OCT: Pre- & Post-intervention

Takashi Akasaka, MD, PhD, FESC
Department of Cardiovascular Medicine
Wakayama Medical University, Japan

TCTAP 2014

Wakayama Medical University

Disclosure Statement of Financial Interest

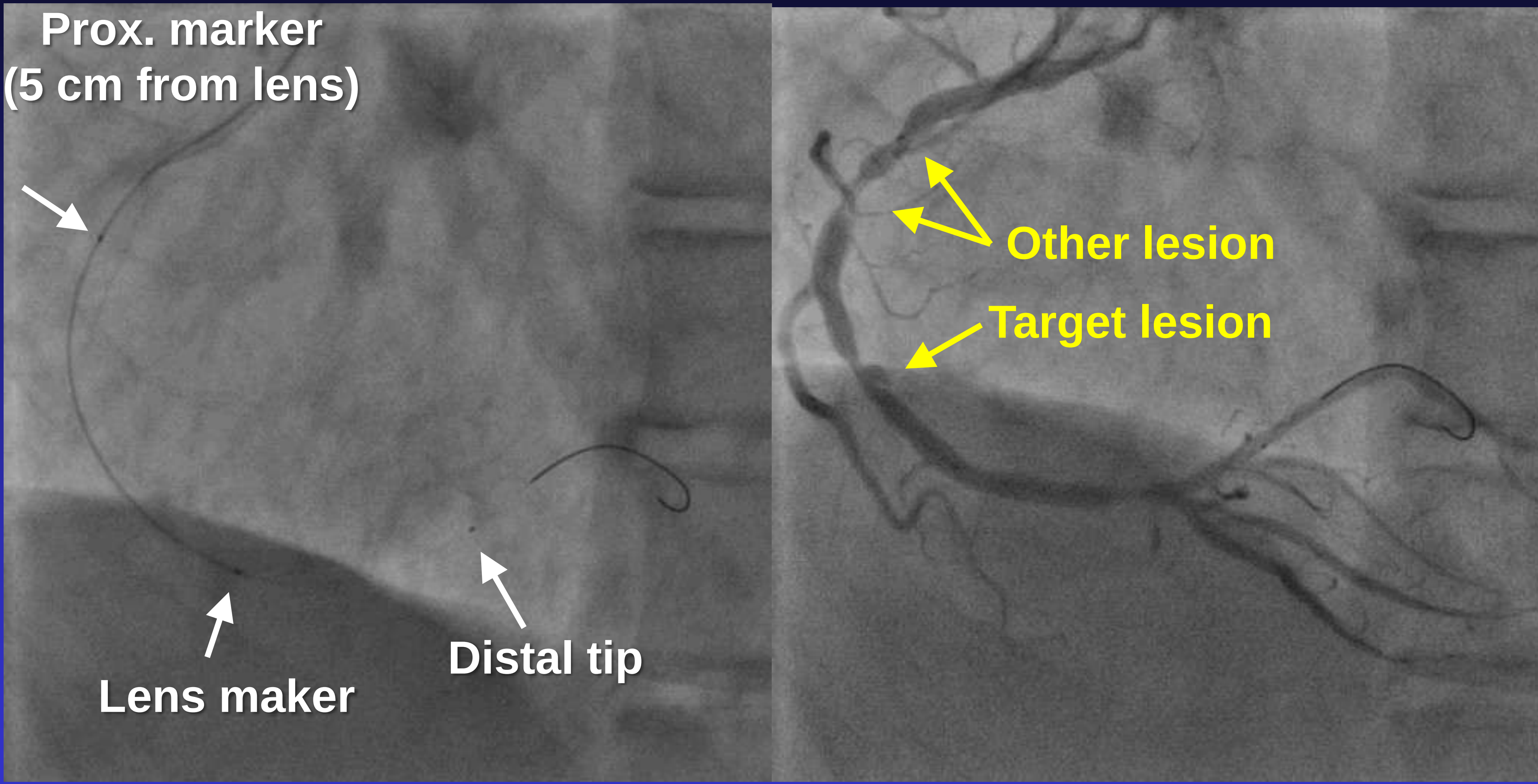
Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

Affiliation/Financial Relationship

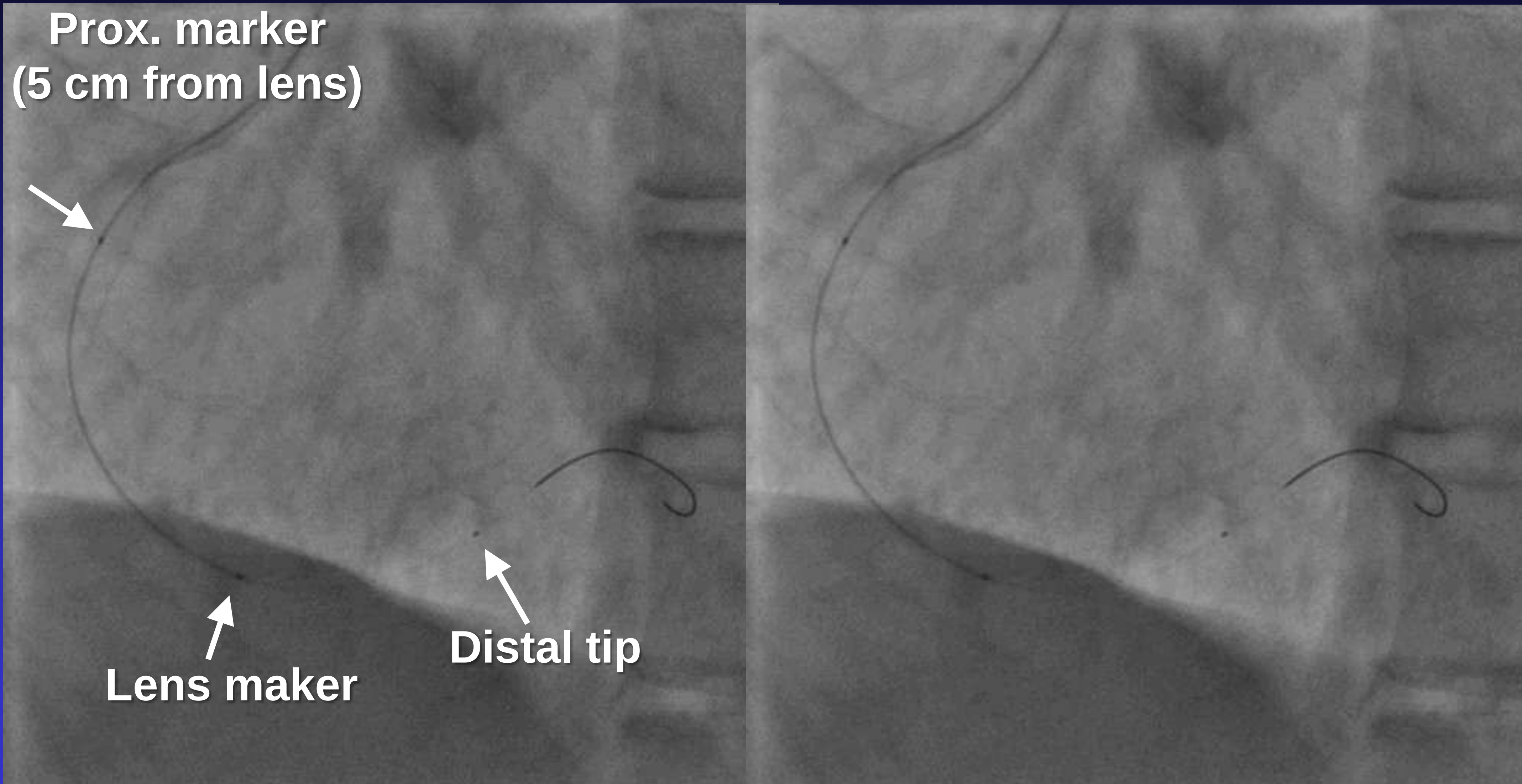
- **Grant/Research Support** : Abbott Vascular Japan
  Boston Scientific Japan
  Goodman Inc.
  Sent Jude Medical Japan
  Terumo Inc.

- **Consulting Fees/Honoraria** : Astellas Pharmaceutical Inc.
  Daiichi-Sankyo Pharmaceutical Inc.
  Goodman Inc.
  Sent Jude Medical Japan
  Terumo Inc.

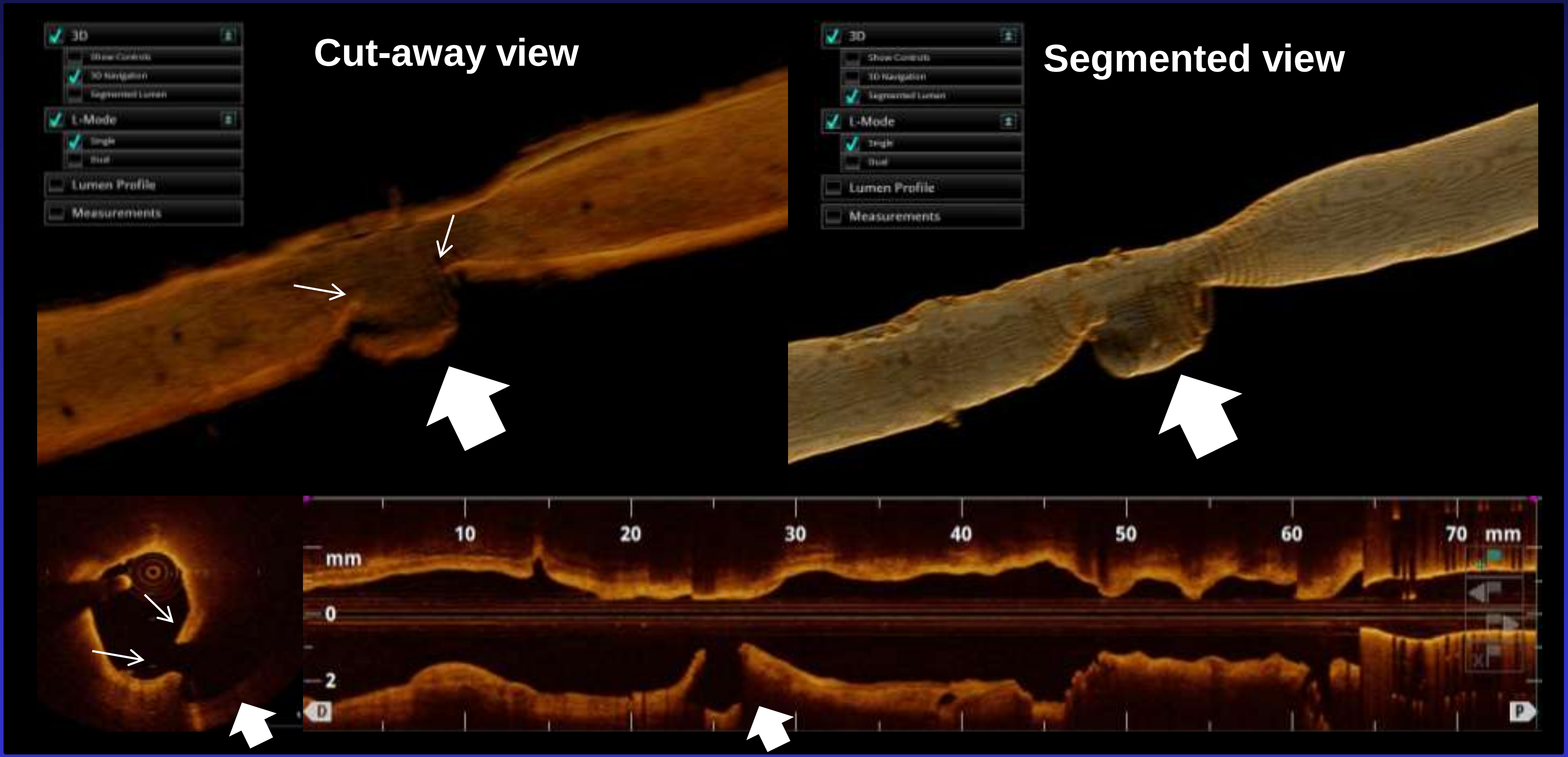
Positioning of OCT Catheter



Positioning of OCT Catheter



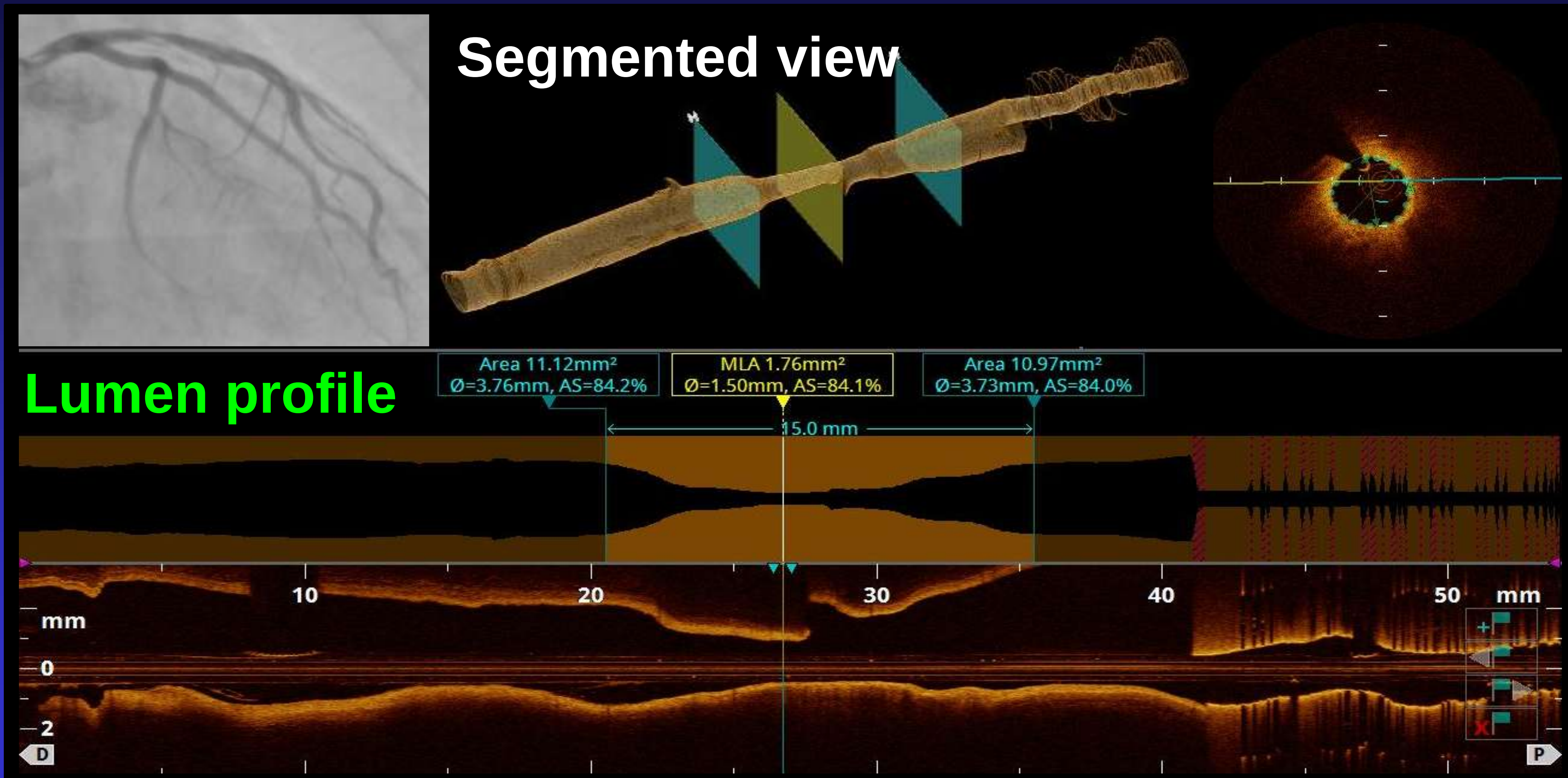
Advantages of Newly developed FD-OCT system (ILUMIEN OPTIS ®)



