Challenging Case Presentation & Focus Review

Step-by-step Approach of OCT-guided Atherectomy

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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 organizations listed below.

Affiliation/Financial Relationship

- **Grant/Research Support:** Abbott Vascular Japan
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Nipro Inc.
Terumo Inc.
- **Consulting Fees/Honoraria:** Abbott Vascular Japan
Daiichi-Sankyo Pharmaceutical Inc.
Nipro Inc.
Terumo Inc.

State of the art: evolving concepts in the treatment of heavily calcified and undilatable coronary stenoses – from debulking to plaque modification, a 40-year-long journey

EuroIntervention 2017;13:696-705

Emanuele Barbato[1,2*], MD, PhD; Evan Shlofmitz[3,4], DO; Anastasios Milkas[1,5], MD; Richard Shlofmitz[4], MD; Lorenzo Azzalini[6], MD, PhD, MSc; Antonio Colombo[6], MD

- **Because of the difficulty in adequately dilating the lesions and/or the inability to deliver and implant stents appropriately, PCI to heavily calcified fibrotic coronary stenosis is often associated with high rates of procedural complications and suboptimal long-term clinical outcomes.**

- **Thus, heavily calcified, fibrotic coronary stenosis has traditionally represented a very challenging scenario for PCI, and very common indication for surgical revascularization.**

- **After developing dedicated cutting and scoring balloons and atherectomy devices, the treatment of most fibrotic and heavily calcified stenoses has become feasible and safe recently.**

Case 60's y.o. Female

Clinical Diagnosis: Effort AP

Colon cancer (before operation)

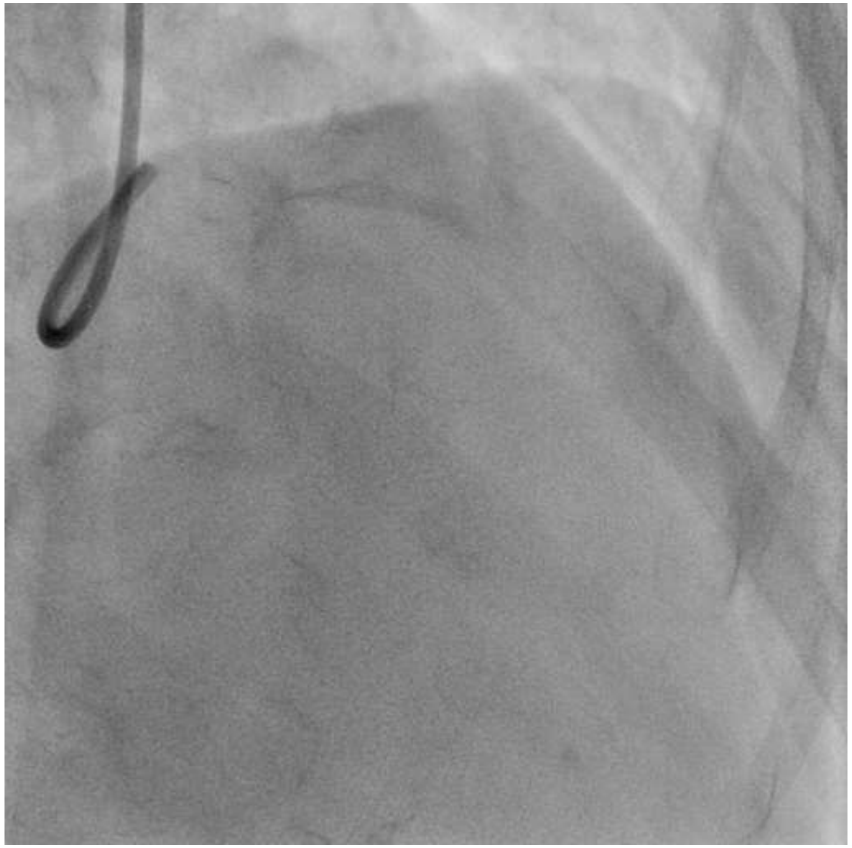
Coronary risk factor: HT, DM

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

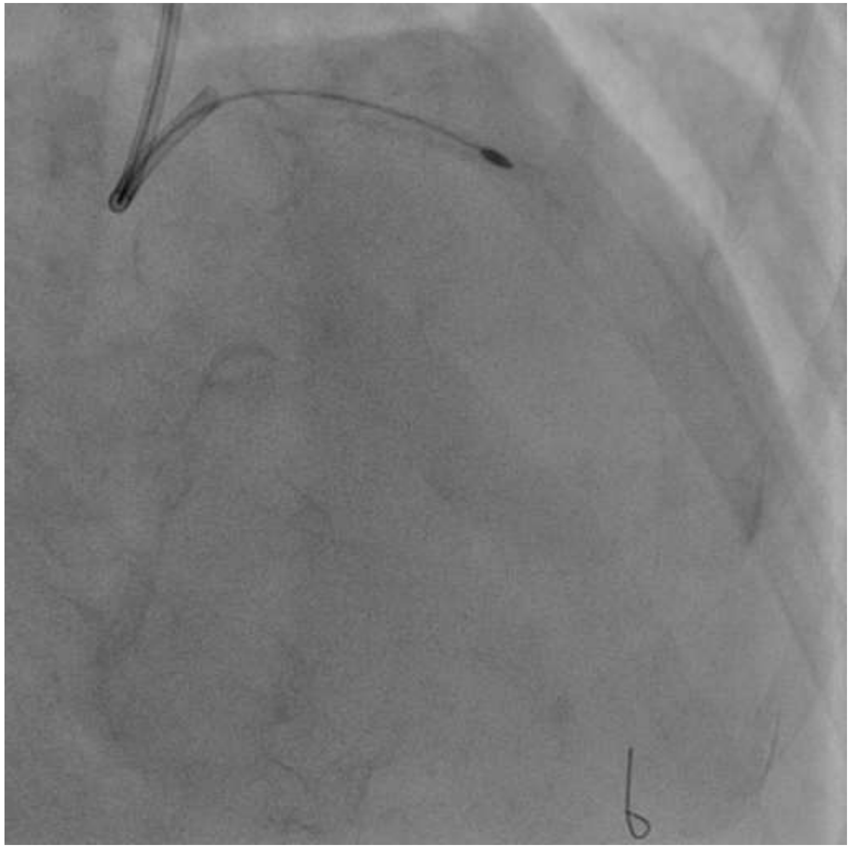
Cardiac Function: EF 63%, asynergy(-)

