OCT guided PCI for Calcified Lesion

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Disclosure Statement of Financial Interest

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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

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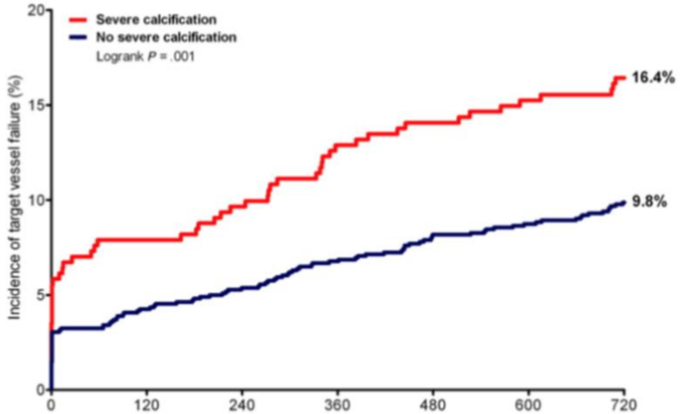
• Medical Advisor (Employed):	Terumo Corp.

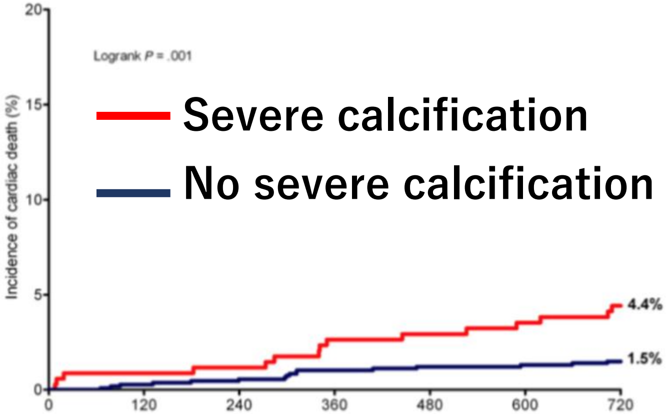
TWENTE and DUTCH PEERS trials

Am Heart J. 2016;175:121-129

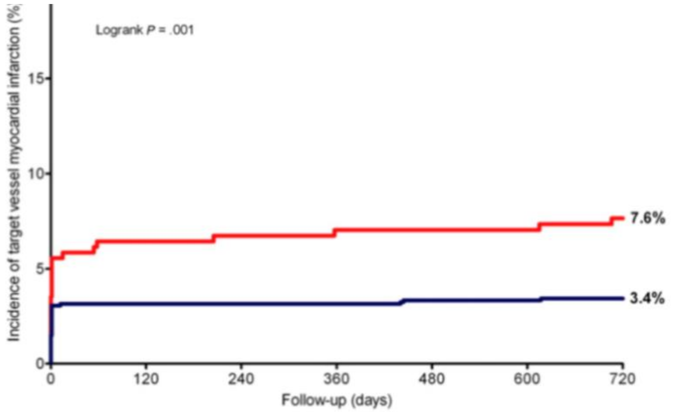
Target vessel failure



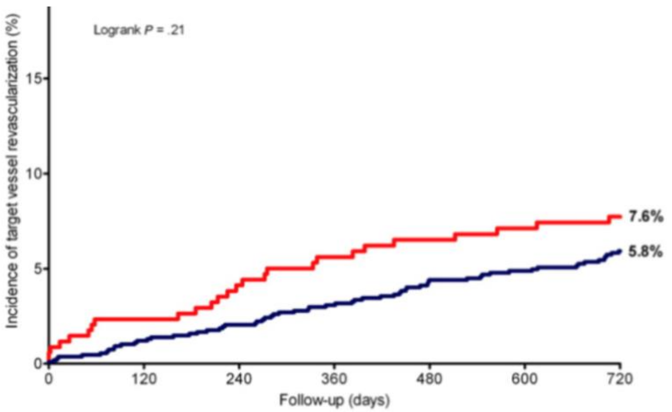
Cardiac death



Target vessel MI

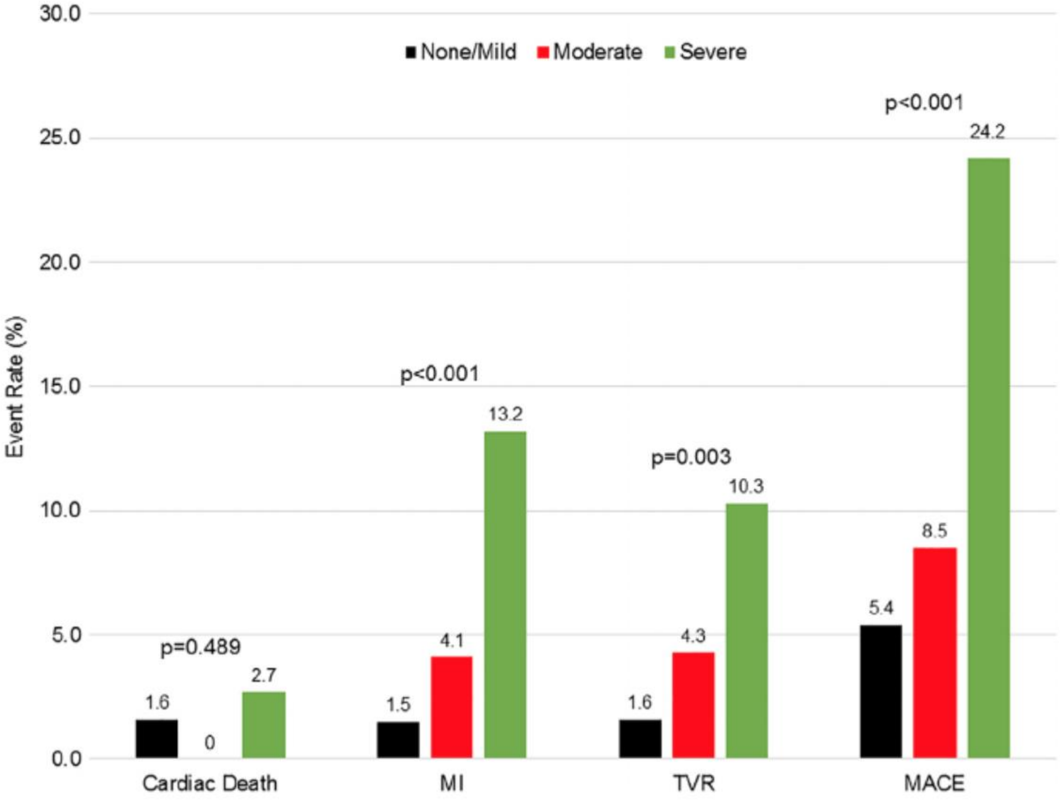


Clinically indicated TVR



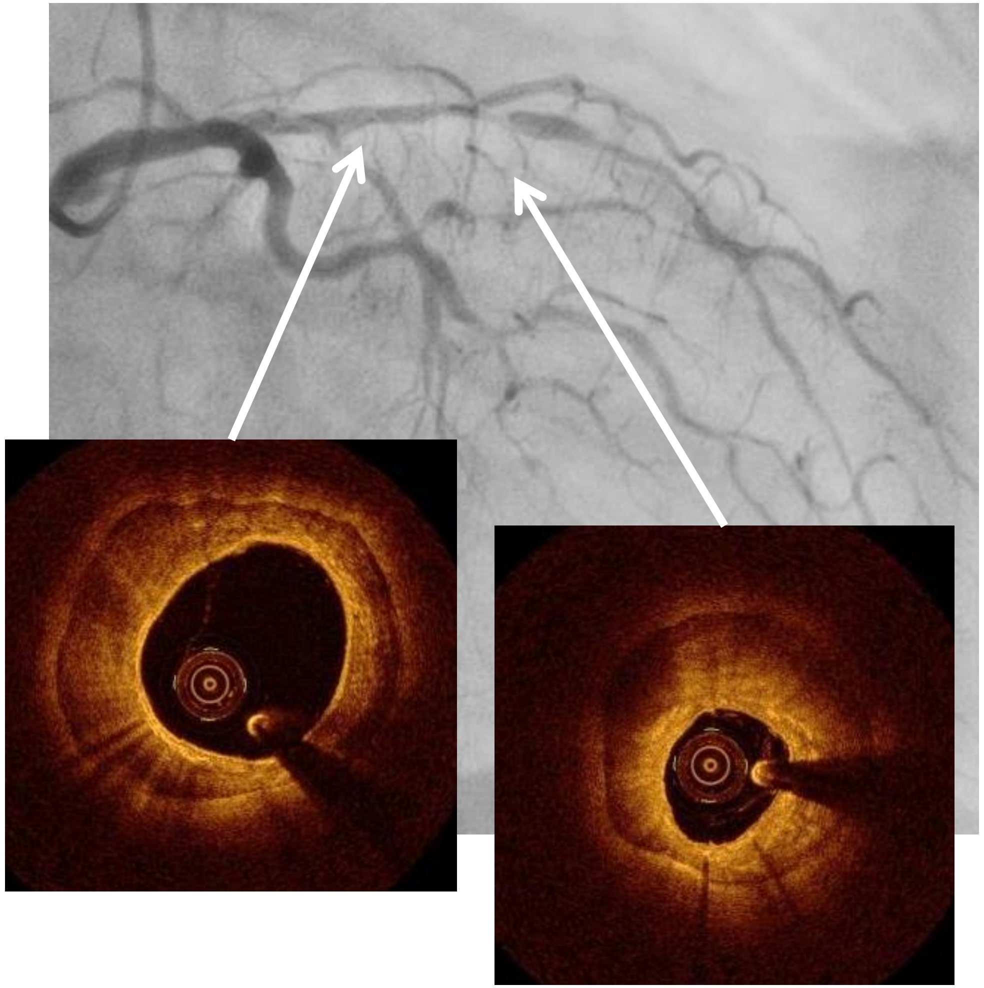
MACE-Trial 1-year results

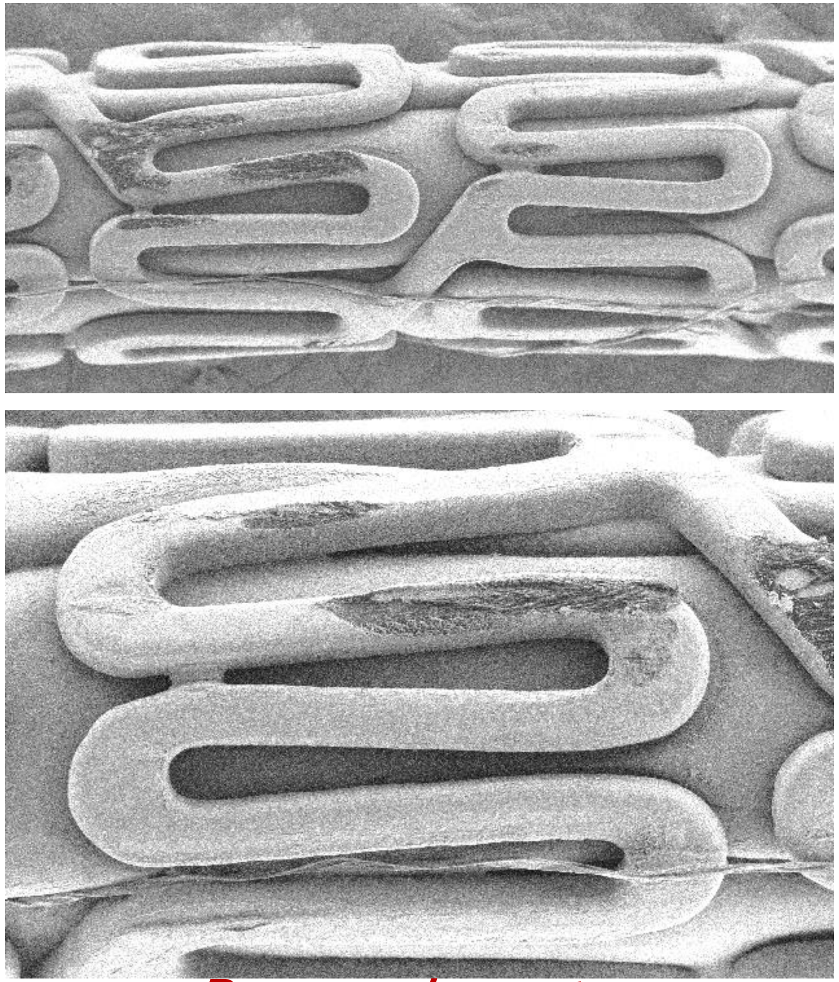
Catheter Cardiovasc Interv. 2019;94(2):187-194



- Why coronary calcium is so important?⇒Patients with severe calcification had significantly worse outcomes compared to those without.

Polymer damage of DES during PCI in OCT-derived severe calcified lesion without lesion modification



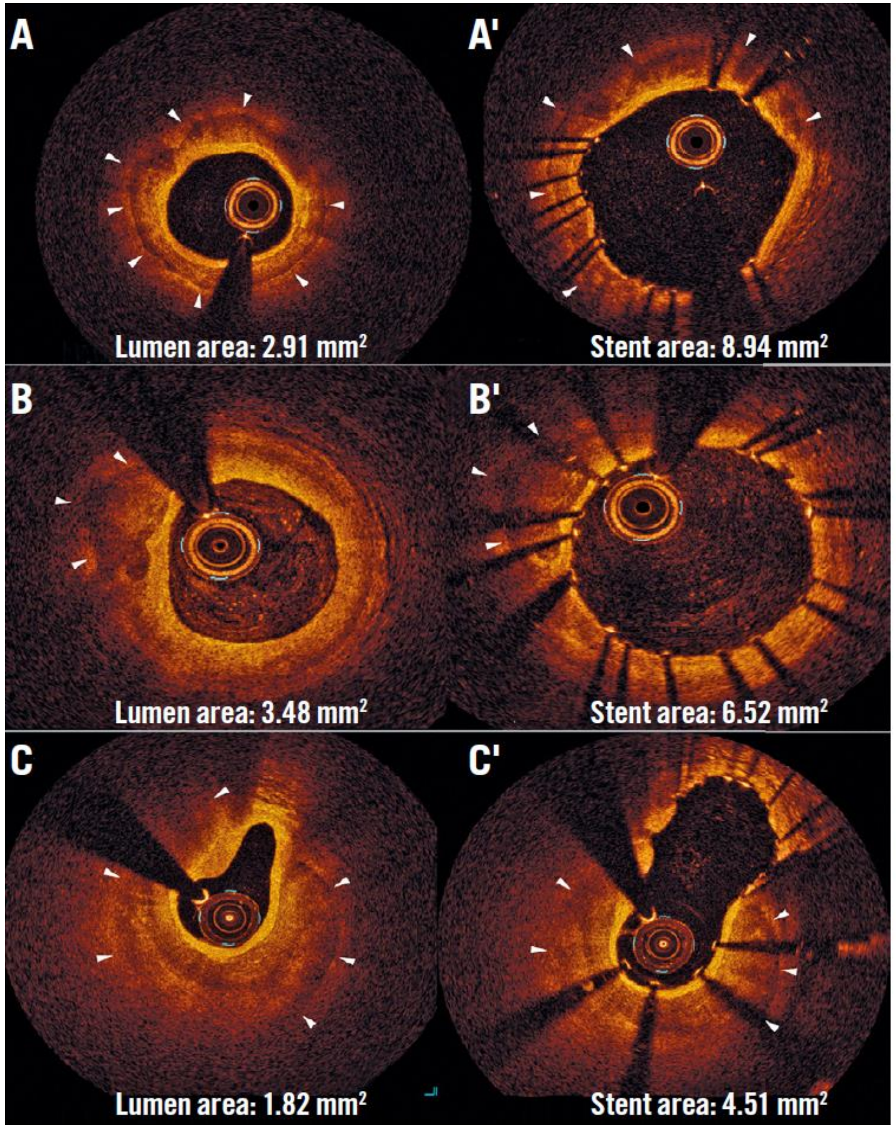


Promus element

Shimokado, Kubo, Akasaka et al. Int J Cardiov Imag. 2013;29:1909-1913

Calcium eccentricity, thickness & length and stent expansion

Baseline **Final**



Angle: 360°
Thickness: 0.48 mm
Length: 3.8 mm
Calcium score: 2 points

Expansion: 99%

Enough stent expansion could be expected if the calcium thickness is thin even if it is circumferential.

Angle: 75°
Thickness: 1.1 mm
Length: 4.3 mm
Calcium score: 1 point

Expansion: 97%

Enough stent expansion could be expected in cases with thick calcium if it is localized.

Angle: 312°
Thickness: 1.4 mm
Length: 11.0 mm
Calcium score: 4 points

Expansion: 68%

Severe thick calcium more than 180 degree may cause stent under-expansion.

