



Seoul, Hyangwonjeong Pavilion

TCTAP Fellowship Course - Left Main & Bifurcation PCI II. Bifurcation PCI

# Stent Thrombosis After BMS, DES and BRS for Bifurcations

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# Disclosure of Financial Interest

Within the past 12 months, I, **Davide Capodanno**, have had a financial interest/arrangement or affiliation with the organization(s) listed below.






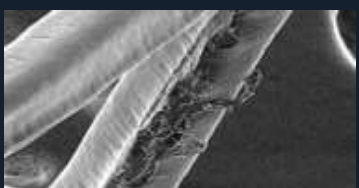


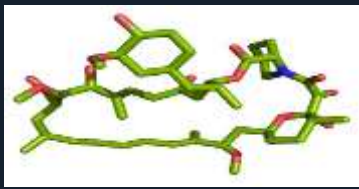
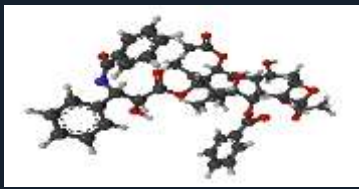
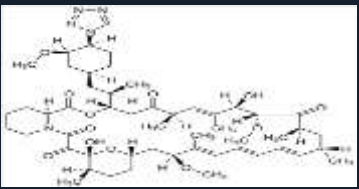
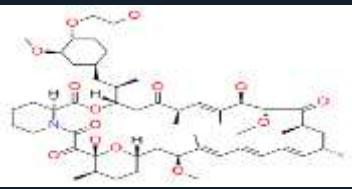
## Affiliation/Financial Relationship

- **Speakers' Honoraria**
- **Advisory Board**

## Company

- *Eli-Lilly/Daiichi Sankyo, AstraZeneca, Bayer, Abbott Vascular*
- *Eli-Lilly/Daiichi Sankyo, AstraZeneca*

# Stent Thrombosis in 2015: Impact of Stent Evolution

	First generation		Second generation	
Product	Cypher	Taxus	Resolute	Xiience
Stent				
Polymer				
Drug				
Propensity for ST versus BMS	Greater	Greater	Similar or lower	Similar or lower

# Stent Thrombosis in 2015: Impact of New Antiplatelets

## Prasugrel

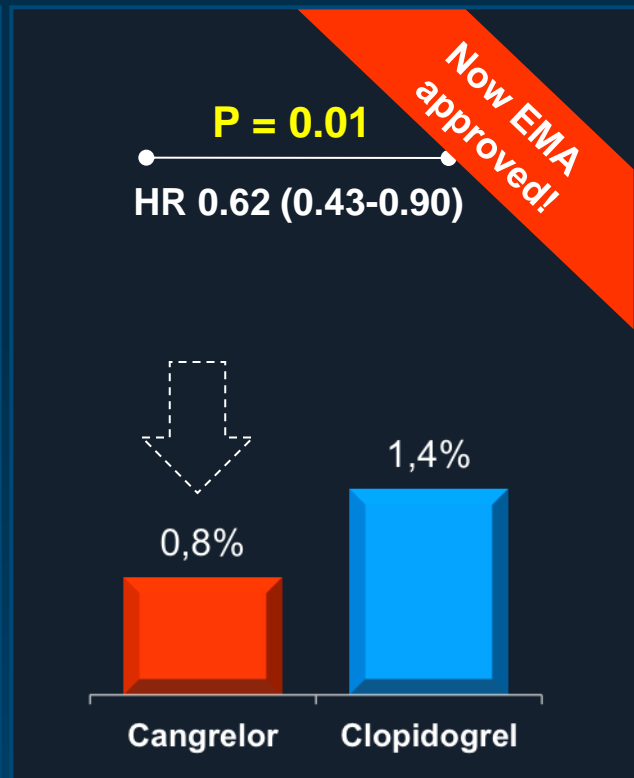
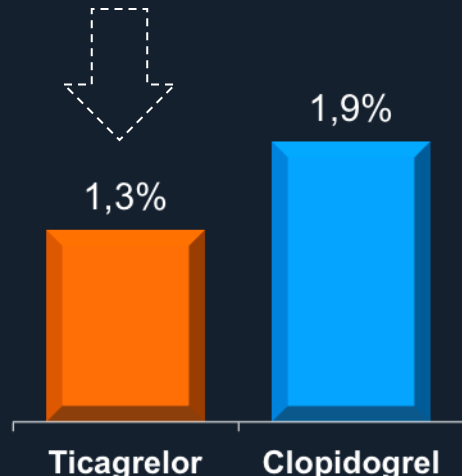
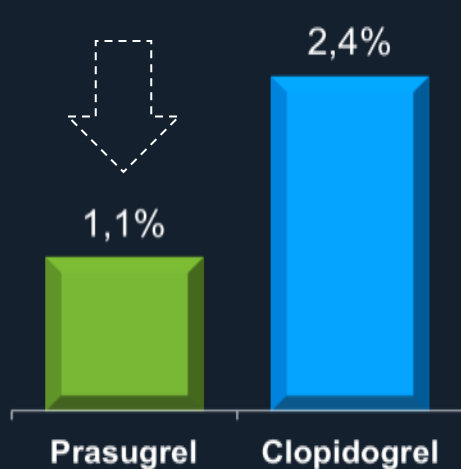
## Ticagrelor

