ASIAN INTERVENTIONAL CARDIOVASCULAR THERAPEUTICS
THE OFFICIAL CONGRESS OF APSIC

Use of IVUS in the Diagnosis and Management of Stent Underexpansion

Jose Nicolas Cruz, MD
St. Luke's Medical Center-Global City
Philippines

Conflicts of Interest

Speaker's name : Jose Nicolas Cruz, MD

No conflict of interest in relation to this presentation

Objectives

- Present a case of a post-STEMI patient who had multiple DES PCI without intracoronary imaging guidance
- Present the IVUS findings in this case during follow-up CAG
- Demostrate the role of IVUS guidance in the management of multiple stent underexpansion
- Emphasize the importance of intracoronary imaging in optimizing PCI outcomes

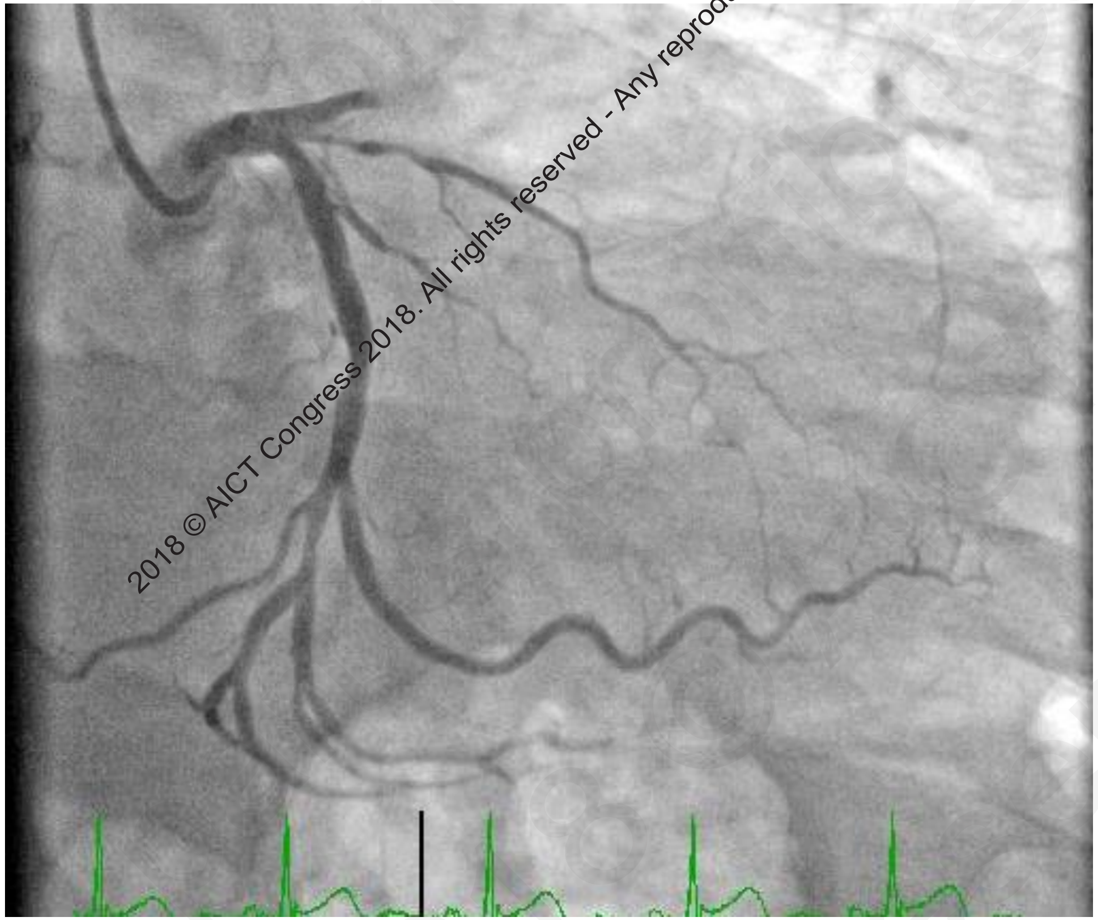
2018 © AICT Congress 2018. All rights reserved - Any reproduction even in part is prohibited.

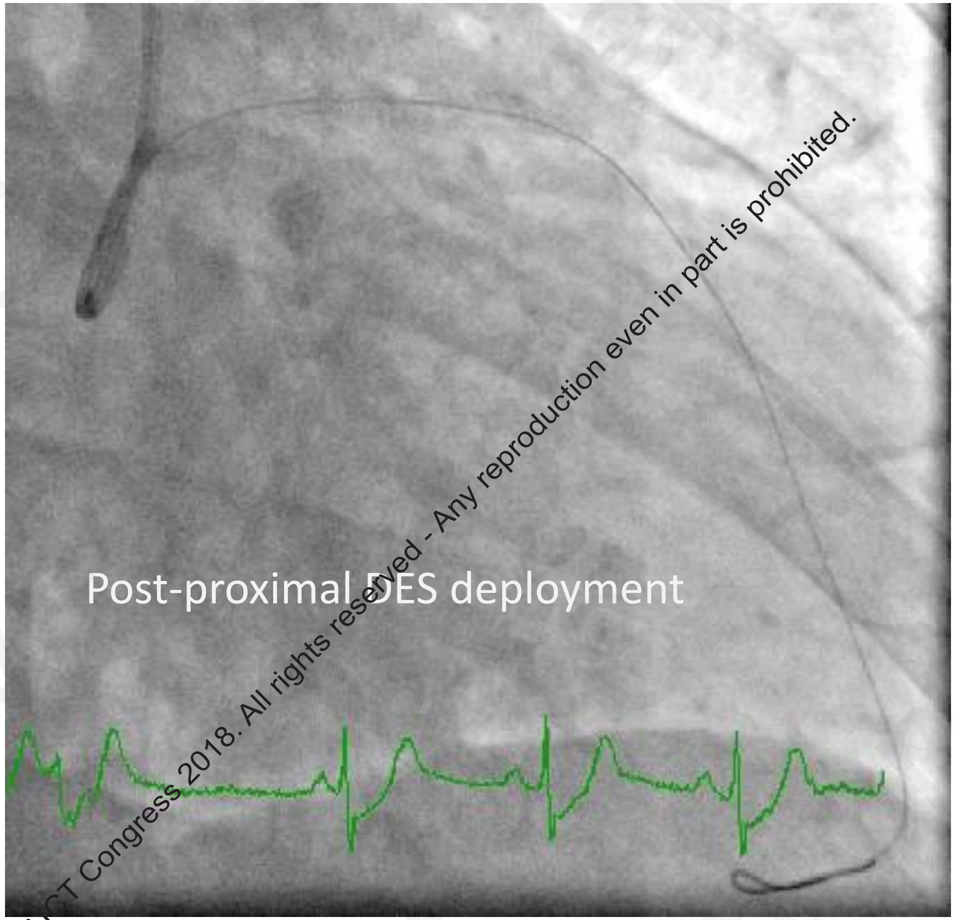
Case

- 51/male
- Dyslipidemic
- Substernal heaviness for about 3 hours
- Anterior wall STEMI
- Immediate STEMI team activation

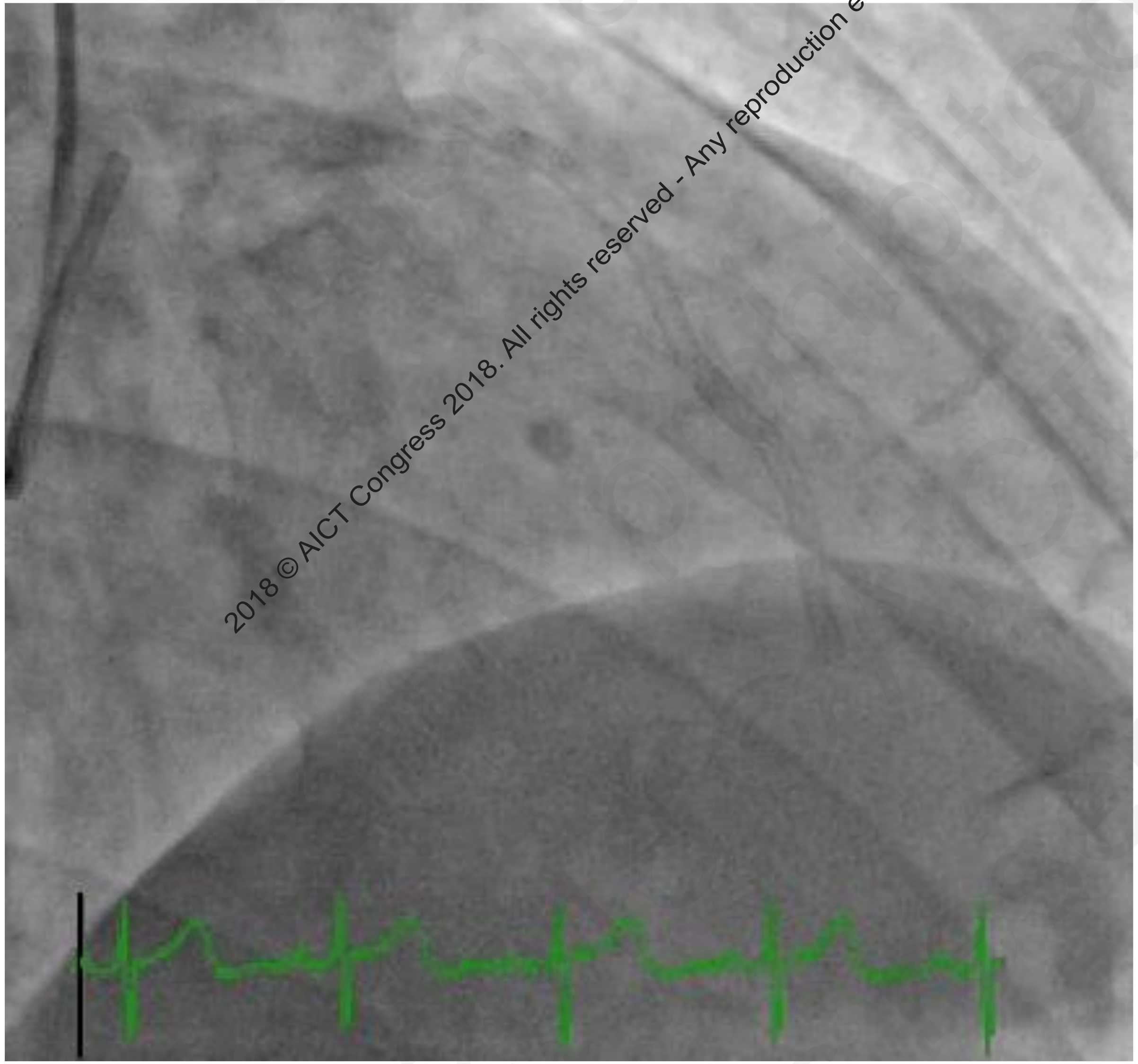
2018 © AICT Congress 2018. All rights reserved - Any reproduction even in part is prohibited.

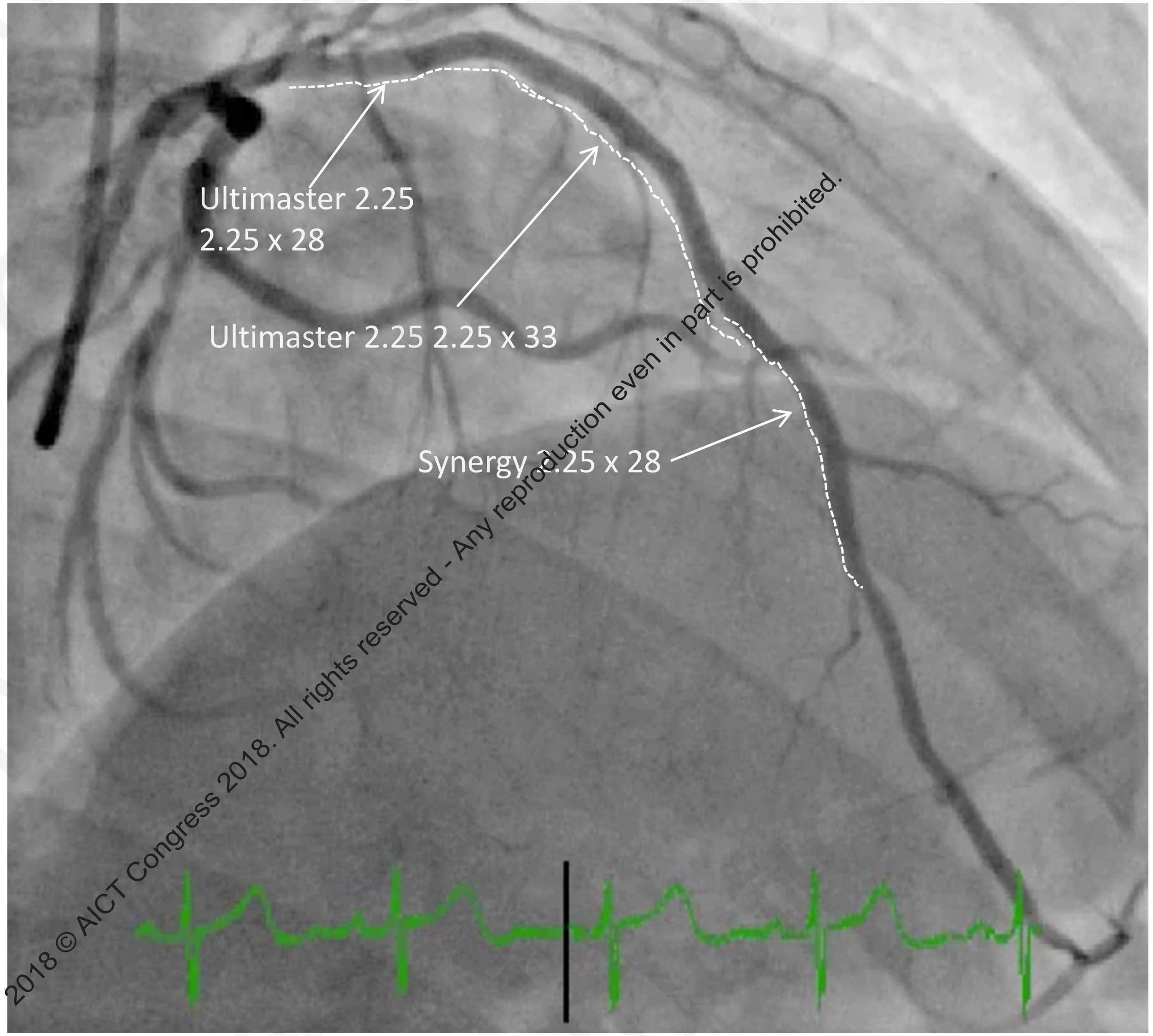
Initial CAG and PCI of culprit lesion





Post PCI with 3 stents!