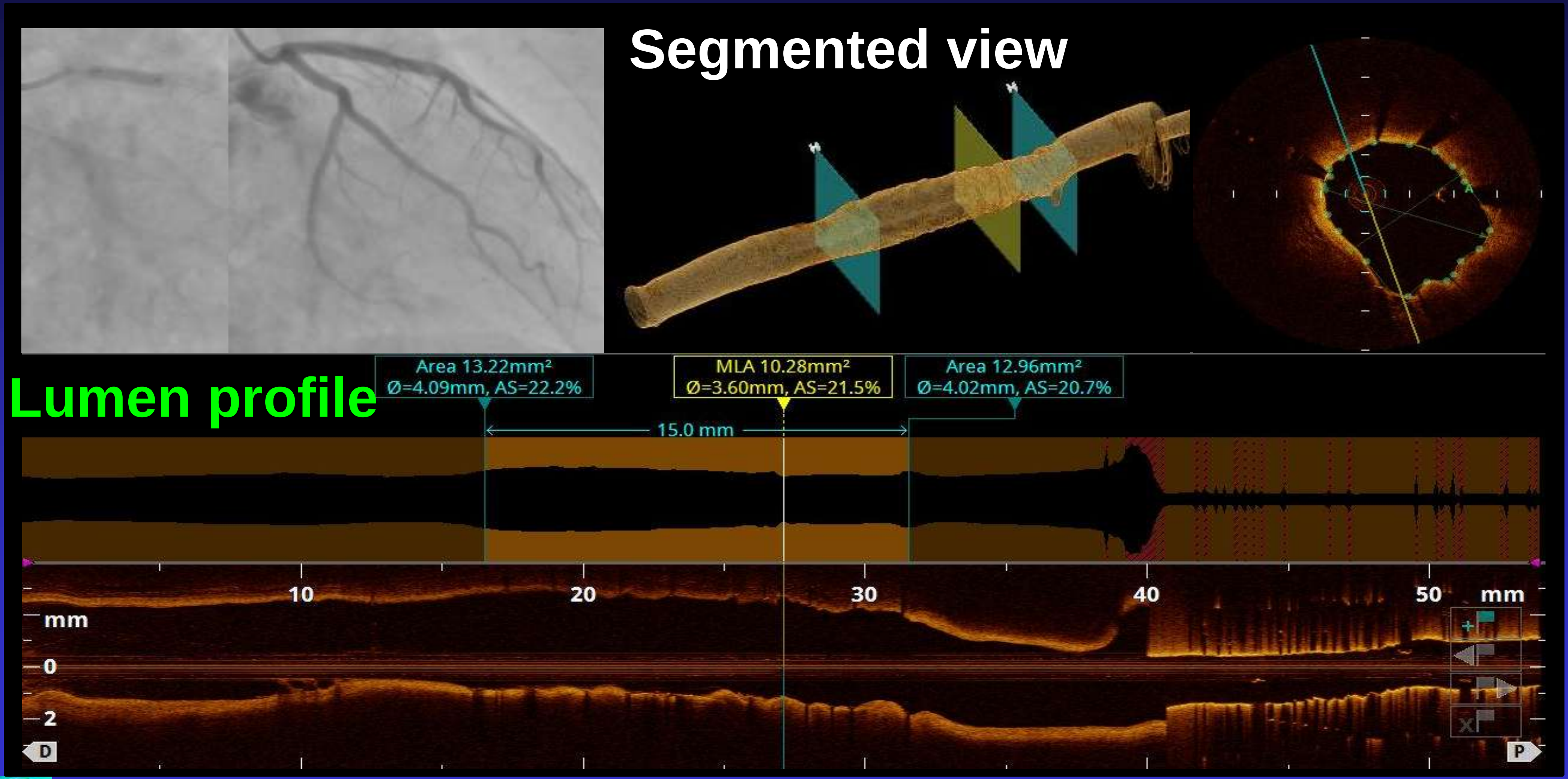
Kubo, Akasaka et al. RC 2013

Wakayama Medical University

Pre-PCI assessment, #6 90%, (MultiLink 4.0×15mm)

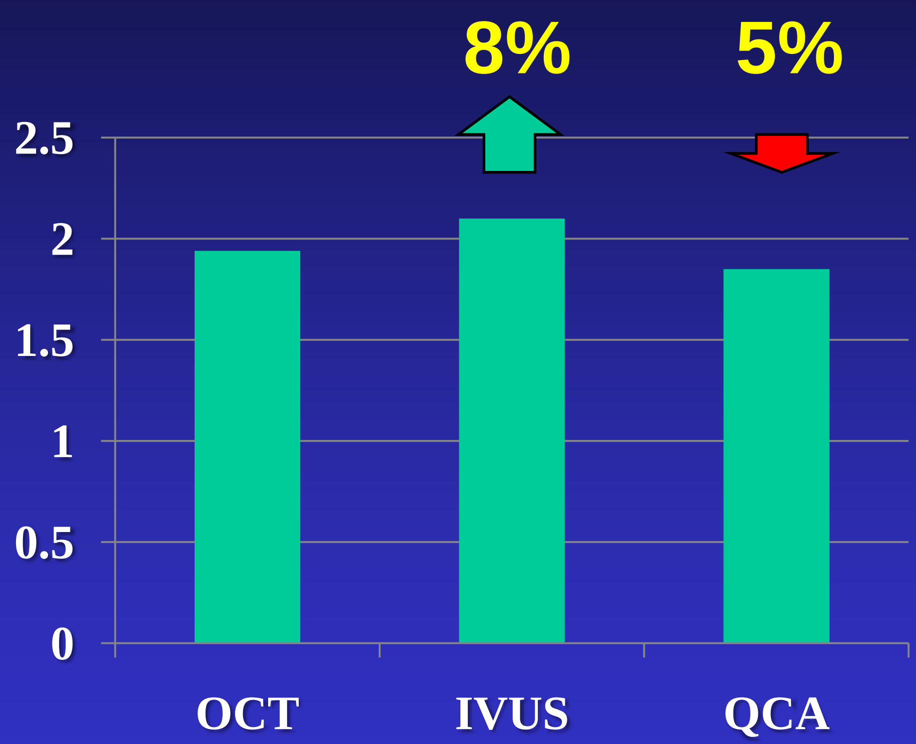


Post-PCI assessment, #6 90%, (MultiLink 4.0×15mm)



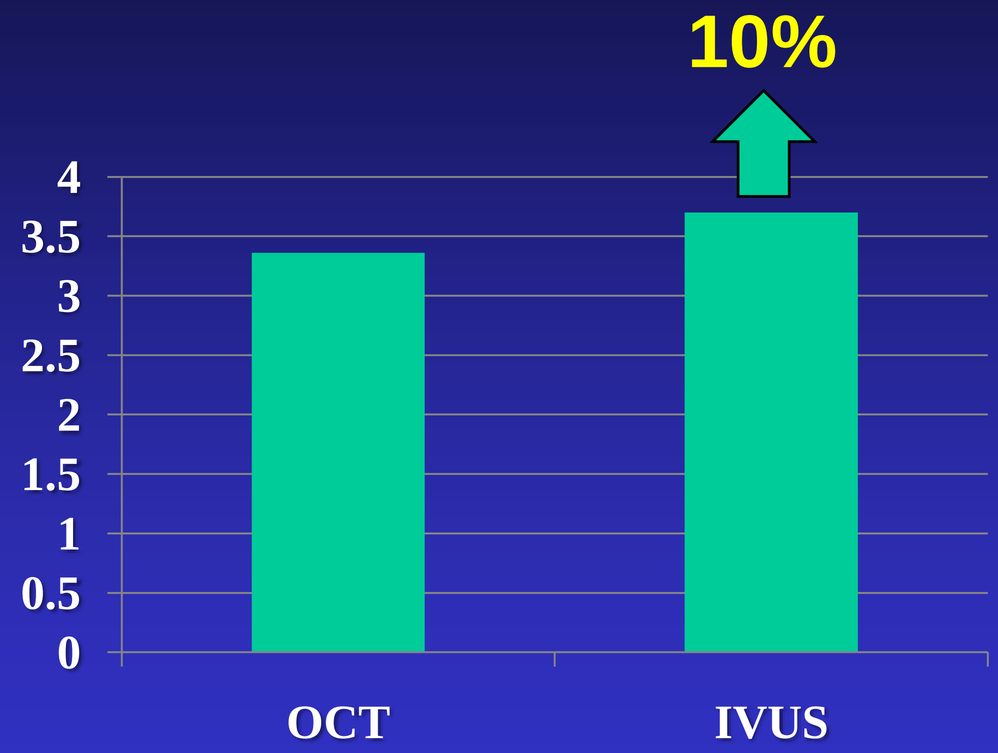
Comparison of measurements among OCT, IVUS & QCA
(OPUS-CLASS study)

MLD



1.94± 0.70 mm | 2.10± 0.59 mm | 1.85± 0.77mm

MLA



3.36±2.28mm² | 3.70±2.04mm²

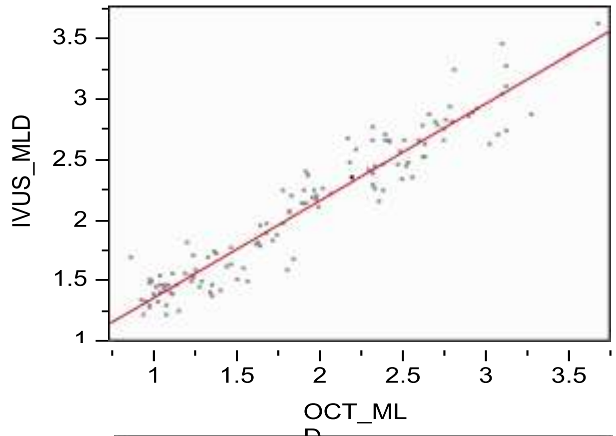
Kubo T, Akasaka T, et al. JACC Cardiovasc Img. 2013;6:1095-1104