## Cangrelor

**P < 0.001**  
HR 0.48 (0.36–0.64)

**P = 0.009**  
HR 0.67 (0.50–0.91)

**P = 0.01**  
HR 0.62 (0.43–0.90)



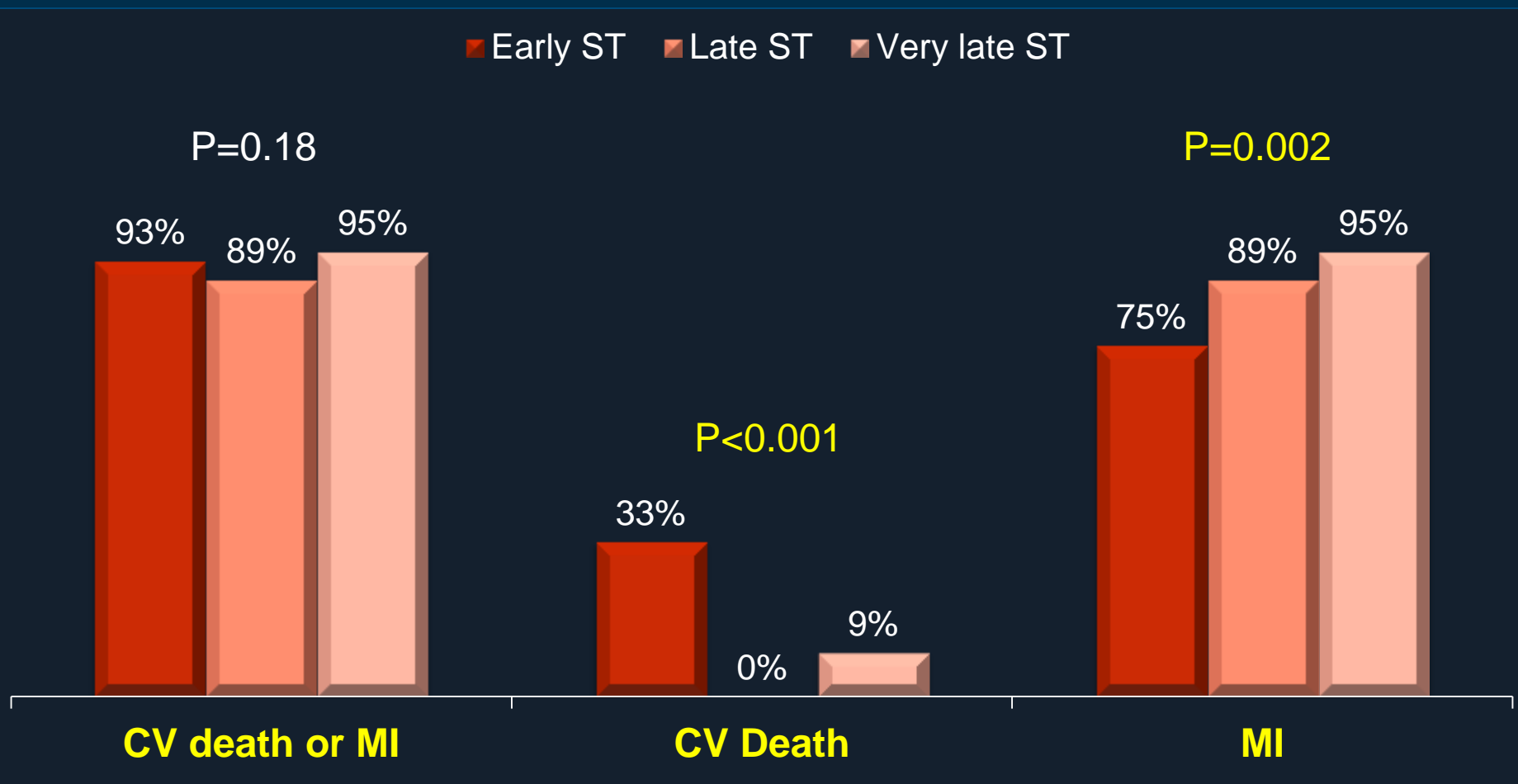
TRITON-TIMI 38

PLATO

CHAMPION-PHOENIX

# Cardiac Outcomes of Acute, Late and Very Late ST

184 stent thromboses in 8,709 patients with SES and PES from the PROTECT studies



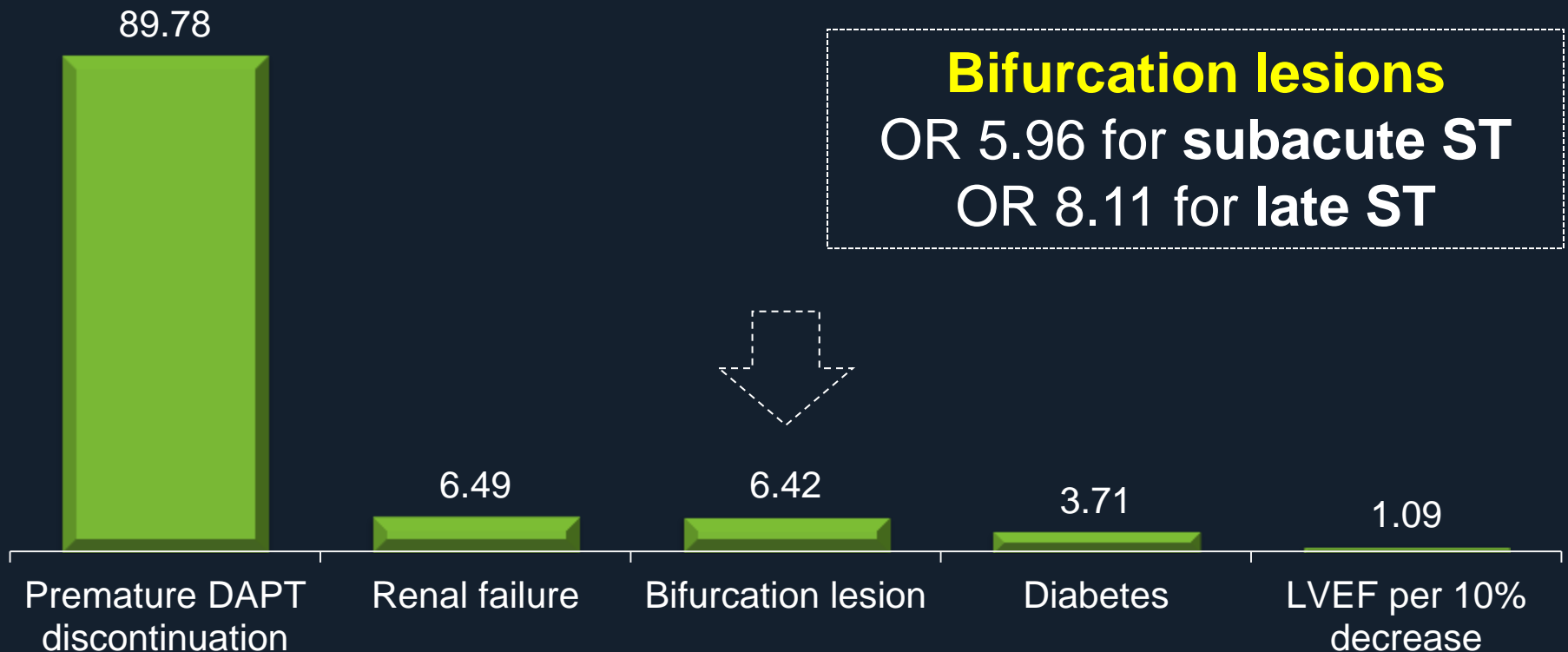
# WHAT ABOUT STENT THROMBOSIS IN CORONARY BIFURCATION LESIONS?



