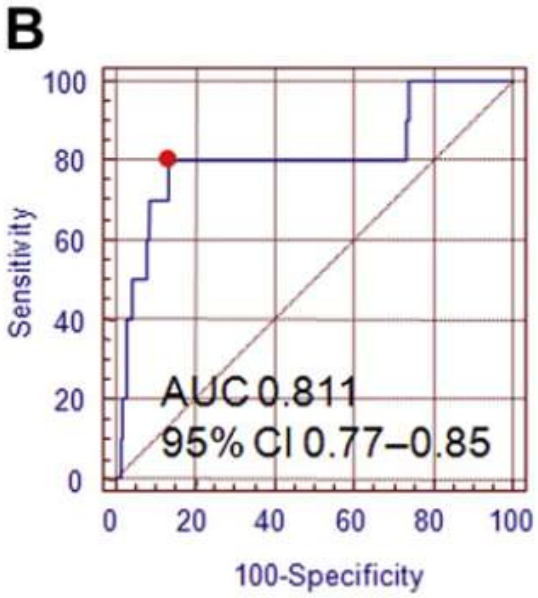
# Cutoff value of plaque burden for ISR

## ZES



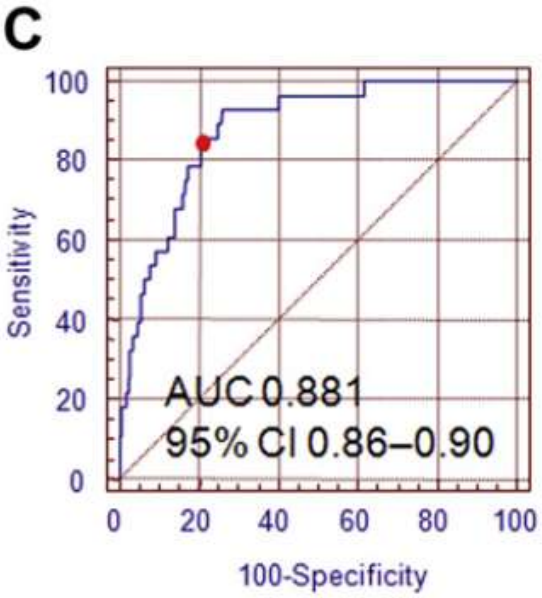

Plaque burden 56.3%
Sensitivity 67%
Specificity 86%

## ZES-R



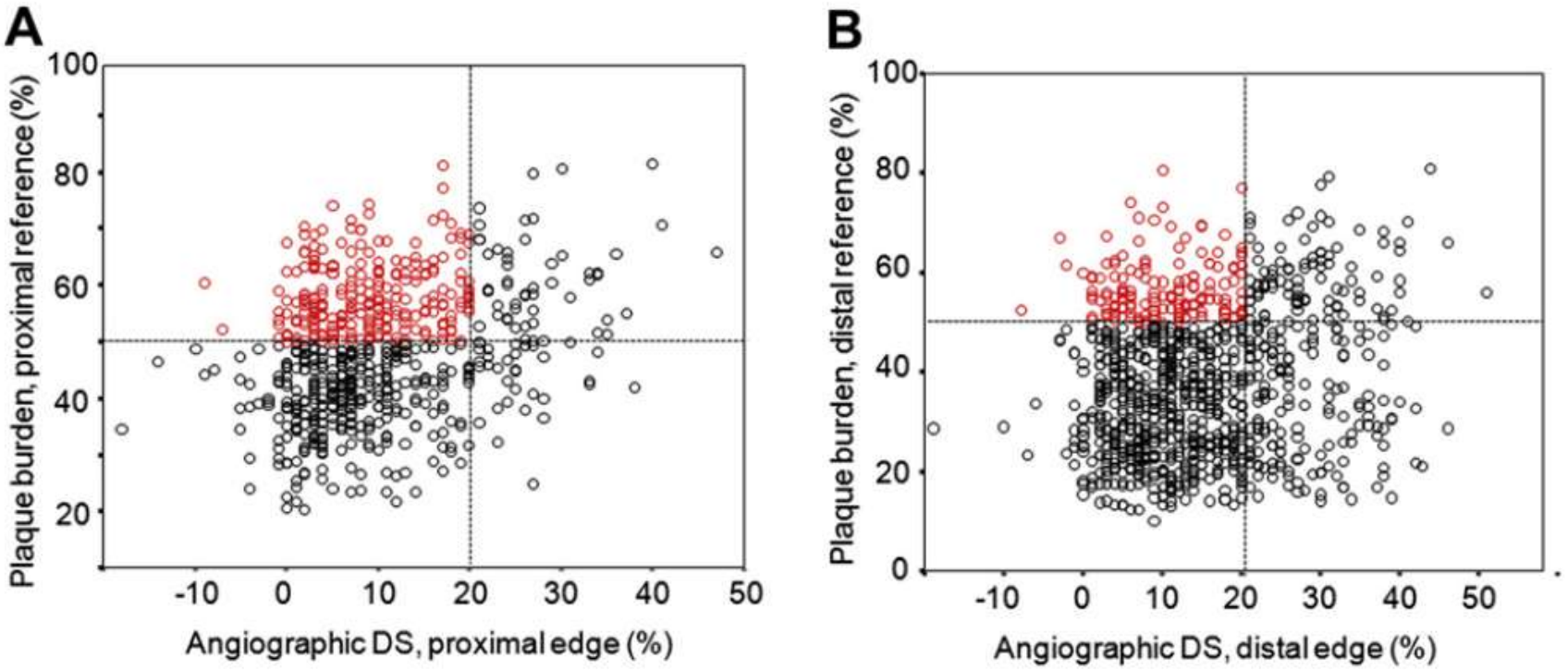

Plaque burden 57.3%
Sensitivity 80%
Specificity 87%

## EES



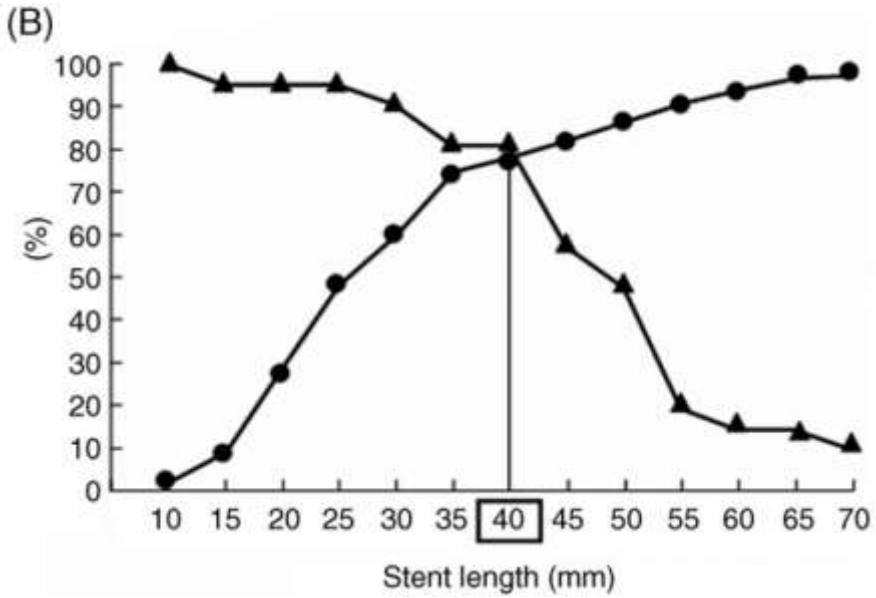

Plaque burden 54.2%
Sensitivity 86%
Specificity 80%

