# Temporal Patterns of DES Failure and Relation to Clinical Outcomes

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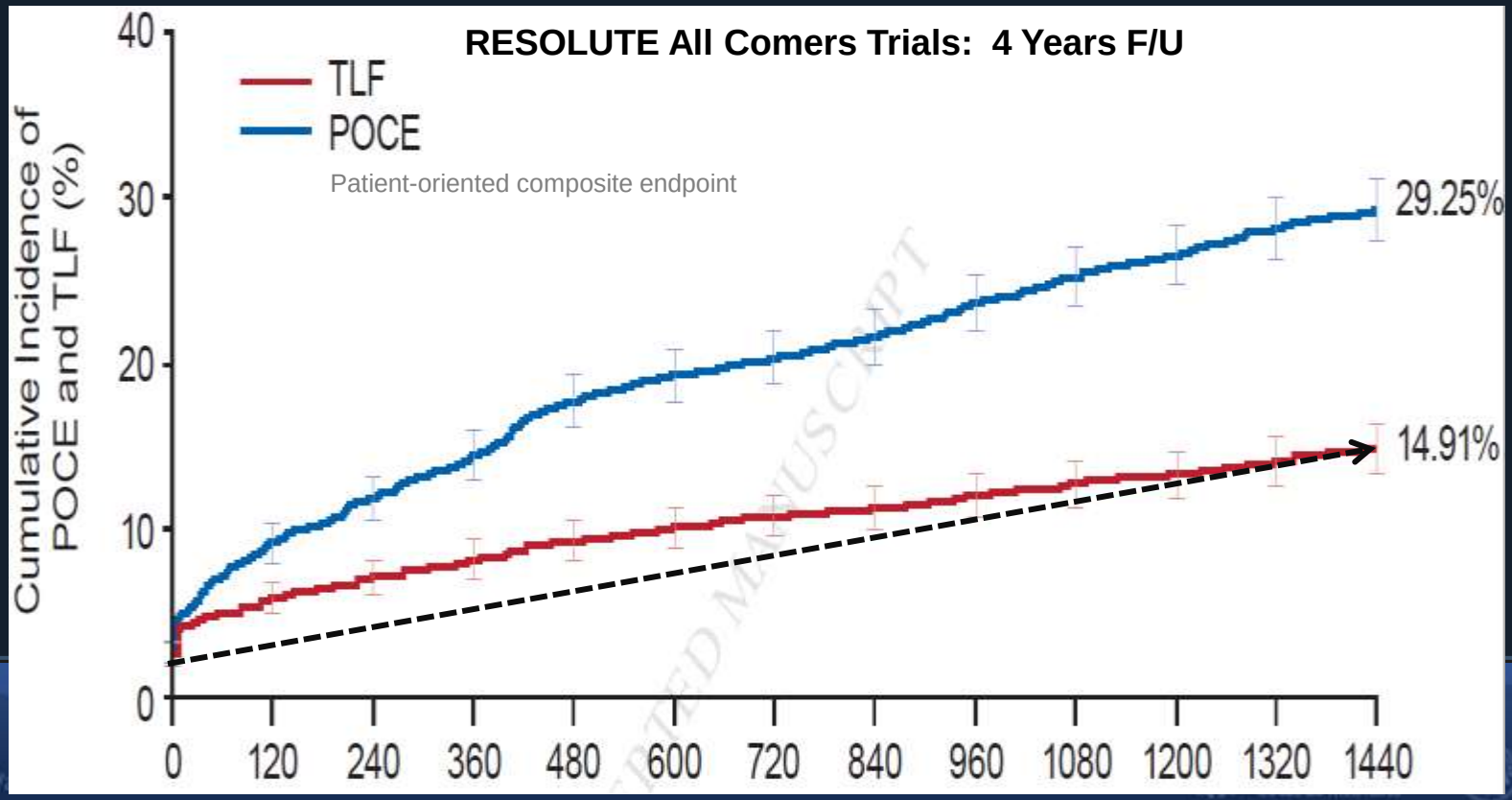
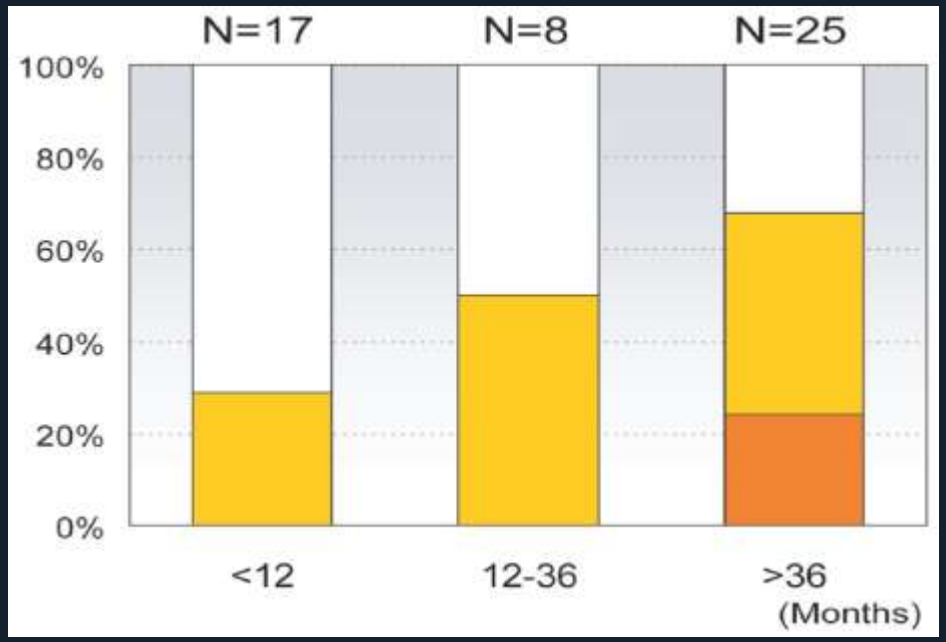
# Drug-Eluting Stents Failure