Wakayama Medical University

MLD & MLA

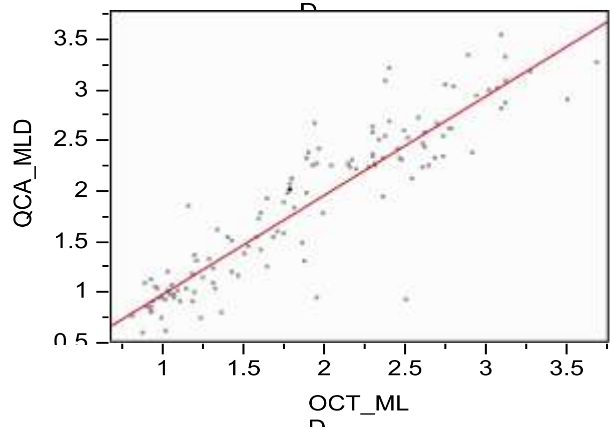
IVUS vs. OCT

R^2=0.92, P<0.001



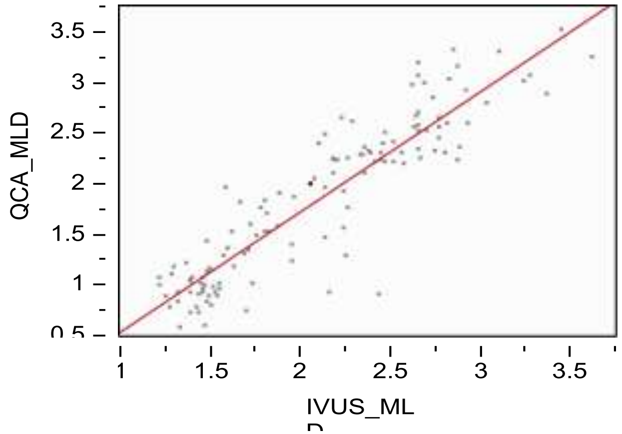
QCA vs. OCT

R^2=0.83, P<0.001



QCA vs. IVUS

R^2=0.82, P<0.001



OCT =2.11±0.82mm

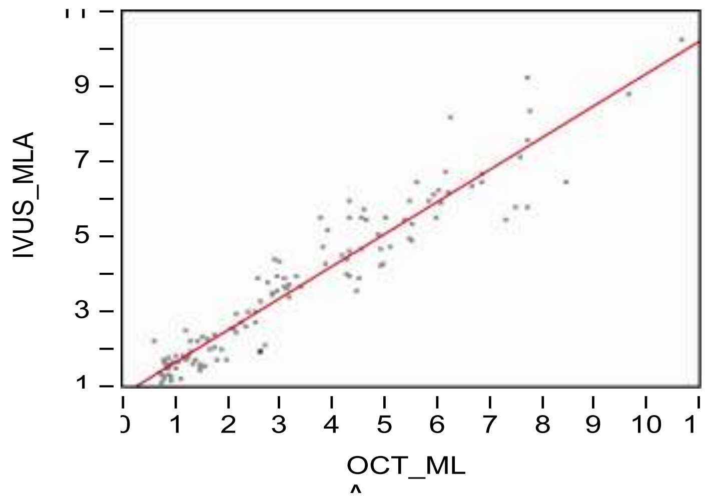
IVUS=2.27±0.61mm

QCA =2.03±0.71mm

Kubo T, et al,
JACC Cardiovasc Img. 2013;6:1095-1104

IVUS vs. OCT

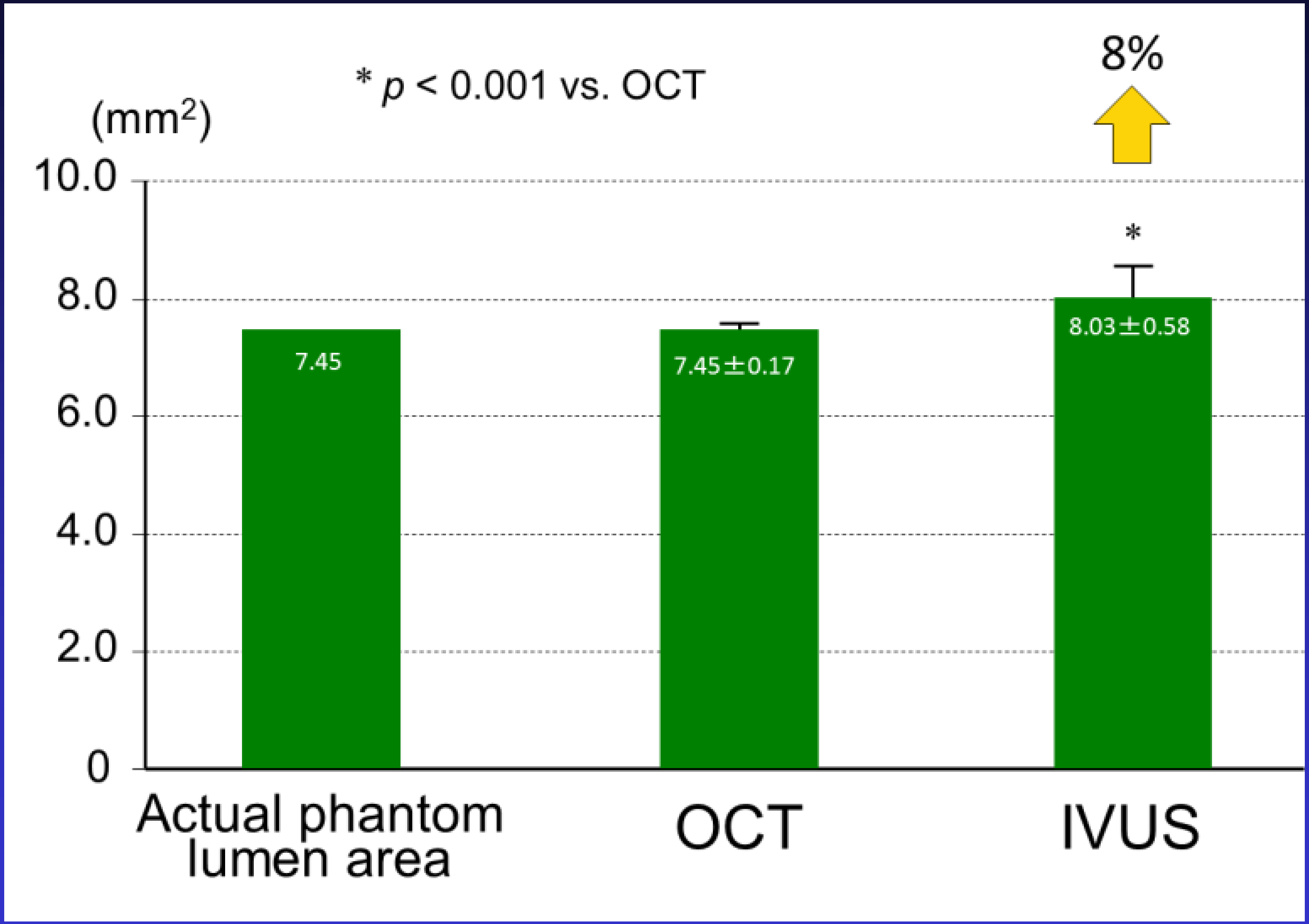
R^2=0.91, P<0.001
y= 0.83 + 0.85x



OCT=3.36±2.28mm²

IVUS=3.70±2.04mm²

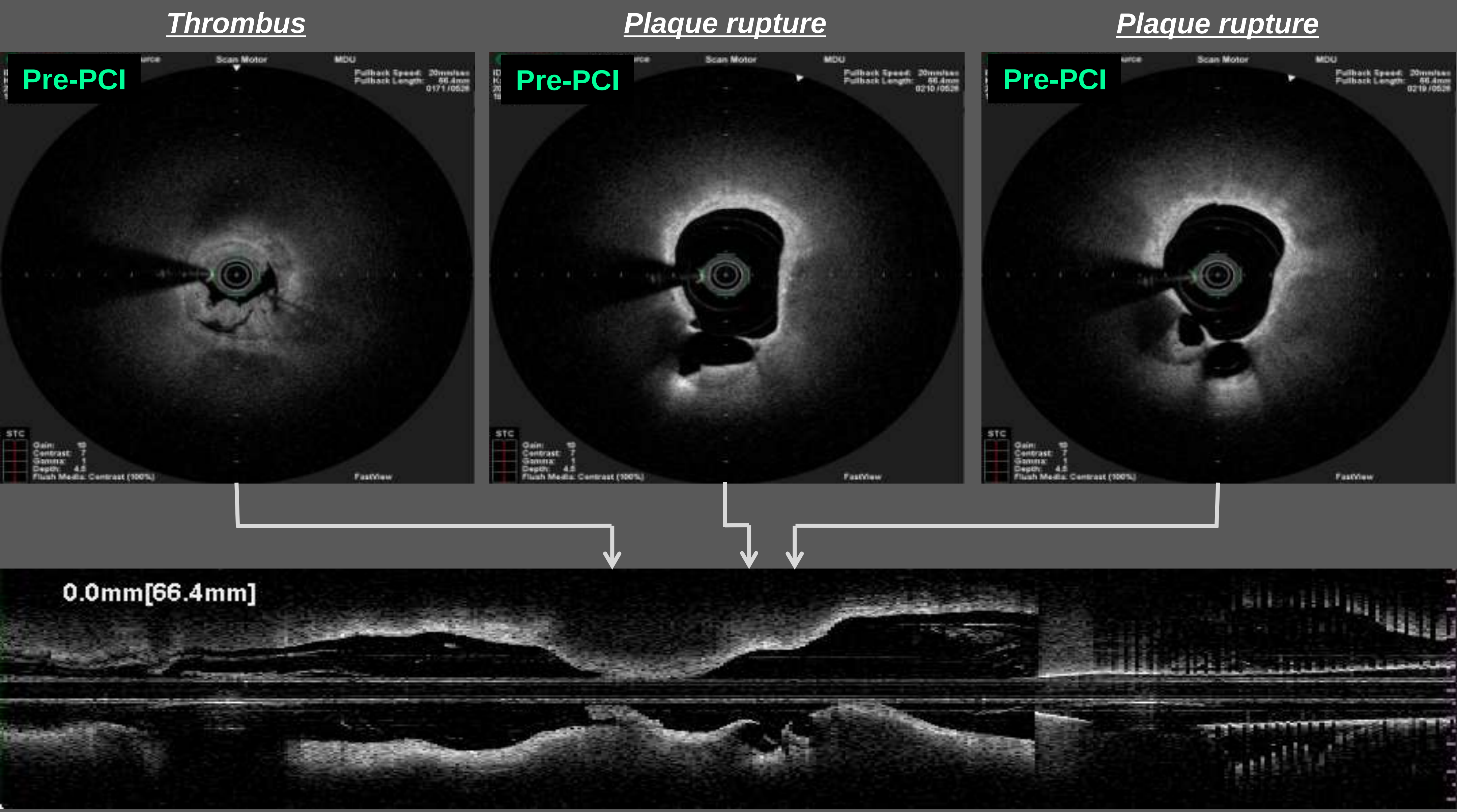
Accuracy of the measurement: MLA



Kubo T, Akasaka T, et al, JACC Cardiovasc Img. 2013;6:1095-1104

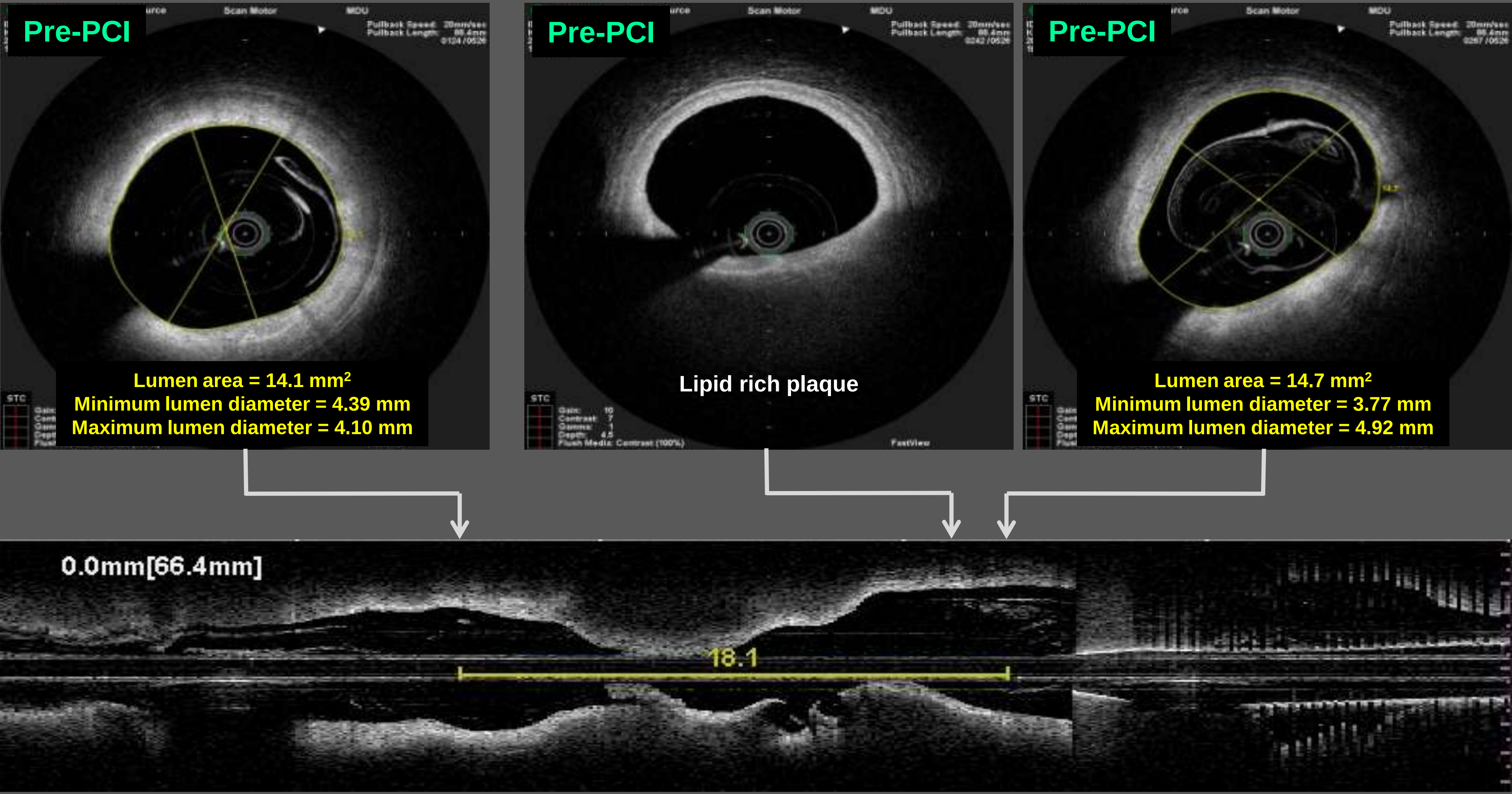
Pre-PCI FD-OCT

OFDI at culprit site

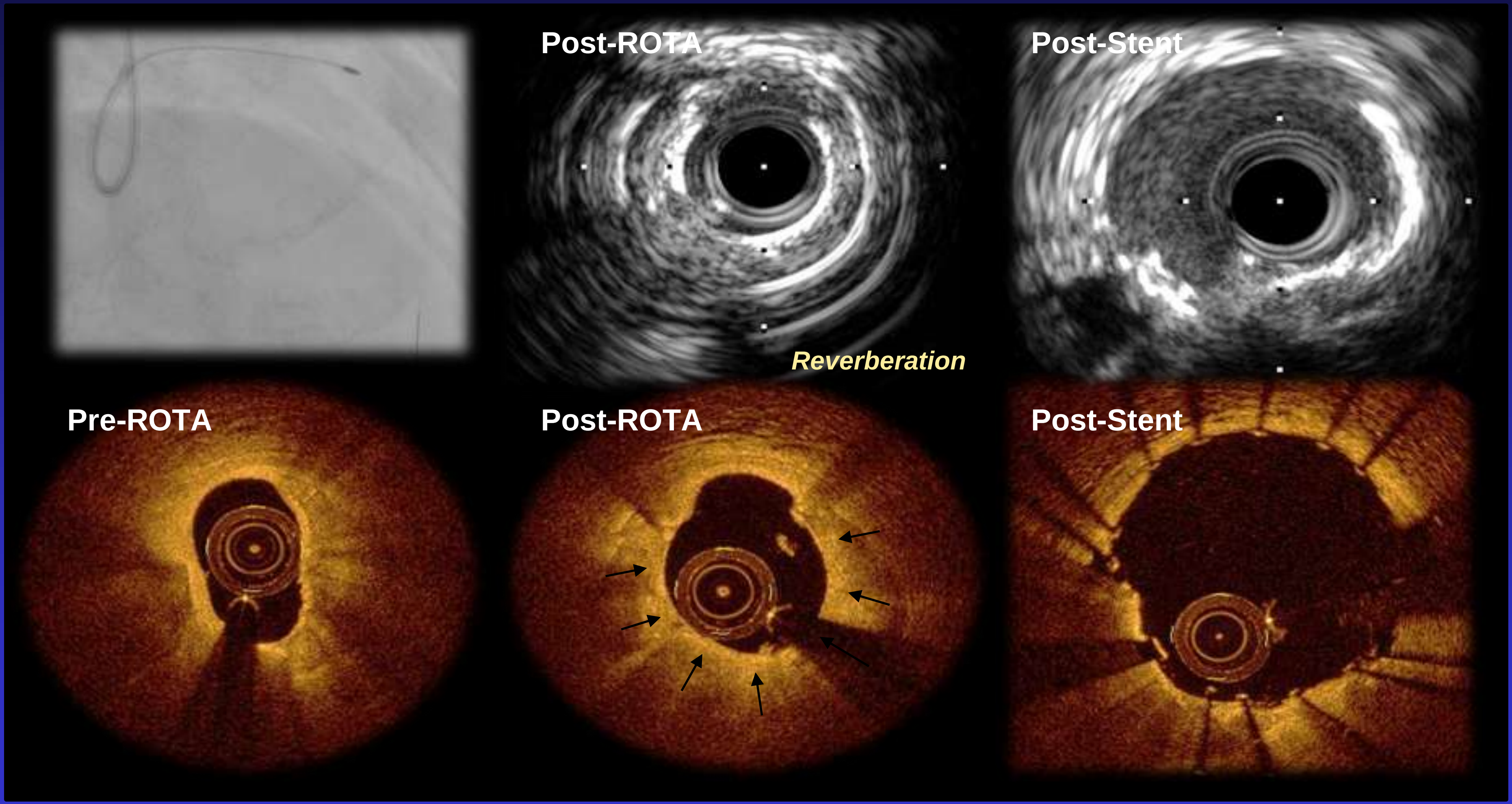


OFDI at reference site (How to select landing zone)

Distal reference ***Proximal reference***



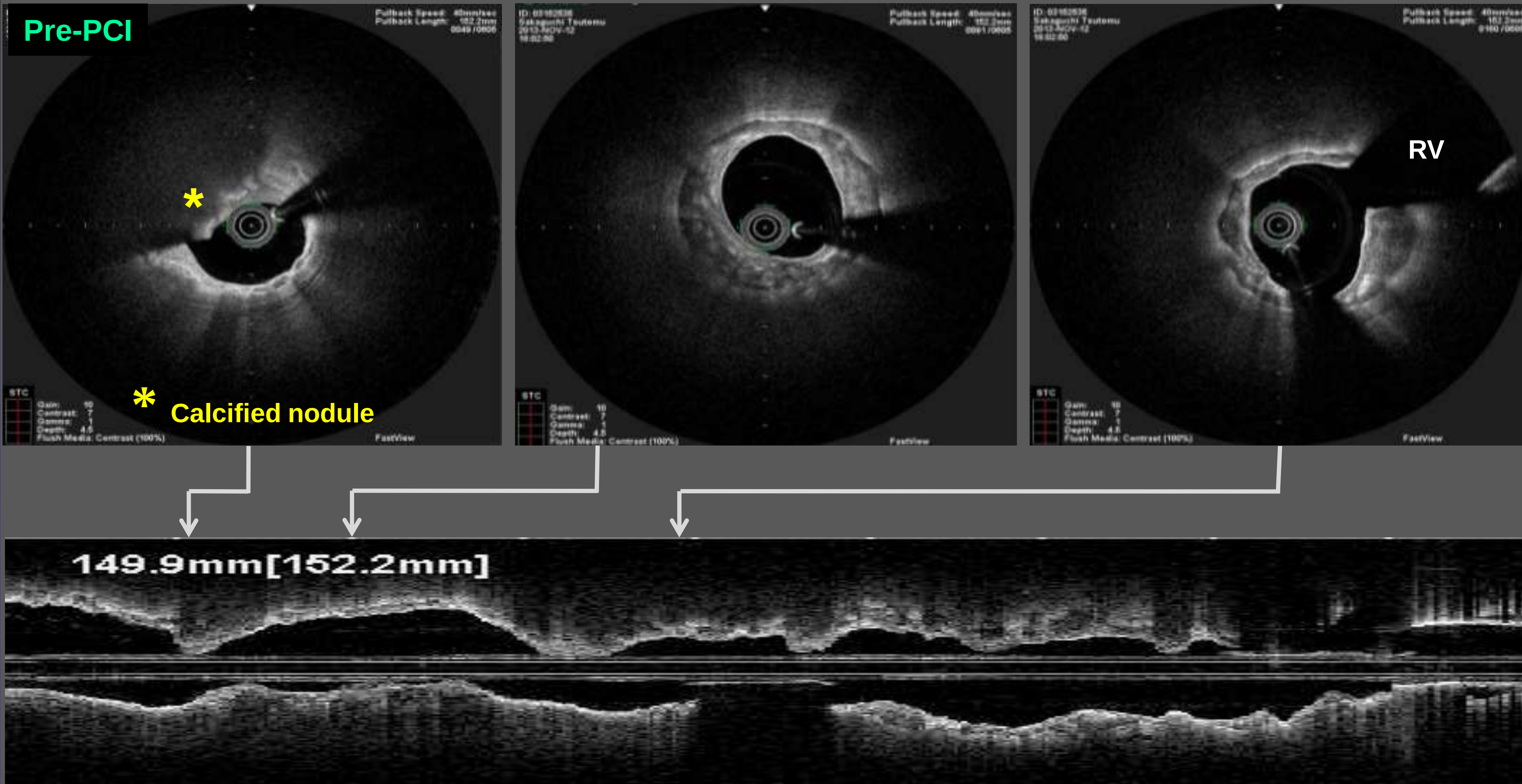
Rotational atherectomy



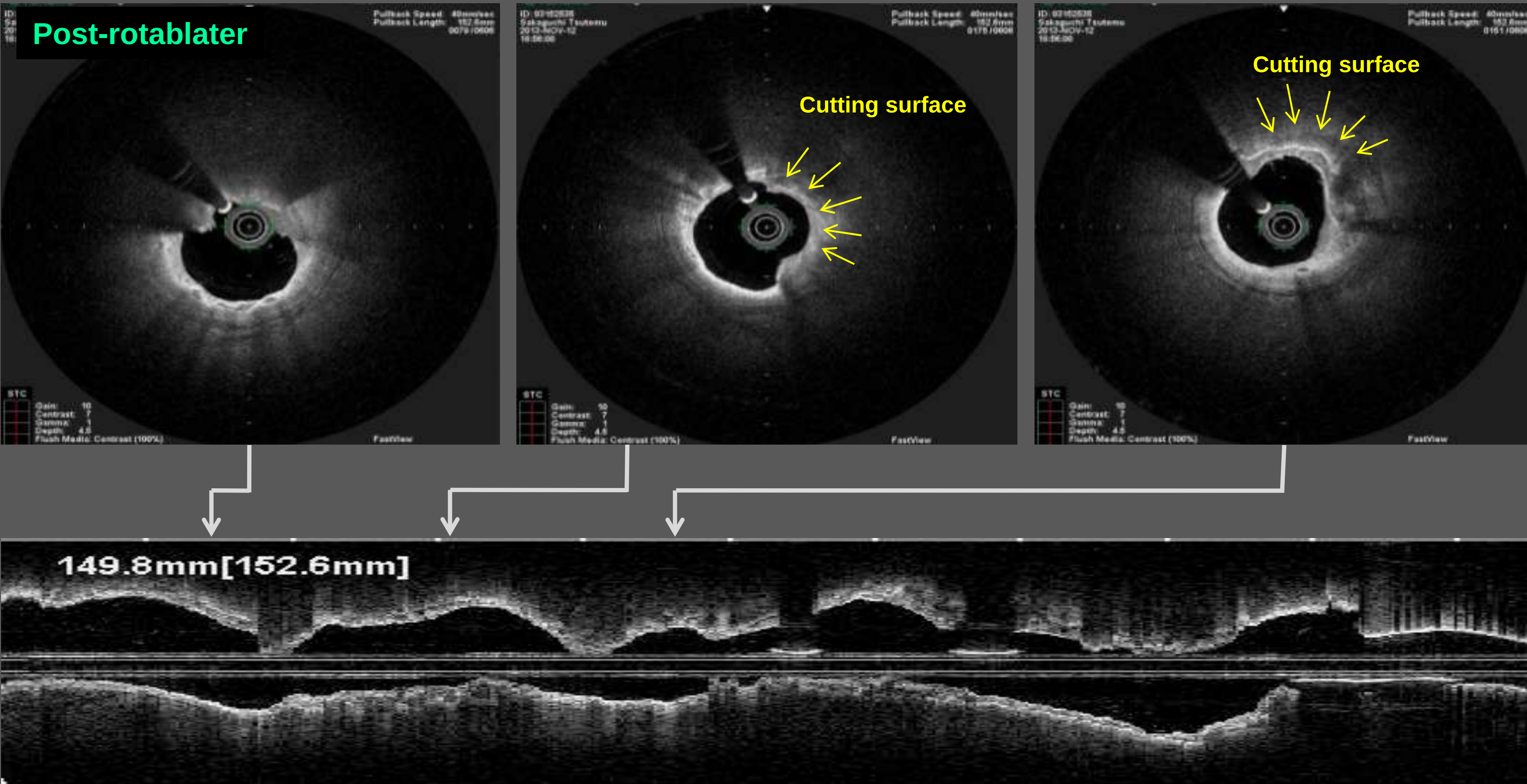
Markedly calcified lesion

Pre-PCI FD-OCT (Markedly calcified lesion)