# Predictors of ST with 1<sup>st</sup> Generation DES

2229 patients undergoing PCI with SES or PES between April 2002 and January 2004

## Adjusted Odds Ratio for Cumulative ST

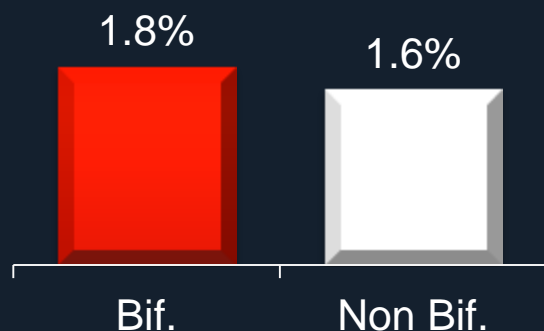


# Bifurcation ST and 2<sup>nd</sup> Generation DES

## EES+ZES-R

2-Year def. or prob. ST

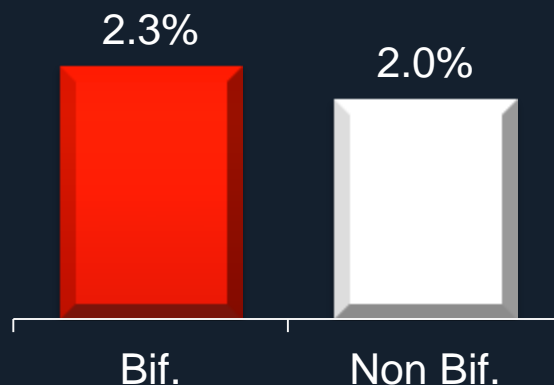
**P = 0.66**



## EES

2-Year def. or prob. ST

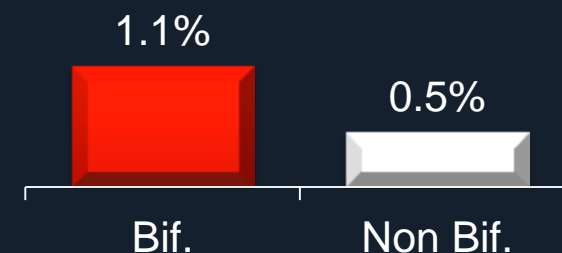
**P = 0.72**



## EES+ZES-R

2-Year def. or prob. ST

**P = 0.62**



## RESOLUTE AC

N=392 bif, 1-stent in 79.1%

Diletti R, et al. Heart 2013;99:1267–1274

## SPIRIT V

N=492 bif, 1-stent in 92.5%

Džavík V, et al. CCI 2013;82:163-72

## TWENTE

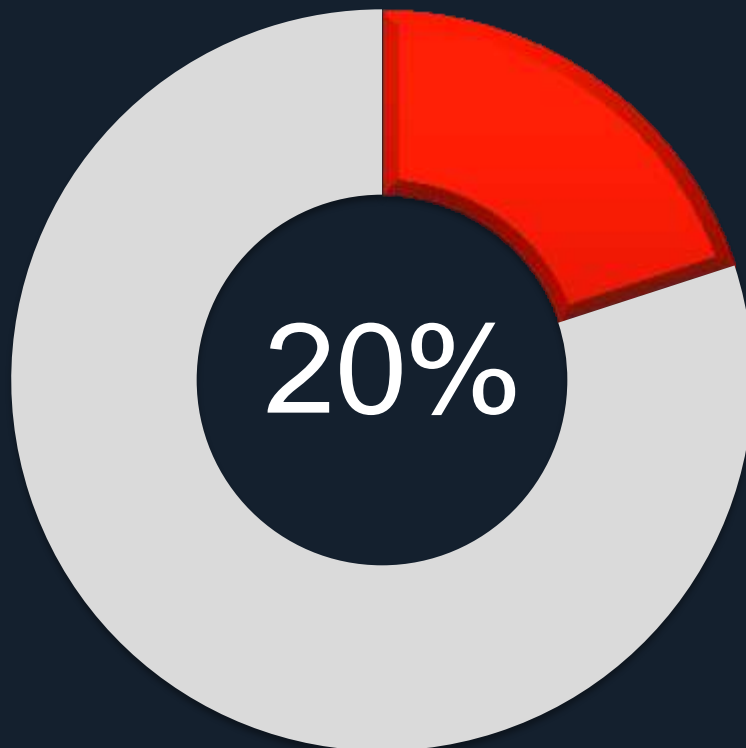
N=362 bif, 1-stent in 77.3%

Lam MK, et al. AHJ 2015;169:69-77

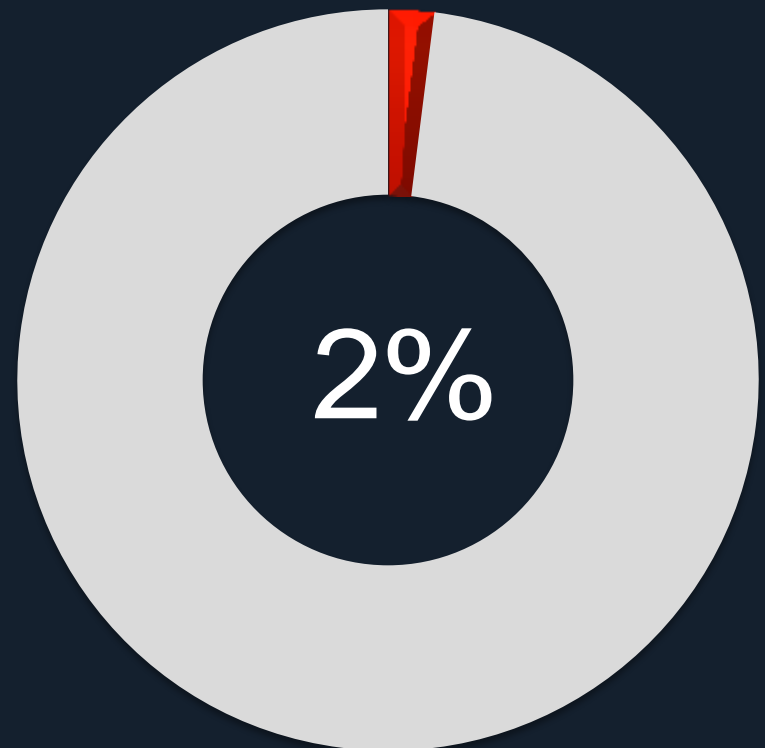


# In-Hospital Mortality of Coronary Bifurcation ST

173 cases of stent thrombosis from 5 US centers between 2005 and 2010



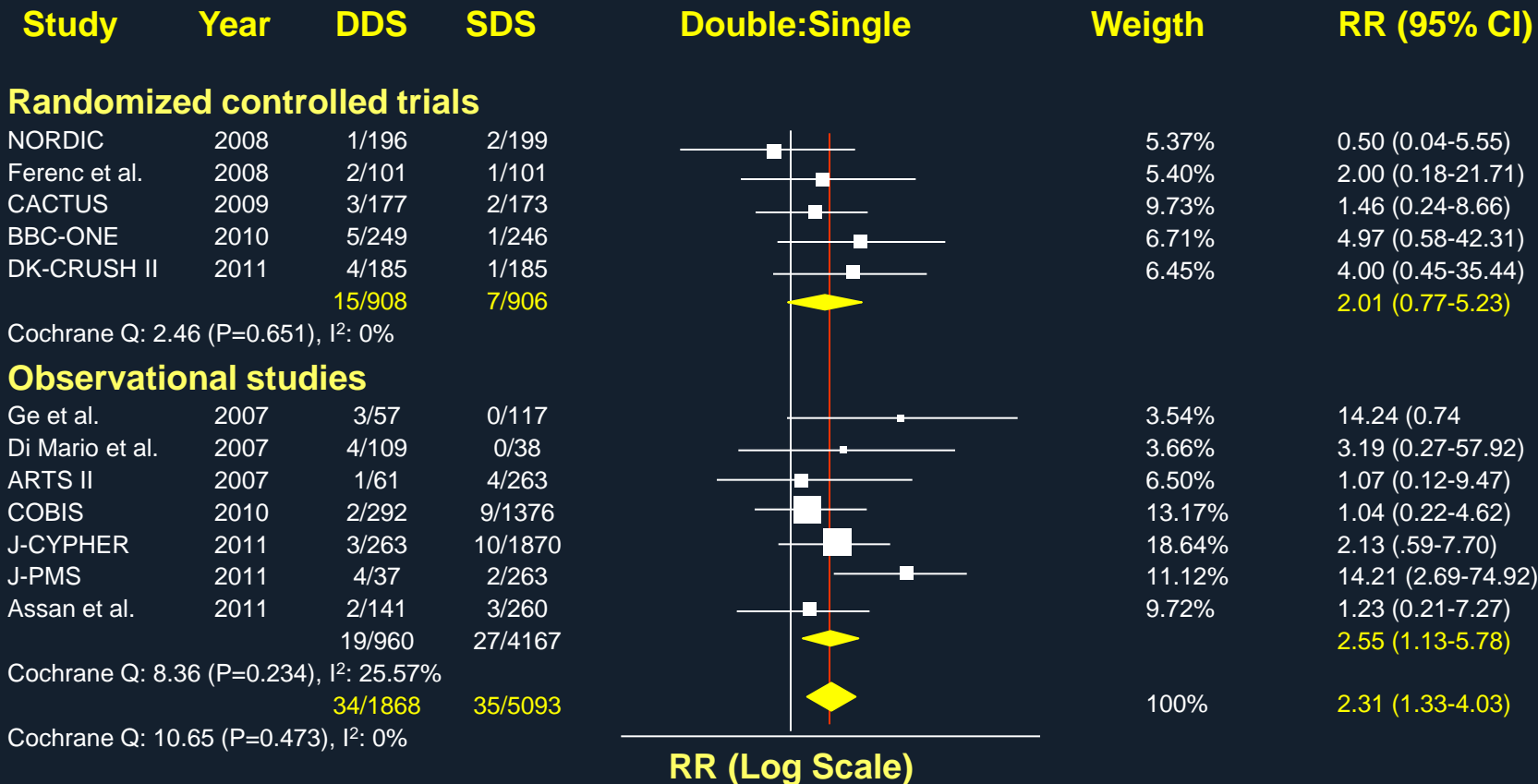
**Bifurcations**



**Non-Bifurcations**







# Impact of Bifurcation Strategy on ST

Meta-analysis of 6,961 patients from 5 RCTs and 7 Oss of single vs double stenting



