OCT predictors of long-term stent complication

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Potential conflicts of interest

☐ I have the following potential conflicts of interest to report:

Consulting
Employment in industry
Stockholder of a healthcare company
Owner of a healthcare company
Other(s)

☒ I do not have any potential conflict of interest

CLINICAL RESEARCH

CME

Examination of the In Vivo Mechanisms of Late Drug-Eluting Stent Thrombosis

Findings From Optical Coherence Tomography and Intravascular Ultrasound Imaging

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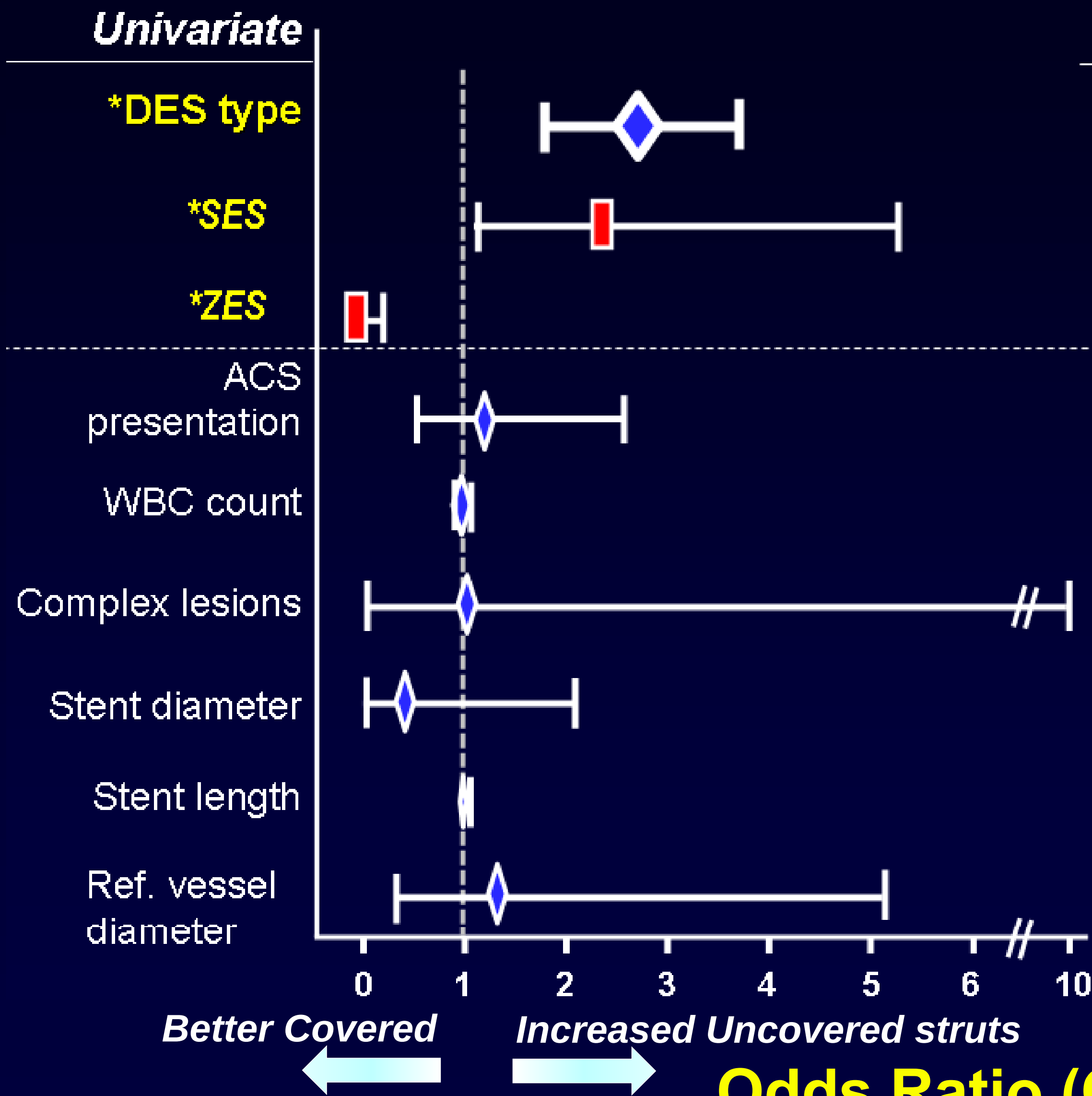
Bergamo, Italy; London, United Kingdom; Gaithersburg, Maryland; and New York, New York

	Stent thrombosis (n=18)	Control (n=36)	p
Frequency of uncovered struts, %	12.3	4.1	0.001
Frequency of malapposed struts, %	4.6	1.8	0.001
Frequency of cross-sections with any uncovered strut,%	33.3	0	0.003
Frequency of cross-sections with uncovered strut ratio > 0.3, %	21.6	0	0.002

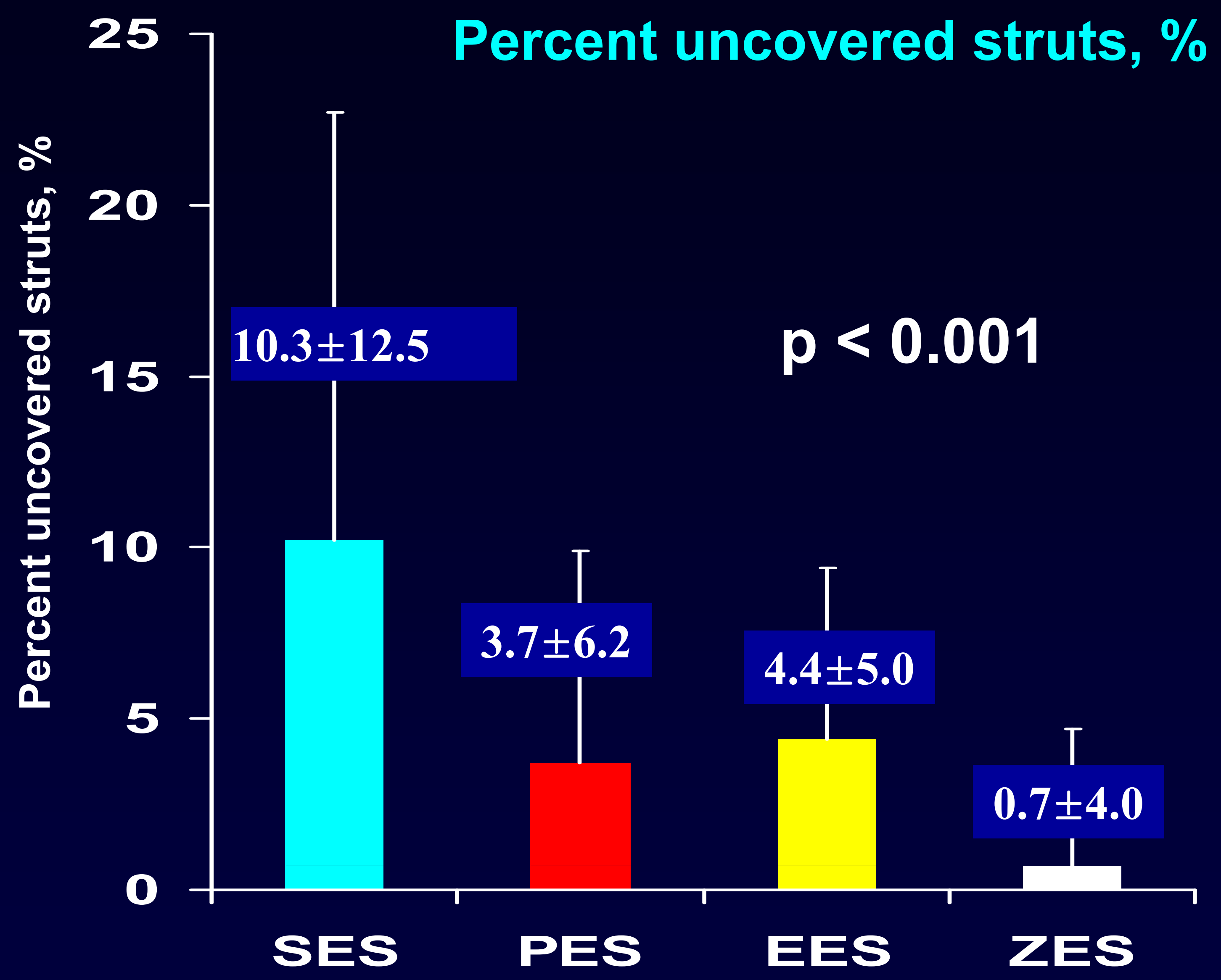
Guagliumi G et al, *J Am Coll Cardiol Intv* 2012;5:12-20