- The expanded use of DES in more complex procedures has increased the risk of DES failure. Furthermore, the development of late lumen narrowing is not uncommon on long-term follow-up.



# Temporal Patterns of DES Failure

- The morphology of restenotic tissues changes over time. Patterns of DES failure may differ depending on “time window” following DES implantation.




**In-stent neoatherosclerosis may be an important mechanism of DES failure, especially late after DES implantation**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# Aim of The Study

We investigate the temporal patterns of DES failure and the relationship to clinical outcomes in a large number of patients who developed DES failure.

# Study Population

633 patients with 676 lesions who presented with their first instance of DES failure following PCI in the non-LM native coronary arteries between Oct 2003 and Dec 2011 at Asan Medical Center.

Patients were divided into 3 groups according to the interval from index procedure to DES failure:

- group 1 (early DES failure: < 12 months),
- group 2 (late DES failure: 12–36 months),
- group 3 (very late DES failure: ≥ 36 months).

# Definitions

DES failure was defined as restenosis or stent thrombosis following DES implantation.

Restenosis was defined as > 50% luminal stenosis within the stent or within 5 mm of the stent edges on quantitative coronary angiography that is responsible for patient's symptoms or positive noninvasive functional tests.

Stent thrombosis was defined as the definite occurrence of thrombotic events according to the classifications of the Academic Research Consortium.

# Angiographic Analysis

Coronary angiography was performed before the procedure, after the procedure, and at the time of DES failure.

All angiograms were submitted to the angiographic core analysis center (Asan Medical Center, Seoul, Korea), and analyzed using an automated edge-detection system (CASS II, Pie Medical, Netherlands).

# Follow-Up

Follow-up information after retreatment was obtained by chart review and telephone interviews.

Follow-up examinations were completed by 95.1% of patients. The unique personal identification number was used to determine the vital status of the remaining 31 patients (4.9%) who could not be contacted.

# Clinical Outcomes
## after Treatment of DES Failure

### Primary Outcome

Death from any causes

following treatment for DES failure

### Secondary Outcomes

- Composite of death or nonfatal MI
- Composite of death, nonfatal MI or repeat TLR

# Statistical Analysis

Comparisons between groups were performed using the one-way ANOVA test for continuous variables or Fisher exact test for categorical variables.

Differences in risk-adjusted clinical outcomes between groups were assessed using multivariate Cox proportional-hazards regression.

# Results

DES failure occurred a median of 10.1 months (IQR = 6.9–35.3 months) after the index procedure.

663 patients with DES failure:
- 548 DES restenosis (86.6%)
- 85 stent thrombosis (13.4%)
  - 11 early instances [0–30 days]
  - 14 late instances [30 days–12 months]
  - 60 very late instances [> 12 months]

# Baseline Patients Characteristics (Index Procedure)

| Characteristic | Group 1 (n=343) | Group 2 (n=138) | Group 3 (n=152) |
|---|---|---|---|
| Age (yr) | 59.6±10.1 | 58.6±10.7 | 58.9±10.0 |
| Men* | 251 (73.2%) | 95 (68.8%) | 125 (82.2%) |
| Current smoker | 121 (35.3%) | 44 (31.9%) | 66 (43.4%) |
| Diabetes mellitus | 118 (34.4%) | 50 (36.2%) | 45 (29.6%) |
| Hypertension | 195 (56.9%) | 76 (55.1%) | 90 (59.2%) |
| Diagnosis* | | | |
| Stable angina | 191 (55.7%) | 78 (56.5%) | 79 (52.0%) |
| Unstable angina | 85 (24.8%) | 48 (34.8%) | 51 (33.6%) |
| AMI | 67 (19.5%) | 12 (8.7%) | 22 (14.5%) |