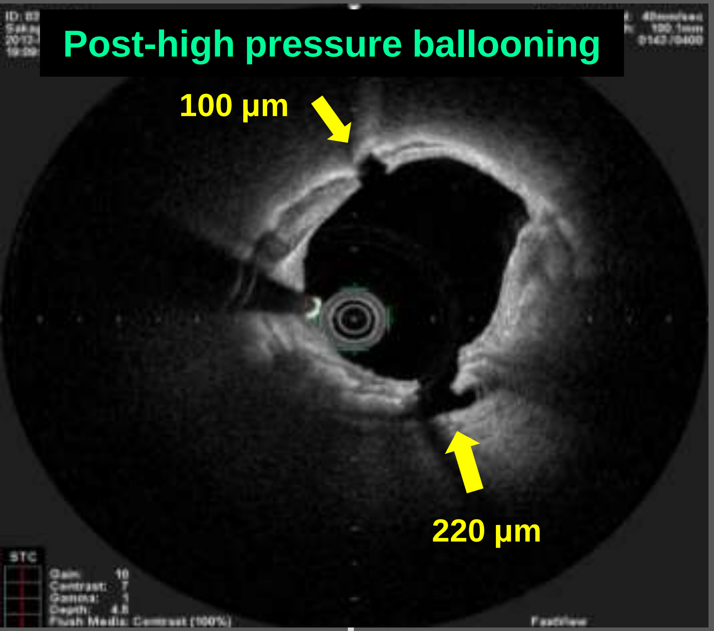
Minimum lumen area site — *Severe calcification* — *Severe calcification*



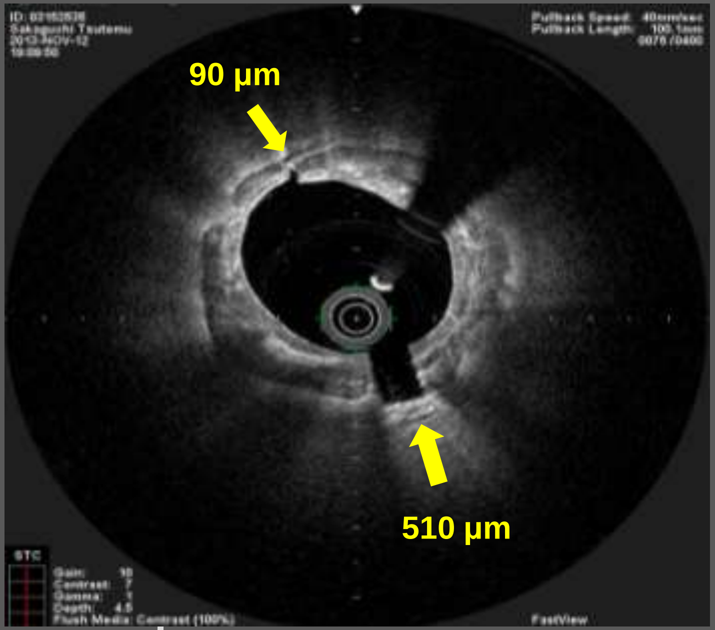
Minimum lumen area site ***Calcification*** ***Calcification***



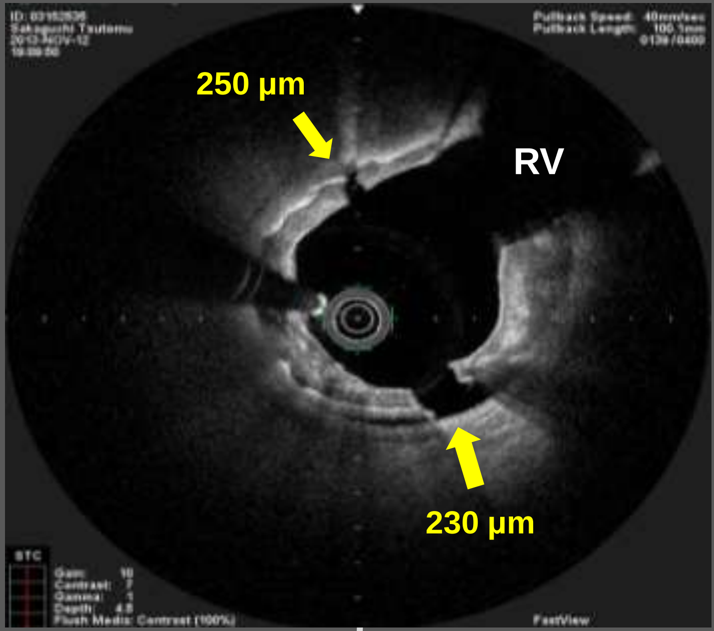
Broken calcium plate



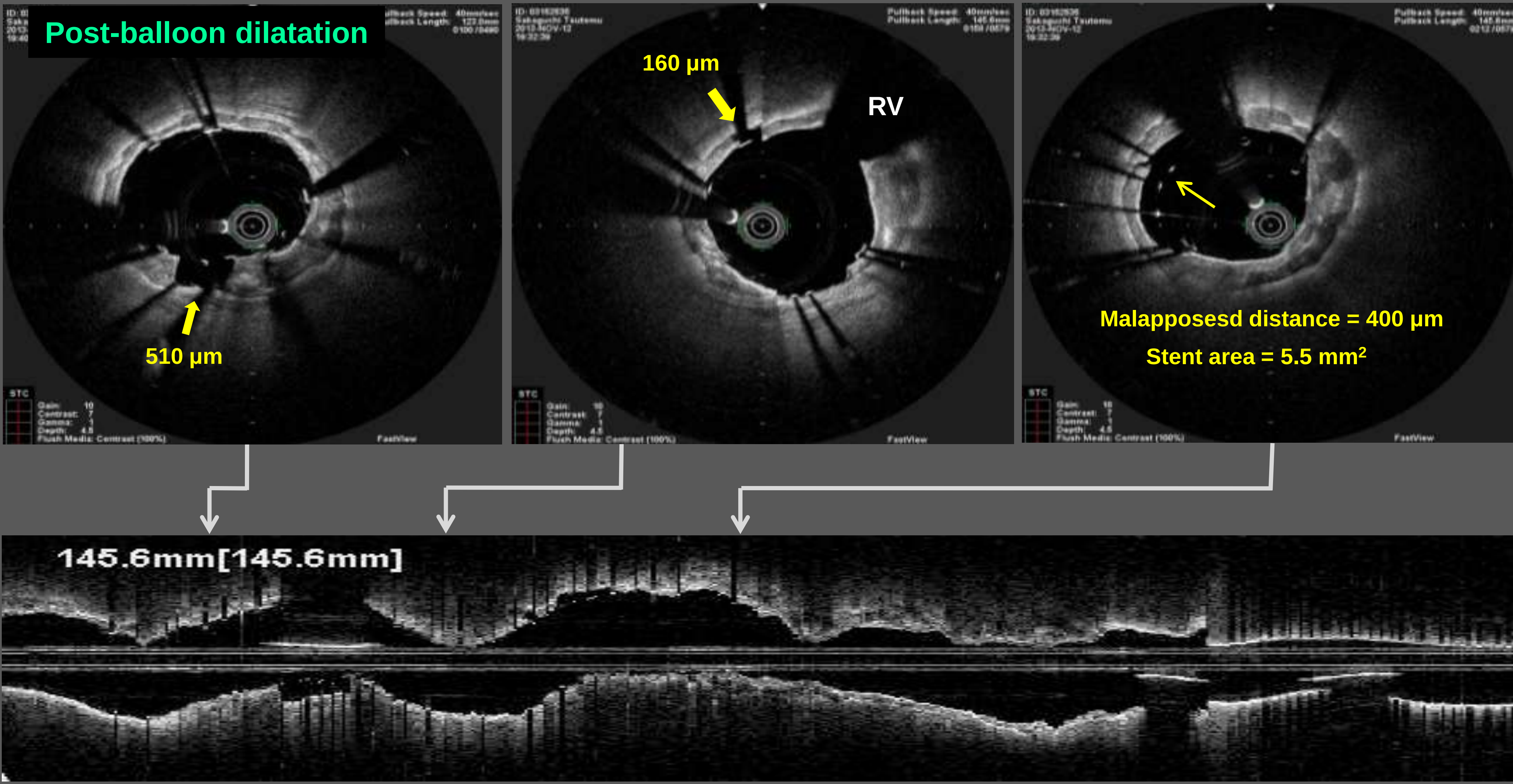
Broken calcium plate



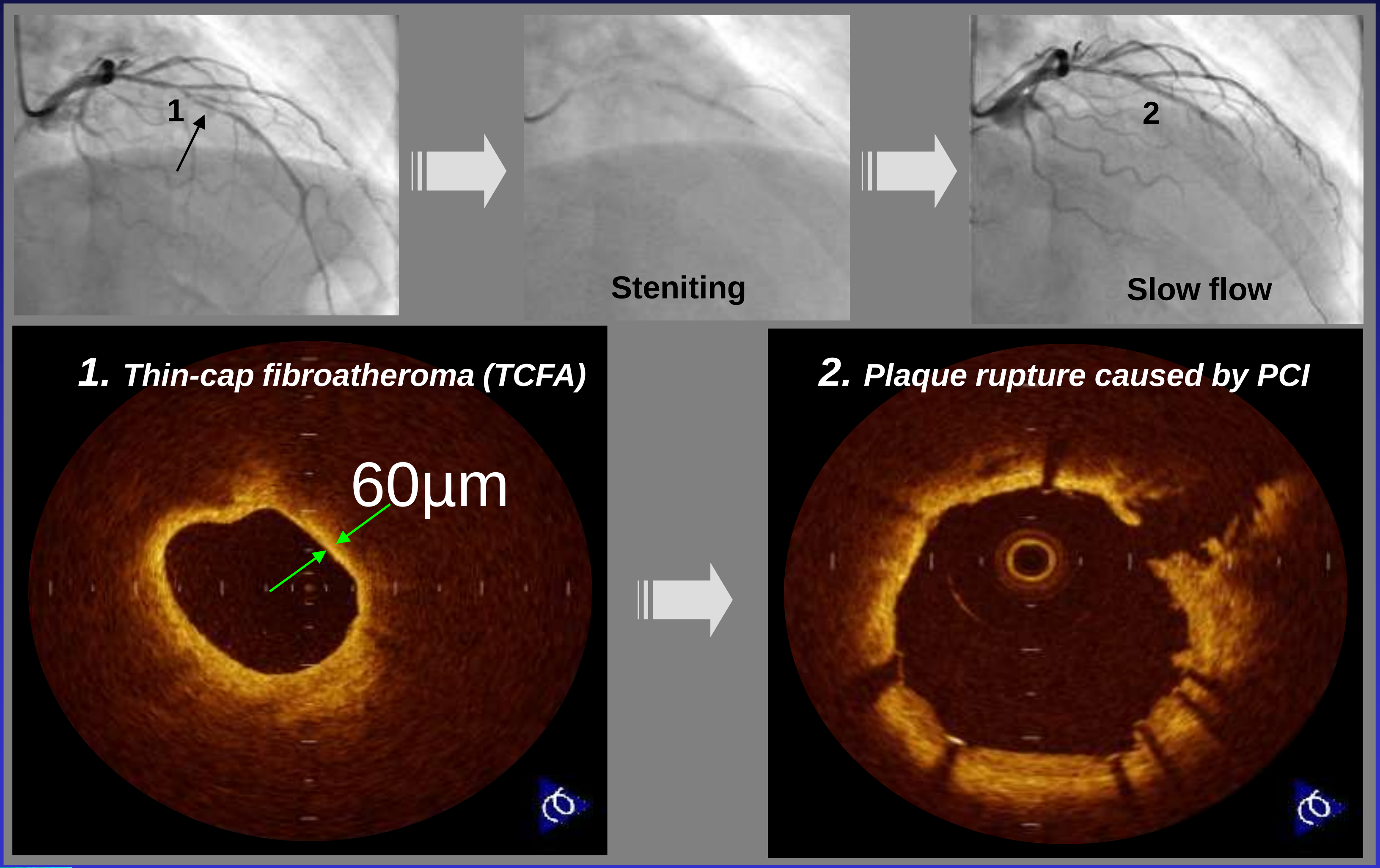
Broken calcium plate



Broken calcium plate | **Broken calcium plate** | **Stent malappsoition**



Prediction of angiographic slow flow



A 73-year-old male underwent PCI for the treatment of mid-LAD lesion (arrow).

In OCT image at pre-intervention, the culprit lesion presented lipid-rich plaque with thin-fibrous cap (TCFA).

After stenting, angiogram showed slow flow, and OCT disclosed plaque rupture behind stent.

TCFA is easy to be ruptured by PCI and has a high risk for coronary slow flow.

Prediction of No-reflow Post-PCI

	No-reflow n=14	Reflow n=69	*p*-Value
Plaque rupture, %	71	48	0.053
Thrombus, %	79	80	0.567
TCFA, %	50	16	0.034
Lipid-arc, degree*	166	44	0.012

Tanaka A, Kubo T, Akasaka T et al. Eur Heart J 2009;30:1348-55

Prediction of Microvascular Obstruction

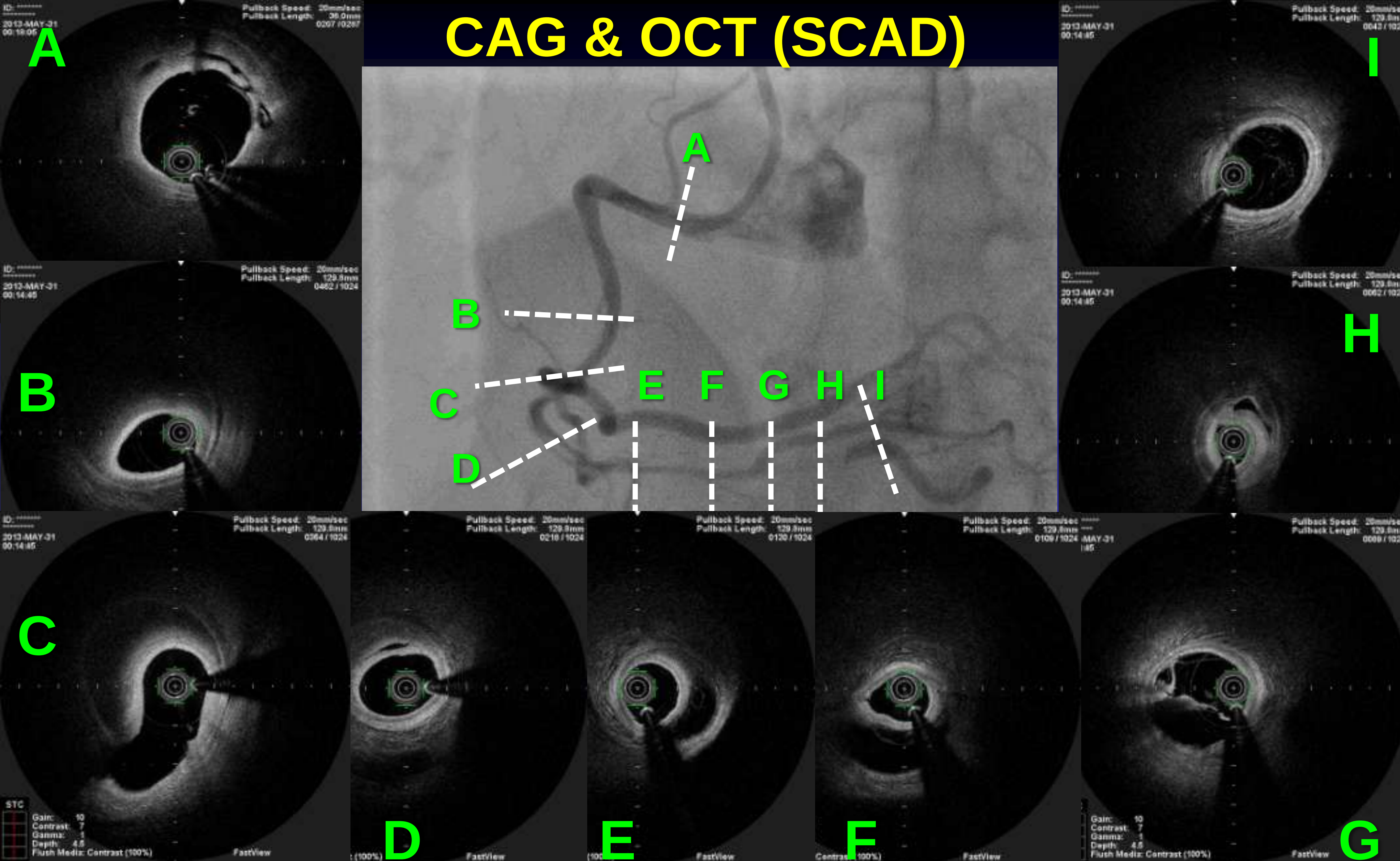
	OR	95% CI	*P*
ST-elevation myocardial infarction	48.05	2.85–809.11	0.007
TCFA at culprit	5.43	1.27–23.32	0.023
Thrombectomy	0.014	0.001–0.35	0.009
Diameter stenosis, %	1.1	1.02–1.19	0.011

Ozaki, Kubo, Akasaka et al. Circulation Img 2011;4:620-7

There is not enough data demonstrating the efficacy of distal protection during PCI.