Major determinants of uncovered struts



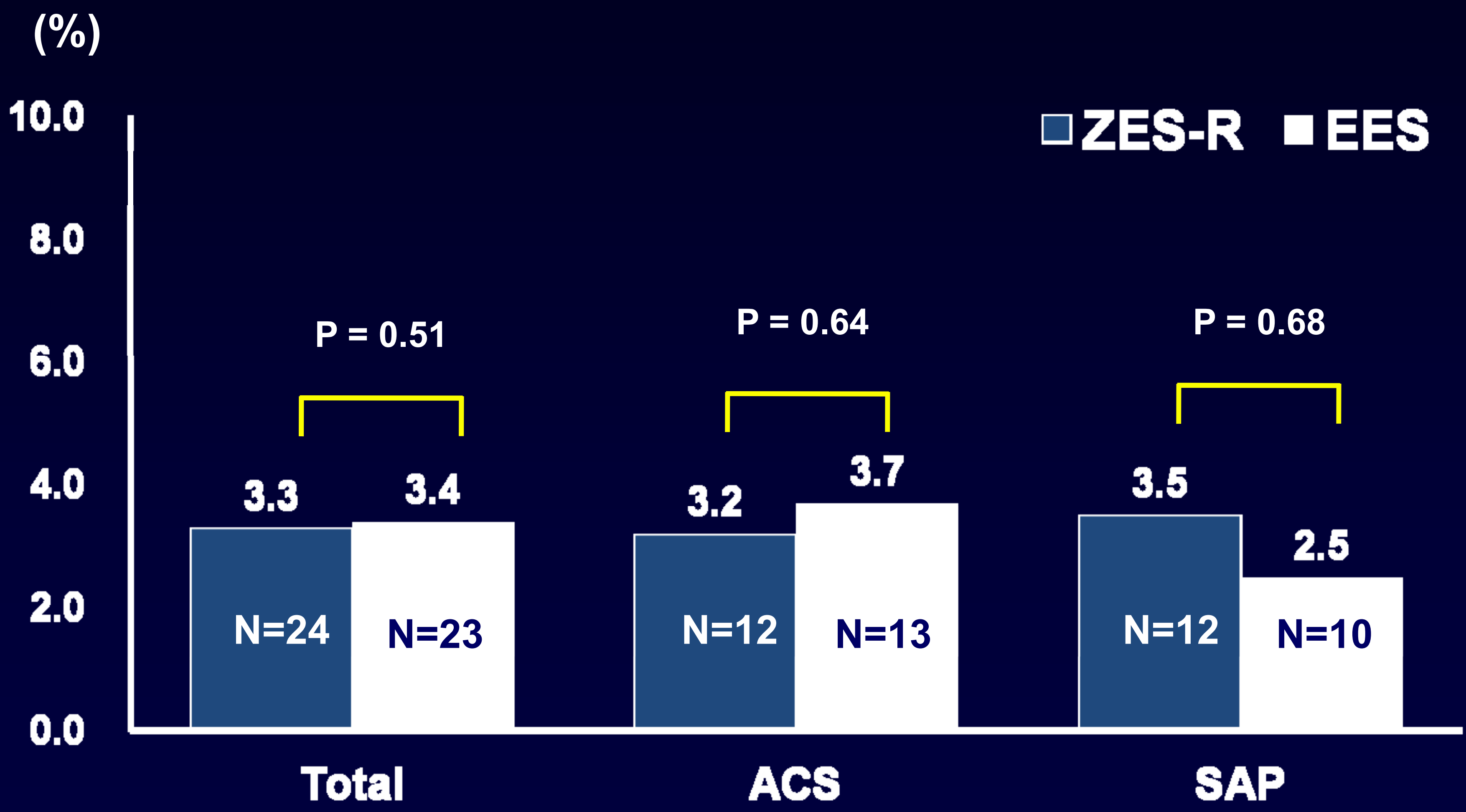
Univariate	OR	95% CI	p value
*DES type	2.61	1.81-3.76	<0.001
*SES	2.47	1.15-5.30	0.021
*ZES	0.02	0.01-0.24	0.002
ACS presentation	1.23	0.58-2.60	0.585
WBC count	1.01	0.99-1.02	0.248
Complex lesions	1.07	0.11-10.26	0.952
Stent diameter	0.46	0.10-2.21	0.332
Stent length	1.03	0.98-1.09	0.238
Ref. vessel diameter	1.42	0.39-5.16	0.599

Kim BK, Hong MK, *Int J Cardiovasc Imaging (in press)*



Kim BK, Hong MK, *Int J Cardiovasc Imaging (in press)*

The prevalence of uncovered struts in ZES-R and EES at 9-Month follow-up: Randomized study



Kim JS, et al. *Am Heart J* (in press)

Malapposed vs. Uncovered Struts.

Variables	Non-malapposition (n=232)	Malapposition (n=74)	p value
No. of cross section, n	5448	1731	-
% malapposed struts, %	0	3.2 ± 4.9	-
% uncovered struts from all cross sections, %	3.7 ± 6.4	11.6 ± 13.3	<0.001
% uncovered struts in the cross sections without malapposition, %	3.7 ± 6.4	10.1 ± 12.0	<0.001
Thrombi, n (%)	20 (9%)	18 (24%)	<0.001
Types of DES used			<0.001
SES, n (%)	59 (25%)	37 (50%)	
PES, n (%)	44 (19%)	10 (14%)	
ZES-Sprint, n (%)	54 (23%)	4 (5%)	
ZES-Resolute, n (%)	38 (16%)	15 (20%)	
EES, n (%)	37 (16%)	8 (11%)	

