



Left Main PCI: Can Different stents make different outcomes?

LIM Soo Teik

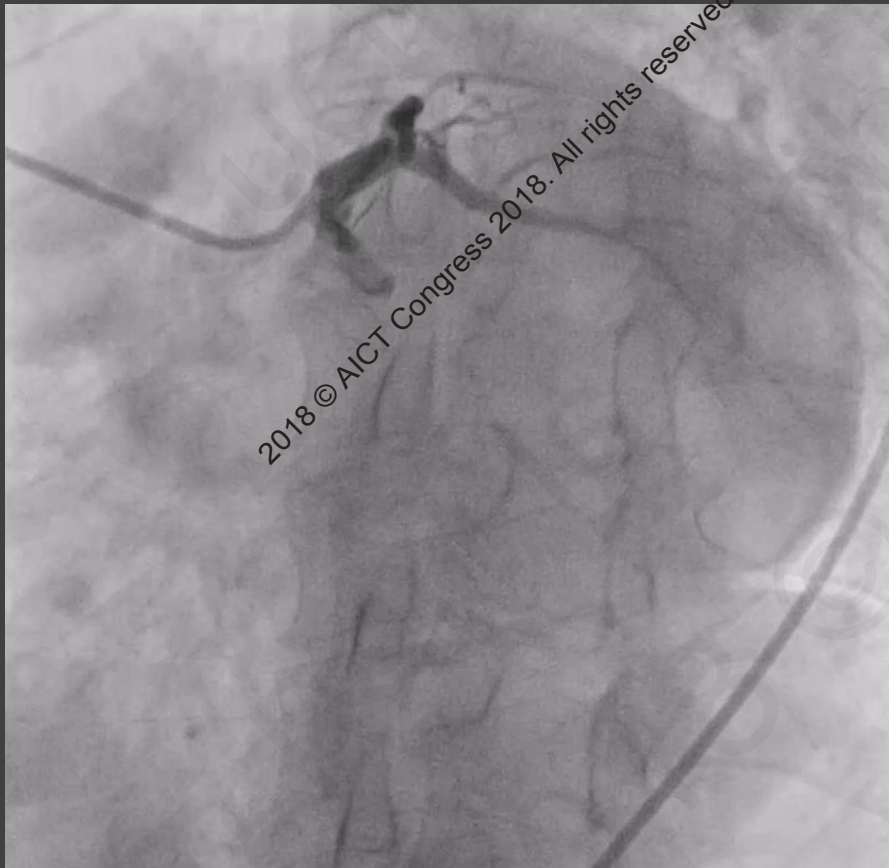
National Heart Centre Singapore

Sep 2018

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Outcome of Left Main Stenting



Patient factors

- comorbidities
- genetic and behavioural factors (e.g medication compliance)
- LV function

Anatomic factors

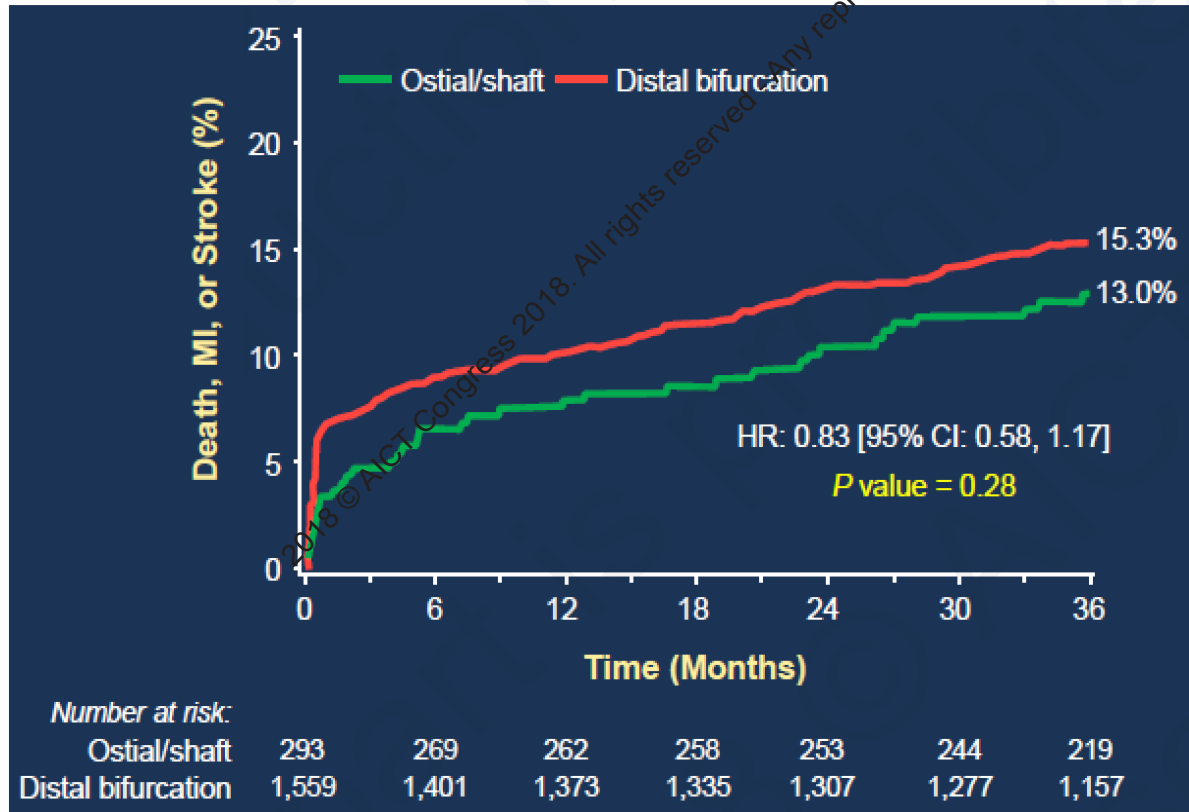
- ostial / shaft vs distal bifurcation
- simple vs complex lesion
- Total coronary disease burden (SYNTAX score)

Procedure / Device factors

- stenting strategy – provisional vs two stent; stenting technique
- imaging guidance
- device choice