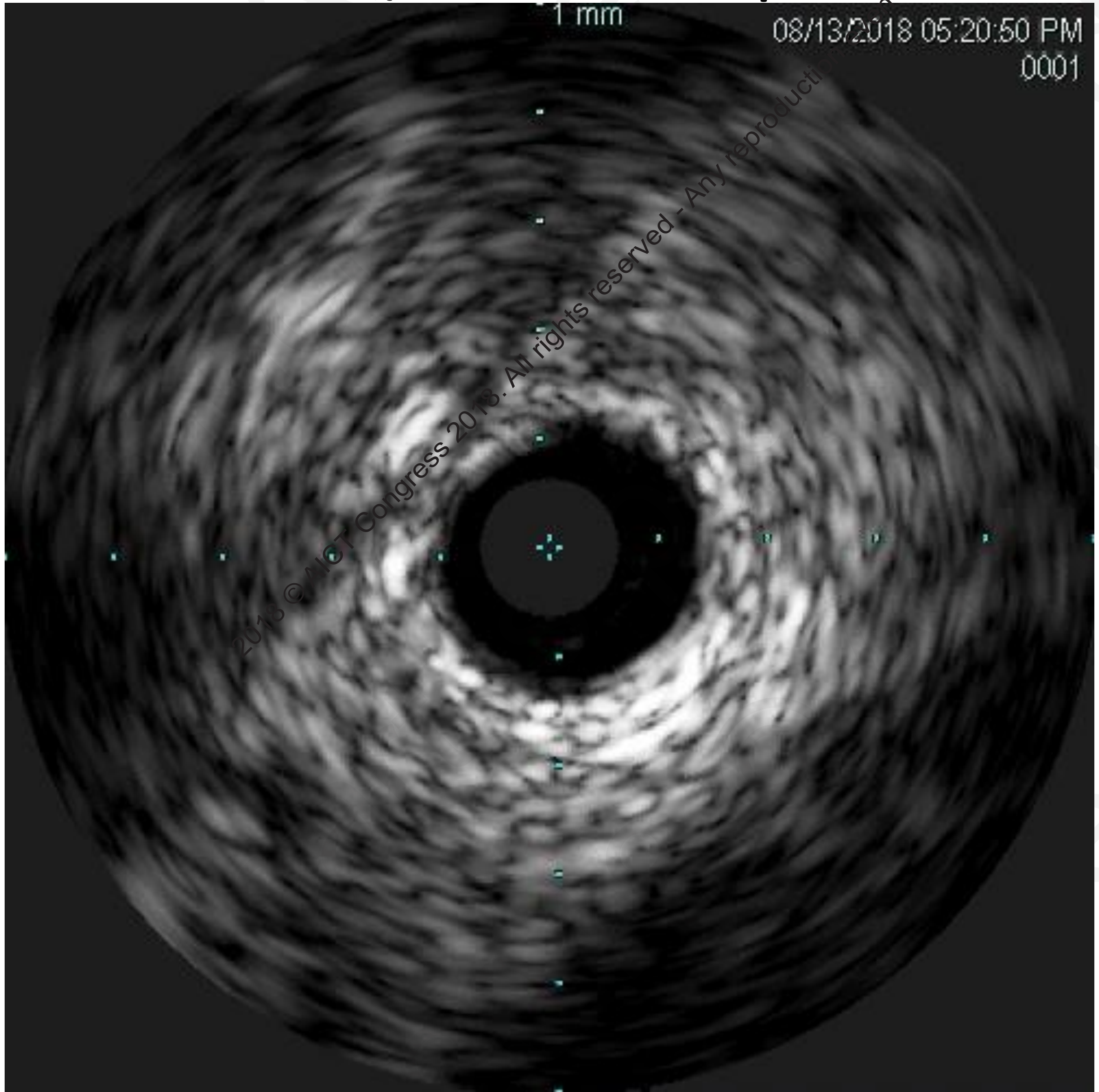


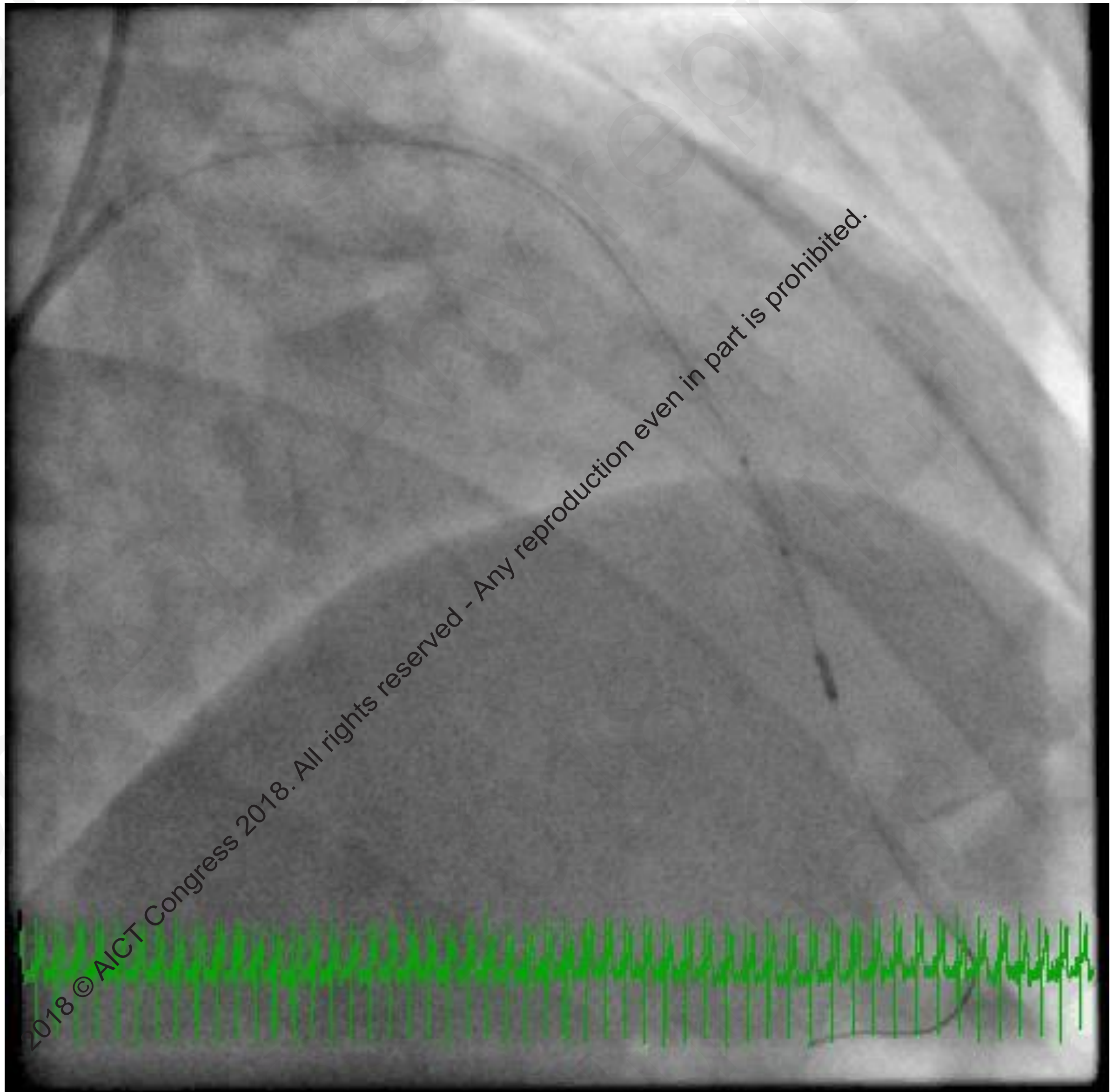
2018 © AICT Congress 2018. All rights reserved - Any reproduction even in part is prohibited.

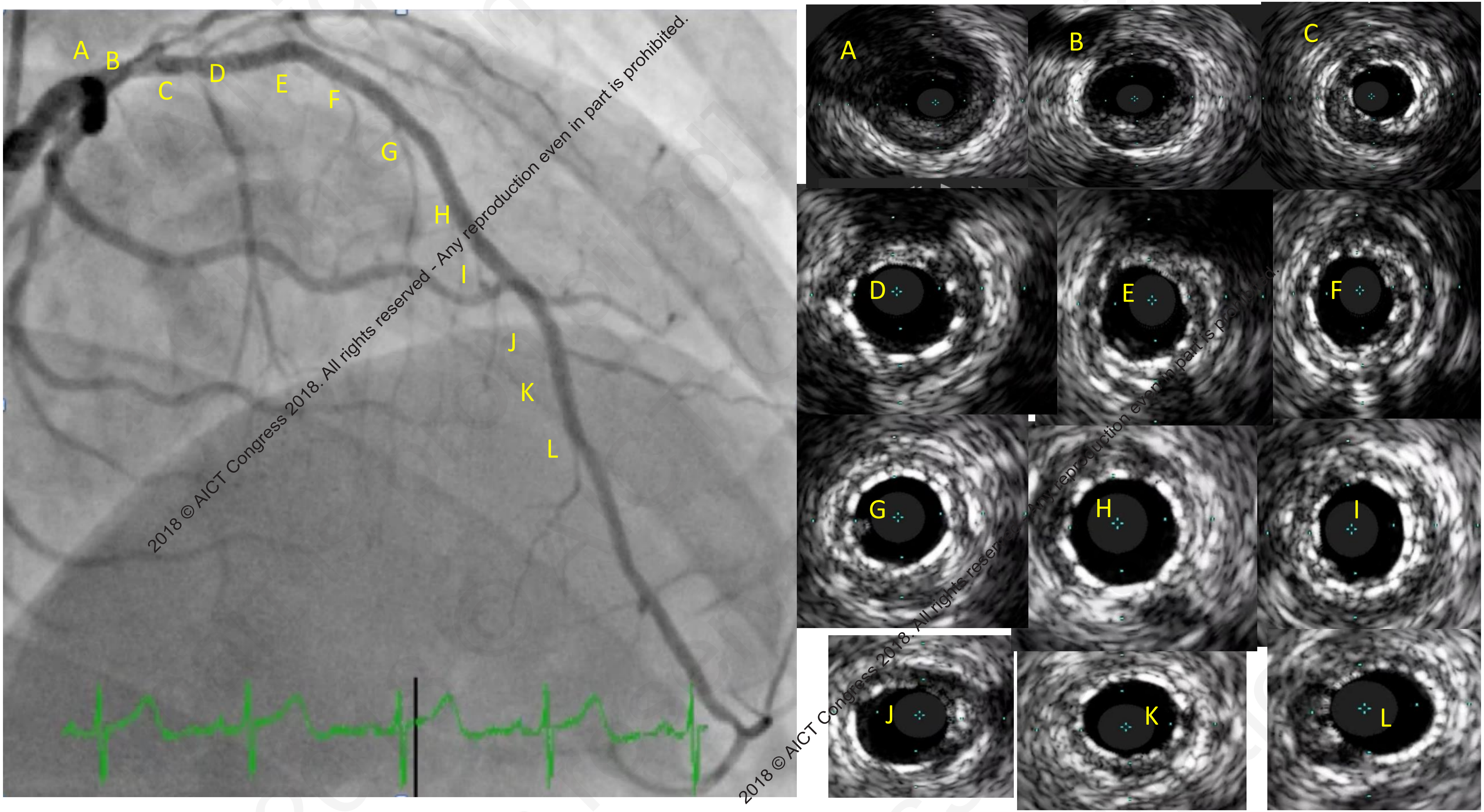
3 months later

- Vague/atypical chest discomfort associated with physical exertion
- Compliant with cardiac rehab, DAPT plus statins, B-blockers/ARBs
- No new ECG changes
- Advised CAG and IVUS assessment of coronary stents

IVUS (manual pullback)







2018 © AICT Congress 2018. All rights reserved - Any reproduction even in part is prohibited.