# Poststenting angiographic DS and plaque burden




(A) Of 785 normal-looking proximal reference segments with post-stenting angiographic DS <20%, 290 (37%) had reference segment maximal plaque burden >50%. (B) Of 724 distal reference segments with DS <20%, 153 (21%) had plaque burden >50%.

# Stent length: predictor of ISR



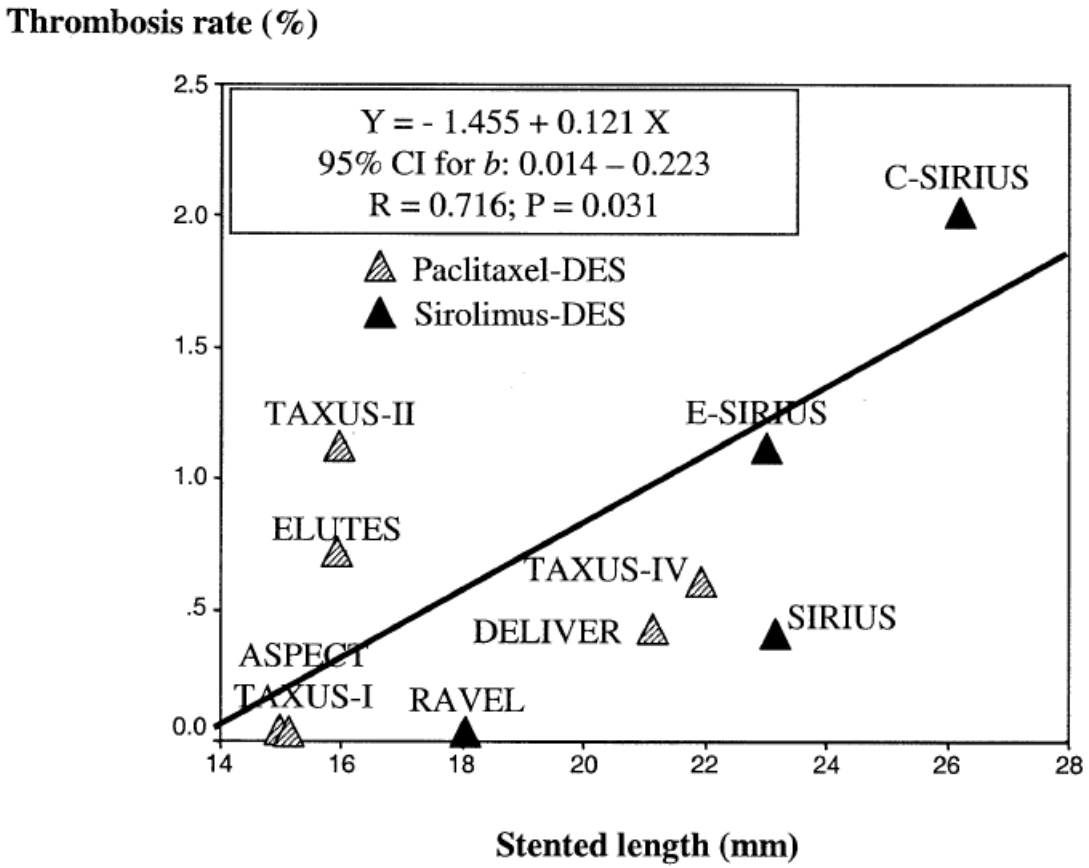

Hong MK et al. Eur Heart J 2006.