Coronary angiography & rotational atherectomy

Pre PCI



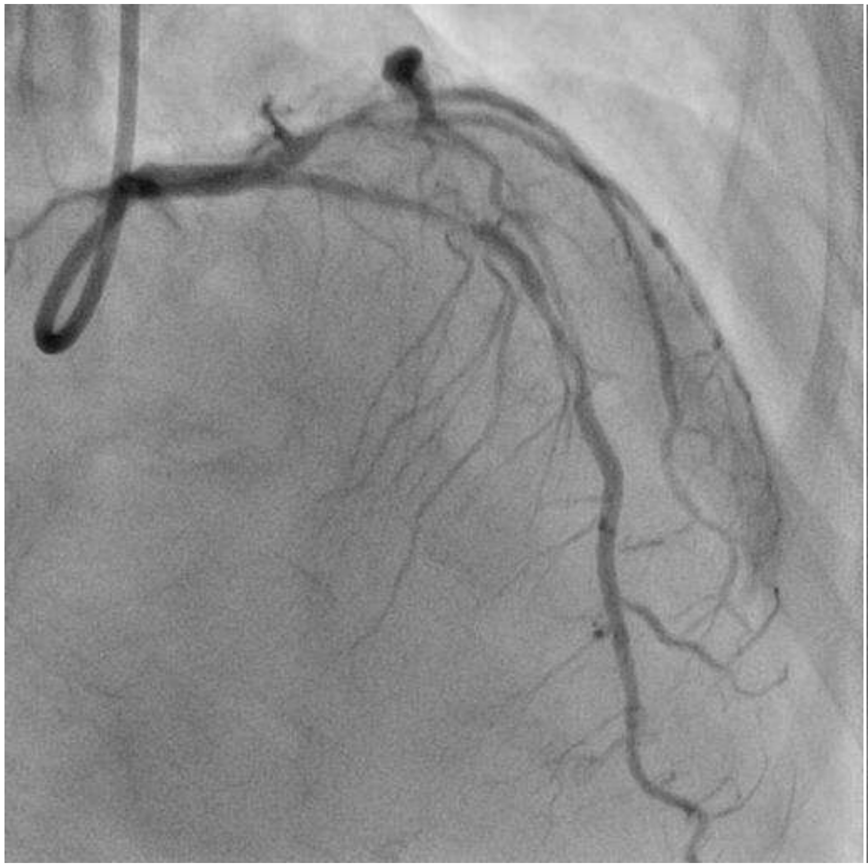
Rota 1.5 mm



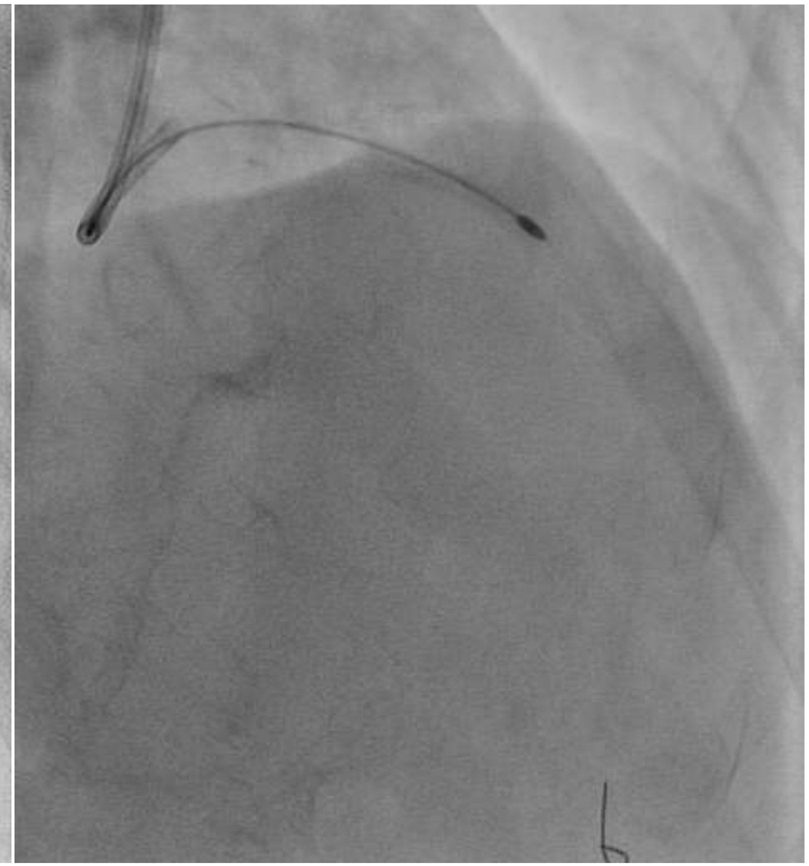
Because of heavy calcification, it was difficult to pass any imaging device after angiography, and rotablator with 1.5mm burr was selected for lesion modification.