Table 1. IVUS Criteria for Optimal Stent Deployment

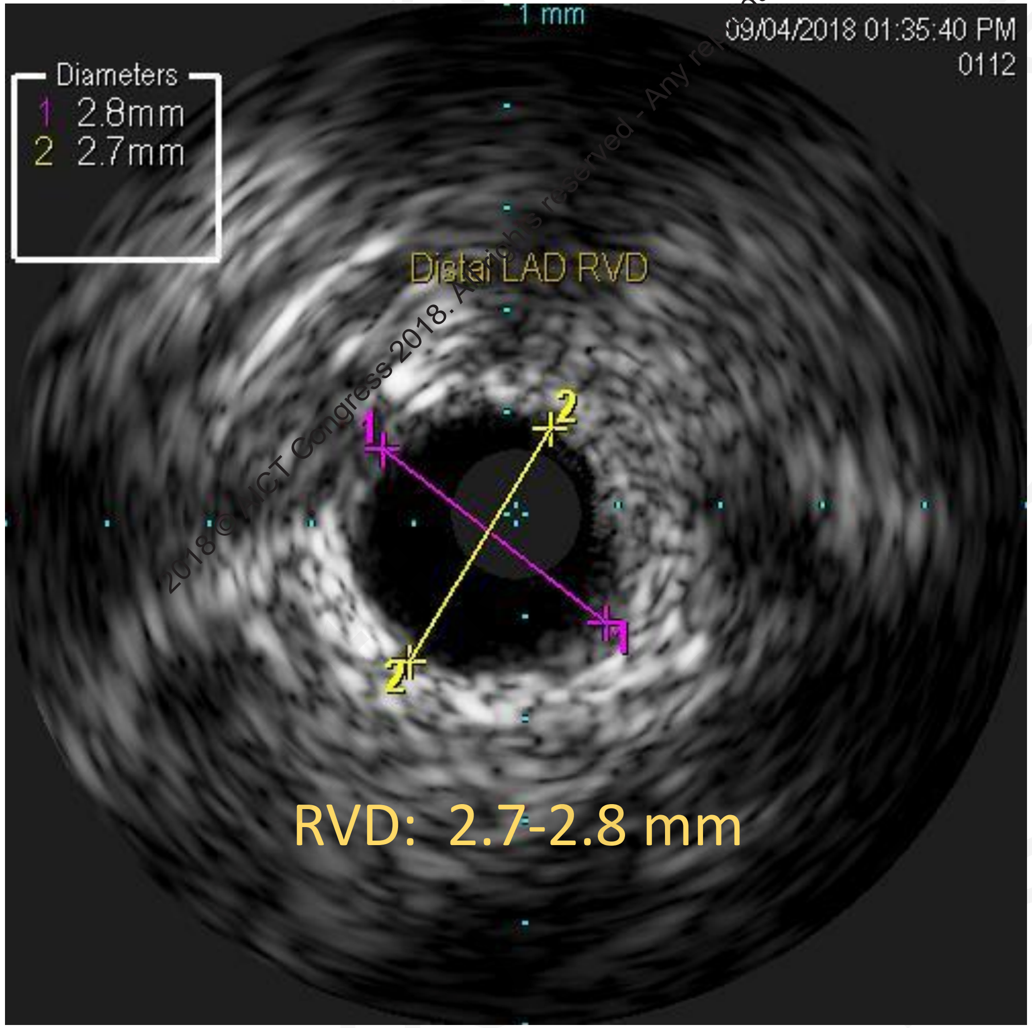
JACC: CARDIOVASCULAR INTERVENTIONS, VOL. 4, NO. 11, 2011
NOVEMBER 2011:1155–67

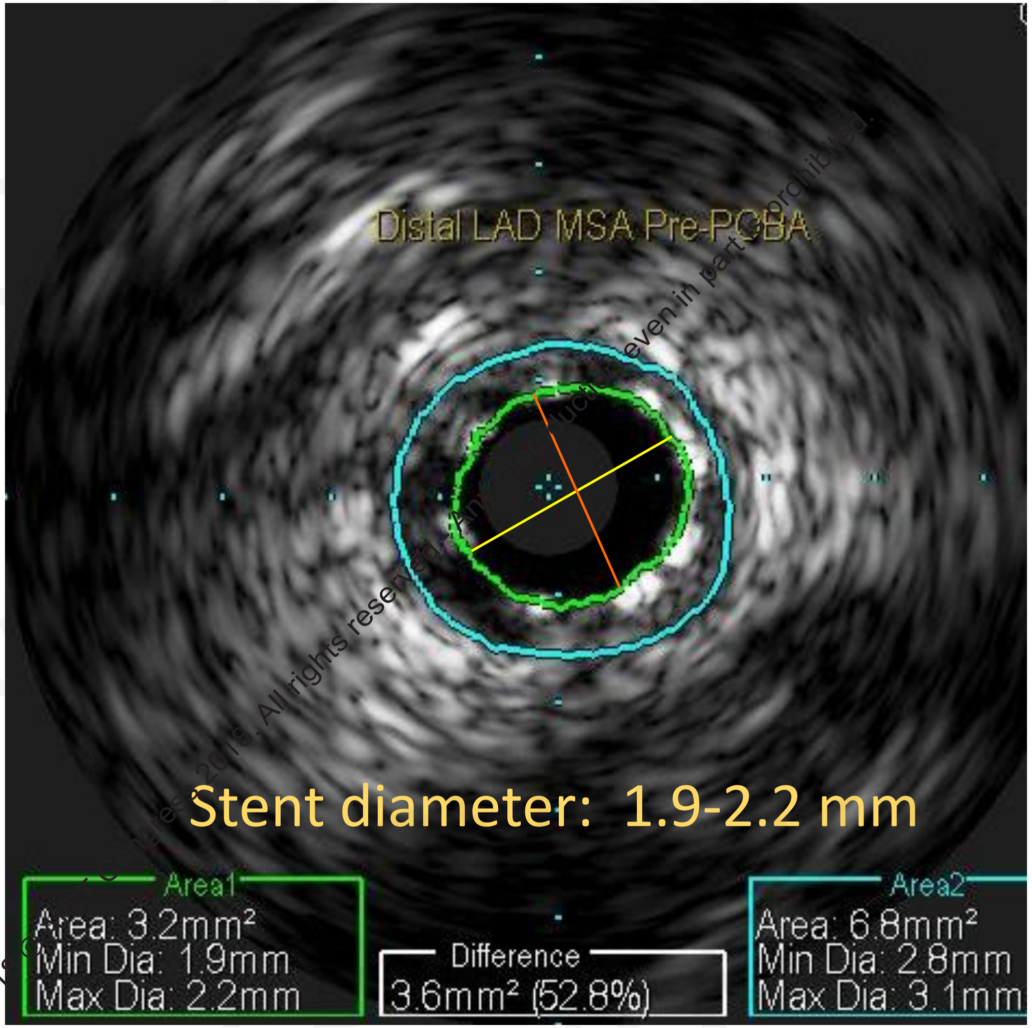
MUSIC Criteria	AVIO Criteria
• Complete apposition of stent	• Minimal post-stent area >70% of the balloon cross-sectional area used to post-dilate the stent
• Adequate stent expansion MSA ≥90% of the average reference lumen area or ≥100% of reference segment with the lowest area when the MSA is <9 mm^2 or MSA ≥80% of the average reference lumen area or ≥90% of reference segment with the lowest area when the MSA is >9 mm^2	• The noncompliant post-dilation balloon size selected according to the average of the maximum and minimum media-to-media diameter at the following points: 1. Distal in-stent segment 2. Proximal in-stent segment 3. In-stent of maximal narrowing
• Symmetrical stent expansion Defined by minimum lumen diameter divided by maximum lumen diameter ≥0.7	

The criteria for optimal stent deployment used in the MUSIC (33) and AVIO (46) studies.

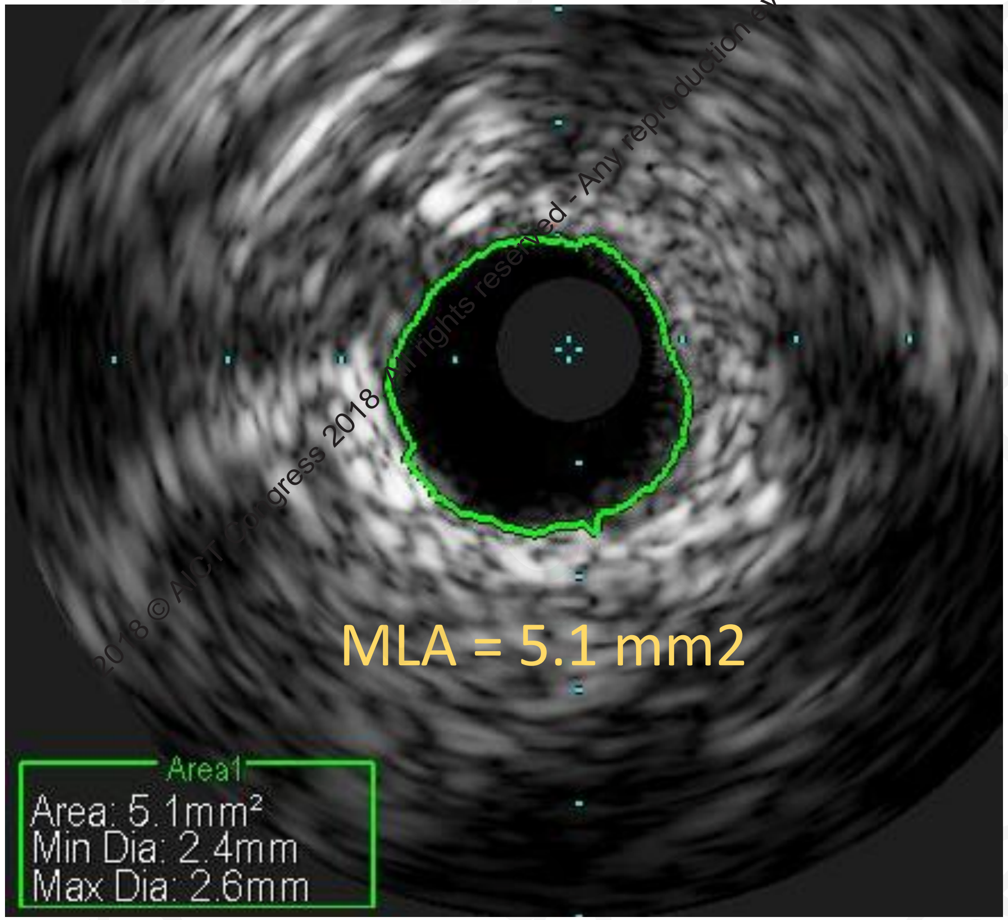
AVIO = Angiography Versus IVUS Optimization study; IVUS = intravascular ultrasound; MSA = minimal stent area; MUSIC = Multicenter Ultrasound Guided Stent Implantation in the Coronaries study.