**TABLE 4. Clinical, Procedural, and Angiographic Multivariate Predictors of In-Segment Restenosis After SES Restenosis***

| | OR | 95% CI | *P* |
|---|---|---|---|
| Treatment of in-stent restenosis | 4.16 | 1.63–11.01 | <0.01 |
| Ostial location | 4.84 | 1.81–12.07 | <0.01 |
| Diabetes mellitus | 2.63 | 1.14–6.31 | 0.02 |
| Total stented length (per 10-mm increase) | 1.42 | 1.21–1.68 | <0.01 |
| Reference diameter (per 1.0-mm increase) | 0.46 | 0.24–0.87 | 0.03 |
| Left anterior descending artery | 0.30 | 0.10–0.69 | <0.01 |

Circulation. 2004;109:1366-1370.

# Stent length: predictor of stent thrombosis



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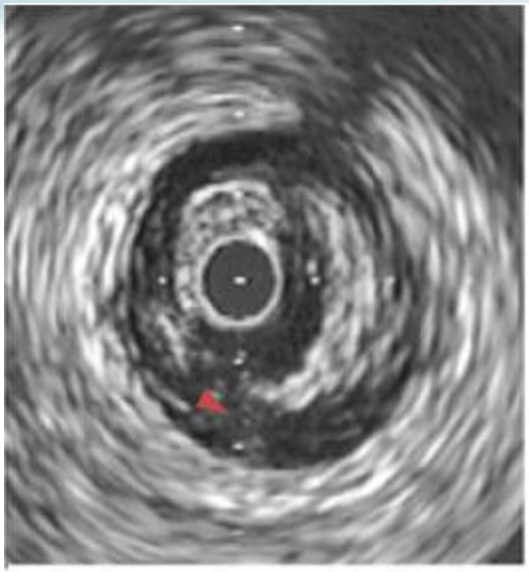
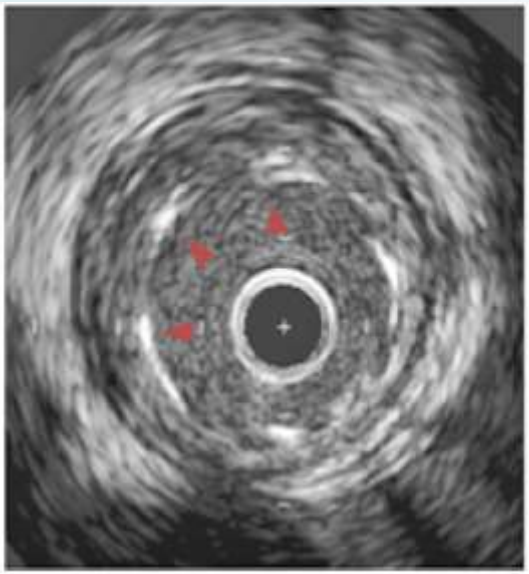
- Full lesion coverage
- Assessment of acute problems
  - Dissection, hematoma, thrombus, etc.
  - Inadequate stent apposition (ISA)
  - Longitudinal stent deformation