Coronary angiography & Rotablator

Pre PCI

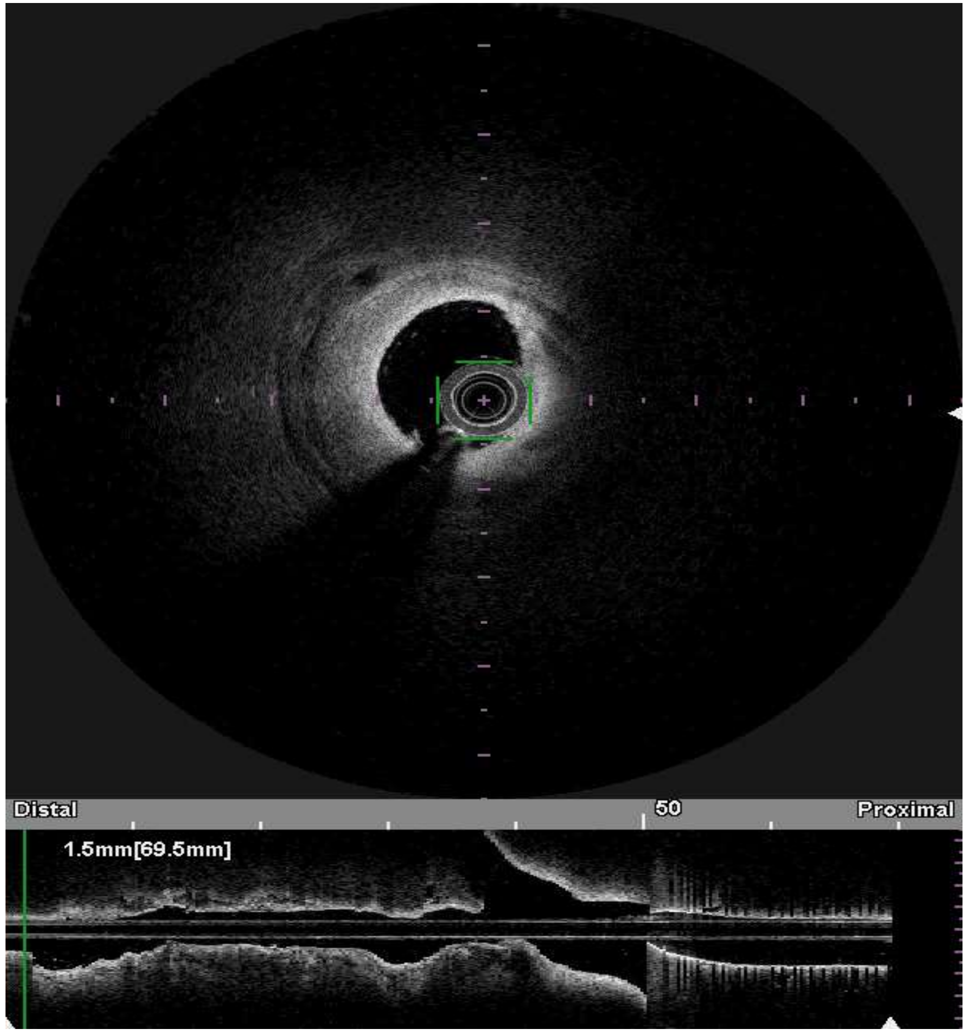


Rota 1.5 mm



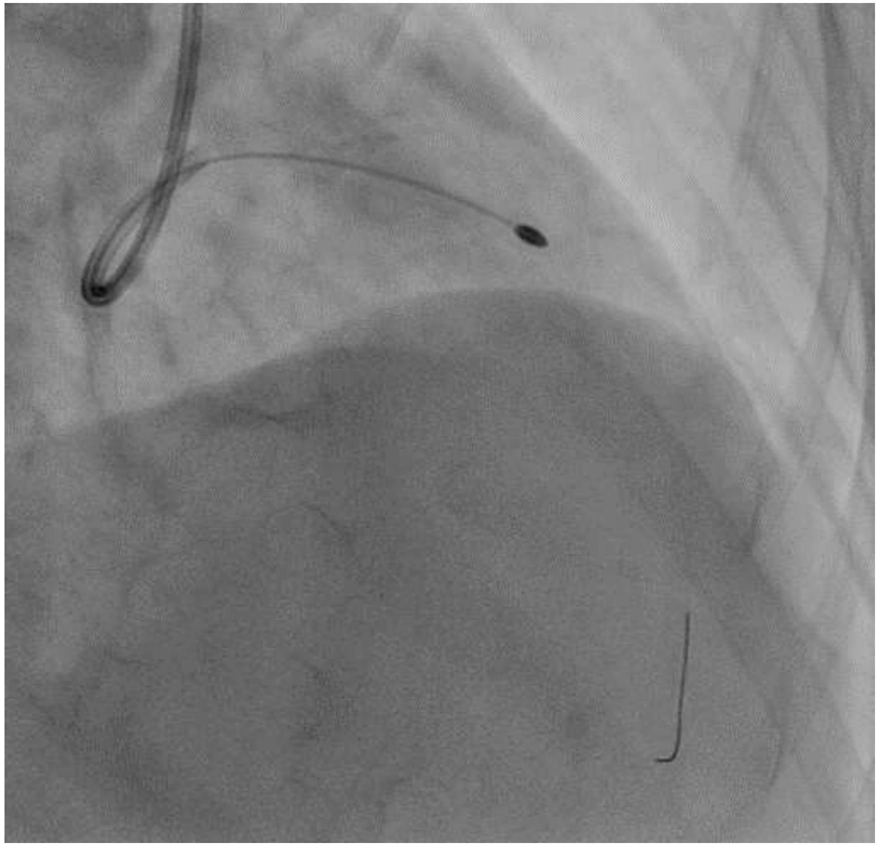
FD-OCT

Post Rota 1.5 mm



Coronary angiography & Rotablator

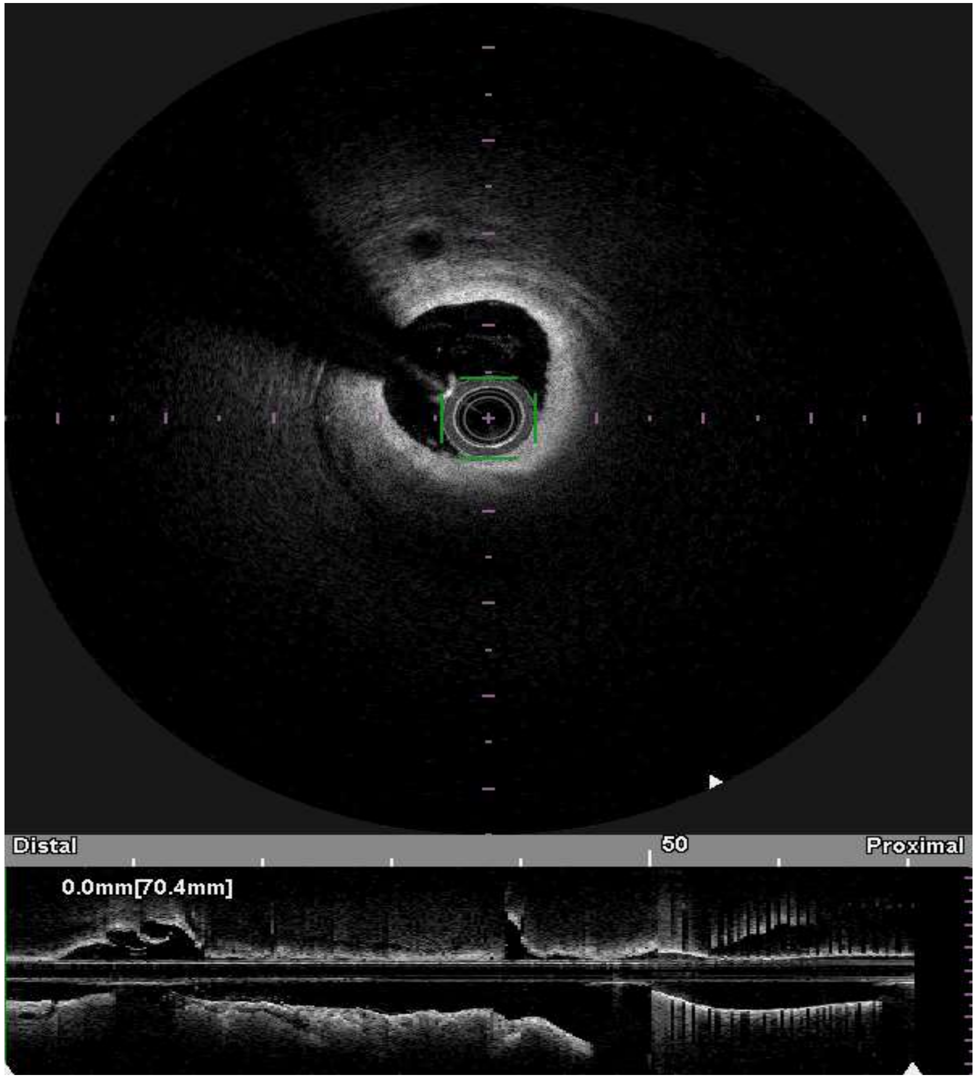