*$p<0.025$

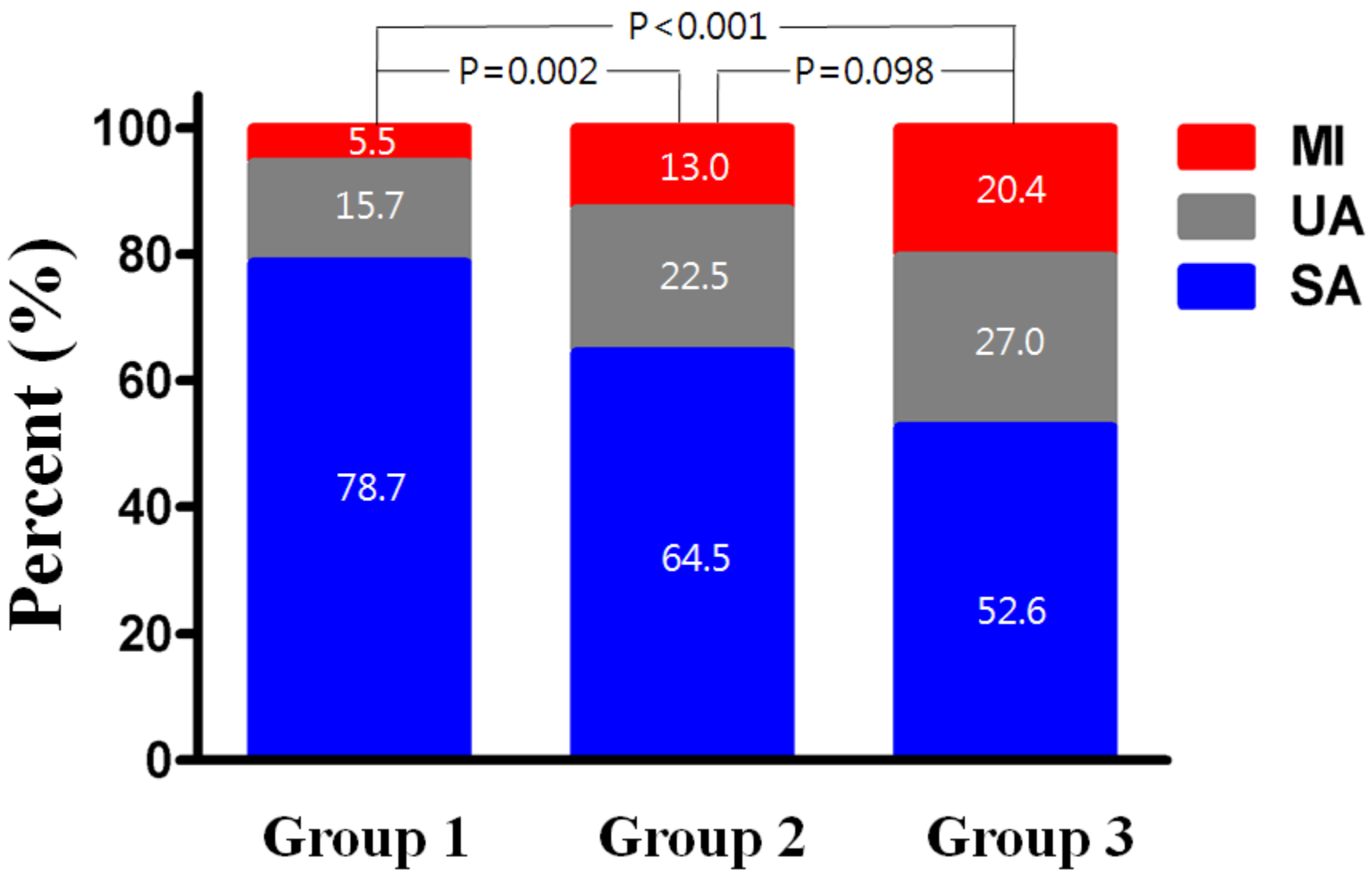
# Baseline Patients Characteristics (Index Procedure)

| Characteristic | Group 1 (n=343) | Group 2 (n=138) | Group 3 (n=152) |
|---|---|---|---|
| Target coronary arteries | | | |
| LAD | 187 (54.5%) | 80 (58.0%) | 78 (51.3%) |
| LCX | 42 (12.2%) | 21 (15.2%) | 26 (17.1%) |
| RCA | 112 (32.7%) | 35 (25.4%) | 44 (28.9%) |
| RI | 2 (0.6%) | 2 (1.4%) | 4 (2.6%) |
| Multi-vessel disease | 154 (44.9%) | 55 (39.9%) | 71 (46.7%) |
| Types of DES* | | | |
| Previous (Cypher, Taxus) | 248 (72.3%) | 112 (81.2%) | 140 (92.1%) |
| New | 95 (27.7%) | 26 (18.8%) | 12 (7.9%) |