# Acute problems

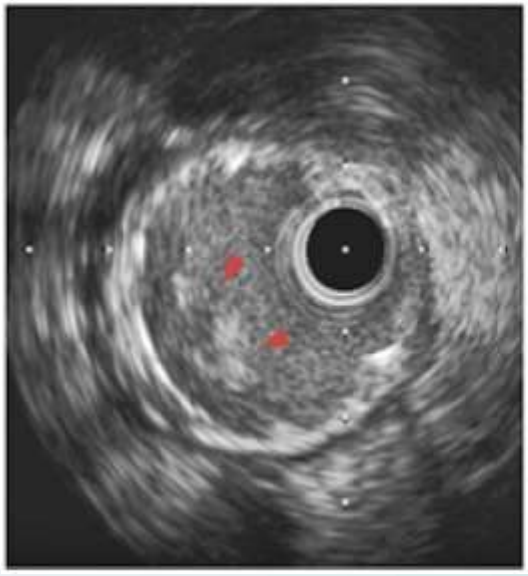
Edge dissection



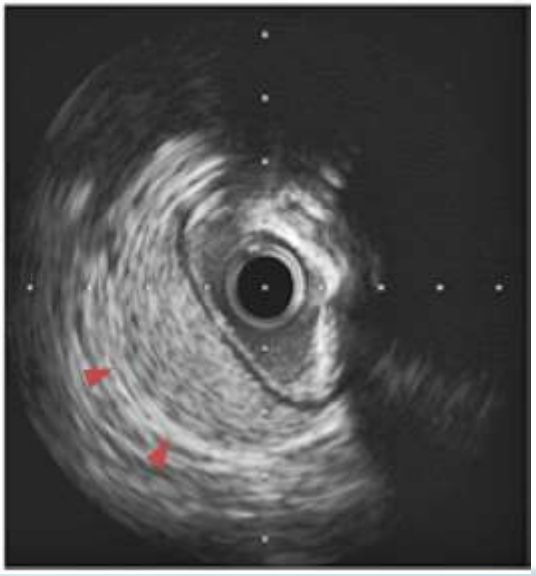
ISA



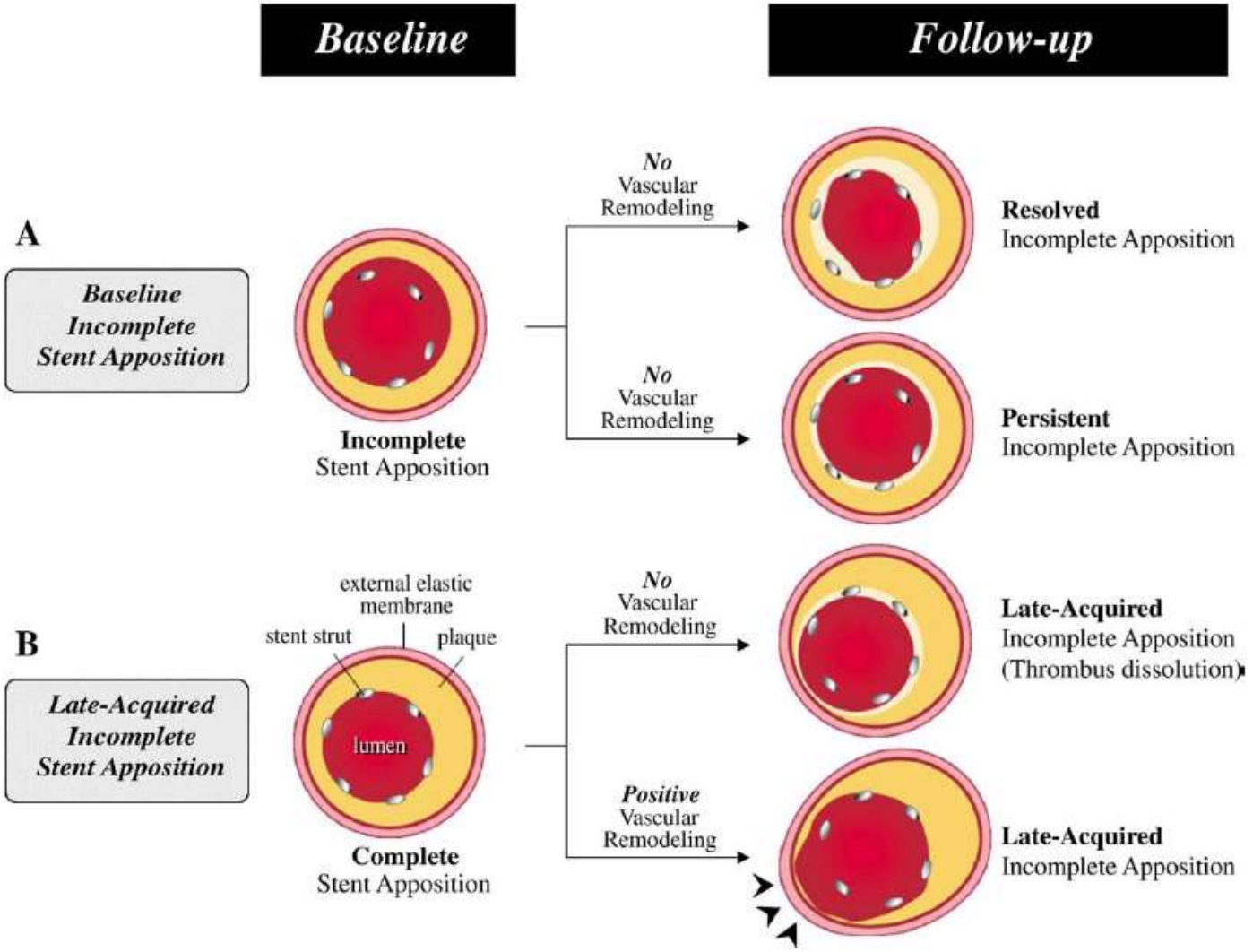
Thrombi or tissue prolapse



Hematoma

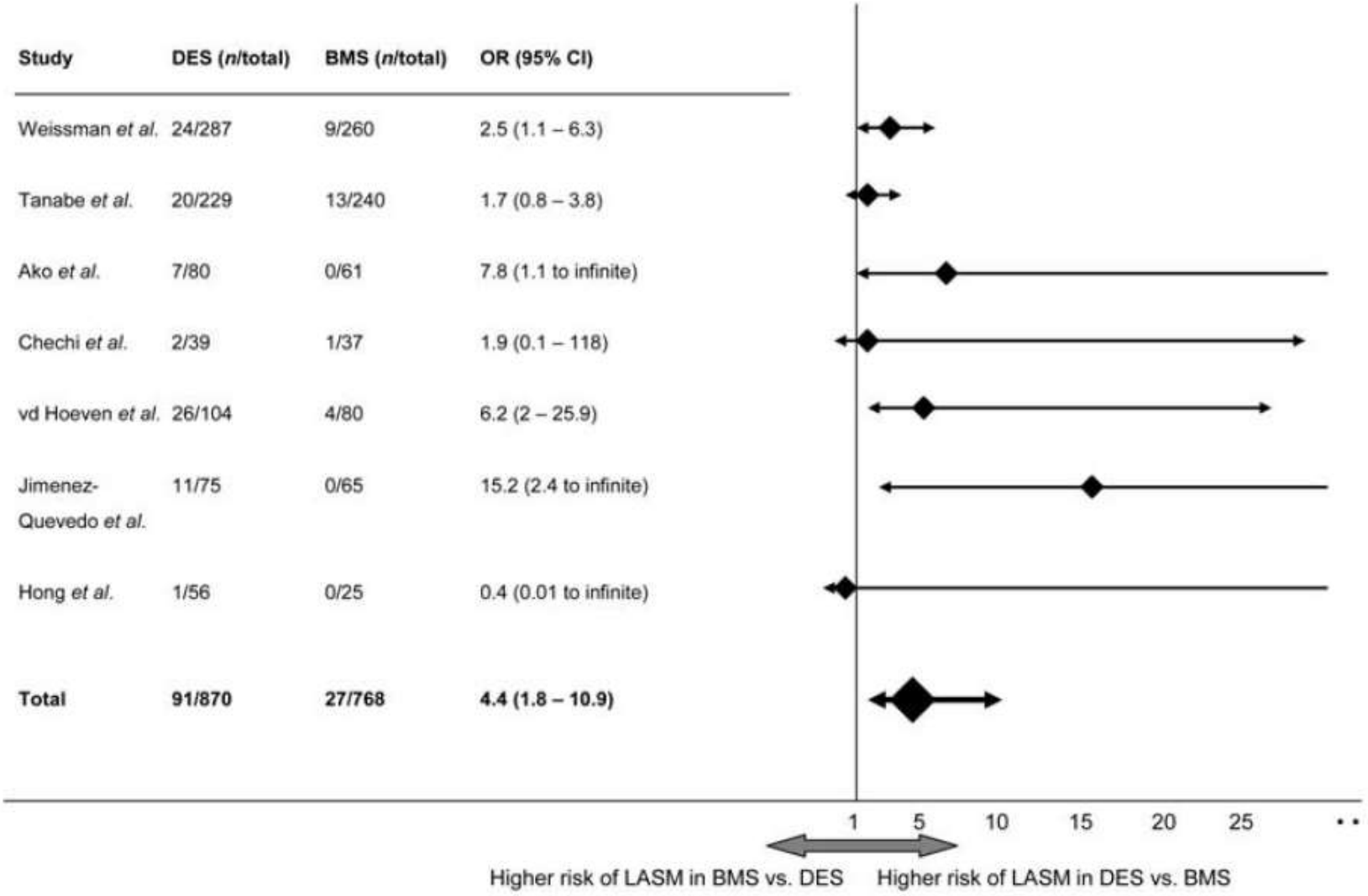


# Classification of ISA



# late-acquired stent malapposition in DES vs. BMS

| Study | DES (*n*/total) | BMS (*n*/total) | OR (95% CI) |
|---|---|---|---|
| Weissman *et al.* | 24/287 | 9/260 | 2.5 (1.1 – 6.3) |
| Tanabe *et al.* | 20/229 | 13/240 | 1.7 (0.8 – 3.8) |
| Ako *et al.* | 7/80 | 0/61 | 7.8 (1.1 to infinite) |
| Chechi *et al.* | 2/39 | 1/37 | 1.9 (0.1 – 118) |
| vd Hoeven *et al.* | 26/104 | 4/80 | 6.2 (2 – 25.9) |
| Jimenez-Quevedo *et al.* | 11/75 | 0/65 | 15.2 (2.4 to infinite) |
| Hong *et al.* | 1/56 | 0/25 | 0.4 (0.01 to infinite) |
| **Total** | **91/870** | **27/768** | **4.4 (1.8 – 10.9)** |



# Late stent thrombosis (ST) and late stent malapposition (LSM)

| Study | Design | Clinical follow-up (months) | Type of stent | LSM | Patients number | Observed values for (very) late ST | | Expected values for (very) late ST |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Late ST (≤12 months) | Very late ST (>12 months) | |
| Hoffmann *et al.*[39] | RCT | 48 | SES+BMS | Yes | 57 | 0 | 1 | 0.18 |
| | | | | No | 268 | 0 | 0 | 0.82 |
| Tanabe *et al.*[33] | RCT | 12 | PES+BMS | Yes | 46 | 0 | NA | 0.20 |
| | | | | No | 423 | 2 | NA | 1.80 |
| Hong *et al.*[40] | OS | 36 | SES+PES | Yes | 82 | NA | 1 | 0.44 |
| | | | | No | 475 | NA | 2 | 2.56 |
| Siqueira *et al.*[38] | OS | 29[a] | SES+PES | Yes | 10 | 0 | 2 | 0.11 |
| | | | | NO | 172 | 0 | 0 | 1.89 |
| Weissman *et al.*[37] | RCT | 24 | PES+BMS | Yes | 33 | 0 | 0 | 0.06 |
| | | | | NO | 514 | 1 | 0 | 0.94 |