Rota burr size 2.0



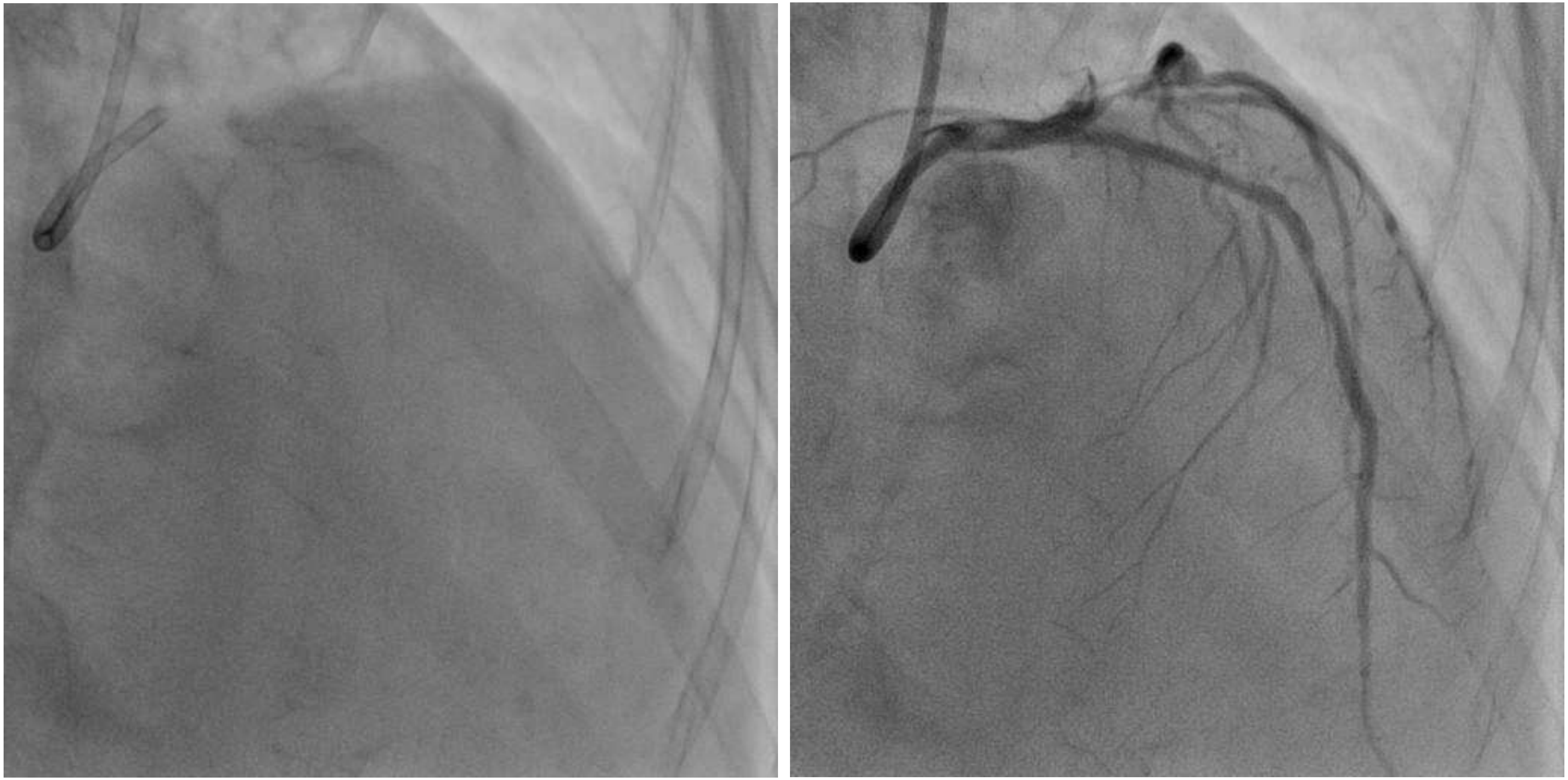
Based on OCT findings, there are still very thick superficial calcium more than 500 μm, and further bigger burr size was selected for further ablation.