CAG (SCAD)

CAG & OCT (SCAD)


A
B
C
D
E
F
G
H
I
Pullback Speed: 20mm/sec
Pullback Length: 129.8mm
FastView

Diagnosis of Spontaneous Coronary Artery Dissection by Optical Coherence Tomography

Fernando Alfonso, MD, PHD, Manuel Paulo, MD, Nieves Gonzalo, MD, PHD, Jaime Dutary, MD, Pilar Jimenez-Quevedo, MD, PHD, Vera Lennie, MD, Javier Escaned, MD, PHD, Camino Bañuelos, MD, Rosana Hernandez, MD, PHD, Carlos Macaya, MD, PHD

Madrid, Spain

Objectives This study sought to assess the diagnostic value of optical coherence tomography (OCT) in patients with suspected spontaneous coronary artery dissection (SCAD).

Background SCAD is a rare but challenging clinical entity.

Methods Following a prospective protocol, OCT was performed in 17 consecutive patients with a clinical and angiographic suspicion of SCD from a total of 5,002 patients undergoing coronary angiography. A conservative management strategy was followed.

Results OCT ruled out the diagnosis of SCAD in 6 patients with coronary artery disease (atherosclerotic plaques and/or intracoronary thrombus). In 11 patients (age 48 ± 9 years, 9 female), OCT confirmed the presence of SCAD. A double-lumen or intramural hematoma image was visualized in all cases. However, only 3 patients presented an intimal "flap" on angiography. OCT readily identified the intimal rupture site (n = 7), the thickness (348 ± 84 μm) and length (31 ± 9 mm) of the intimomedial membrane, the area of the true (1.1 ± 0.5 mm^2) and false lumen (5.9 ± 2.1 mm^2), the associated intramural hematoma (n = 9), and thrombi in the true or false lumens (n = 11). Most of these findings were angiographically silent. After stenting (n = 4), OCT disclosed adequate stent coverage, expansion, and apposition, but also residual intramural hematoma at the stented site (ablumi-nal) and at the distal vessel.

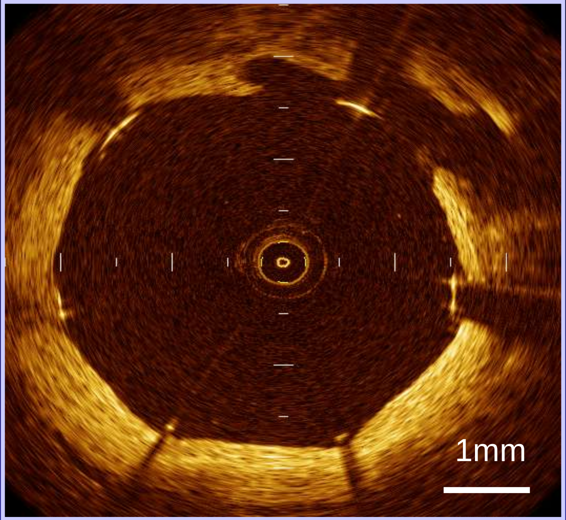
Conclusions OCT provides unique insights in patients with SCAD that allow an early diagnosis and adequate management. Most of these findings are undetectable by angiography. (J Am Coll Cardiol 2012;59:1073–9)

How to use OCT-guided PCI

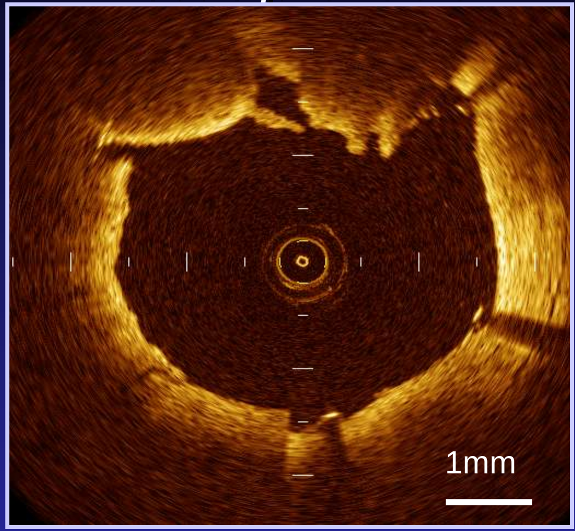
- **Pre PCI Assessment**
  - Image acquisition is very fast and easy.
  - Precise measurements might be possible automatically.
  - Lesion morphology can be assessed in detail.
    Easy to plan PCI strategies, easy to decide stent landing zone, easy to identify unexpected lesions, etc.

Inadequate lesion morphologies after stenting

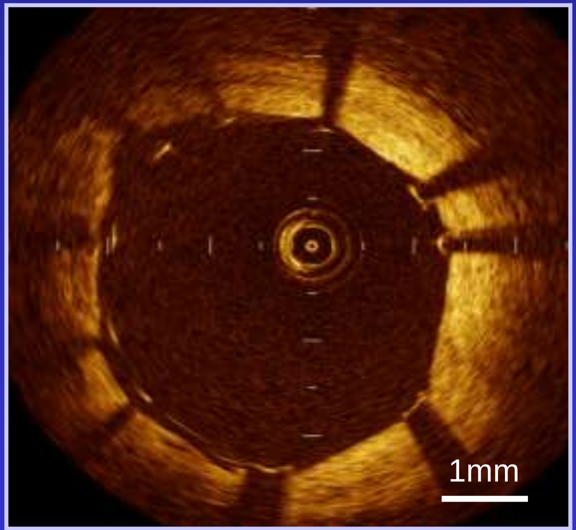
Stent malapposition



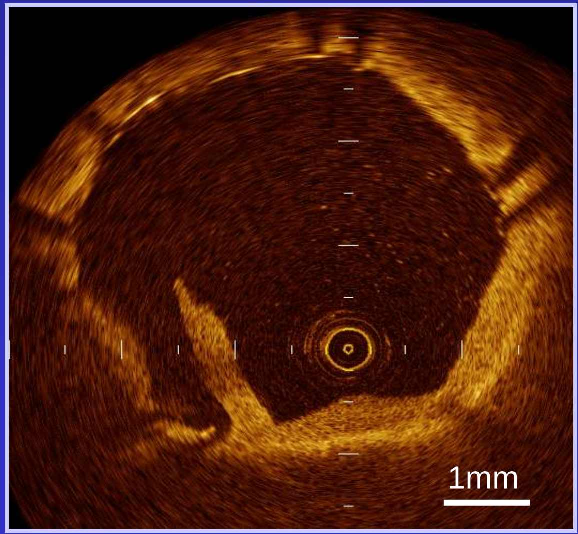
Tissue protrusion



Incomplete stent apposition



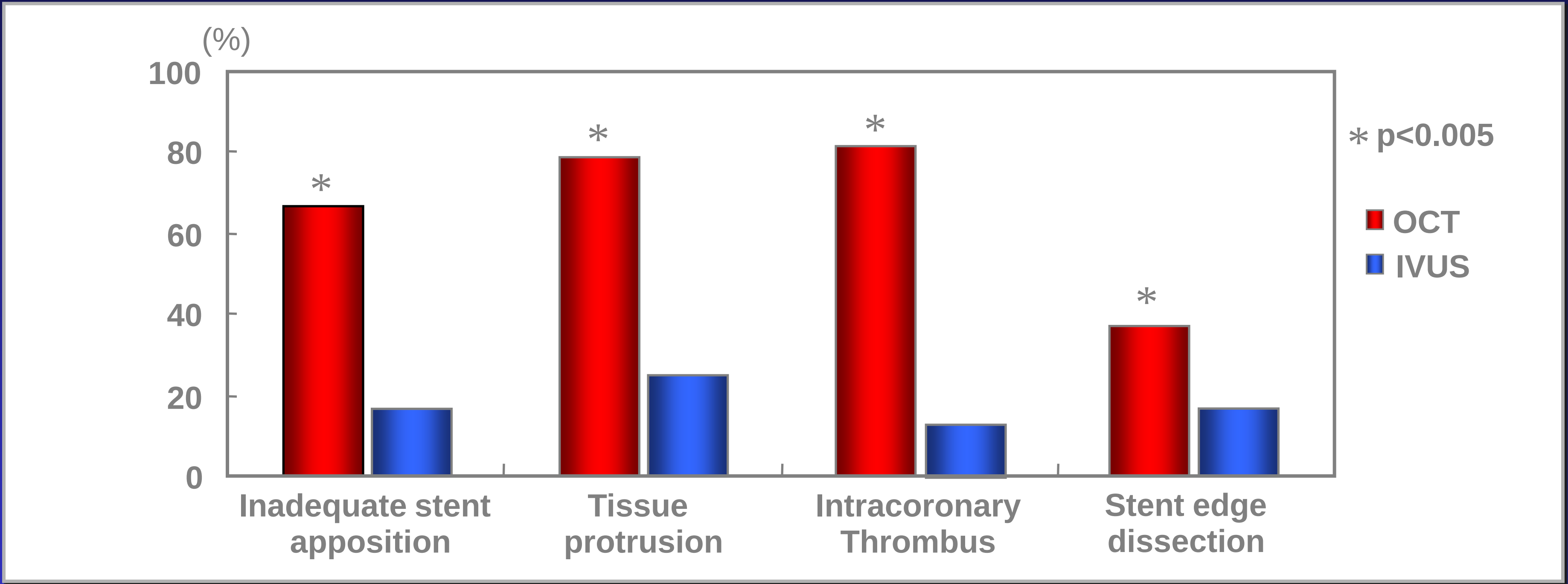
Stent edge dissection



Kubo T, et al, JACC Img. 2008 1:475–84

Comparison of the ability for monitoring stent deployment between OCT and IVUS

55 patients were examined by OCT and IVUS to evaluate lesion morphologies after stent implantation.



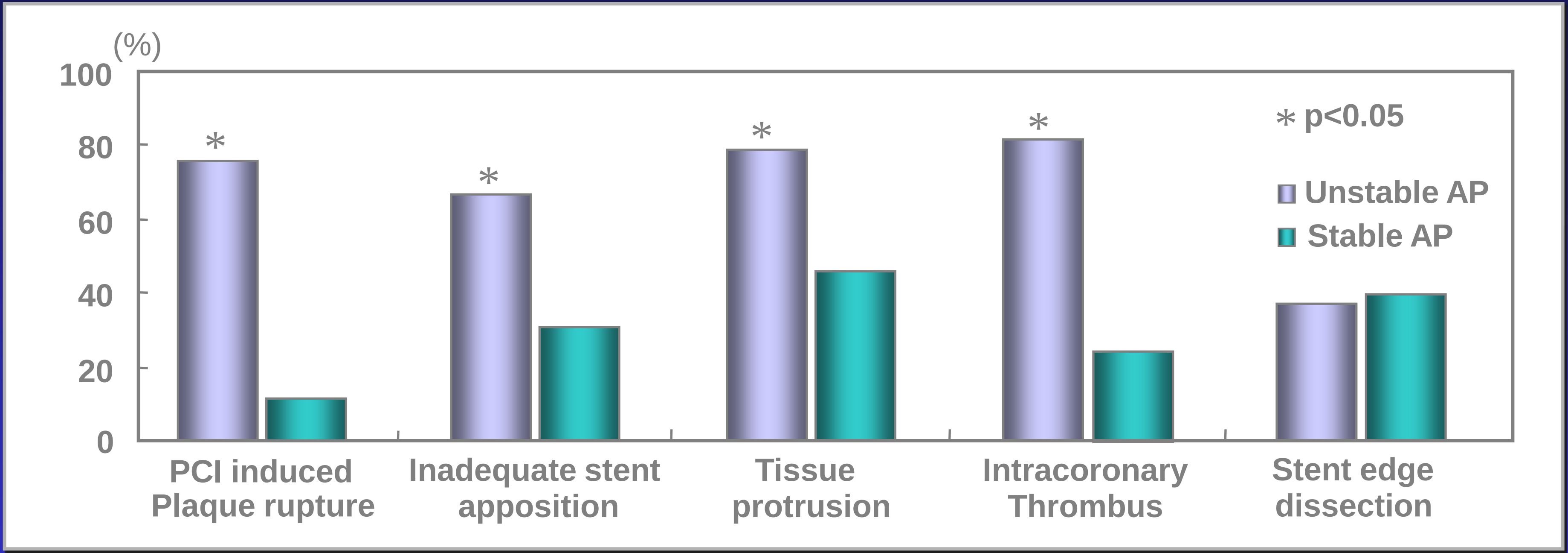
Conclusion: OCT can provide more detailed morphological information after stenting than IVUS.

Kubo T, et al, JACC Img. 2008 1:475–84

Wakayama Medical University

Vascular response after stent implantation between unstable and stable AP

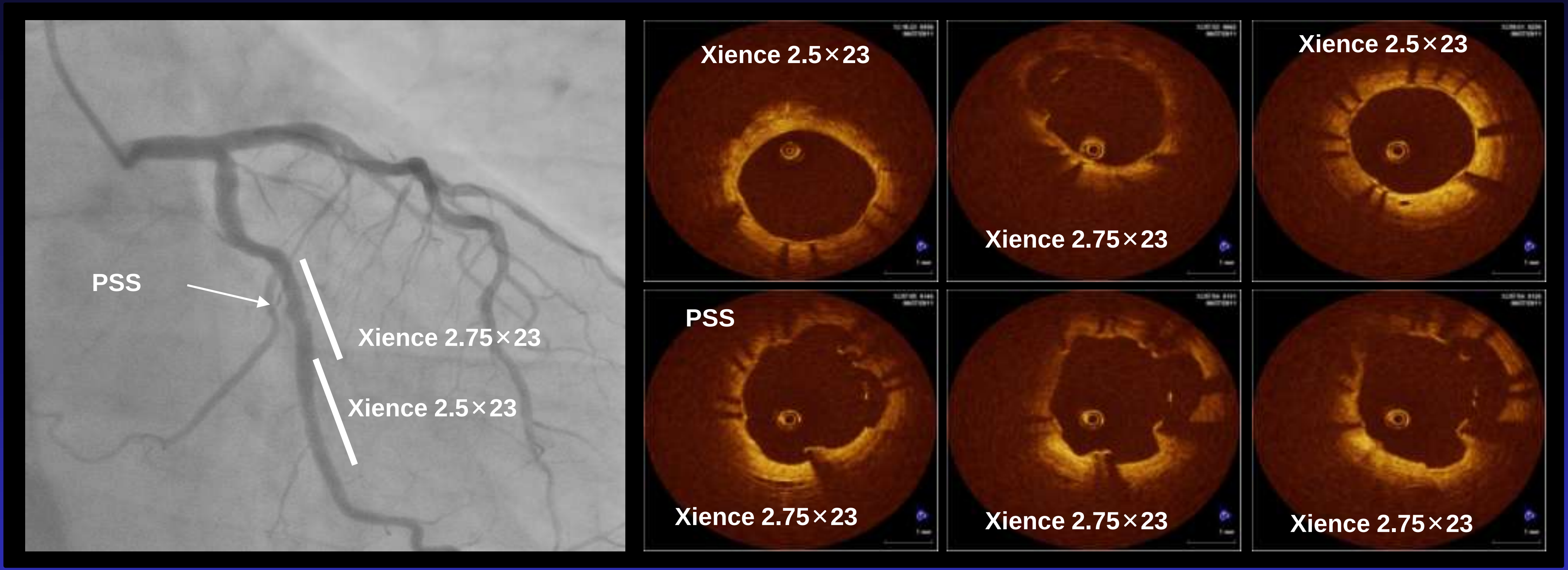
24 unstable and 31 stable AP patients were examined by OCT to evaluate lesion morphologies after stent implantation.



Conclusion: The inadequate lesion morphologies after stenting were observed more frequently in unstable AP patients.