***p<0.025**

**New DES: Biomatrix, Endeavor, Endeavor resolute, Nobori, Promus Element, Xience stent**

# Clinical Presentation (DES Failure)



# QCA Findings

| Characteristic | Group 1 (n=343) | Group 2 (n=138) | Group 3 (n=152) |
|---|---|---|---|
| Reference diameter (mm) | 3.03 ±0.54 | 2.89± 0.75 | 3.07±0.54 |
| Lesion length (mm) | 31.1±16.2 | 27.8±18.1 | 28.0±16.1 |
| Stented length (mm) | 37.5±18.2 | 36.5±18.0 | 35.9±16.7 |
| Stents per lesion | 1.6±0.9 | 1.6±0.9 | 1.6±0.9 |
| MLD (mm) | | | |
| Before procedure | 0.86±0.51 | 0.87±0.52 | 0.91±0.51 |
| After procedure | 2.31±0.52 | 2.30±0.70 | 2.40±0.54 |
| At follow-up* | 0.90±0.52 | 0.80±0.55 | 0.62±0.51 |

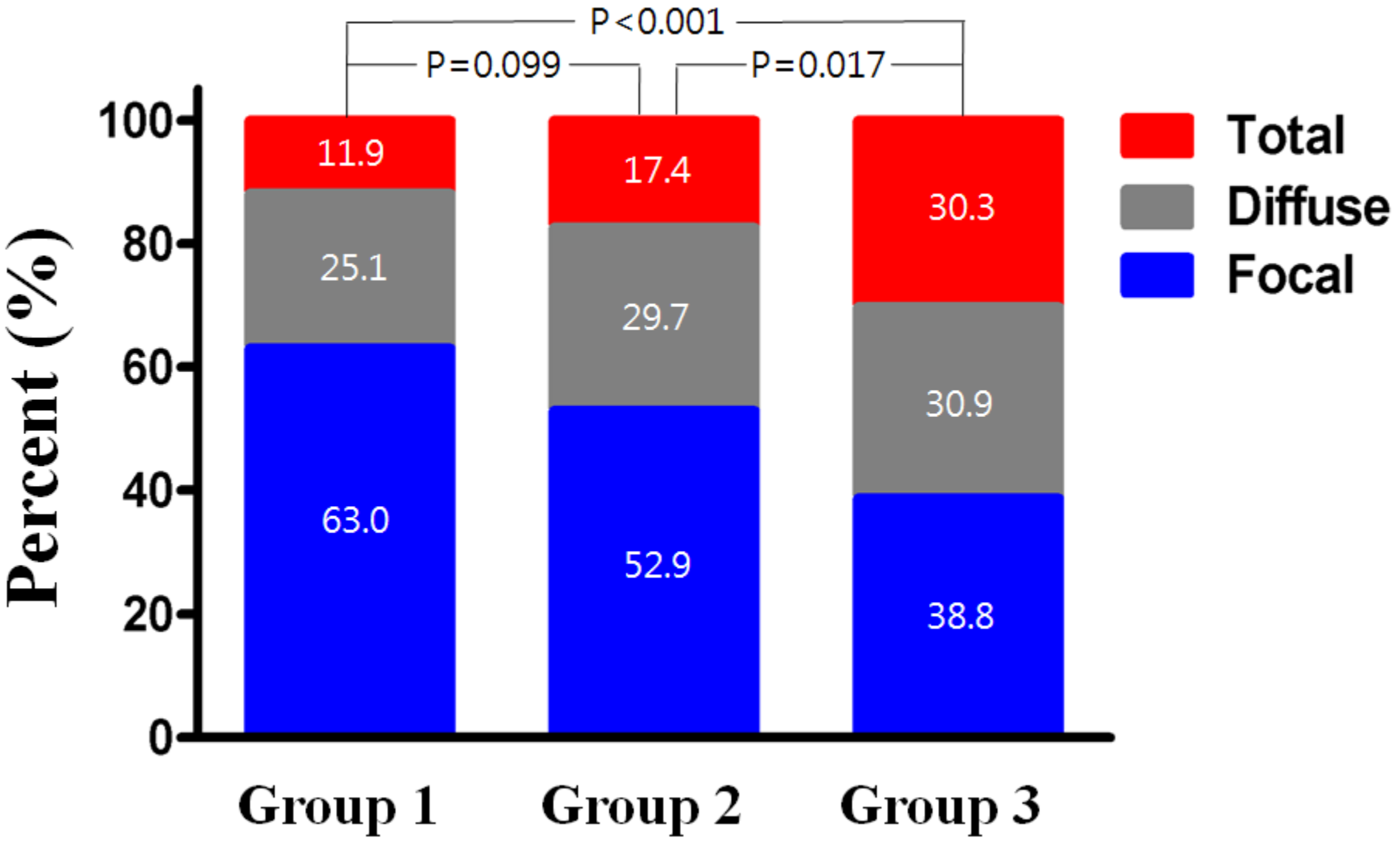
***p<0.001**

# Patterns of DES Failure

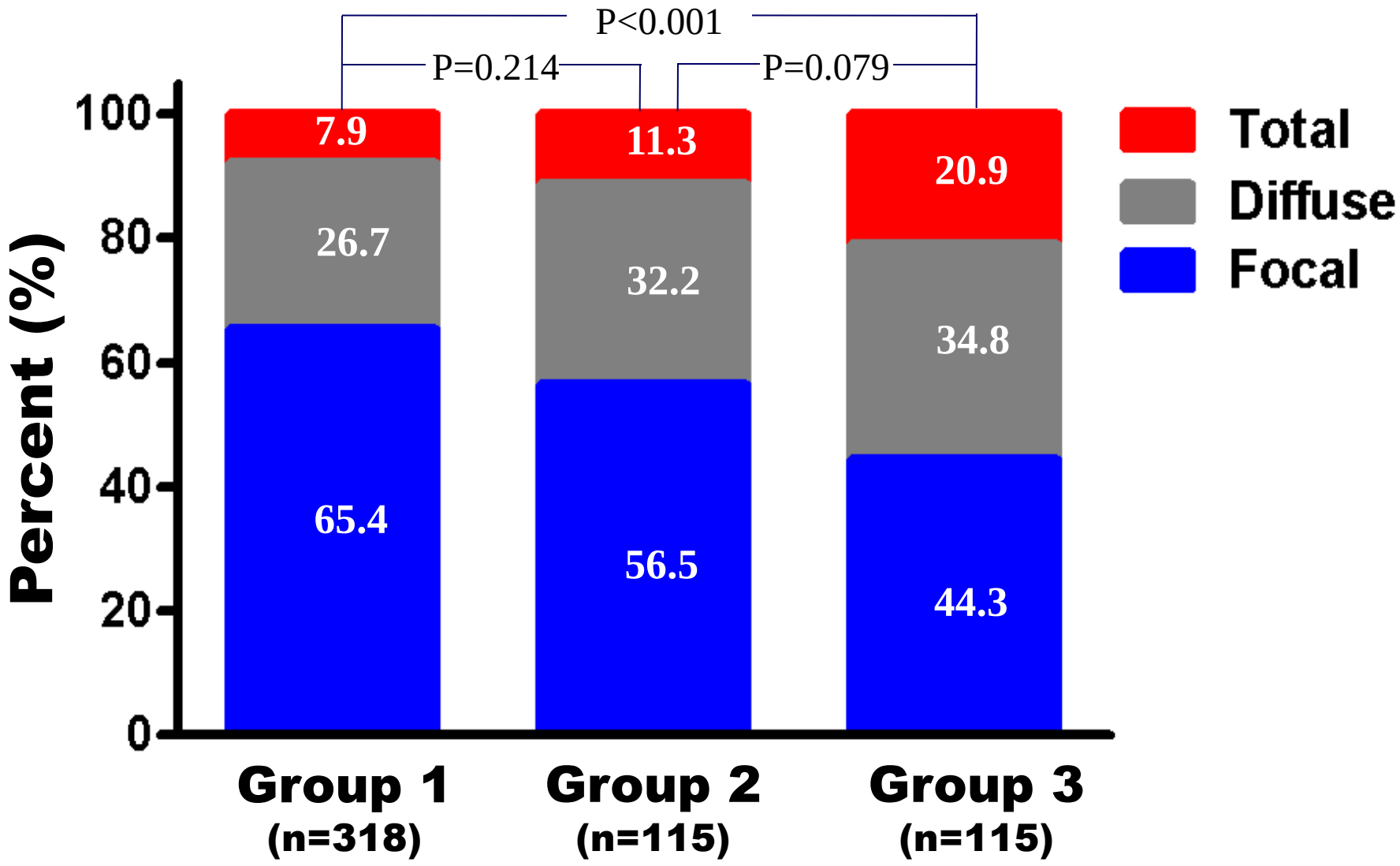
| Characteristic | Group 1 (n=343) | Group 2 (n=138) | Group 3 (n=152) |
|---|---|---|---|
| Focal* | 216 (63.0%) | 73 (52.9%) | 59 (38.8%) |
| Body | 131 (38.2%) | 47 (34.1%) | 33 (21.7%) |
| Proximal edge | 57 (16.6%) | 11 (8.0%) | 15 (9.9%) |
| Distal edge | 16 (4.7%) | 13 (9.4%) | 7 (4.6%) |
| Multifocal | 12 (3.5%) | 2 (1.4%) | 4 (2.6%) |
| Diffuse* | 86 (25.1%) | 41 (29.7%) | 47 (30.9%) |
| Diffuse intrastent | 64 (18.7%) | 31 (22.5%) | 33 (21.7%) |
| Diffuse proliferative | 22 (6.4%) | 10 (7.2%) | 14 (9.2%) |
| Total occlusion* | 41 (12.0%) | 24 (17.4%) | 46 (30.3%) |

