Procedural & Prognostic Impact of OCT on Coronary Intervention

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Disclosure Statement of Financial Interest

Takashi Akasaka, MD, PhD

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

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  Terumo Inc.

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ESC European Society of Cardiology
European Heart Journal (2018) **00**, 1–96
doi:10.1093/eurheartj/ehy394

2018 ESC/EACTS Guidelines on myocardial revascularization

**The Task Force on myocardial revascularization
Society of Cardiology (ESC) and European Asso
Cardio-Thoracic Surgery (EACTS)**

**Developed with the special contribution of the E
Association for Percutaneous Cardiovascular In**

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Adna
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Dirk
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Co-or
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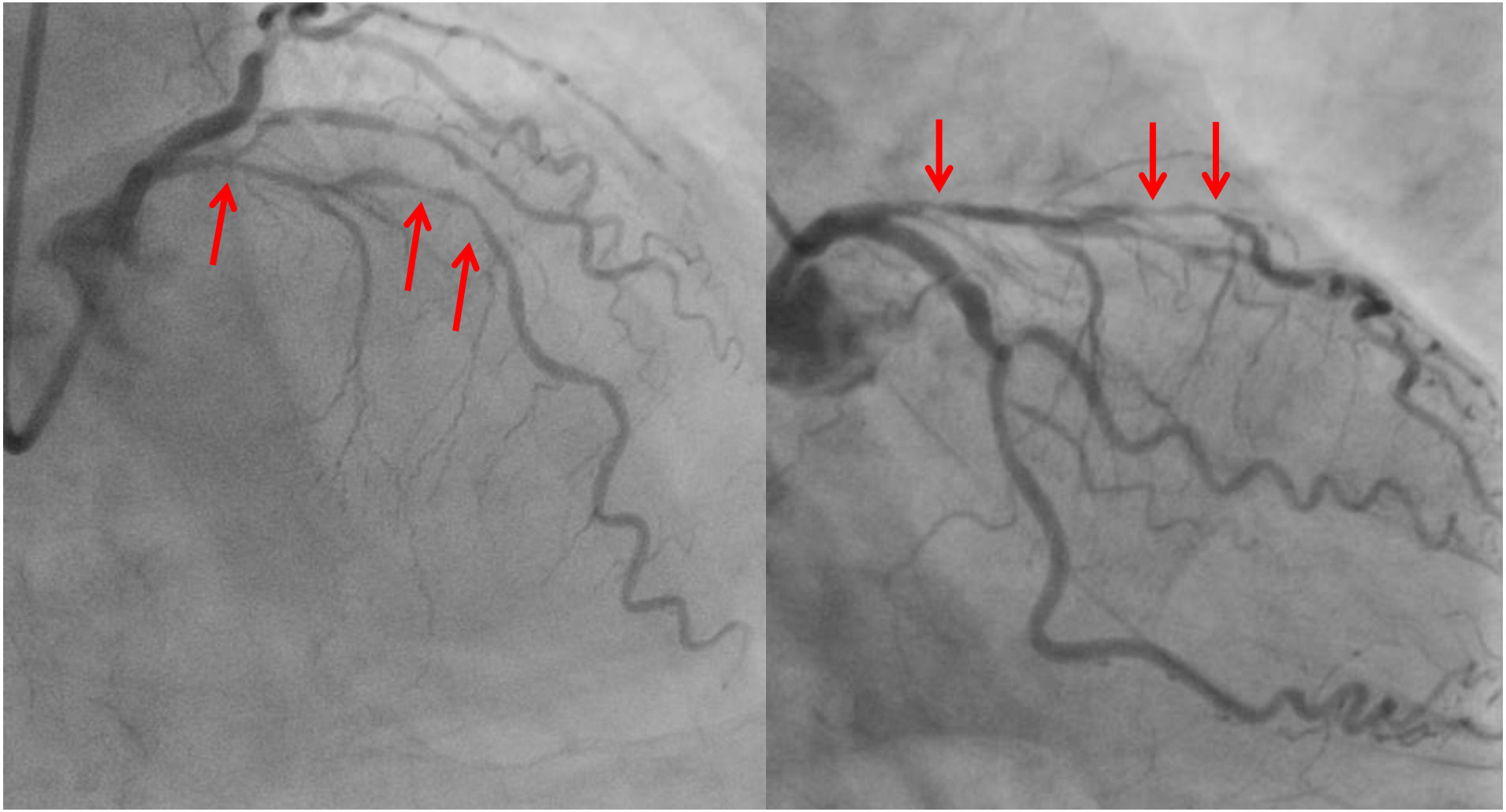
Recommendations on intravascular imaging for procedural optimization

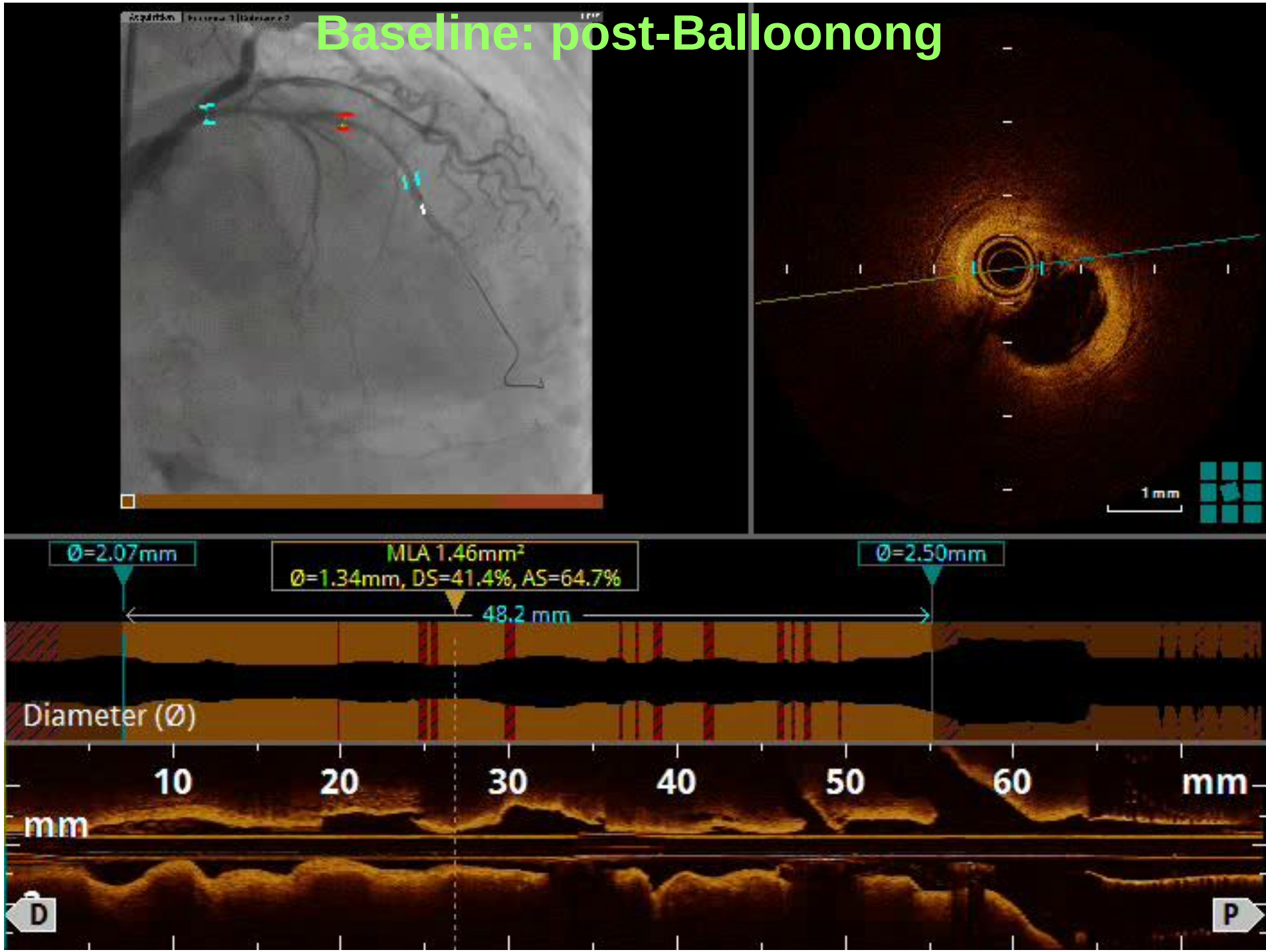
Recommendations	Class[a]	Level[b]
IVUS or OCT should be considered in selected patients to optimize stent implantation.[603,612,651–653]	IIa	B
IVUS should be considered to optimize treatment of unprotected left main lesions.[35]	IIa	B

Restenosis		
DES are recommended for the treatment of in-stent restenosis of BMS or DES.[373,375,378,379]	I	A
Drug-coated balloons are recommended for the treatment of in-stent restenosis of BMS or DES.[373,375,378,379]	I	A
In patients with recurrent episodes of diffuse in-stent restenosis, CABG should be considered by the Heart Team over a new PCI attempt.	IIa	C
IVUS and/or OCT should be considered to detect stent-related mechanical problems leading to restenosis.	IIa	C

Coronary angio. (Pre PCI)

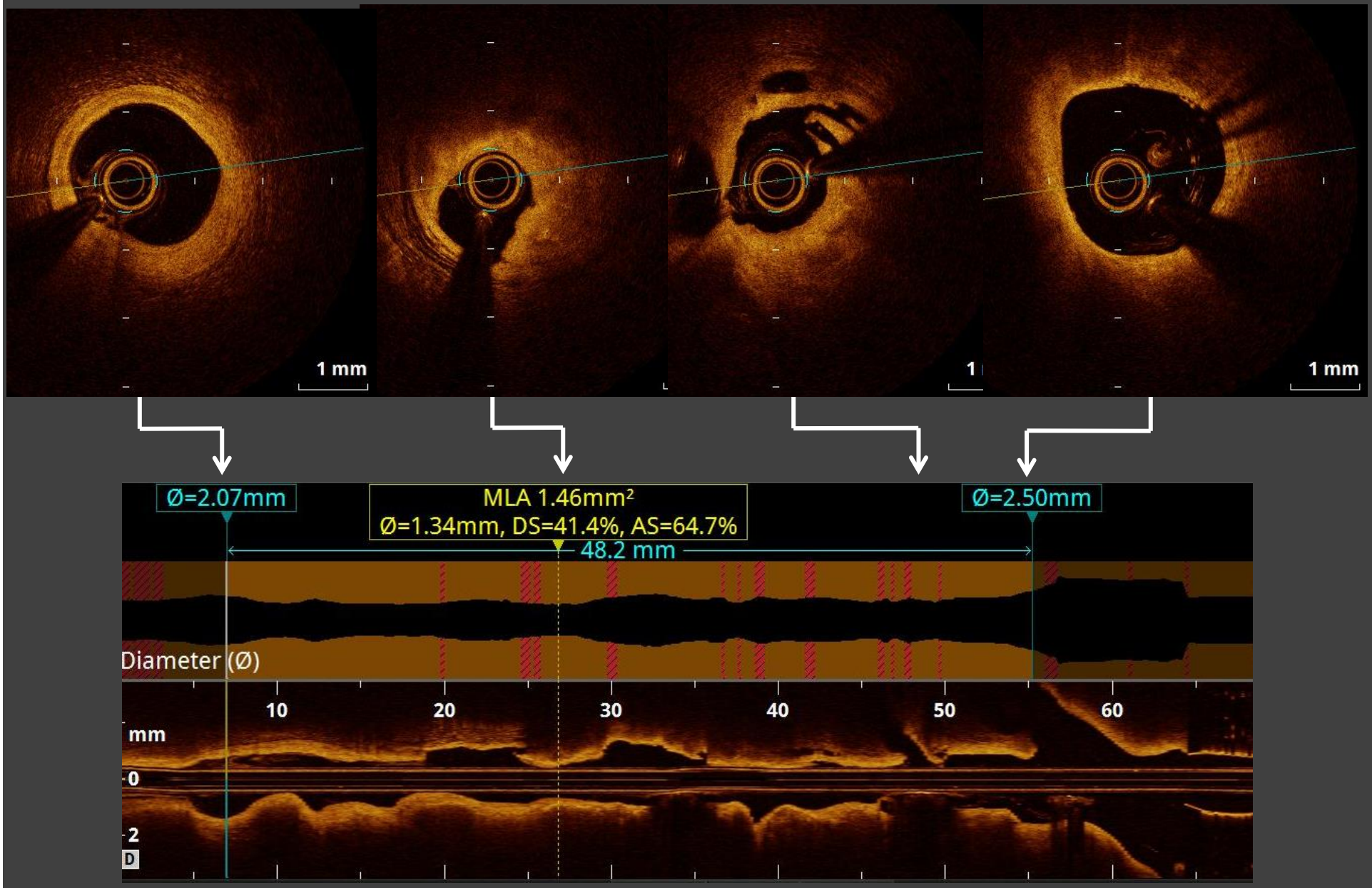


Baseline: post-Balloonong

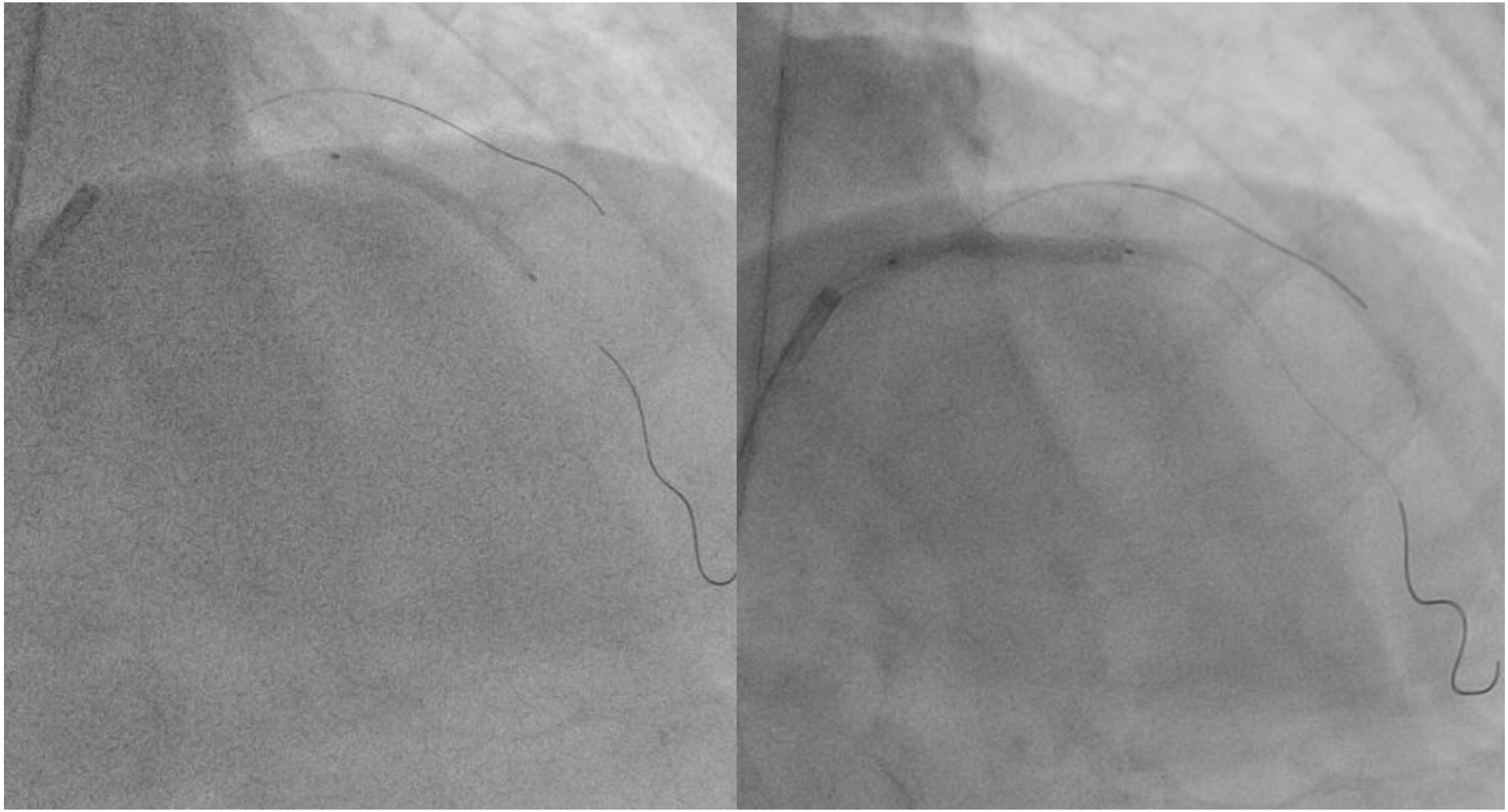


Baseline: post-Balloonong

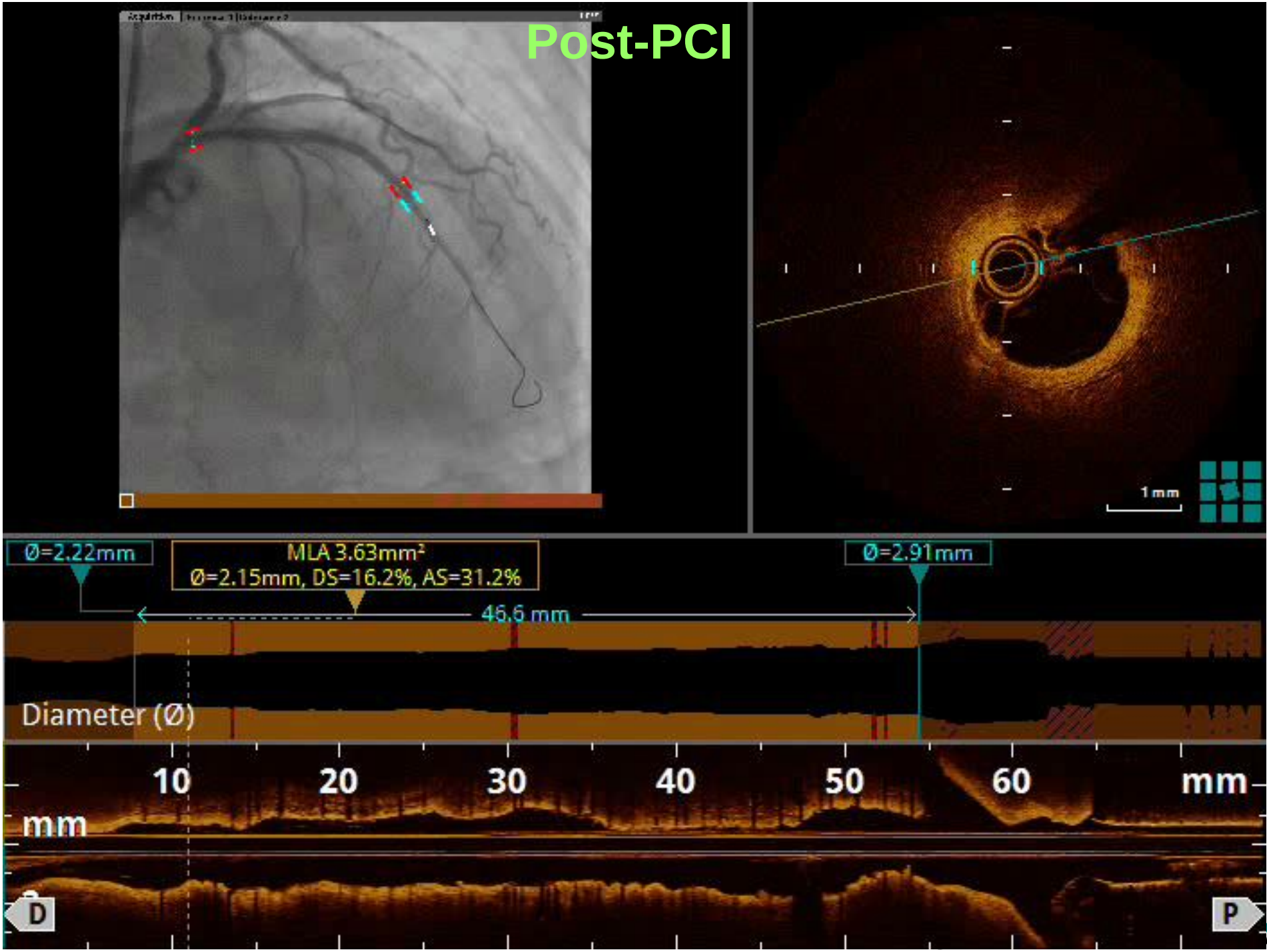
Distal reference ***MLA site*** ***Bifurcation site*** ***Prox. Reference***