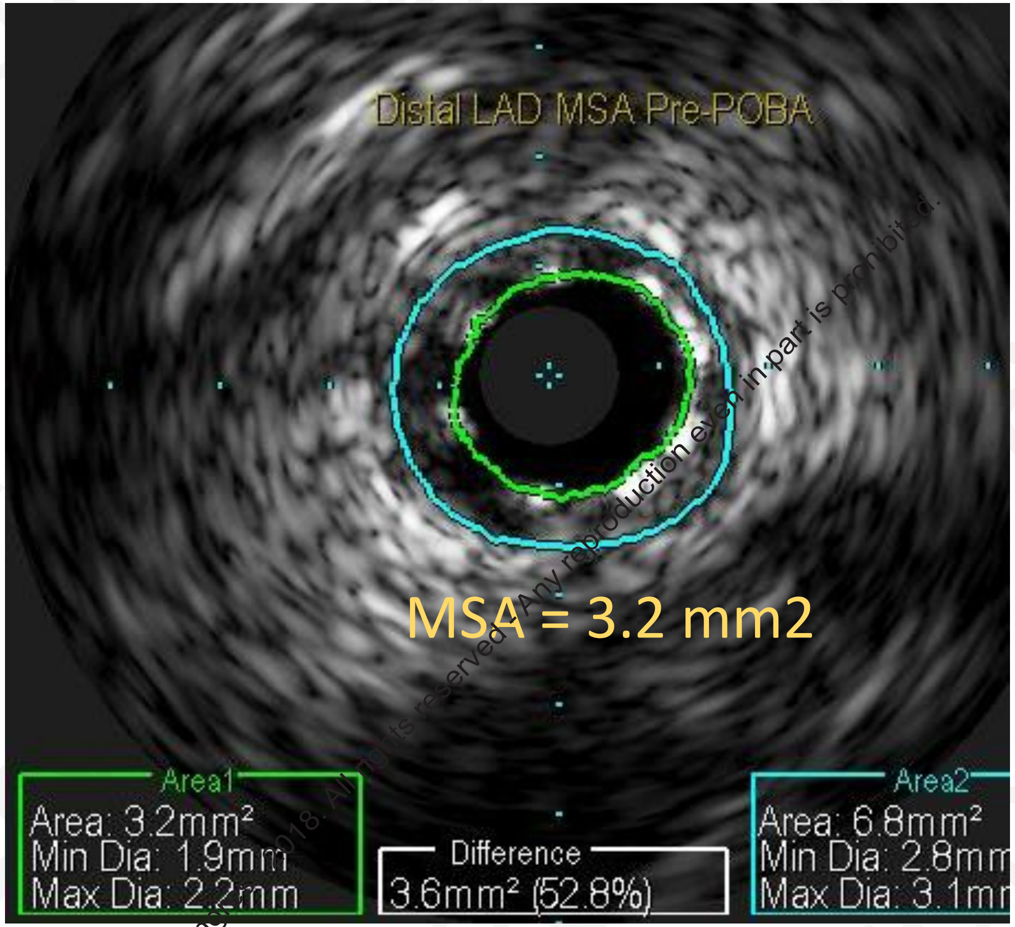
Distal RVD and Distal Stent diameter





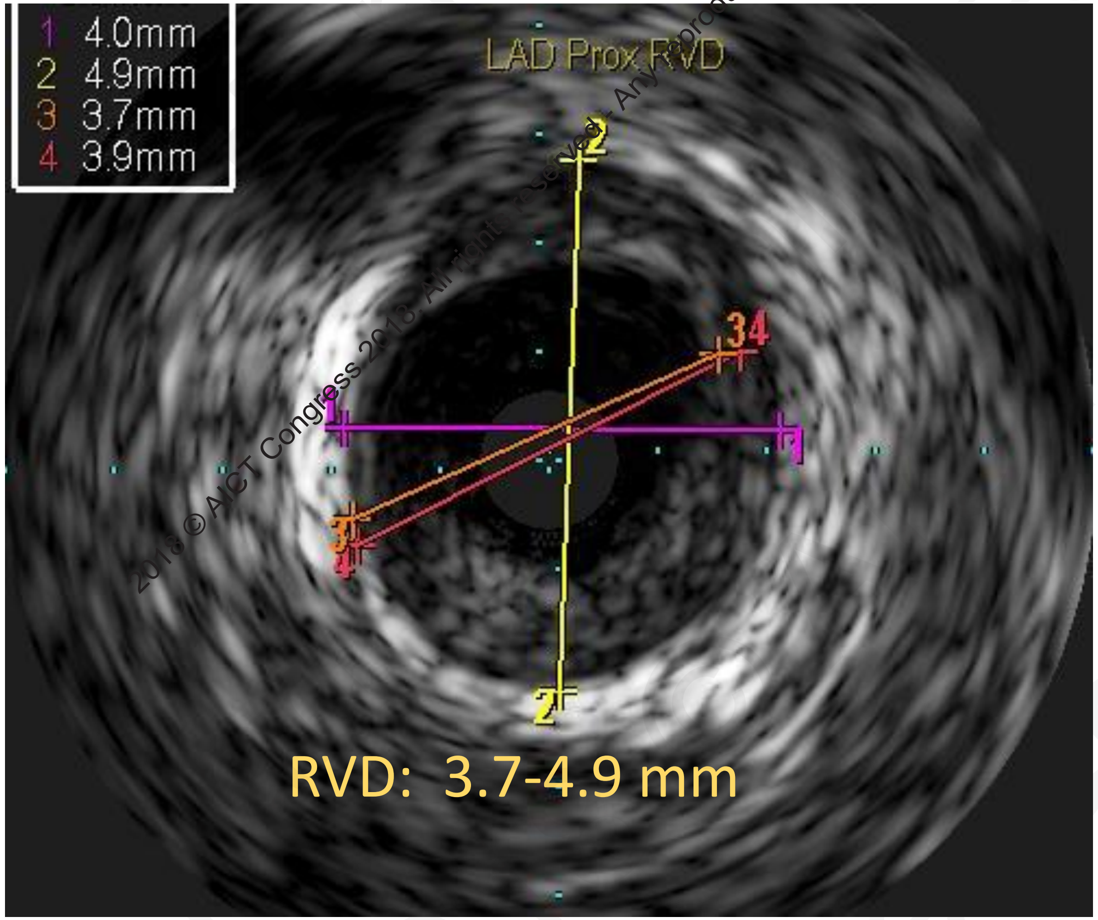
Distal RV-MLA and Distal MSA

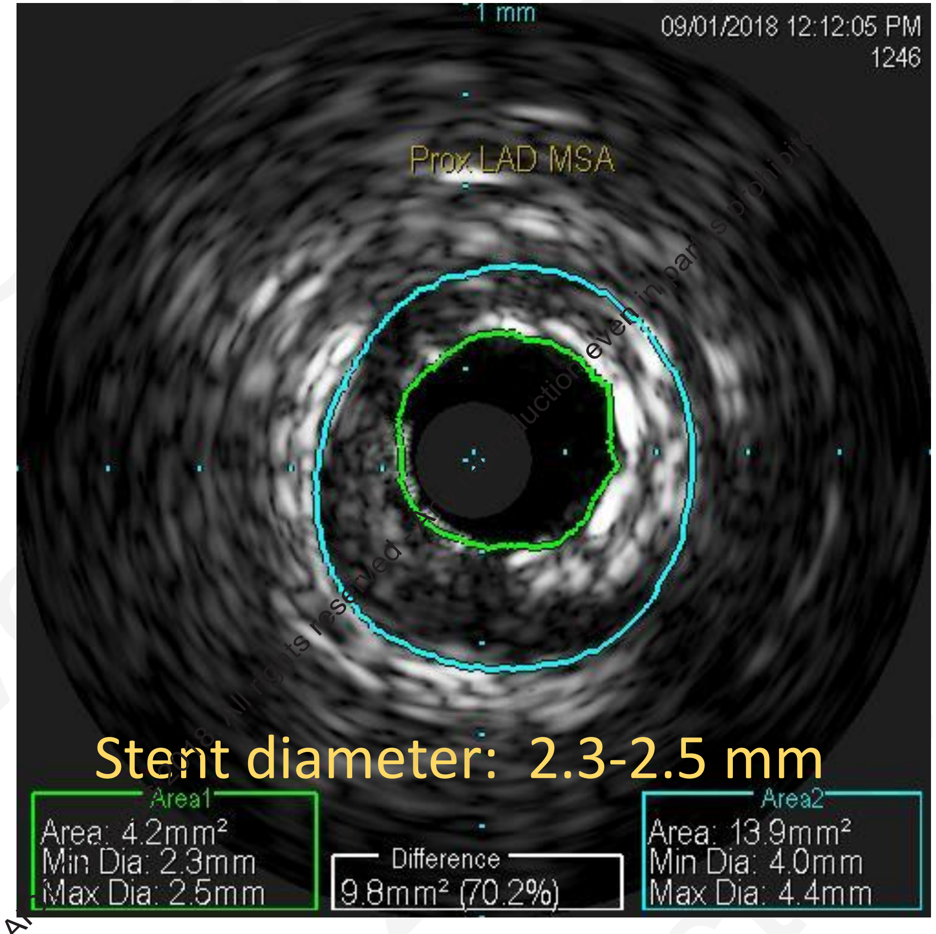




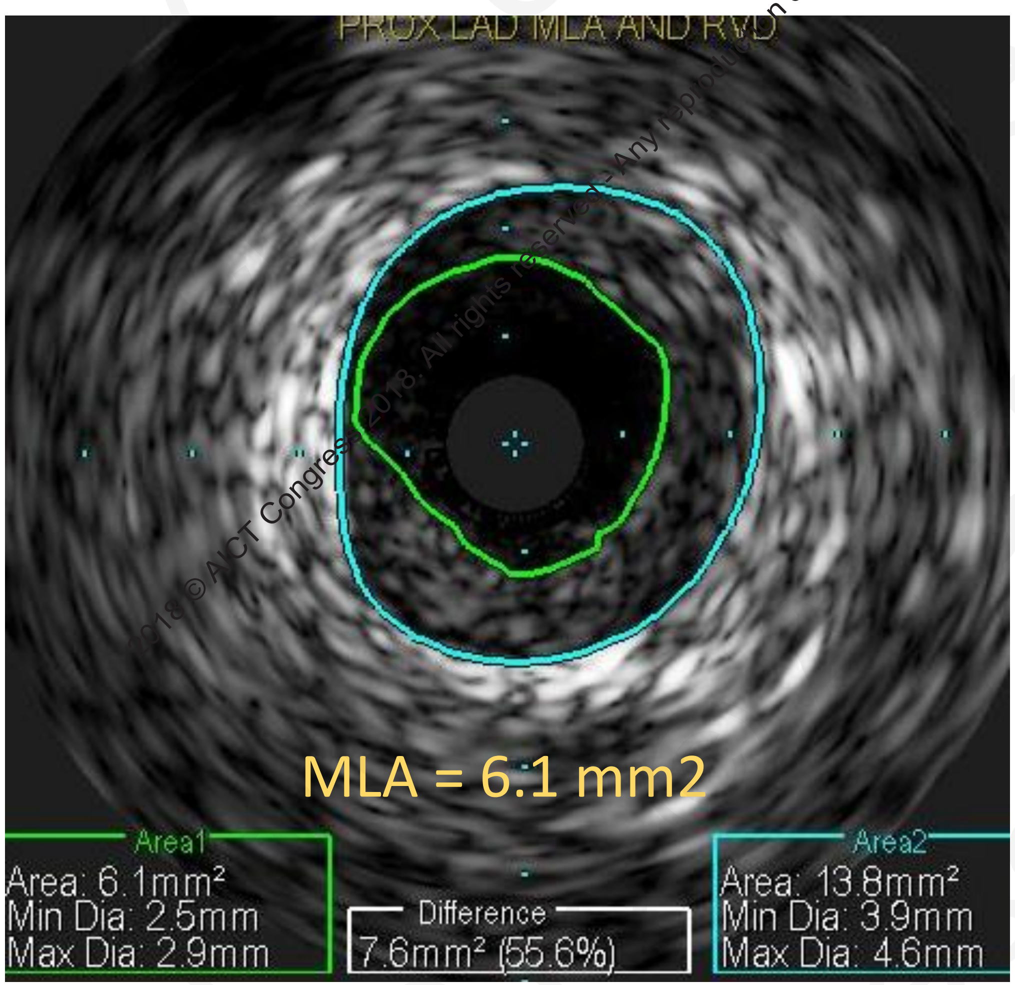
MSA=60% of MLA of distal reference vessel