FD-OCT

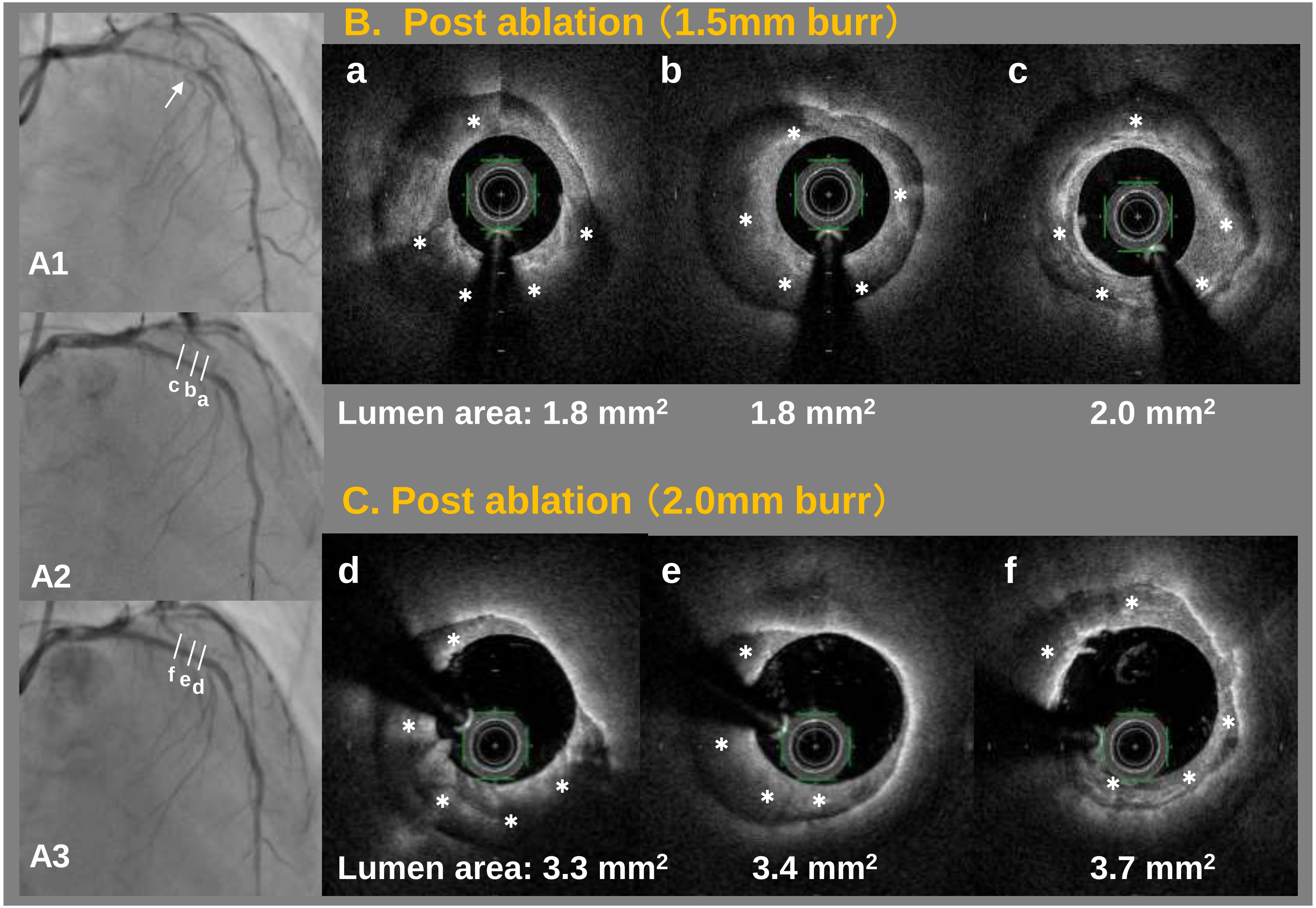
Post Rota 2.0mm



Final Angiography



Comparison of OCT findings after rotational atherectomy



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

Similarities & differences between OCT & IVUS

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

OCT Very good	OCT Good	OCT Feasible		IVUS Feasible	IVUS Good	IVUS Very good
			Pre-PCI			
●	●	●	Severity of calcium	●	●	
		●	Prediction of slow flow	●		
	●	●	Stent sizing by vessel wall	●	●	●
●	●	●	Stent length to cover normal to normal	●	●	●
			Post-PCI			
●	●	●	Stent expansion	●	●	●
●	●	●	Tissue protrusion through strut	●	●	
●	●	●	Stent malapposition	●	●	
	●	●	Stent deformation (frequently at aorto-ostium)	●	●	
●	●	●	Stent edge dissection	●	●	
●	●	●	Residual disease at stent edge	●	●	●
			Follow-up			
●	●	●	Old stent expansion	●	●	●
	●	●	Tissue coverage	●		
●	●	●	Neointimal hyperplasia	●	●	●
	●	●	Stent fracture	●	●	
●	●	●	Stent malapposition	●	●	
		●	Positive remodeling of vessel wall	●	●	●
●	●	●	Neoatherosclerosis	●	●	

Case 70's y.o. Male

Clinical Diagnosis: Effort AP

Coronary risk factor: HT, DM, DLP, Past smoking, Obesity

Renal Function: Cr 0.73mg/dl, eGFR 80.2 ml/min/1.73m^2

Cardiac Function: EF 61%, asynergy(-)