PCI for #6-7

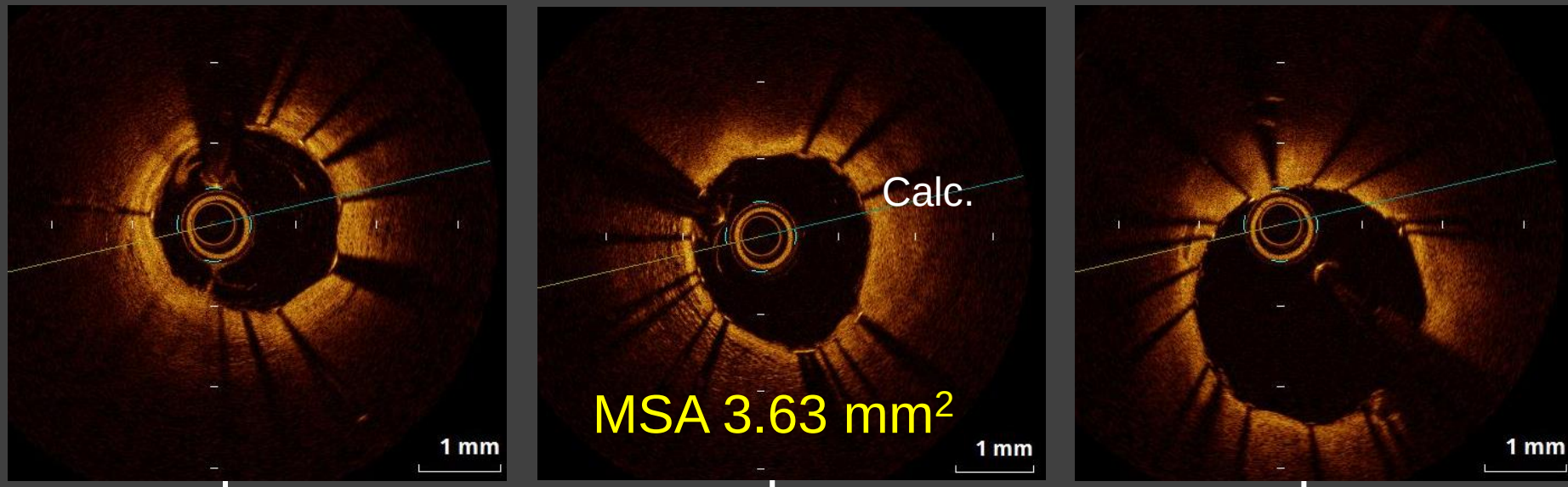


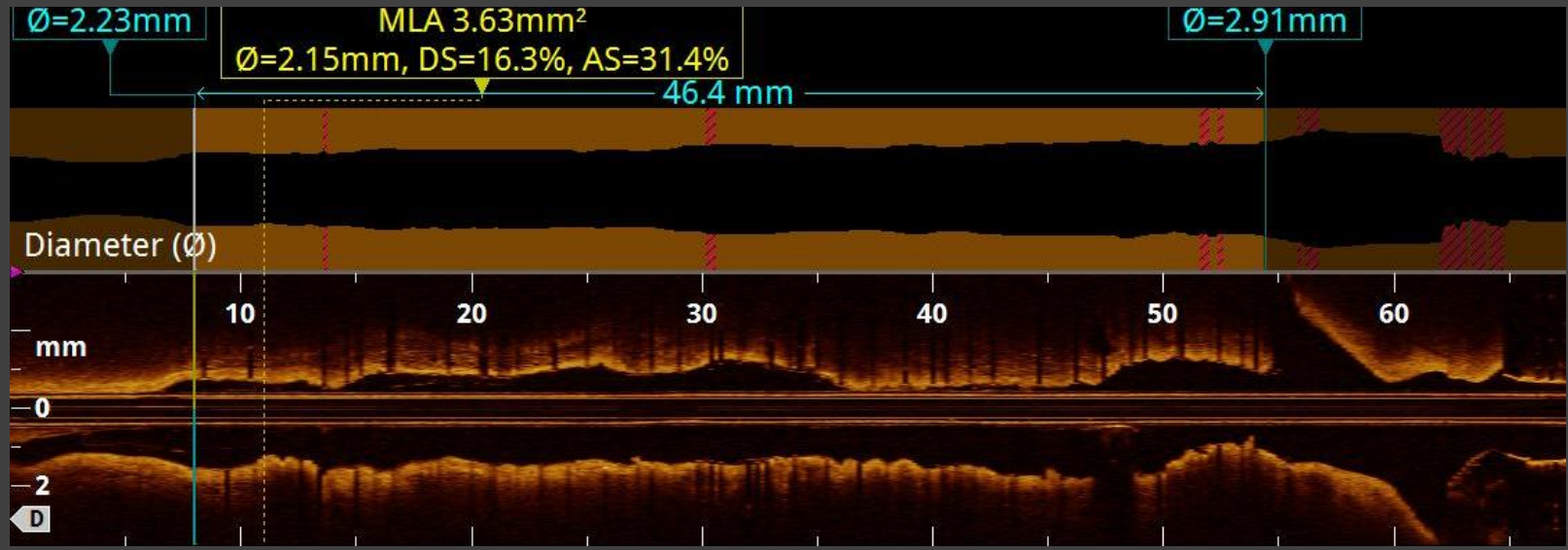
EES : 2.5*26mm / 2.75*26mm (14atm.)


Post-PCI
1 mm
Ø=2.22mm
MLA 3.63mm²
Ø=2.15mm, DS=16.2%, AS=31.2%
Ø=2.91mm
46.6 mm
Diameter (Ø)
10
20
30
40
50
60
mm
mm
D
P

Post-PCI

Distal reference ***MSA site*** ***Prox. Reference***





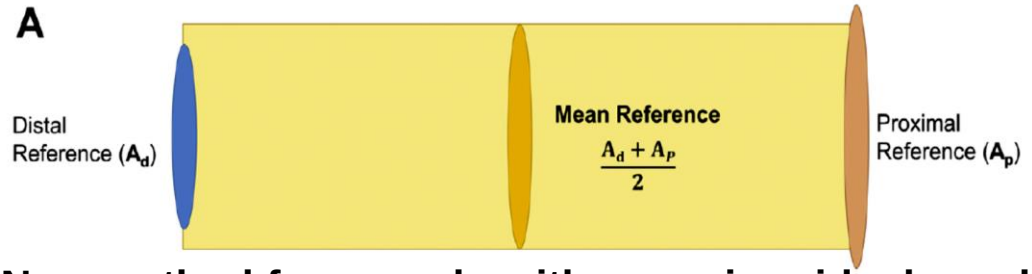
Procedural Impact of OCT on Coronary Intervention

- Angio-co-registration may allow us to understand the lesion and reference site on angiography and OCT at the same time.

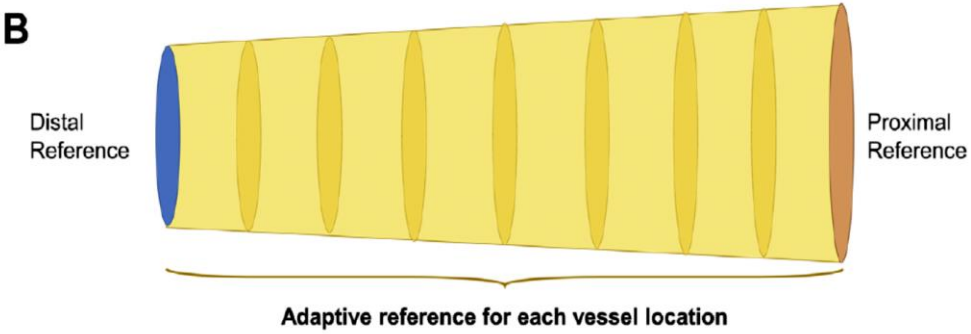
Volumetric Stent Expansion Assessment

Nakamura D, et al. J Am Coll Cardiol Intv 2018;11:1467-1478

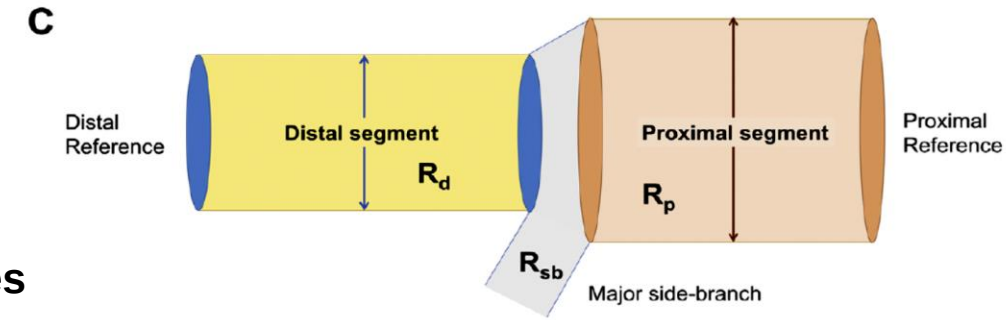
Conventional Method



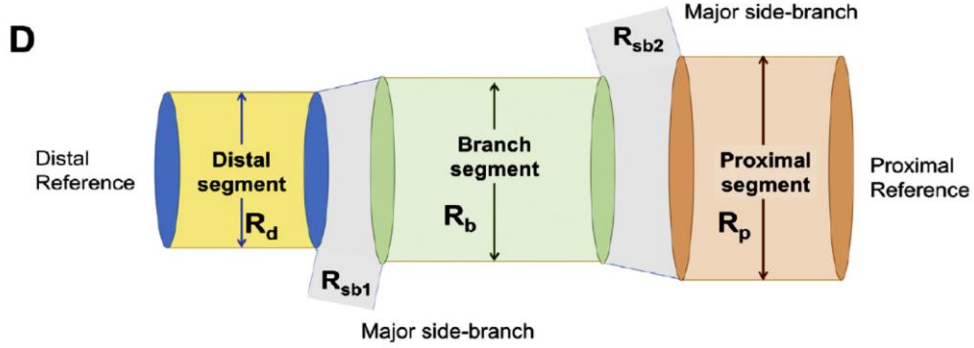
New method for vessels with no major side -branches



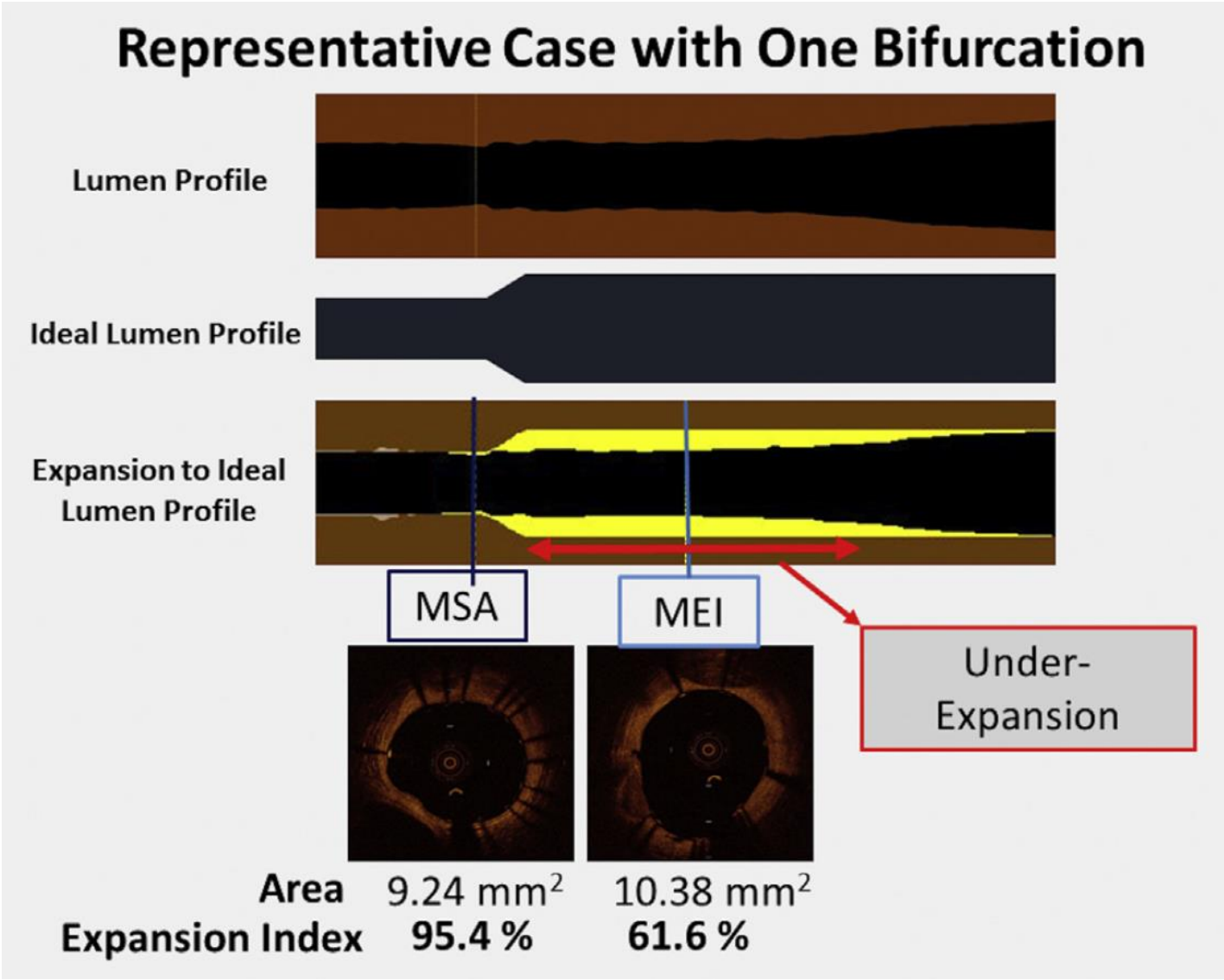
Method for vessels with 1 major side -branches



Method for vessels with 2 major side -branches



Representative Case with One Bifurcation



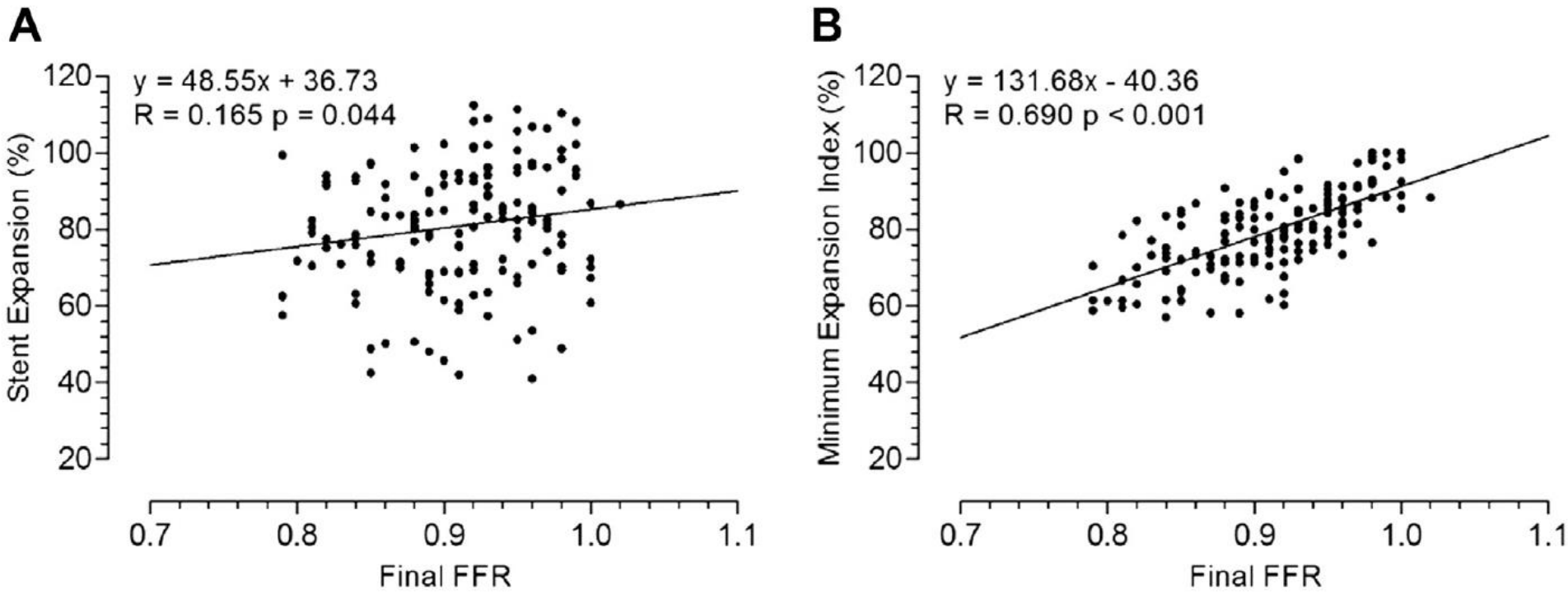
Normalized Expansion Index Value = actual lumen area / ideal lumen area x 100