*p<0.001

# Angiographic Patterns of DES Failure



# Angiographic Patterns of DES Restenosis



# Predictors of Non-focal DES Failure

| Variables | Univariate Analysis | | | Multivariate Analysis | | |
|---|---|---|---|---|---|---|
| | OR | 95% CI | *p* | OR | 95% CI | *p* |
| Group 3 vs. Group 1 | 2.68 | 1.81–3.97 | < 0.001 | 2.78 | 1.87–4.13 | < 0.001 |
| Stented length (mm) | 1.01 | 1.00–1.02 | 0.007 | 1.01 | 1.01–1.02 | 0.003 |
| Stented length >40 mm | 1.44 | 1.05–1.99 | 0.026 | | | |
| Diabetes mellitus | 1.33 | 0.95–1.86 | 0.095 | | | |
| R artery diameter | 0.96 | 0.73–1.26 | 0.759 | | | |
| Postintervention MLD | 0.82 | 0.61–1.09 | 0.175 | | | |
| Use of previous DES | 1.17 | 0.80–1.72 | 0.420 | | | |

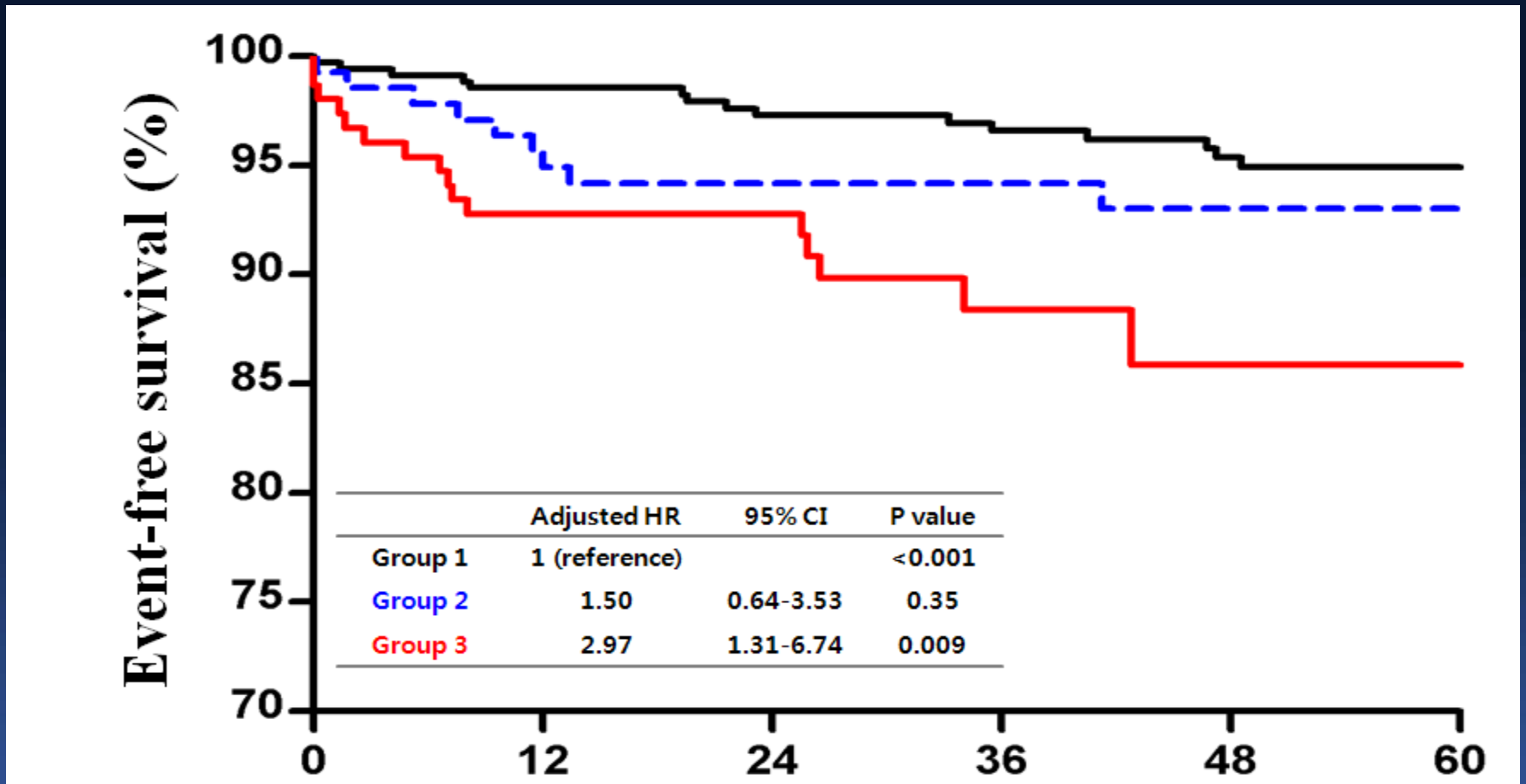
# Clinical Outcomes after Retreatment

DES failure was treated using medical treatment (n=161), balloon angioplasty (n =160), drug-eluting balloon angioplasty (n =14), DES implantation (n=256), or bypass graft surgery (n=42).

The median length of the follow-up period following treatment for DES failure was 52.8 months (IQR = 30.9–71.2 months).