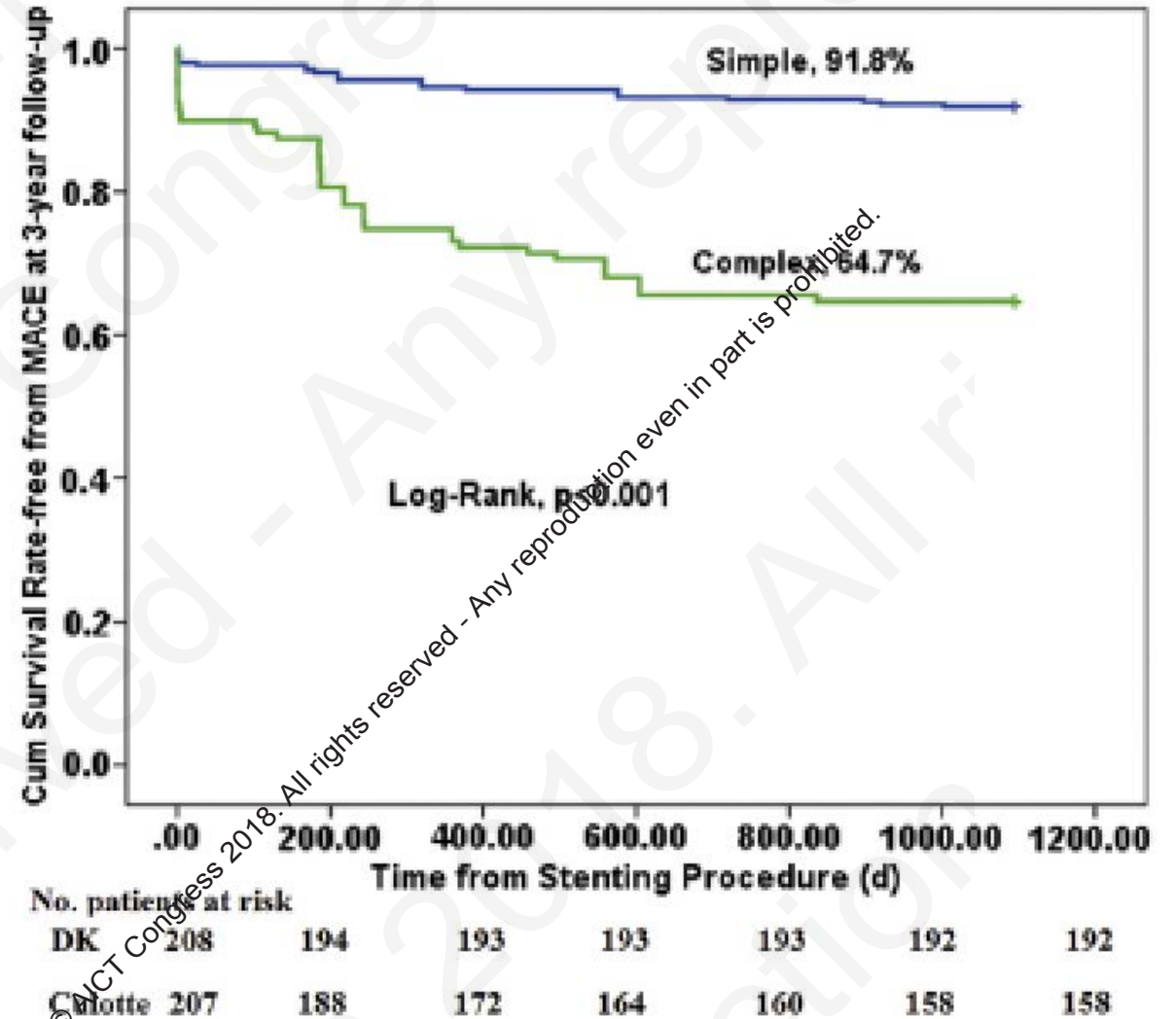
EXCEL Study

Distal LM bifurcation vs ostial/shaft stenosis



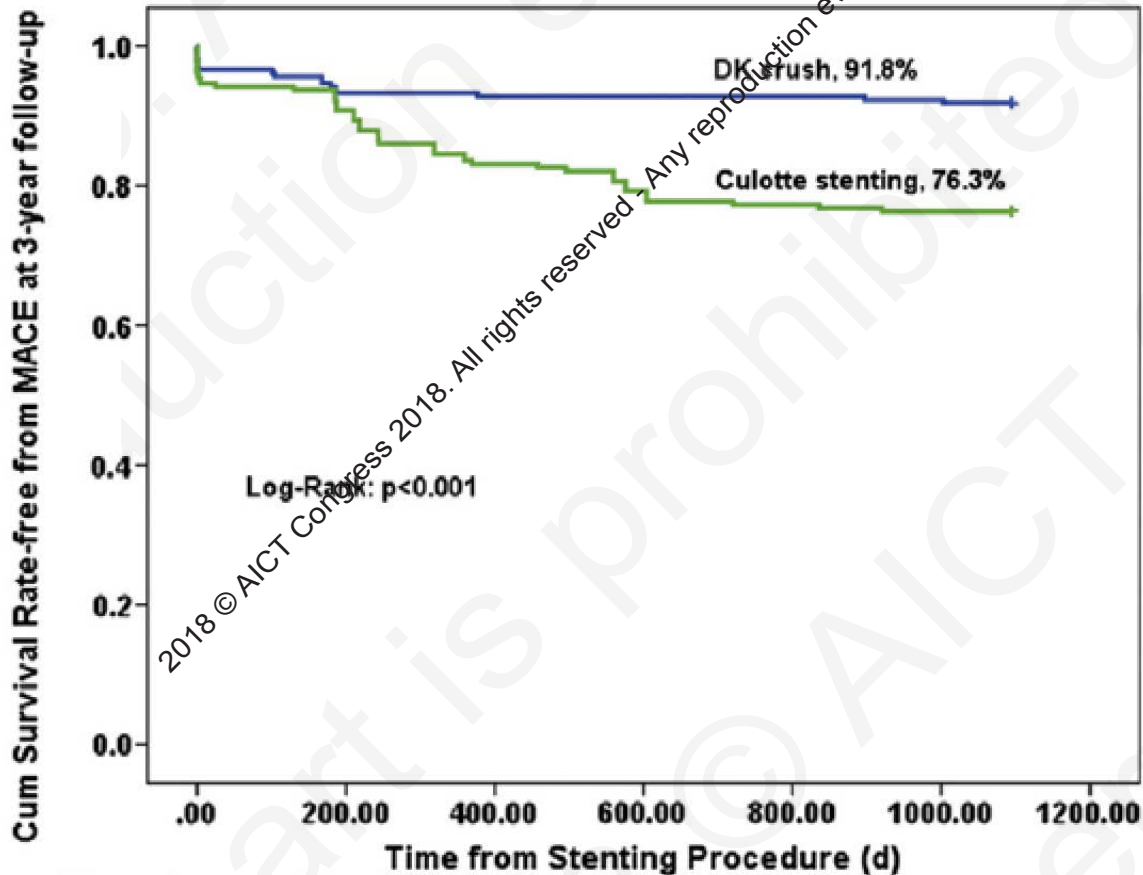
DKCRUSH III

Simple vs Complex Left Main Bifurcation Lesion

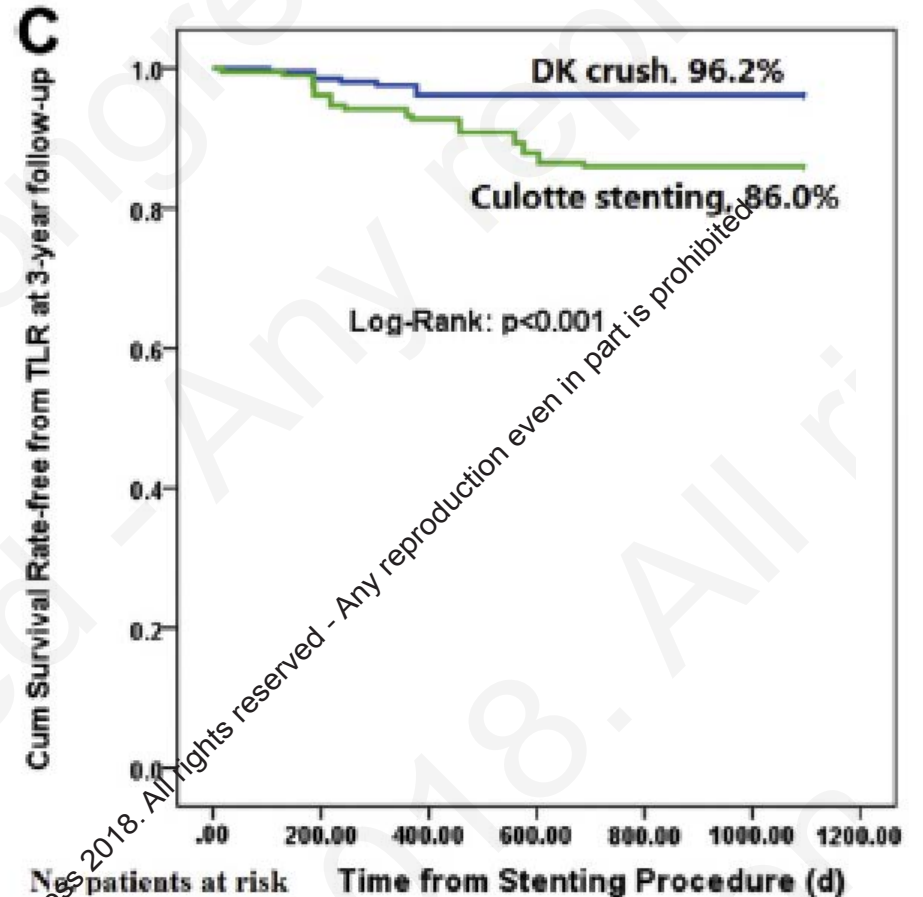


DKCRUSH III

DKCRUSH vs Culotte technique for LM bifurcation

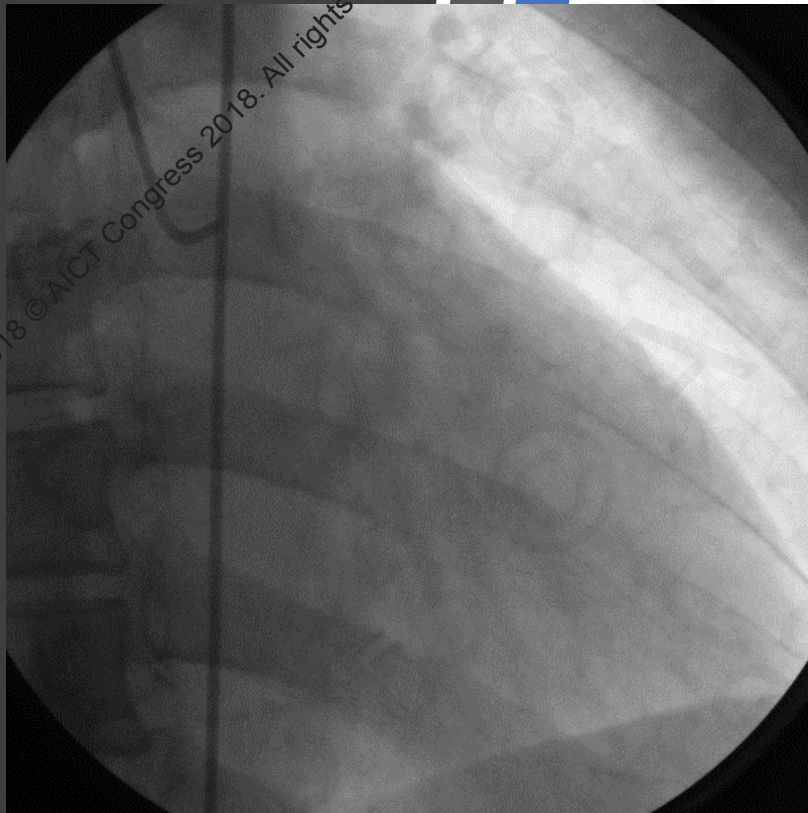


No. patients at risk		Time from Stenting Procedure (d)						
	.00	200.00	400.00	600.00	800.00	1000.00	1200.00	
DK	208	196	193	193	193	192	191	
Culotte	207	194	173	164	160	158	158	



No. patients at risk		Time from Stenting Procedure (d)						
	.00	200.00	400.00	600.00	800.00	1000.00	1200.00	
DK	208	205	200	200	200	200	200	
Culotte	207	199	192	182	178	178	178	

Different Stents → ?? Different Outcomes



BMS vs DES

1G vs 2G DES

Different 2G
DES

Balloon
expandable
vs self-
expanding
stent

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Different
Stents → ??
Different
Outcomes

YES

BMS vs DES

YES

1G vs 2G DES

??

Different 2G
DES

??

Balloon
expandable
vs self-
expanding
DES

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1G → 2G / 3G
Drug-eluting Stents

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Evolution of TAXUS / PROMUS / SYNERGY DES

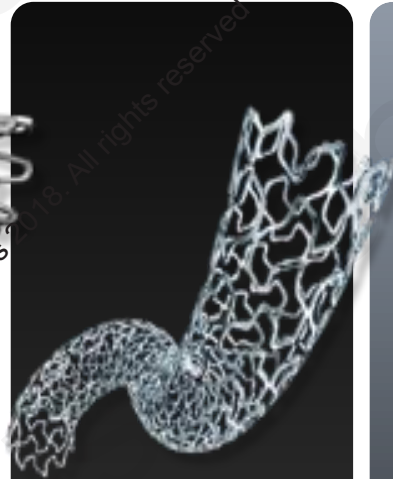
Stent: → Thinner strut ; design change
→ more deliverable / conformable

Drug: Paclitaxel → Everolimus
Polymer: Permanent → Bioresorbable
Drug/Polymer: Circumferential → Abluminal



2003

TAXUS™ Express²™ Stent System



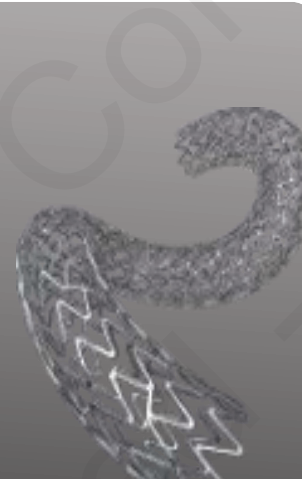
2005

TAXUS™ Liberté™ Stent System



2006

PROMUS™ Stent System



2009-2010

TAXUS Element™ and PROMUS Element™ Stent Systems



2013

Promus PREMIER™ Stent System



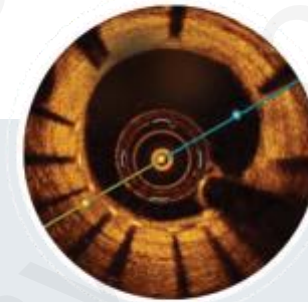
2013

SYNERGY™ Stent System

Impact of Stent Design on Healing

Design Factors Impacting Healing

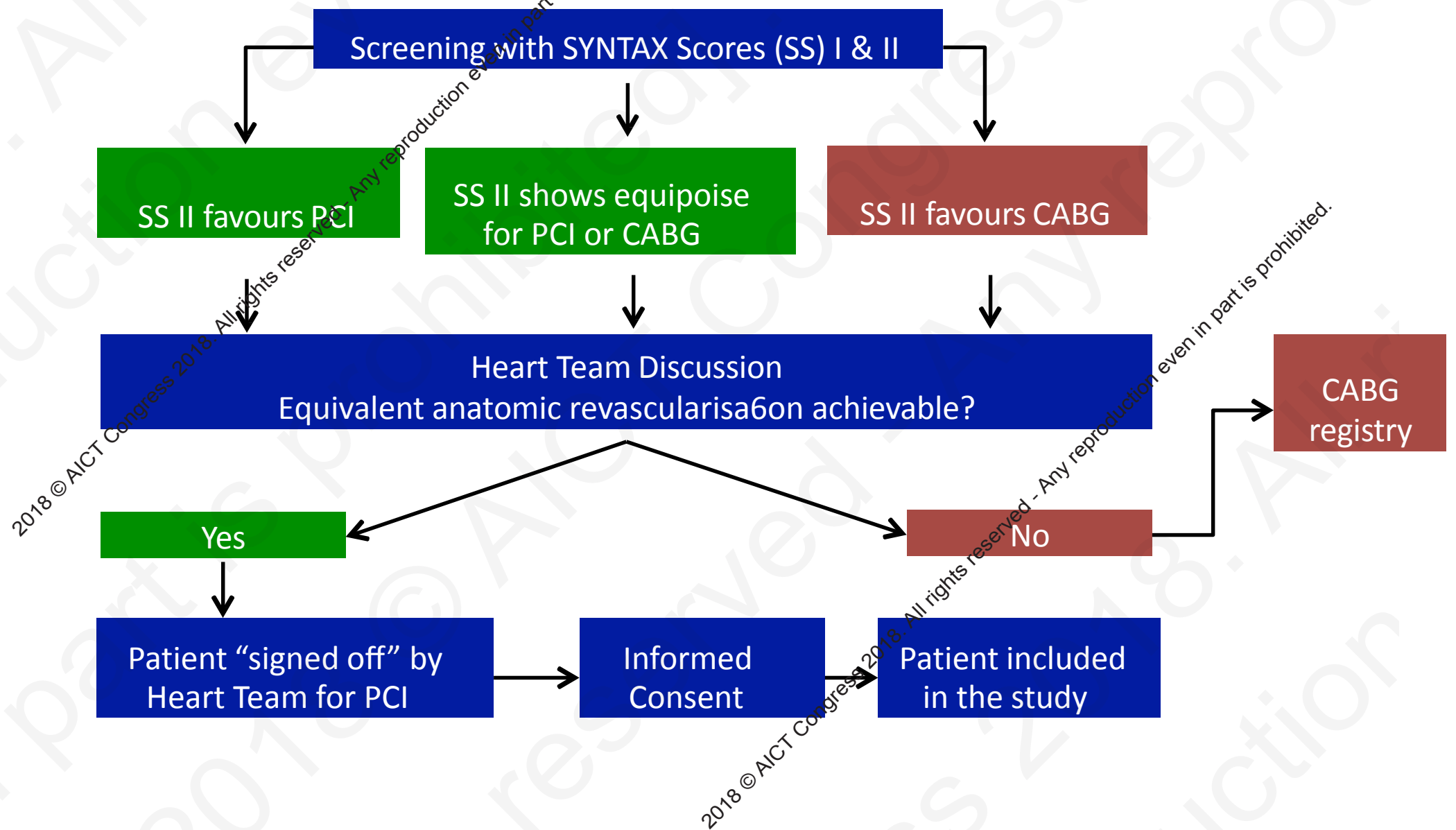
- **Strut thickness**
- **Polymer Location**
- **Polymer Load and Duration**



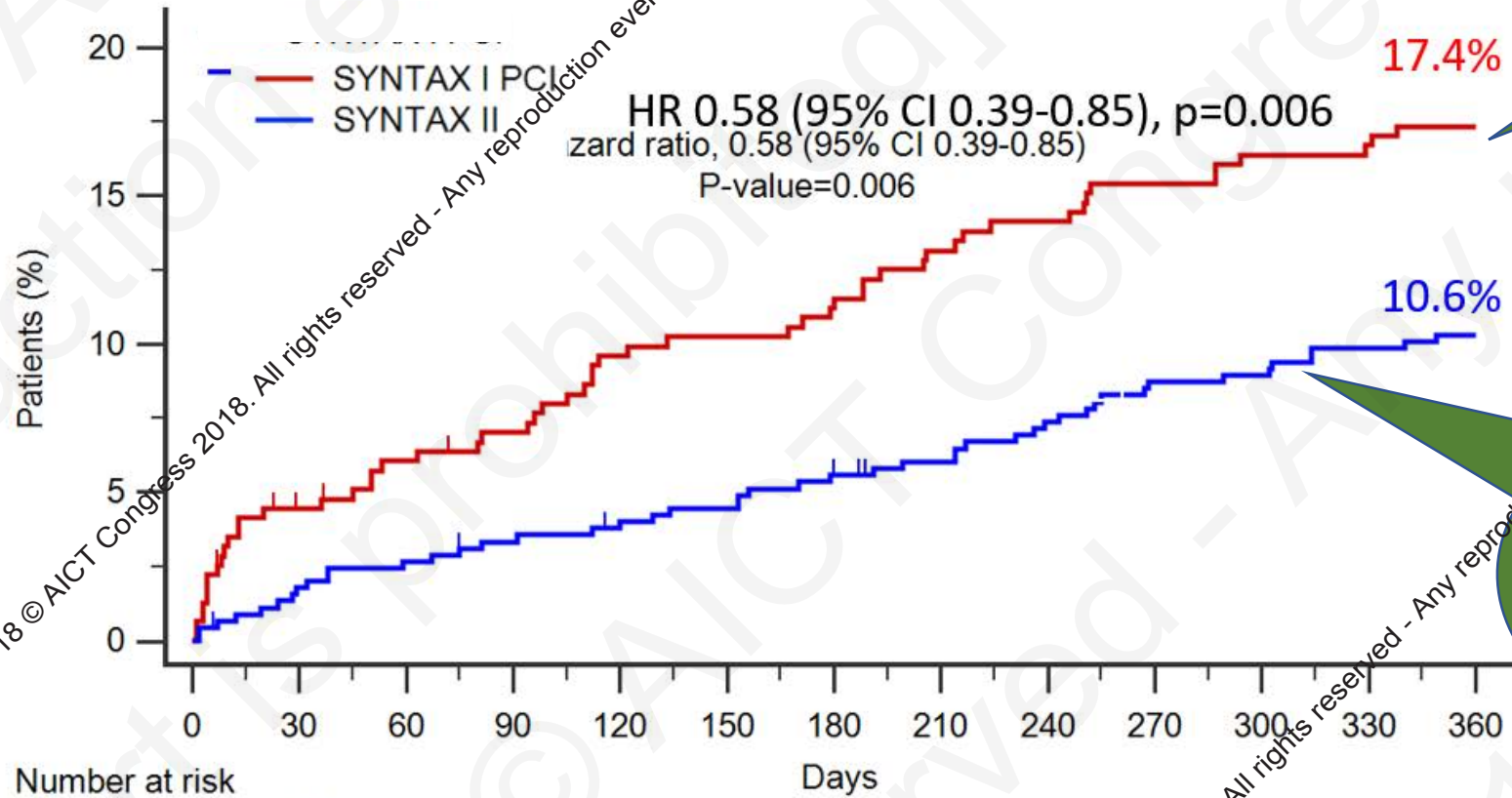
Optimal Healing

- **Increased Endothelial Coverage**
- **Reduced Inflammation**
- **Reduced Likelihood of Stent Thrombosis**