MEI = cross section with lowest expansion index along the entire stented segment

Nakamura D, et al. J Am Coll Cardiol Intv 2018;11:1467-1478

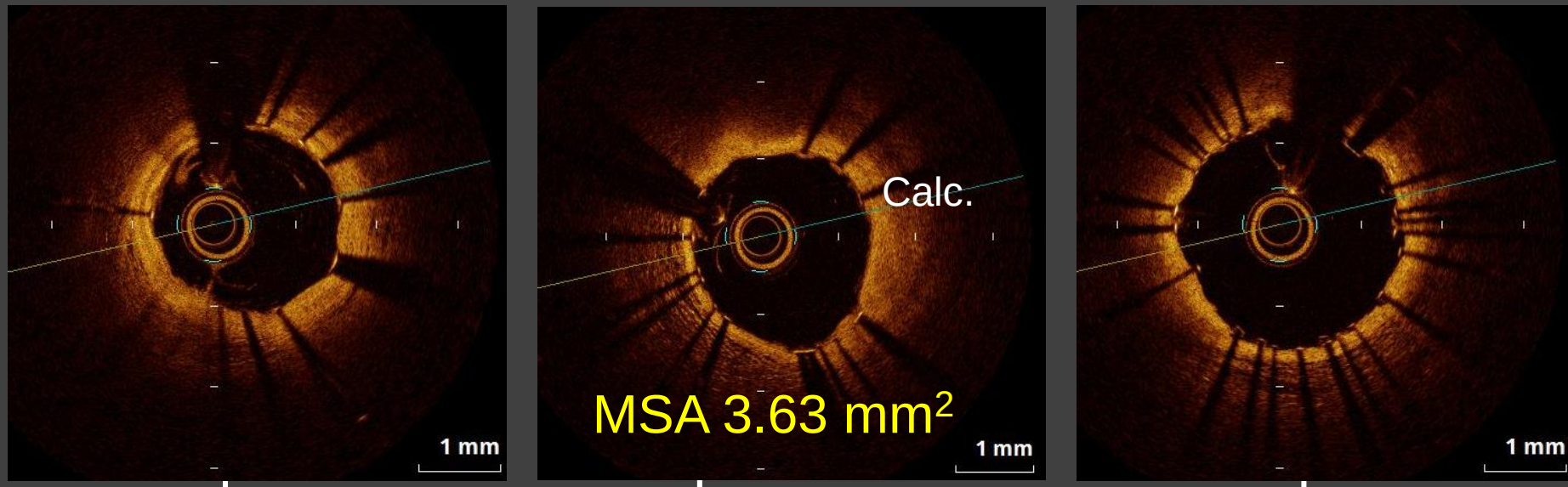
Correlation of %AS with Final FFR Value for Conventional Method and New Volumetric Method

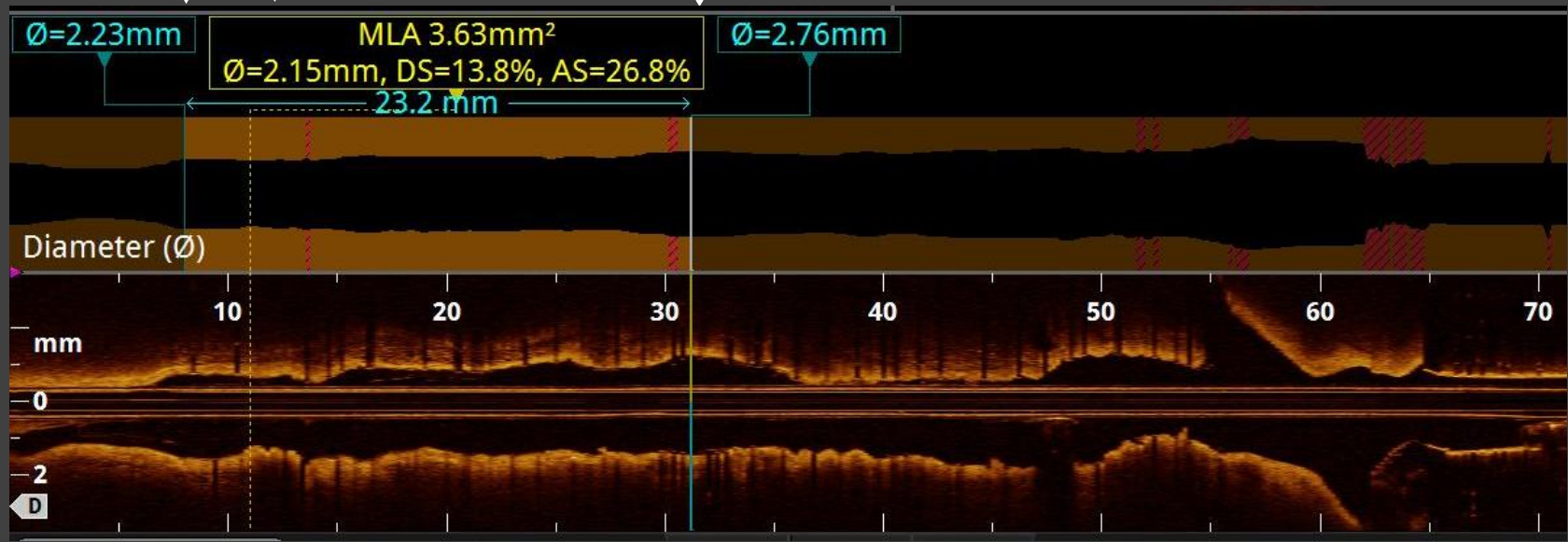
Nakamura D, et al. J Am Coll Cardiol Intv 2018;11:1467-1478



Post-PCI

Distal reference ***MSA site*** ***Prox. Reference***

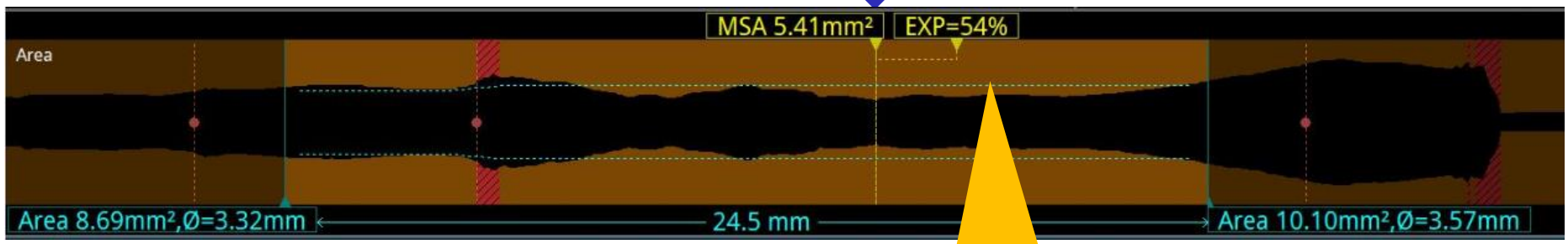




Calculation of Stent Expansion: Taper Reference

- Calculation of ideal lumen frame by frame based on proximal & distal lumen
- Ideal lumen is demonstrated based in HK Model taking the branch diameter into account
- Stent expansion (EXP%) can be assessed frame by frame based on this ideal reference

Cross section with lowest expansion index along the entire stented segment
EXP%= (Stent area/Reference area)



Distal Reference Area

Autodetection of branch & area

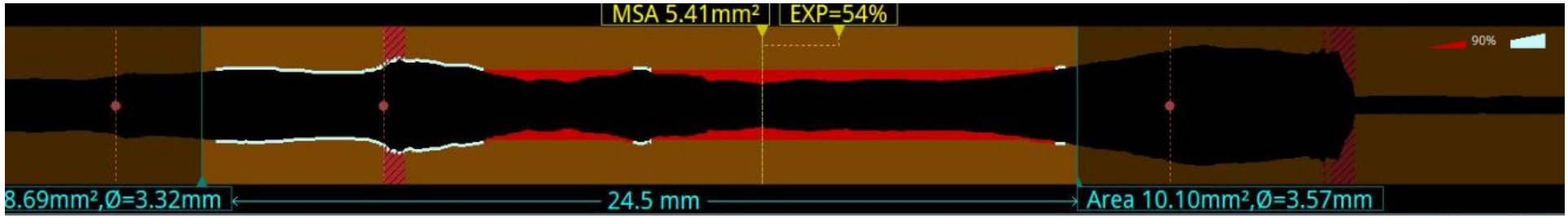
Demonstration of ideal expansion taking distal & proximal reference & side branch diameter into account

Proximal Reference Area

Calculation of Stent Expansion: Taper Reference

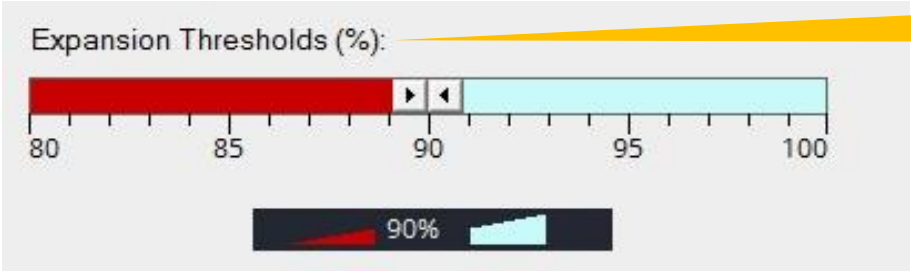
- Calculation of ideal lumen frame by frame based on proximal & distal lumen
- Ideal lumen is demonstrated based in HK Model taking the branch diameter into account
- Stent expansion (EXP%) can be assessed frame by frame based on this ideal reference

Demonstration of stent expansion indicator



Demonstration of stent expansion indicator after auto-detection of stent

- Underexpansion is demonstrated by red color (default is set as 90%)
- Well expanded stent is demonstrated by white blue



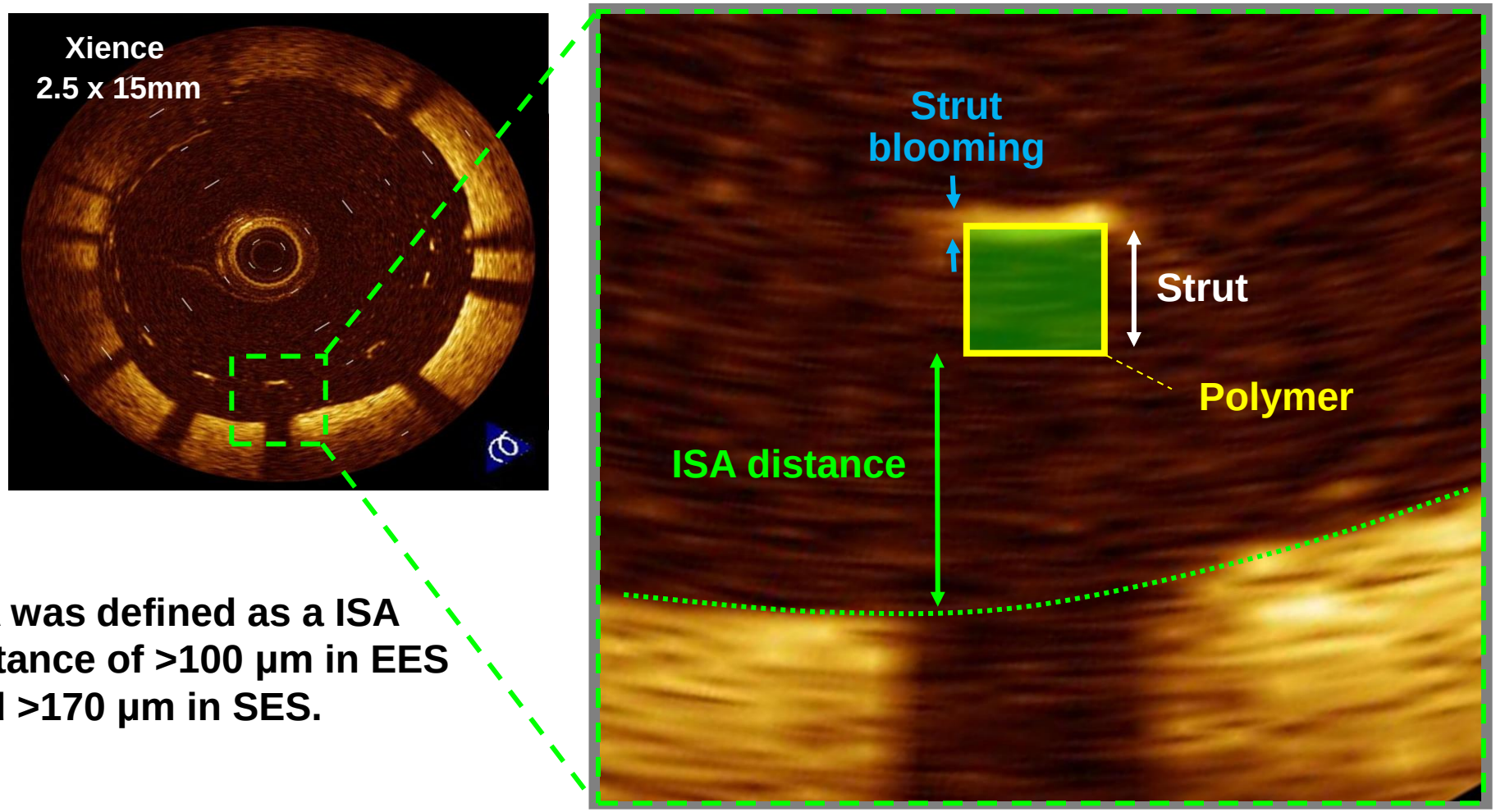
Thresholds can be set individually
2 different (color) set is available

Procedural Impact of OCT on Coronary Intervention

- **Angio-coregistration may allow us to understand the lesion and reference site on angiography and OCT at the same time.**

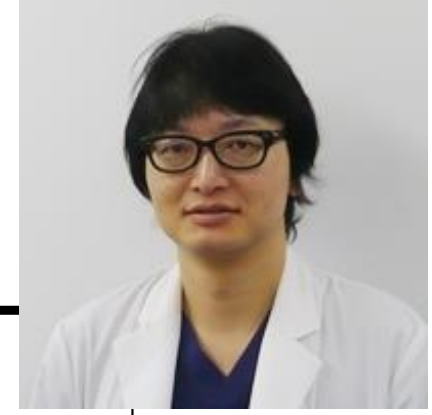
- **Newly developed expansion indicator can provide us the site and degree of under-expansion by color coded image.**

Definition of incomplete stent appostion (ISA)

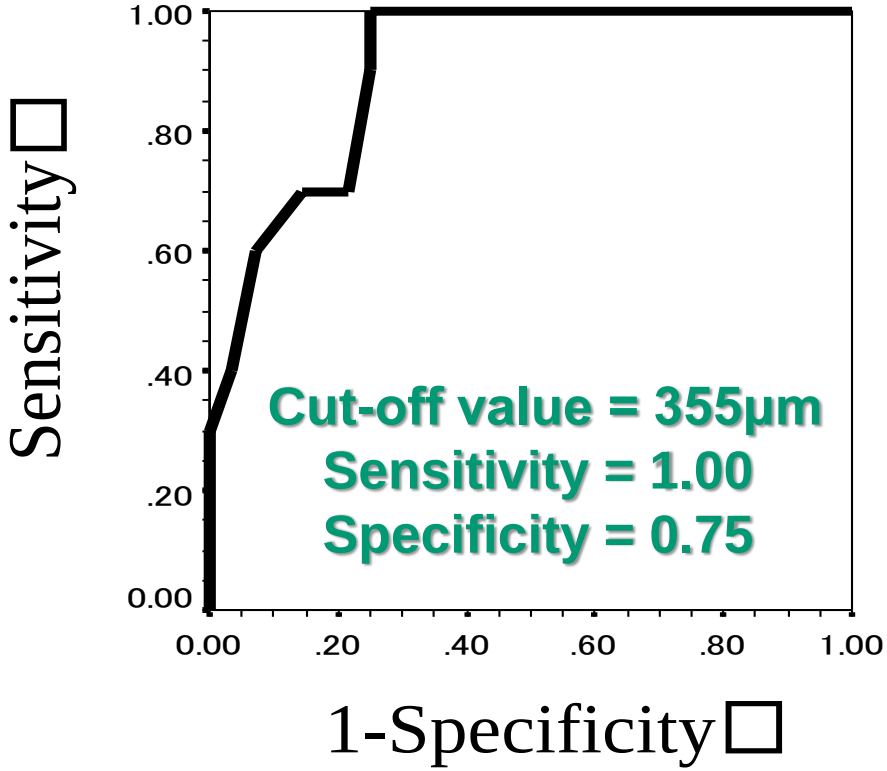


ISA was defined as a ISA distance of >100 μm in EES and >170 μm in SES.

ROC curve analysis of maximum ISA distance for predicting persistent ISA (Subanalysis of RESET study)

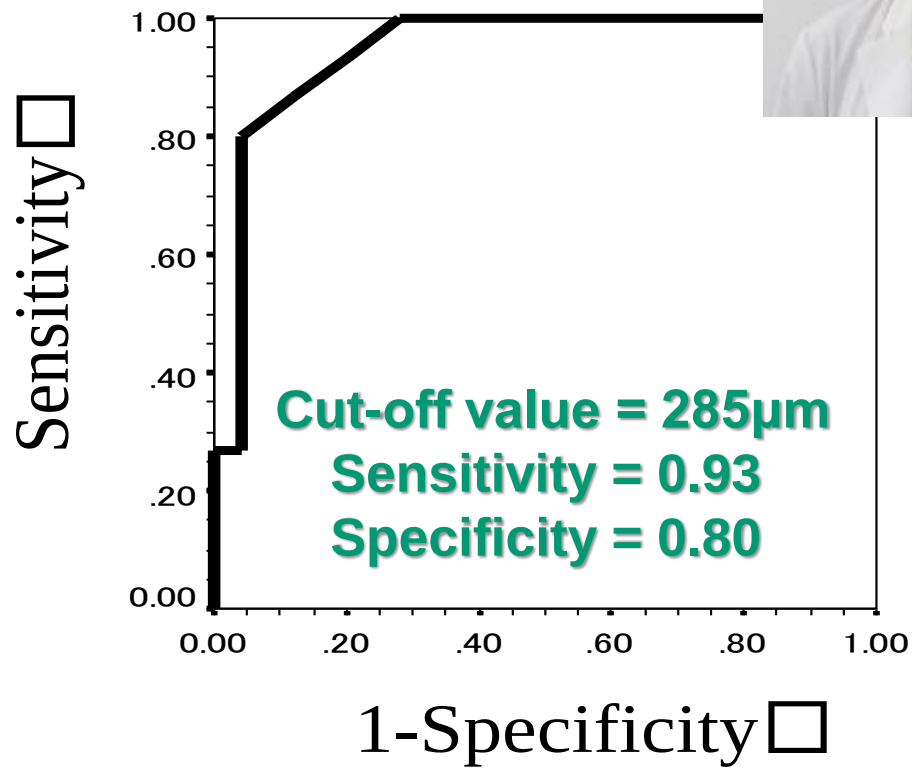


EES



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).