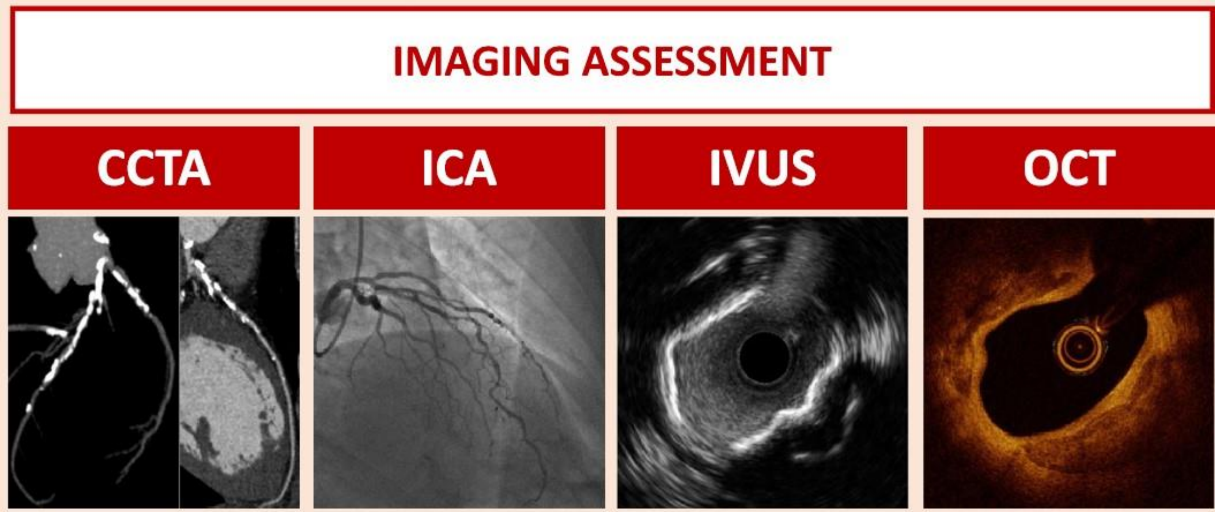
Fusiono A, et al. EuroInterv 2018;13:e2182-e2189

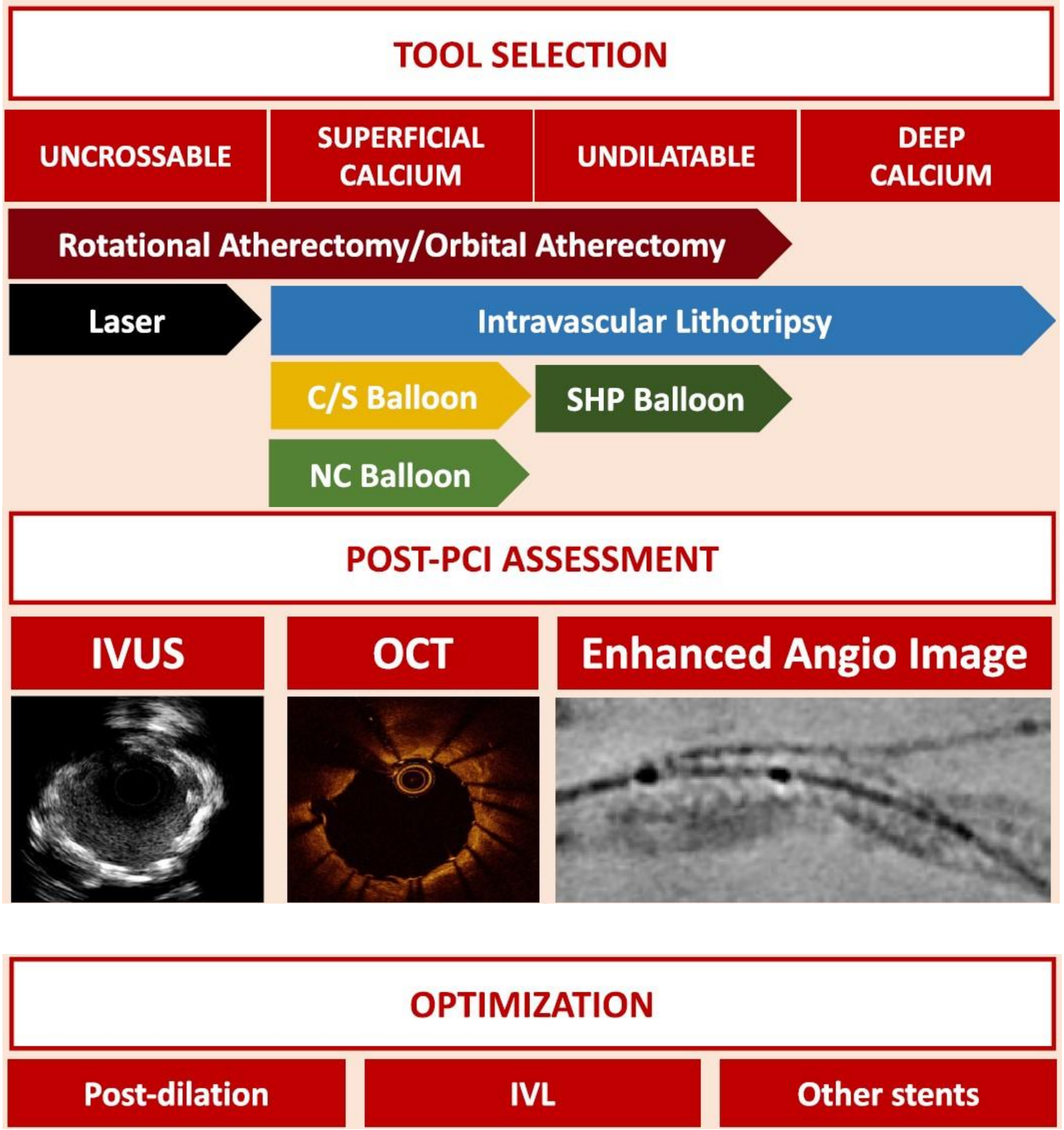
ESC European Society of Cardiology
European Heart Journal (2023) **44**, 4340–4356
https://doi.org/10.1093/eurheartj/ehad342

*FAST*TRACK CLINICAL RESEARCH
Interventional cardiology

Management strategies for heavily calcified coronary stenoses: an EAPCI clinical consensus statement in collaboration with the EURO4C-PCR group

Emanuele Barbato [1]*, **Emanuele Gallinoro** [2], **Mohamed Abdel-Wahab** [3],

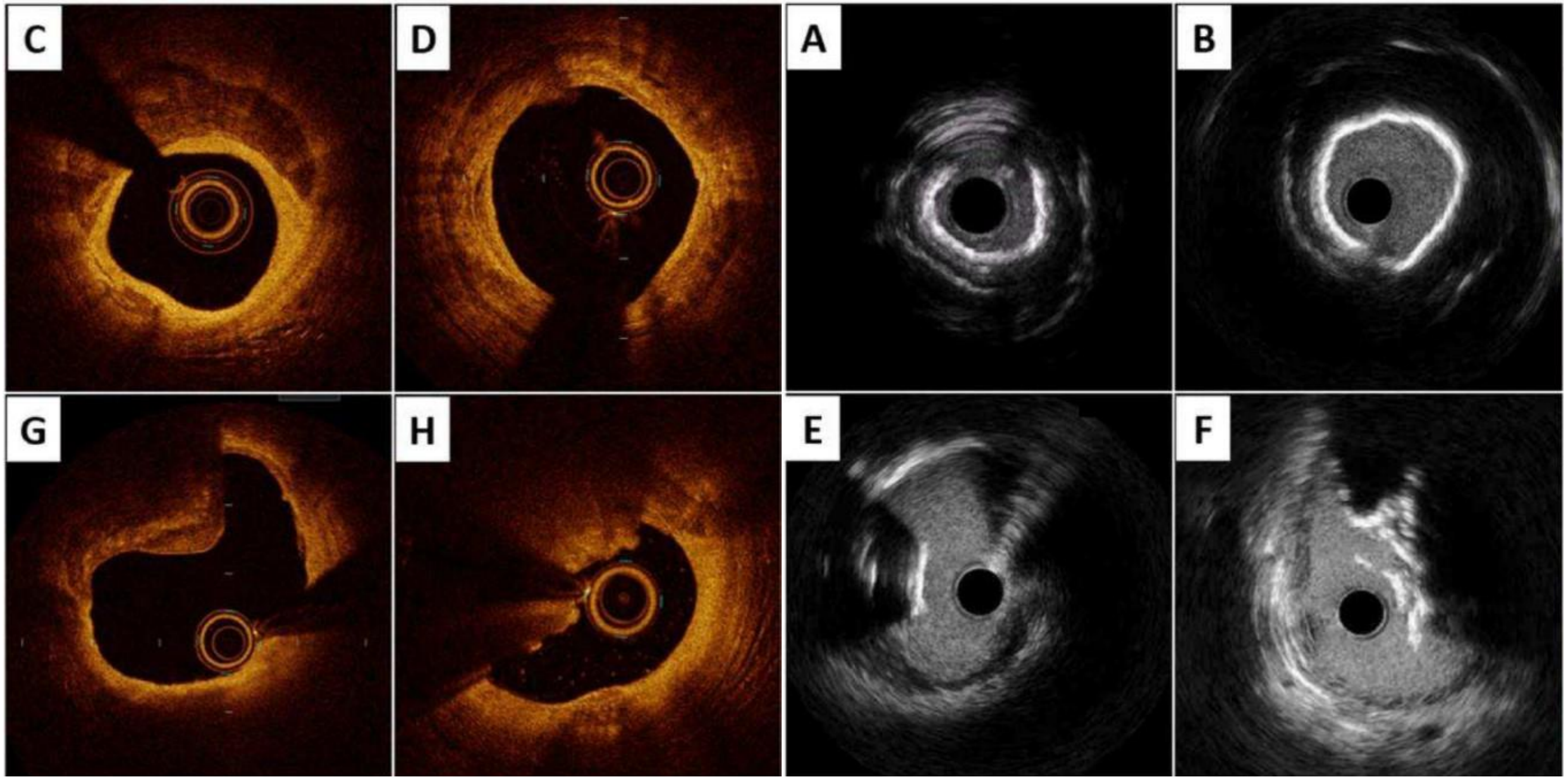




Similarities & differences between OCT & IVUS

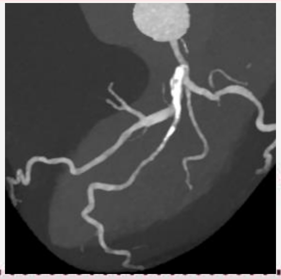
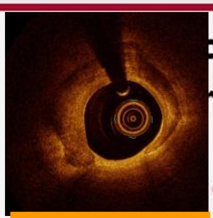
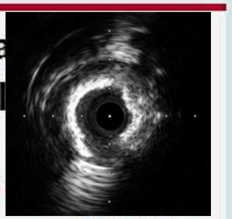
Maehara A, et al. J Am Coll Cardiol Img 2017;10:1487-1503

OCT				IVUS		
Very good	Good	Feasible	Pre-PCI	Feasible	Good	Very good
●	●	●	Severity of calcium	●	●	
		●	Prediction of slow flow	●		
	●	●	Stent sizing by vessel wall	●	●	●



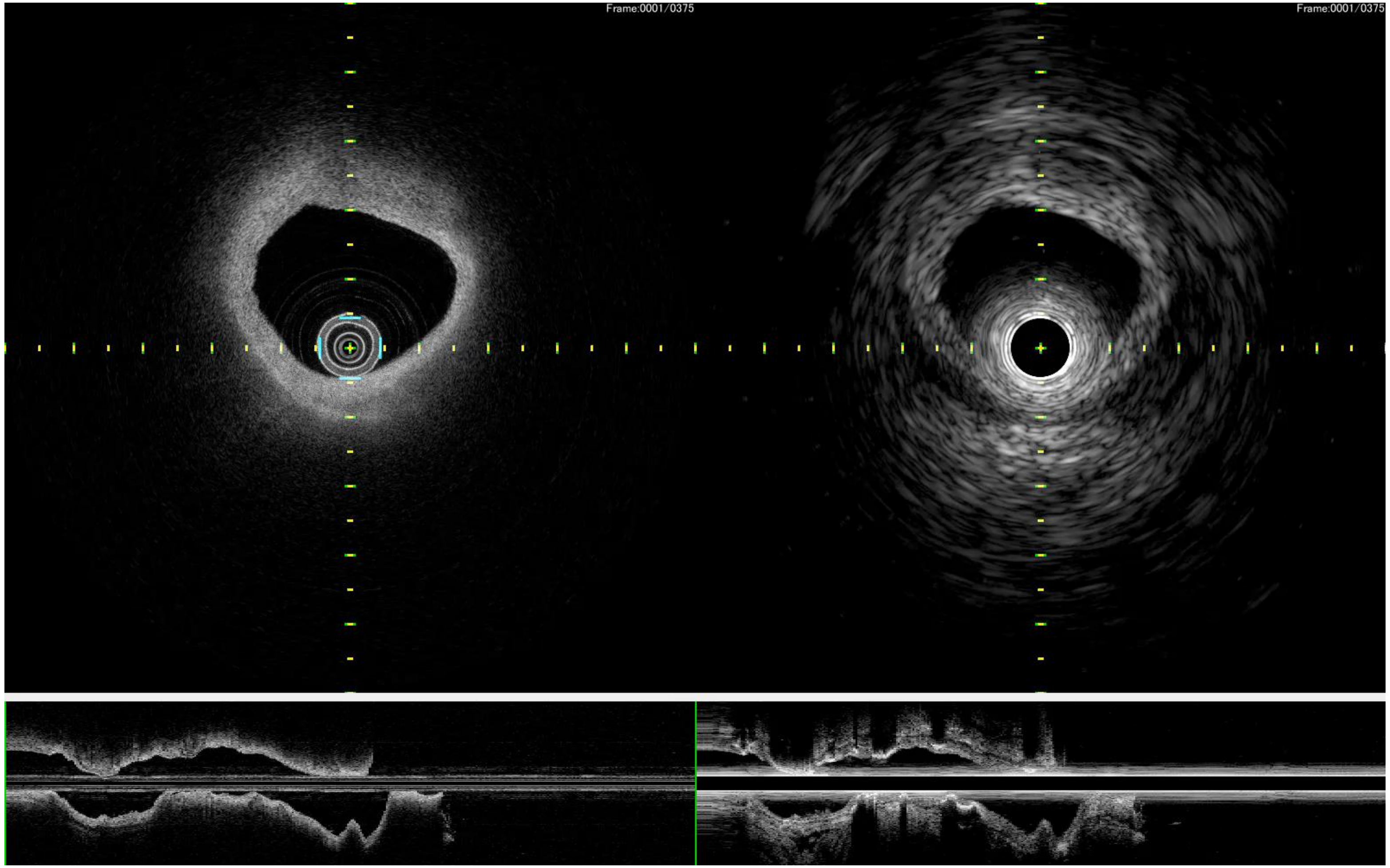
Power DA, et al. Prog Cardiovasc Dis 2024;86:26-37

Comparison of clinically available coronary imaging tools

		Non-invasive imaging prior to the catheterization laboratory		ICA 	 ular ima rization l	
		CCTA	CS		OCT	IVUS
Spatial resolution		0.2–0.5 mm	1.25 mm	0.5–0.6 mm	15–20 µ	50–200 µ
Contrast needed		Yes	No	Yes	Yes	No
Time of data acquisition		1–5 min	1 min	15 min[a]	<5–10 s	2–4 min
Availability		+++	+++	+++	+	++
Additional cost		+	+	+	+++	+++
Tissue penetration (non-calcified)		+++	+++	+++	+	++
Global assessment of calcification		+++	+++	+	-	-
Calcium volume quantification		+	-	-	++	-
Calcium arc		++	-	-	+++	+++
Calcium thickness		+	-	-	+++	-
Longitudinal calcium length		+	-	-	+++	+++