WHERE DO **BIORESORBABLE  
SCAFFOLDS** STAND IN THE  
CURRENT LANDSCAPE OF  
**BIFURCATION PCI?**

# Strut Thickness of BRS Resembles 1<sup>st</sup> Gen DES

	Commercially Available		Reva ReZolve	ART	Amaranth Fortitude	Biotronik DREAMS-2
Template Thickness	 Abbott Vascular Absorb PLLA	 Elixir DESolve PLA-based	 Tyrosine-derived Polycarbonate	 PDLA	 PLLA	 Magnesium
Template Thickness	~150 μm	~150 μm	~122 μm X 2	~160 μm	~150 μm	~125 μm
Support Time	6 months	3 – < 6 months	~6 months	≤ 3 months	3 – 6 months	≤ 3 months
Degradation Products	H <sub>2</sub> O & CO <sub>2</sub>	H <sub>2</sub> O & CO <sub>2</sub>	I <sub>2</sub> DAT, I <sub>2</sub> DT, PCL, Tyrosine	H <sub>2</sub> O & CO <sub>2</sub>	H <sub>2</sub> O & CO <sub>2</sub>	Soft Hydroxyapatite
Resorption Time	< 36 months (slow)	18 – 24 months (fast)	~ 36 months (slow)	~18 months (very fast)	> 48 months (very slow)	9 – 12 months (very fast)

# Impact of Strut Geometry on Thrombogenicity

3-day adherent thrombus (mm<sup>2</sup>) in animal models treated with thin- (81x81 μm) or thick-strut (162x81 μm) BMS