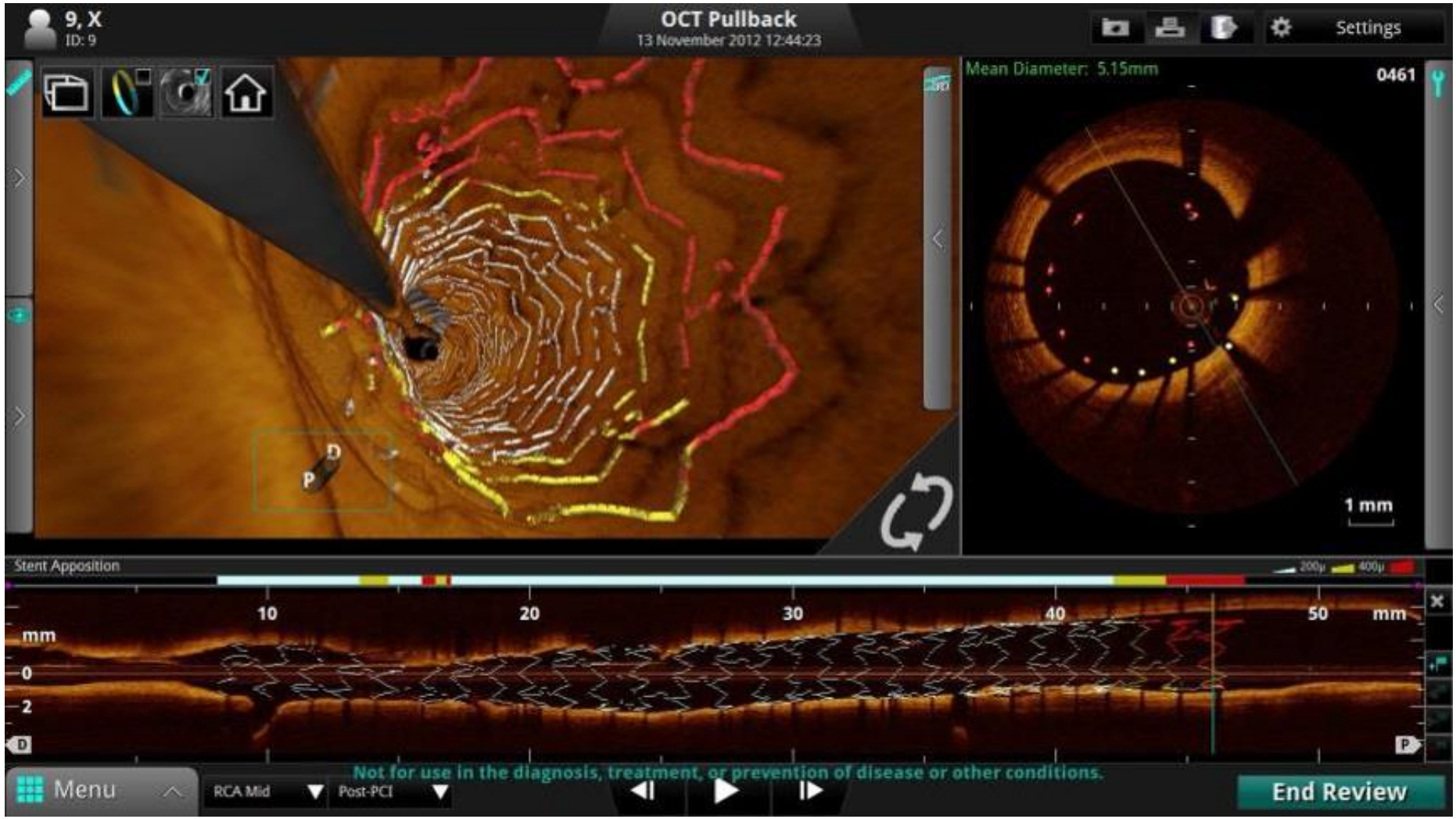
SES



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).

Shimamura K. et al, Eur Heart J CV Imaging 2015;16:23-28

New Development in OCT

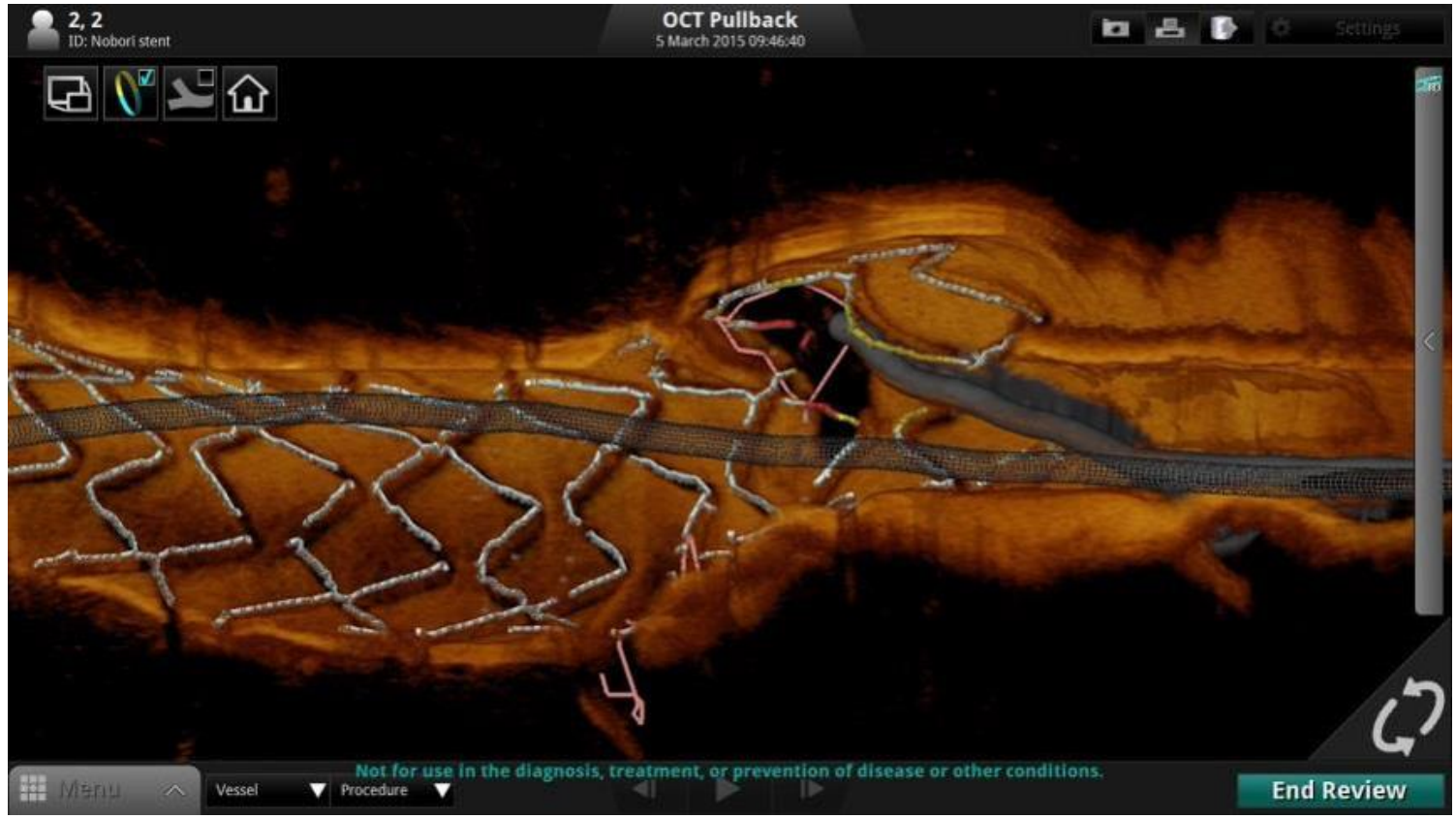


3-D reconstruction and auto-detection of stent incomplete apposition can be demonstrated as fly through image by new OCT.

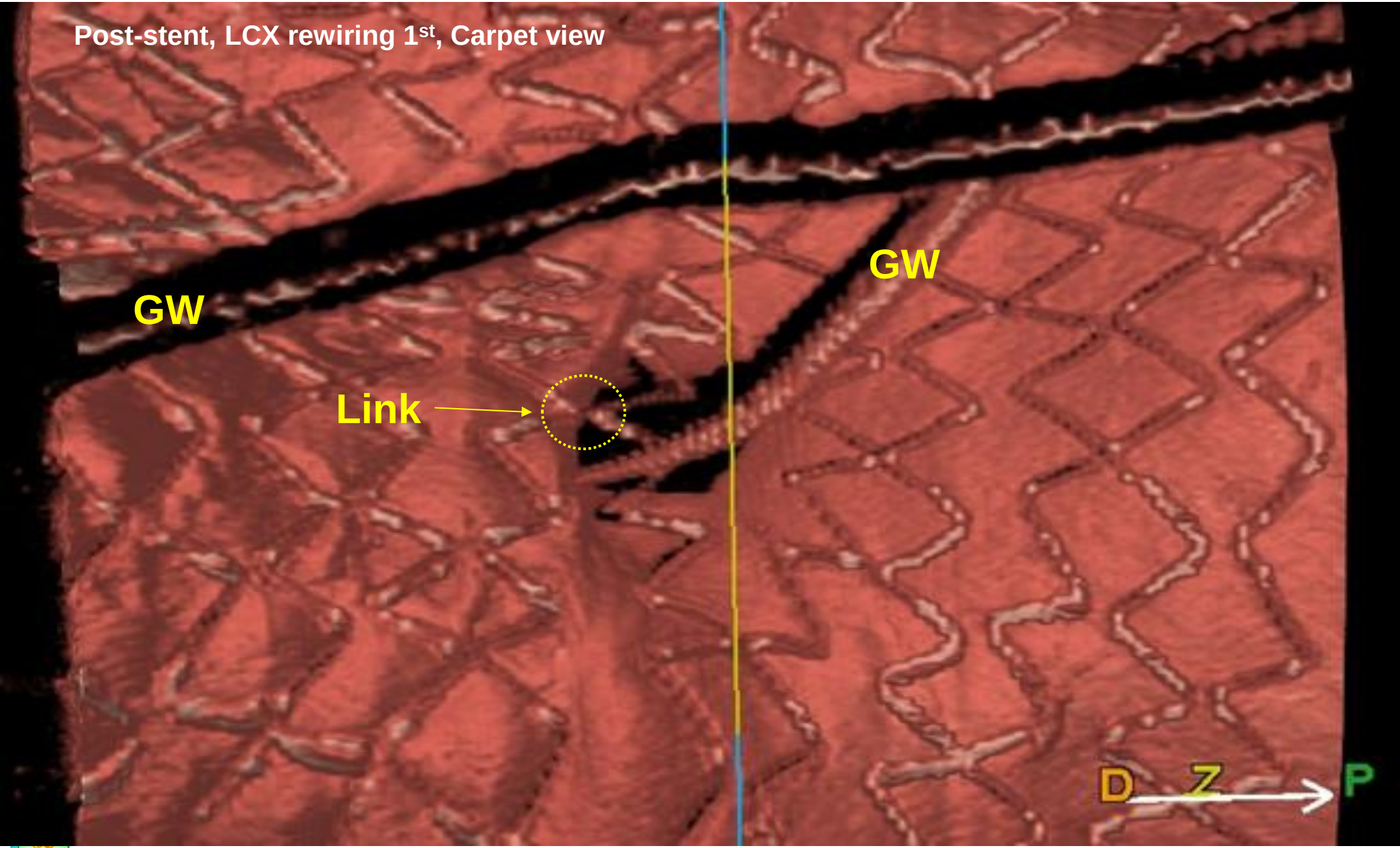
Procedural Impact of OCT on Coronary Intervention

- Angio-coregistration may allow us to understand the lesion and reference site on angiography and OCT at the same time.
- Newly developed expansion indicator can provide us the site and degree of under-expansion by color coded image.
- Apposition indicator demonstrates the site and degree of incomplete apposition by color coded bar and 3D-image.

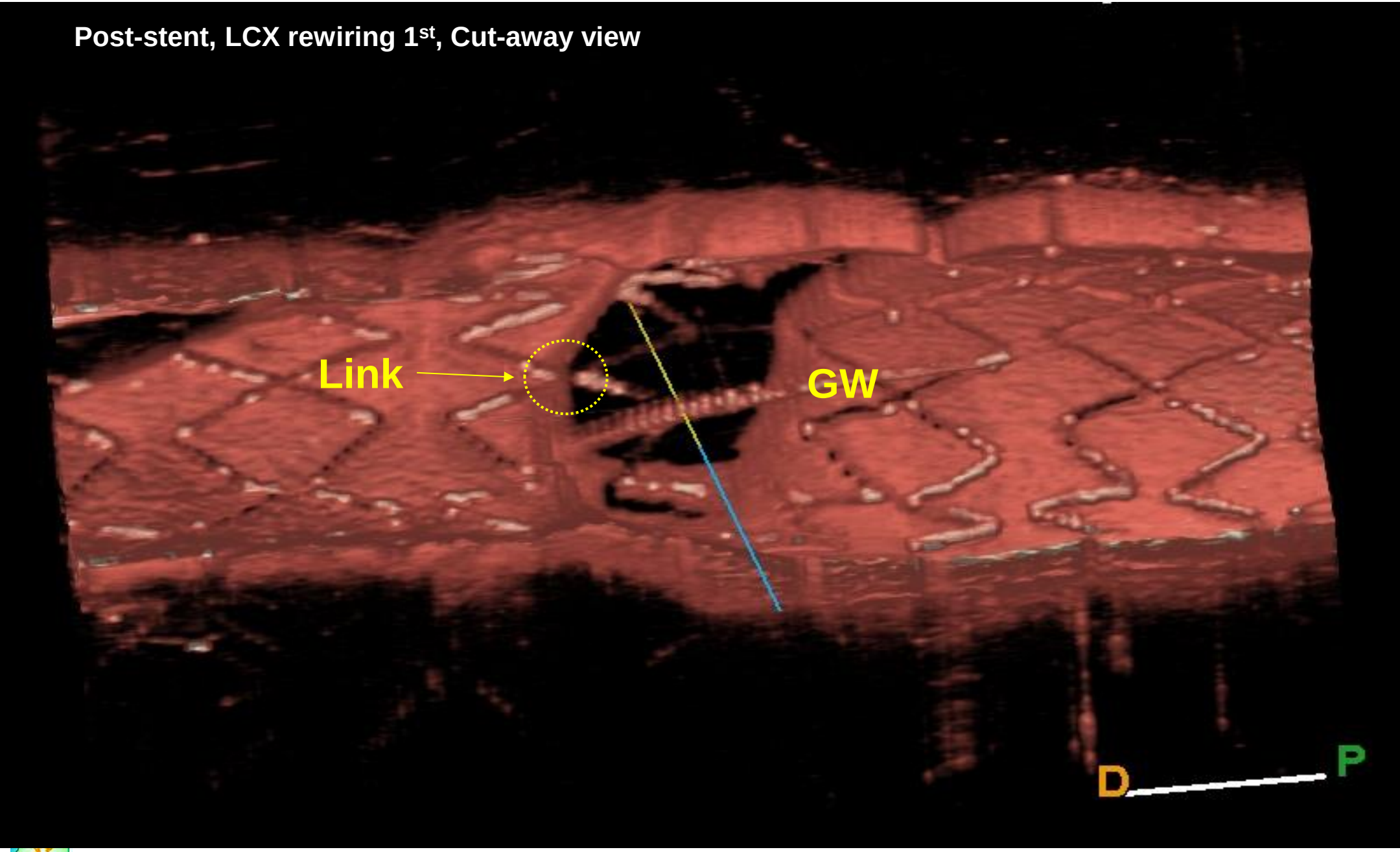
New Development in OCT



Re-crossing wire position in the jailed side branch can be easily identified by newly developed OCT software and improvement of side branch KBT procedure could be expected by the guidance of new OCT.


Post-stent, LCX rewiring 1st, Carpet view
GW
GW
Link
D
Z
P

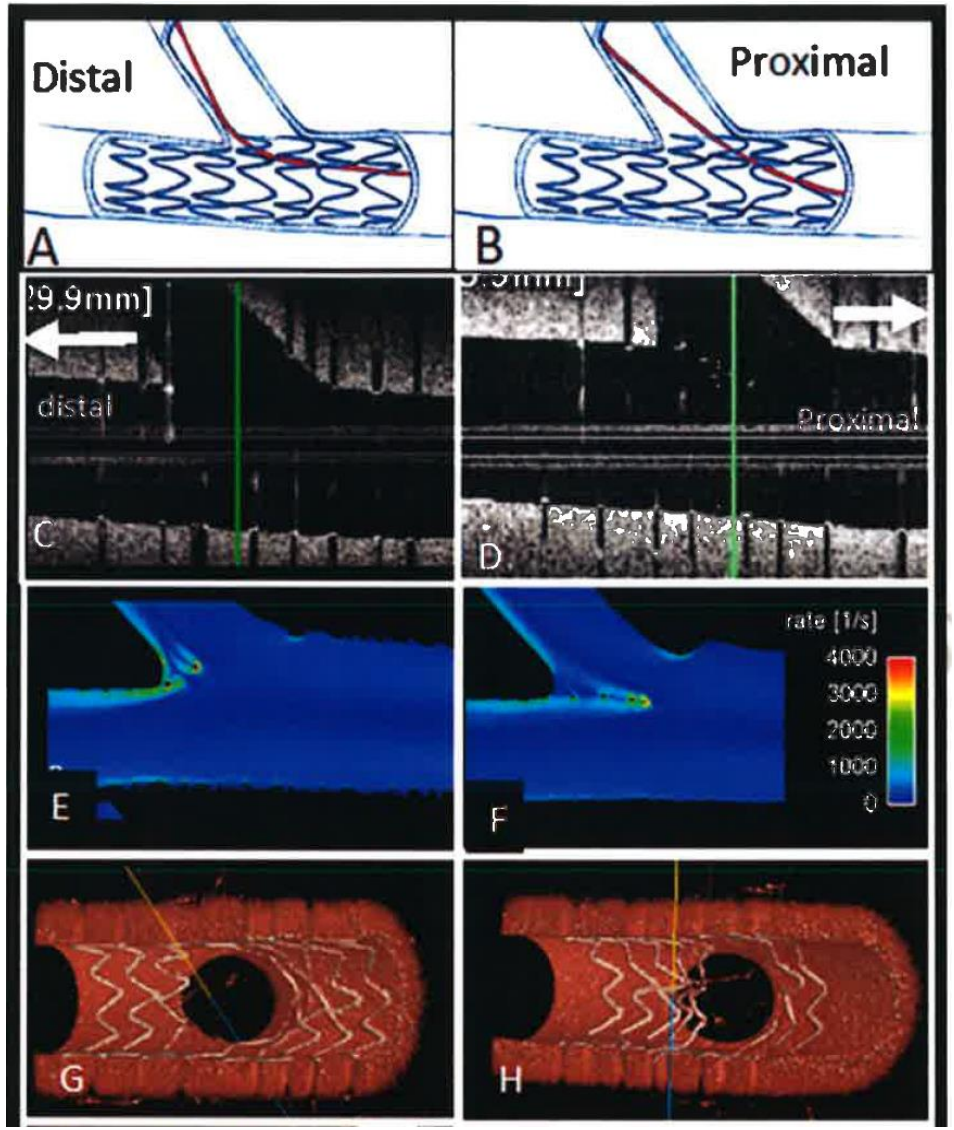
Post-stent, LCX rewiring 1st, Cut-away view