Barbato E, et al. Eur Heart J 2023;44:4340–4356

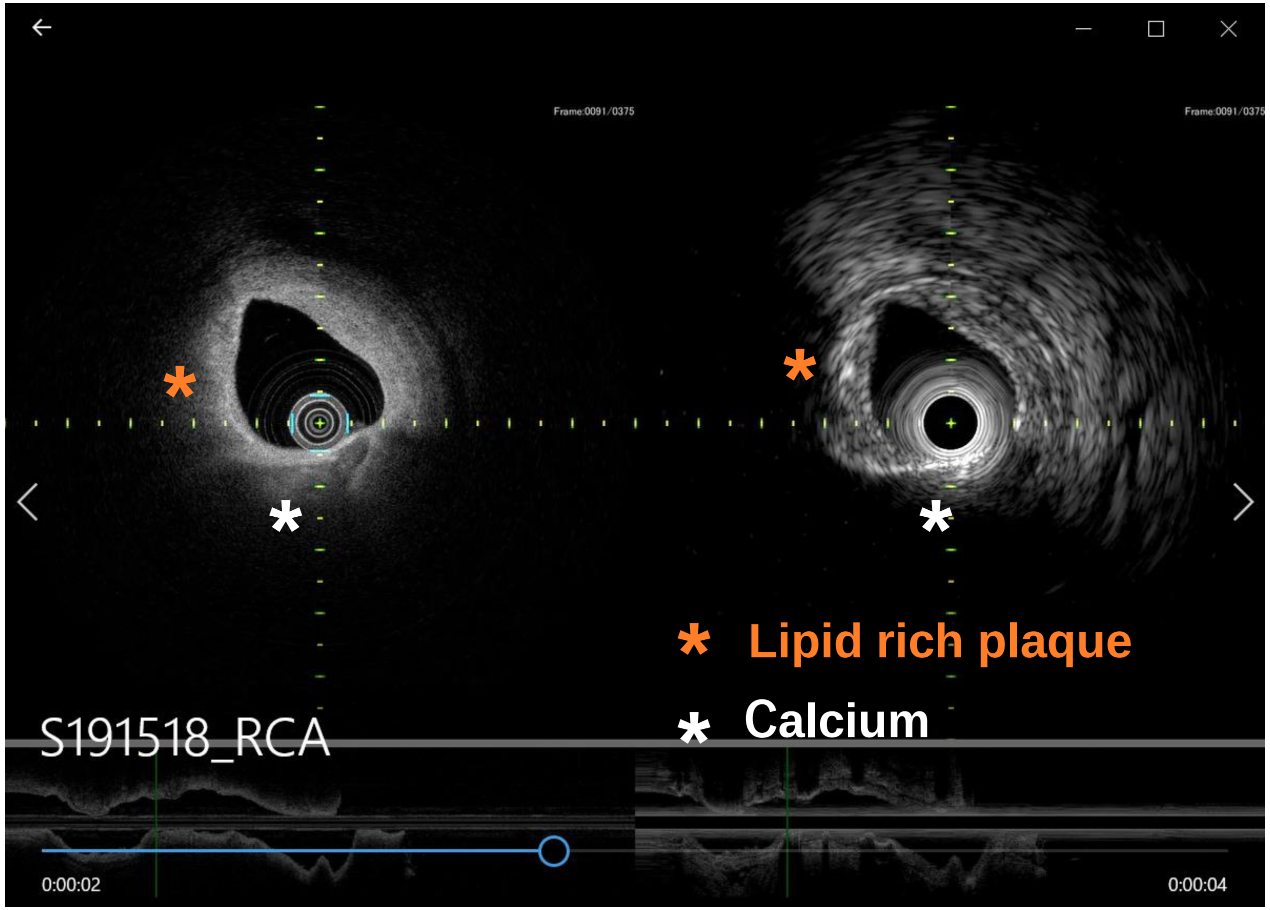
Dual sensor images with FD-OCT & IVUS

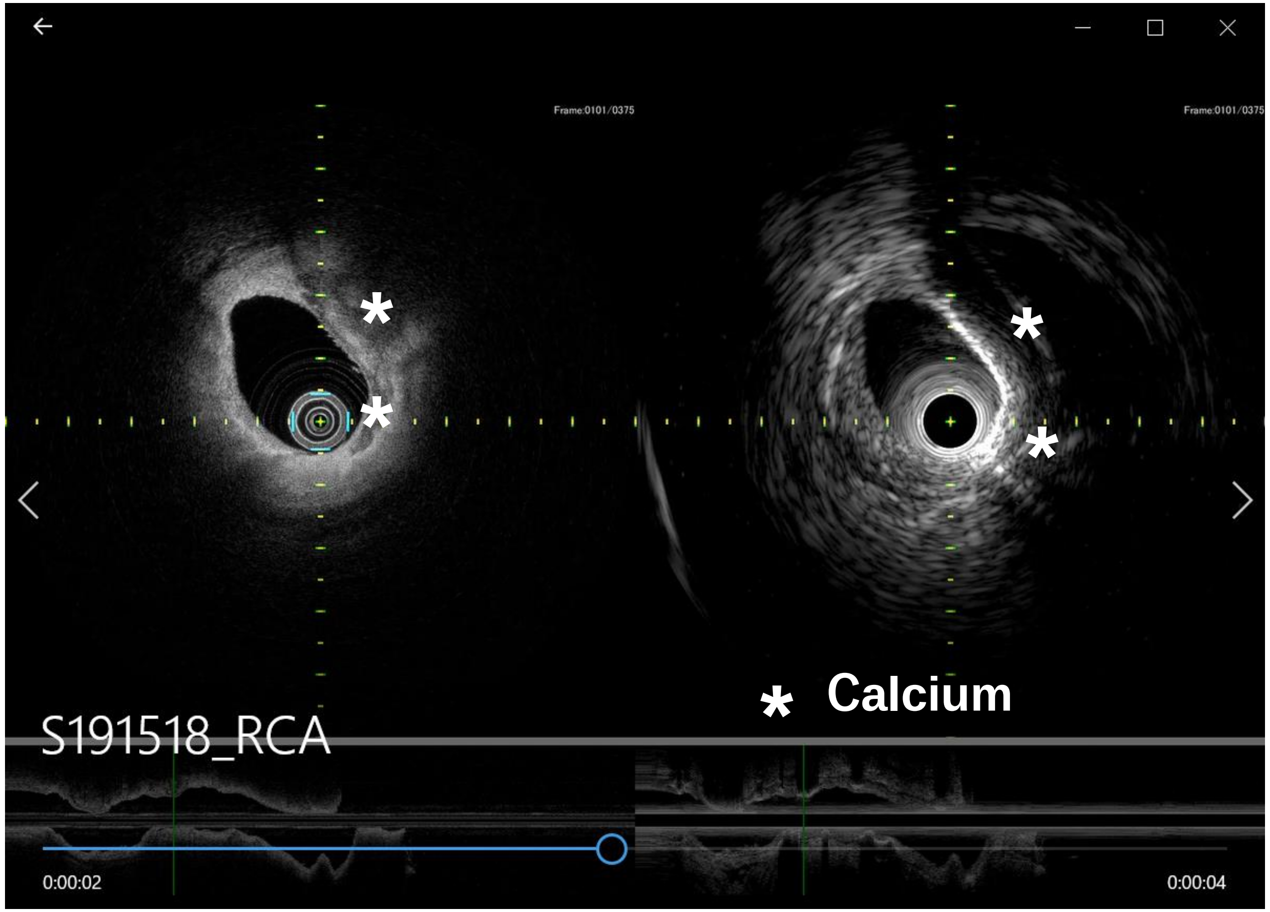


Because each modality may have advantages & disadvantages, dual sensor images may resolve these disadvantages in each modality.

Representative images using dual sensor images

FD-OCT IVUS FD-OCT IVUS

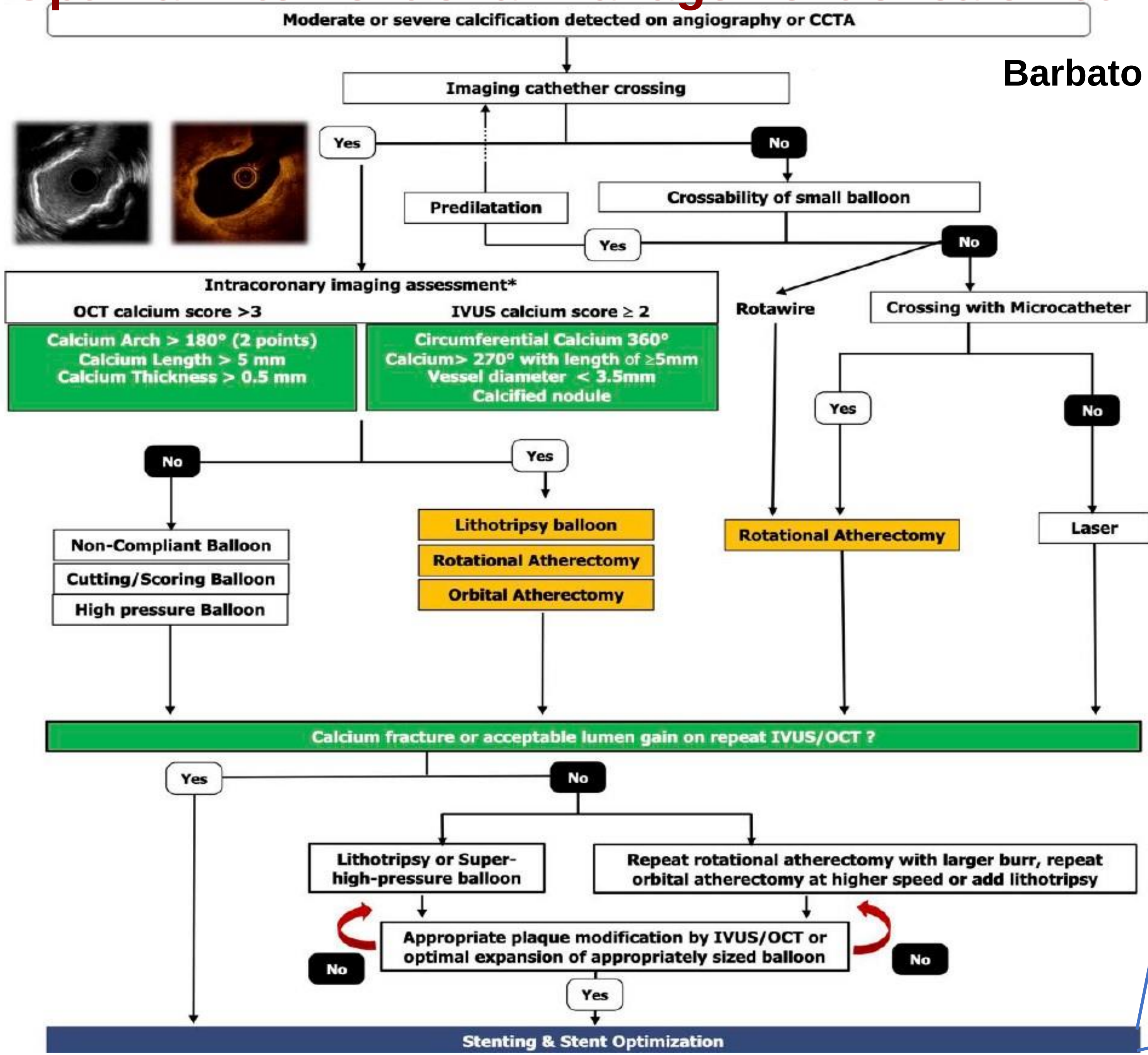


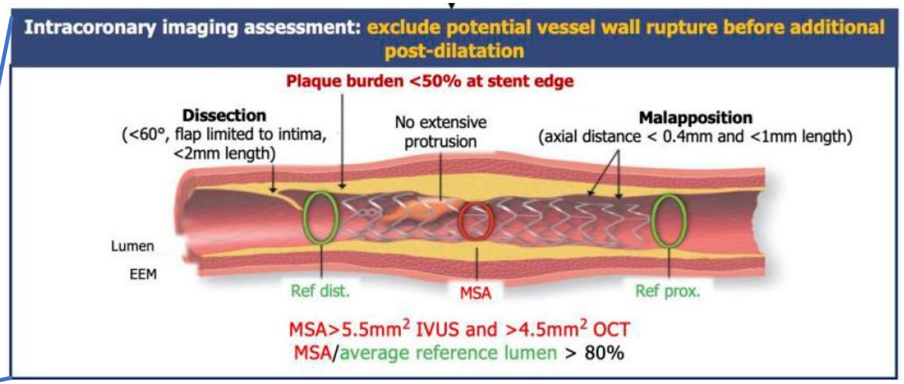


Using dual sensor images with FD-OCT & IVUS, not only identification of calcium with accurate measurement of its' thickness but also differentiation among attenuation plaques by IVUS could be easy by OCT.

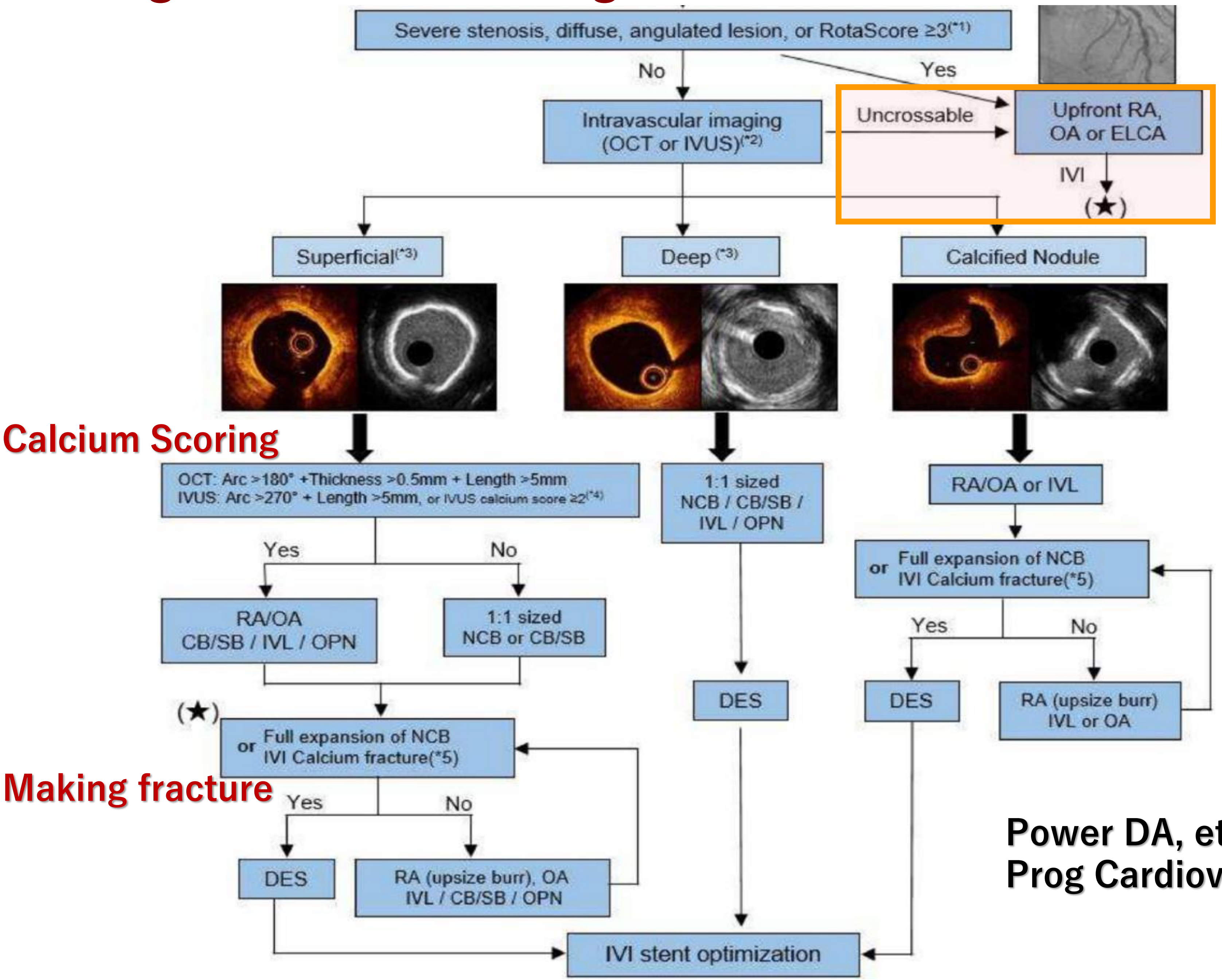
Optimal interventional management of calcified lesions based on IV imaging

Barbato E, et al. Eur Heart J 2023;44:4340–4356





A Practical Algorithm for Management of Calcified Coronary Lesions



Power DA, et al.
Prog Cardiovasc Dis 2024;86:26-37

Case 1.　60’s y.o. Female

Clinical Diagnosis: Effort AP

Colon cancer (before operation)

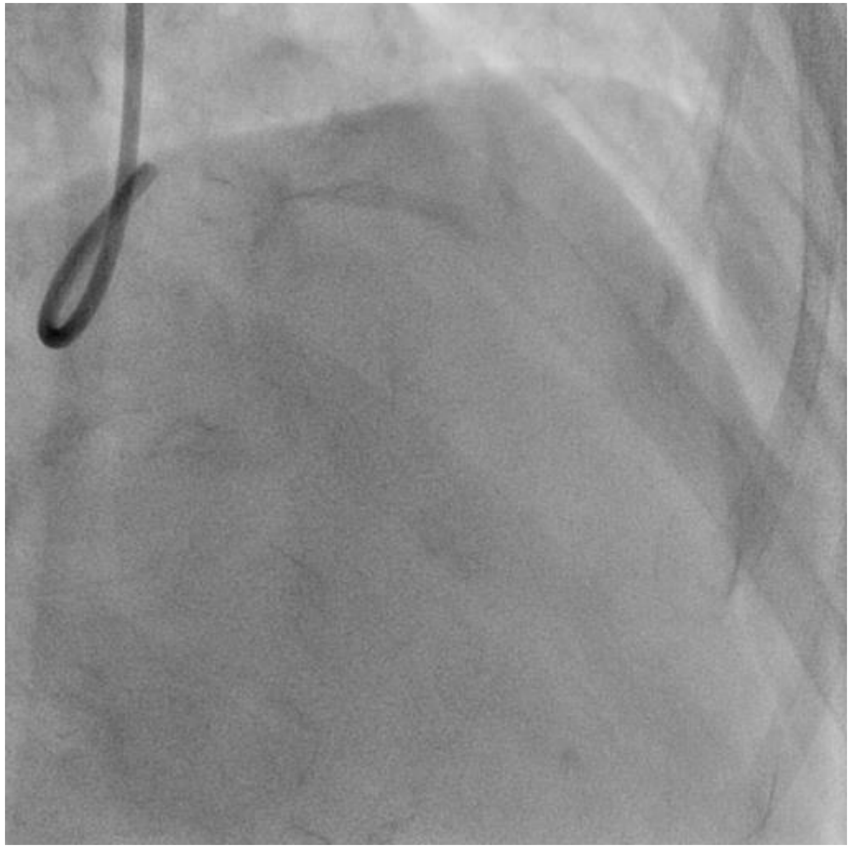
Coronary risk factor: HT, DM

Renal Function: Cr 0.88mg/dl, eGFR 56.3ml/min/1.73m^2

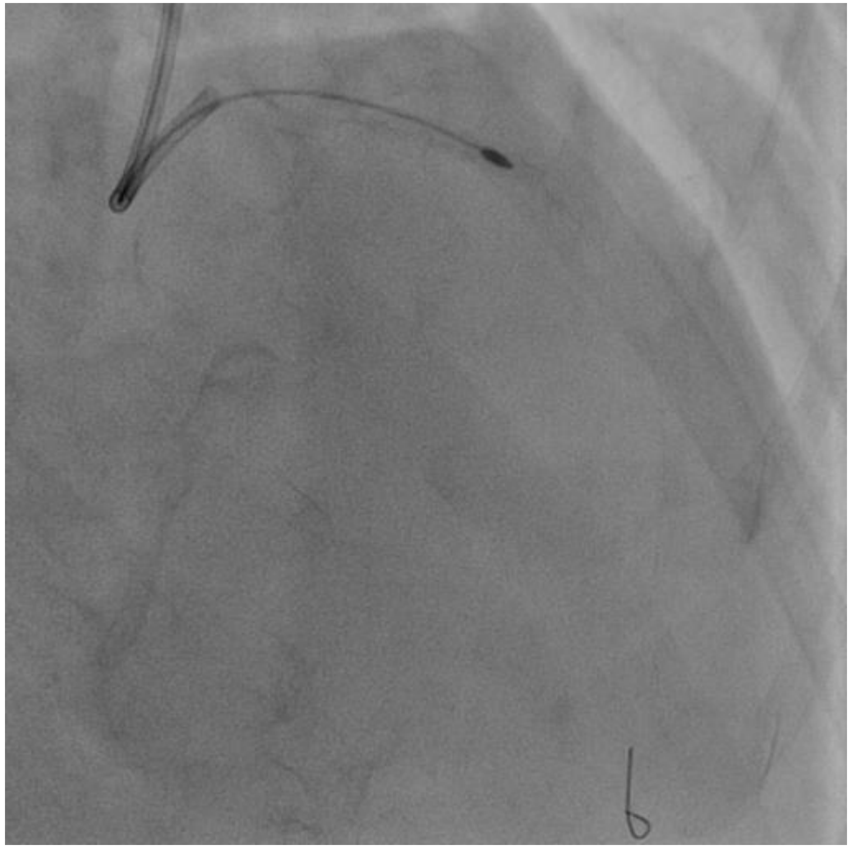
Cardiac Function: EF 63%, asynergy(-)