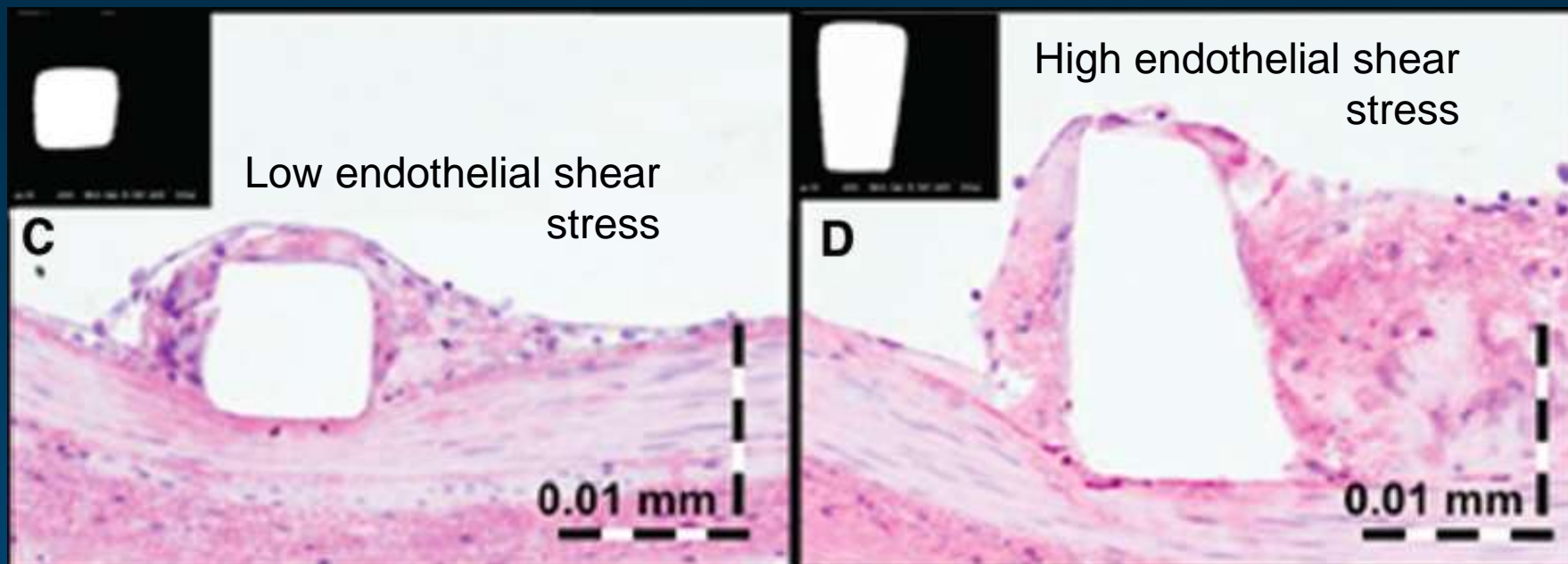
0.13

P=0.004

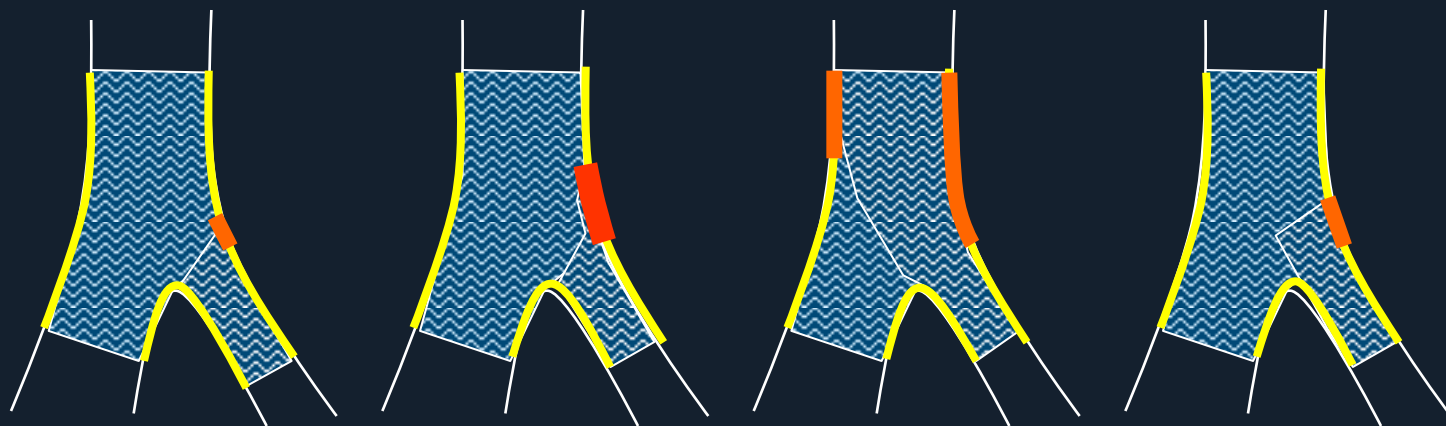
0.21

Thin-strut BMS (81 μm)

Thick-strut BMS (162 μm)



# Strut Layering In BRS Double Stenting



**T stenting**

**Internal crush**

**Culotte**

**TAP**

**Triple layer**