Impact of the rewiring position

Strut malapposition & shear stress

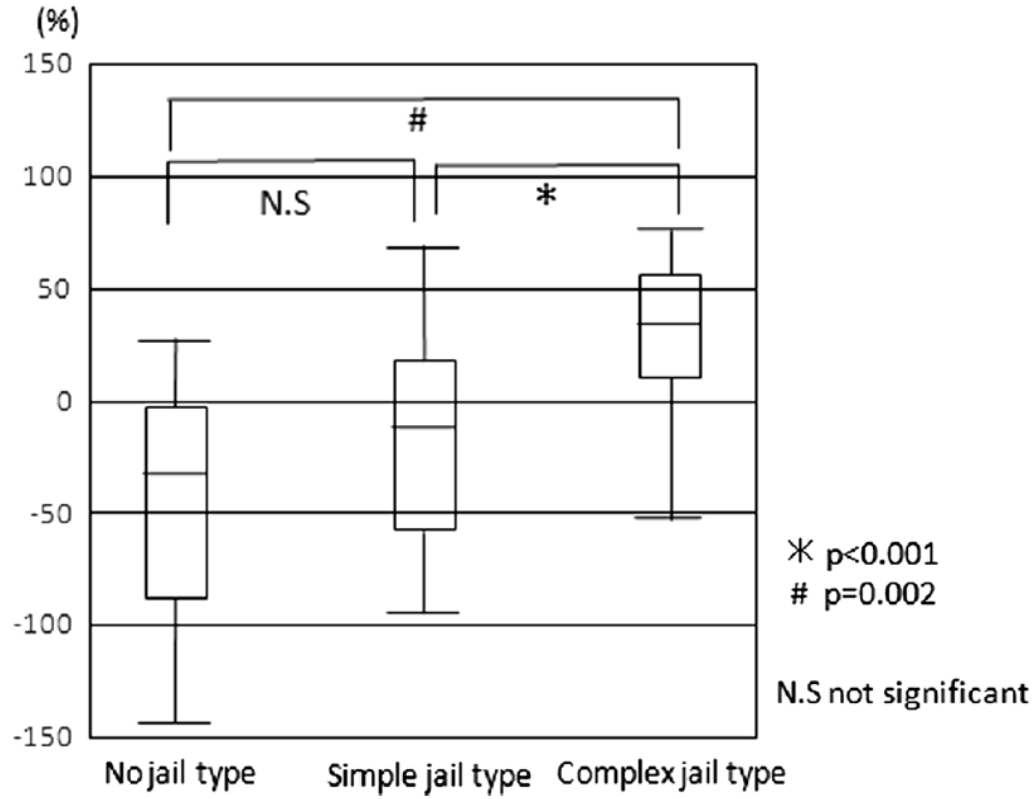
Onuma Y, et al. EuroInterv 2018, doi: 10.4244/EIJ-D-18-00391



Comparison of % reduction of the side branch flow area

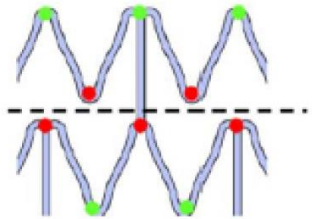
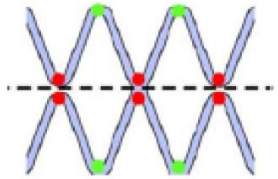
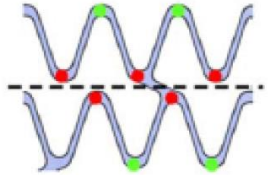
Comparison among each jailed type

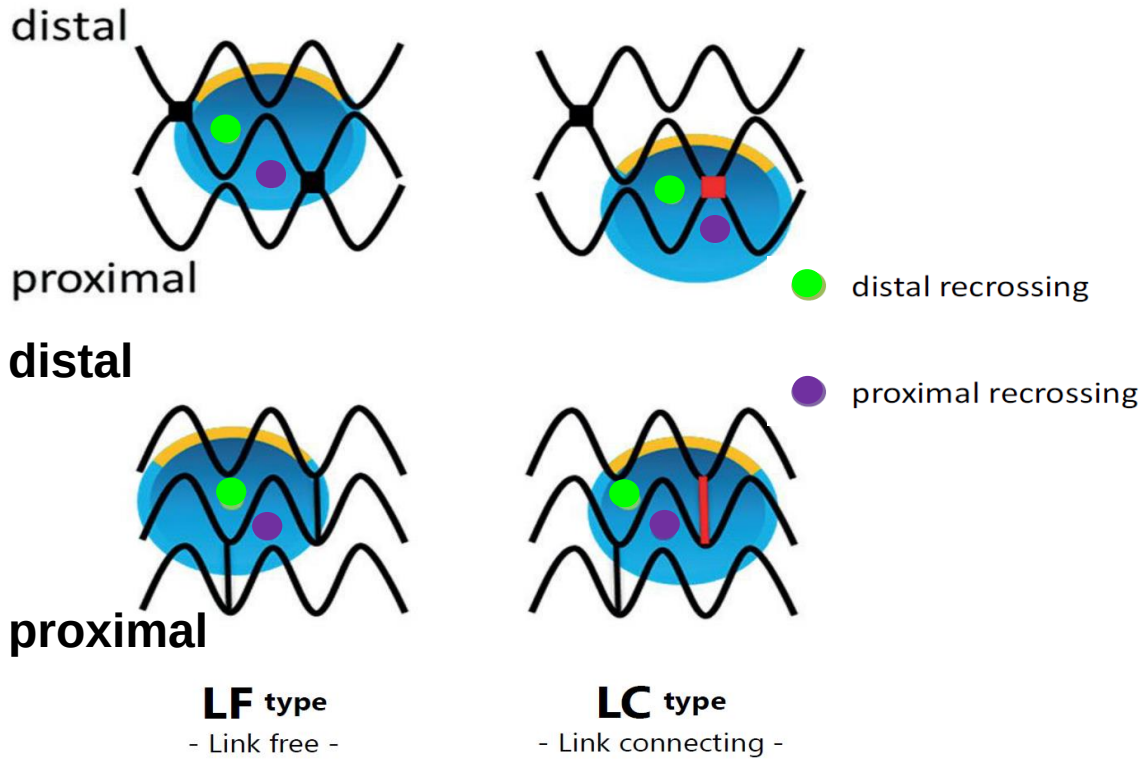
Nakamura T, et al. Int J CV Imag 2017;33: 797 – 806



Residual stent strut on the surface of bifurcation orifice may reduce the side branch flow area during follow up.

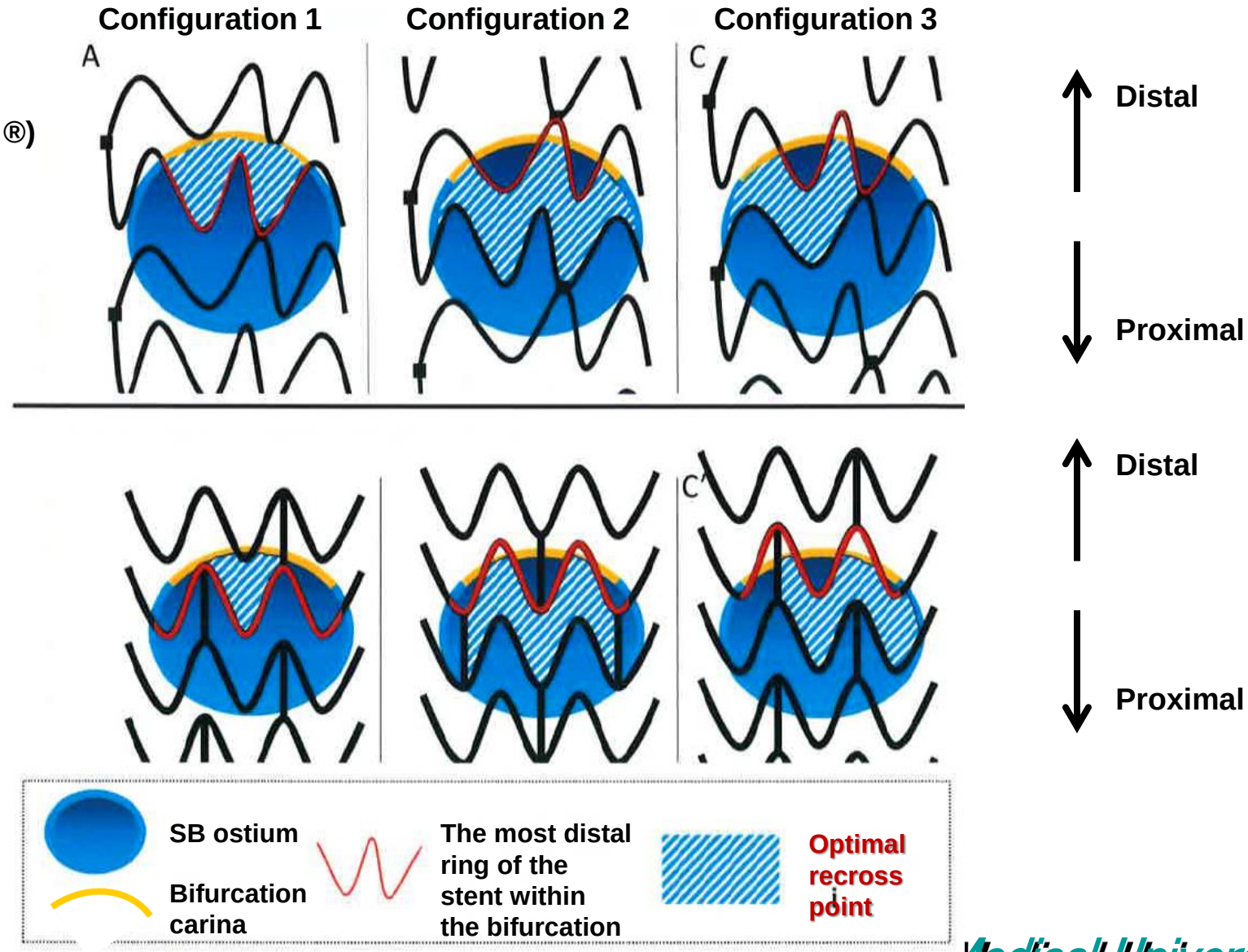
Stent design based on the rink position & wire re-cross point at bifurcation orifice

Peak to Valley (P-V) DES	Peak to Peak (P-P) DES
XIENCE	Synergy Resolute Onyx Ultimaster
	Peak to Peak  Offset Peak to Peak 

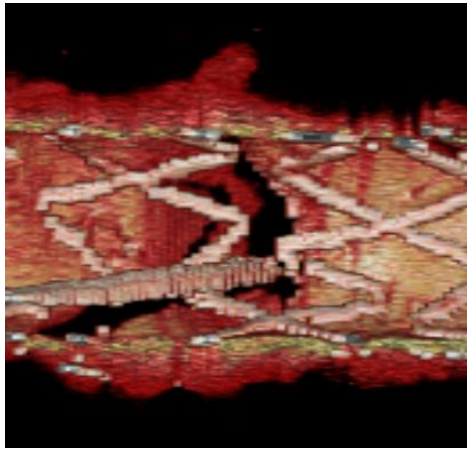


Optimal rewiring point in side branch ostium according to different configurations of overhanging struts

Onuma Y, et al. EuroInterv 2018;accepted

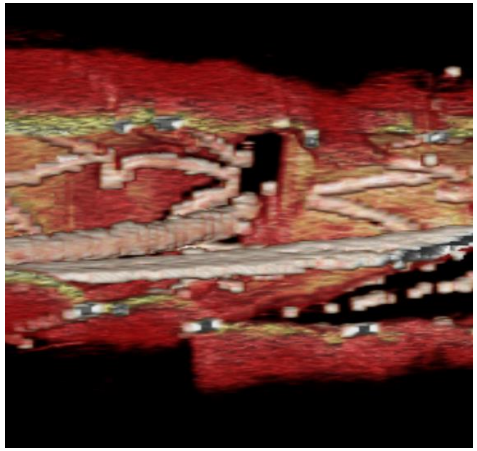


Relation between stent link & side branch orifice



Stent link did not locate at side branch orifice:

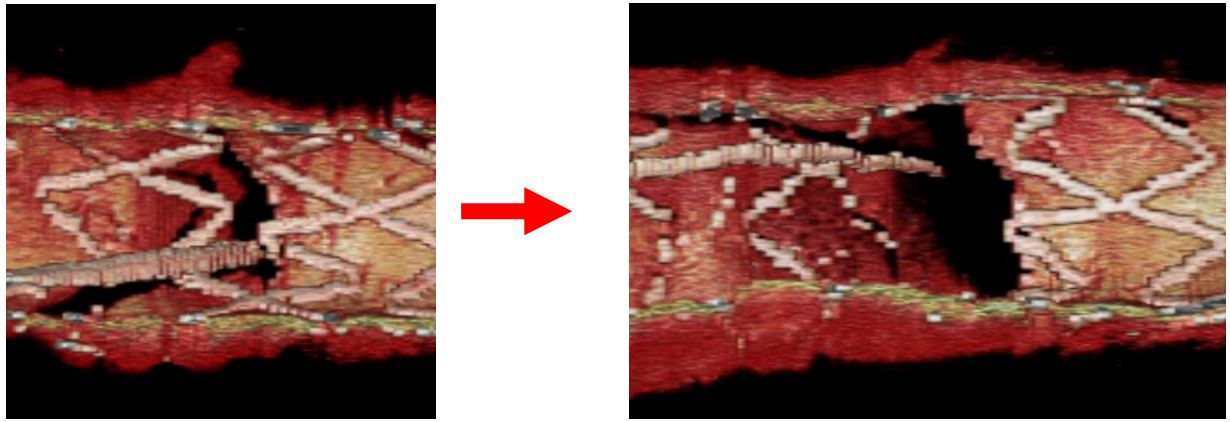
Link Free type



Optimal GW re-cross point:

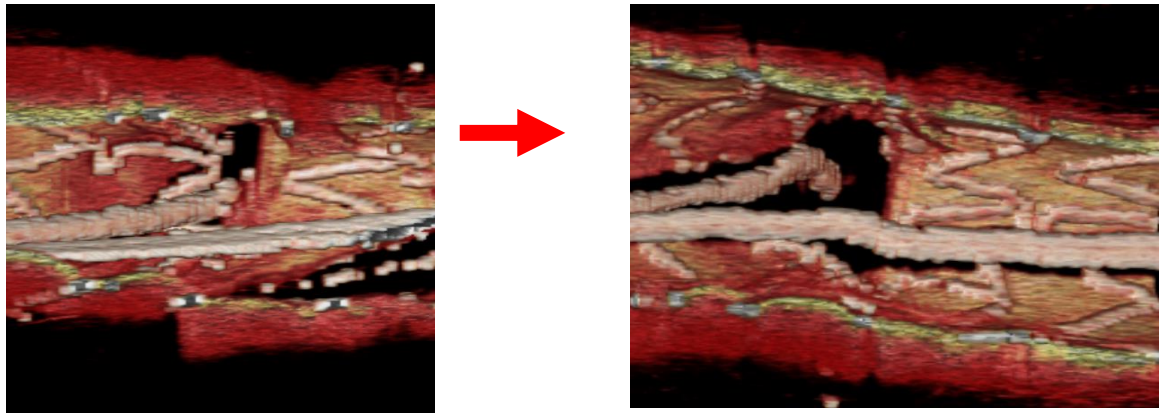
Distal cell close to carina

Link Free type



GW distal cell re-cross and KBT

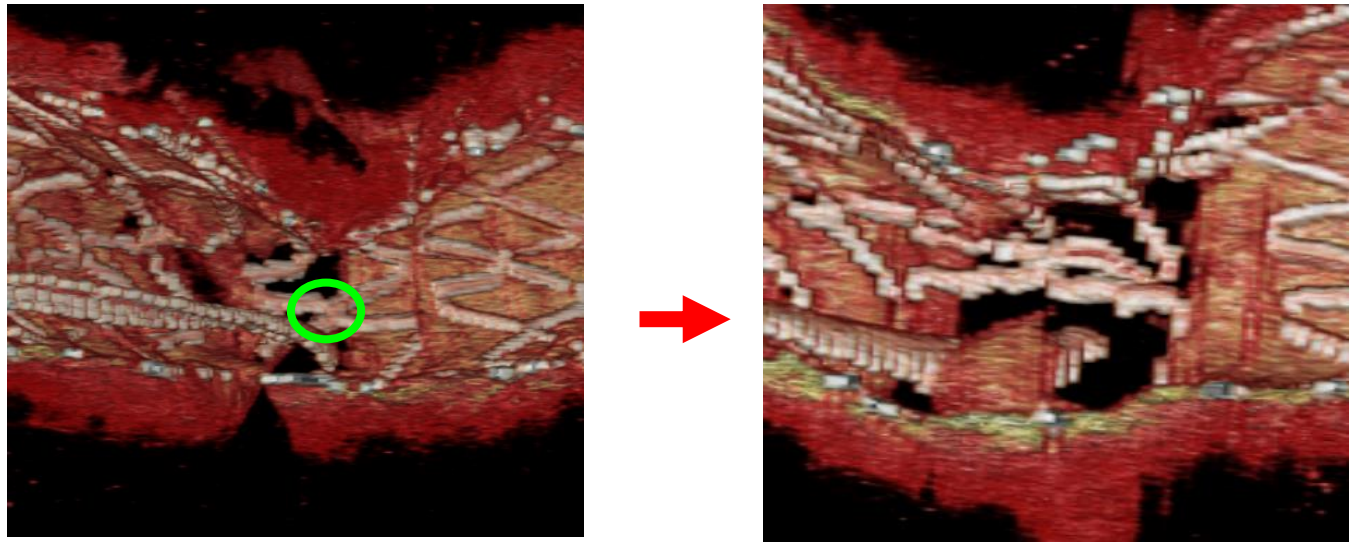
Kissing ballooning



Optimal

Relation between stent link & side branch orifice

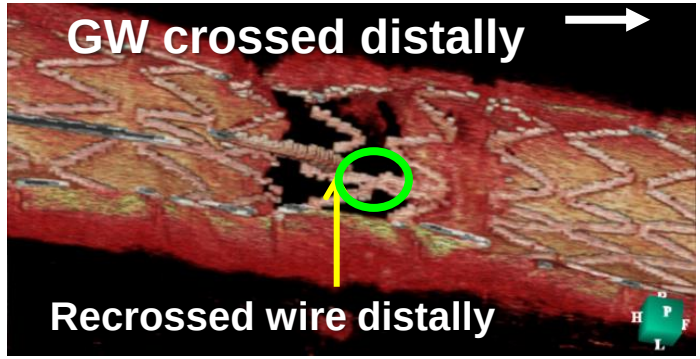
If the stent link locates closed to carina, it would be difficult to remove the jailed struts by KBT:
Link connecting to carina type