Patient inclusion



SYNTAX II (Triple Vessel Disease)



Taxus DES

Synergy DES
iFR/FFR
IVUS/OCT guidance;
CTO by CTO operators

SYNTAX I PCI
SYNTAX II

Number at risk														
Group: SYNTAX I PCI		0	30	60	90	120	150	180	210	240	270	300	330	360
		315	298	292	288	280	278	274	269	266	262	259	258	256
Group: SYNTAX II		0	30	60	90	120	150	180	210	240	270	300	330	360
		450	441	437	433	429	427	421	417	411	405	404	400	398

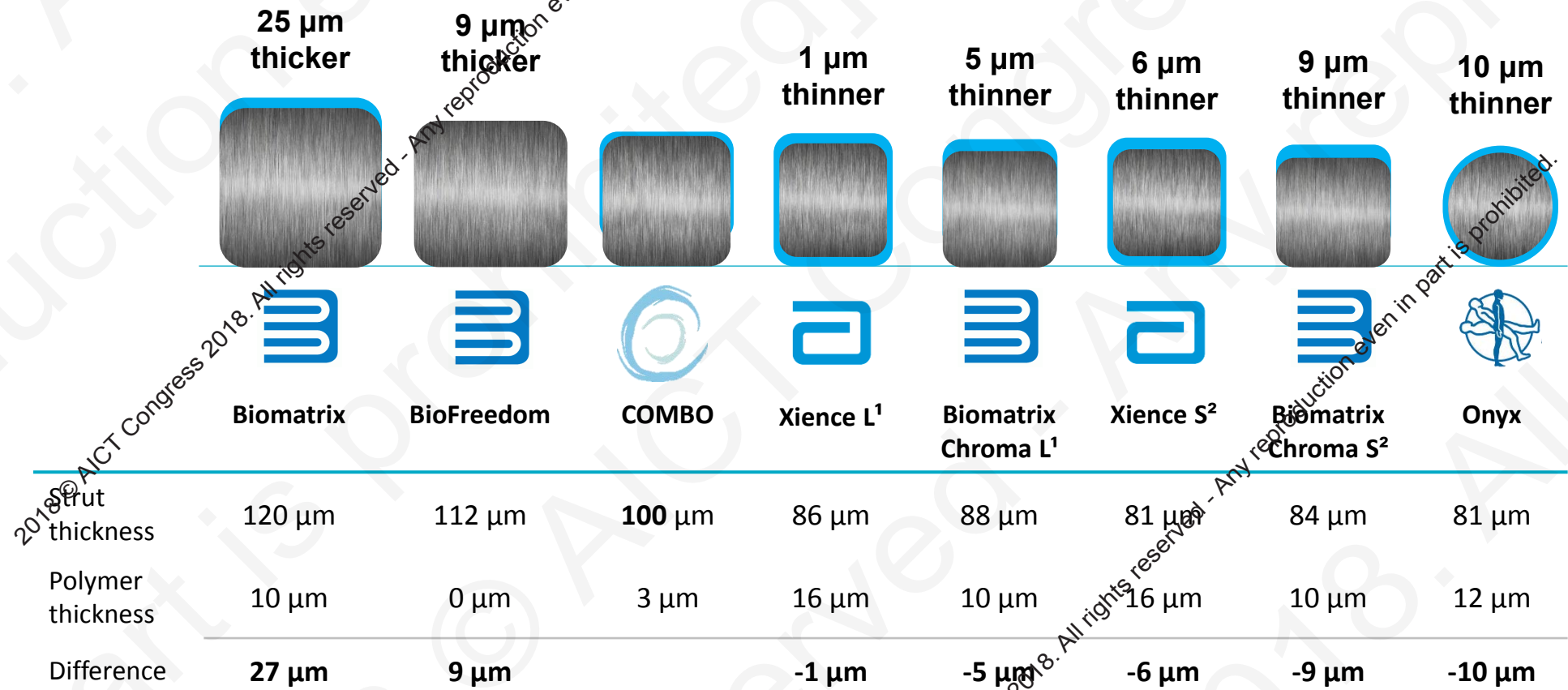
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Different 2G / 3G DES

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Strut Thickness



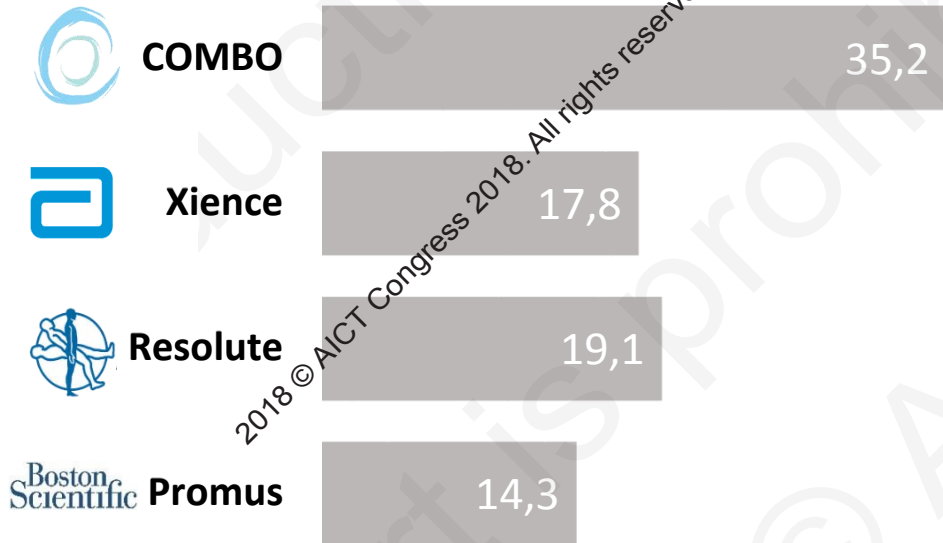
¹ 3.5-4.0 mm

² 2.25-3.0 mm

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Radial Strength,

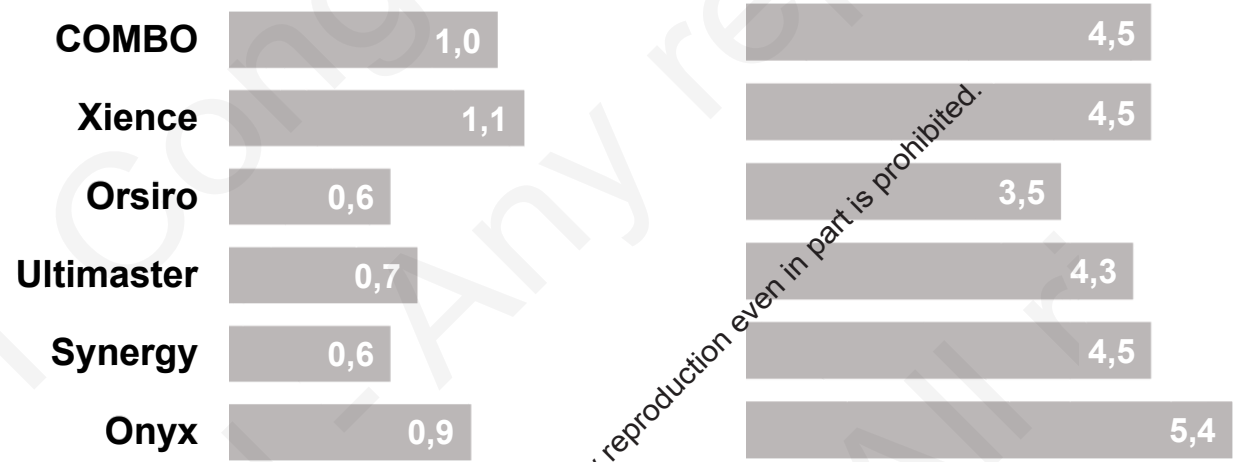
as measured in psi for >50% collapse



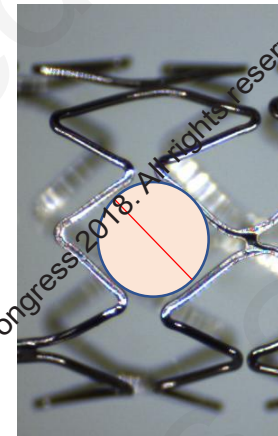
Cell Opening / Side Branch Access

Cell Opening (mm) at NP for 3.0 mm stents

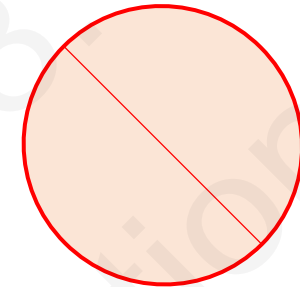
Maximum achievable cell diameter (mm) for 3.0 mm stents