Kubo T, et al, JACC Img. 2008 1:475–84

PSS, #13 CTO (2010/10/26)

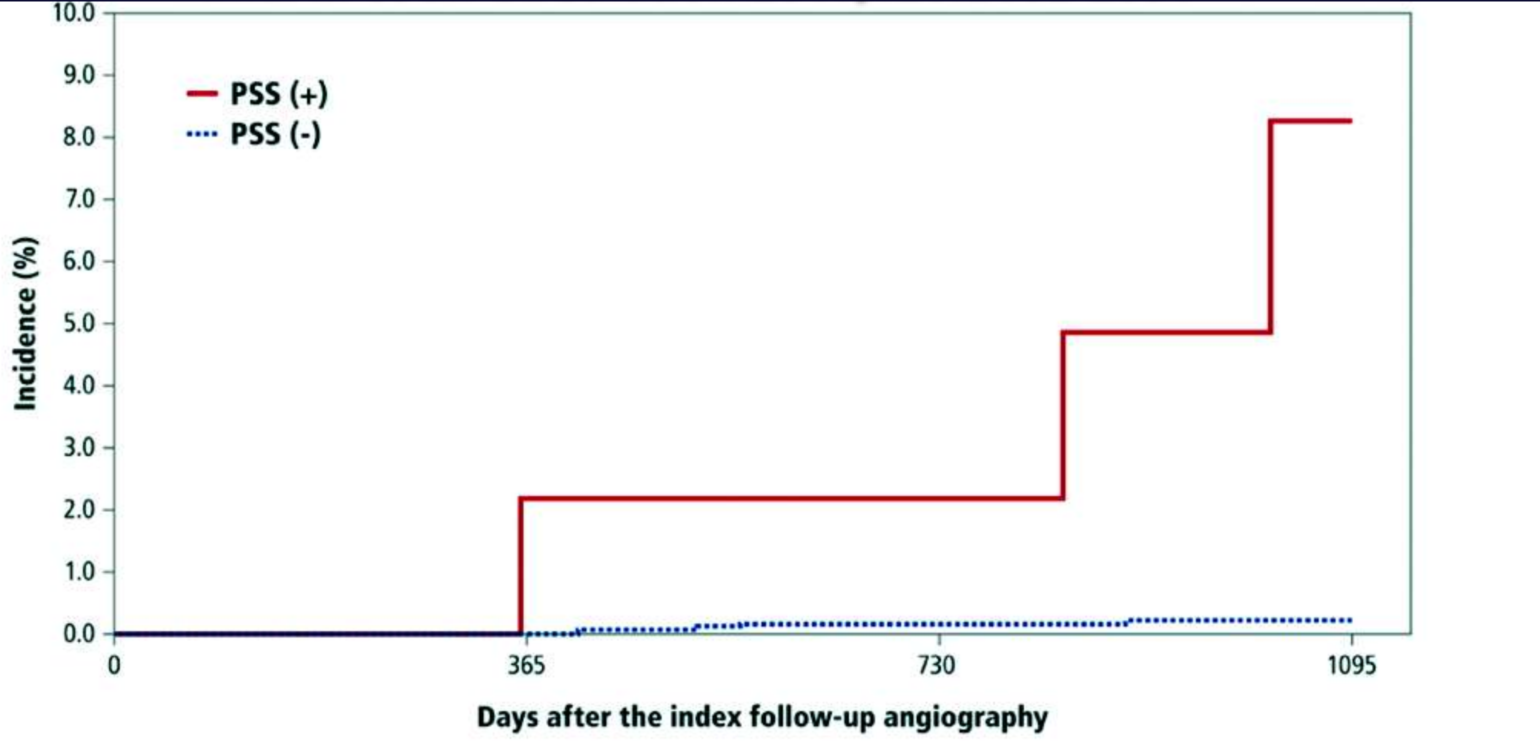


PSS by CAG is demonstrated as mal-apposition by OCT.

Persistent incomplete apposition & late acquired mal-apposition should be considered as the cause of mal-apposition in late phase.

Cumulative incidence of ST after the index follow-up CAG

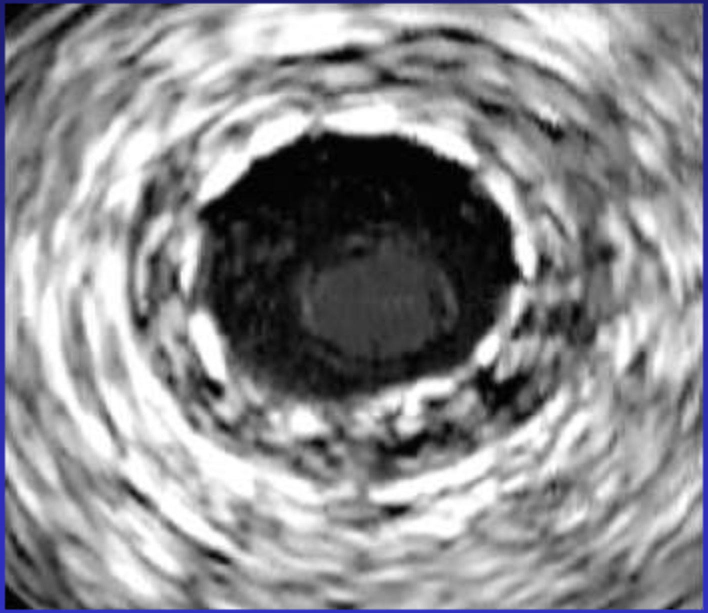
Imai M et al. Circulation 2011;123:2382-2391



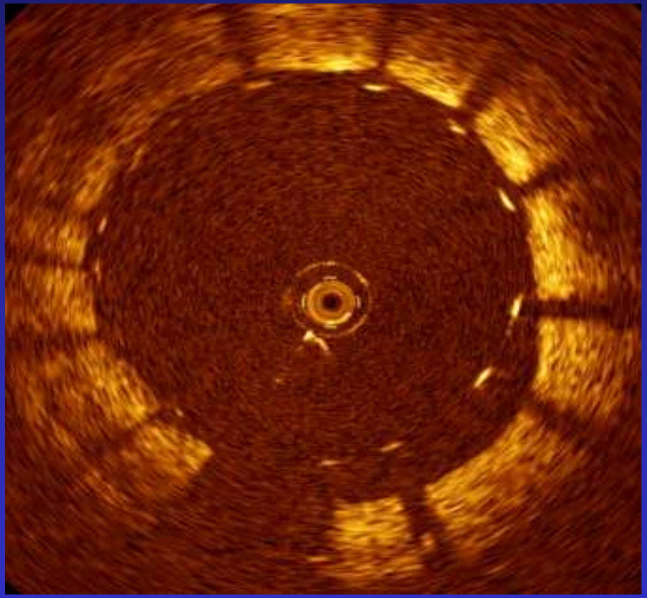
Days	0	365	730	1095
PSS (+) N of lesions at risk	51	46	40	26
N of lesions with events	0	1	1	3
Cumulative incidence	0%	2.1%	2.1%	8.2%
PSS (-) N of lesions at risk	2761	2532	1847	580
N of lesions with events	0	0	3	4
Cumulative incidence	0%	0%	0.13%	0.2%

Incomplete stent apposition

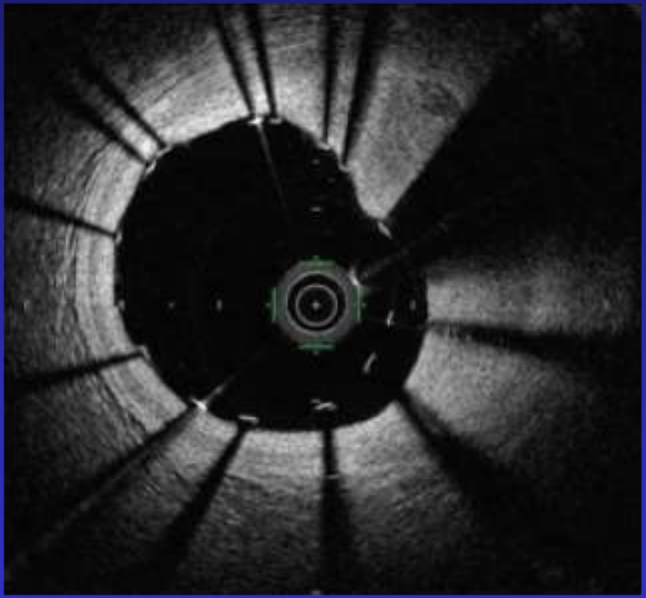
Incomplete stent apposition can be easily demonstrated by OFDI/FD-OCT, even if it is not identified by IVUS.



IVUS

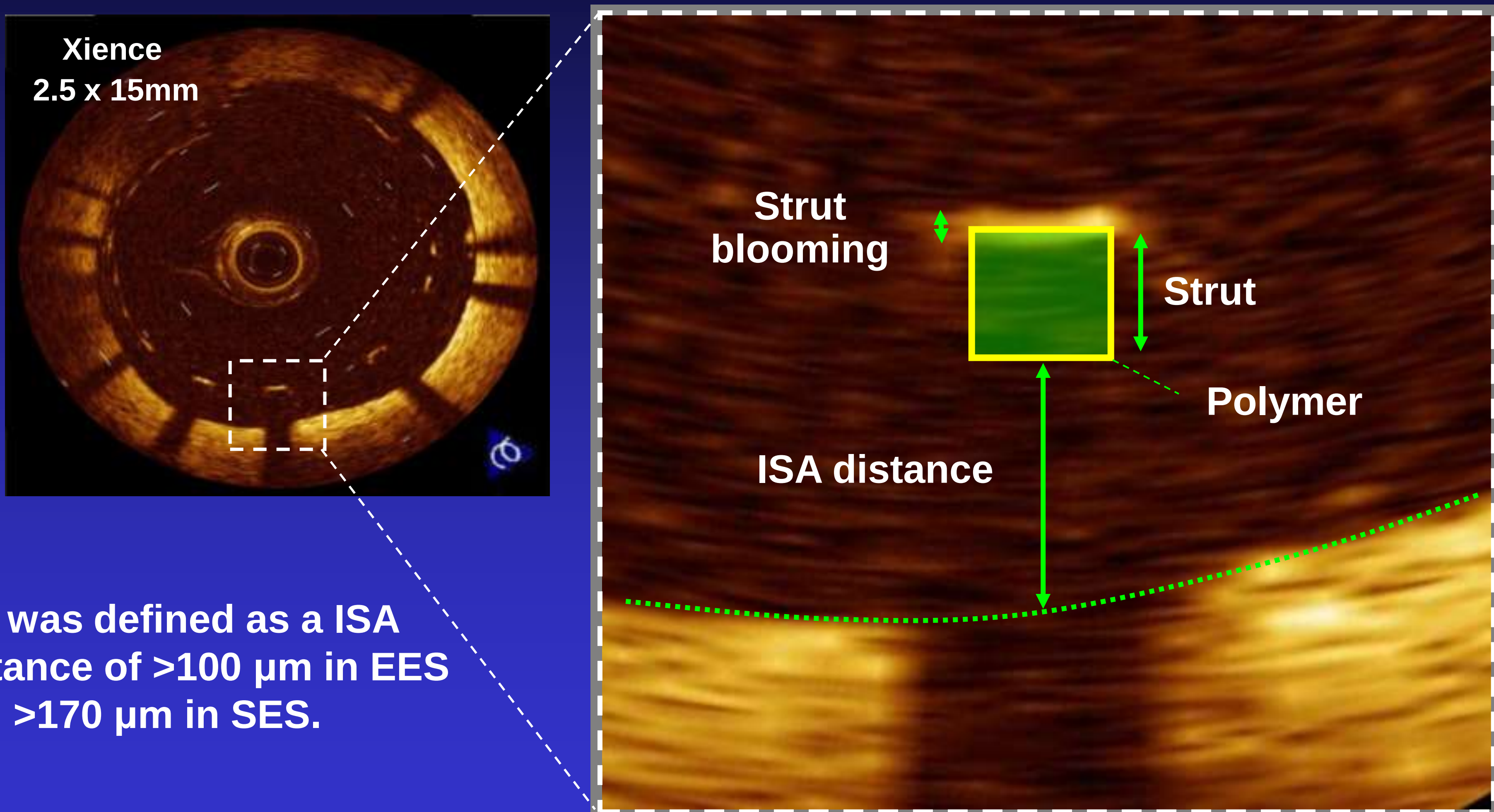


FD-OCT



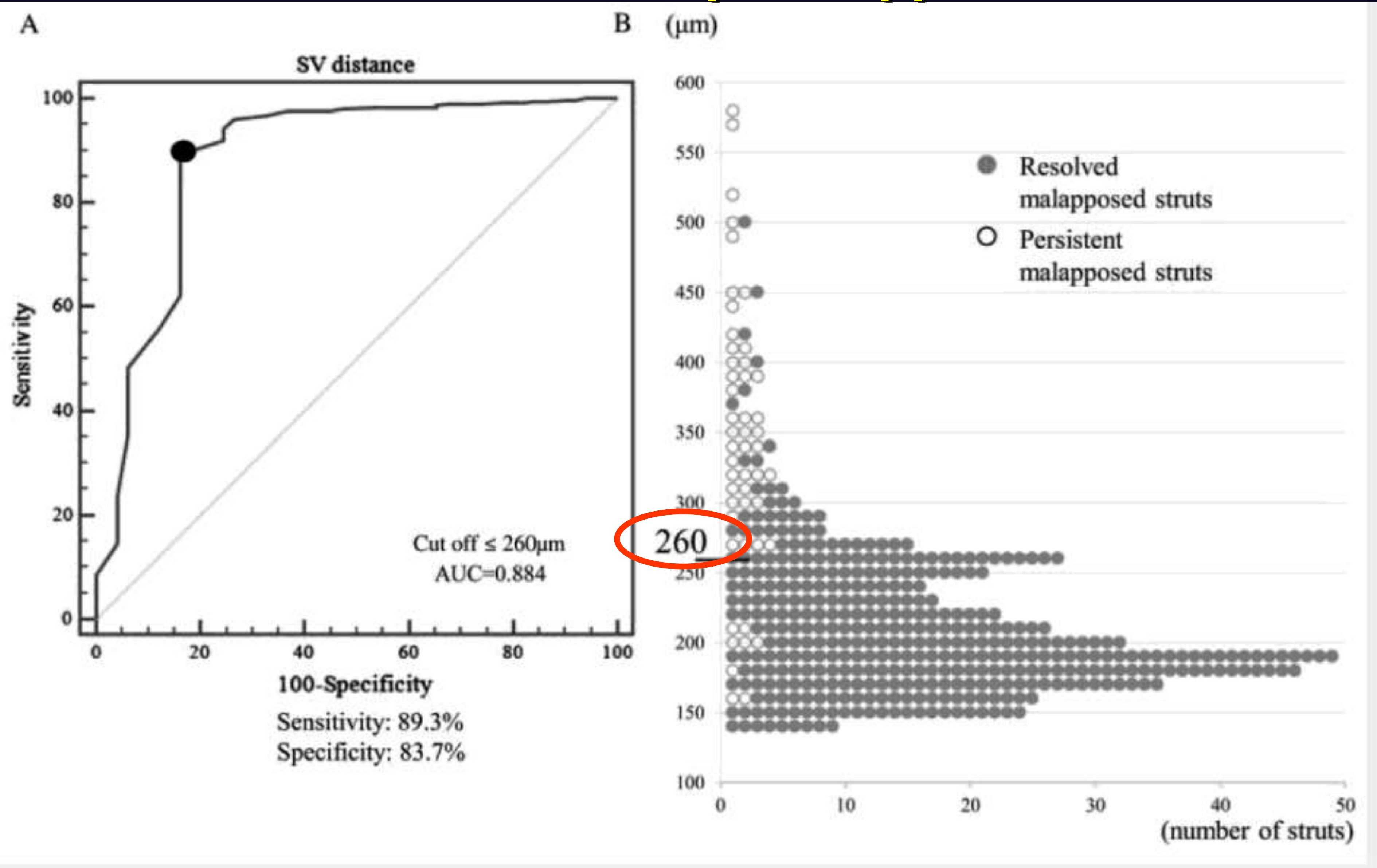
OFDI

Definition of incomplete stent appostion (ISA)



ISA was defined as a ISA distance of >100 μm in EES and >170 μm in SES.