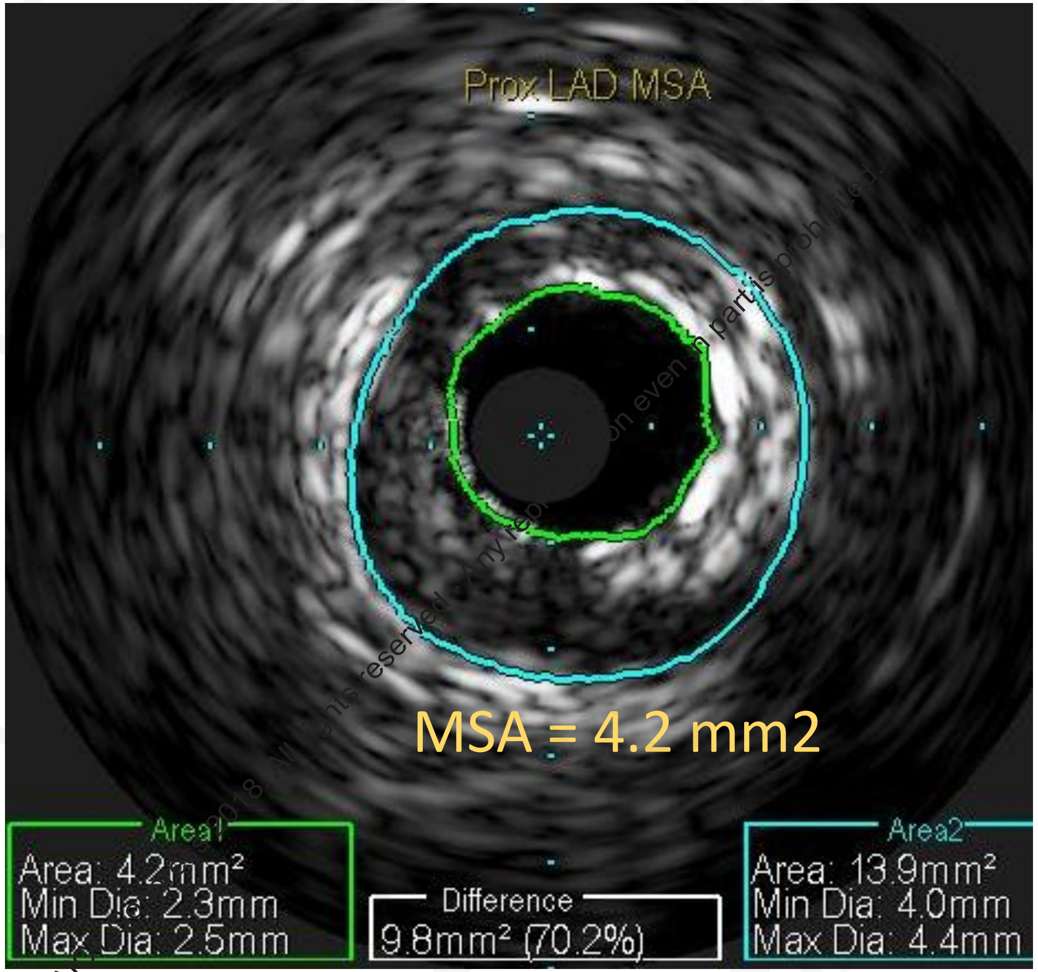
Prox RVD and Prox Stent Underexpansion





Prox RV-MLA and Prox MSA



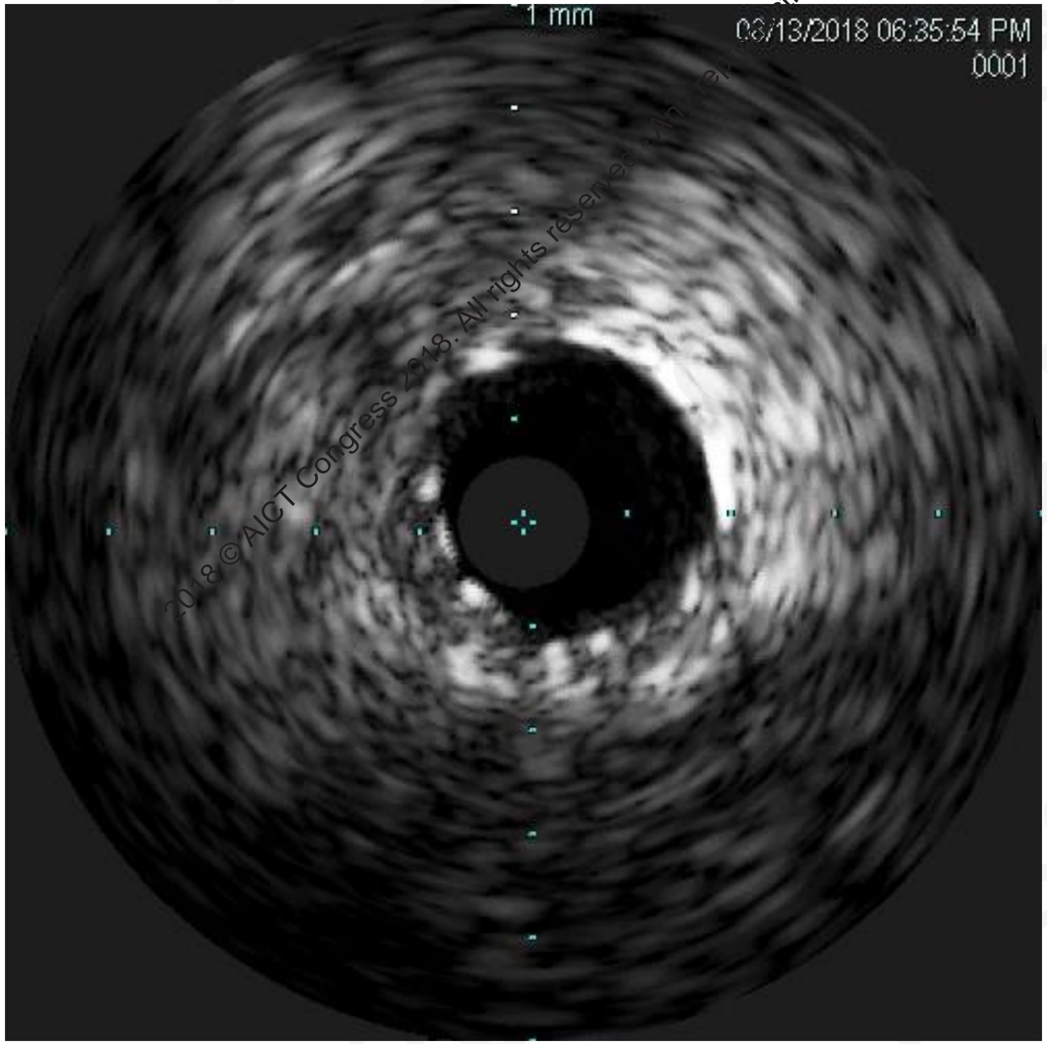


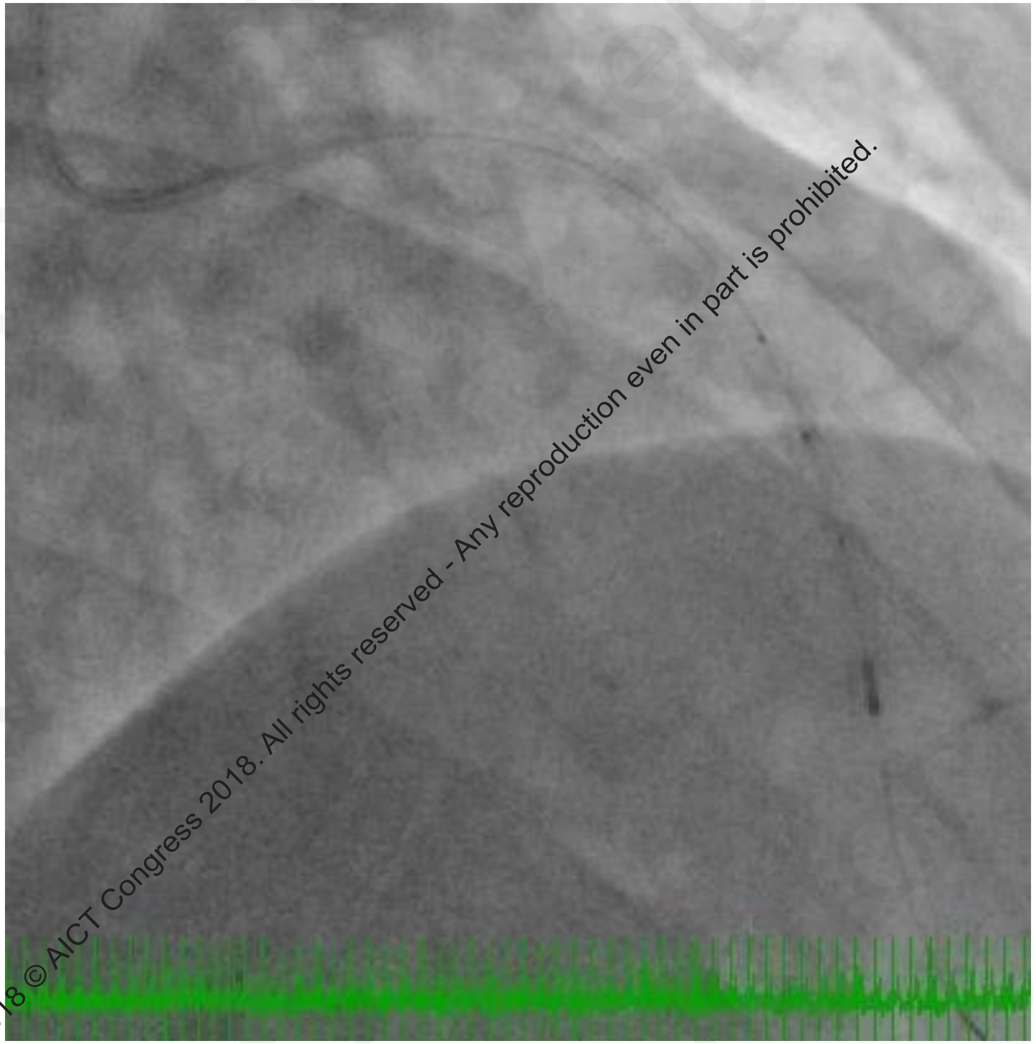
MSA < 70% of MLA of proximal reference vessel

Strategy

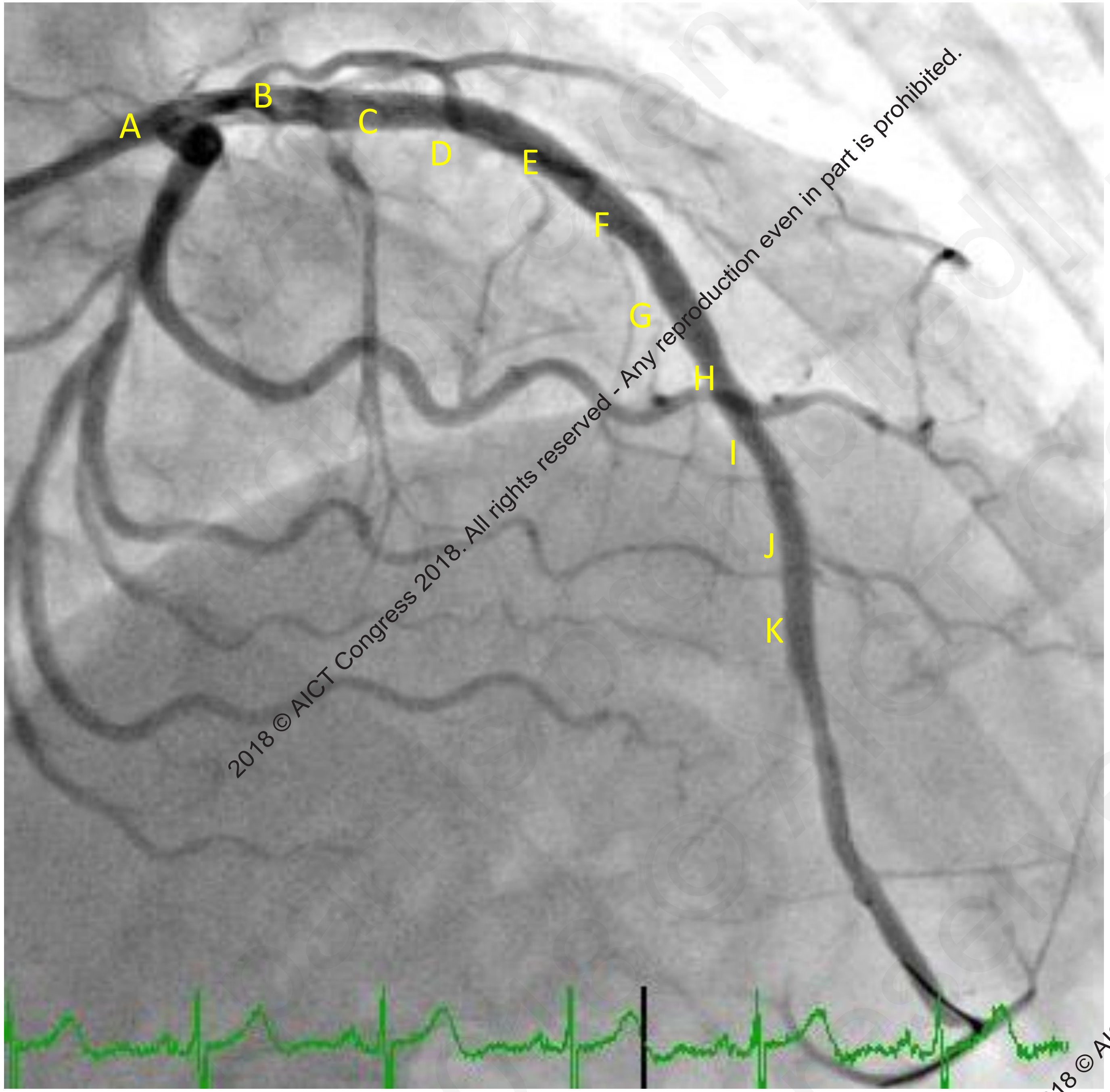
- Review over-expansion capacity of previously deployed stents:
- Ultimaster 2.25 mm: 4.3 mm
- Synergy 2.25: 3.5 mm
- Non-compliant balloons used: Accuforce 3.0, 3.5, 4.0 inflated to maximum pressure of 22 ATM
- Caution on stent edges
- Use of stent boost