During follow-up, 43 deaths (27 cardiac and 16 noncardiac), 10 myocardial infarctions, and 45 target lesion revascularizations were identified.

# Primary Outcome: Death from Any Cause

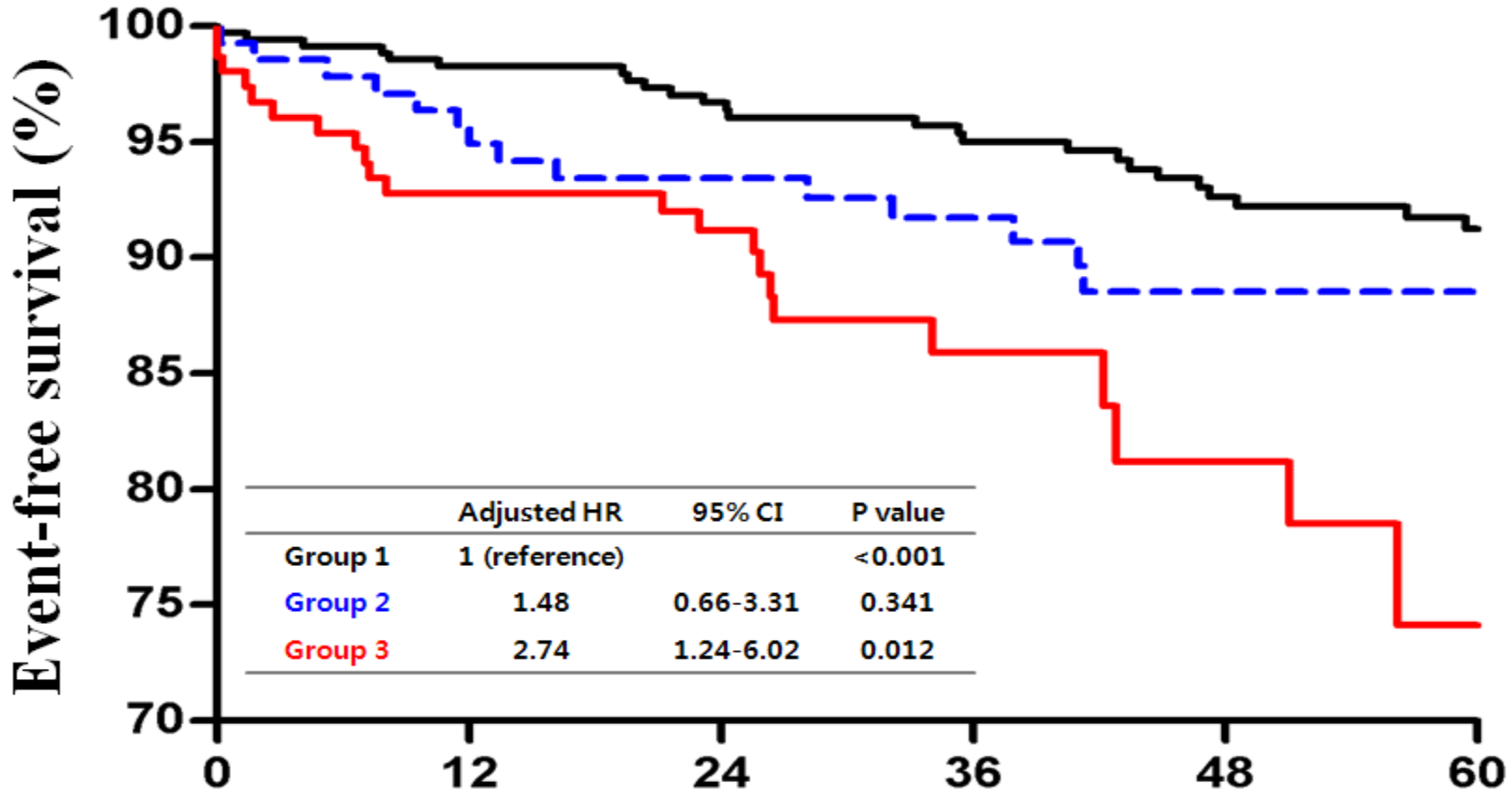



| | Adjusted HR | 95% CI | P value |
|---|---|---|---|
| Group 1 | 1 (reference) | | <0.001 |
| Group 2 | 1.50 | 0.64-3.53 | 0.35 |
| Group 3 | 2.97 | 1.31-6.74 | 0.009 |

**No. at Risk**

| | | | | | | |
|---|---|---|---|---|---|---|
| Group 1 | 343 | 336 | 305 | 267 | 229 | 179 |
| Group 2 | 138 | 130 | 117 | 101 | 76 | 59 |
| Group 3 | 152 | 142 | 106 | 52 | 31 | 14 |