Persistent incomplete apposition

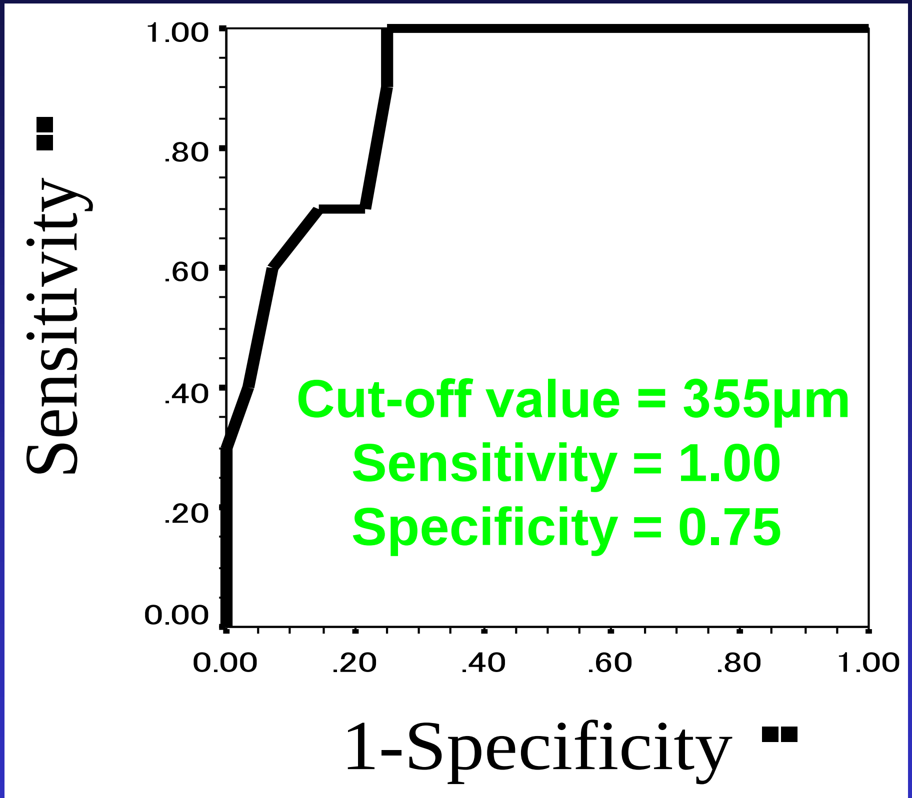


Kawamori H. et al, Eur Heart J CV Imaging 2013

Wakayama Medical University

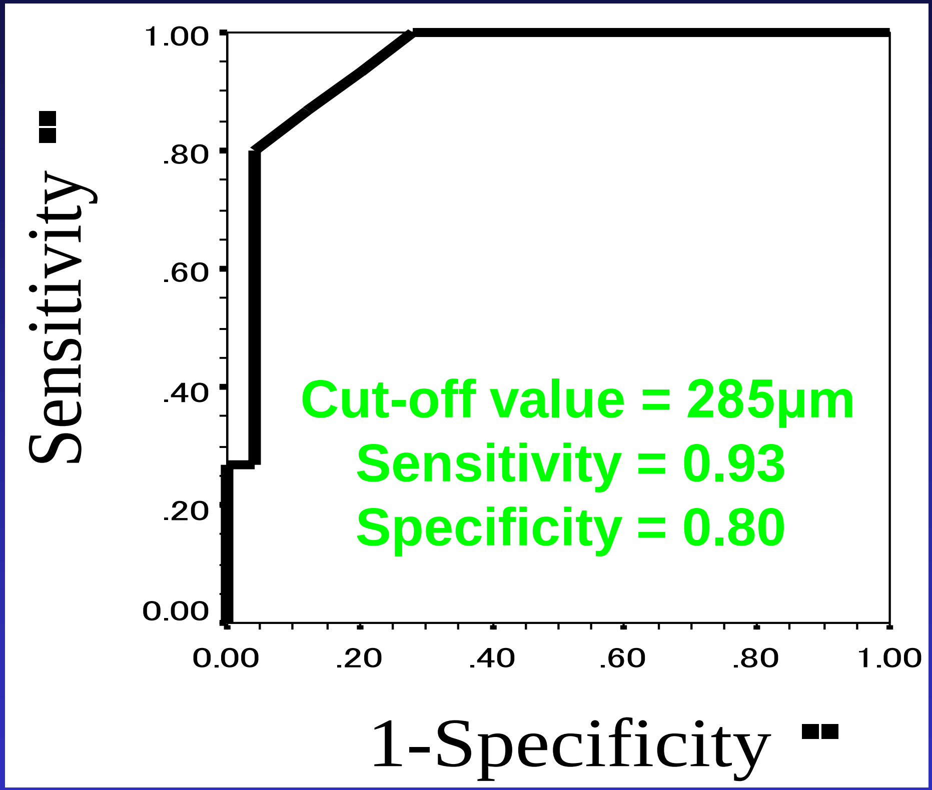
ROC curve analysis of maximum ISA distance for predicting persistent ISA

EES



ROC curve analysis identified a maximum ISA distance of EES > 355μm with as separating persistent from resolved ISA (sensitivity 100%, specificity 75%, area under the curve = 0.905; 95%CI, 0.812 to 0.999).

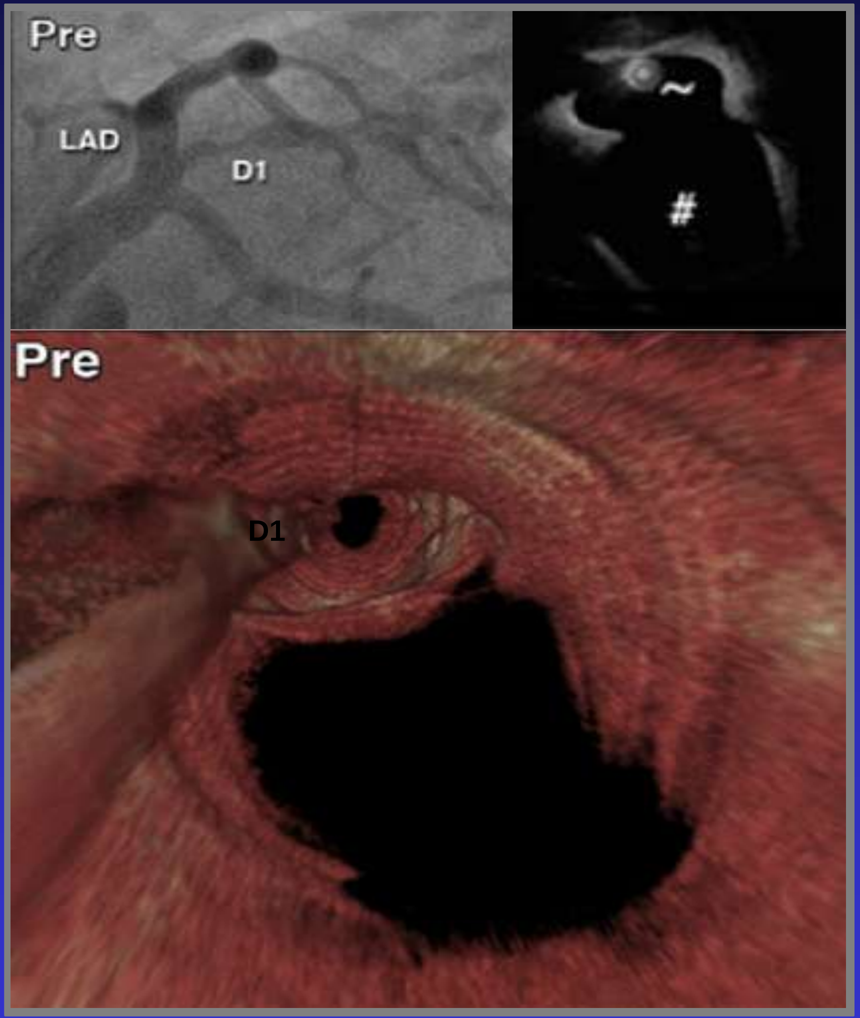
SES

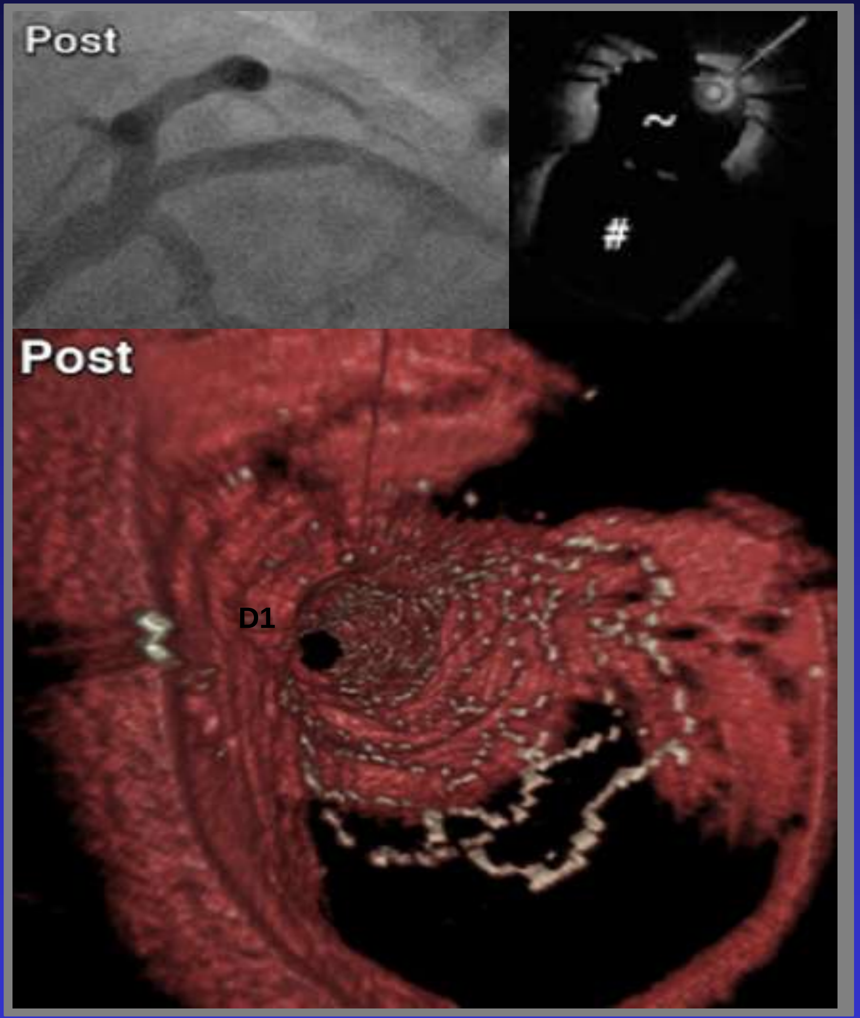


ROC curve analysis identified a maximum ISA distance of SES > 285μm with as separating persistent from resolved ISA (sensitivity 93%, specificity 80%, area under the curve = 0.947; 95%CI, 0.878 to 1.015).

Wakayama Medical University

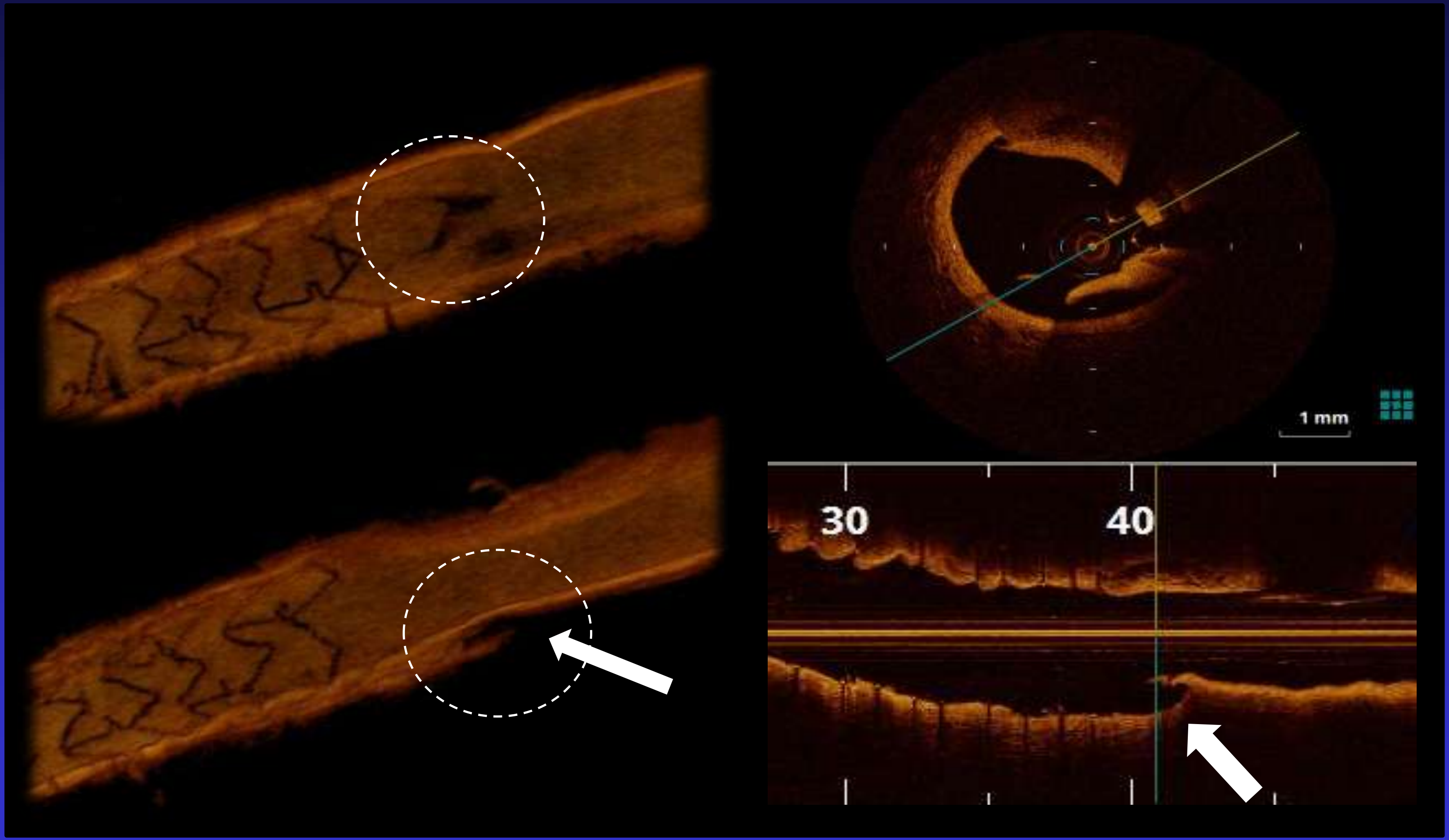
"Overhanging" struts of the D1 stent into the LAD orifice