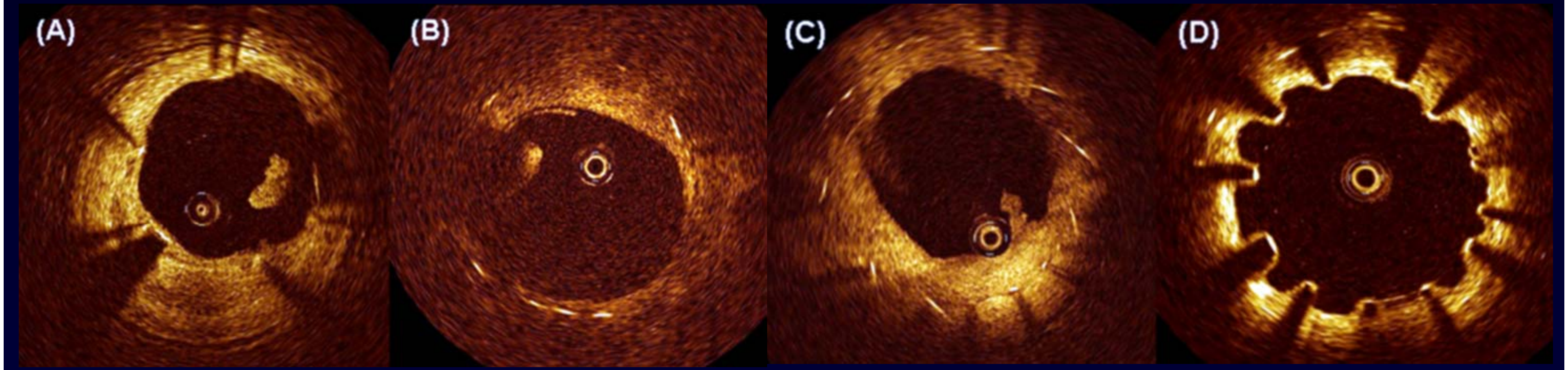
Kim BK, Hong MK, et al. J Interven Cardiol (in press)

Malapposed vs. Uncovered Struts.

Variables	Non-malapposition (n=232)	Malapposition I % malapposed struts <1.3% (n=37)	Malapposition II % malapposed struts ≥1.3% (n=37)	p value
% malapposed struts, %	0%	0.7 ± 0.3%	5.6 ± 6.1%	<0.001
% uncovered struts from all cross sections, %	3.7 ± 6.4	5.5 ± 5.6	17.6 ± 15.9	<0.001
% uncovered struts in the cross sections without malapposition, %	3.7 ± 6.4	5.2 ± 5.7	15.0 ± 14.4	<0.001
Thrombi, n (%)	20 (9%)	8 (22%)	10 (27%)	<0.001
Time to OCT (days)	312 ± 92	303 ± 68	315 ± 81	0.785
FU after OCT (days)	480 ± 315	484 ± 282	475 ± 210	0.921
Duration of DAT after OCT (days)	252 ± 214	299 ± 227	313 ± 258	0.129
MACE after OCT	0	0	1 STEMI	

Kim BK, Hong MK, et al. J Interven Cardiol (in press)

Intracoronary Thrombus Formation After DES Implantation; OCT Study



Representative images of intracoronary thrombus in each stent (SES in A, PES in B and ZES in C), and malapposed struts without neointima in D

Kim JS, Hong MK et al. Am Heart J 2010;159:278-83

Intracoronary Thrombus Formation After DES Implantation; OCT Study

- **Intracoronary thrombus was detected in 35/244 stents (14%)**

  - 27/95 SES (28%)

  - 7/62 PES (11%)

  - 1/87 ZES (1 %) ($p<0.001$)

Kim JS, Hong MK et al. Am Heart J 2010;159:278-83

Determining Factors of IC Thrombus

	Univariate analysis			Multivariate analysis		
	OR	95% CI	*p* value	OR	95% CI	*p* value
OCT parameters						
MLA follow-up	1.00	0.81-1.24	0.97			
Mean neointima thickness	0.92	0.87-0.97	0.001	1.00	0.94-1.06	0.97
Presence of malapposed struts	5.18	2.44-10.97	<0.001	2.19	0.83-5.78	0.11
≥ 8 struts without neointima in stent	9.19	4.04-20.90	<0.001	3.29	1.07-10.17	0.04

OCT findings of very late stent thrombosis

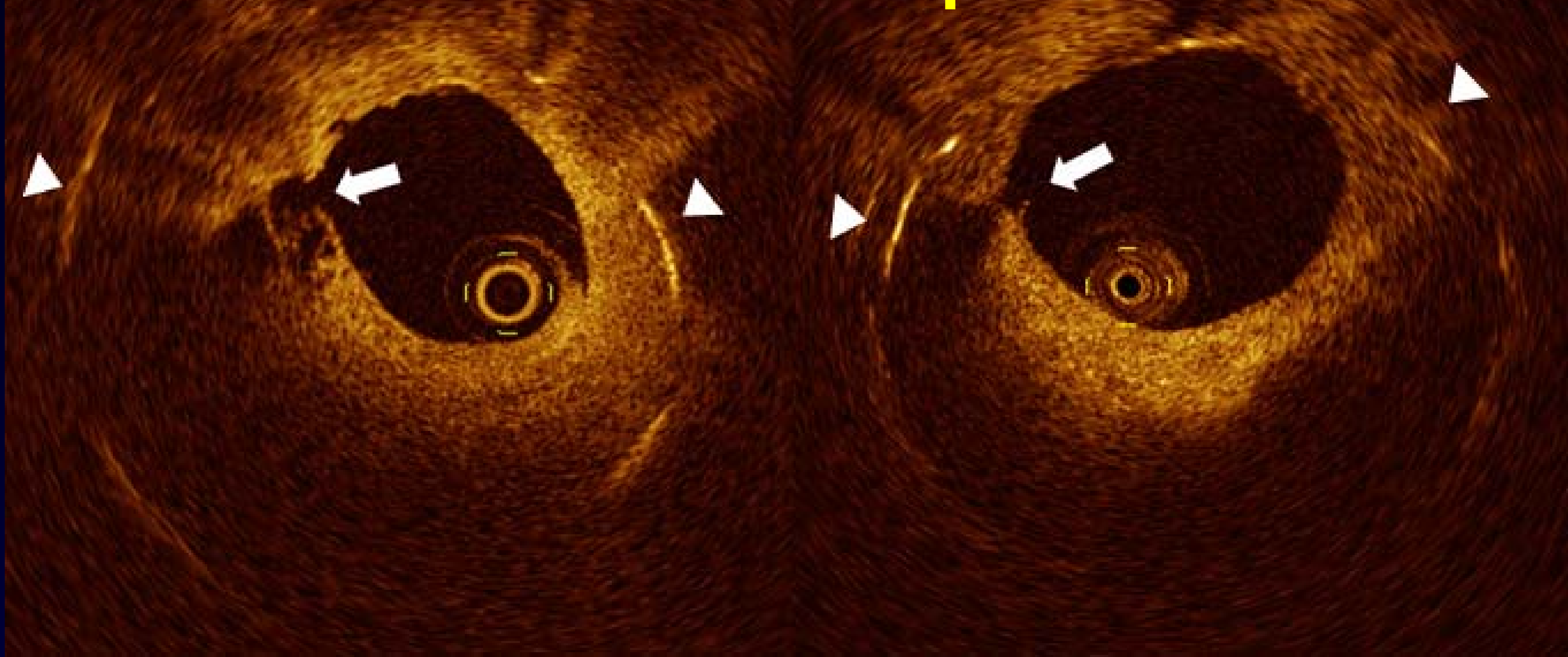
Very Late Stent Thrombosis (VLST) Group

- 18 patients from 4 PCI centers.
  presented with VLST after implantation of DES April 2008~July 2010