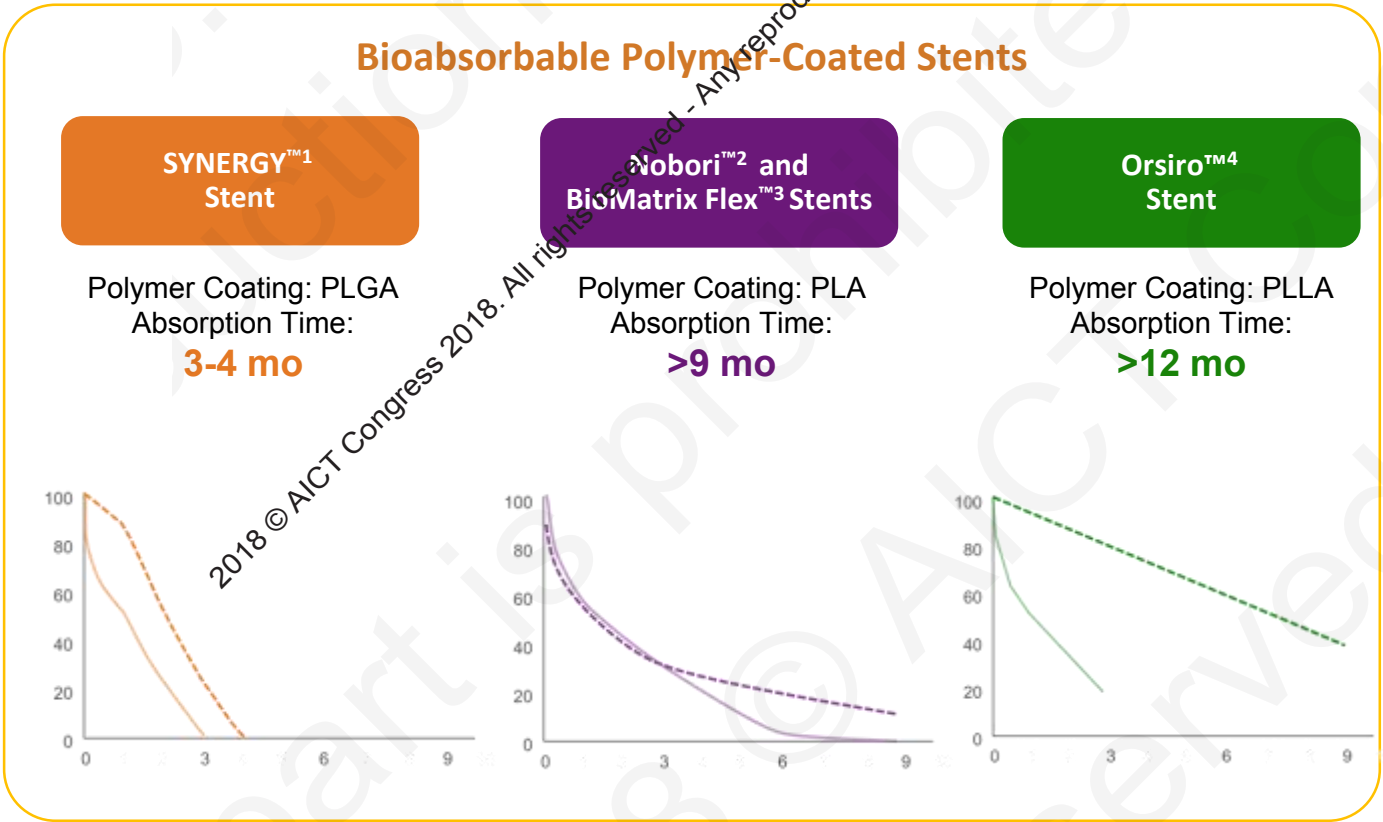
Diameter of maximum cell opening at NP



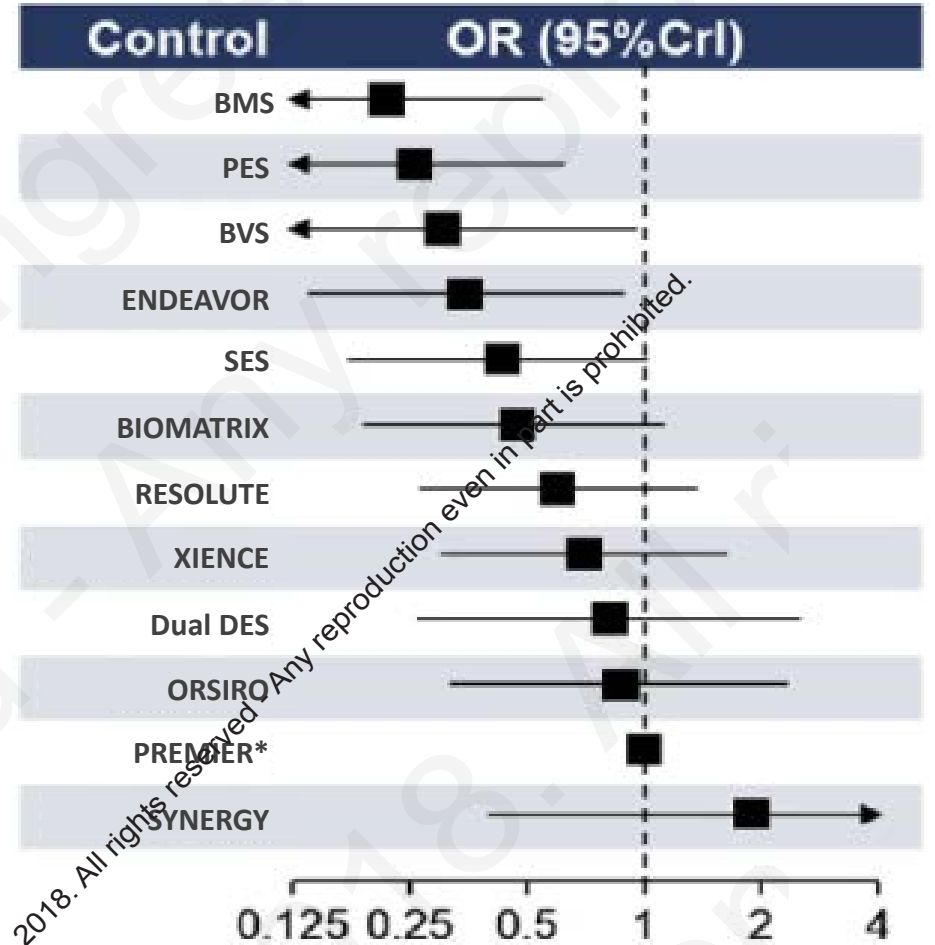
Maximum achievable cell diameter



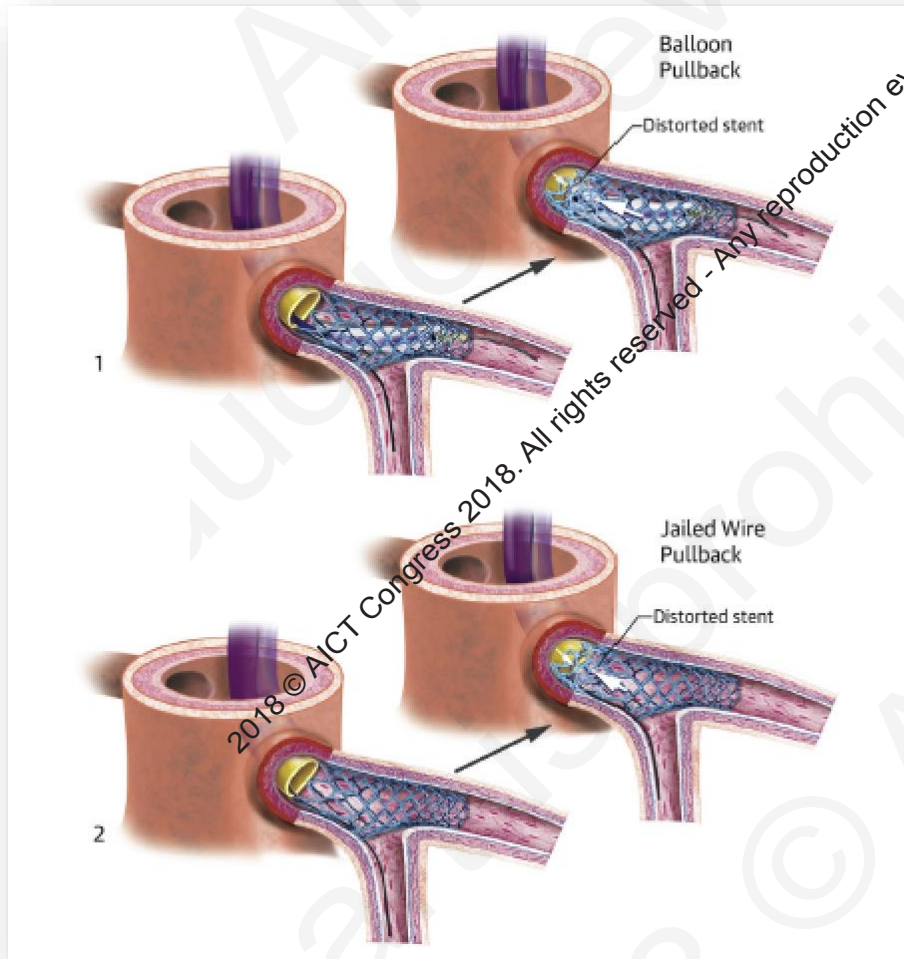
Bioabsorbable polymer degradation profile



Stent thrombosis risk: metanalysis

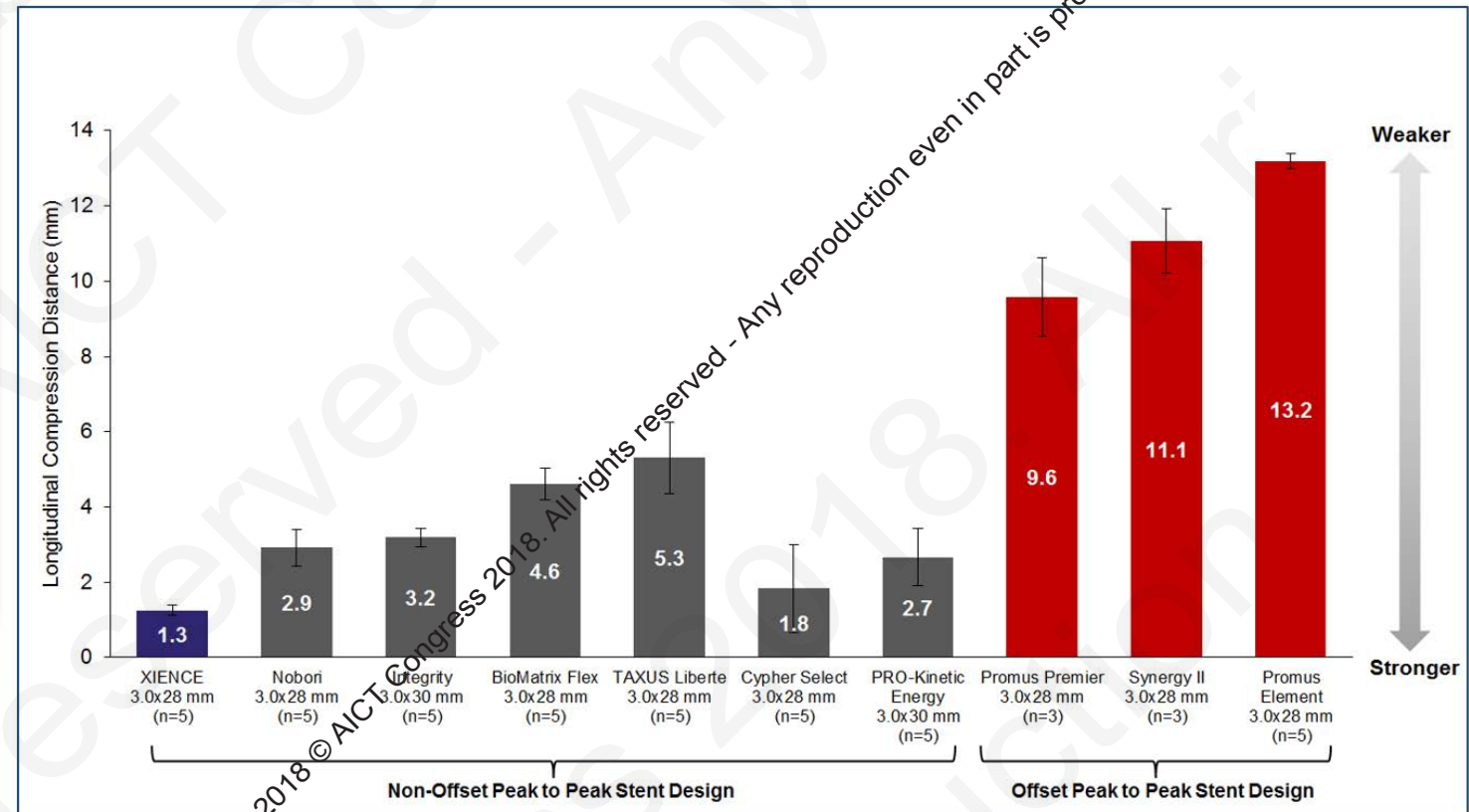


Longitudinal Stent Compression



(Rab T et al. JACC Interv 2017;10:849-65)

Abbott Xience Xience PRIME XPEDITION	Boston Scientific Promus Element Promus Premier	Boston Scientific Synergy
3-3-3 link	4 angled links Prox & Distal, 2 angled links	4 angled links Prox & Distal, 2 angled links

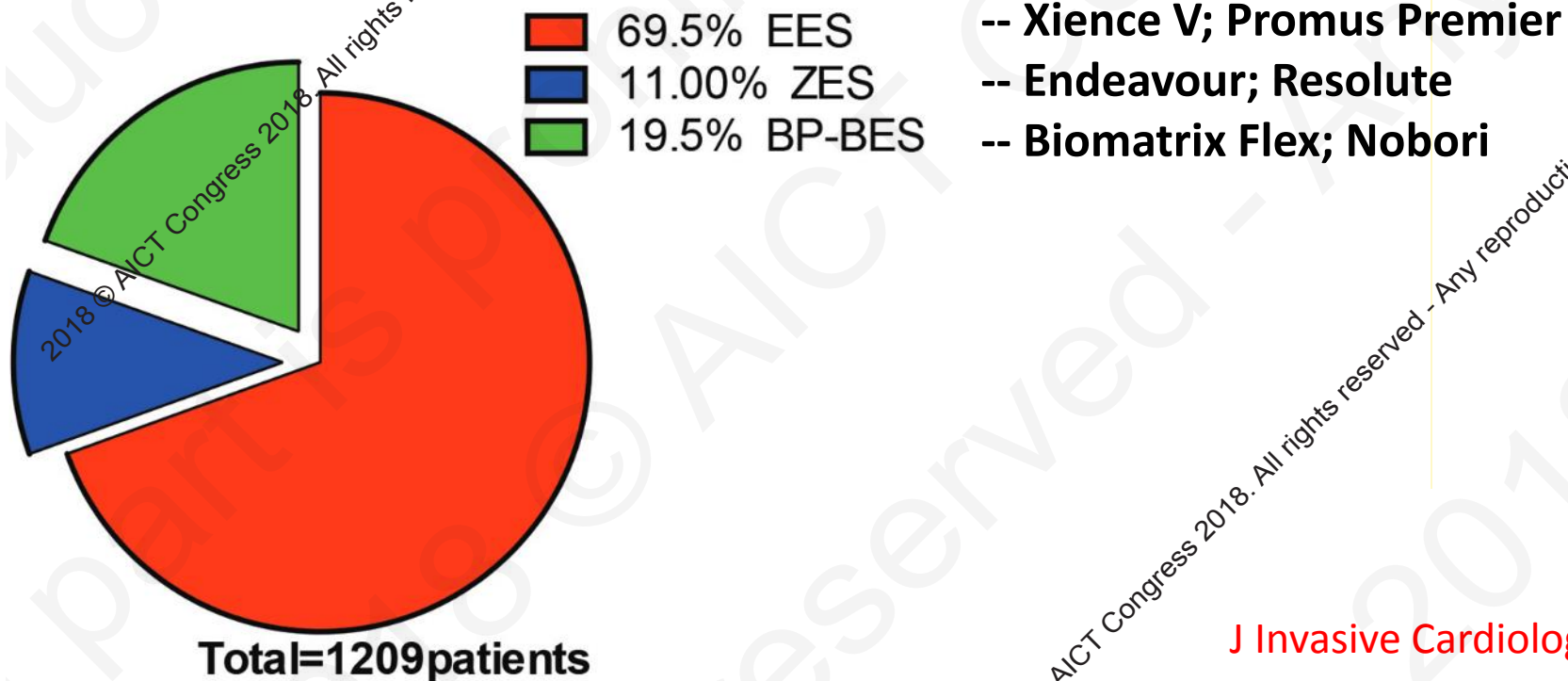


Note: XIENCE tested is XIENCE Xpedition. Data on file at Abbott Vascular.