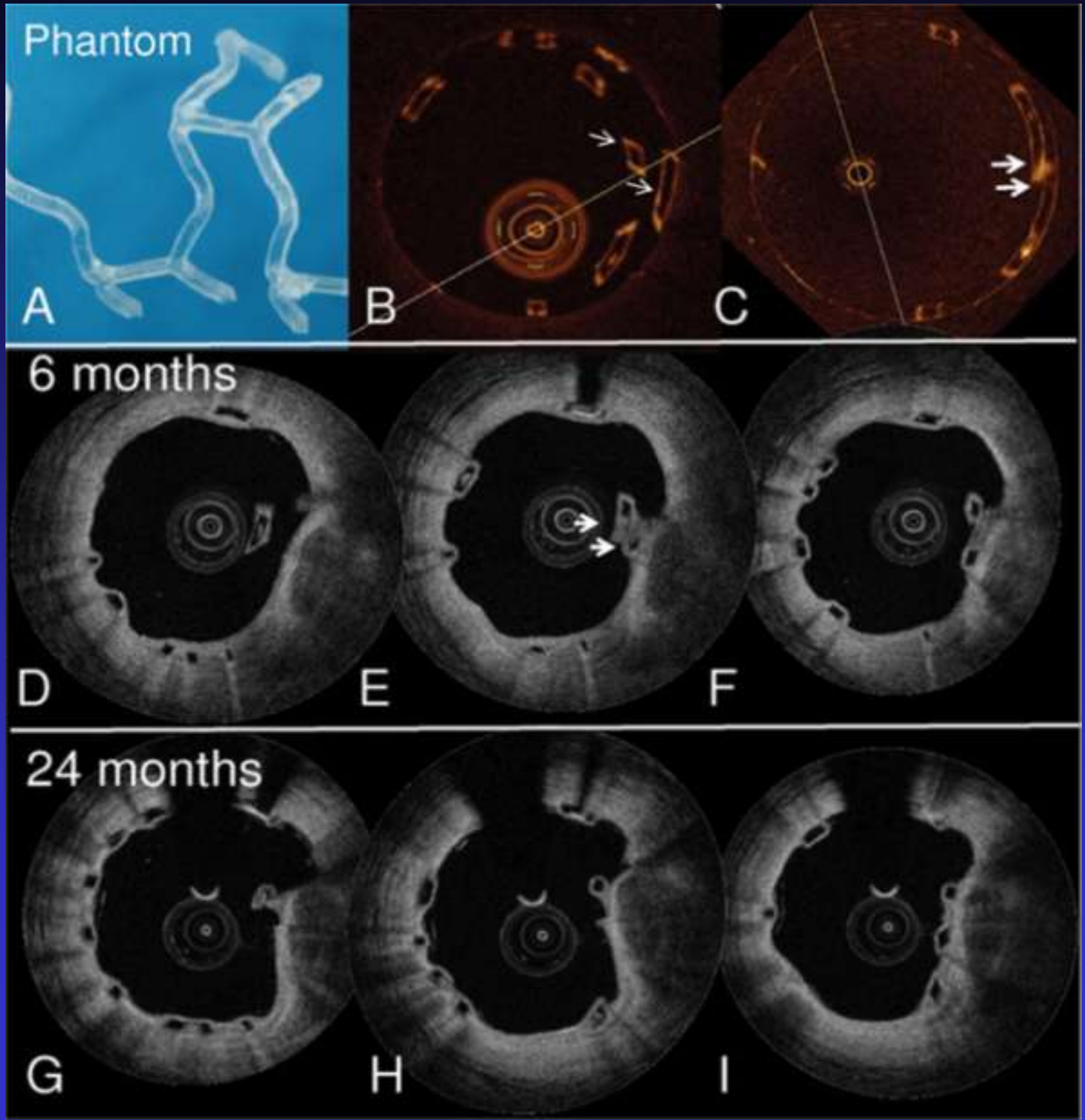


Farooq et al. JACC int 2011;9:1044-6

SAP, #6 99% Xience 2.75x18, Dissection



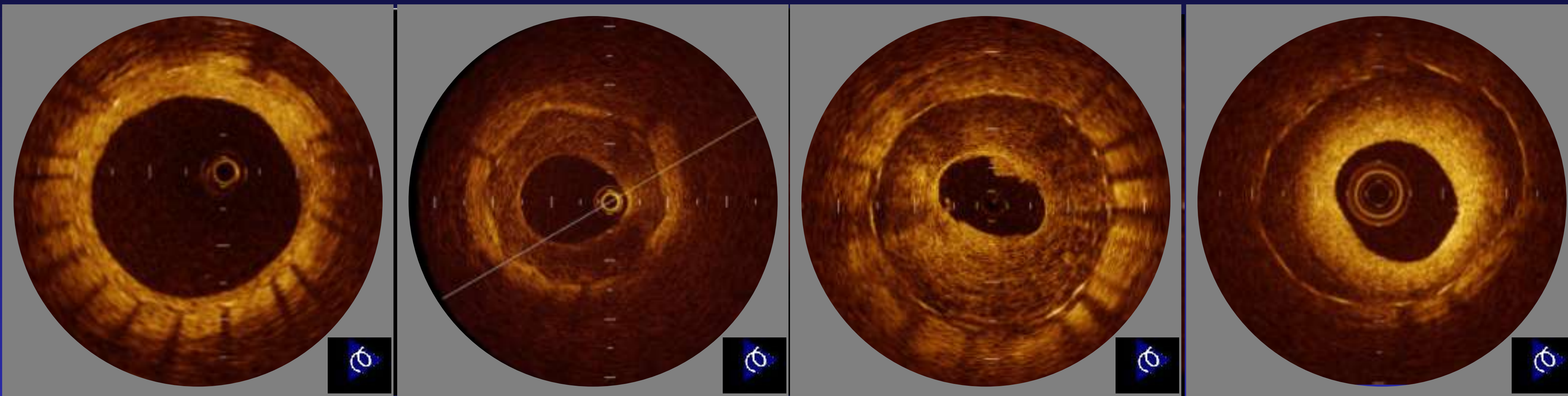
Assessment of BVS by OFDI



Ormiston J A et al. Circ Cardiovasc Interv 2012;5:620-632

Neointimal tissue characterization by OCT

Homogeneous | *Heterogeneous* | *Layered*



Restenotic tissue has uniform optical properties and dose not show focal variations in backscattering pattern.

Restenotic tissue has focally changing optical properties and show various backscattering patterns.

Restenotic tissue consists of concentric layers with different optical properties:an adluminal high scattering layer and adluminal low scattering layer.

No data showing the relation between OCT-findings & histology in detail, and furthermore, there is no recommendation of treatment according to OCT finding.

European Heart Journal – Cardiovascular Imaging (2014) **15**, 307–315
doi:10.1093/ehjci/jet165

Association between tissue characteristics evaluated with optical coherence tomography and mid-term results after paclitaxel-coated balloon dilatation for in-stent restenosis lesions: a comparison with plain old balloon angioplasty

Takeshi Tada[1]*, Kazushige Kadota[1], Shingo Hosogi[2], Koshi Miyake[1], Hideo Amano[1], Michitaka Nakamura[1], Yu Izawa[1], Shunsuke Kubo[1], Tahei Ichinohe[1], Yusuke Hyoudou[1], Haruki Eguchi[1], Yuki Hayakawa[1], Suguru Otsuru[1], Daiji Hasegawa[1], Yoshikazu Shigemoto[1], Seiji Habara[1], Hiroyuki Tanaka[1], Yasushi Fuku[1], Harumi Kato[1], Tsuyoshi Goto[1], and Kazuaki Mitsudo[1]

[1]Department of Cardiovascular Medicine, Kurashiki Central Hospital, 1-1-1 Miwa, Kurashiki 710-8602, Japan; and [2]Department of Cardiovascular Medicine, Kochi Health Sciences Center, Kochi, Japan

Received 14 May 2013; revised 13 August 2013; accepted after revision 16 August 2013; online publish-ahead-of-print 15 September 2013

Aims Morphological assessment of neointimal tissue using optical coherence tomography (OCT) is important for clarifying the pathophysiology of in-stent restenosis (ISR) lesions. The aim of this study was to determine the impact of OCT findings on recurrence of ISR after paclitaxel-coated balloon (PCB) dilatation compared with plain old balloon angioplasty (POBA).

Methods and results Between July 2008 and May 2012, we performed percutaneous coronary intervention for 214 ISR lesions using POBA + PCB (146 lesions, PCB group) or POBA only (68 lesions, POBA group). Morphological assessment of neointimal tissue using OCT, including assessment of restenotic tissue structure and restenotic tissue backscatter, was performed. We examined the association between lesion morphologies and mid-term (6–8 months) results including ISR and target lesion revascularization (TLR) rates. Both ISR and TLR rates of lesions with a homogeneous structure were significantly lower in the PCB group than those in the POBA group (ISR: 20.0 vs. 55.6%, $P = 0.002$, TLR: 12.7 vs. 37.0%, $P = 0.019$), but there was no difference between the two groups in ISR and TLR rates of lesions with a heterogeneous or layered structure. Both ISR and TLR rates of lesions with high backscatter were significantly lower in the PCB group than those in the POBA group (ISR: 19.8 vs. 52.5%, $P < 0.001$, TLR: 13.6 vs. 42.5%, $P = 0.001$), but there was no difference between the two groups in ISR and TLR rates of lesions with low backscatter.

Conclusion Morphological assessment of ISR tissue using OCT might be useful for identifying ISR lesions favourable for PCB dilatation.

Keywords optical coherence tomography • in-stent restenosis lesion • paclitaxel-coated balloon

Wakayama Medical University

Association between restenotic tissue morphology and acute/mid-term results

	Tissue structure								
	Homogenous type			Heterogenous type			Layered type		
	PCB (n=55)	POBA (n=27)	P value	PCB (n=20)	POBA (n=8)	P value	PCB (n=71)	POBA (n=33)	P value
Acute gain mm	1.14±0.53	0.90±0.56	0.060	1.25±0.58	1.21±0.38	0.885	1.20±0.58	1.14±0.60	0.597
Late loss mm	0.25±0.50	0.70±0.58	0.000	0.45±0.72	0.84±0.85	0.234	0.23±0.60	0.61±0.69	0.005
Net gain mm	0.90±0.61	0.20±0.67	0.000	0.80±0.69	0.38±0.98	0.208	0.98±0.73	0.53±0.63	0.003
ISR n (%)	11 (20.0)	15 (55.6)	0.002	7 (35.0)	3 (37.5)	1.000	16 (22.5)	13 (39.4)	0.100
TLR n (%)	7 (12.7)	10 (37.0)	0.019	5 (25.0)	3 (37.5)	0.651	14 (19.7)	12 (36.4)	0.089

Acute gain = (post-procedural – pre-procedural) MLD

Late loss = (post-procedural - follow-up) MLD

Net gain = (follow-up - pre-procedural) MLD

Tada T, et al. Eur Heart J Cardiovasc Img. 2014;15:307-315

Association between restenotic tissue morphology and acute/mid-term results

Tissue backscatter	High backscatter			Low backscatter		
	PCB (n=81)	POBA (n=40)	P value	PCB (n=65)	POBA (n=28)	P value
Acute gain mm	1.12±0.50	0.97±0.58	0.139	1.26±0.62	1.17±0.54	0.476
Late loss mm	0.23±0.51	0.73±0.70	0.000	0.31±0.66	0.59±0.62	0.059
Net gain mm	0.90±0.61	0.25±0.67	0.000	0.96±0.76	0.58±0.70	0.027
ISR n (%)	16 (19.8)	21 (52.5)	0.000	18 (27.7)	10 (35.7)	0.467
TLR n (%)	11 (13.6)	17 (42.5)	0.001	15 (23.1)	8 (28.6)	0.606

Acute gain = (post-procedural – pre-procedural) MLD

Late loss = (post-procedural - follow-up) MLD

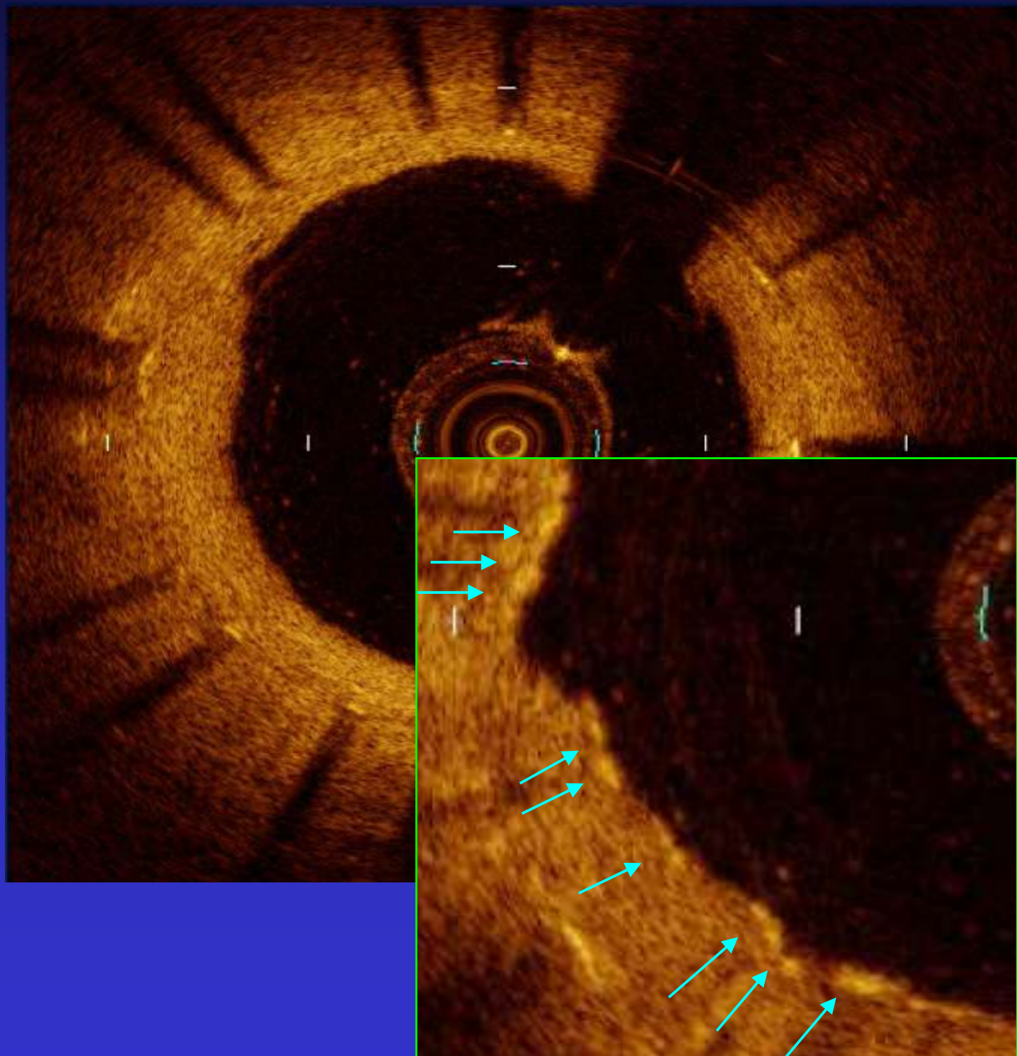
Net gain = (follow-up - pre-procedural) MLD

Tada T, et al. Eur Heart J Cardiovasc Img. 2014;15:307-315

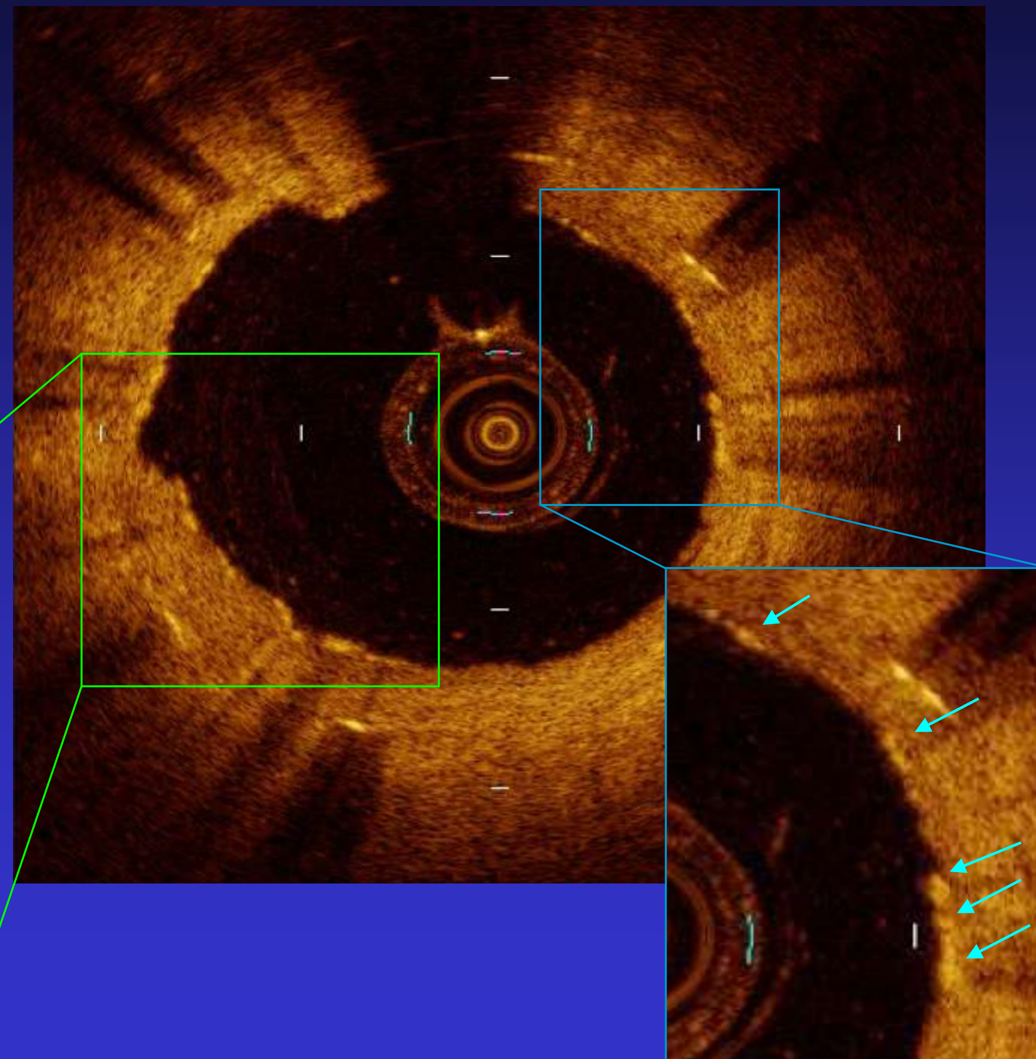
OCT findings after PCB for BMS restenosis

Courtesy by Dr. Habara S (Kurashiki Central Hosp.)

Post POBA



Post PCB



How to use OCT-guided PCI

- **Pre PCI Assessment**
  - Image acquisition is very fast and easy.
  - Precise measurements might be possible automatically.
  - Lesion morphology can be assessed in detail.
    Easy to plan PCI strategies, easy to decide stent landing zone, easy to identify unexpected lesions, etc.
- **During and after PCI.**
  - Results of PCI such as tissue protrusion, incomplete apposition, mal-apposition, small dissection, etc. can be assessed precisely.
  - Much more delicate treatment may be expected to bifurcation lesion stenting by 3D-OCT.
  - Pathophysiology of LST & VLST could be demonstrated in detail and ideal treatment could be expected by OCT-guided PCI using PCB.
  - OCT-guided PCI should be essential for BVS.

OCT: Pre- & Post Intervention (conclusions)

- Pre- & post-PCI lesion morphology can be assessed easily & precisely by OCT because of higher resolution with high frame rate, auto-pullback & auto-measurement systems, etc.

- Improvement of clinical outcomes can be expected in PCI by the guidance of OCT, although there are not enough data to support the reduction of the adverse clinical events by OCT guided PCI.

- Randomized prospective studies should be planned to demonstrate the improvement of clinical outcome by OCT-guided PCI in the near future.