Variables	VLST with neointimal rupture (n=4)	VLST without neointimal rupture (n=14)	p
QCA at the index procedure			
Stent length (mm)	28.0±5.0	27.6±5.0	0.945
Reference diameter (mm)	3.0±0.3	3.1±0.7	>0.999
Pre-intervention MLD (mm)	0.6±0.5	0.9±0.4	0.346
Post-intervention MLD (mm)	2.8±0.6	2.9±0.4	0.814
OCT findings			
Uncovered struts	0 (0.0)	9 (64.3)	0.082
Malapposed struts	0 (0.0)	7 (50.0)	0.092
Lipid-laden neointima	4 (100.0)	4 (28.6)	0.023

Ko YG, Hong MK, et al. *Int J Cardiovasc Imaging (in press)*

Neointimal rupture

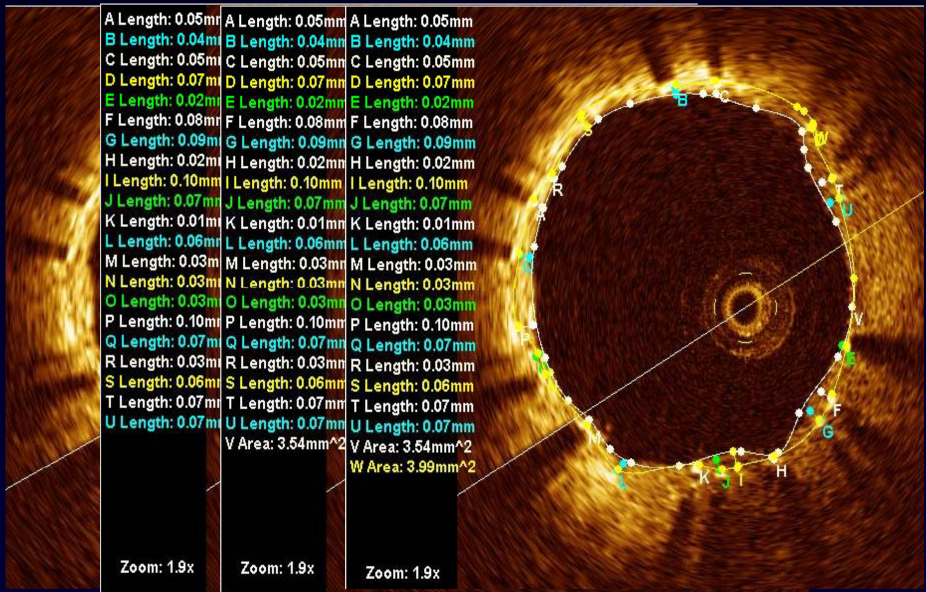


Rupture of lipid-laden neointima did exist inside DES in some patients (28.6%, 4/14) with VLST after DES implantation.

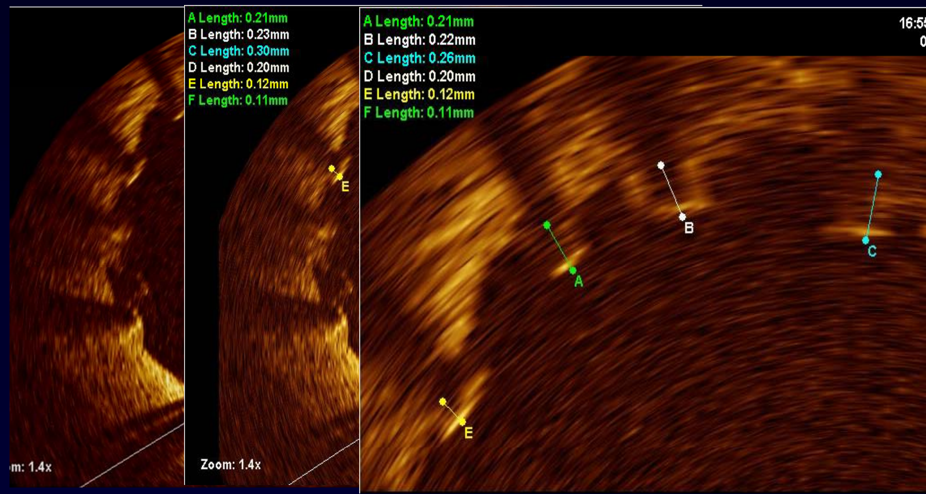
In addition, uncovered and malapposed struts were identified in 9 (50.0%) and 7 (38.9%) of 18 patients with VLST, respectively.

Ko YG, Hong MK, et al. *Int J Cardiovasc Imaging (in press)*

Is the traditional OCT analysis sufficient ?