Coronary angiography & rotational atherectomy

Pre

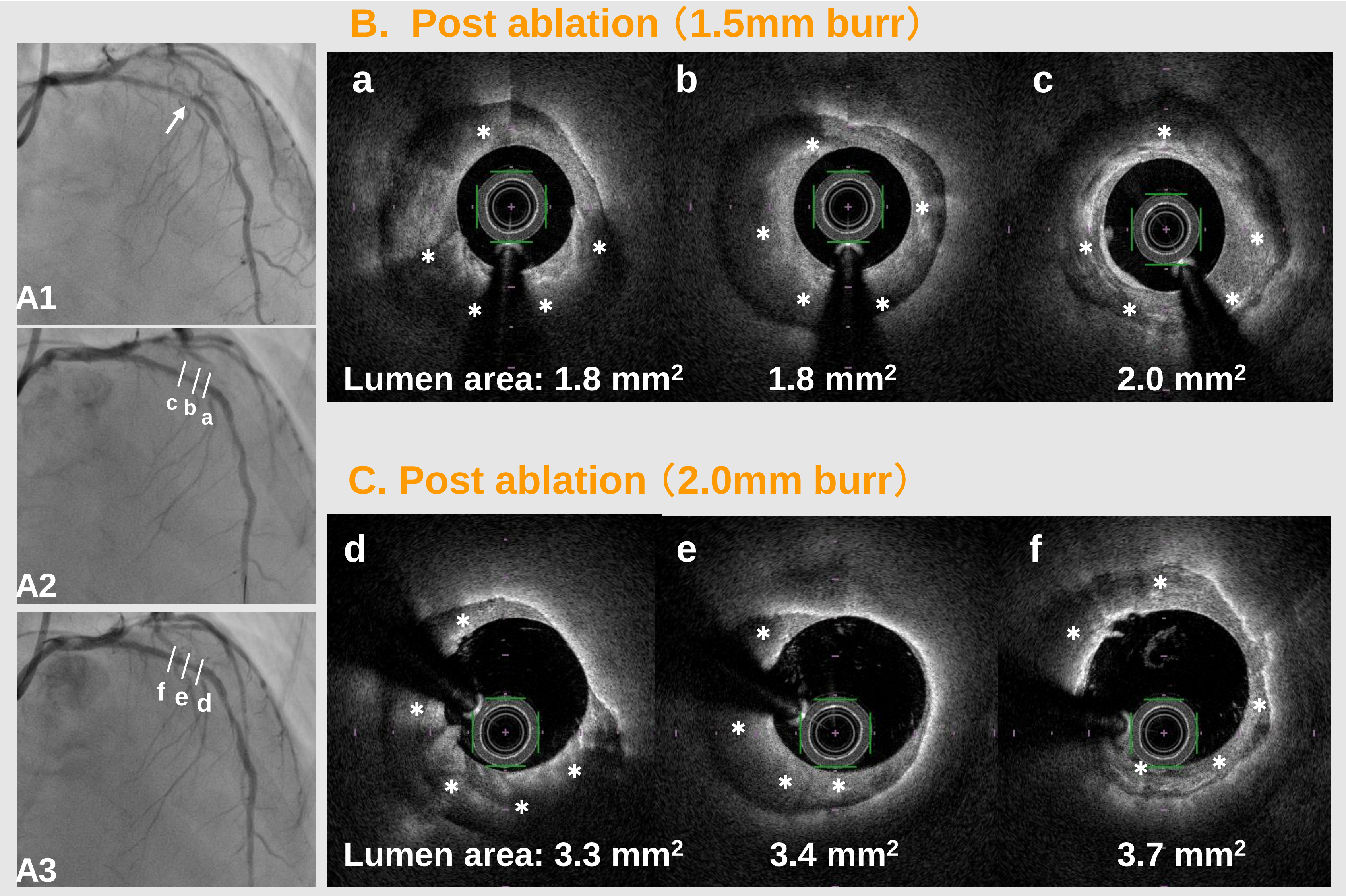


Rota 1.5 mm



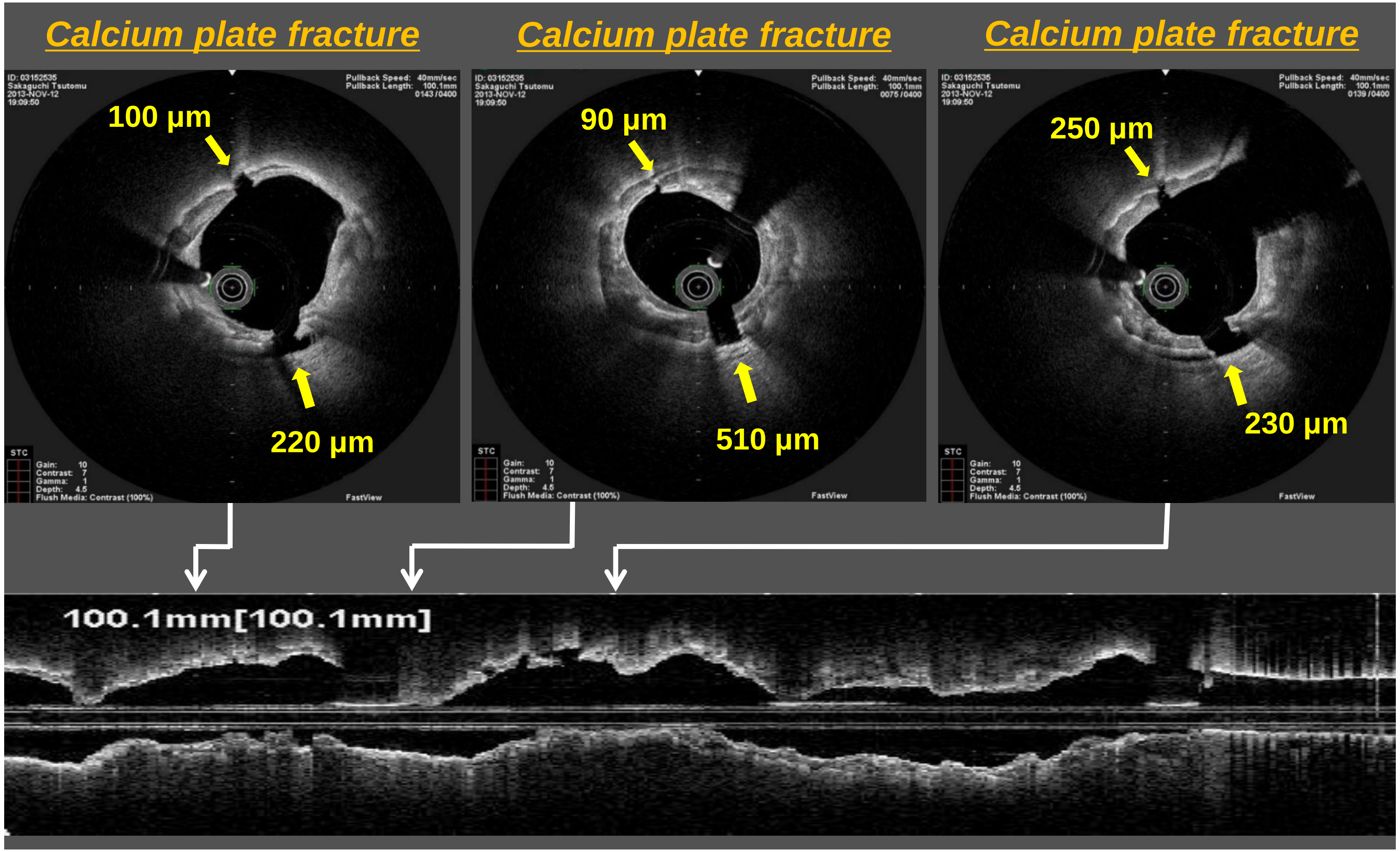
Because of heavy calcification, it was difficult to pass any PCI devices & imaging modalities through the MLA site, and rotational atherectomy with 1.5mm burr was selected for lesion modification.

Comparison of FD-OCT findings after rotational atherectomy



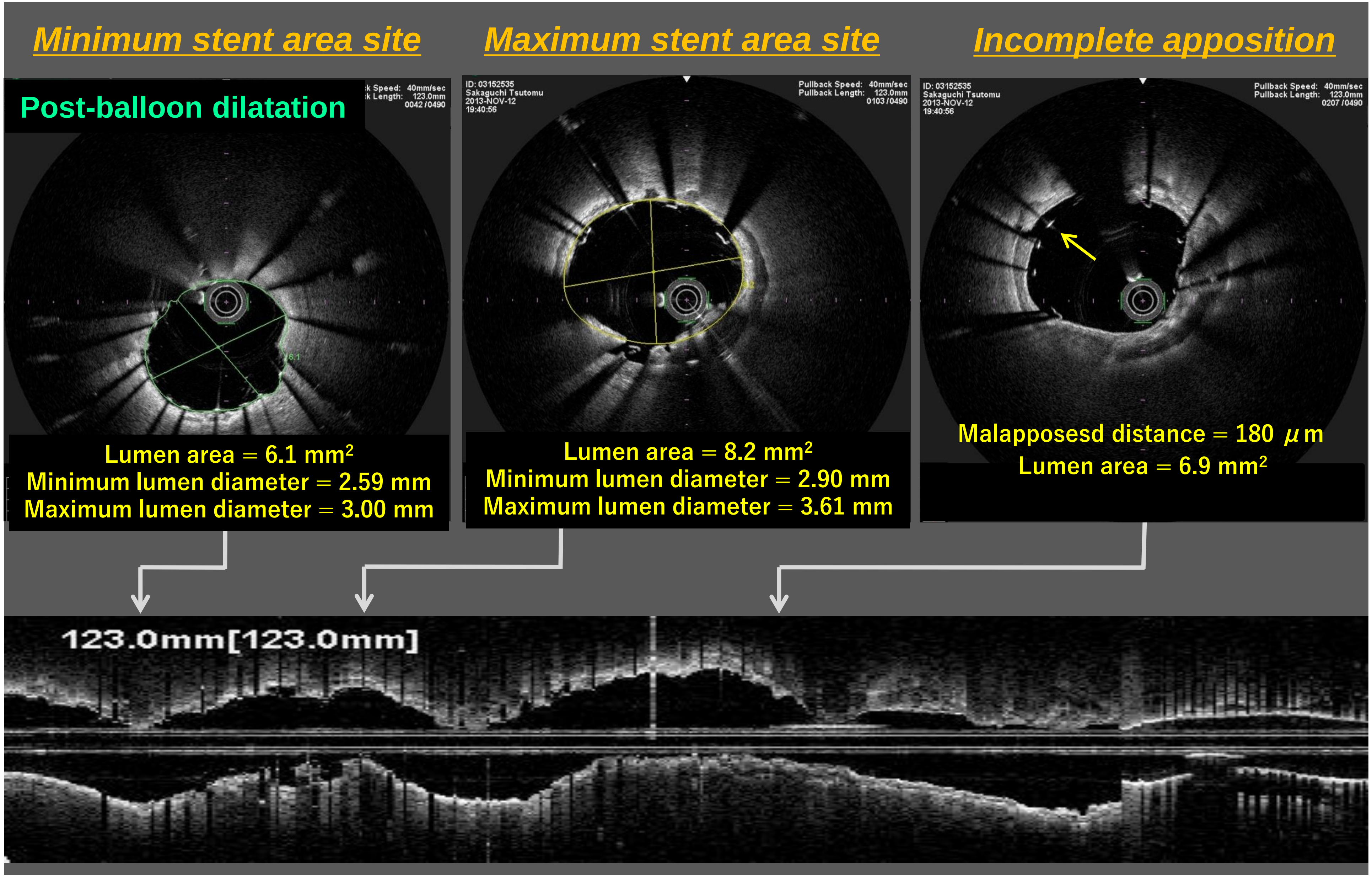
Burr size-up could be safely decided, and non-stent strategy was selected because of the following colon cancer operation.

Post-high pressure ballooning



Calcium plate fracture can be made by high pressure ballooning if the thickness of it becomes <500 µm, and confirmation of it by imaging should be important before stenting.

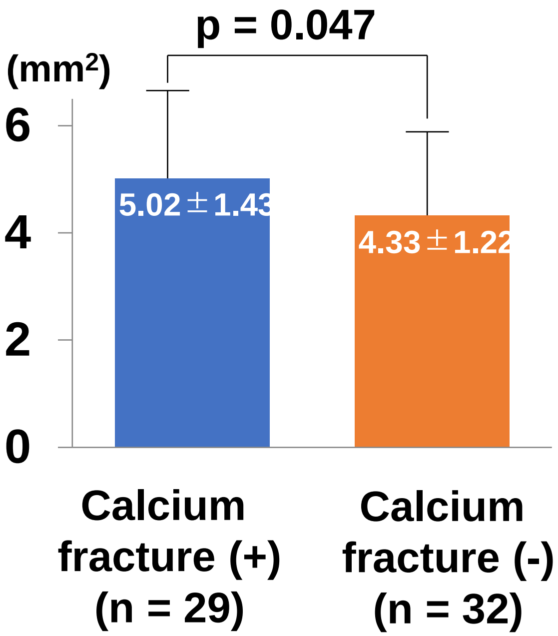
Post-high pressure ballooning after stenting



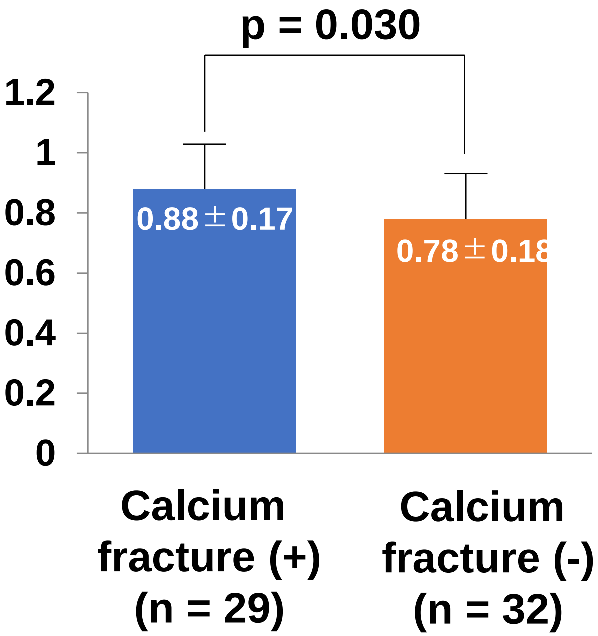
Stent expansion at post-PCI

Restenosis and TLR at 10 months follow-up

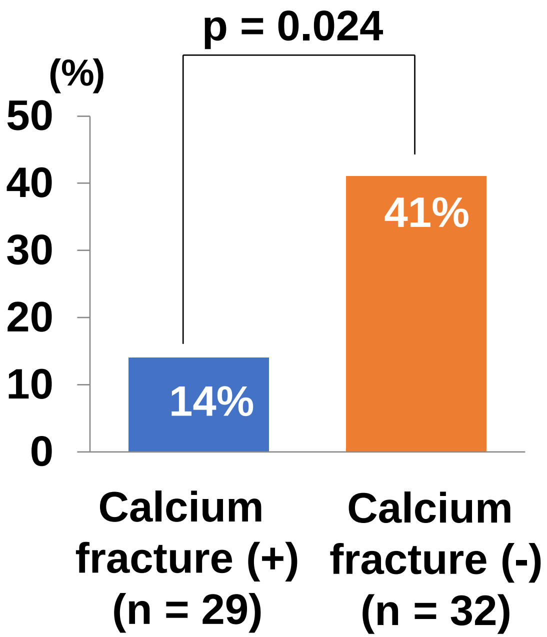
Minimum stent area



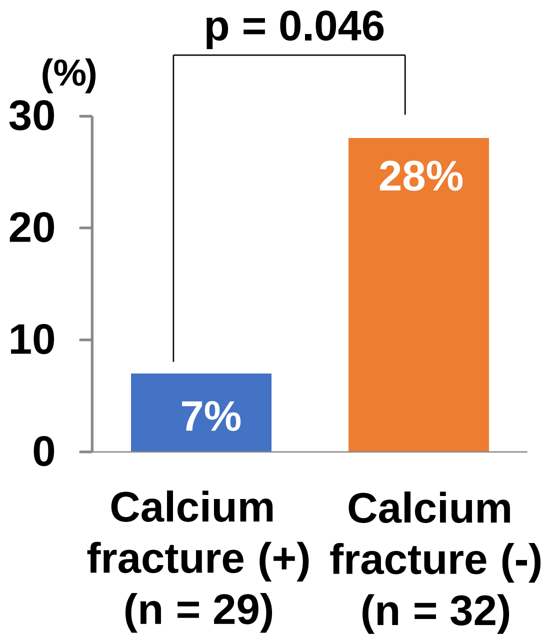
Stent expansion index



Binary restenosis



TLR



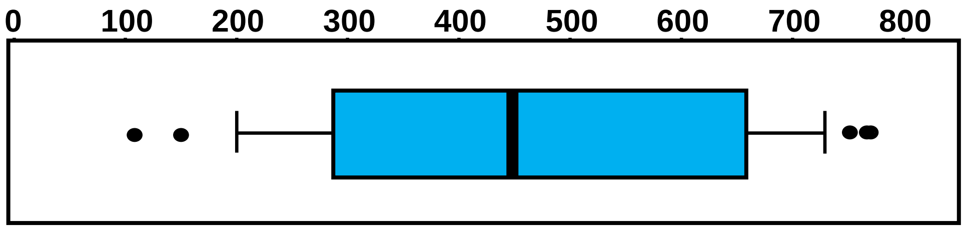
Minimum stent area and stent expansion index were significantly greater, the rate of binary restenosis and TLR was significantly lower in the group with calcium fracture compared with those in the group without calcium fracture.