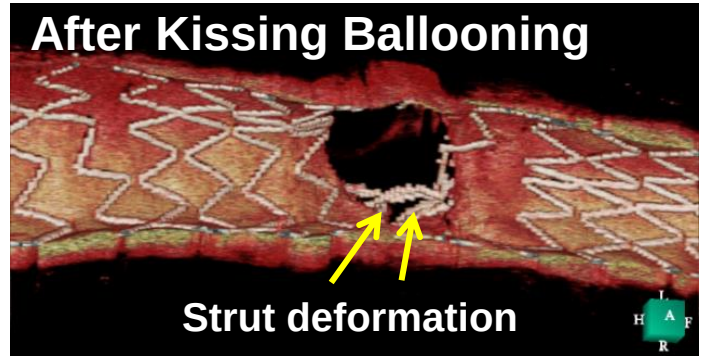


Suboptimal

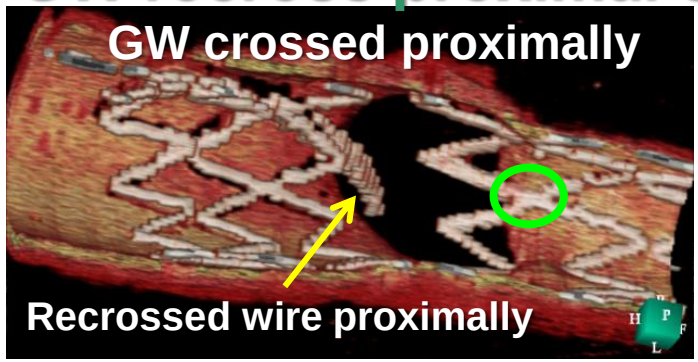
Link connecting to carina type

GW recross distal cell





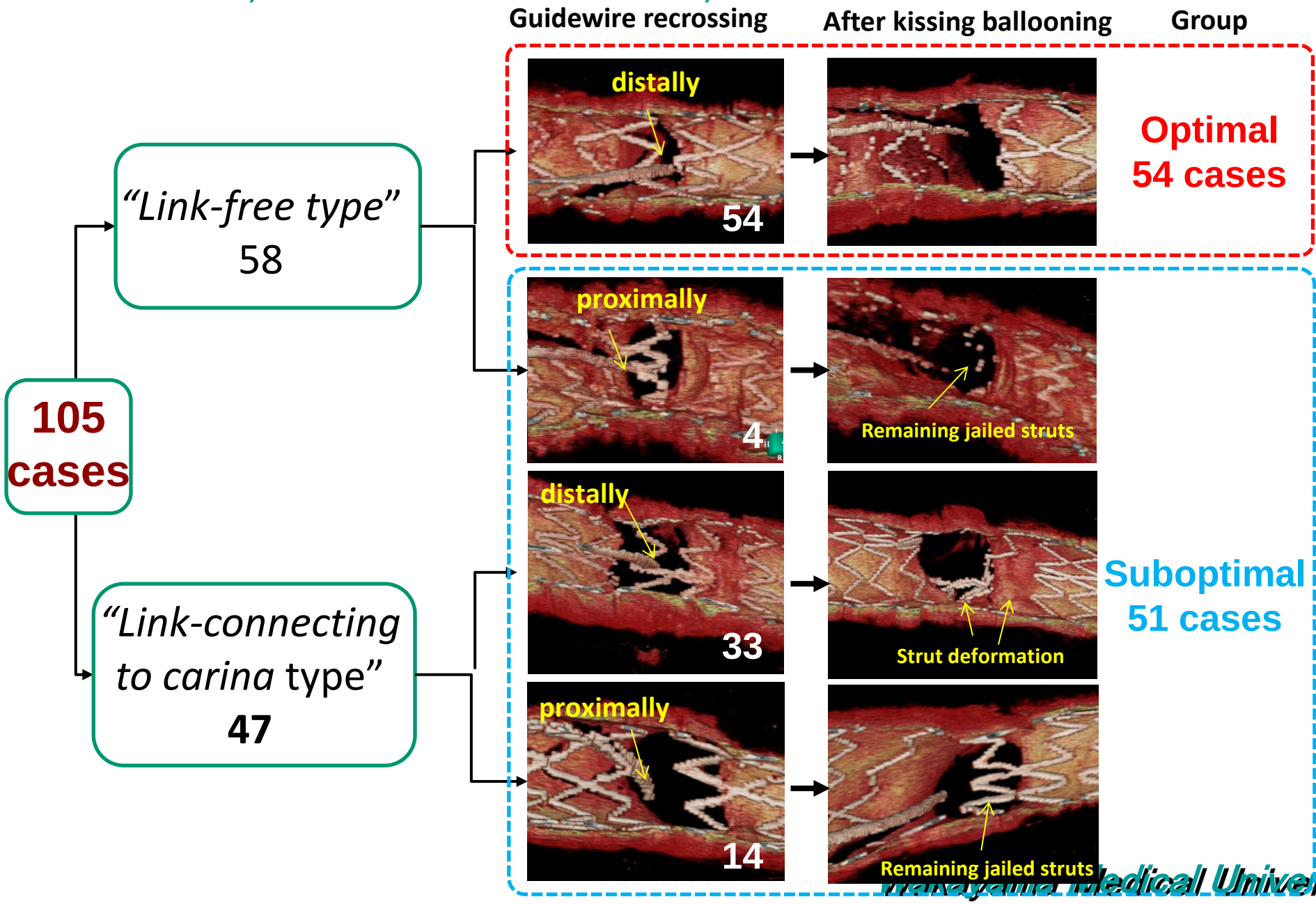
GW recross proximal cell



suboptimal

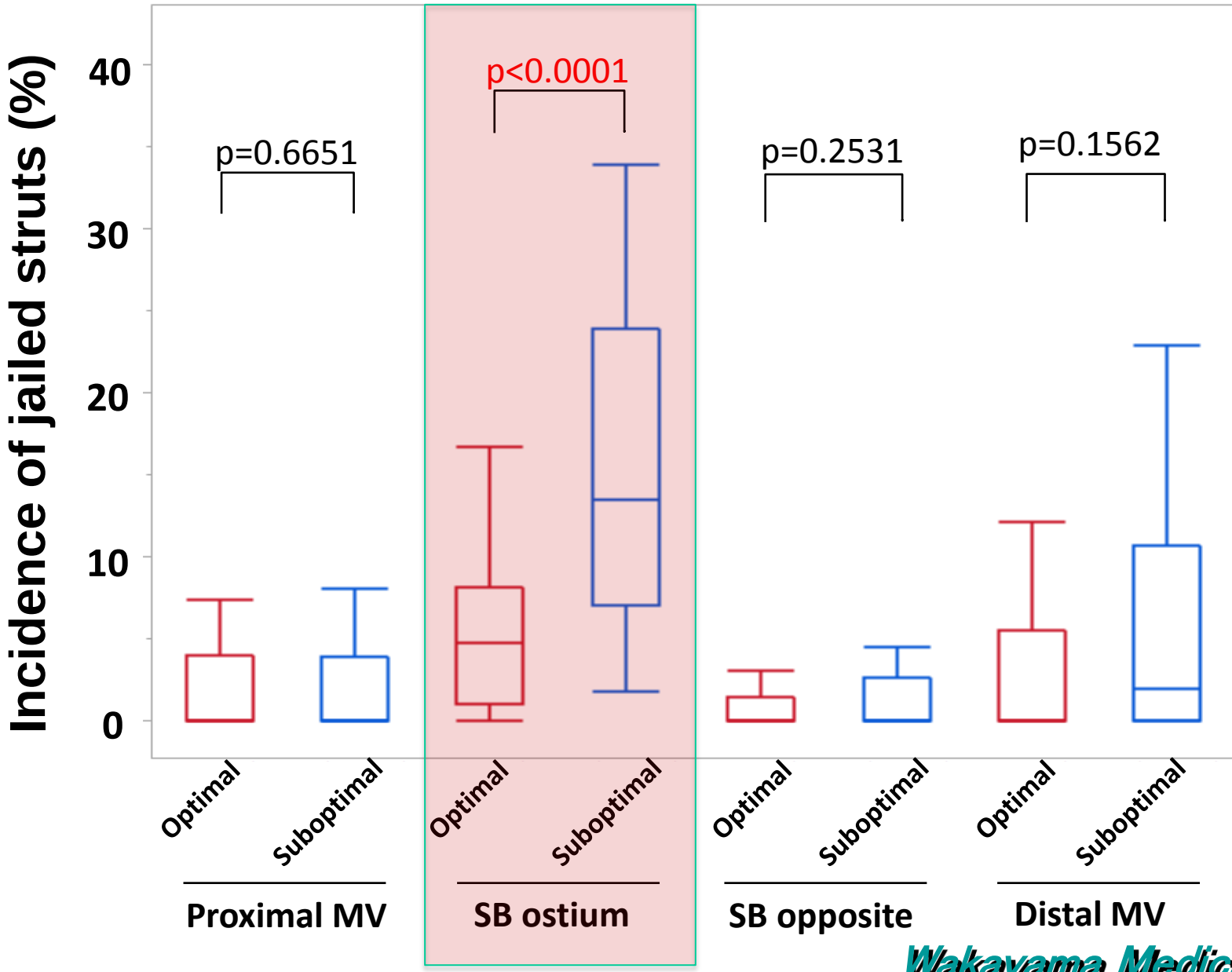
Frequency of jailing configuration & GW rewiring position

Okamura T, et al. EuroIntervention 2018;13:e1785-e1793



Incidence of ISA at each segment

Okamura T, et al. EuroIntervention 2018;13:e1785-e1793



Angiographic ISR at 9 Month

Okamura T, et al. EuroIntervention 2018;13:e1785-e1793

	All	Optimal	Suboptimal	P value
n	87	48	39	
ISR	12(13.8%)	4(8.3%)	8(20.5%)	0.1254
PMV	0(0%)	0(0%)	0(0%)	-
DMV	1(1.1%)	1(2.1%)	0(0%)	1.0000
Side Br Orifice	12(13.8%)	4(8.3%)	8(20.5%)	0.1254

Japanese registry for 3-D OCT guided bifurcation stenting

Study population

600 bifurcation lesions

Side branch opening guided by 3-D OCT:400
Optimal
Suboptimal

No side branch opening:200

Primary endpoint

Incidence of side branch restenosis at 1 year.

Secondary endpoint

MACE at 3 years

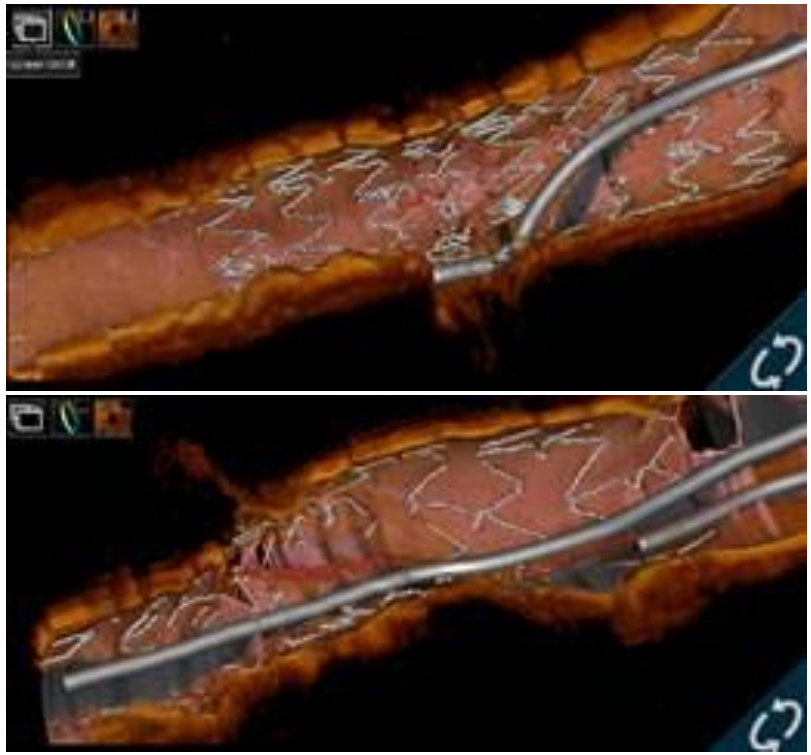
PI

Dr. Junya Shite (Osaka Nakatsu Saiseikai Hospital)

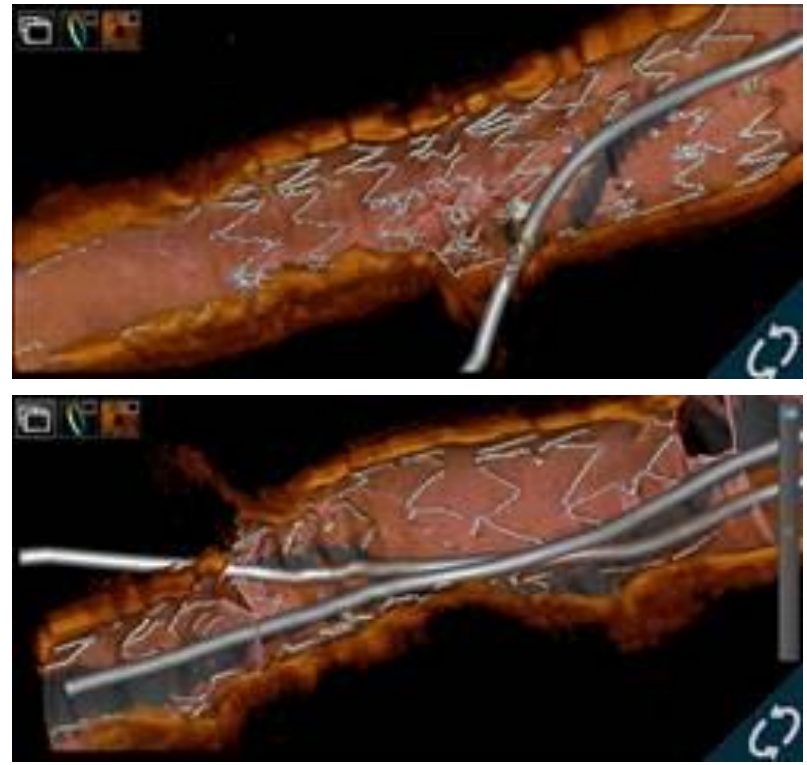
Improvement of auto detection of 2nd GW at bifurcation site

- Detection of 2nd GW to side branch improves significantly, and wire position is visualize more easily compared with the present system

Present



AptiVue

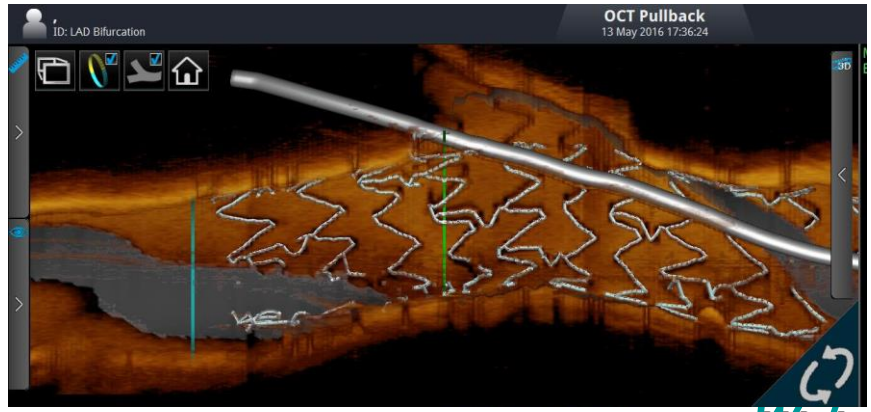


Improvement of 3-D stent rendering demonstration

Clear demonstration of stent strut & side branch wire by using bifurcation mode

Present

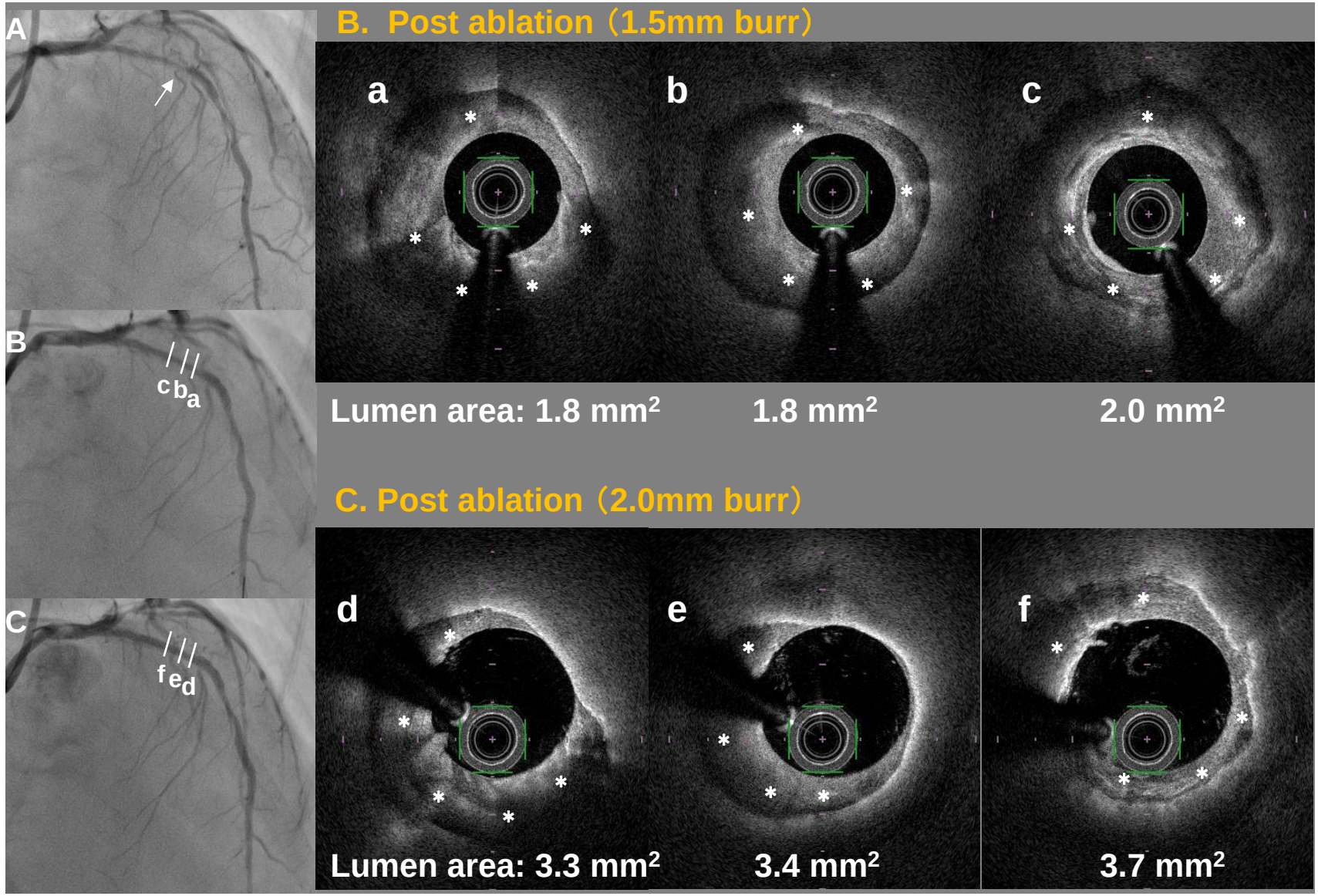
AptiVue



Procedural Impact of OCT on Coronary Intervention

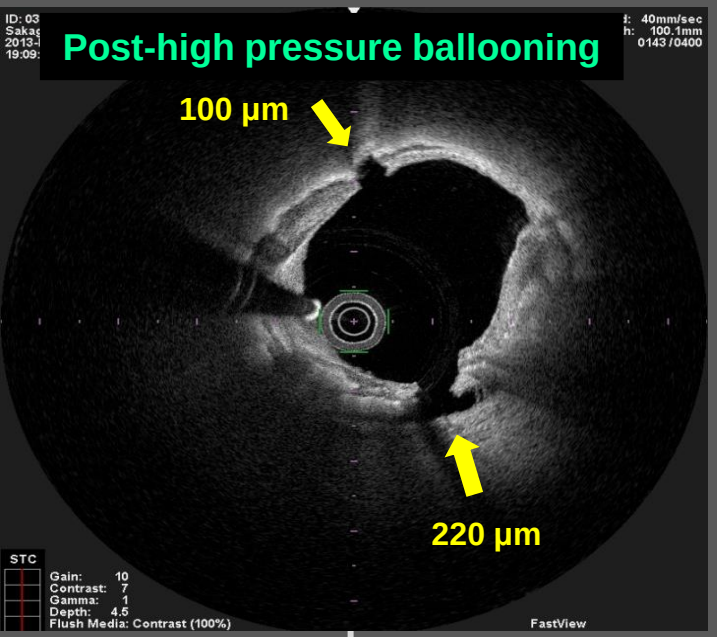
- Angio-coregistration may allow us to understand the lesion and reference site on angiography and OCT at the same time.
- Newly developed expansion indicator can provide us the site and degree of under-expansion by color coded image.
- Apposition indicator demonstrates the site and degree of incomplete apposition by color coded bar and 3D-image.
- 3D-reconstruction image might indicate the strut & rink position on the side-branch orifice precisely and demonstrate the relation between side-branch wire and stent cell in detail.