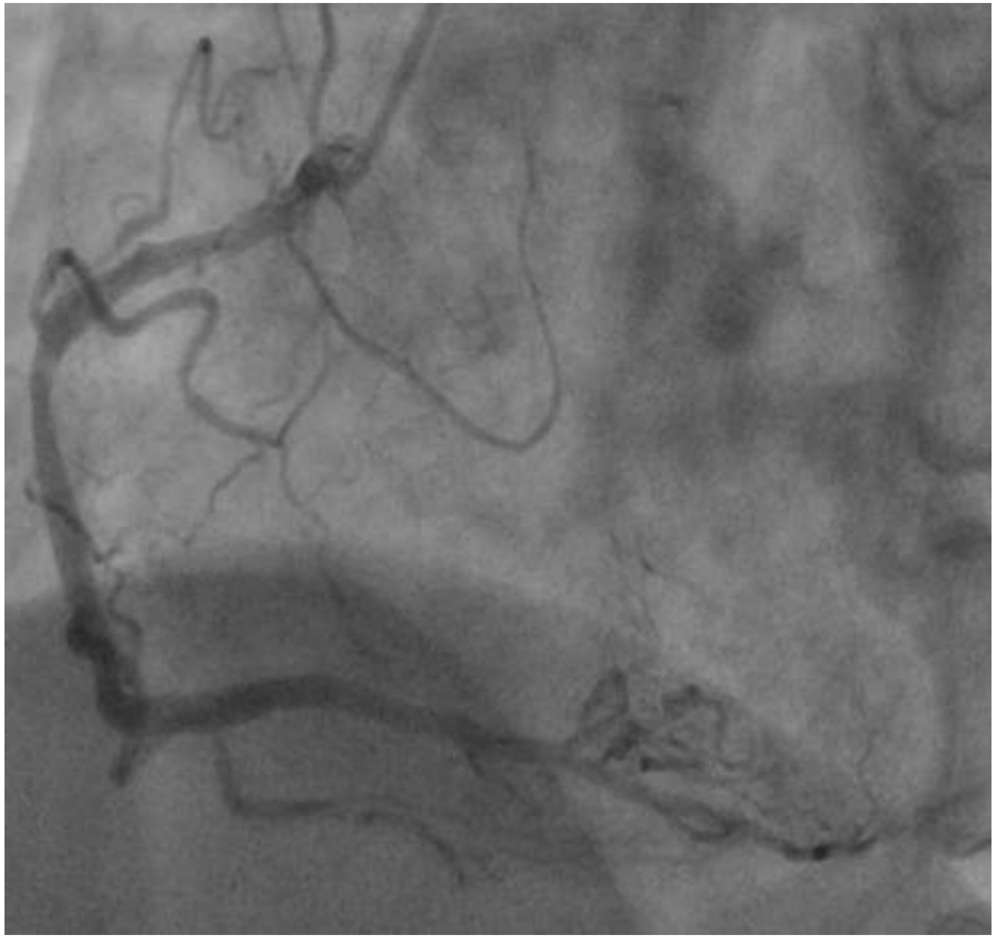
Coronary angiography

Pre PCI

Coronary angiography

Pre PCI

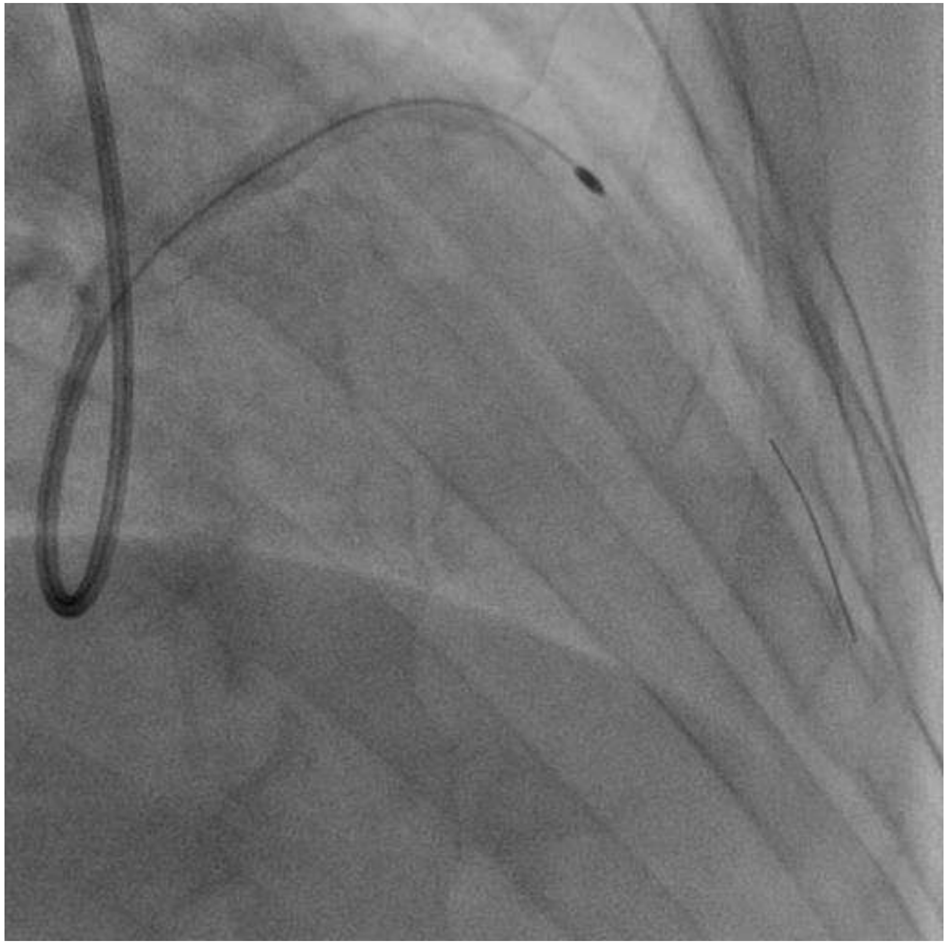
RCA



LCA

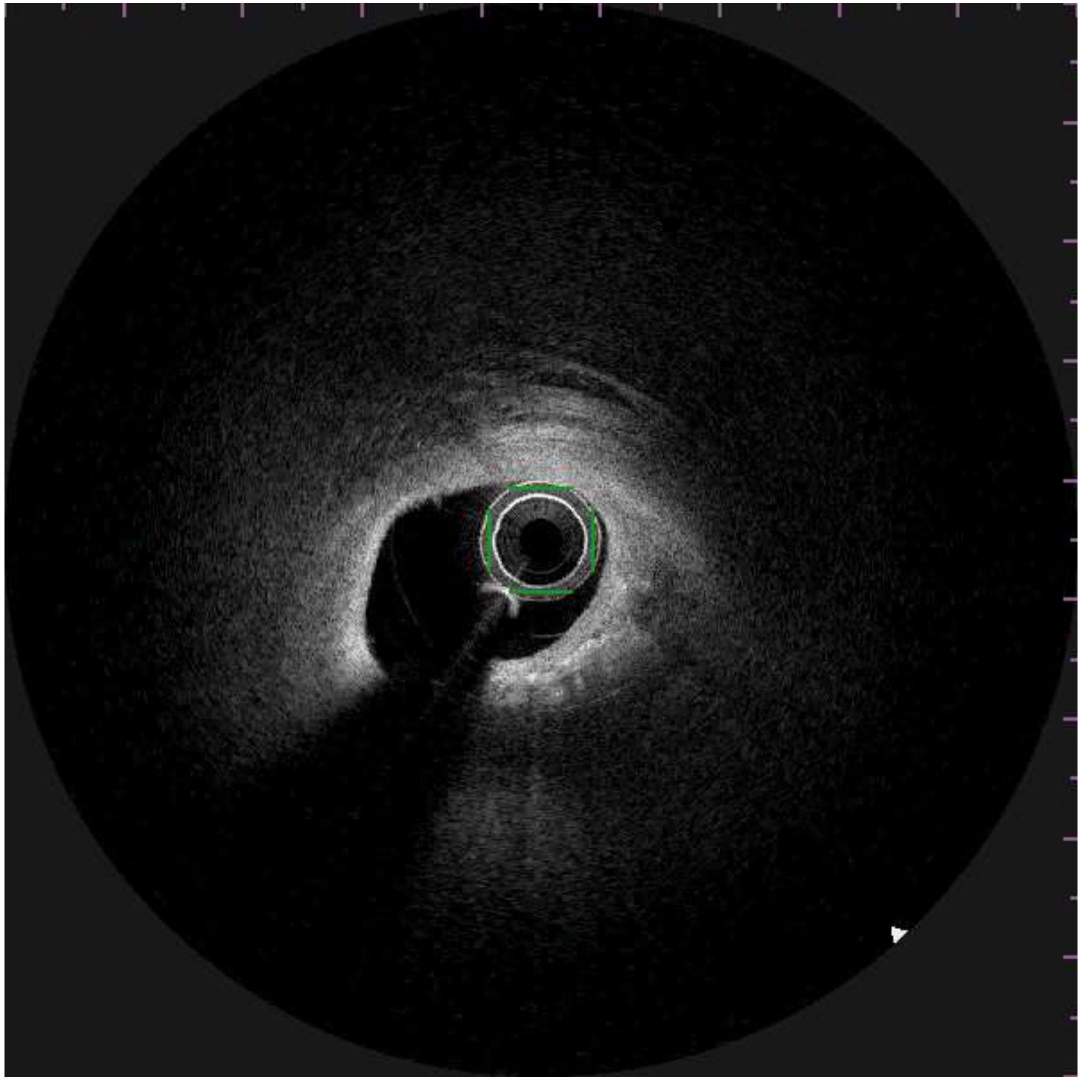