Kubo, Akasaka et al. JACC Imag 2015;8:1228-1229

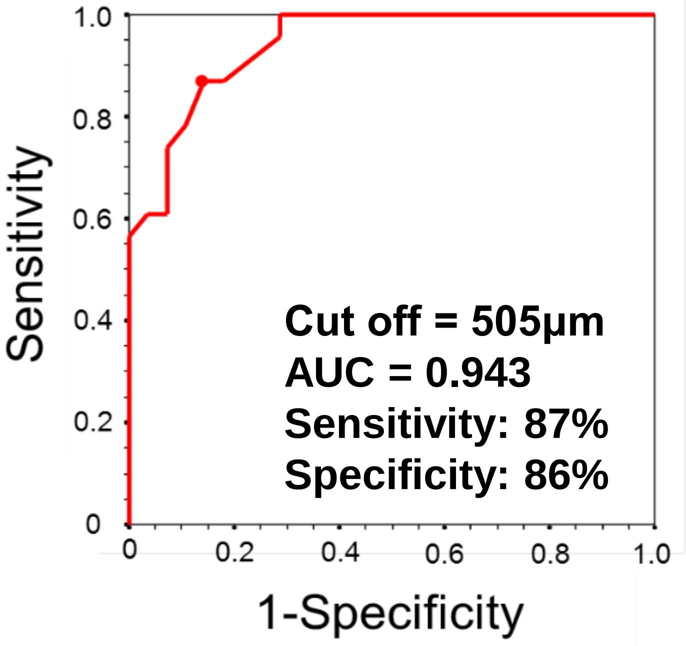
Prediction of calcium plate fracture by ballooning

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

Thickness distribution of calcium fracture



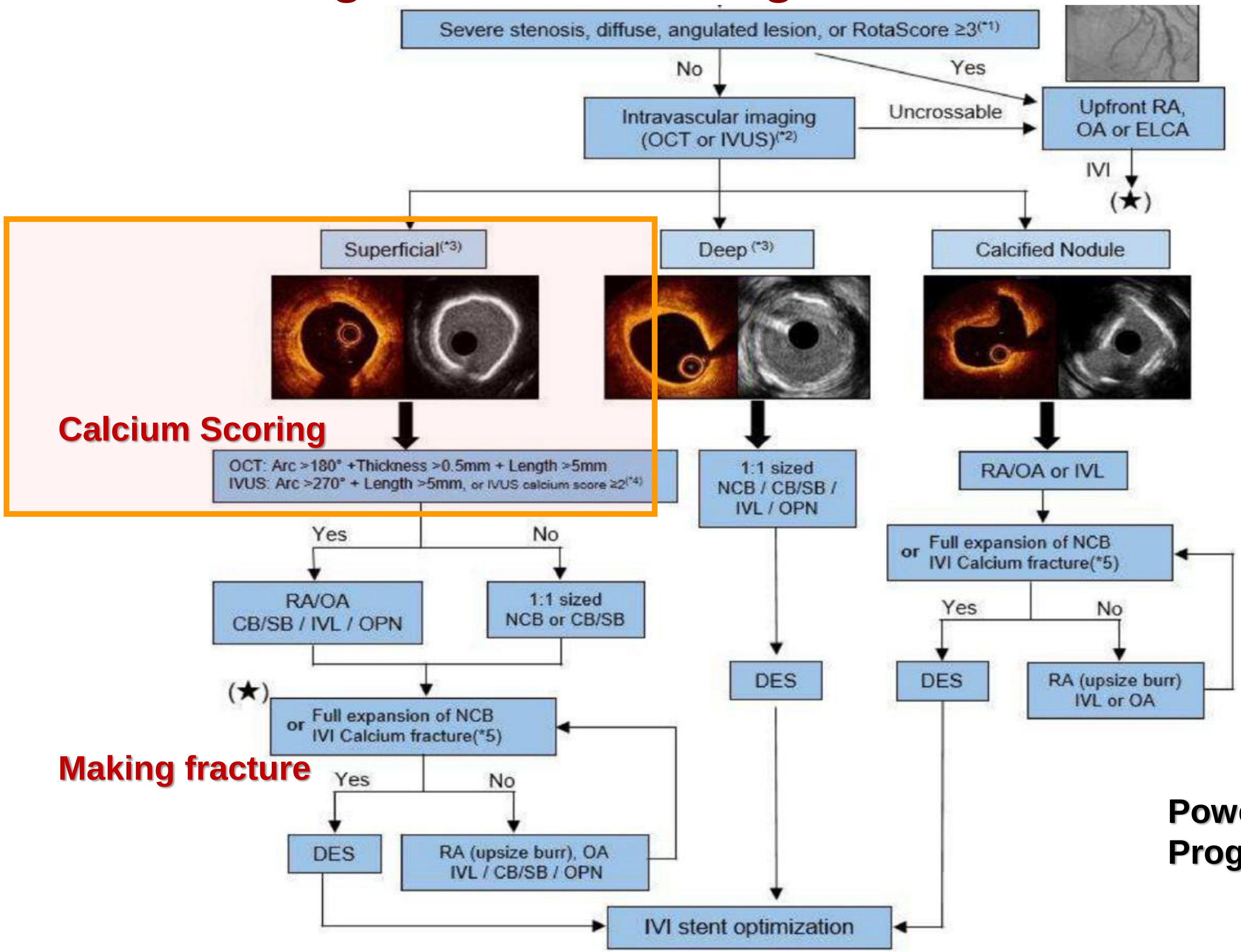
Median = 450μm; Lower quartile = 300μm; Upper quartile = 660μm; Minimum = 110μm; and Maximum = 770μm.



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 Img 2015;8:1228-9

A Practical Algorithm for Management of Calcified Coronary Lesions



Calcium Scoring by OCT

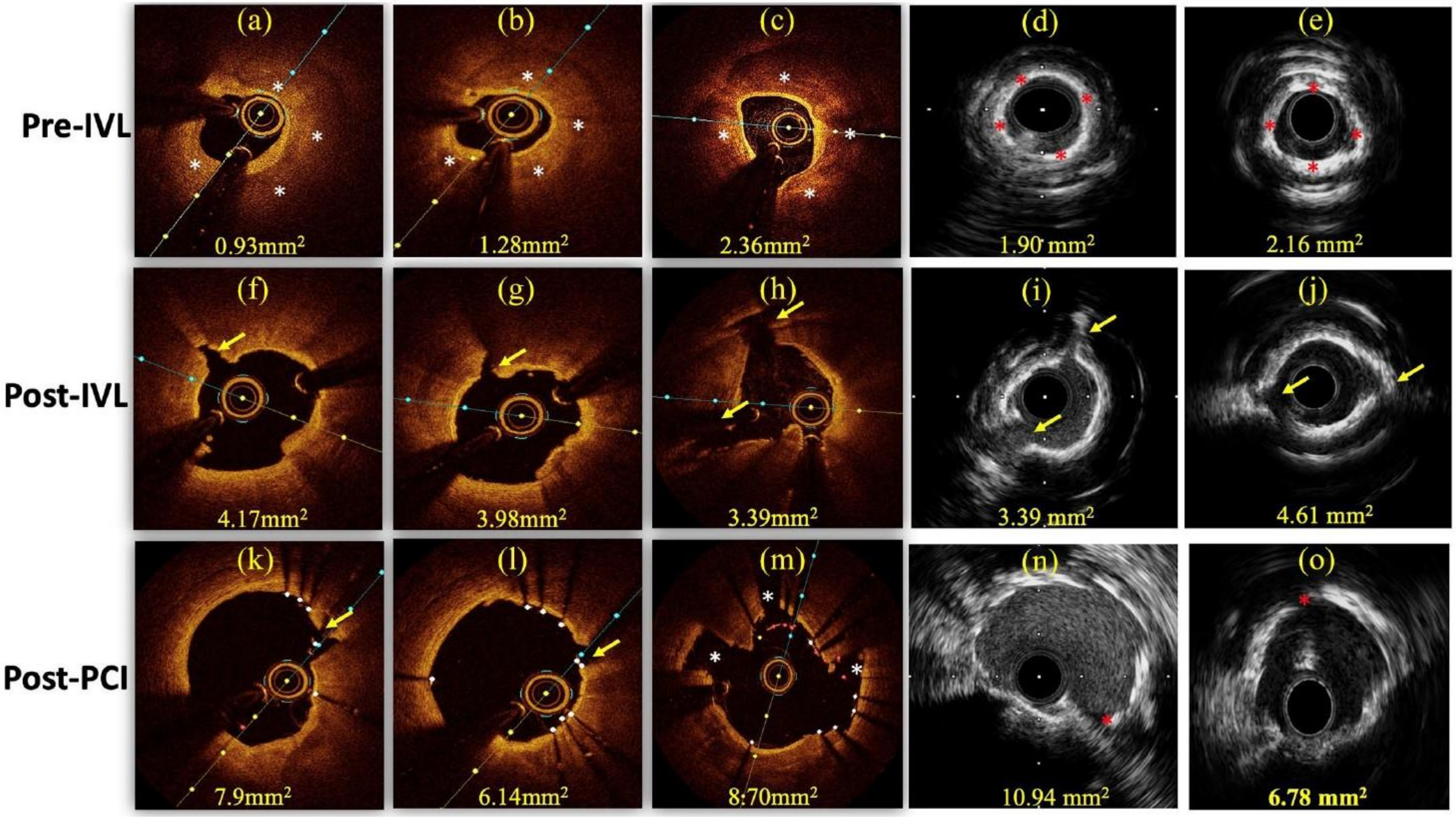
	OCT score	point
Calcium Thickness	≦0.5mm	0
	>0.5mm	1
Calcium Arc	≦90°	0
	90-180°	1
	>180°	2
Calcium Length	≦5mm	0
	>5mm	1

Calcium Scoring by IVUS

	IVUS score	point
Circumferential Calcium	≦360°	0
	360°	1
Length of Calcium > 270°	≦5mm	0
	>5mm	1
Diameter	>3.5mm	0
	≦3.5mm	1
Calcified Nodule	Absent	0
	Present	1