**++**

**With BVS**

**468 μm**

**Double layer**

**+++**

**+**

**With BVS**

**312 μm**

**312 μm**

# Early Delay in Strut Coverage in Overlapping BVS

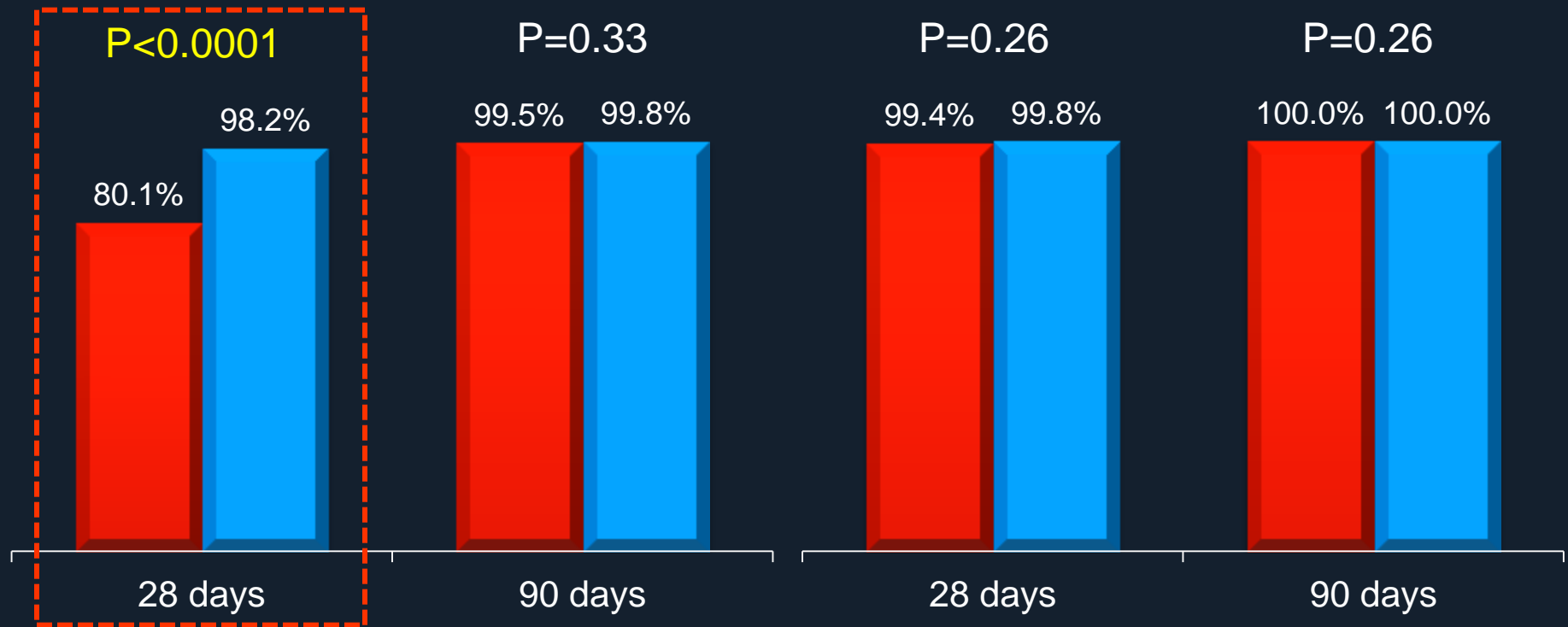
Serial OCT assessments in 41 swine at 28 and 90 days (1,407 cross-sections)