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| | | | | | | | | 0.82 |
| Tanabe *et al.*[33] | RCT | 12 | | | | | | 0.20 |
| | | | | | | | | 1.80 |
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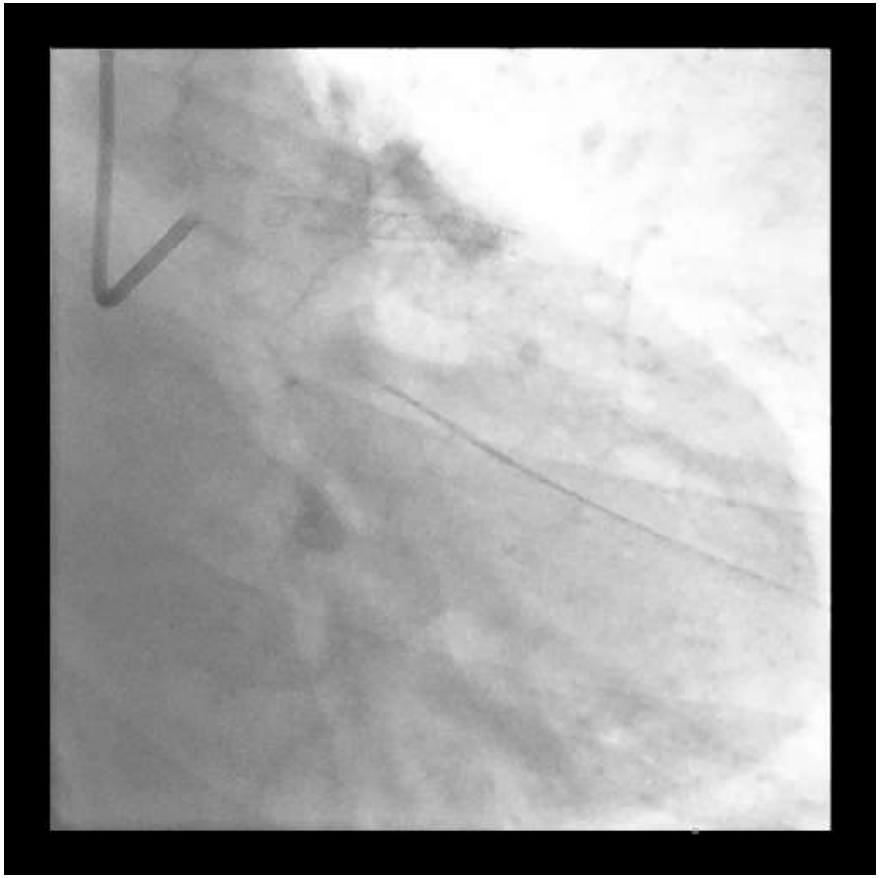
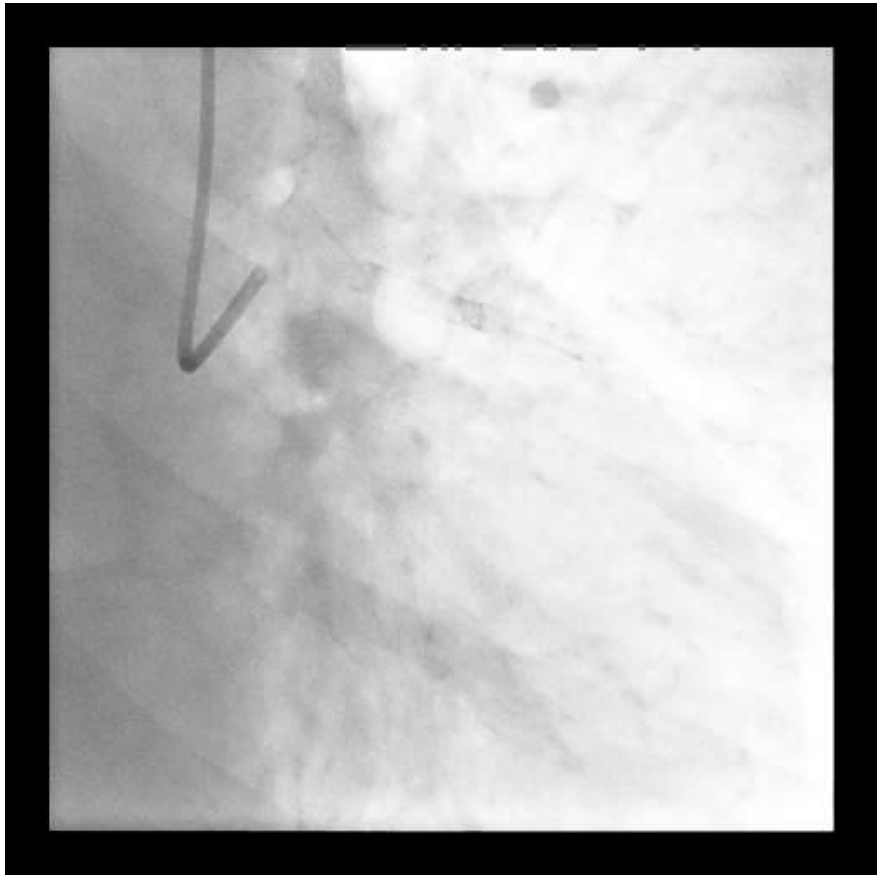
| | | | | NO | 514 | 1 | 0 | 0.94 |

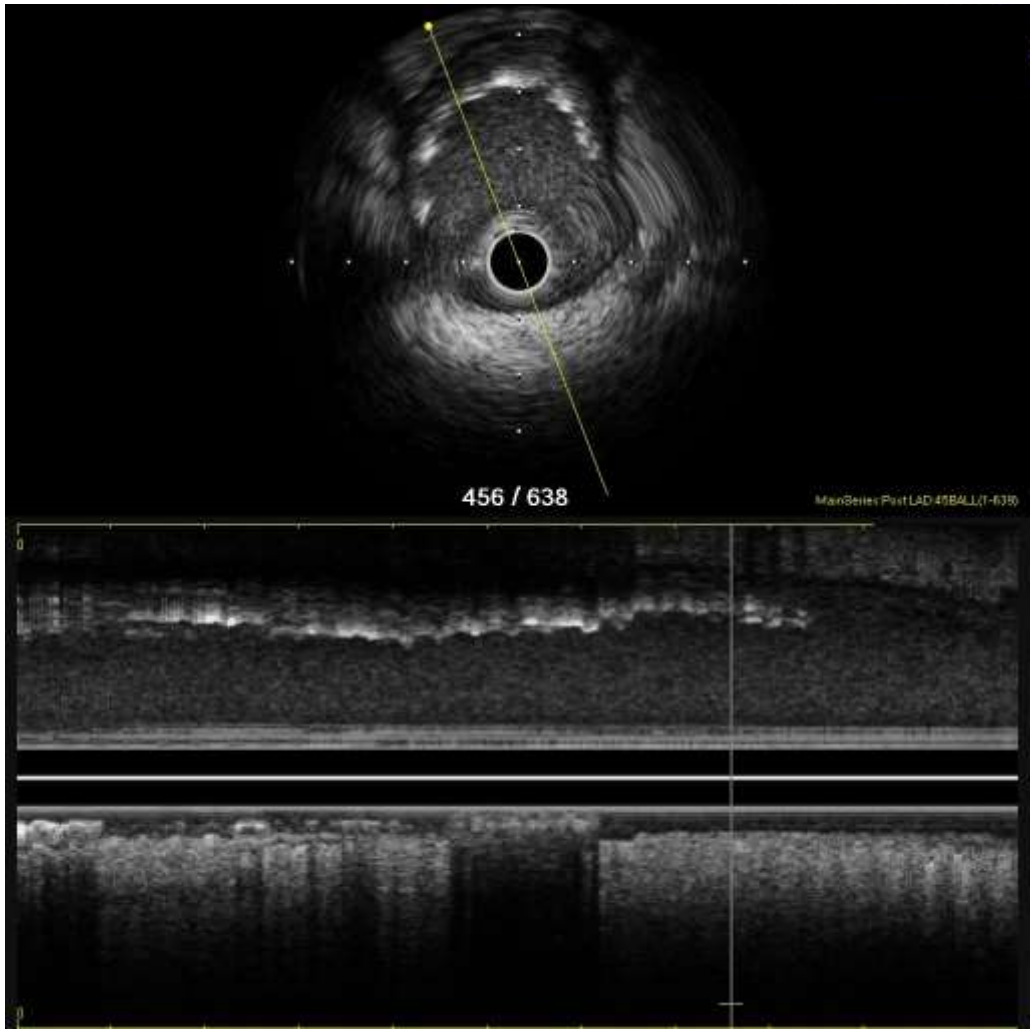
the risk of (very) late ST in patients with LSM was higher compared with those without LSM (OR = 6.51, CI 95% 1.34–34.91, P = 0.02)