Power DA, et al.
Prog Cardiovasc Dis 2024;86:26-37

IV Imaging of IVL effect on circumferential coronary calcium



Gupta A, et al. Ther Adv Cardiovasc Dis 2024;18:1-13

Case 2 – 60's y.o. Female

Clinical diagnosis

Effort AP

Clinical history

Chest pain on effort

No history of prior intervention

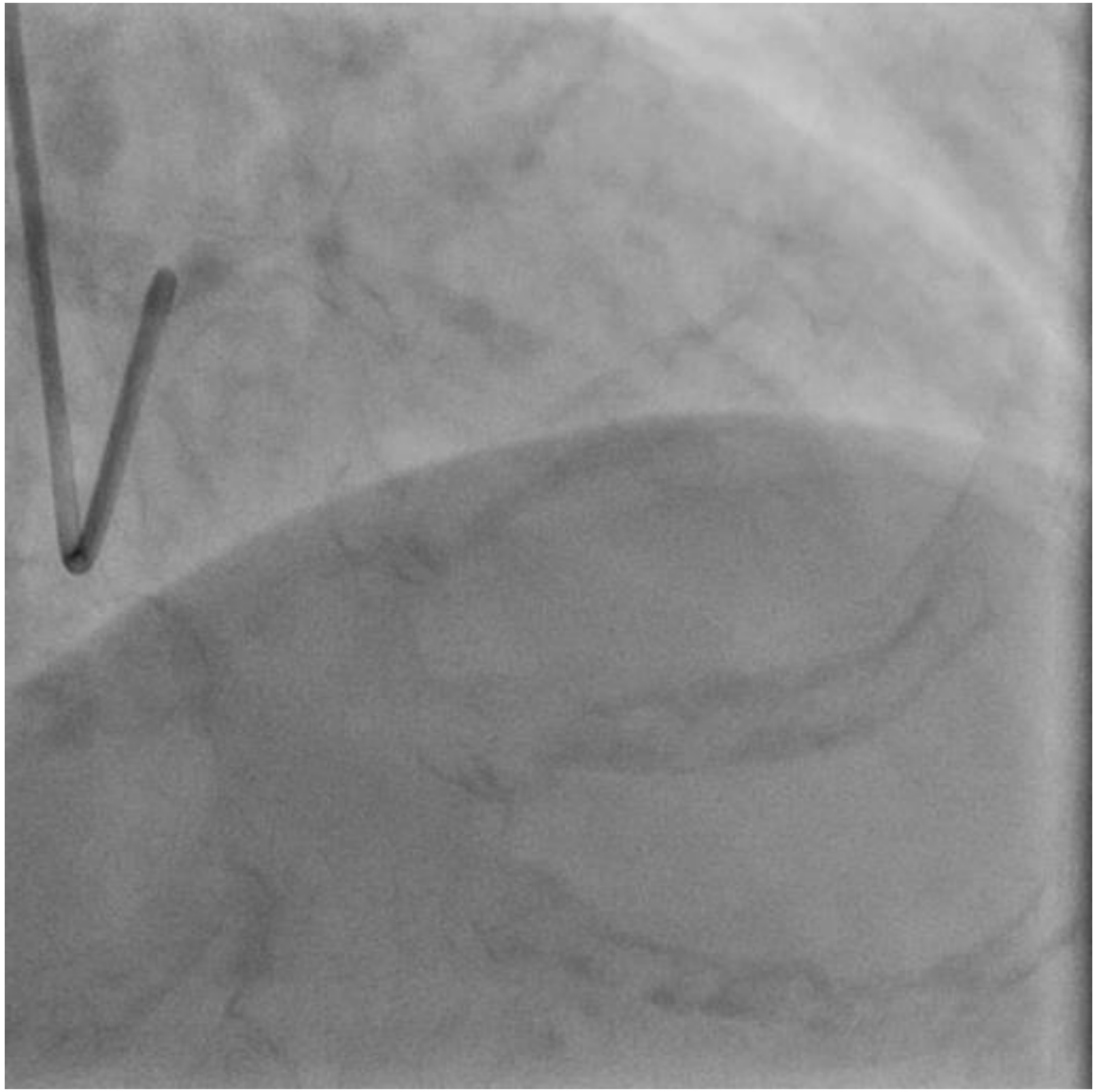
LVEF: 55%

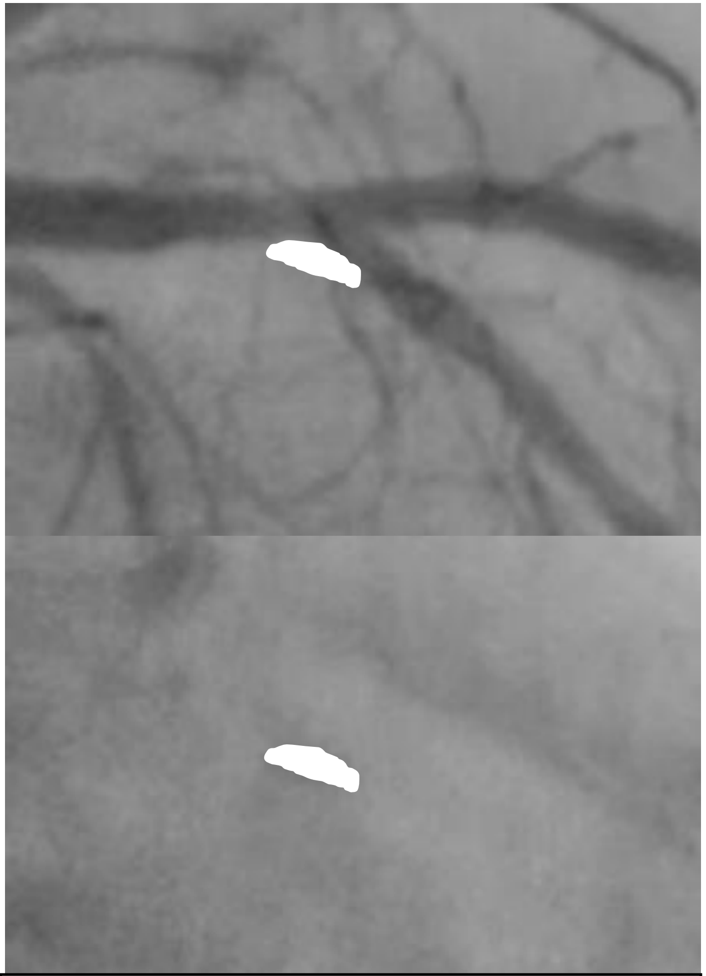
Cr: 1.0, eGFR: 40

Coronary risk factors

HT, DLP, DM

Coronary angiography – Target lesion: LAD seg 7:50-75%



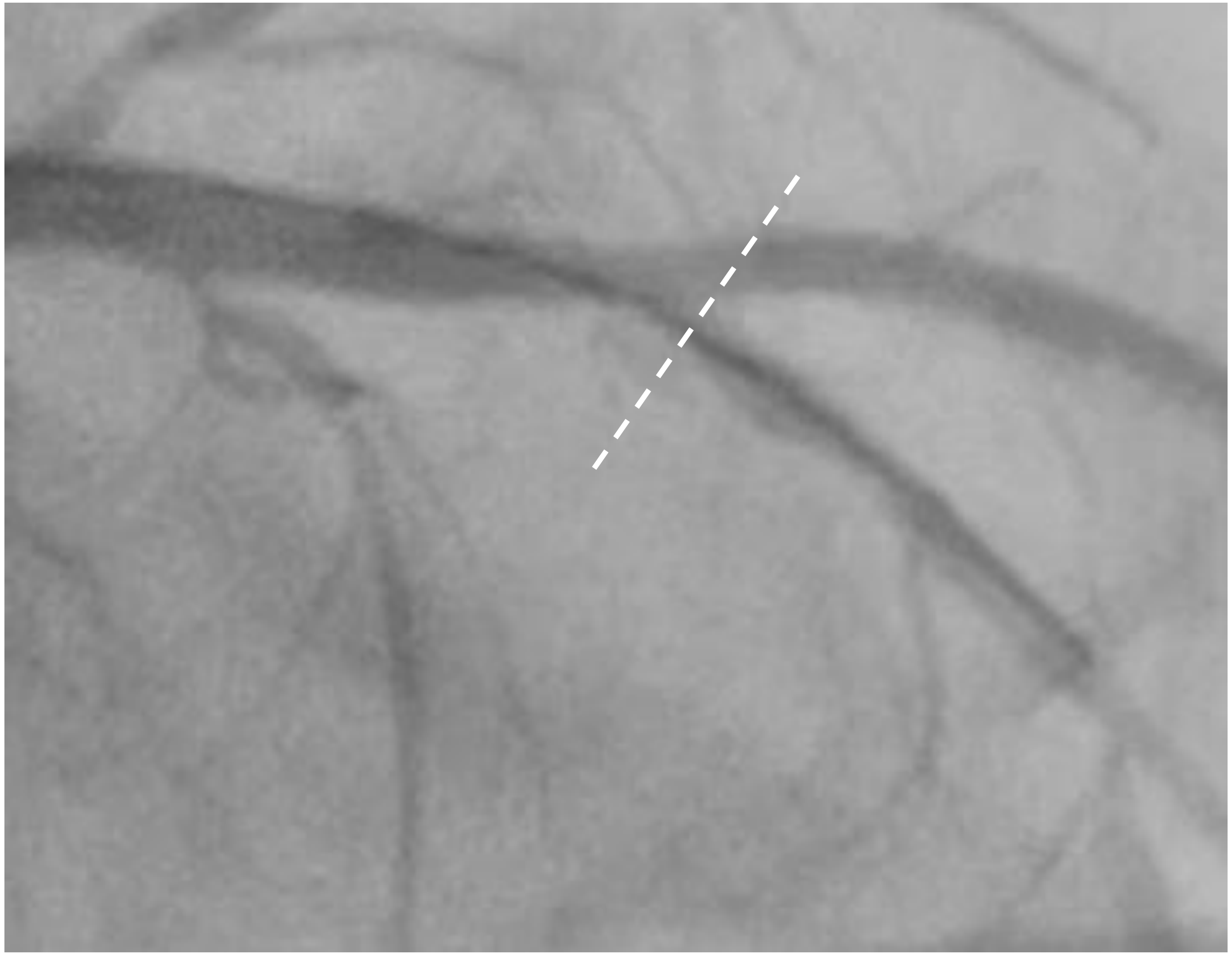


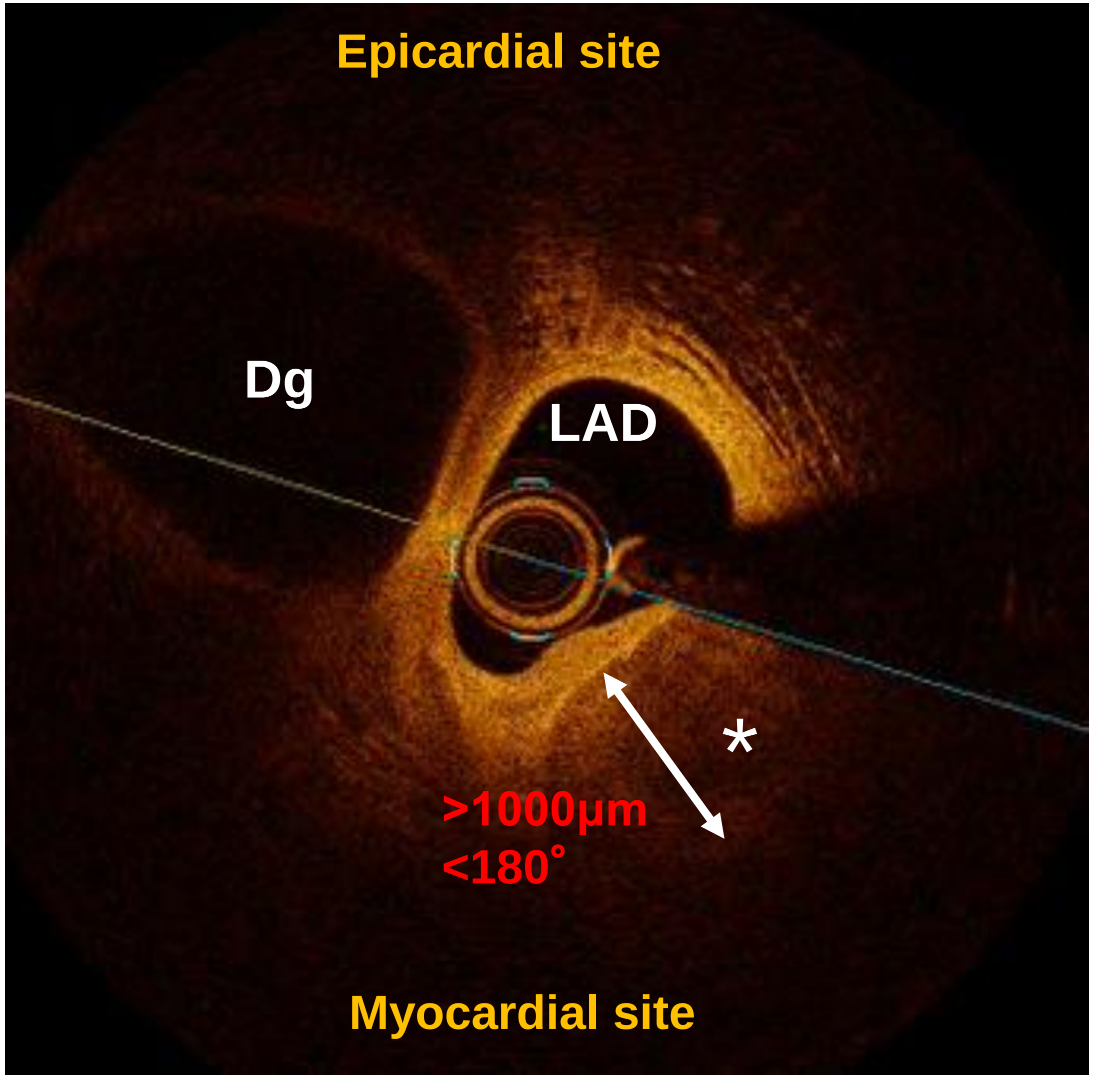
angiographically visible calcium

FFR_{LAD}=0.72,
seg 7:75% & ΔFFR=0.23.

Eccentric heavily thick calcium

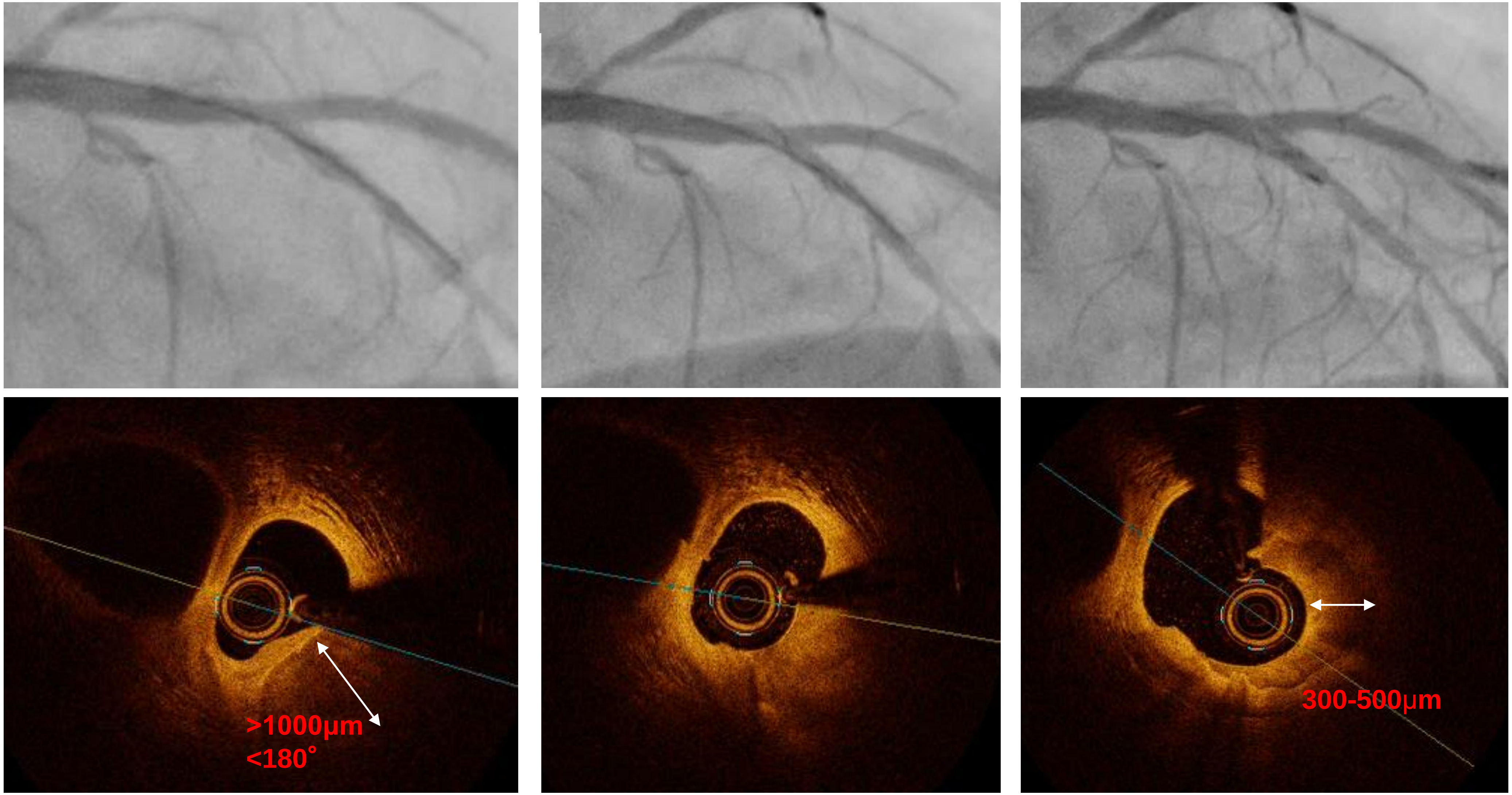
LAD seg.7:50-75%, FFR_{LAD}=0.72, ΔFFR=0.23





OCT findings of the lesion before and after OAS

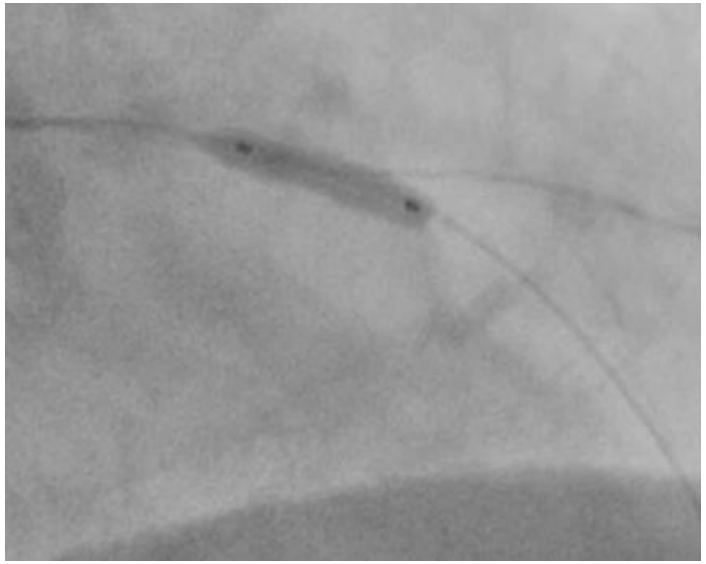
Before OAS **After low speed OAS** **After high speed OAS**

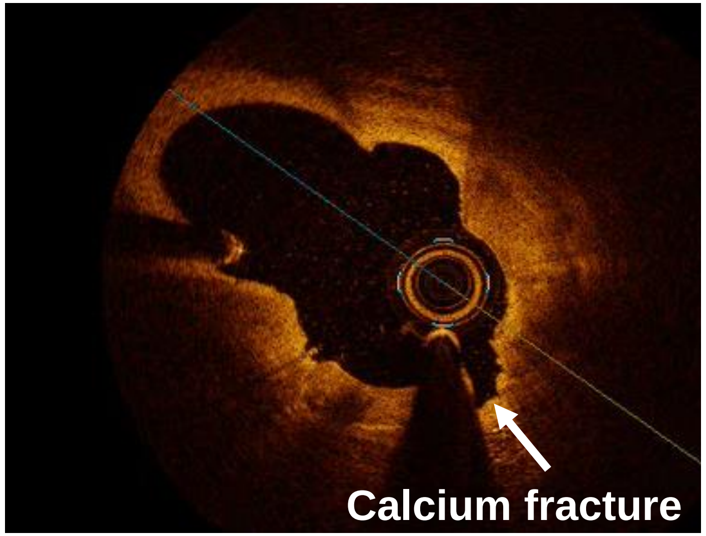


After confirming the effect of OAS with low speed using Viper wire bias, additional OAS with high speed was repeated 4 times as a pull back way.