Case; 60's y.o. Female (Effort AP, Colon cancer)

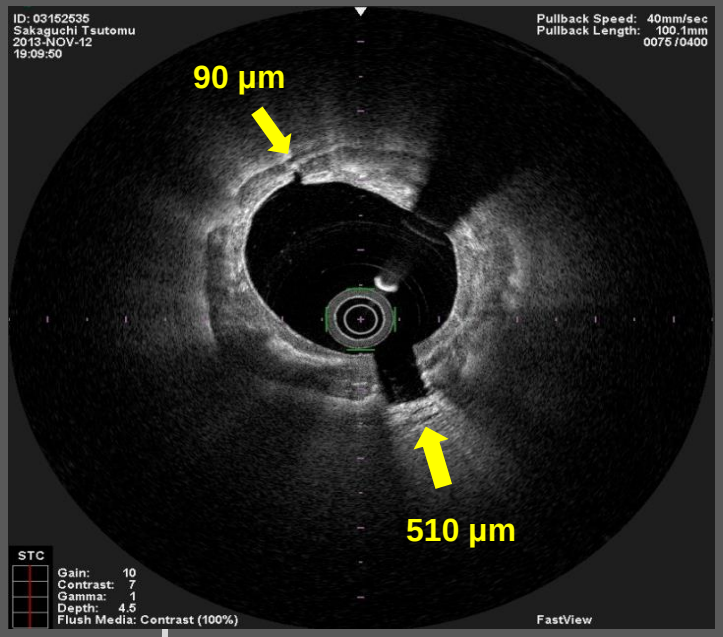


Non-stent strategy was selected because of colon cancer ope.

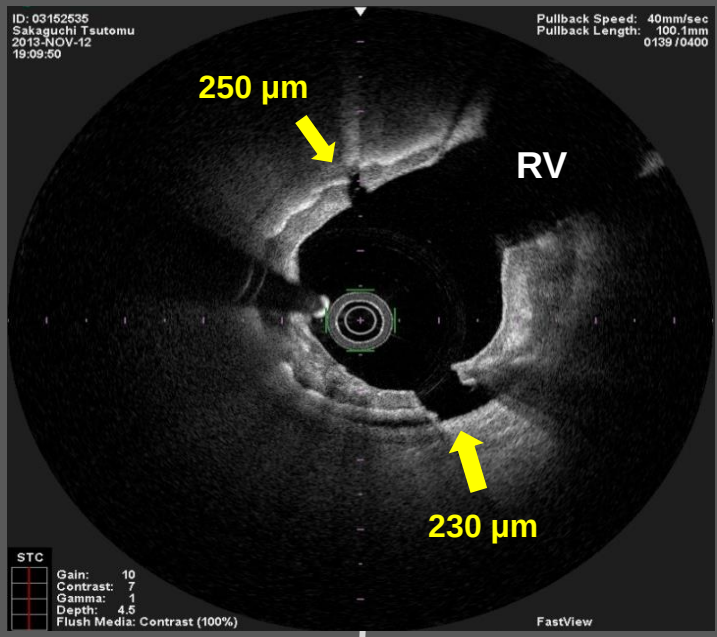
Broken calcium plate

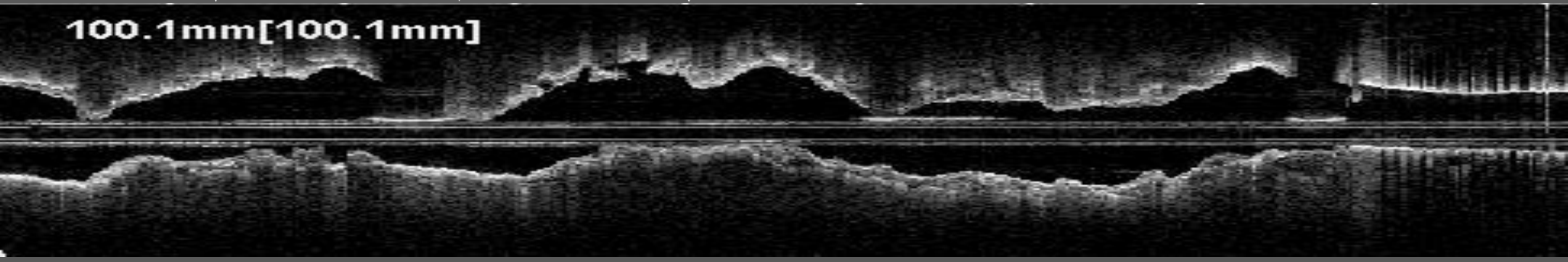


Broken calcium plate

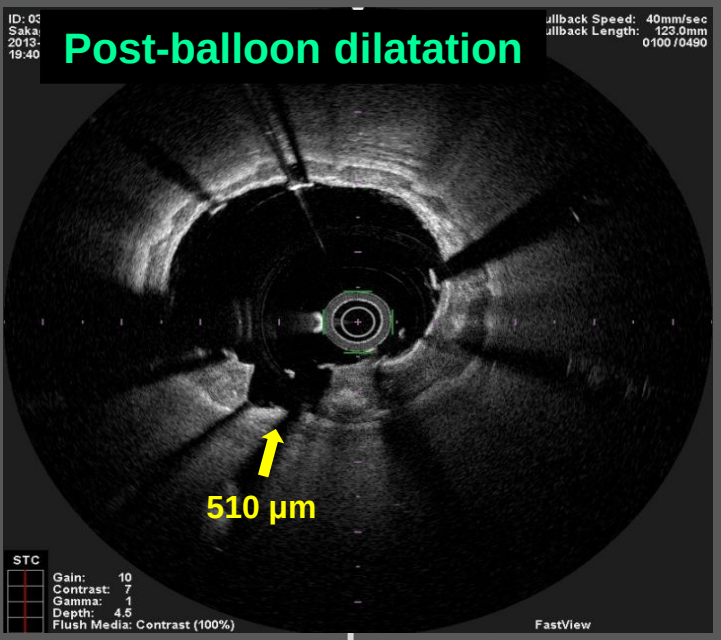


Broken calcium plate

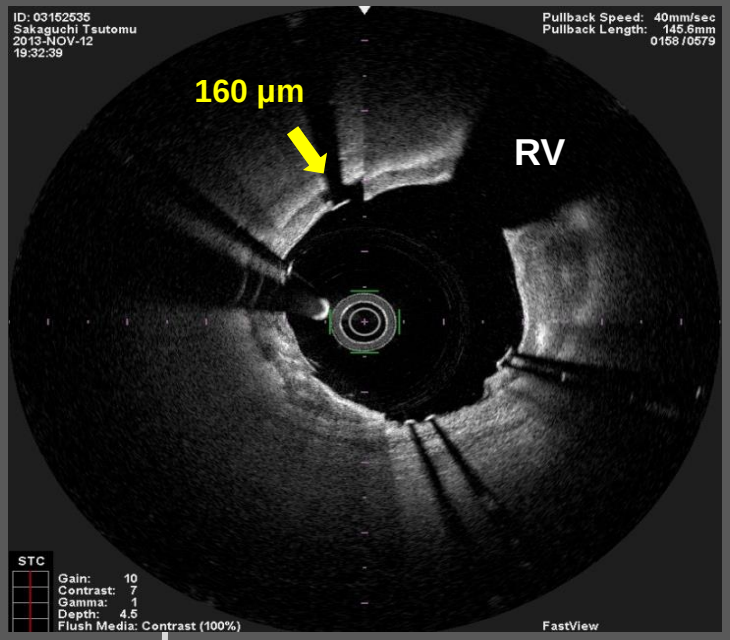




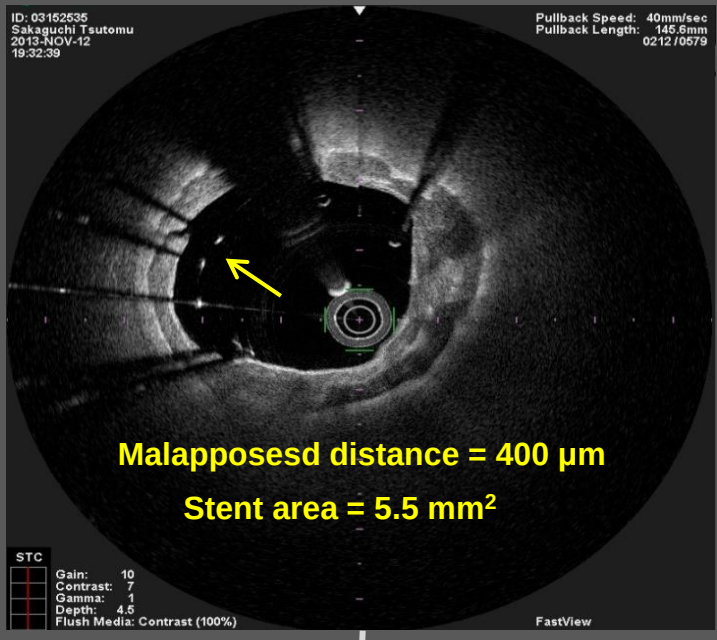
Broken calcium plate

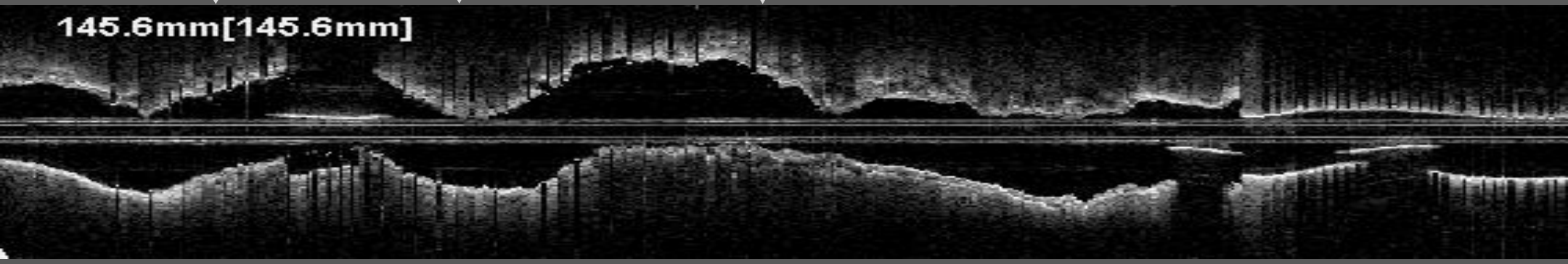


Broken calcium plate



Stent malappsoition

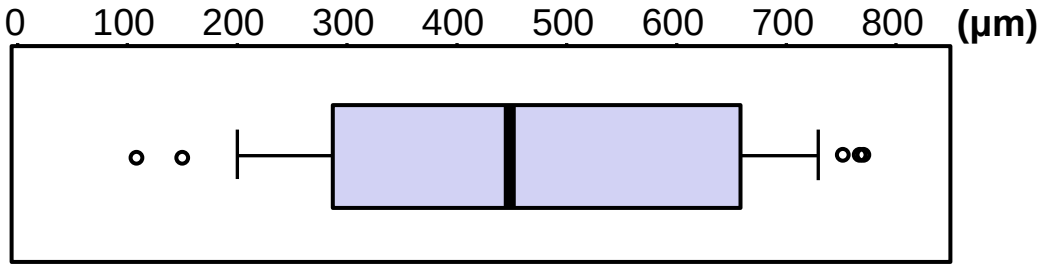




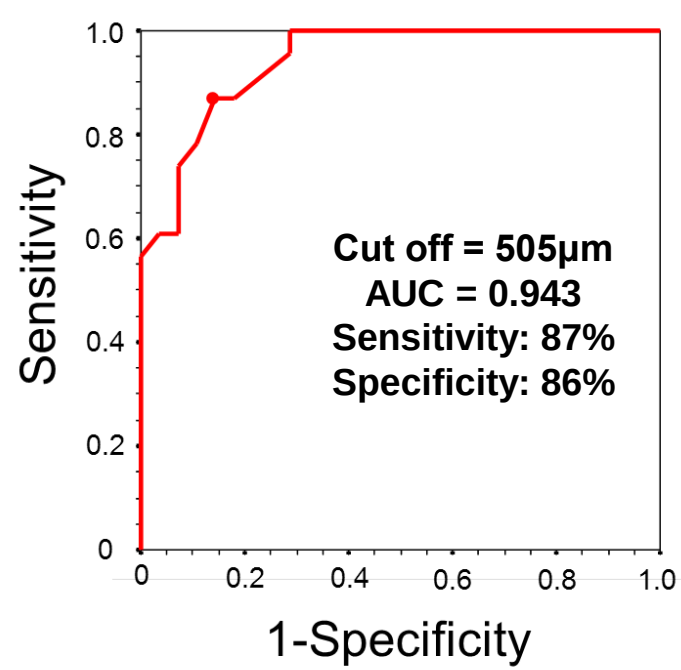
Prediction of calcium plate fracture by ballooning

OFDI was performed to assess vascular response immediately after high pressure ballooning in 61 patients with severe calcified coronary lesion.

Thickness distribution of calcium fracture



Median = 450μm; Lower quartile = 300μm; Upper quartile = 660μm; Minimum = 110μm; and Maximum = 770μm.

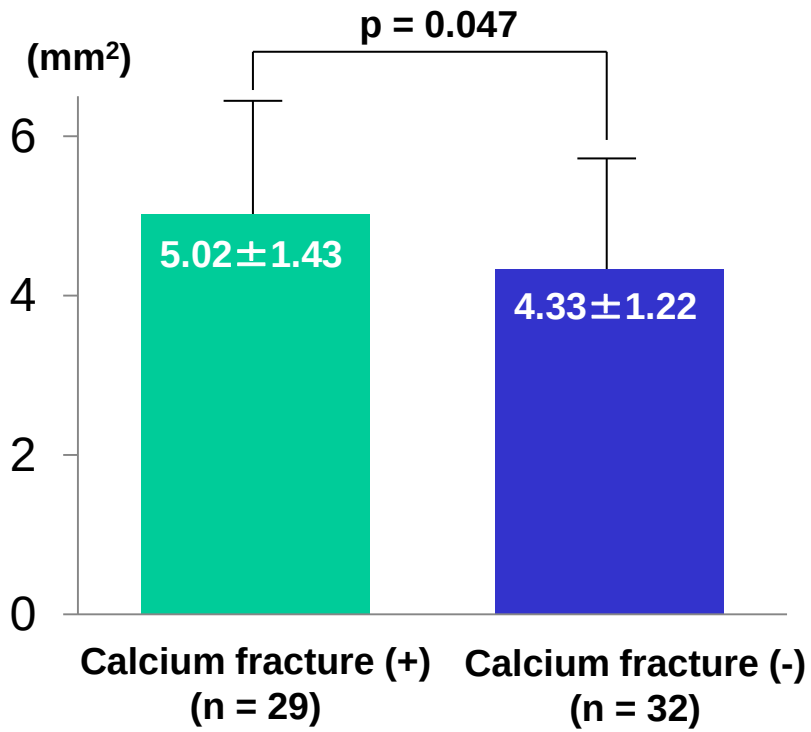


Conclusion: A calcium plate thickness < 505 μm was the corresponding cut-off value for predicting calcium plate fracture by high pressure ballooning.