## Absorb BVS

■ Overlap ■ Nonoverlap

## Xience V EES

■ Overlap ■ Nonoverlap





# ABSORB II - Scaffold thrombosis

501 patients with coronary artery disease 2:1 randomized to BVS or EES

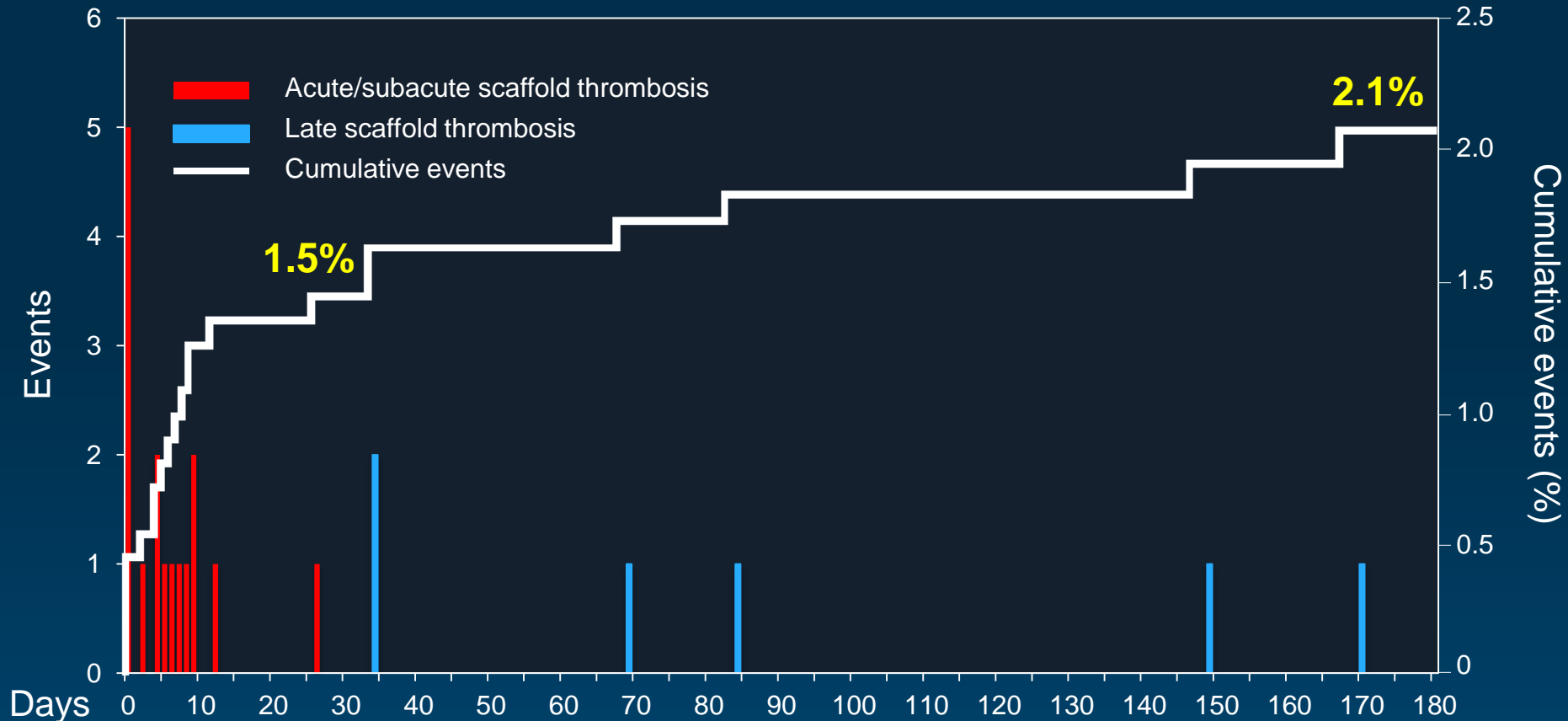
	<b>BVS (N=355)</b>	<b>EES (N=166)</b>	<b>Difference (95% CI)</b>	<b>P value</b>
1-year definite ST	2 (0.6%)	0	0.61% (-1.72 to 2.19)	1.00
Acute (0-1 day)	1 (0.3%)	0	0.30% (-1.98 to 1.67)	1.00
Subacute (2-30 days)	1 (0.3%)	0	0.30% (-1.98 to 1.68)	1.00
Late (31-365 days)	0	0	0.00% (NA)	1.00
Definite or probable ST	3 (0.9%)	0	0.91% (-1.45 to 2.65)	0.55

“Two myocardial infarctions in the BVS group (one Q-wave and one non-Q-wave) were attributed to definite scaffold thrombosis, in one case involving overlapping scaffolds and in the other case involving bifurcation scaffolding (a protocol deviation)”

# GHOST-EU

## Absorb BVS in Daily Practice

1,189 patients, 1,440 lesions, 1,731 BVS from 10 centers. Median FU 189 (IQR 120-284) days