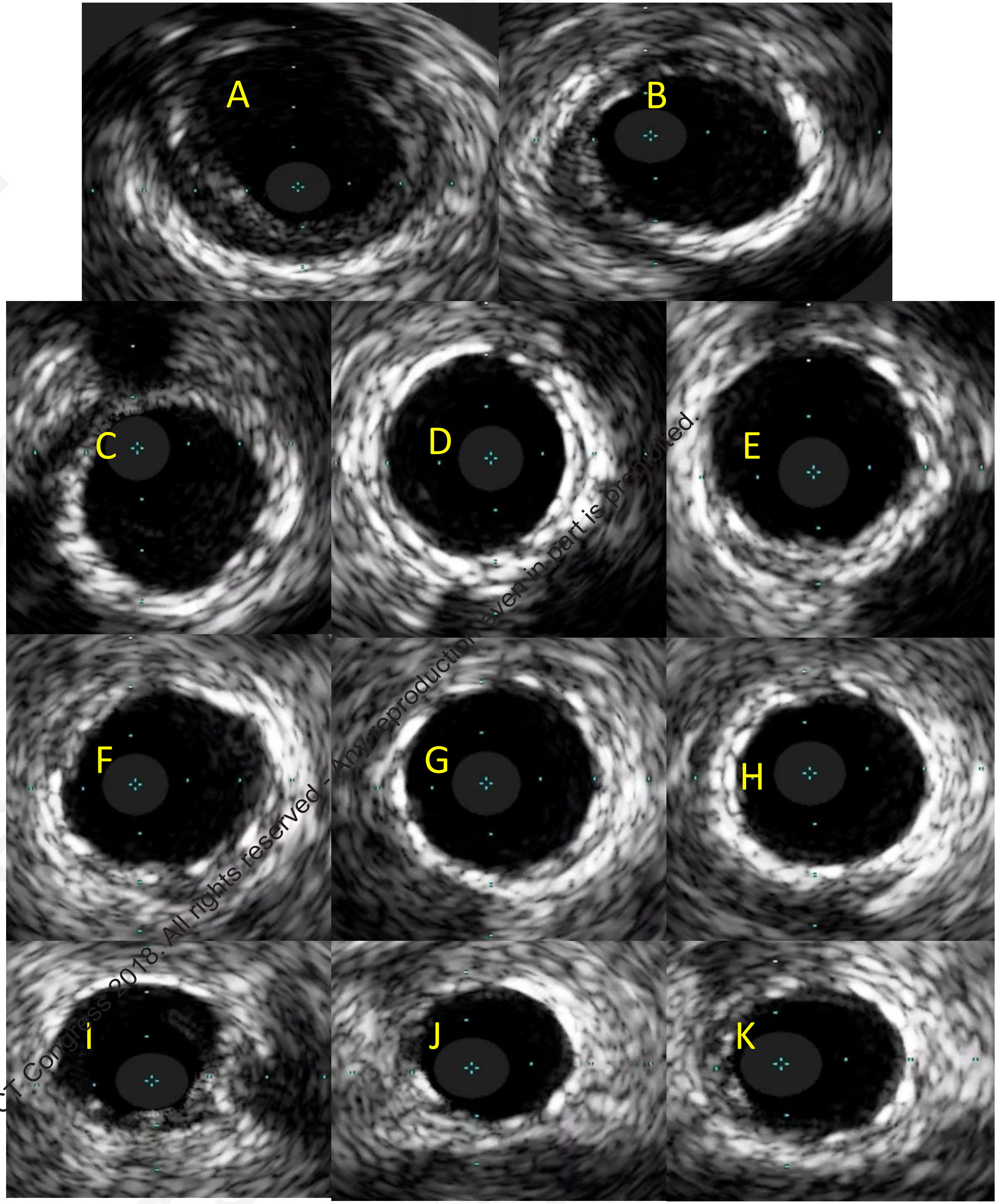
Post-Balloon Fluoro and IVUS



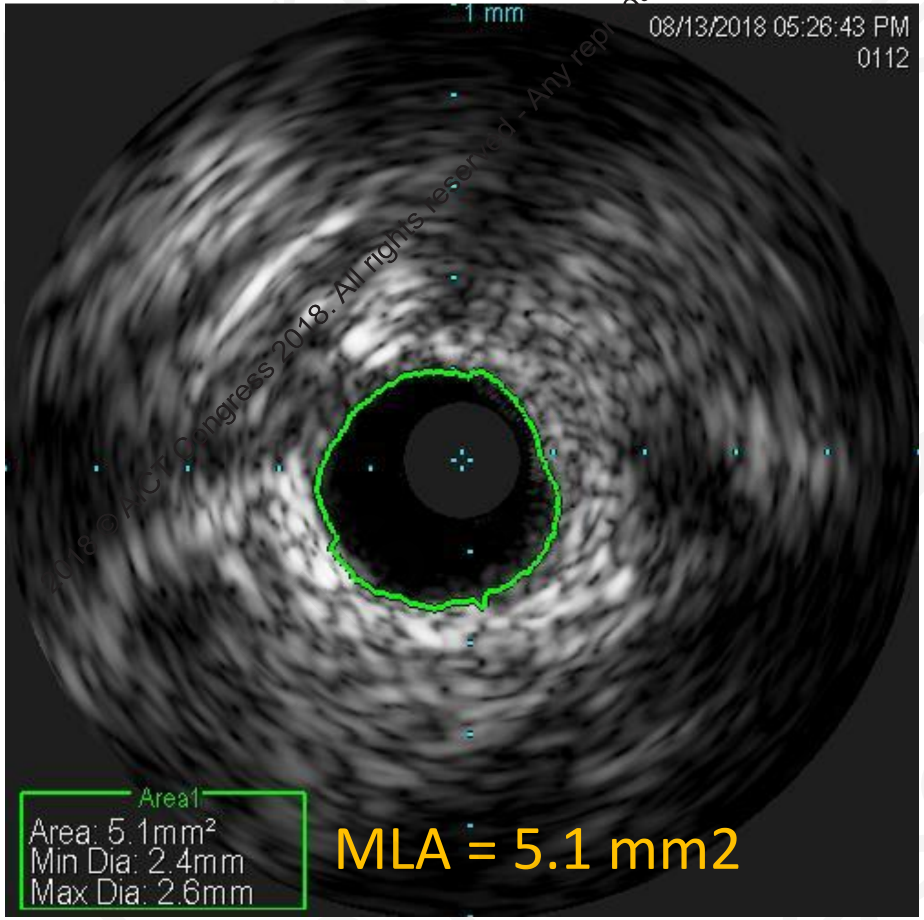


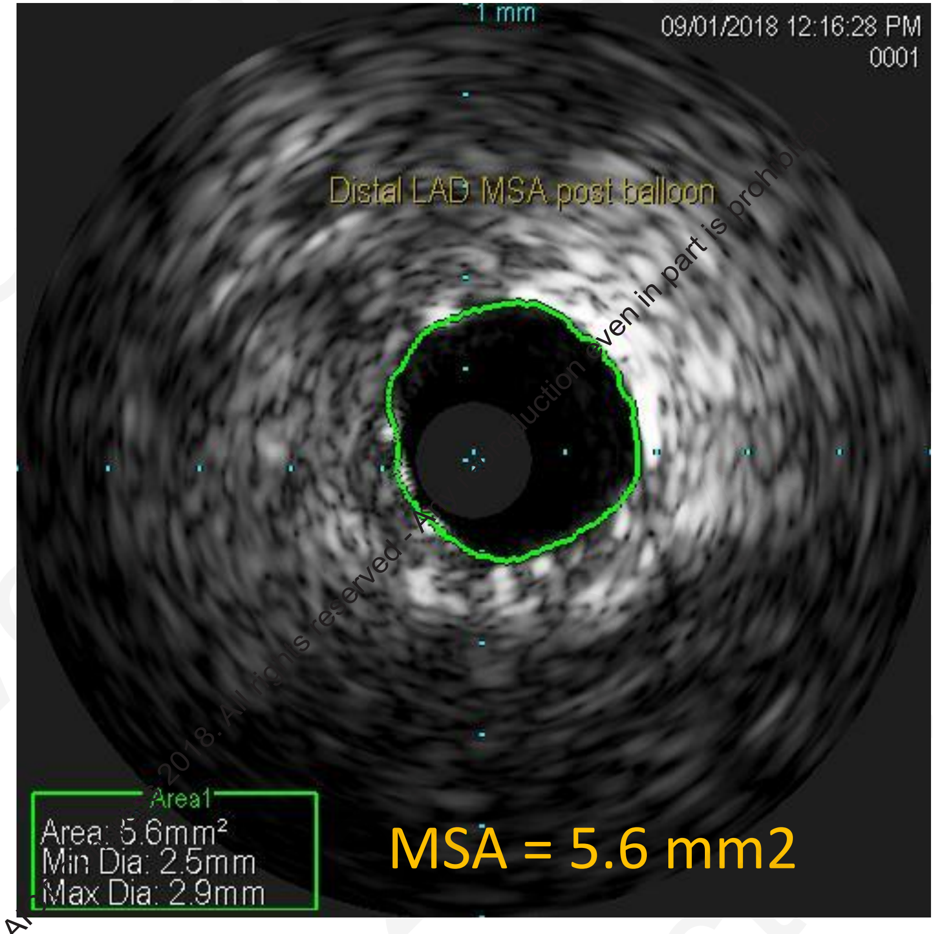
2018 © AICT Congress 2018. All rights reserved - Any reproduction even in part is prohibited.


A
B
C
D
E
F
G
H
I
J
K


A
B
C
D
E
F
G
H
I
J
K

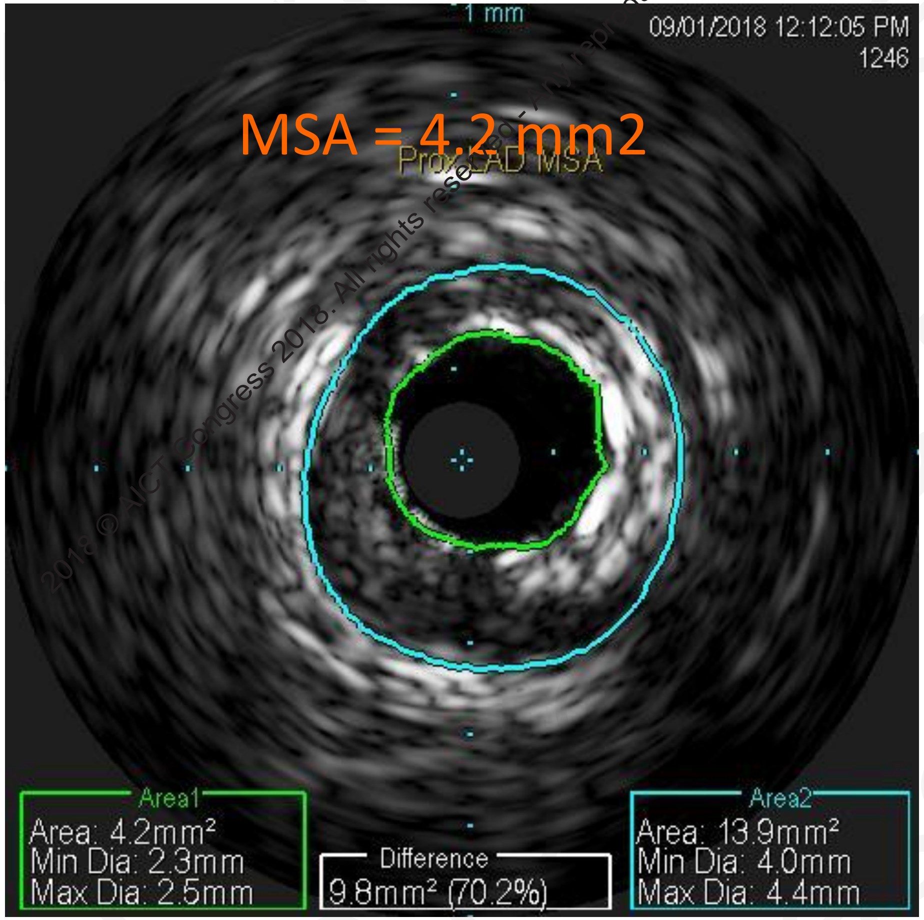
Distal LAD RV-MLA and MSA Post-POBA

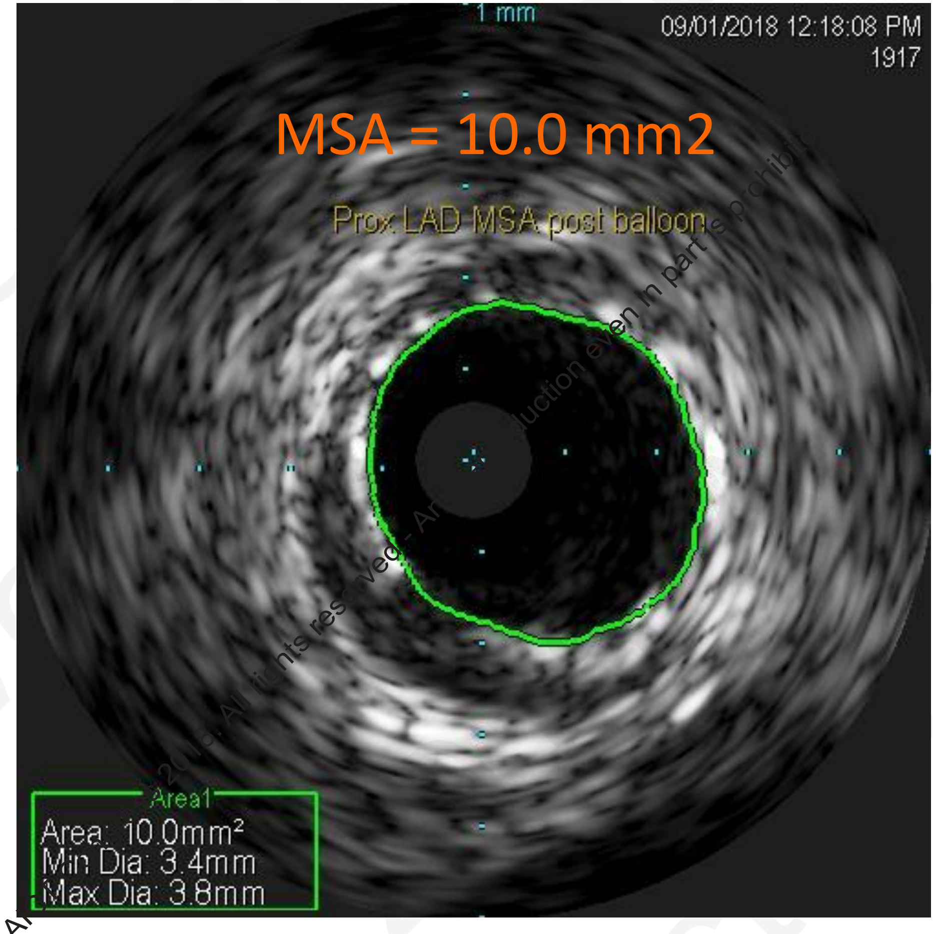




Final MSA > 100% of smallest reference lumen area!

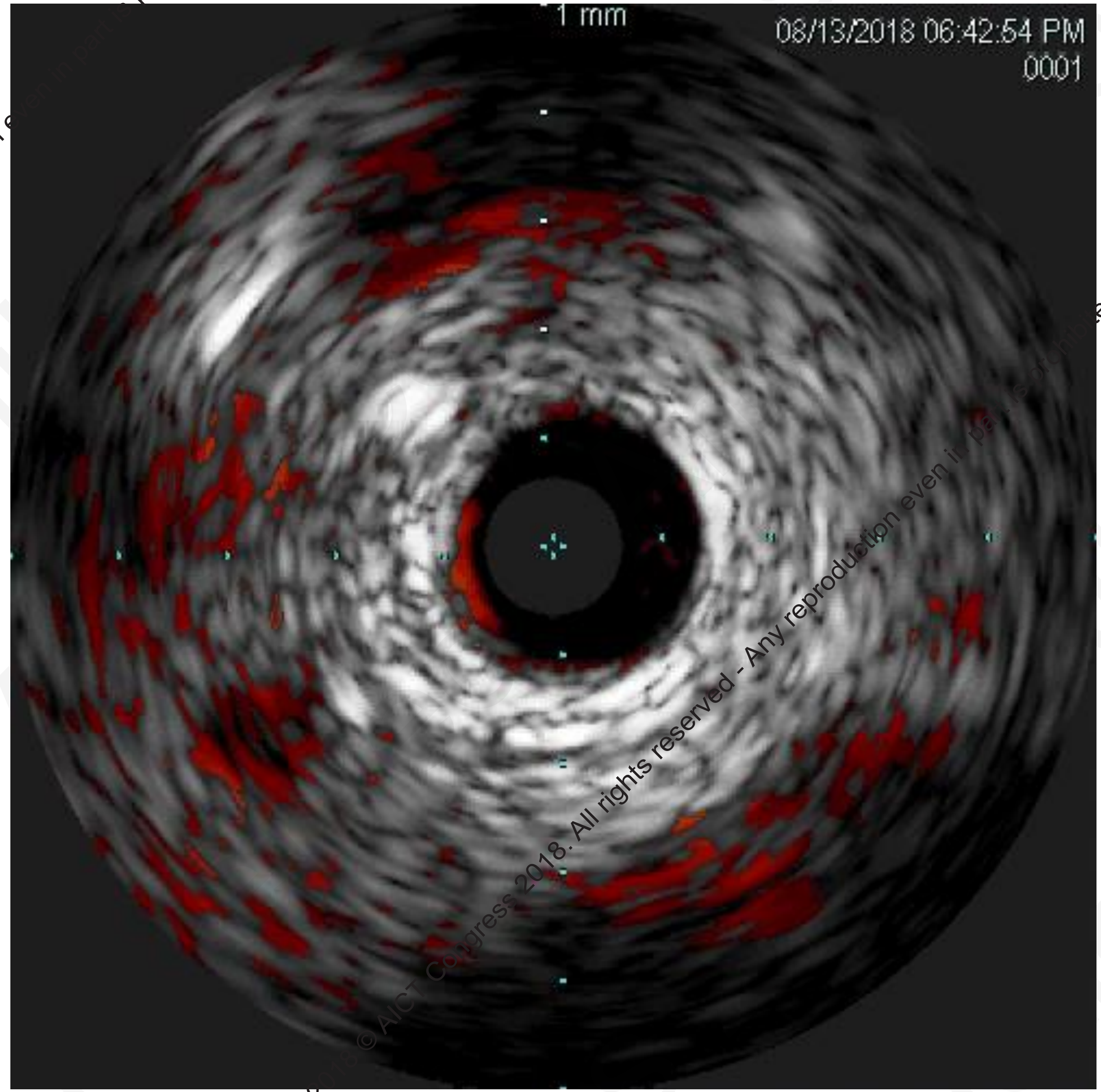
Prox LAD MSA Pre- and Post- POBA





Final prox LAD MSA = 10 mm2!