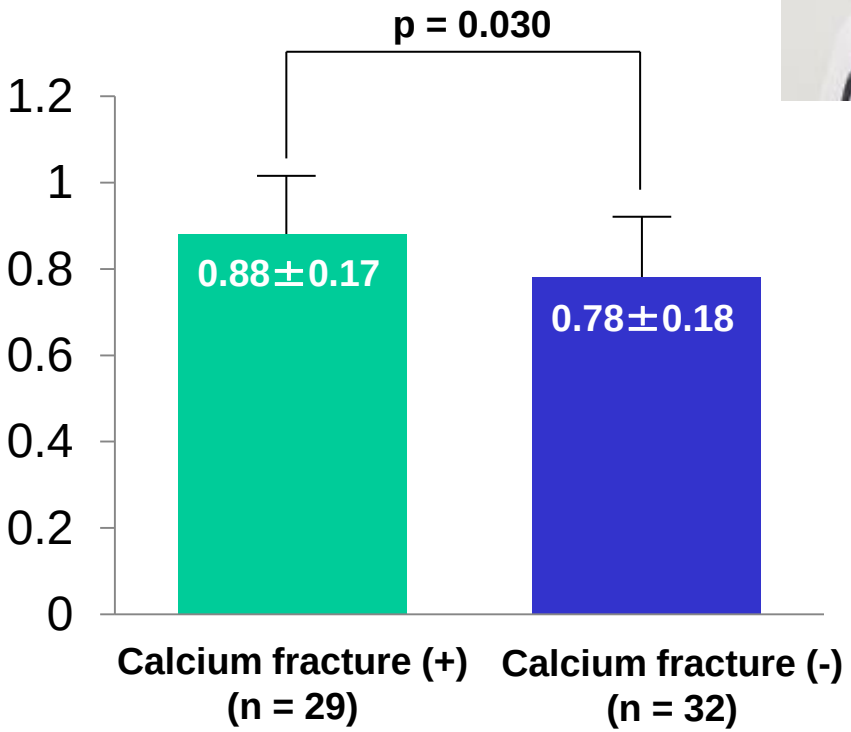
Kubo, Akasaka et al. JACC Imag 2015;8:1228-9

Stent expansion at post-PCI

Minimum stent area



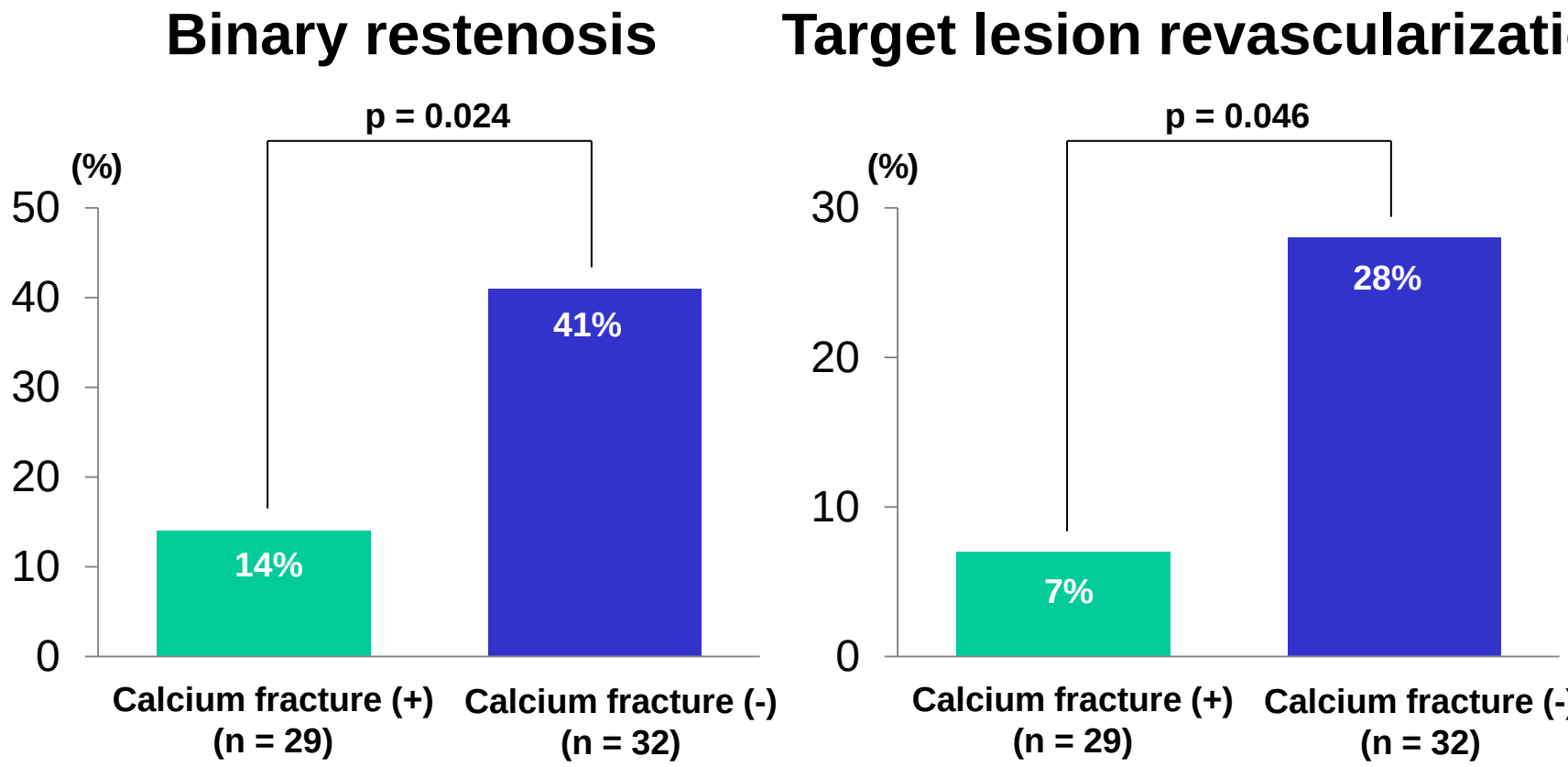
Stent expansion index



Minimum stent area and stent expansion index were significantly greater in the group with calcium fracture compared with the group without calcium fracture.

Kubo, Akasaka et al. JACC Imag 2015;8:1228-9

Restenosis and TLR at 10 months follow-up



The frequency of binary restenosis and target lesion revascularization was significantly lower in the group with calcium fracture compared with the group without calcium fracture.

Kubo, Akasaka et al. JACC Imag 2015;8:1228-9

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- 3D-reconstruction image might indicate the strut & rink position on the side-branch orifice precisely and demonstrate the relation between side-branch wire and stent cell in detail.
- Calcium distribution and thickness can be easily identified, and rotational athelectomy may be safely performed by OCT.

OCT- vs. angio-guided PCI with DES or BMS

The retrospective Centro per la Lotta contro l'Infarto-Optimisation of Percutaneous Coronary Intervention (CLI-OPCI) study

Events at 1-year follow-up	Angiographic guidance group (n=335)	Angiographic plus OCT guidance group (n=335)	*p*-value
Death	23 (6.9%)	11 (3.3%)	0.035
Cardiac death	15 (4.5%)	4 (1.2%)	0.010
Myocardial infarction	29 (8.7%)	18 (5.4%)	0.096
Target lesion repeat revascularisation	11 (3.3%)	11 (3.3%)	1.0
Definite stent thrombosis	2 (0.6%)	1 (0.3%)	1.0
Cardiac death or myocardial infarction	43 (13.0%)	22 (6.6%)	0.006
Cardiac death, myocardial infarction, or repeat revascularisation	50 (15.1%)	32 (9.6%)	0.034

The use of OCT can improve clinical outcomes of patients undergoing PCI.

Prati F, et al., EuroIntervention 2012;8:823-829

Optimal vs Suboptimal OCT-guided PCI (CLI-OPCI ACS substudy)

	All Patients, 507	Patients With OCT Suboptimal Stent Deployment*, 280	Patients Without OCT Suboptimal Stent Deployment, 227	HR (CI)	*P* Value
DoCE (%)	61 (12.0)	50 (17.9)	11 (4.8)	4.12 (2.1–7.9)	<0.001
Cardiac death (%)	14 (2.8)	12 (4.3)	2 (0.9)	5.42 (1.2–24.4)	0.028
Myocardial infarction (%)	42 (8.3)	33 (11.8)	9 (4.0)	3.27 (1.6–6.9)	0.002
Periprocedural	12 (2.4)	8 (2.9)	4 (1.8)	1.69 (0.5–5.6)	0.671
During follow-up	30 (5.9)	25 (8.9)	5 (2.2)	4.57 (1.7–12.0)	0.002
Target lesion revascularization (%)	37 (7.3)	31 (11.1)	6 (2.6)	4.76 (2.0–11.4)	<0.001
Stent thrombosis (%)	25 (4.9)	21 (7.5)	4 (1.8)	4.65 (1.6–13.6)	0.005
Acute	5 (1.0)	3 (1.1)	2 (0.8)	1.29 (0.2–7.7)	0.782
Subacute	16 (3.1)	14 (5.0)	1 (0.4)	11.81 (1.6–89.8)	0.017
Late	2 (0.4)	3 (1.1)	0 (0.0)	0.00 (0.0–0.0)	0.257
Very late	2 (0.4)	1 (0.3)	1 (0.4)	1.33 (0.8–22.5)	0.843
Days of follow-up†	345 (219–540)	342 (205–540)	352 (230–540)		0.202

CI indicates confidence interval; DoCE, hierarchical device-oriented cardiovascular events (cardiac death, target vessel myocardial infarction, and target lesion revascularization); HR, hazard ratio; and OCT, optical coherence tomography.

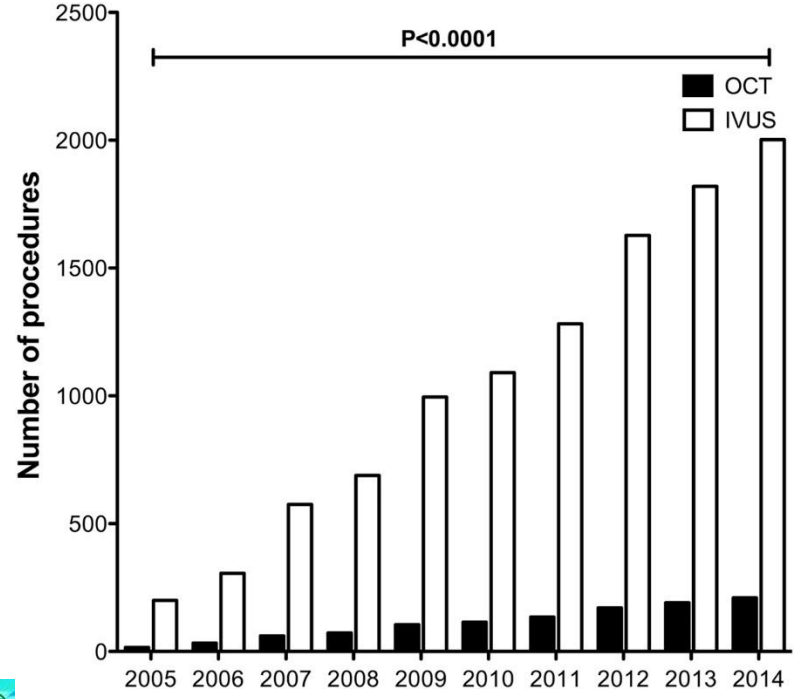
*Either in-stent minimum lumen area <4.5 mm^2, intrastent atherothrombotic tissue prolapse >500 μm, dissection >200 μm at the distal stent edge, distal or proximal reference narrowing.

Prati F, et al. Circ CV Interv 2016;9:e003726.

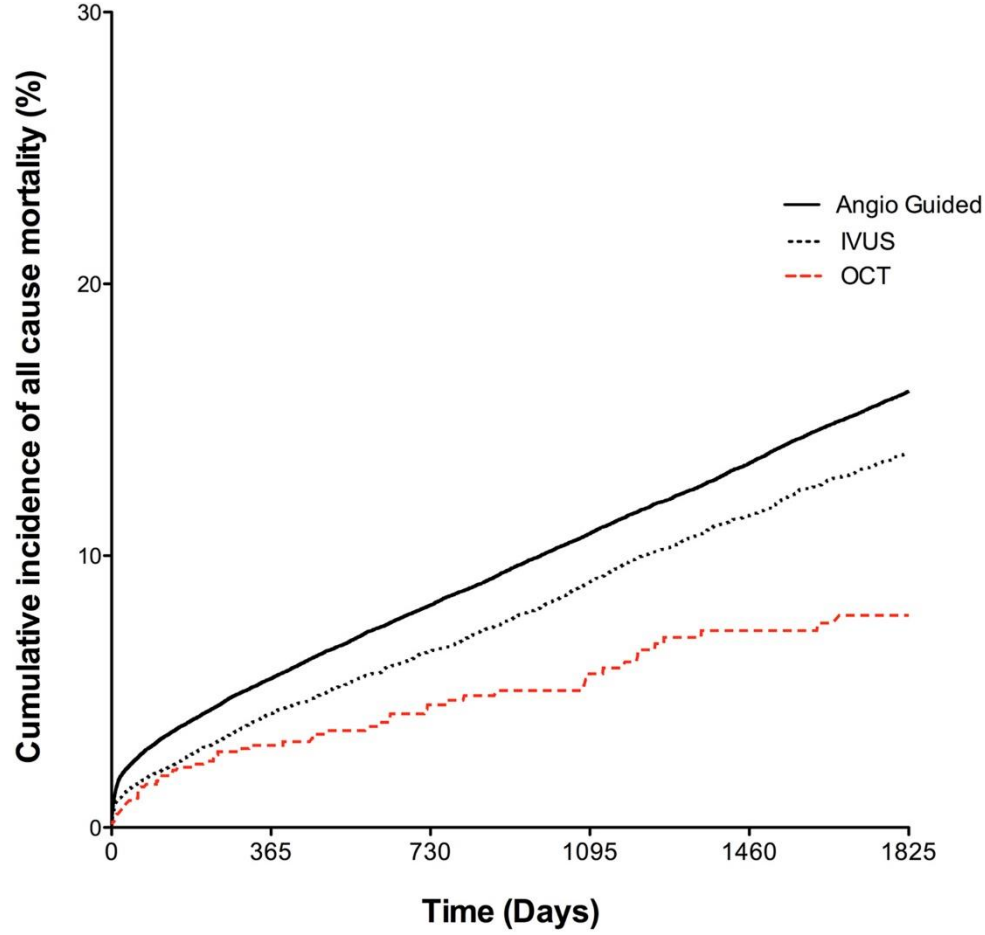
Angiography Alone Versus Angiography Plus Optical Coherence Tomography to Guide Percutaneous Coronary Intervention

Outcomes From the Pan-London PCI Cohort

Daniel A. Jones, MD, PhD,[a] Krishnaraj S. Rathod, MD,[a] Sudheer Koganti, MD,[a] Stephen
Zoe Astroulakis, MD, PhD,[c] Pitt Lim, MD,[c] Alexander Sirker, MD, PhD,[a] Constantinos O'
Ajay K. Jain, MD,[a] Charles J. Knight, MD,[a] Miles C. Dalby, MD,[d] Iqbal S. Malik, MBBS, F
Anthony Mathur, MD, PhD,[a] Roby Rakhit, MD,[e] Tim Lockie, MBChB, PhD,[e] Simon Redw
Philip A. MacCarthy, MBChB, PhD,[g] Ranil Desilva, MD, PhD,[d] Roshan Weerackody, MD,
Andrew Wragg, MD, PhD,[a] Elliot J. Smith, MD,[a] Christos V. Bourantas, MD, PhD[a]



Kaplan-Meier Curve Comparing All-Cause Mortality Among OCT-, IVUS- and Angio-guided PCI



Numbers at risk						
Angio Only	75046	66033	56182	51030	40053	28765
IVUS	10971	8954	7838	6632	5431	4242
OCT	1149	901	789	654	561	410

Jones DA, et al., J Am Coll Cardiol Intv 201811:1313-1321

Angiography Alone Versus Angiography Plus Optical Coherence Tomography to Guide Percutaneous Coronary Intervention

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Zoe Astro
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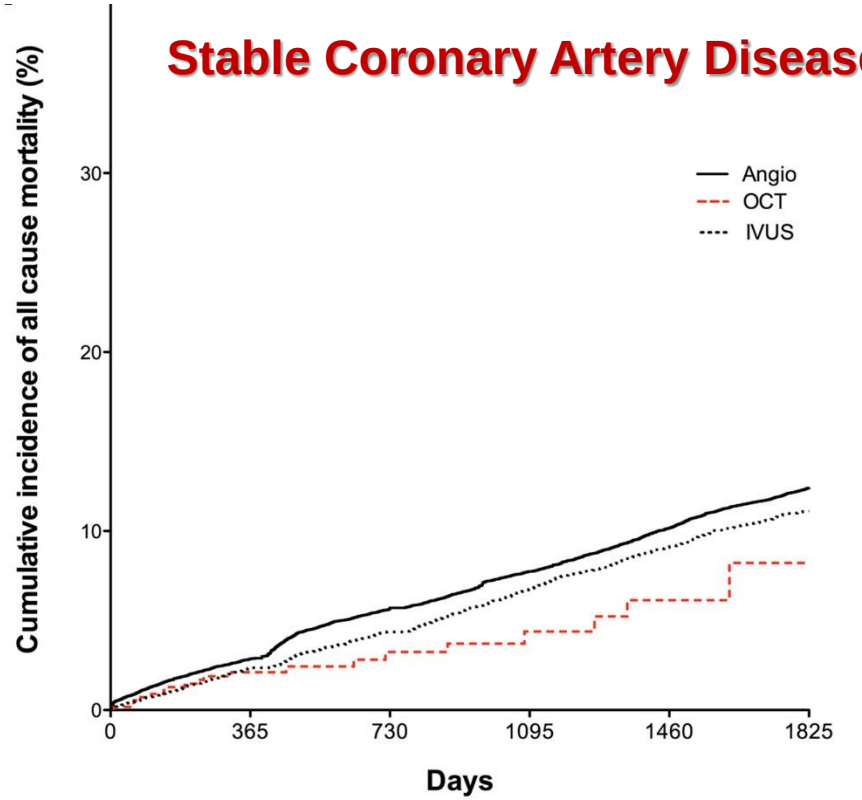
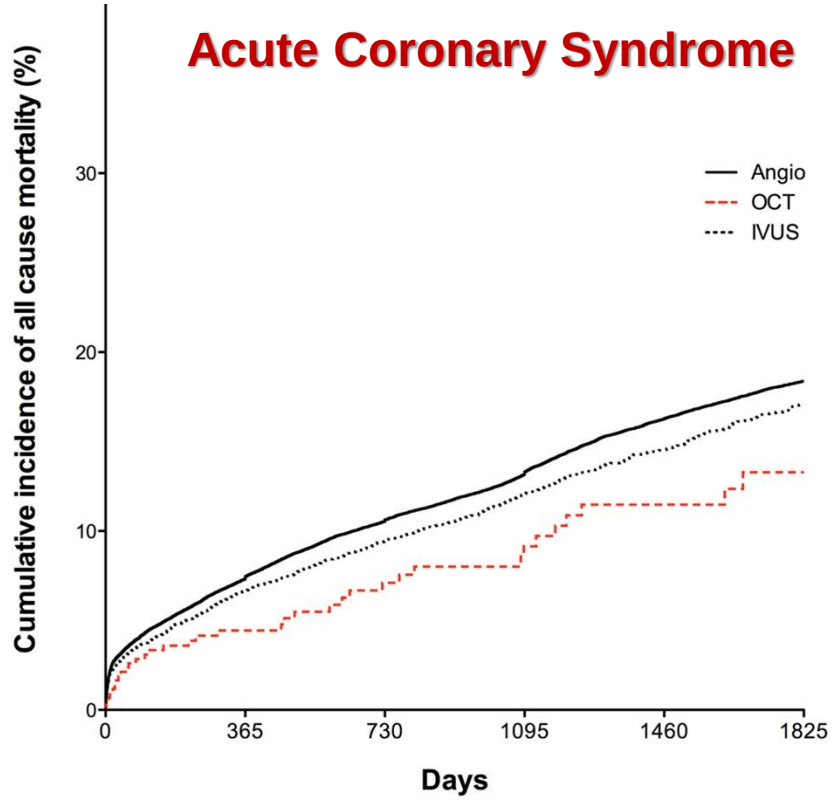
Kaplan-Meier Curve Comparing All-Cause Mortality Among OCT-, IVUS- and Angio-guided PCI

Stable Coronary Artery Disease



Numbers at risk						
Angio Only	43144	38185	33381	30130	26053	23765
IVUS	5911	4954	4358	3792	3135	2941
OCT	662	540	496	405	371	301

Acute Coronary Syndrome



Numbers at risk						
Angio Only	31902	28083	23182	21130	19053	15765
IVUS	5060	4254	3838	3272	2631	2242
OCT	487	420	389	314	261	201

Jones DA, et al., J Am Coll Cardiol Intv 201811:1313-1321

Take home message

Procedural and Prognostic Impact of OCT on Coronary Intervention

- **Several procedural advantages have been developed in OCT, and additional improvement in soft ware could be expected in the future in OCT.**

- **These development in OCT may allow us to perform PCI more easily and precisely.**

- **Although the improvement of prognosis has been reported by OCT-guided PCI at the moment, further improvement of PCI prognosis could be expected by newly developing OCT guidance.**

Thank you for your kind attention !!

Welcome to APSC 2020 in Kyoto, Japan!!