Unprotected Left Main Coronary Artery Disease: Outcomes of Treatment With Second-Generation Drug-Eluting Stents – Insight From the FAILS-2 Study

Umberto Barbero, MD^{1,2}; Rahim Kanji, BSc, MBBS, MRCP²; Enrico Cerrato, MD³; Roberto Di Summa, MD⁴; Federico Conrotto, MD⁴; Hiroyoshi Kawamoto, MD⁵; Giuseppe Biondi-Zoccai, MD, PhD⁶; Sebastiano Gili, MD⁷; Fabrizio Ugo, MD⁸; Mario Iannaccone, MD⁸; Marco Gagliardi, MD⁴; Michele De Benedictis, MD¹; Baldassarre Doronzo, MD¹; Ferdinando Varbella, MD³; Maurizio D'Amico, MD⁴; Claudio Moretti, MD⁴; Antonio Colombo, MD⁹; Javier Escaned, MD, PhD; Prof¹⁰; Fabrizio D'Ascenzo, MD⁴

- June 2007 – Jan 2015
- retrospective study



Freedom from left main TLR

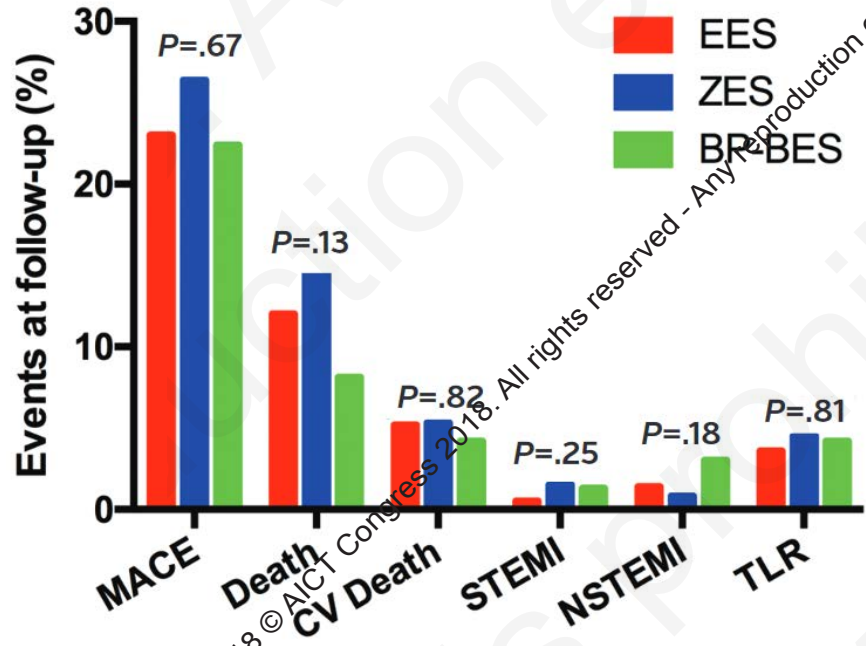
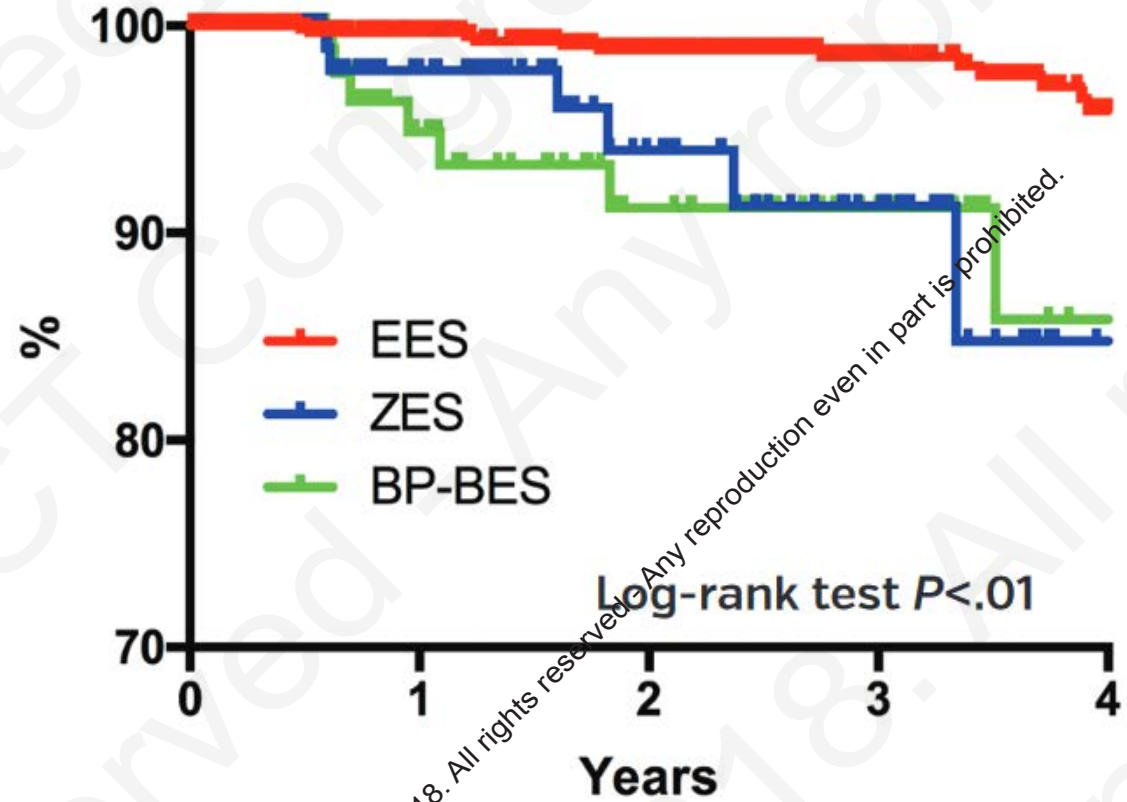


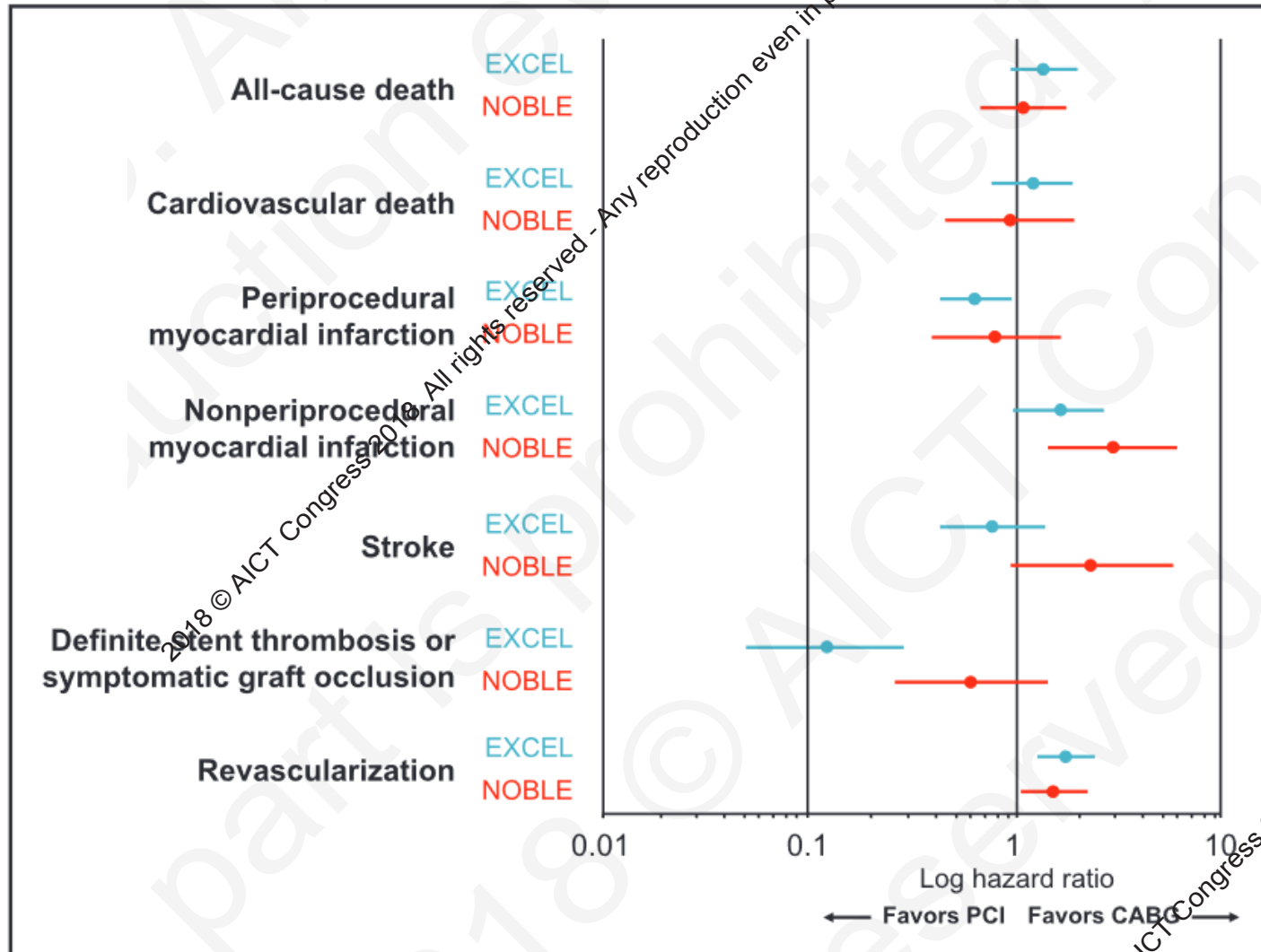
FIGURE 4. Distribution of events at follow-up according to stent type in the study population.

Different risk profile



Log-rank test $P < .01$

EXCEL vs NOBLE -- CABG vs PCI for ULMCA



EXCEL

- Sep 2010 – Mar 2014
- ** Xience EFs

NOBLE

- Dec 2008 – Jan 2016
- ** Biomatrix Flex BES

(Circ Cardiovasc Intervention 2016;9:e004782)

ISAR LEFT-MAIN 2 Study

CLINICAL RESEARCH

Interventional Cardiology

Zotarolimus- Versus Everolimus-Fluting Stents for Unprotected Left Main Coronary Artery Disease

Julinda Mehilli, MD,* Gert Richardt, MD,† Marco Valgimigli, MD,‡ Stefanie Schulz, MD,§ Ambika Singh,§ Mohamed Abdel-Wahab, MD,† Klaus Tiroch, MD,|| Jürgen Pache, MD,¶ Jörg Hausleiter, MD,* Robert A. Byrne, MB,§ Ilka Ott, MD,§ Tareq Ibrahim, MD,# Massimiliano Fusaro, MD,§ Melchor Seyfarth, MD,|| Karl-Ludwig Laugwitz, MD,# Steffen Massberg, MD,* Adnan Kastrati, MD,§ for the ISAR-LEFT-MAIN 2 Study Investigators
Munich, Bad Segeberg, Starnberg, and Wuppertal, Germany; and Ferrara, Italy

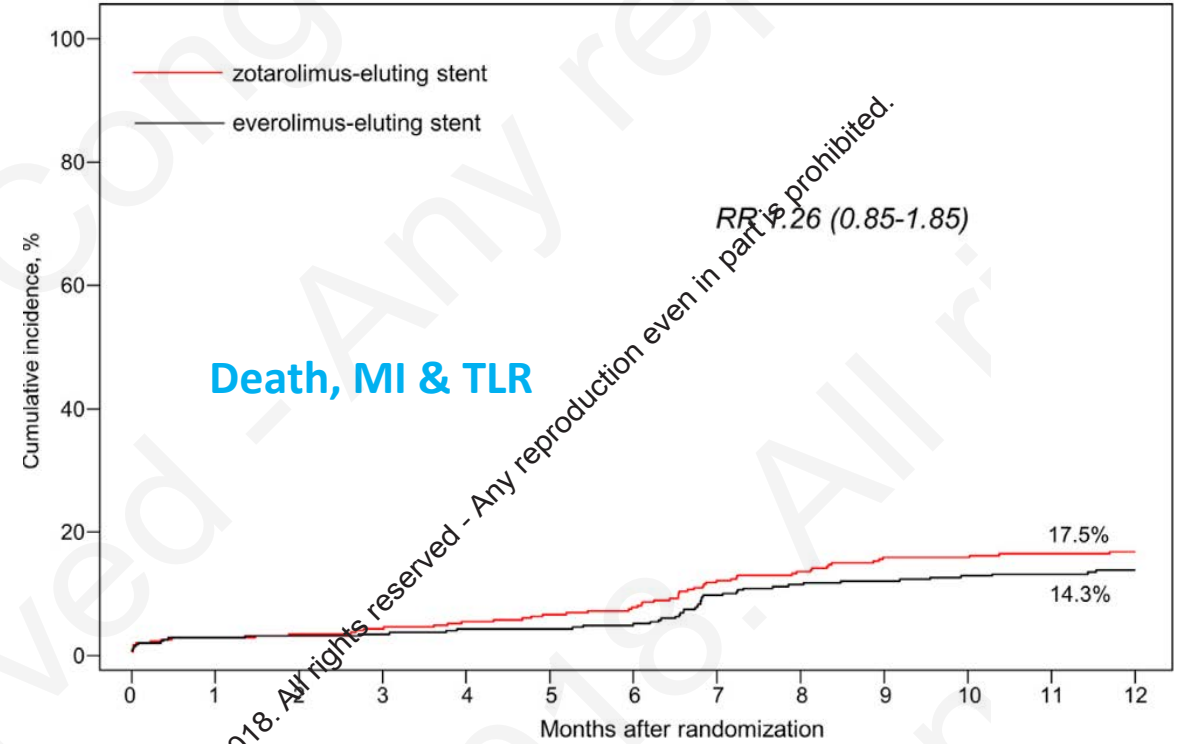
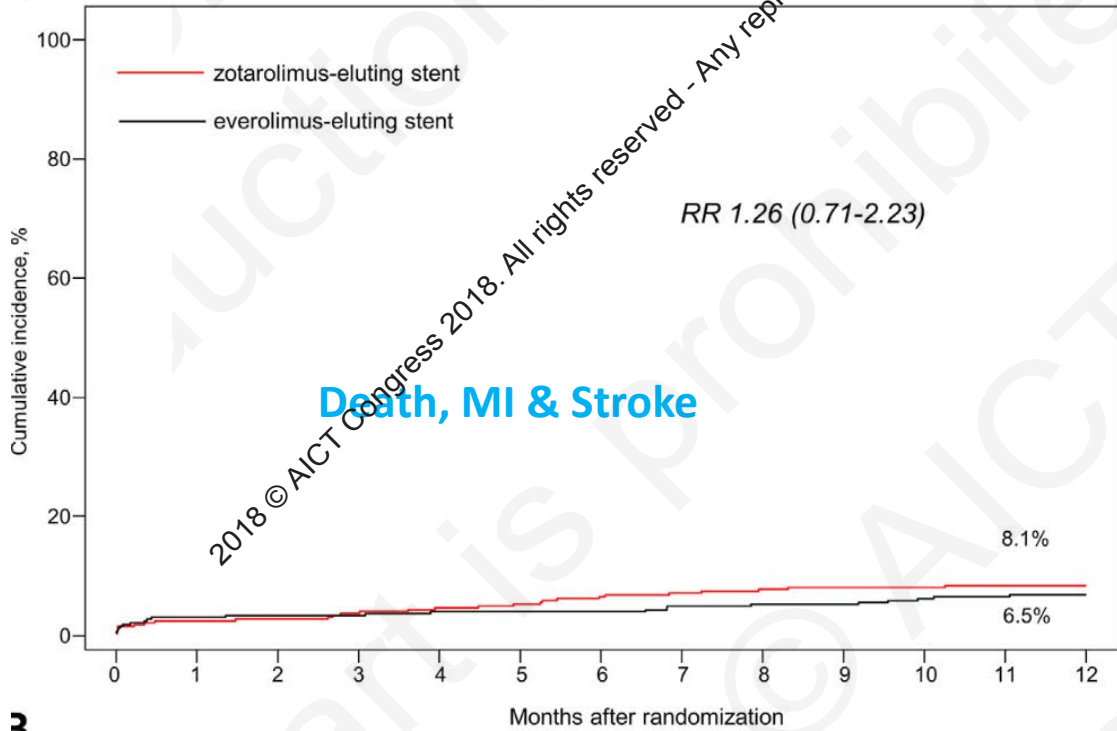
(JACC 2013;62:2075 – 82)