Final Chromaflo

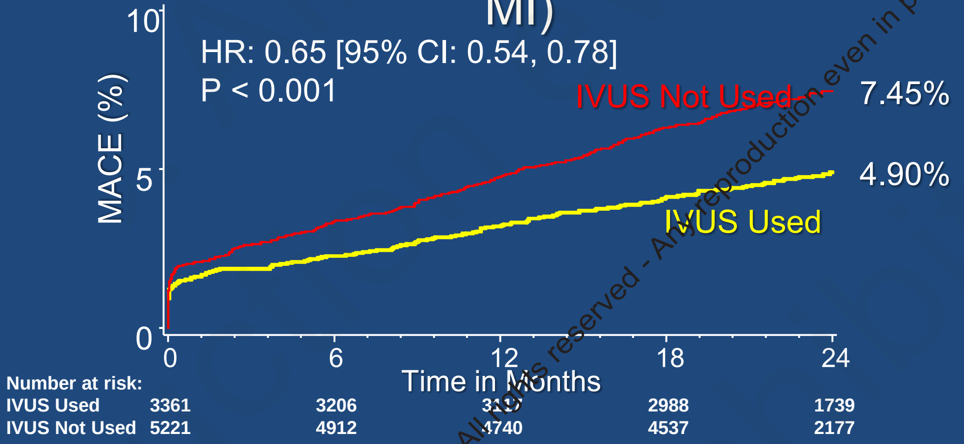


IVUS Predictors of Early DES Thrombosis & Restenosis

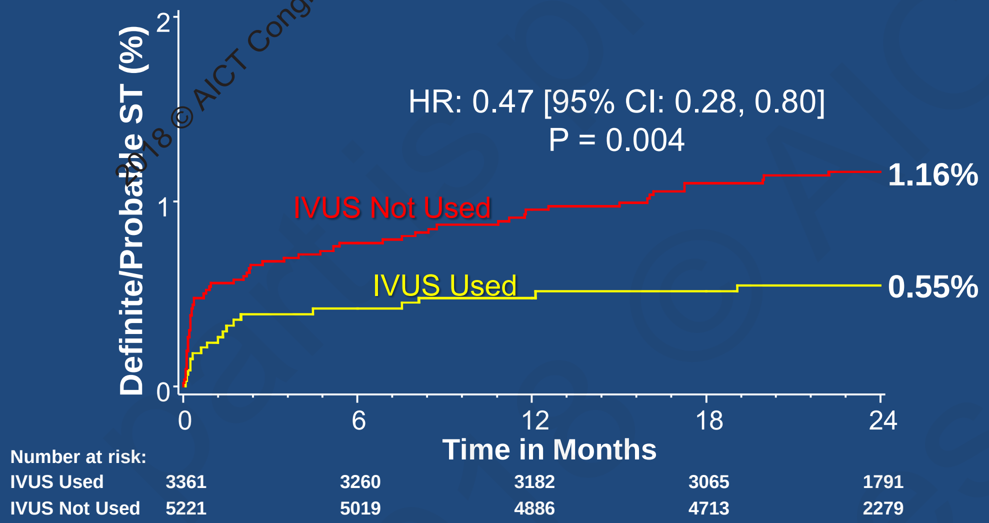
	Early Thrombosis	Restenosis
Small MSA or underexpansion in stable lesions **Small MLA in ACS/MI lesions (accounting for plaque/thrombus protrusion)**	•*Fujii et al. J Am Coll Cardiol 2005;45:995-8* •*Okabe et al. Am J Cardiol. 2007;100:615-20* •*Liu et al. JACC Cardiovasc Interv. 2009;2:428-34* •*Choi et al. Circ Cardiovasc Interv 2011;4:239-47*	•*Sonoda et al. J Am Coll Cardiol 2004;43:1959-63* •*Hong et al. Eur Heart J 2006;27:1305-10* •*Doi et al JACC Cardiovasc Interv. 2009;2:1269-75* •*Fujii et al. Circulation 2004;109:1085-1088* •*Kang et al. Circ Cardiovasc Interv 2011;4:9-14* •*Choi et al. Am J Cardiol 2012;109:455-60* •*Song et al. Catheter Cardiovasc Interv 2014;83:873-8* •*Kang et al. PLoS One 2015;10(10):e0140421*
Edge problems (geographic miss, secondary lesions, large plaque burden, dissections, etc)	•*Fujii et al. J Am Coll Cardiol 2005;45:995-8* •*Okabe et al., Am J Cardiol. 2007;100:615-20* •*Liu et al. JACC Cardiovasc Interv. 2009;2:428-34* •*Choi et al. Circ Cardiovasc Interv 2011;4:239-47*	•*Sakurai et al. Am J Cardiol 2005;96:1251-3* •*Liu et al. Am J Cardiol 2009;103:501-6* •*Costa et al, Am J Cardiol, 2008;101:1704-11* •*Kang et al. Am J Cardiol 2013;111:1408-14* •*Kobayashi et al. ACC2014*
Stent length (>40mm)		•*Hong et al. Eur Heart J 2006;27:1305-10*

Two year follow-up data from ADAPT-DES (3361 pts treated with IVUS-guidance vs 5221 pts treated with angiographic guidance)

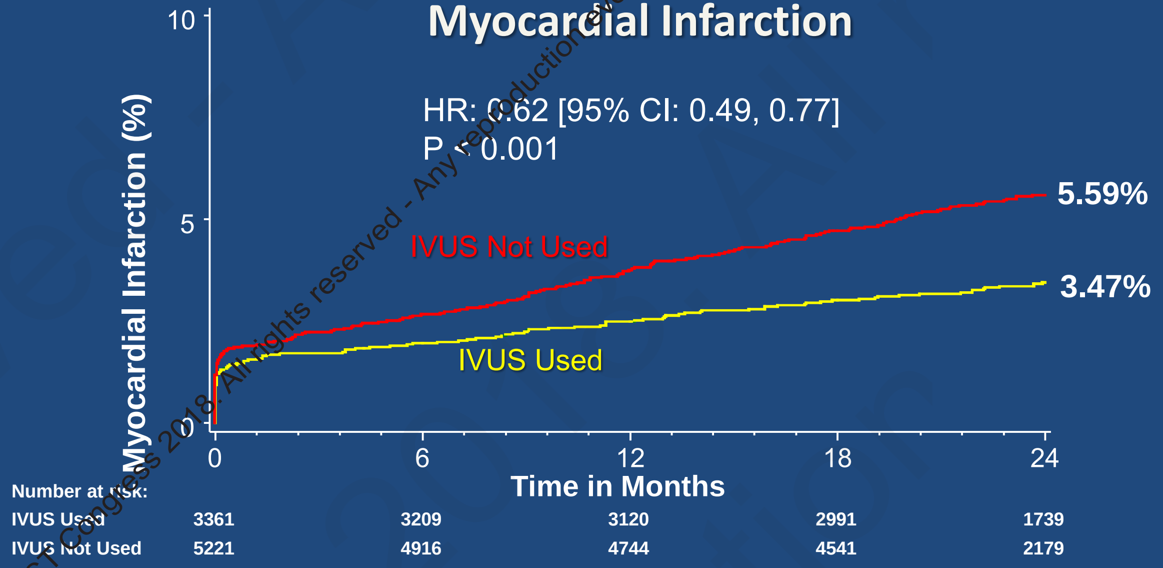
MACE (Definite/Probable ST, Cardiac Death, MI)



Definite/Probable ST



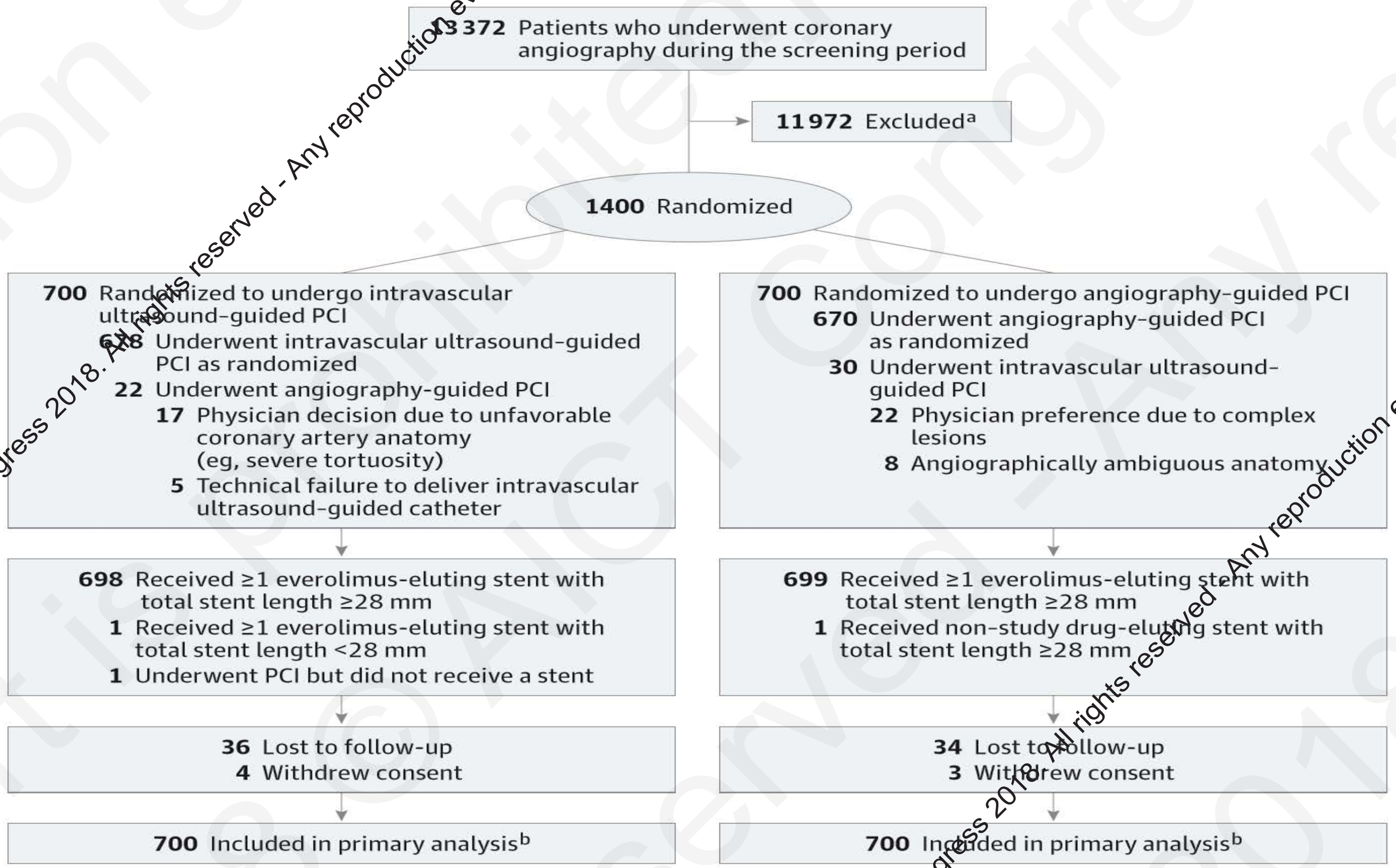
Myocardial Infarction



Maehara et al. J Am Coll Cardiol 2013;62:B21-B22

Is IVUS better than ANGIO to guide PCI for long lesions?

The IVUS-XPL Randomized Clinical Trial



IVUS criteria for stent optimization after PCI was defined as a minimal lumen cross-sectional area greater than the lumen cross-sectional area at the distal reference segments

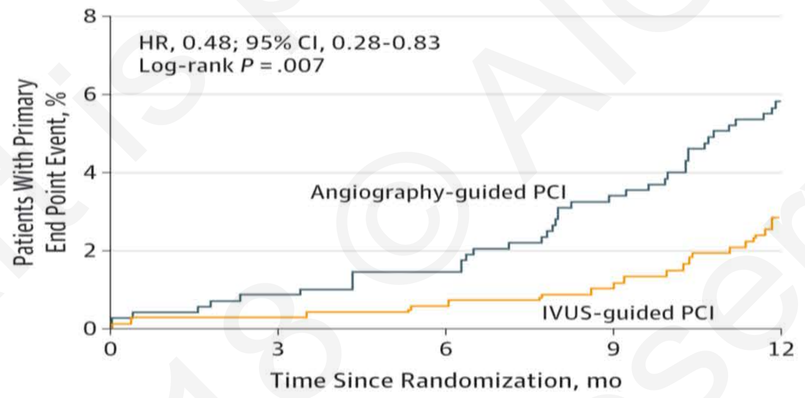
Hong SJ, et al. JAMA. 2015; 314: 2155-2163.

Is IVUS better than ANGIO to guide PCI for long lesions?

The IVUS-XPL Randomized Clinical Trial

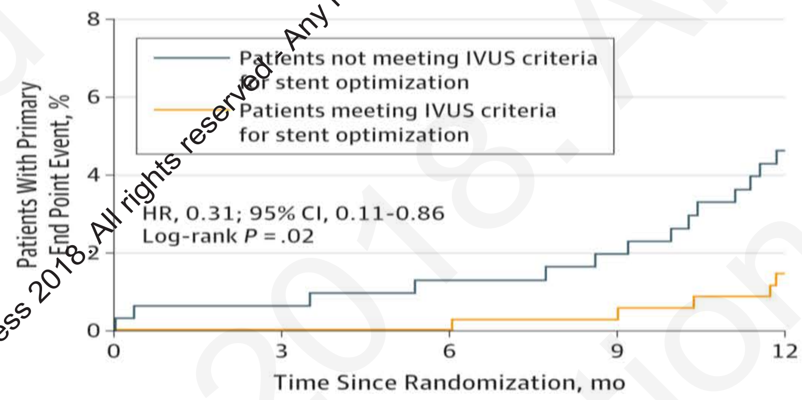
	IVUS-Guided PCI (n = 700)[a]	Angiography-Guided PCI (n = 700)[a]	Risk Difference (95% CI)	Hazard Ratio (95% CI)[b]	*P* Value[c]
Primary End Point					
Major adverse cardiac event[d]	19 (2.9)	39 (5.8)	−2.97 (−5.14 to −0.79)	0.48 (0.28 to 0.83)	.007
Secondary End Point					
Cardiac death	3 (0.4)	5 (0.7)	−0.30 (−1.11 to 0.52)	0.60 (0.14 to 2.52)	.48
Target lesion–related myocardial infarction	0	1 (0.1)	−0.15 (−0.45 to 0.14)		.32
Ischemia-driven target lesion revascularization	17 (2.5)	33 (5.0)	−2.39 (−4.43 to −0.36)	0.51 (0.28 to 0.91)	.02
Definite or probable stent thrombosis	2 (0.3)	2 (0.3)	0 (−0.57 to 0.56)	1.00 (0.14 to 7.10)	>.99
Acute	1 (0.1)	1 (0.1)			
Subacute	1 (0.1)	0			
Late	0	1 (0.1)			

A All patients



No. at risk					
PCI					
Angiography-guided	700	673	660	643	624
IVUS-guided	700	671	665	654	641

B Patients in IVUS-guided PCI group who underwent IVUS-guided stent implantation[a]



No. at risk					
IVUS criteria					
Not meeting	315	299	297	394	285
Meeting	363	362	345	338	334

Hong SJ, et al. JAMA. 2015; 314: 2155-2163.