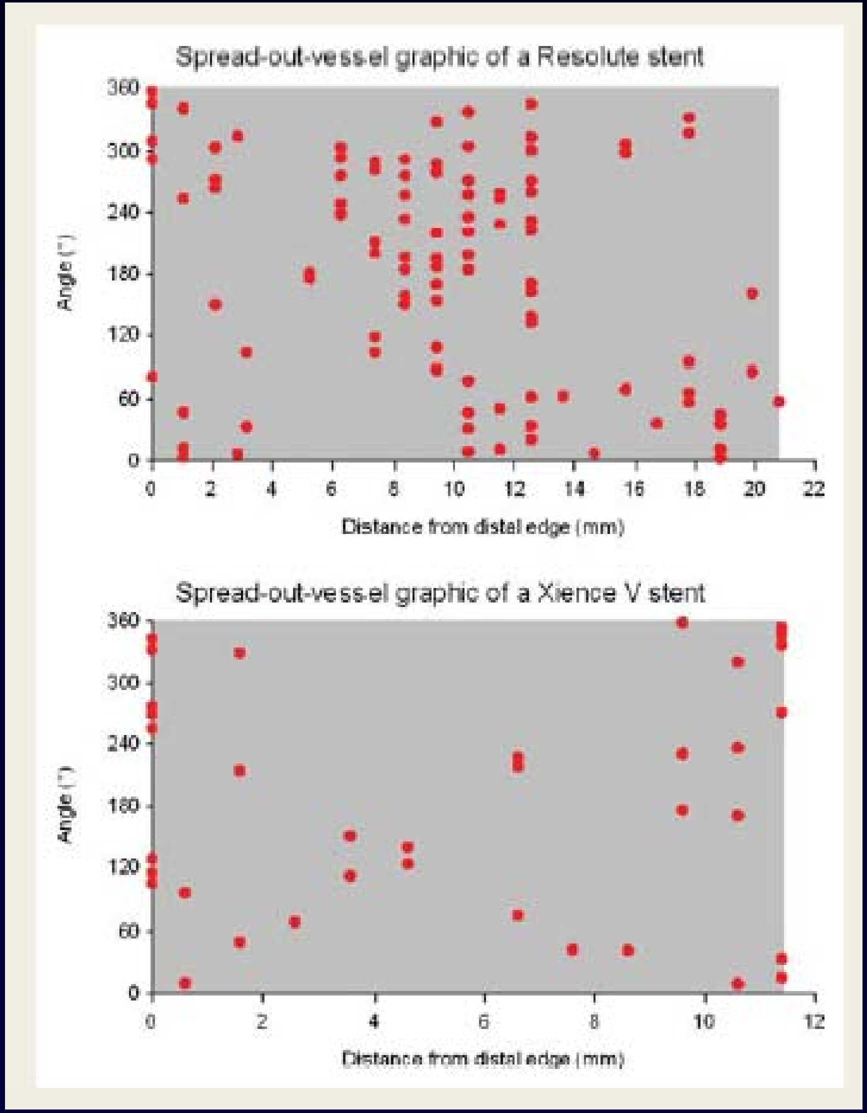
Neointimal thickness



Stent apposition

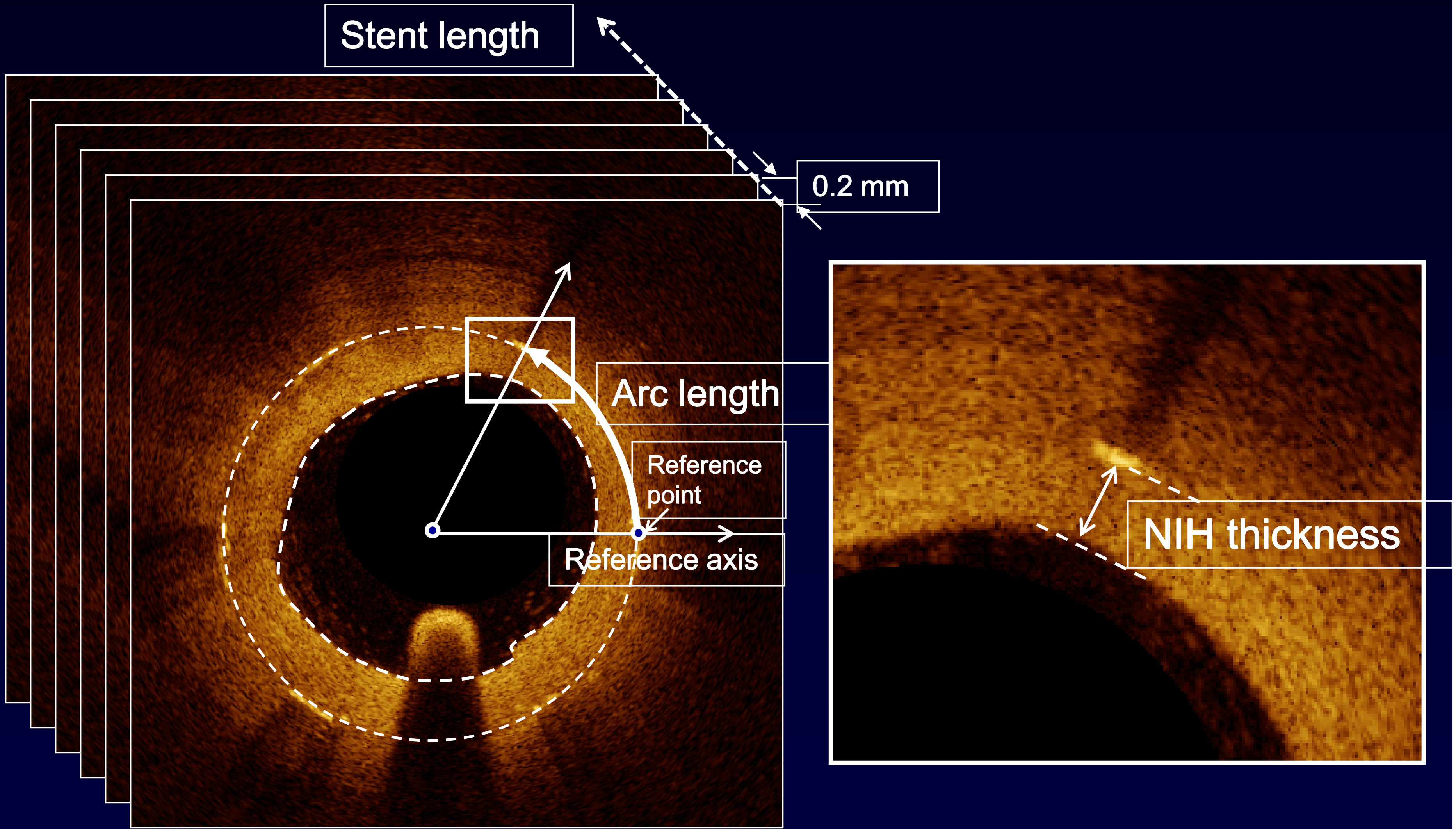
What are the spatial distributions of uncovered or malapposed struts ?

Spread-out-vessel graphic



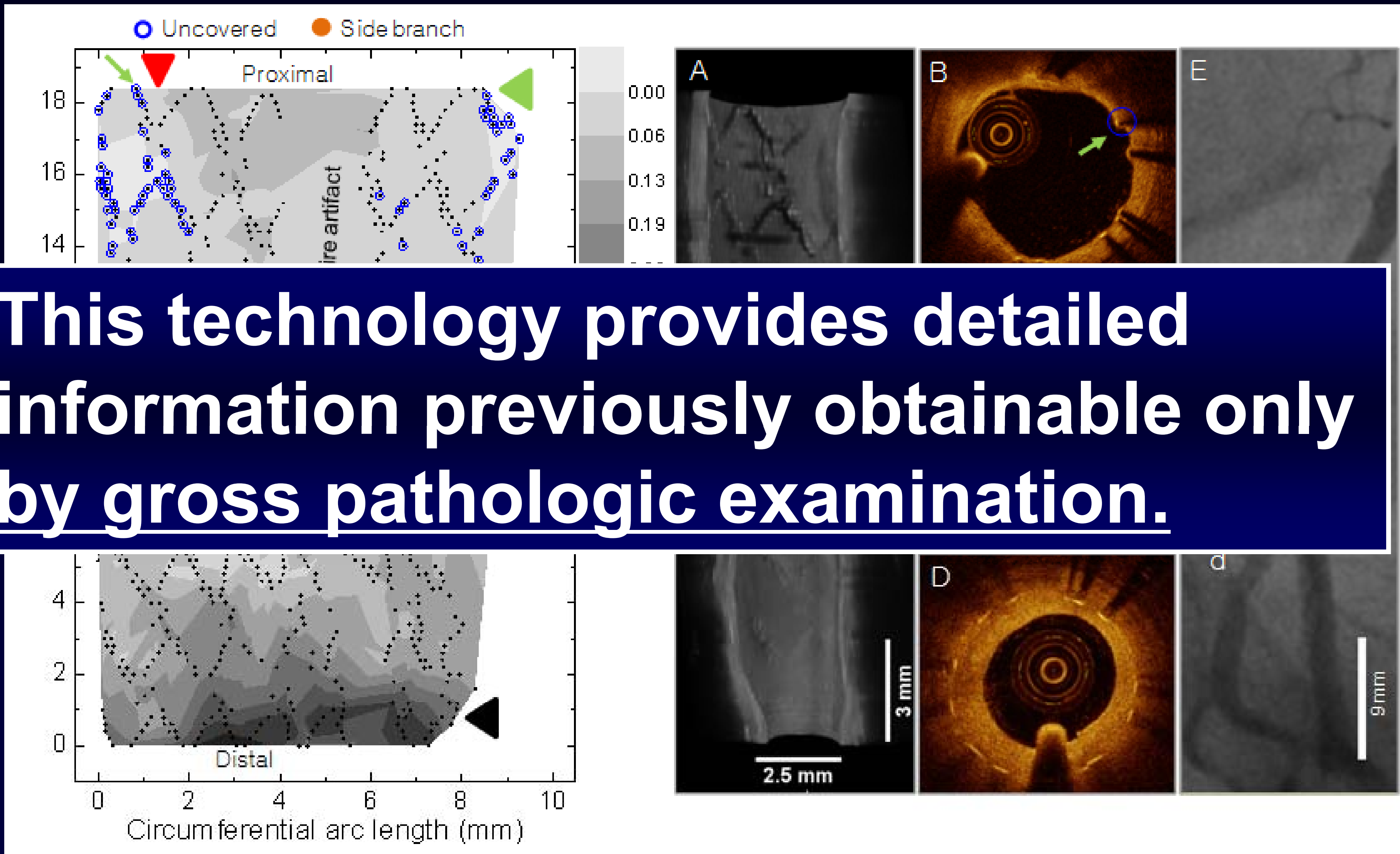
Gutie´rrez-Chico JL et al, *Eur Heart J* 2011; 32: 2454-2463