- Dec 2007 – Sep 2011
- randomised study
- n= 650

Table 2 Angiographic and Procedural Characteristics

	ZES (n = 324)	EES (n = 326)	p Value
Left ventricular ejection fraction (%)	52.1 ± 11.9	53.8 ± 11.4	0.05
Vessel size of left main artery (mm)	3.66 ± 0.44	3.63 ± 0.45	0.20
Coronary artery dominance			0.95
Right	273 (84.3)	274 (84.1)	
Left	31 (9.6)	30 (9.2)	
Balanced	20 (6.1)	22 (6.7)	
Three-vessel disease	222 (68.5)	241 (73.9)	0.13
Occluded right coronary artery	29 (8.9)	37 (11.3)	0.31
Trifurcation morphology	51 (15.7)	52 (16)	0.95
Localization of left main lesion			0.13
Ostium	39 (10.0)	43 (13.2)	
Midshaft	23 (7.0)	33 (10.0)	
Distal	269 (83.0)	250 (76.8)	
Stenting technique			0.60
Single stenting	200 (61.8)	217 (66.6)	
Crush stenting	4 (1.2)	3 (0.9)	
T-stenting	23 (7.1)	18 (5.5)	
Culotte stenting	97 (29.9)	88 (27.0)	
Kissing balloon technique	115 (35.5)	120 (36.8)	0.73
IABP support	6 (1.9)	9 (2.8)	0.44

ISAR LEFT-MAIN 2 Study



IDEAL Left Main:

Improved Drug Eluting stent for ALI comers Left Main

Principal Investigators:

Professor Keith Oldroyd, MD(Hons)

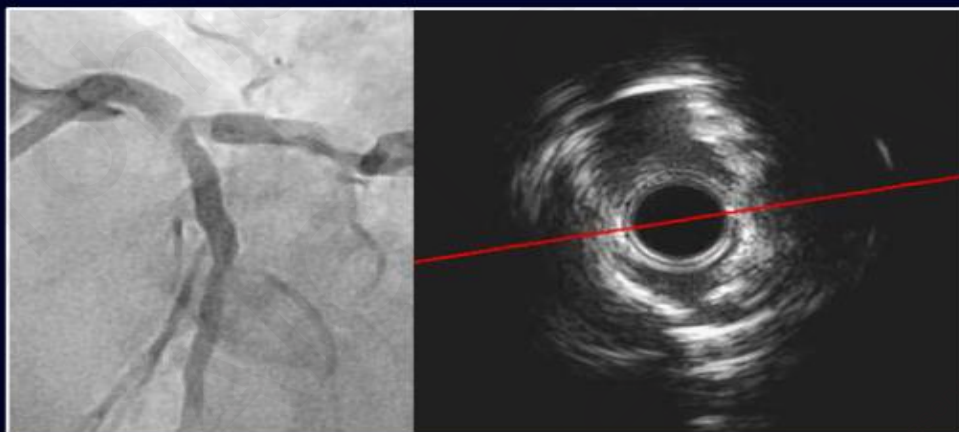
Professor Robert-Jan van Geuns, MD, PhD

OCT substudy

Evelyn Regar, MD, PhD

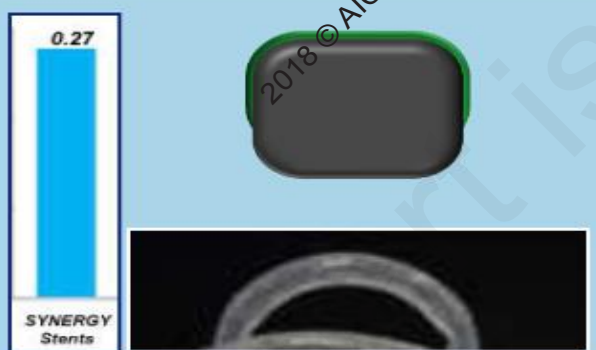
Synergy

409



409

Xience



DAPT 4 Mnth

DAPT 12 Mnth

OCT 3 months
TVR 2-5 years



Expansion Limit & Vessel Size Mismatch

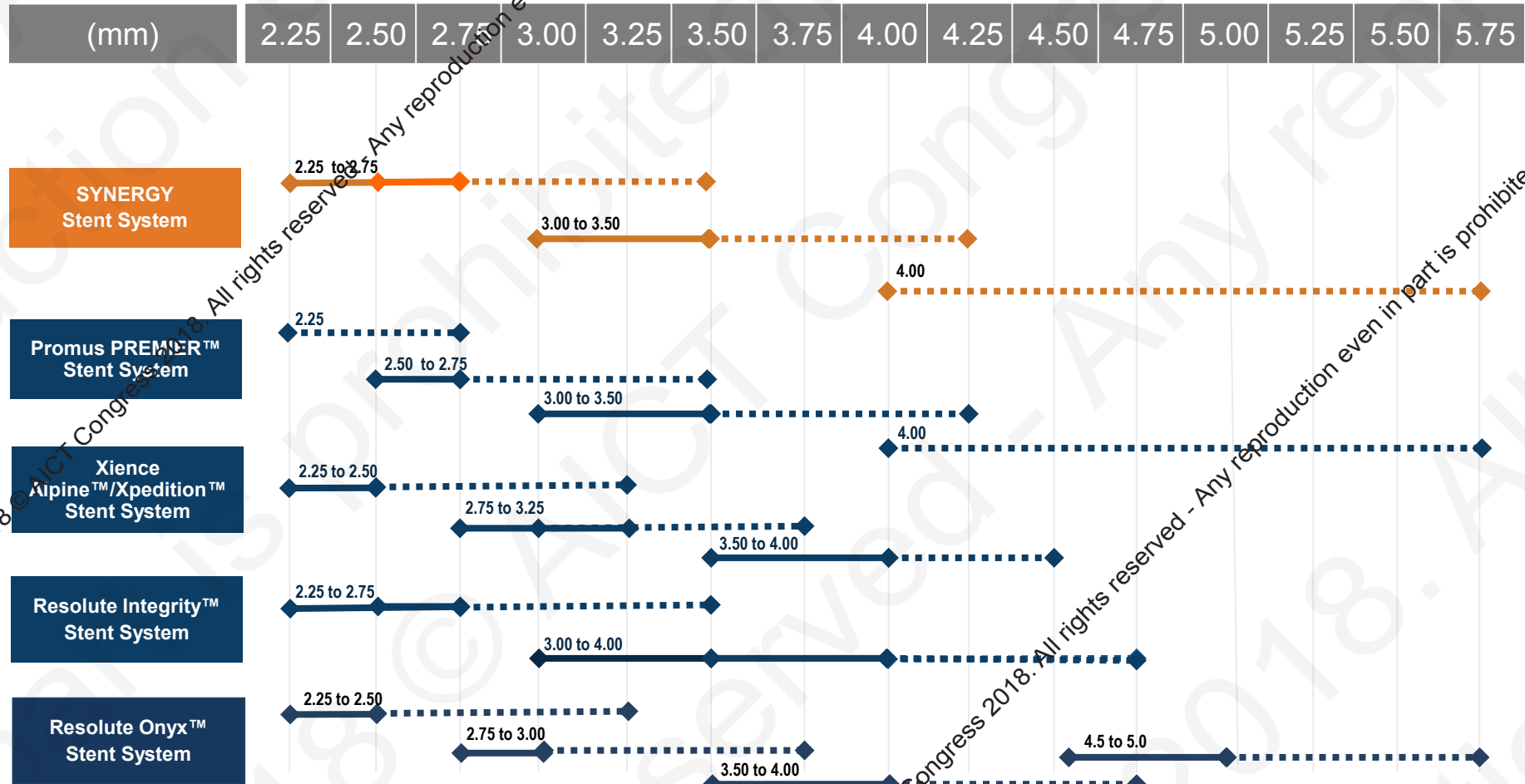
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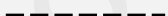
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	Resolute Onyx	Synergy	Xince Expedition	Ultimaster	Orsiro	Combo Plus	Biomatrix Alpha
2.25	Small vessel (6.5 crowns, 2 connectors)	Small vessel (8 crowns, 2-4 connectors)	Small vessel (6 crowns, 3 connectors)	Small vessel (8 crowns, 2 connectors)	Small vessel (6 crowns, 3 connectors)	Small vessel	Small vessel (6 crowns, 2 connectors)
2.50							
2.75	Medium vessel (8.5 crowns, 2 connectors)	Workhorse (8 crowns, 2-4 connectors)				Large vessel	
3.00							
3.50	Large vessel (9.5 crowns, 2.5 connectors)	Large vessel (10 crowns, 2-5 connectors)	Large vessel (9 crowns, 3 connectors)	Large vessel (8 crowns, 2 connectors)	Large vessel (6 crowns, 3 connectors)		Large vessel (9 crowns, 2 connectors)
4.00							
4.50	Extra-Large vessel (10.5 crowns, 2.5 connectors)						
5.00							

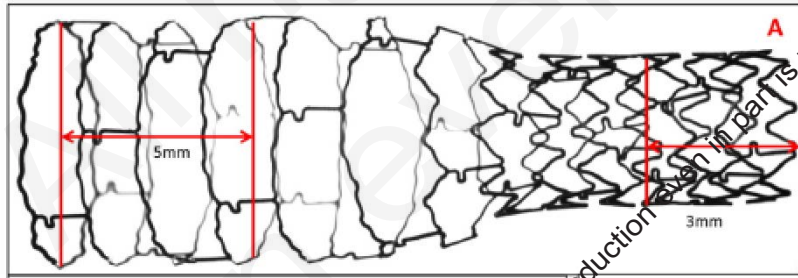
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Large diameter stent: Not all stents are the same



Labeled Nominal: 
 Labeled Post-Dil Limit: 

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Stents:

- Synergy 2.75, 3.0, 4.0
- Xience Prime / Xpedition 3.0, 3.5
- Orsiro 3.0, 4.0
- Ultimaster 3.0, 4.0
- Resolute Onyx 2.5, 3.0, 4.0, 5.0
- Biomatrix Flex / Chroma 3.0, 3.5

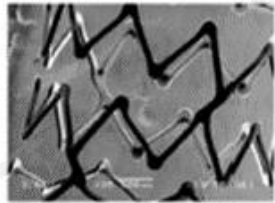
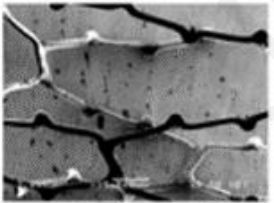
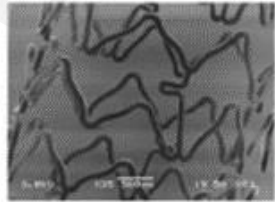
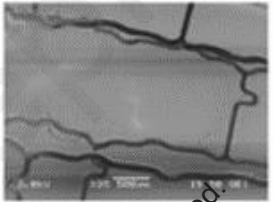
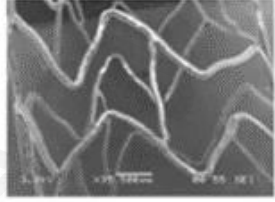
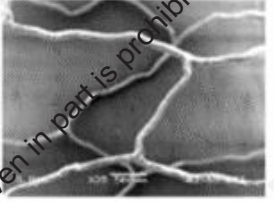

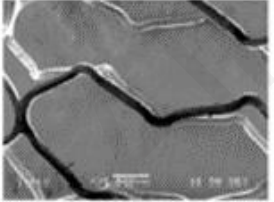
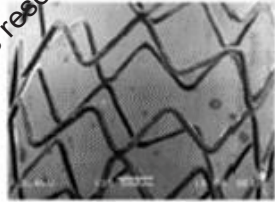
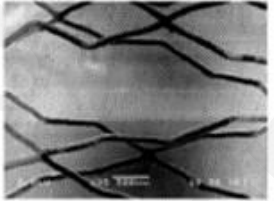
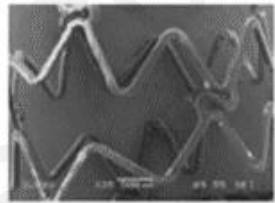
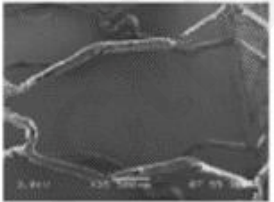
Method:

- stent deployed at nominal pressure
- overexpanded with
 - 4.0 → 5.0 mm NC balloons
 - 5.0 → 6.0 mm NC balloons (for larger workhorse stent)

	OVEREXPANSION WITH 6.0mm SC at 14 ATM	CROSS-SECTION
Synergy		
Xience Xpedition		
Orsiro		
Ultimaster		
Resolute Onyx		
Biomatrix A, Chroma		

Stent Over-expansion

- Most stents can be expanded above the stated maximal stent diameter
- Overexpansion
 - ↑MLD and MLA
 - ↑cell size
 - stent strut straightening
 - morphologic changes depend on stent platform and stent size

	Nominal Pressure	Overexpansion
Synergy		
Xience Xpedition		
Orsiro		
Ultimaster		
Resolute Onyx		
Biomatrix A. Chroma		