# Death or MI

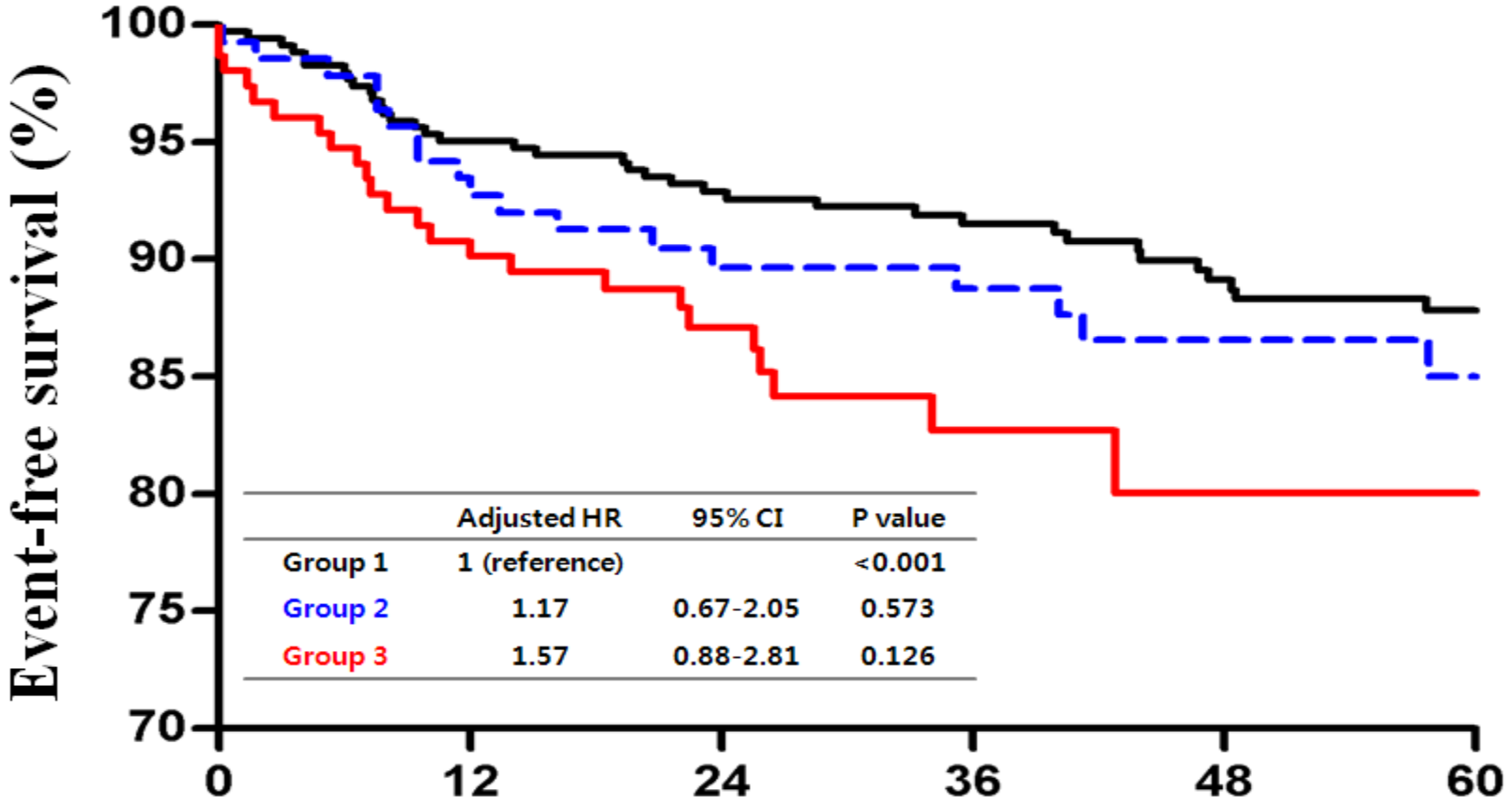



| | Adjusted HR | 95% CI | P value |
|---|---|---|---|
| Group 1 | 1 (reference) | | <0.001 |
| Group 2 | 1.48 | 0.66-3.31 | 0.341 |
| Group 3 | 2.74 | 1.24-6.02 | 0.012 |

**No. at Risk**

| | | | | | | |
|---|---|---|---|---|---|---|
| Group 1 | 343 | 335 | 305 | 267 | 229 | 179 |
| Group 2 | 138 | 130 | 116 | 100 | 75 | 58 |
| Group 3 | 152 | 142 | 106 | 52 | 31 | 14 |

# Death, MI or re-TLR




| No. at Risk | | | Months after treatment of DES failure | | | |
|---|---|---|---|---|---|---|
| Group 1 | 343 | 324 | 292 | 255 | 217 | 167 |
| Group 2 | 138 | 127 | 111 | 96 | 72 | 54 |
| Group 3 | 152 | 139 | 100 | 47 | 27 | 12 |

# Conclusions

- Late DES failure is more likely to progress to AMI, aggressive angiographic patterns, and worse outcomes following retreatment.

- These findings demonstrate time-related differences in the patterns of DES failure, supporting that different biological mechanisms underlie late DES failure.


Thank You!
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