Creation of contour map



Data (x, y, z) = Data (arc length, stent length, NIH thickness)

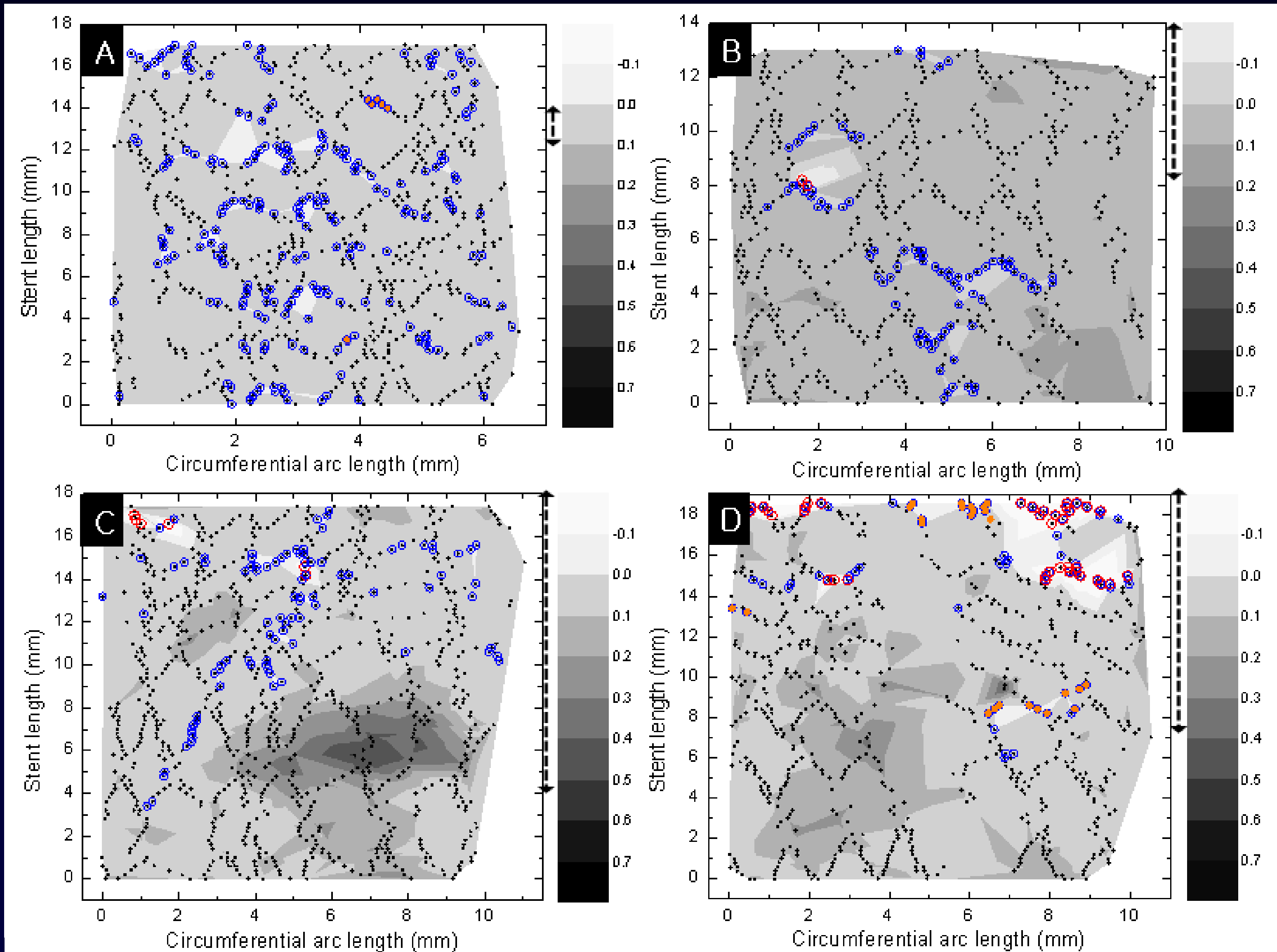
Creation of contour map



This technology provides detailed information previously obtainable only by gross pathologic examination.

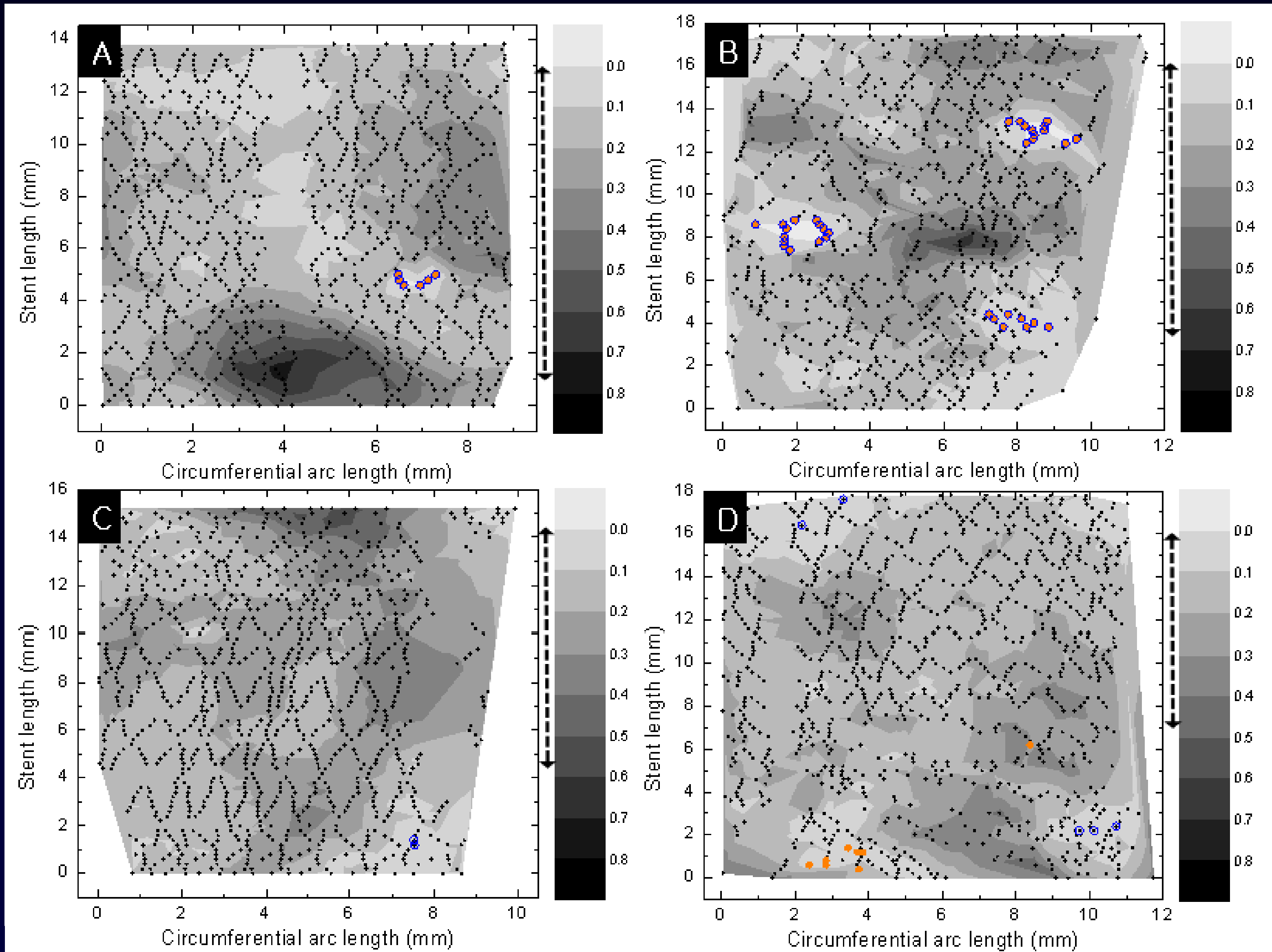
HA J, Kim BK, Hong MK, et al. *J Am Coll Cardiol Img* (in press) **SES**