Meta-Analysis: IVUS vs Angio DES

Reference	Year	RCT	Non-RCT	Pts	MACE	Death	Myocardial Infarction	ST	Target Lesion Revascular-ization	Target Vessel Revascular-ization
					Hazard Ratio/ p-values					
Zhang et al. (Eurointervention) [11]	2012	1	10	1[illegible],619	0.87 p = 0.008	0.59 p < 0.001	0.82 p = 0.13	0.58 p < 0.001	0.90 p = 0.3	0.90 p = 0.2
Propensity score matched subanalysis				5,300	0.86 p = 0.06	0.73 p = 0.04	0.63 p = 0.01	0.57 p = 0.004	0.85 p = 0.3	0.94 p = 0.6
Klersy et al. [12]	2013	3	9	18,707	0.80 p < 0.001	0.60 p < 0.001	0.59 p = 0.001	0.58 p = 0.007	0.95 p = 0.8	
Jang et al. [12]	2014	3	12	24,869	0.79 p = 0.001	0.64 p < 0.001	0.57 p < 0.001	0.59 p = 0.002	0.76 p = 0.01	0.81 p = 0.01
Propensity score matched subanalysis				13,545	0.79 p = 0.01	0.58 p = 0.01	0.56 p = 0.04	0.52 p = 0.004	0.85 p = 0.3	0.93 p = 0.3
Ahn et al. [14]	2014	3	14	26,503	0.74 p < 0.001	0.61 p < 0.001	0.57 p < 0.001	0.59 p < 0.001	0.81 p = 0.046	0.82 p = 0.022
Zhang et al. (BMC Cardiovasc Disorders) [13]	2015	3	17	29,068	0.77 p < 0.001	0.62 p < 0.001	0.64 p < 0.001	0.59 p < 0.001	0.81 p = 0.005	0.86 p = 0.012
Propensity score matched subanalysis				8,331	0.79 p < 0.001	0.64 p < 0.001	0.69 p < 0.001	0.55 p < 0.001	0.92 p = 0.34	0.82 p = 0.02[illegible]
Complex lesions or acute coronary syndrome				6,393	0.69 p < 0.001	0.52 p < 0.001		0.64 p < 0.001		
Elgendy et al. [16]	2016	8		3,275	0.59 p < 0.0001	0.46 p = 0.05	0.58 p = 0.10	0.49 p = 0.04	0.59 p < 0.000[illegible]	

Elgendy IY, Mahmoud A, Elgendy AY, Bavry A. Outcomes With Intravascular Ultrasound-Guided Stent Implantation: A Meta-Analysis of Randomized Trials in the Era of Drug-Eluting Stents. Circ Cardiovasc Interv 2016

Meta-analysis of the eight *randomized* IVUS-guided versus angiography-guided DES implantation studies showed that IVUS guidance was associated with a reduction in risk of MACE by 41%, mortality by 54%, ST by 51%, and ischemia-driven target lesion revascularization by 40%

2018 © AICT Congress 2018. All rights reserved - Any reproduction even in part is prohibited.

The larger the better?

Impact of Stent Size Selection on Acute and Long-Term Outcomes After Drug-Eluting Stent Implantation in De Novo Coronary Lesions

Hideki Kitahara, MD, PhD; Kozo Okada, MD, PhD; Takumi Kimura, MD, PhD; Paul G. Yock, MD; Alexandra J. Lansky, MD; Jeffrey J. Popma, MD; Alan C. Yeung, MD; Peter J. Fitzgerald, MD, PhD; Yasuhiro Honda, MD

Background—Although significant undersizing often results in incomplete stent apposition or underexpansion, the possible impact of oversized stent implantation on arterial wall injury has not been systematically investigated with drug-eluting stents. The aim of this study was to investigate the impact of stent oversizing on acute and long-term outcomes after drug-eluting stents implantation in de novo coronary lesions.

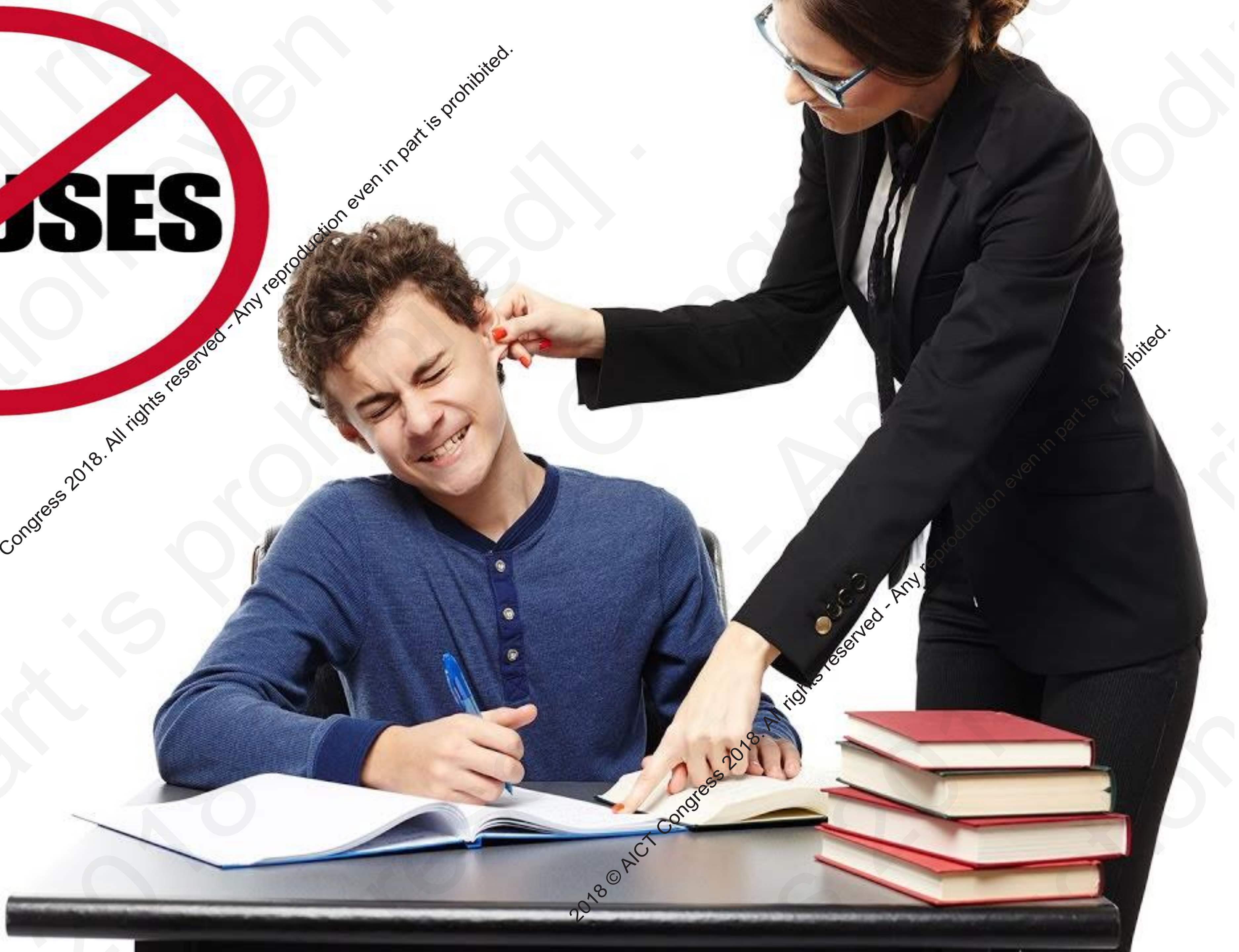
Methods and Results—Serial (baseline and 6–12 months) coronary angiography and intravascular ultrasound were performed in 2931 lesions treated with drug-eluting stents (355 sirolimus, 846 paclitaxel, 1387 zotarolimus, and 343 everolimus). The percentage of stent oversizing to angiographic reference vessel diameter (RVD) was calculated as (nominal stent diameter–RVD)/RVD×100 (%). Clinical outcomes, including target lesion revascularization and stent thrombosis, were followed for 1 year. Overall, smaller preintervention RVD was associated with higher percentage of stent oversizing ($P<0.001$). The significant oversizing group underwent less post-dilatation ($P=0.002$) but achieved greater stent expansion ($P<0.001$) and less incomplete stent apposition ($P<0.001$) without increase of edge dissection after procedure. When stratified by vessel size and stent oversizing, progressive decreases of restenosis ($P=0.002$) and target lesion revascularization rates ($P=0.007$) were found in favor of larger vessel size and oversized stents. Stent thrombosis was observed the most in small RVD with low percentage of stent oversizing group among the subgroups ($P=0.040$).

Conclusions—The positive impact of stent oversizing was documented on procedural and clinical outcomes. In particular, small vessels treated with smaller stents were associated with greater adverse events, suggesting that aggressive selection of larger stents, with appropriate attention to edge effects, may optimize long-term outcomes, even in drug-eluting stents implantation. (*Circ Cardiovasc Interv*. **2017;10:e004795. DOI: 10.1161/CIRCINTERVENTIONS.116.004795.**)

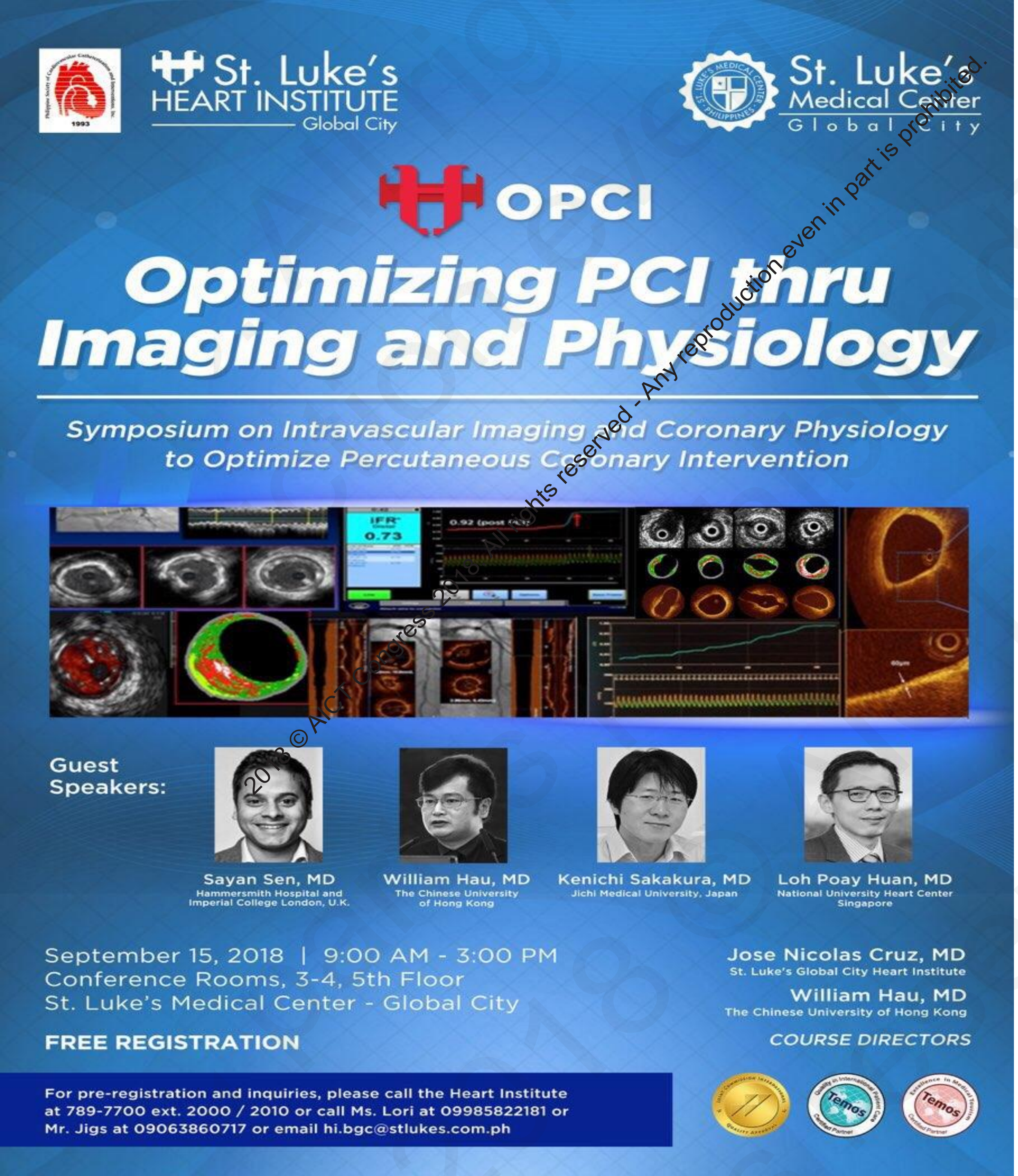
"…small vessels treated with a smaller stent were associated with greater adverse events, suggesting that aggressive selection of larger stents, with appropriate attention to edge effects, may optimize long- term outcomes"

Take Home Message

- Coronary angiography has limitations
- Stent underexpansion is highly associated with poor outcomes
- The benefits of IVUS utilization in PCI are irrefutable



2018 © AICT Congress 2018. All rights reserved - Any reproduction even in part is prohibited.



Thank You and Have a Good Day!

2018 © AICT Congress 2018. All rights reserved - Any reproduction even in part is prohibited.