87% of ST occurred while patients still on DAPT

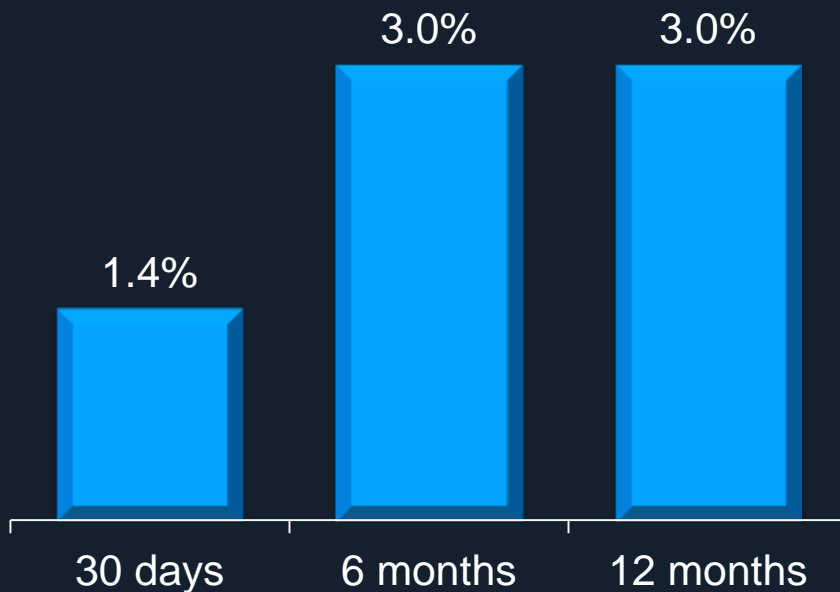
91.3% of patients with ST had a clinical sequelae (Death, MI or TLR)

# GHOST-EU

## Absorb BVS in Bifurcations

289 patients, 302 bifurcation lesions from 10 centers (86% provisional)

### Kaplan-Meier Estimates of Definite Stent Thrombosis



Diabetes mellitus	25%
ACS at presentation	34%
Prasugrel or ticagrelor	19%
True bifurcation	45%
Predilation of MB	95%
Postdilation of MB	61%
FKBI	19%
IVUS	22%
OCT	21%

289 patients with 302 bifurcation lesions from 10 centers (86% provisional)

Case	DM	ACS	Medina	Technique	Post-dilation on MB	KBI	OCT and/or IVUS	P2Y12 inhibitor	On DAPT
1	Yes	No	1,1,1	Single	Yes	No	Yes	Clopidogrel	No
2	No	No	0,1,0	Single	No	No	No	Clopidogrel	Yes
3	No	Yes	1,0,0	Single	No	No	Yes	Clopidogrel	Yes
4	No	Yes	1,1,1	Single	No	No	No	Ticlopidine	Yes
5	Yes	Yes	1,1,0	Single	No	No	No	Clopidogrel	Yes
6	No	Yes	1,1,1	Double*	Yes	No	No	Clopidogrel	No
7	No	Yes	1,1,0	Single	No	No	No	Clopidogrel	Yes
8	Yes	Yes	1,1,0	Single	No	No	No	Clopidogrel	Yes
9	Yes	Yes	0,0,1	Single	No	Yes	No	Prasugrel	Yes

\*DES on SB. Favorable characteristics are shown in green. Unfavorable characteristics are shown in red.

# Contemporary practice and technical aspects in coronary intervention with bioresorbable scaffolds: a European perspective

Corrado Tamburino<sup>1</sup>, MD, PhD; Azeem Latib<sup>2</sup>, MD; Robert-Jan van Geuns<sup>3</sup>, MD; Manel Sabate<sup>4</sup>, MD; Julinda Mehilli<sup>5</sup>, MD; Tommaso Gori<sup>6</sup>, MD, PhD; Stephan Achenbach<sup>7</sup>, MD; Manuel Pan Alvarez<sup>8</sup>, MD; Holger Nef<sup>9</sup>, MD; Maciej Lesiak<sup>10</sup>, MD; Carlo Di Mario<sup>11</sup>, MD; Antonio Colombo<sup>2</sup>, MD; Christoph K. Naber<sup>12</sup>, MD; Giuseppe Caramanno<sup>13</sup>, MD; Piera Capranzano<sup>1</sup>, MD; Salvatore Brugaletta<sup>4</sup>, MD; Salvatore Geraci<sup>13</sup>, MD; Aleksander Araszkiwicz<sup>10</sup>, MD; Alessio Mattesini<sup>11</sup>, MD; Stylianos A. Pyxaras<sup>12</sup>, MD; Lukasz Rzeszutko<sup>14</sup>, MD; Rafalo Depukat<sup>14</sup>, MD; Roberto Diletti<sup>3</sup>, MD; Els Boone<sup>15</sup>, MSc; Davide Capodanno<sup>1\*</sup>, MD, PhD; Dariusz Dudek<sup>14</sup>, MD

1. Provisional technique whenever possible
2. POT, SB fenestration and KBI (ie, undersized or snuggle) with caution
3. For single stent techniques:
  - One BVS across the bifurcation and nothing else
  - SB dilatation and one BVS across the bifurcation
4. For double stent techniques:
  - For bailout SB DES or BRS stenting, prefer techniques with least strut layering (ie, T, TAP)
  - Avoid systematic double scaffolding whenever possible

# Management of Early Scaffold Thrombosis

**Early BVS thrombosis**

Thrombectomy

**Optical coherence tomography**

**Edge dissection**

Treatment with new scaffold or stent

**Fracture**

Treatment with a metallic stent

**Malapposition**

Consider the desired final diameter

Outside the maximal allowed limit of the scaffold range

Treatment with a metallic stent

Inside the maximal allowed limit of the scaffold range

Post-dilatation with a NC balloon

**Underexpansion**

Post-dilatation with a NC balloon

**No mechanical complications**

Consider to optimize scaffold size to the maximal allowed limit with a NC balloon

# Closing Remarks

1. Stent thrombosis in bifurcation lesions has decreased over time, reflecting ongoing progresses in DES platforms, antiplatelet drugs and procedural strategies.
2. The use of BRS in coronary bifurcations carries many limitations, including the uncertain outcome of procedural steps known to be important with DES but potentially hazardous with a breakable device.
3. Until more BRS data are available to provide guidance in this field, provisional DES strategies should be regarded as the standard of care for most (~70-90%) bifurcation lesions.