2009

XIENCE PRIME

- Updated design to reduce flaring and increase rated burst pressure (RBP)
- Broadened the size matrix

2012

XIENCE XPEDITION

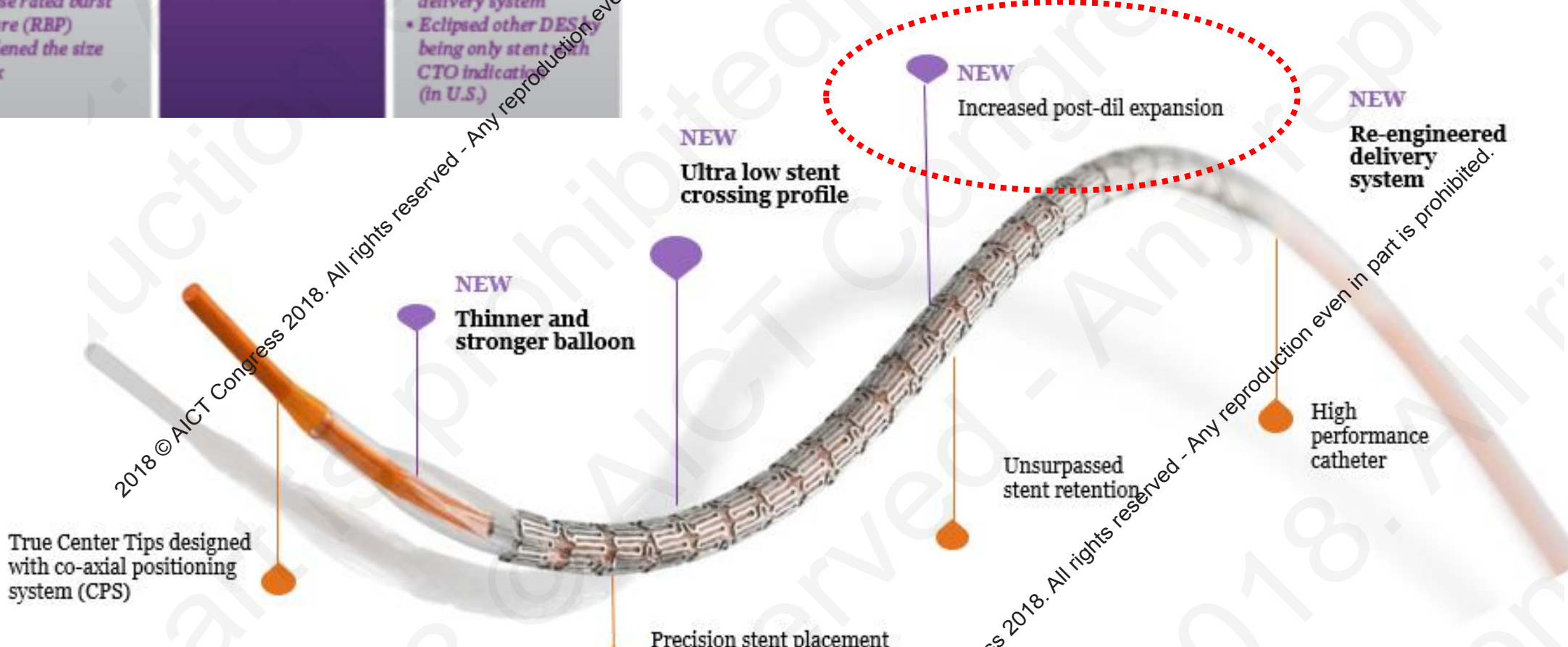
- Provided flatter balloon compliance

2014

XIENCE ALPINE

- Improved deliverability
- Optimized tip and delivery system
- Eclipsed other DES by being only stent with CTO indication (in U.S.)

Xience Sierra

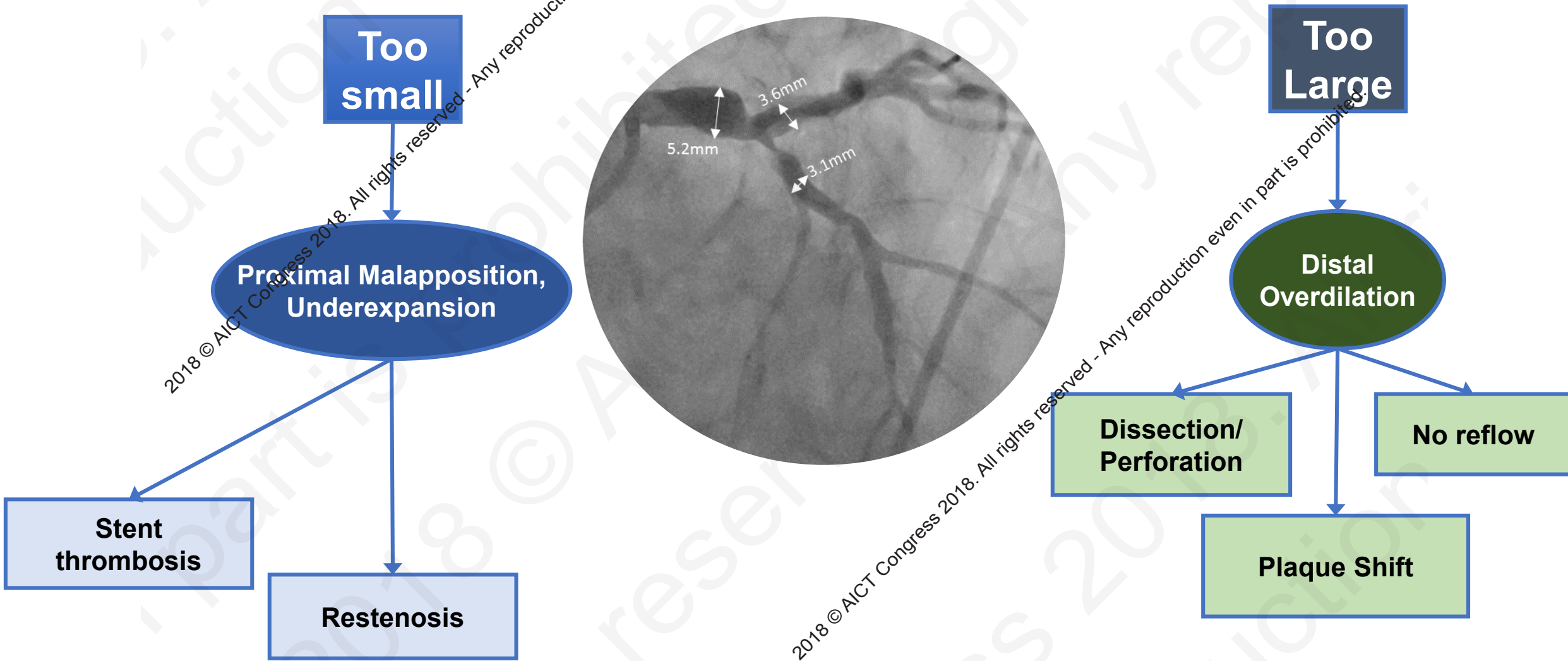


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- ✓ Increased maximal post-dilatation maximal expansion to 5.5 mm for 3.5 & 4.0 mm stents.
- ✓ 0% foreshortening even at maximal 5.5 mm expansion

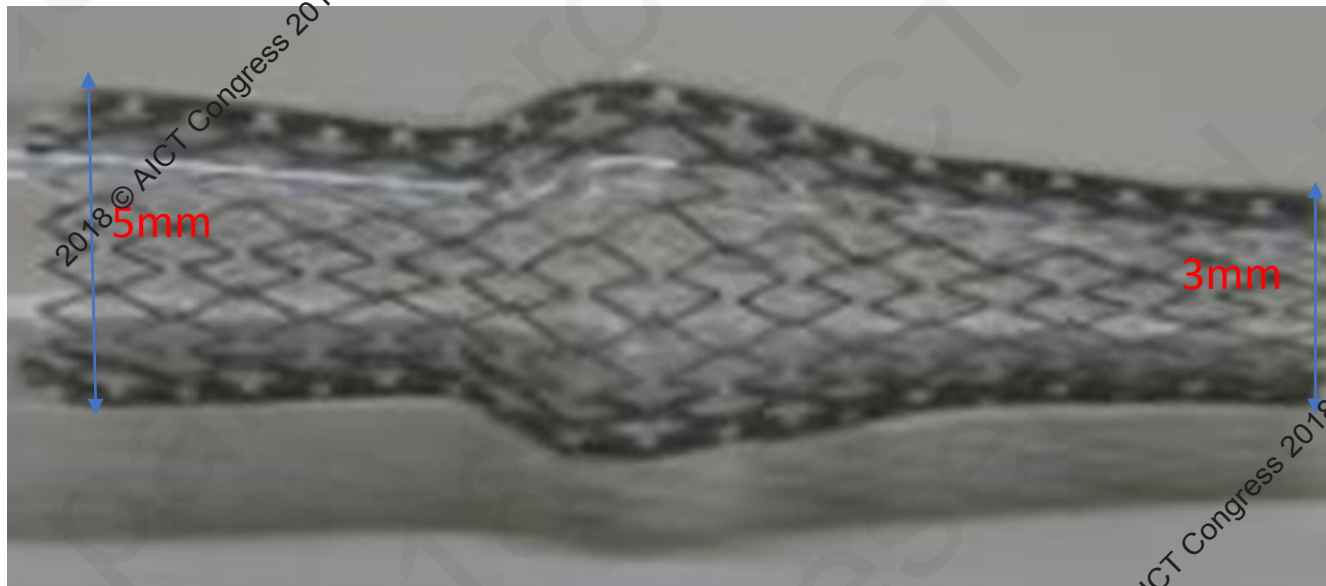
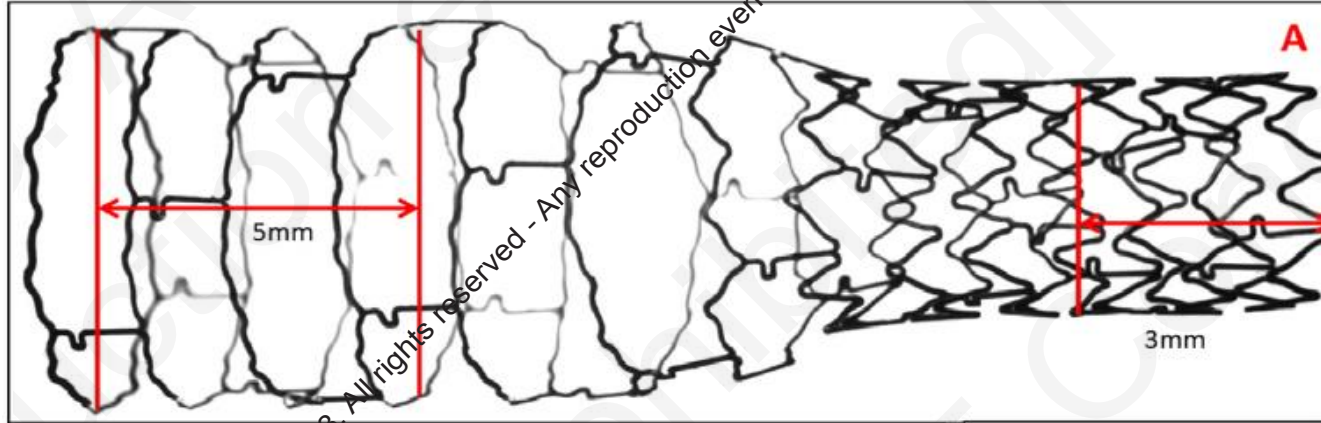
Large size difference between left main and LAD/LCX