Rotational atherectomy

Rota 1.5 mm



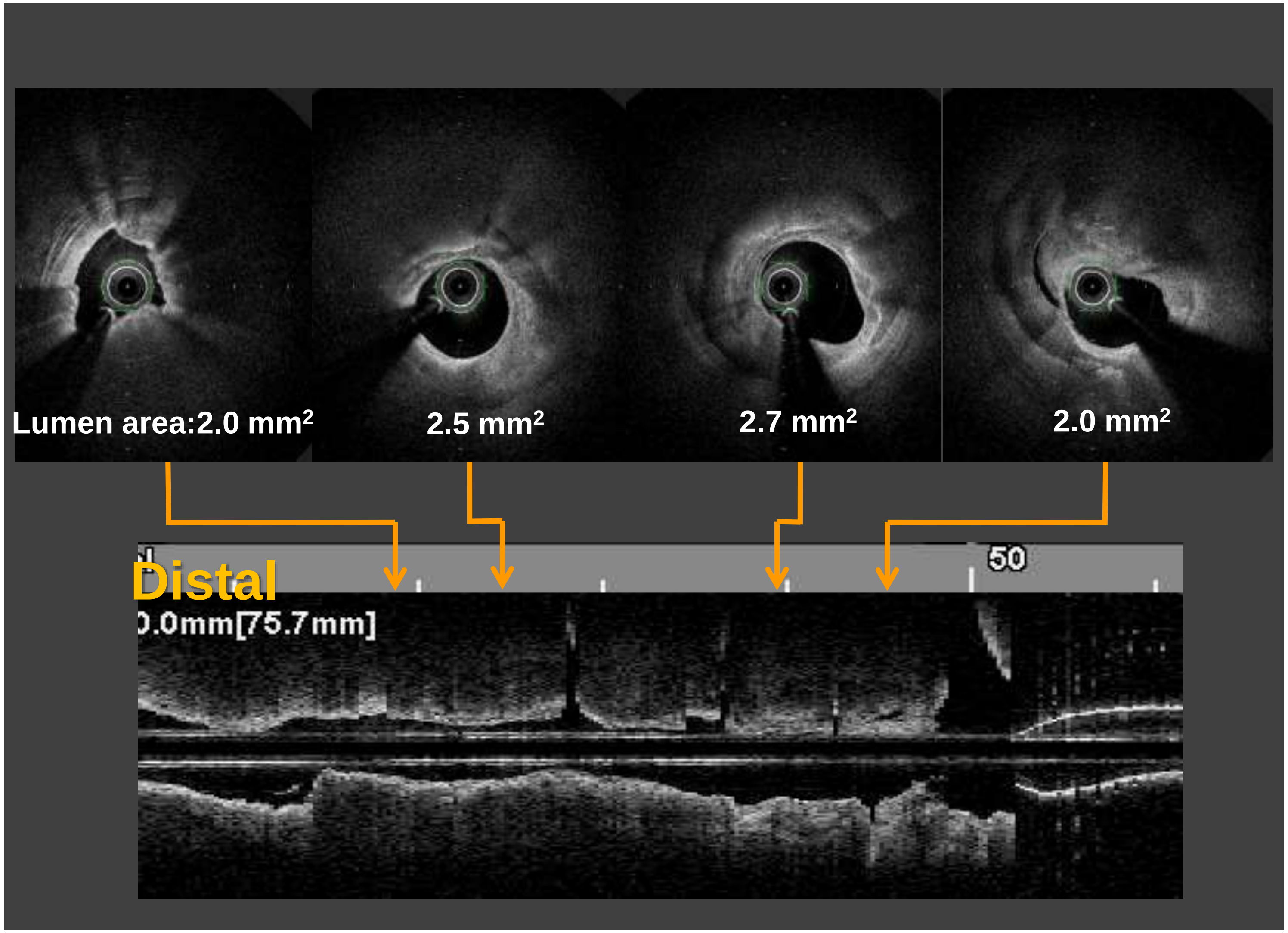
FD-OCT

Post Rota 1.5 mm



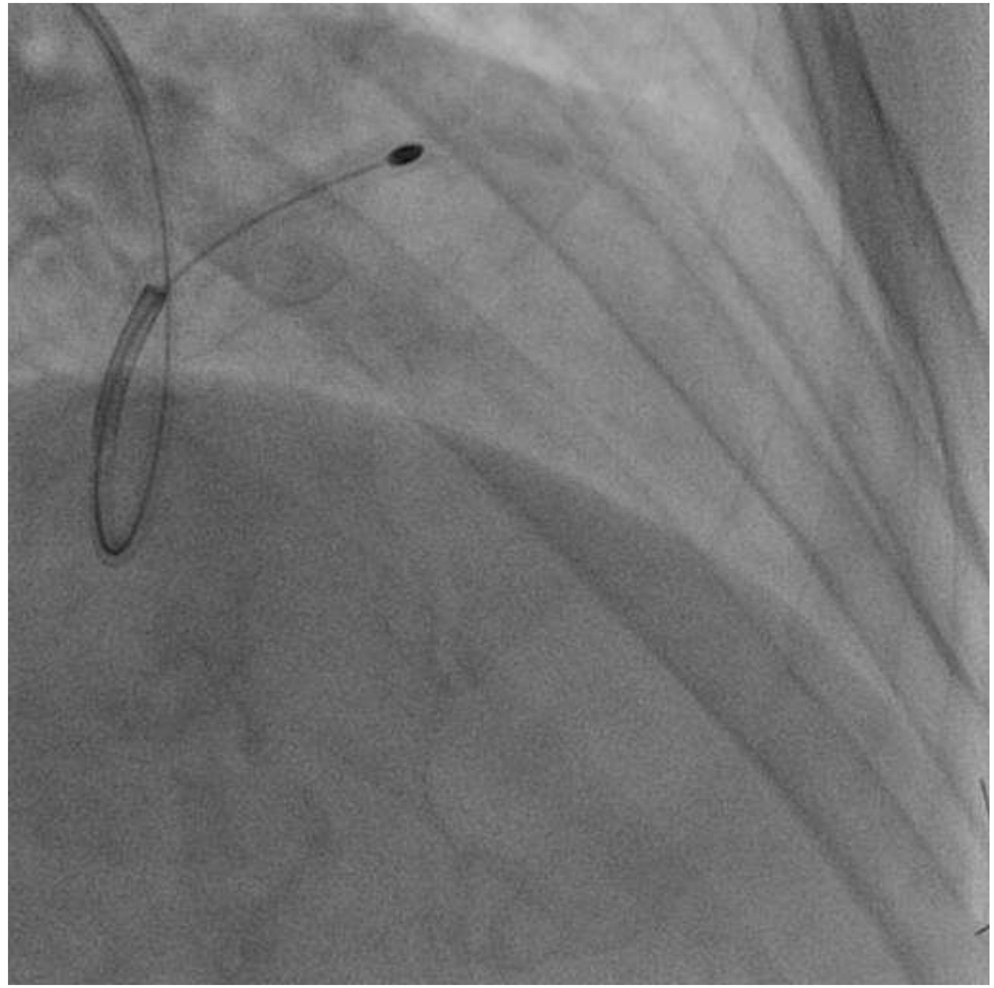
FD-OCT