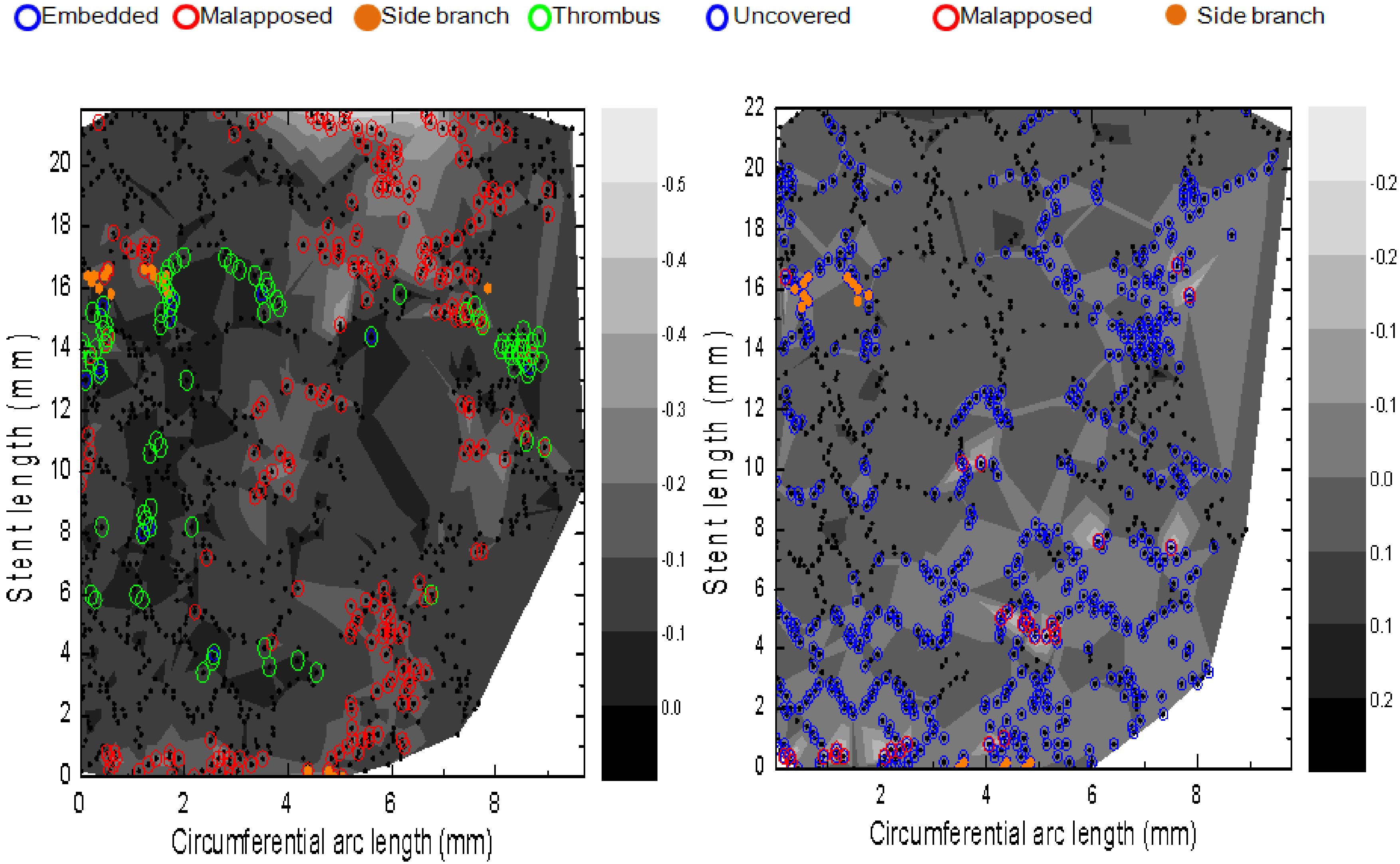
Contour map of SES at follow-up OCT



HA J, Kim BK, Hong MK, et al. *J Am Coll Cardiol Img* (in press)