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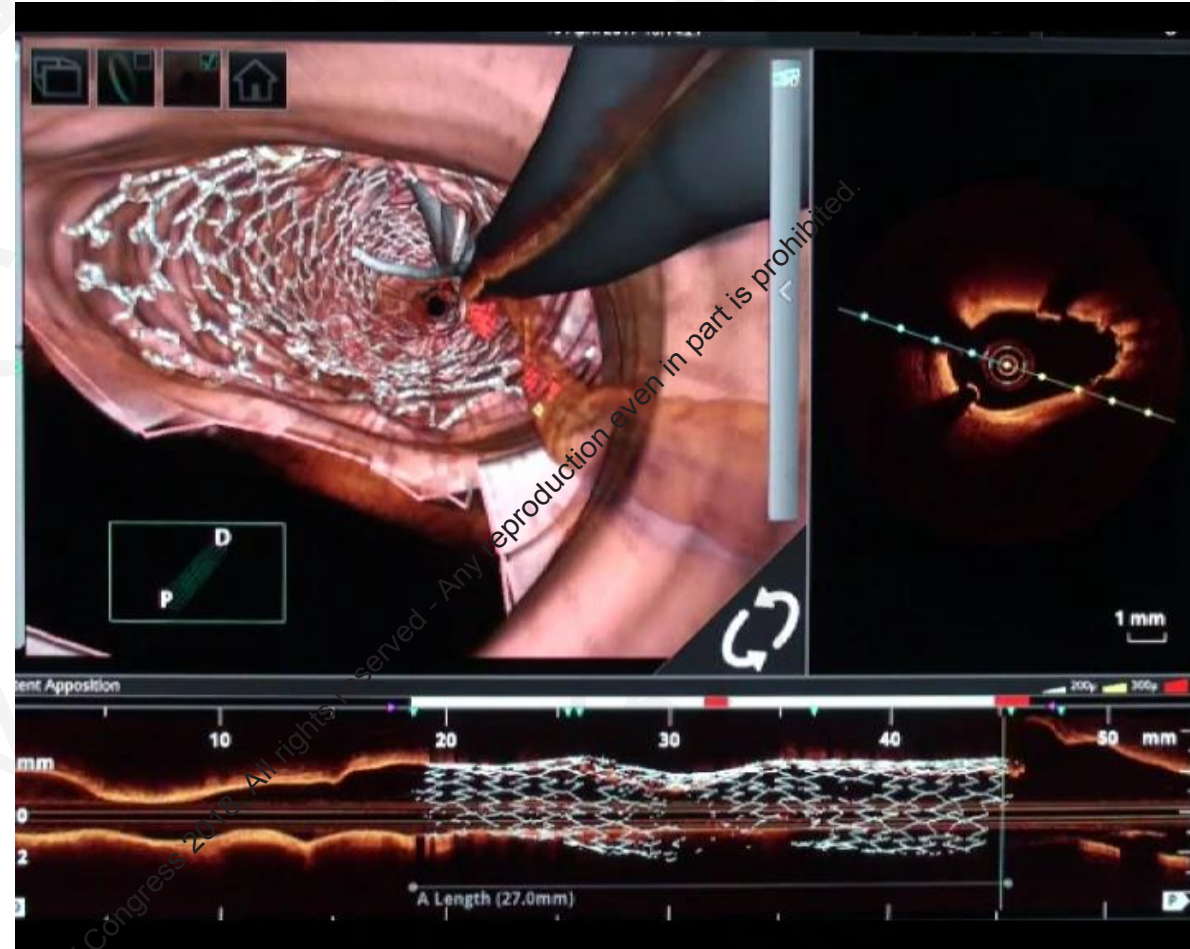
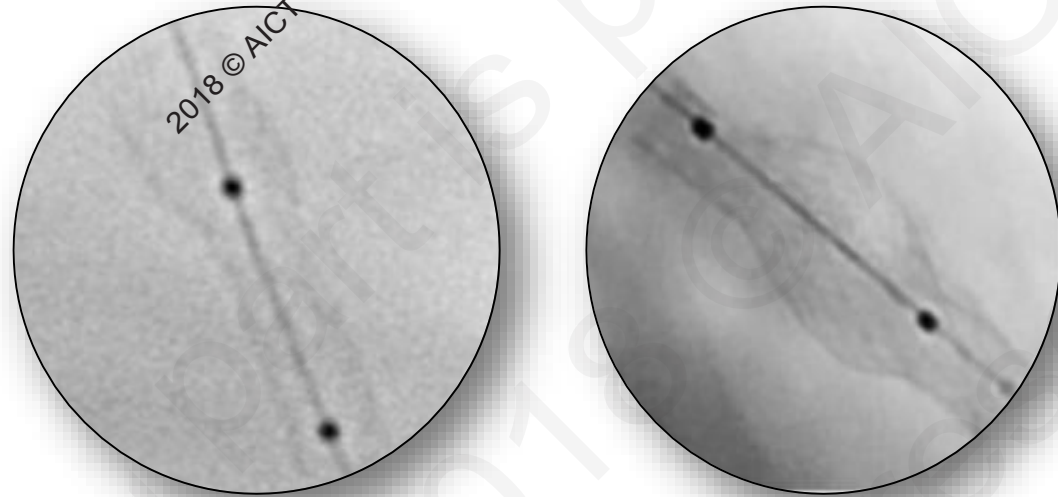
Vessel size mismatch – balloon expandable vs self-expanding stent



	Nominal Pressure	Overexpansion
Synergy		
Xience Xpedition		
Orsiro		
Ulmaster		
Resolute Onyx		
Biomatrix A. Chroma		

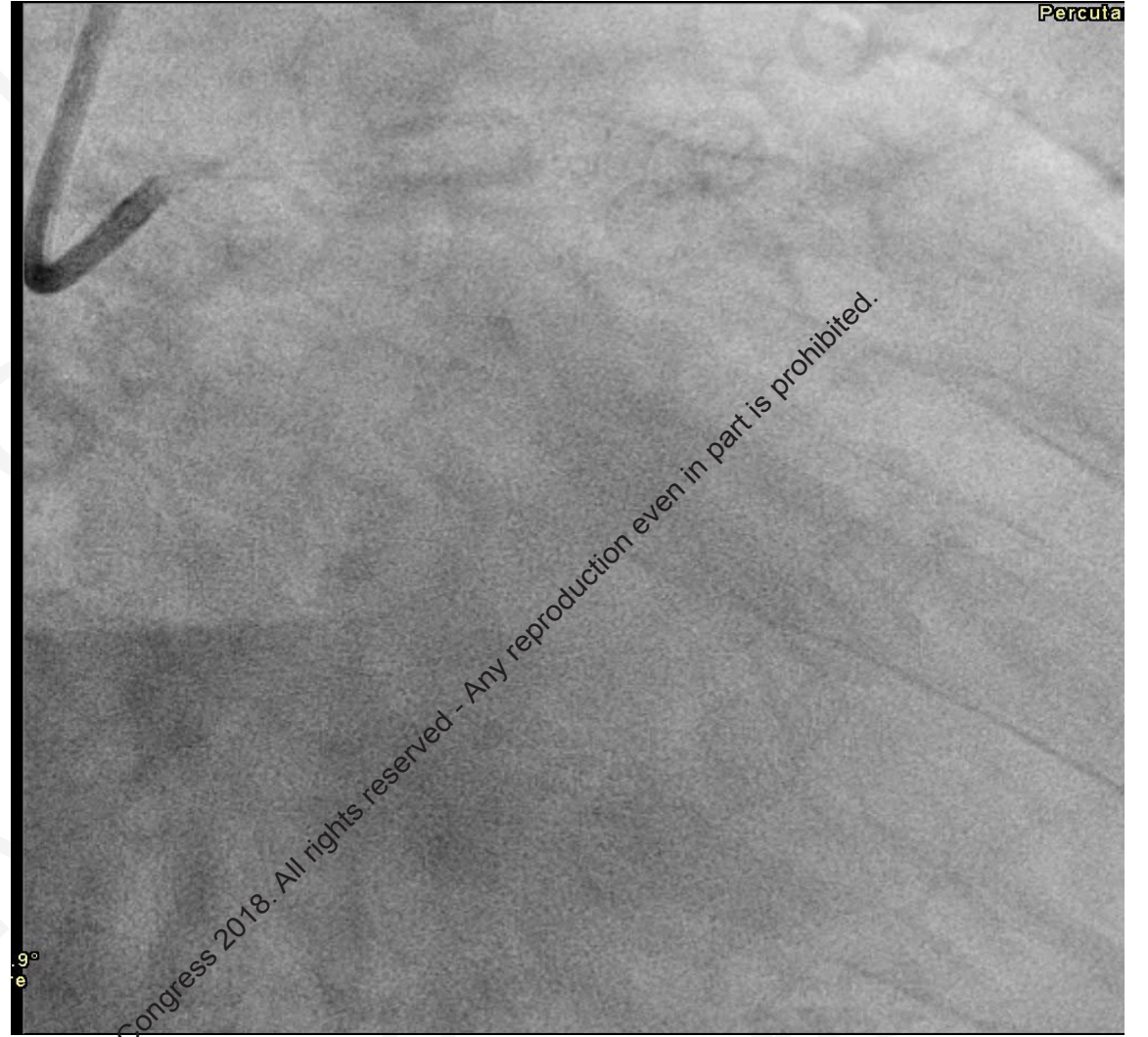
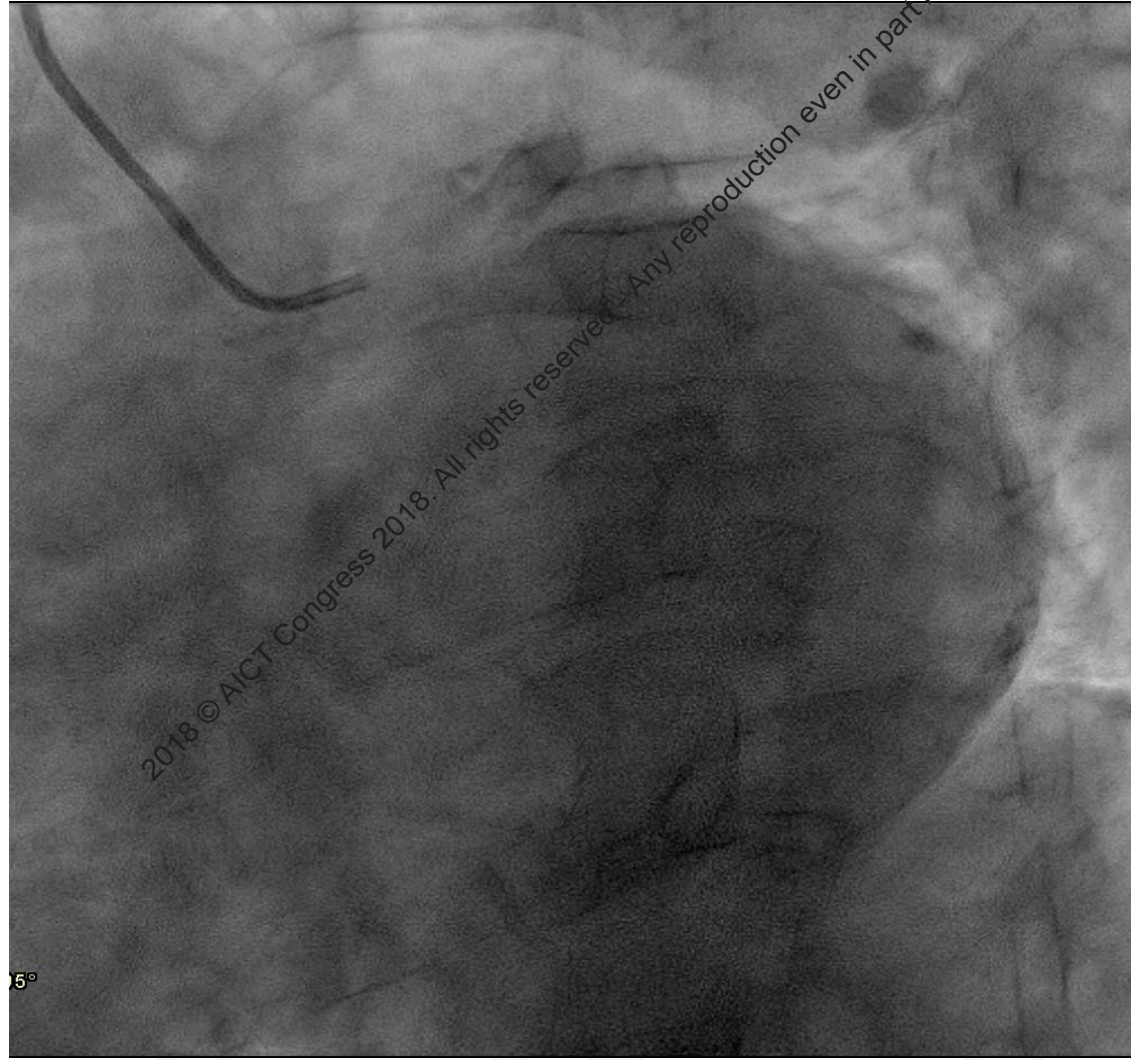
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Self-apposing stent



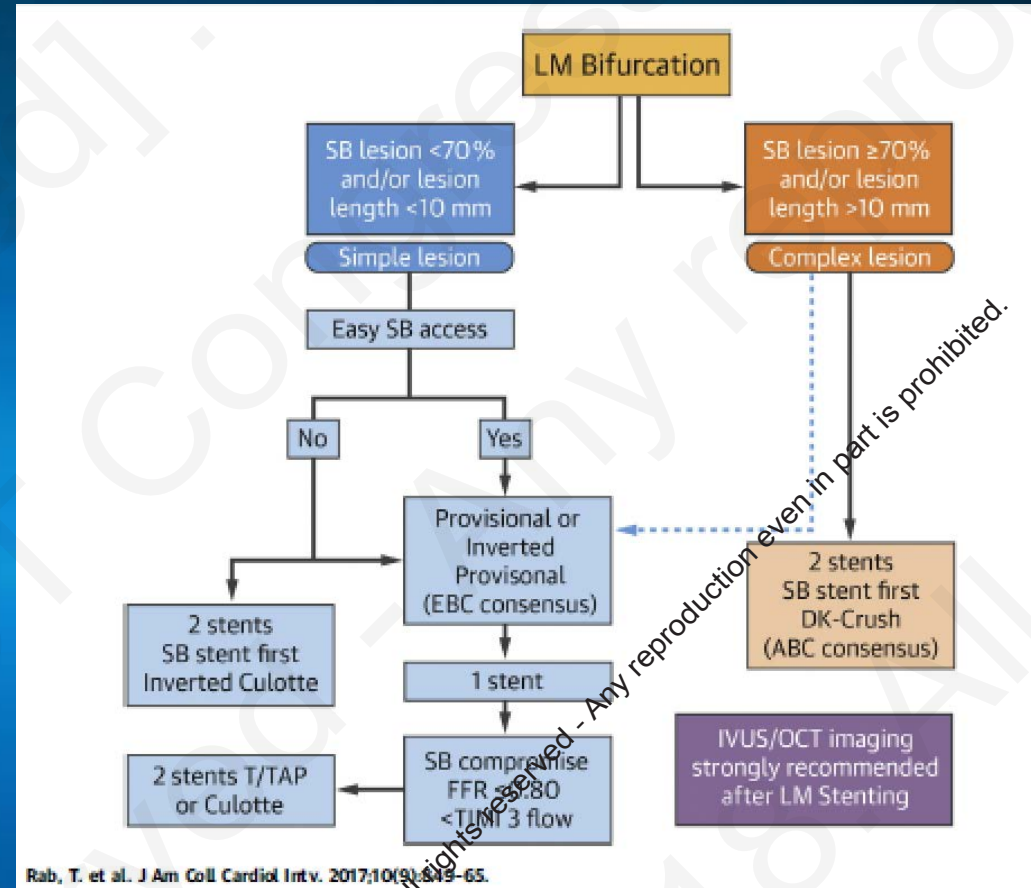
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Summary

- Many factors, including stent type, influence the outcome of ULM PCI
- LM distal bifurcation disease, especially, requires careful consideration for
 - stenting strategy – provisional stenting vs planned 2 stent strategy
 - stenting technique for 2 stent strategy – DK Crush, Culotte, T, TAP, Mini-Crush
 - size discrepancy between LM and LAD / LCX
 - expansion limit of stent
 - balloon-expandable vs self-expanding stent
- Among 2G / 3G DES, unclear whether one is definitely superior to another.



Thank You

謝謝

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