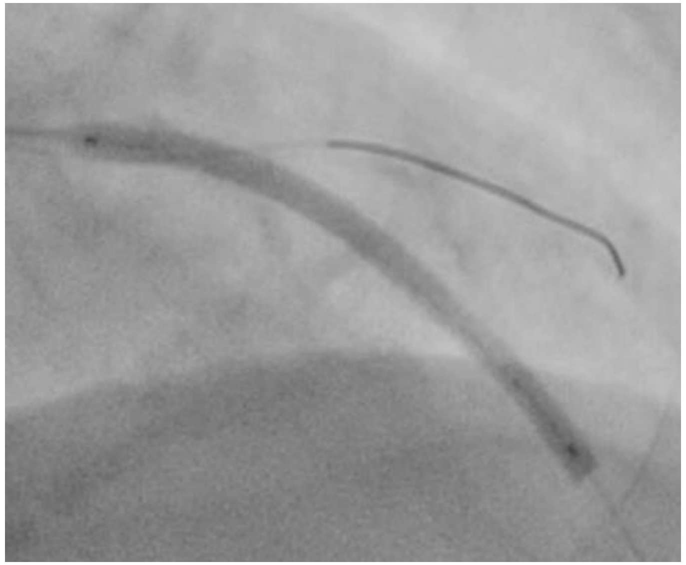
POBA & Stenting

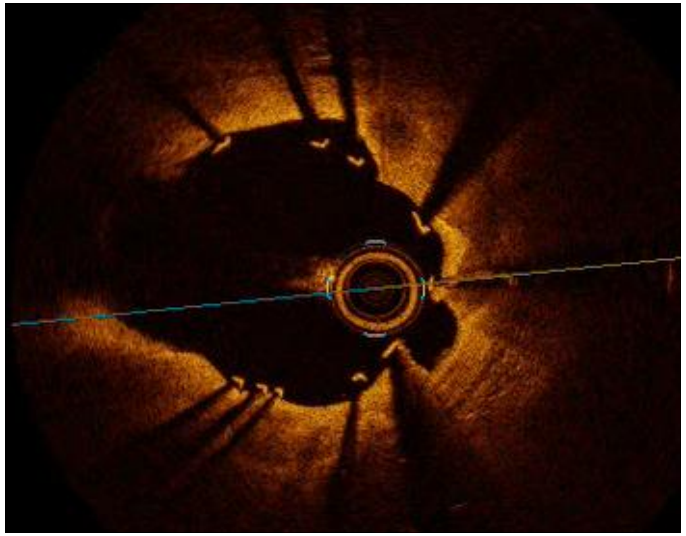
POBA
Wolverine 2.75*10mm





DES
3.0*38mm





Final Angiography
After stenting

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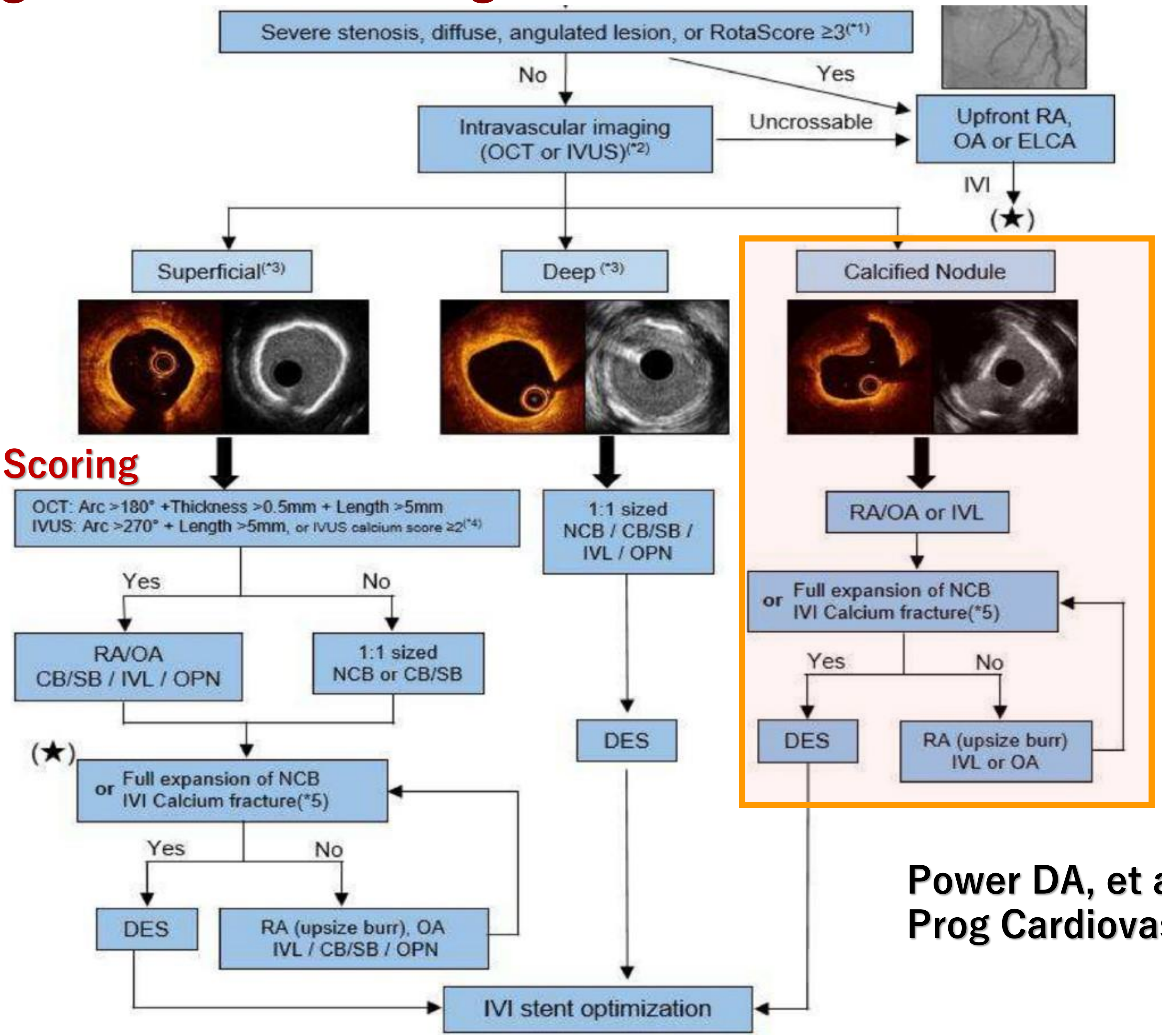
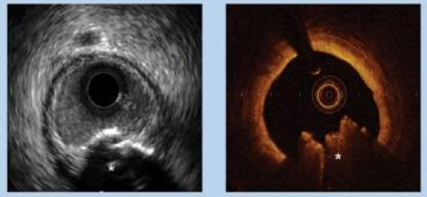
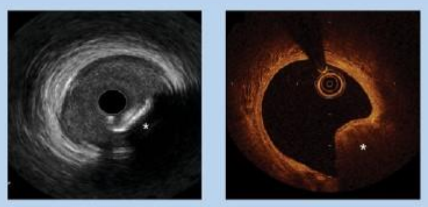
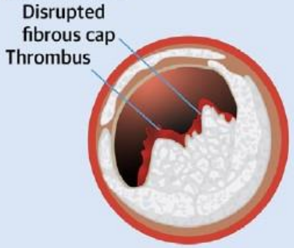
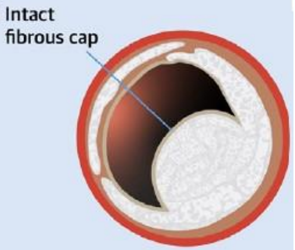


Calcium Scoring

Making fracture

Power DA, et al.
Prog Cardiovasc Dis 2024;86:26-37

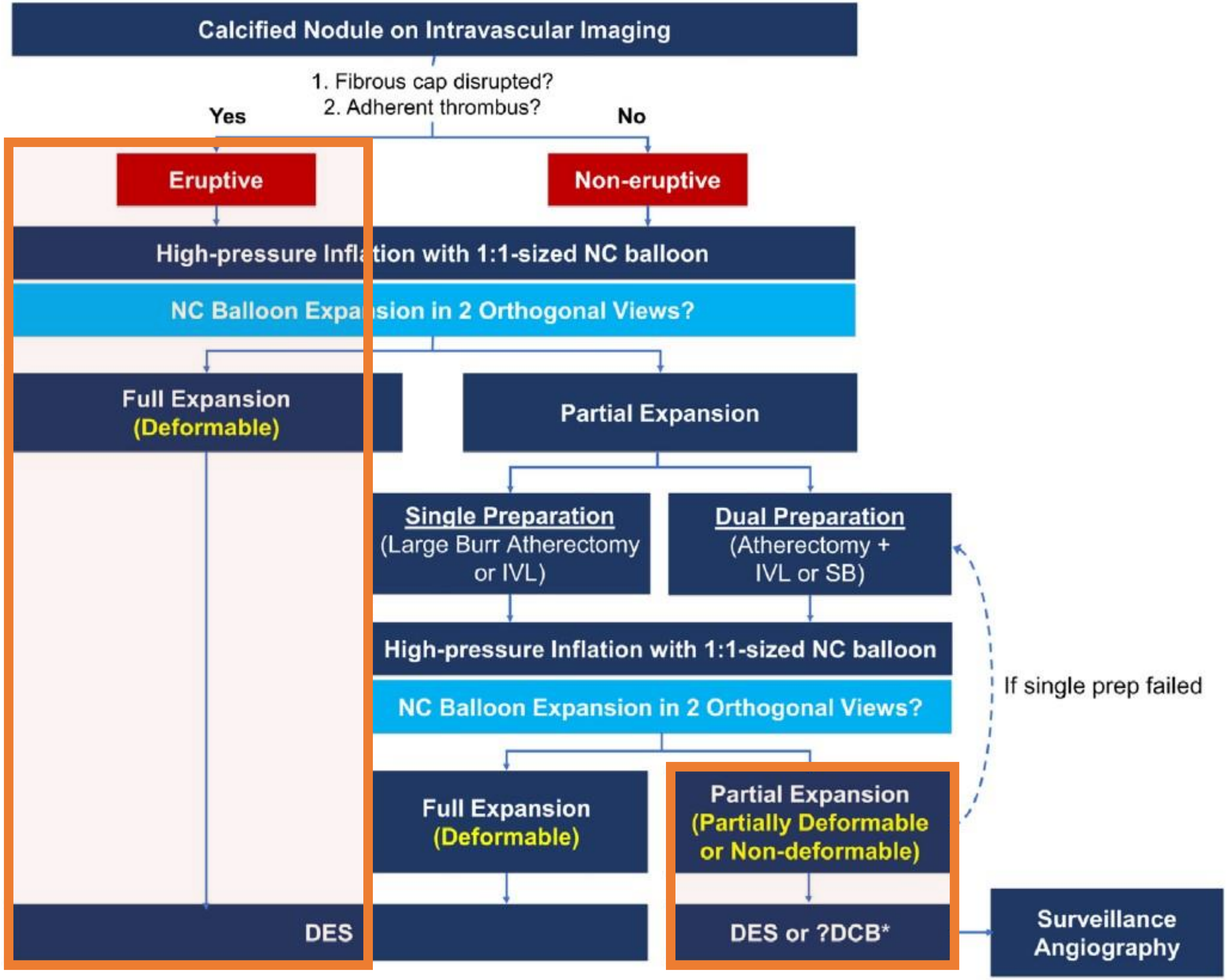
Differences between 2 Subtypes of Calcified Nodules

	Eruptive Calcified Nodule	Noneruptive Calcified Nodule
Intravascular Imaging		
Morphology	Disrupted fibrous cap ± Overlying thrombus 	Intact fibrous cap No thrombus 
Activity	Active Can cause ACS	Stable

	Eruptive Calcified Nodule	Noneruptive Calcified Nodule
Intervention Strategy	• NC balloon • IVL • Atherectomy rarely required • DES (DCB uncertain)	• NC balloon • IVL • Atherectomy • May require combination therapy (eg, atherectomy + IVL) • DES (DCB uncertain)
Immediate Treatment Response	Mostly deformable Greater stent expansion	Can be nondeformable Less stent expansion
Prognosis	More target lesion revascularization Worst prognosis among ACS lesions	Less target lesion revascularization than eruptive

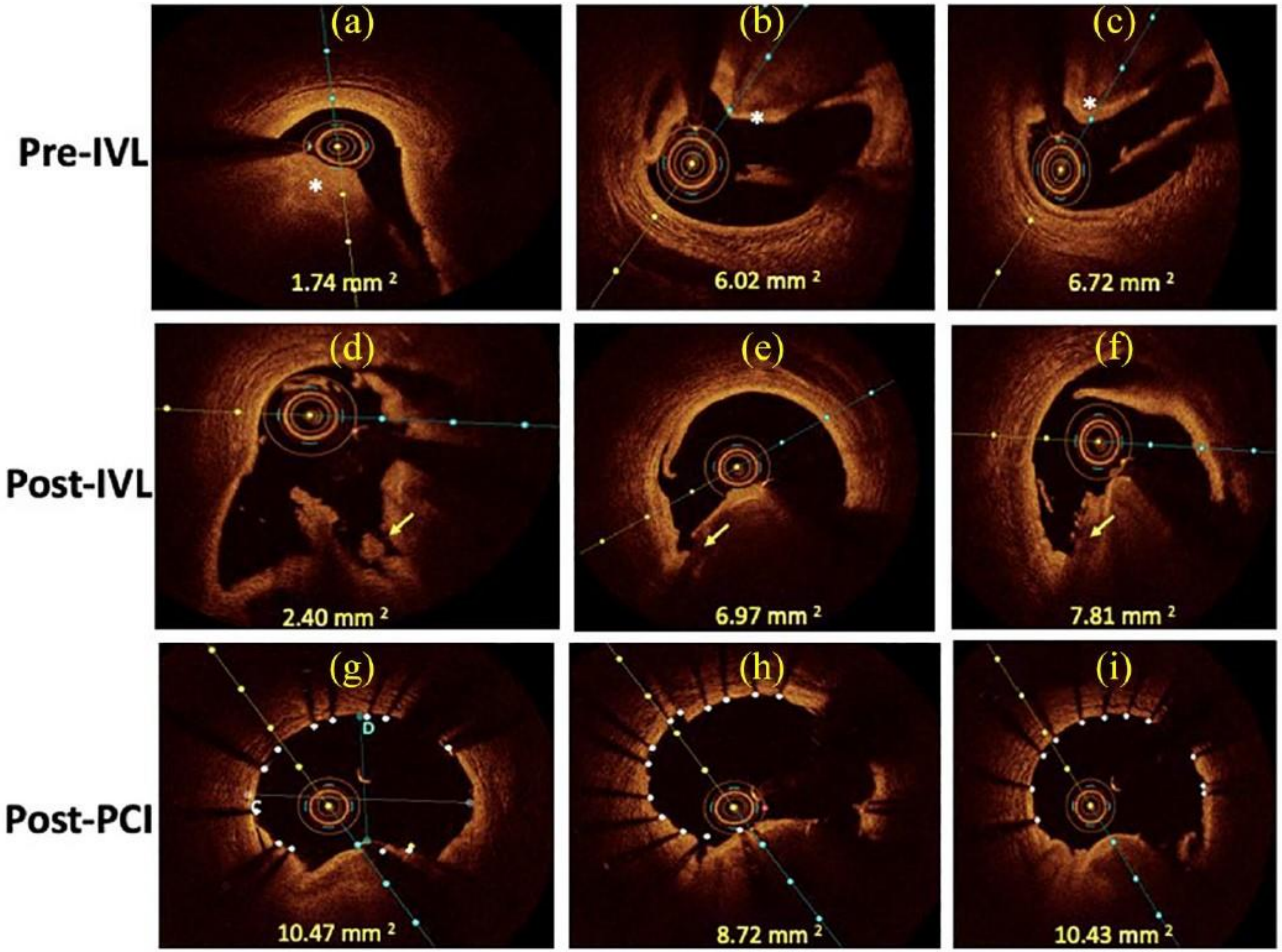
Shin D, et al. J AM Coll Cardiol Intv 2024;1187:1-1199

Potential Approach in the Treatment of Calcified Nodules



Shin D, et al. J AM Coll Cardiol Intv 2024;1187:1-1199

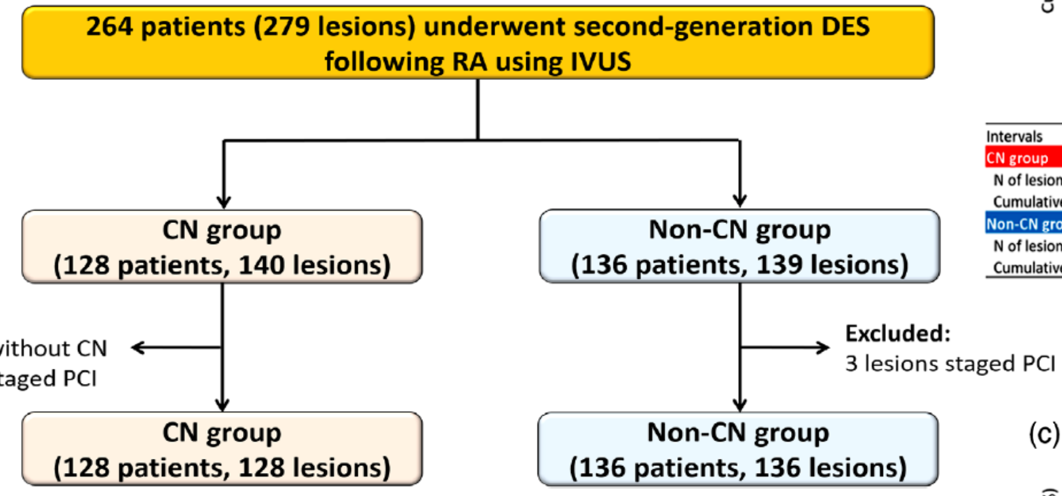
IV Imaging of IVL effect on nodular coronary calcium



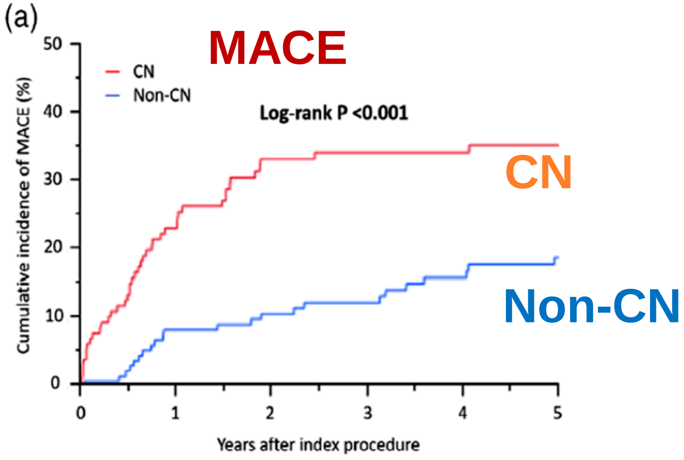
Gupta A, et al. Ther Adv Cardiovasc Dis 2024;18:1-13

Clinical impact of calcified nodule in patients with heavily calcified lesions requiring rotational atherectomy

Toru Morofuji MD[1] | Shoichi Kuramitsu MD, PhD[1] | Tomohiro Shinozaki PhD[2]
Hiroyuki Jinnouchi MD[1] | Shinjo Sonoda MD, PhD[3] | Takenori Domei MD[1] |
Makoto Hyodo MD[1] | Shinichi Shirai MD[1] | Kenji Ando MD[1]