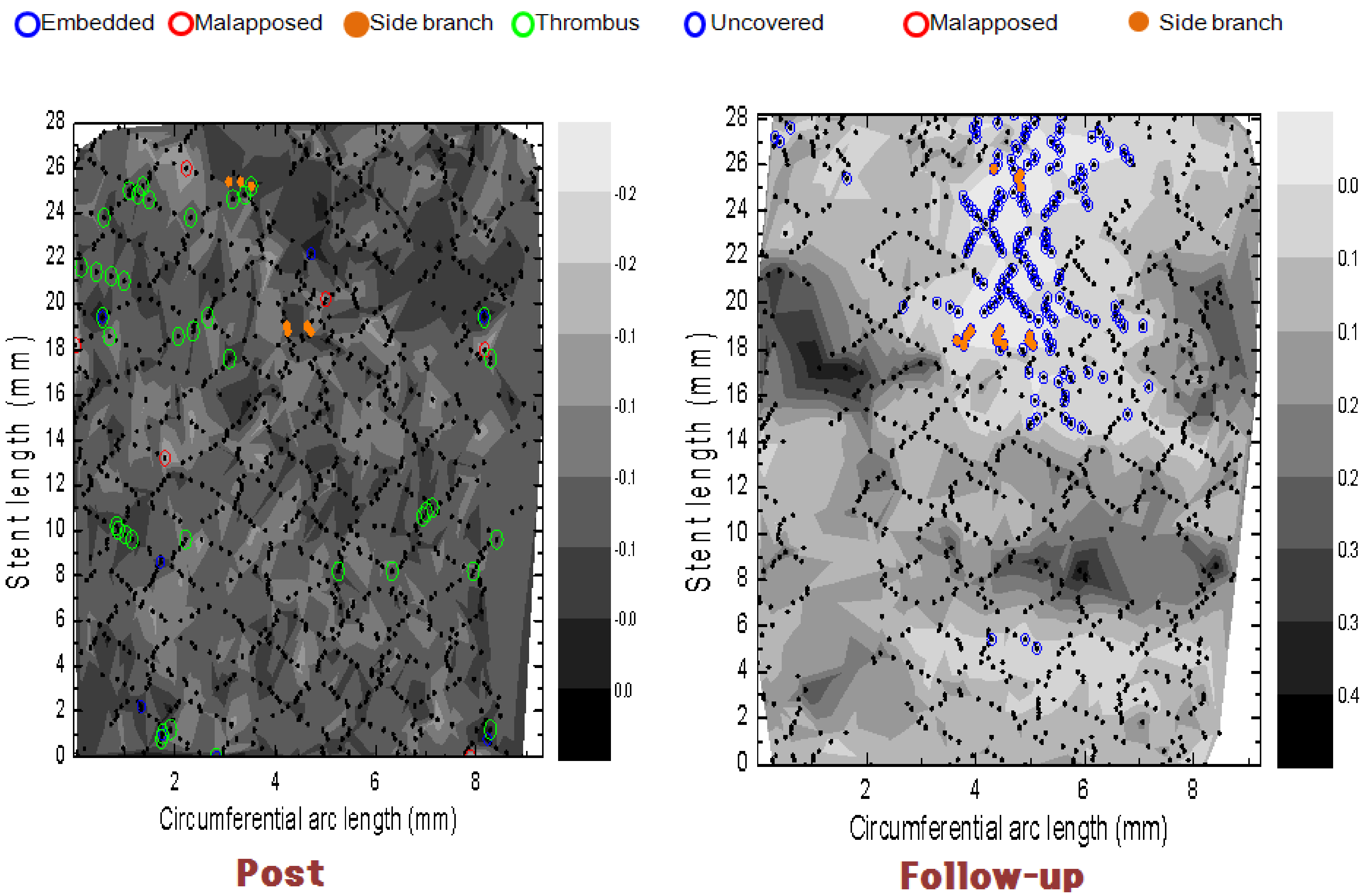
Contour map of ZES at follow-up OCT



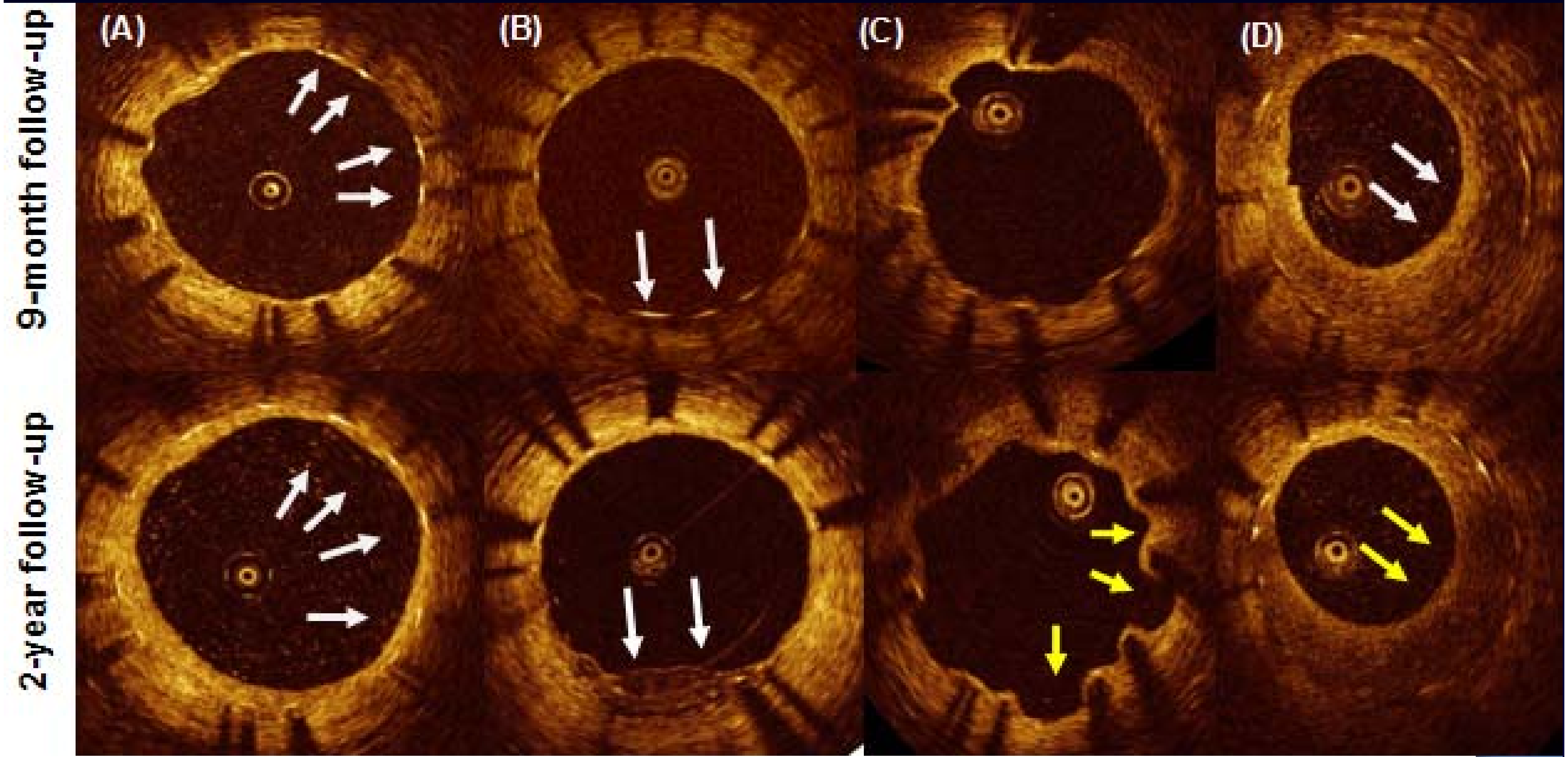


Post

Follow-up


Embedded
Malapposed
Side branch
Thrombus
Uncovered
Malapposed
Side branch
Stent length (mm)
Circumferential arc length (mm)
Post
Follow-up

Serial OCT (72 patients, 76 DES treated lesions)



Kim JS, Hong MK, et al. *J Am Coll Cardiol Img* (in press)

Serial OCT (72 patients, 76 DES treated lesions)

Quantitative OCT analysis

Cross-section (CS) level analysis	9-month	2-year	p
Total cross sections	1947	1947	
Mean stent CSA (mm^2)	7.0 ± 1.6	7.0 ± 1.6	0.92
Mean lumen CSA (mm^2)	5.7 ± 1.4	5.4 ± 1.6	0.01
Mean NIH area (mm^2)	1.3 ± 0.9	1.7 ± 1.1	0.001
Percent NIH CSA (%)	18.7 ± 11.3	23.4 ± 14.5	<0.001
CSs with any uncovered strut	418 (21.5%)	244 (12.5%)	<0.001
CSs with uncovered strut ratio > 0.3	153 (7.9%)	91 (4.7%)	<0.001
CSs with any malapposed strut	50 (2.6%)	70 (3.6%)	0.36

Kim JS, Hong MK, et al. *J Am Coll Cardiol Img* (in press)

Conclusions

After introduction of a frequency-domain OCT system (C7-XR) with faster pullback speeds (20 mm/s) in clinical practice, OCT examination could be a more useful and comfortable tools to evaluate the status of uncovered stent struts and stent malapposition.

Clinical data to evaluate the impacts of uncovered or malapposed DES struts detected by OCT on long-term clinical outcomes will be available in near future.