# Longitudinal stent deformation: Case



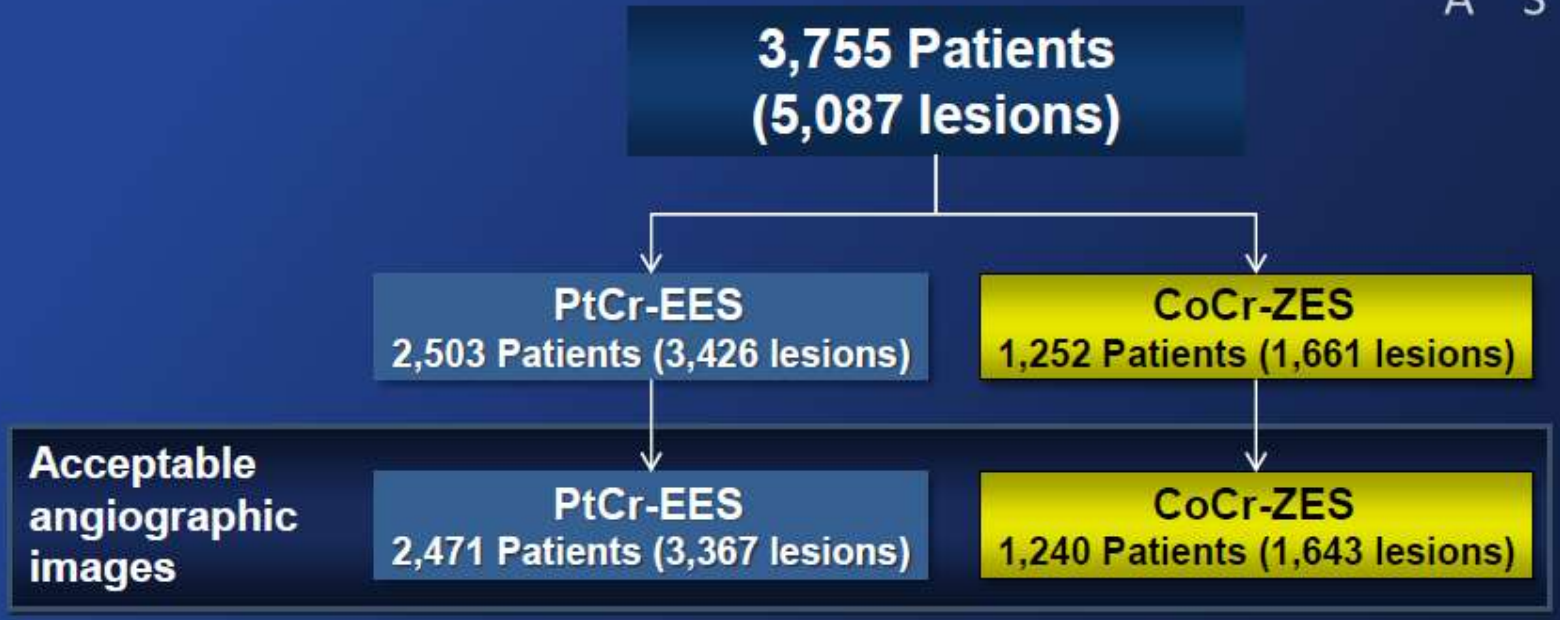
# Longitudinal stent deformation: Case

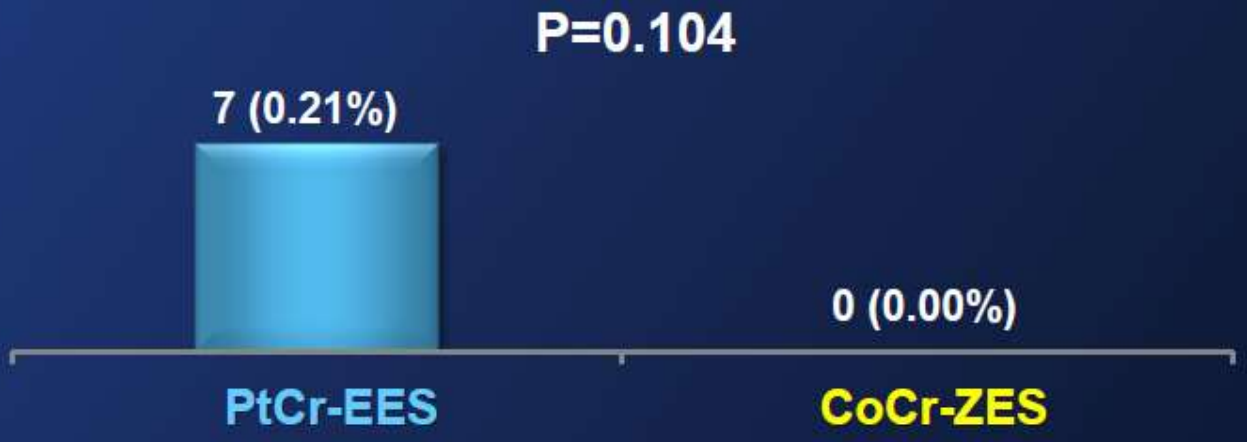




# Longitudinal Stent Deformation



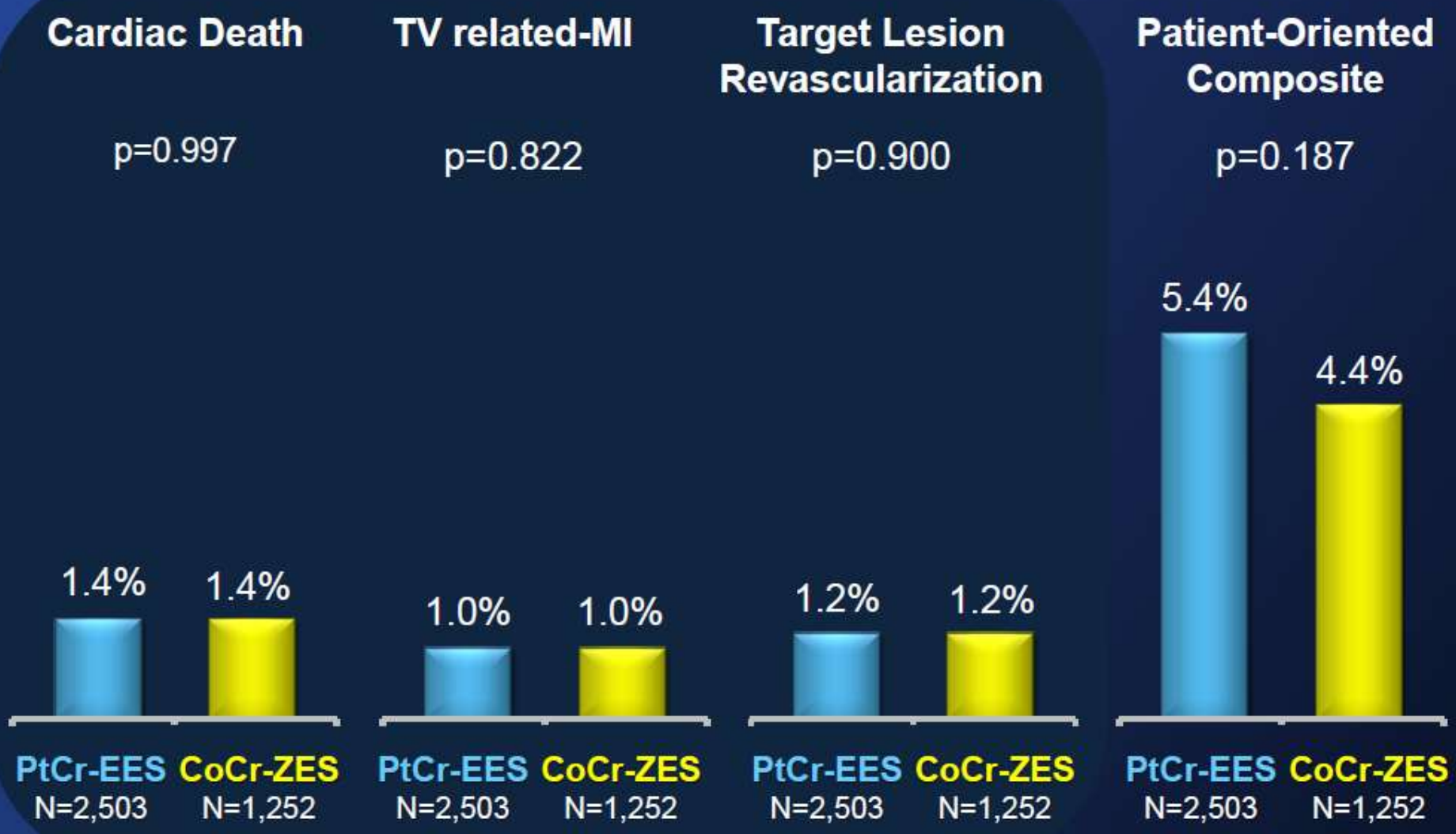



Incidence: 2.1 (95% CI: 0.8-4.3) per 1,000 lesions treated with PtCr-EES

# Clinical Events at 12 Months

HOST ASSURE



# Summary

- Adequate stent expansion is still important in the DES era.
- Full lesion coverage with sufficient rather not excessive length of stents may reduce edge restenosis.
- Postinterventional IVUS can identify several acute problems related stents such as dissection, thrombi, or ISA.
- Late aquired ISA seems to be associated with late and very late ST.

# 경청해 주셔서 감사합니다.
# Thank you for your attention.