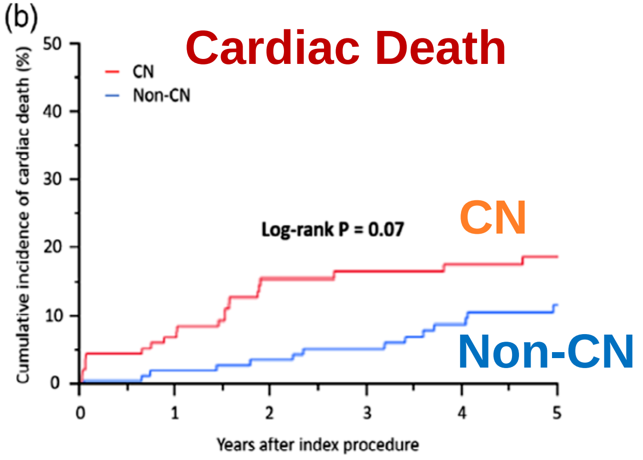


(a)



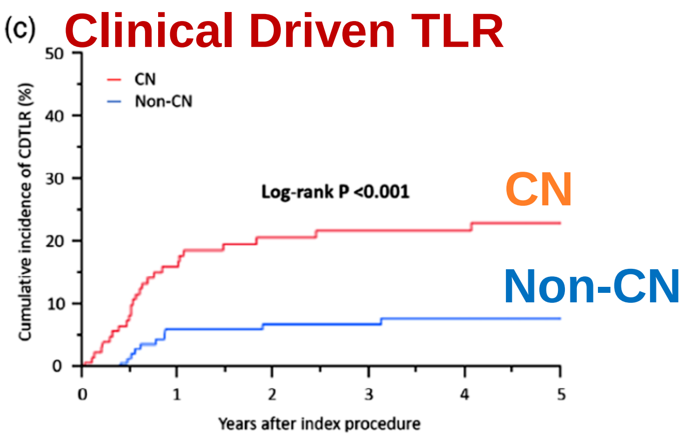
Intervals	0	30 days	1 Year	2 Years	3 Years	4 Years	5 Years
CN group							
N of lesions at risk	128	119	94	73	65	63	56
Cumulative incidence	0.0%	6.3%	24.7%	33.3%	34.3%	34.3%	35.4%
Non-CN group							
N of lesions at risk	136	135	121	111	102	91	81
Cumulative incidence	0.0%	0.74%	8.3%	10.7%	12.3%	15.9%	18.8%

(b)



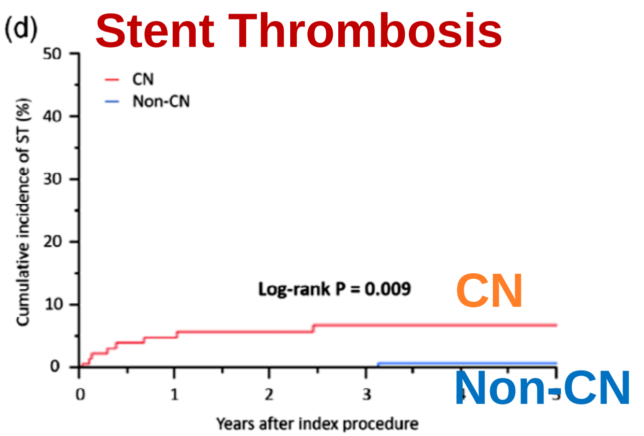
Intervals	0	30 days	1 Year	2 Years	3 Years	4 Years	5 Years
CN group							
N of lesions at risk	128	120	114	94	84	78	70
Cumulative incidence	0.0%	4.7%	8.0%	15.7%	16.7%	17.7%	18.9%
Non-CN group							
N of lesions at risk	136	136	129	120	110	100	90
Cumulative incidence	0.0%	0.0%	2.3%	3.8%	5.5%	9.1%	11.9%

(c)



Intervals	0	30 days	1 Year	2 Years	3 Years	4 Years	5 Years
CN group							
N of lesions at risk	128	119	94	74	66	64	57
Cumulative incidence	0.0%	0.79%	17.0%	20.8%	21.9%	21.9%	23.2%
Non-CN group							
N of lesions at risk	136	136	121	111	101	91	81
Cumulative incidence	0.0%	0.0%	6.1%	7.0%	7.0%	7.9%	7.9%

(d)



Intervals	0	30 days	1 Year	2 Years	3 Years	4 Years	5 Years
CN group							
N of lesions at risk	128	119	108	89	80	74	66
Cumulative incidence	0.0%	0.79%	5.0%	5.9%	7.0%	7.0%	7.0%
Non-CN group							
N of lesions at risk	136	136	129	120	110	99	89
Cumulative incidence	0.0%	0.0%	0.0%	0.0%	0.0%	0.93%	0.93%

Compared with non-calcified nodule, calcified nodule demonstrates poor prognosis including significantly higher rate of MACE, cardiac death, clinical driven TLR and stent thrombosis.

Morofuji T, et al. *Catheter Cardiovasc Interv. 2021;97:10-19*

Diagnosis and Prognostic Value of the Underlying Cause of Acute Coronary Syndrome in Optical Coherence Tomography–Guided Emergency Percutaneous Coronary Intervention

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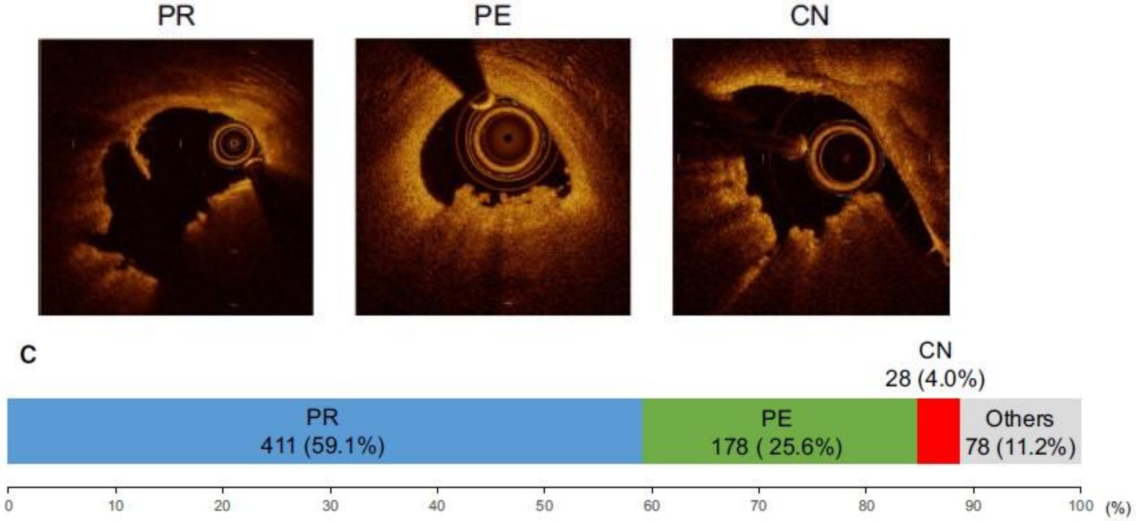
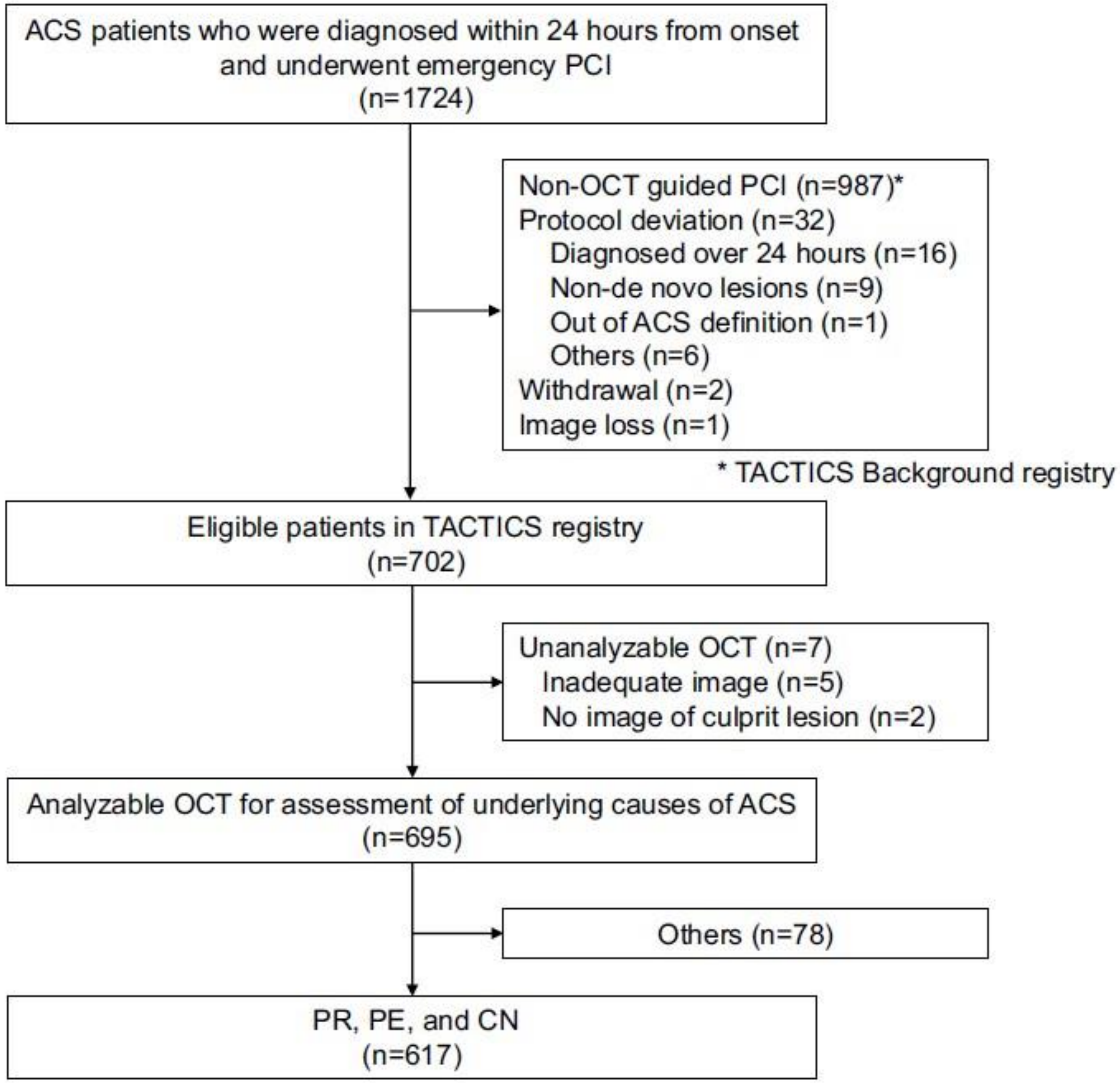
Hiroyoshi Mori, MD, PhD; Myong Hwa Yamamoto, MD, PhD; Takehiko Sambe, MD, PhD;
Sakiko Yasuhara, BSc; Kiyoshi Hibi, MD, PhD; Mamoru Nanasato, MD, PhD; Tomoyo Sugiya
Tsunekazu Kakuta, MD, PhD; Takeshi Kondo, MD; Satoru Mitomo, MD; Sunao Nakamura
Masamichi Takano, MD, PhD; Taishi Yonetsu, MD, PhD; Takashi Ashikaga, MD, PhD; Tomotaka
Hirosada Yamamoto, MD, PhD; Ken Kozuma, MD, PhD; Jun Yamashita, MD, PhD; Junichi Yama
Hiroshi Ohira, MD; Kaneto Mitsumata, MD; Atsuo Namiki, MD, PhD; Shigeki Kimura, MD, PhD;
Junko Honye, MD, PhD; Nozomi Kotoku, MD, PhD; Takumi Higuma, MD, PhD; Makoto Na
Yuji Ikari, MD, PhD; Teruo Sekimoto, MD, PhD; Hidenari Matsumoto, MD, PhD; Hiroshi Suzul
Hiromasa Otake, MD, PhD; Yoichiro Sugizaki, MD, PhD; Naoei Isomura, MD, PhD; Masahiko O
Satoru Suwa, MD; Toshiro Shinke, MD, PhD; TACTICS investigators*

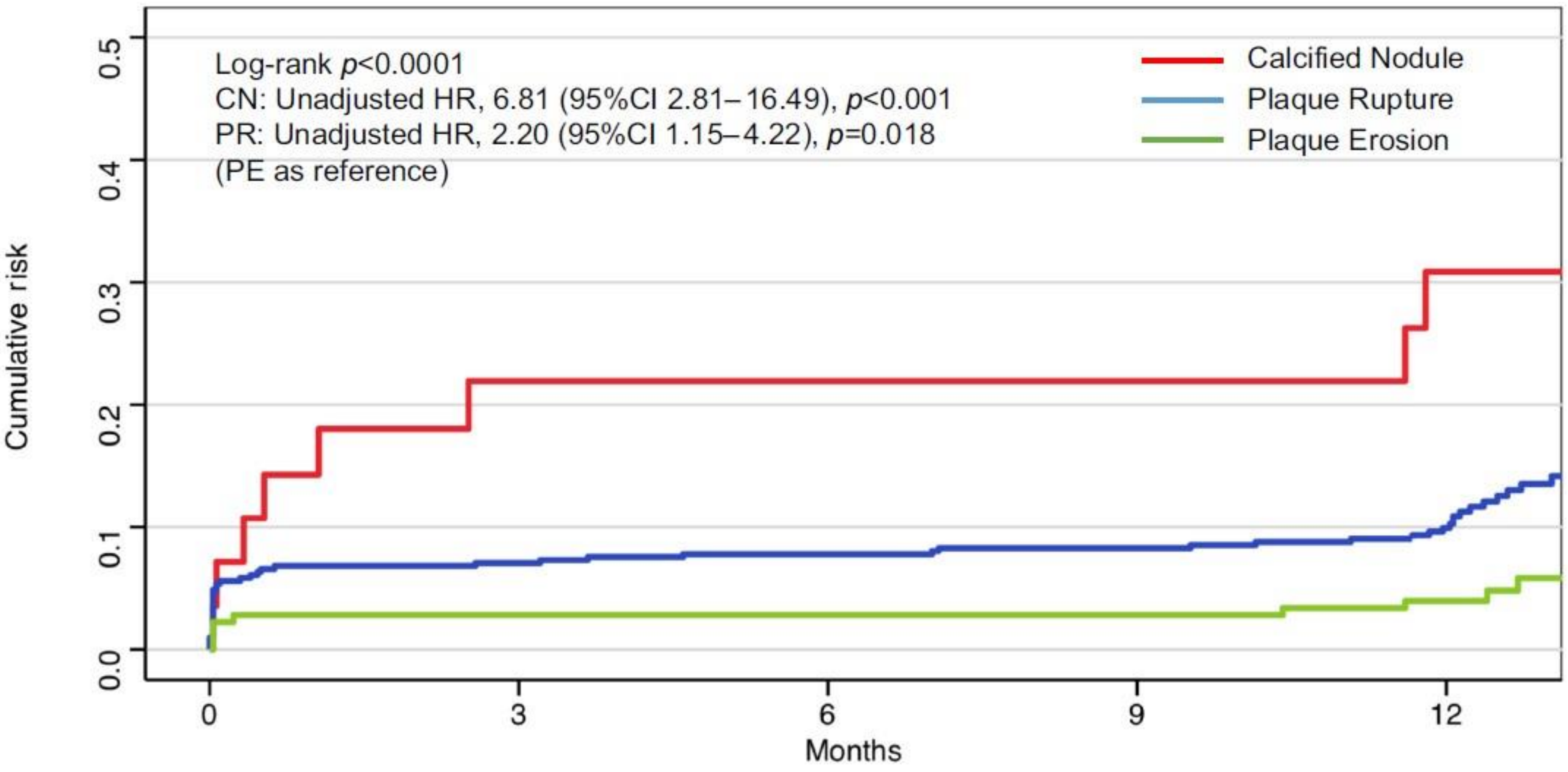


Study Flow of TACTICS Study



Kondo S, et al. J Am Heart Assoc 2023;12:e030412

Kaplan–Meier time-to-event curve for the cumulative MACE rate



Number at risk

	0	3	6	9	12
Calcified Nodule	28	20	20	20	15
Plaque Rupture	411	382	375	371	289
Plaque Erosion	178	171	171	170	151

Kondo S, et al. J Am Heart Assoc 2023;12:e030412

Take home messages

OCT guided PCI for Calcified Lesion

- Lesion modification by atherectomy would be recommended if any imaging devices could not be passed through the tight lesion with severe calcification.
- Step by step approach by changing in burr size and/or rotation speed would be recommended for ablating calcium safely using wire bias under image guidance.
- OCT may allow us to demonstrate clearly the position, distribution and thickness of calcium, although IVUS might be more sensitive to detect calcium than OCT.
- Confirmation of calcium plate fracture by IV imaging after high pressure ballooning should be mandatory in cases with the calcium thickness less than 500μm.
- IVL should be considered if calcium plate fracture cannot be confirmed by IV imaging because of very thick calcium more than 500μm.
- Enough stent expansion and less instent restenosis could be expected if calcium plate fracture can be obtained after high pressure ballooning and/or IVL system.
- Calcified nodule demonstrated poor prognosis compared with non-calcified nodule even after ablation under the guidance of intracoronary imaging.

Thank you for your kind attention !!