Post Rota 1.5 mm



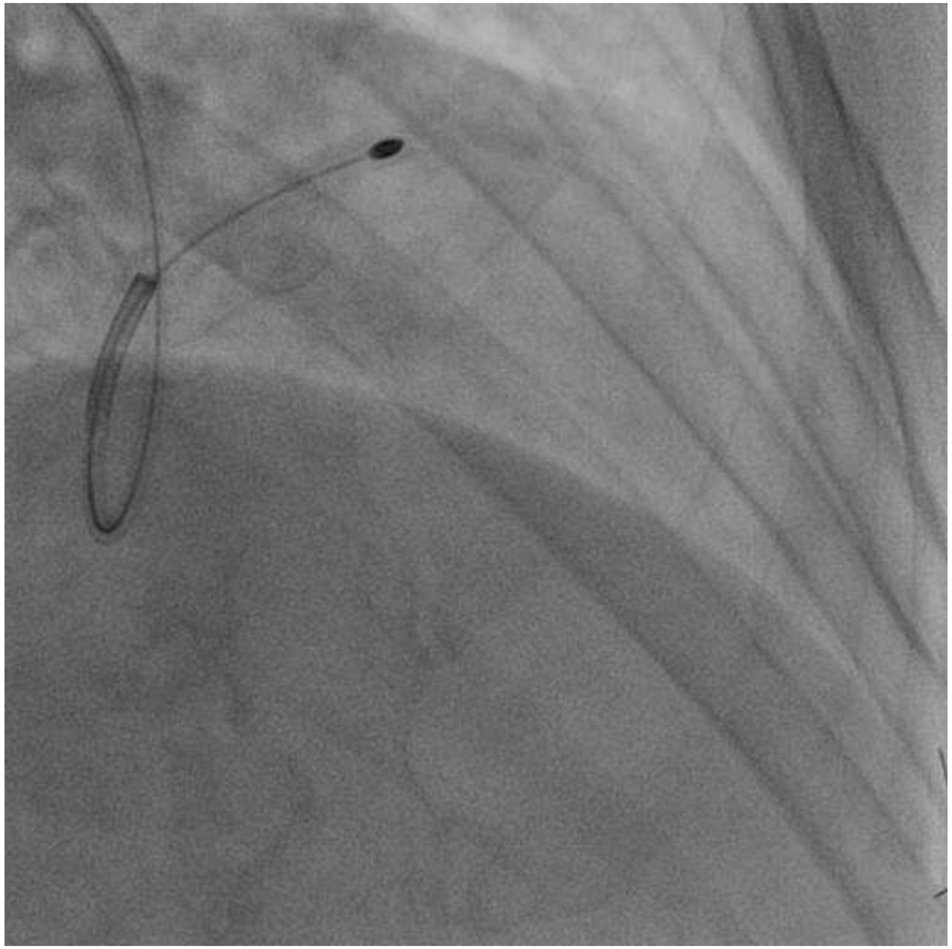
Rotational atherectomy

Rota 2.0 mm

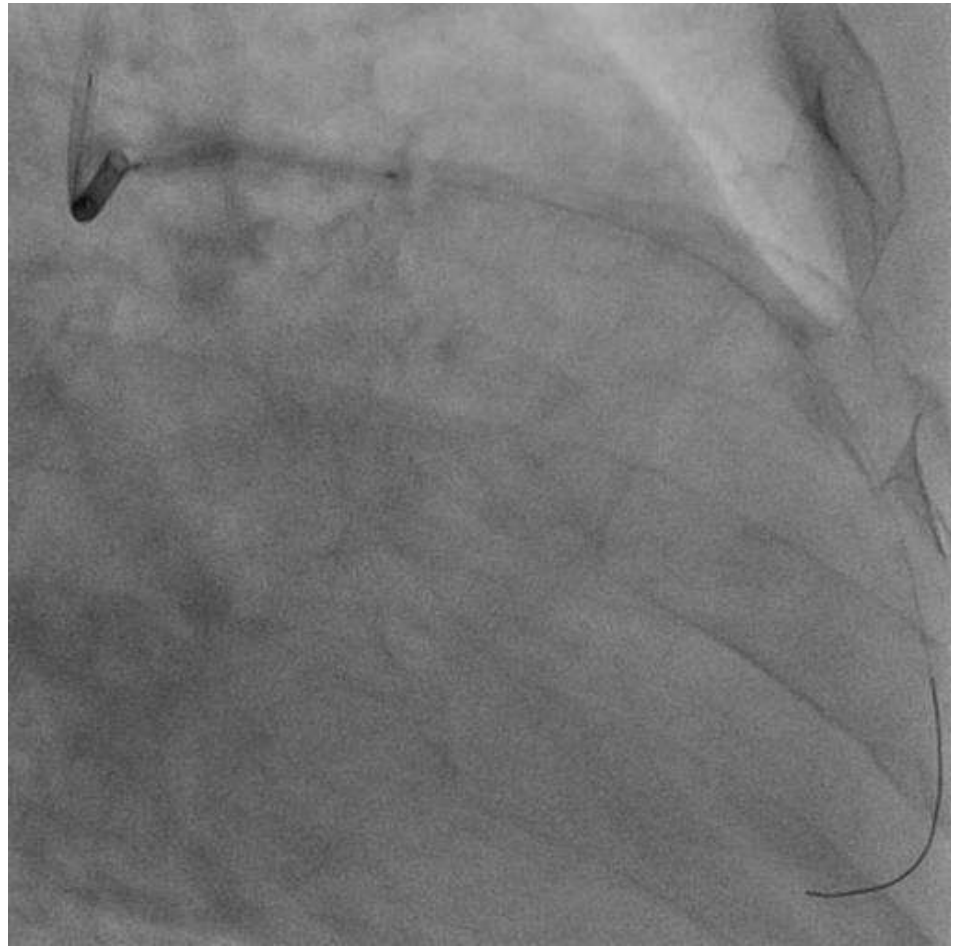


Rota 2.0mm following DCB 3.0x30mm

Rota 2.0 mm

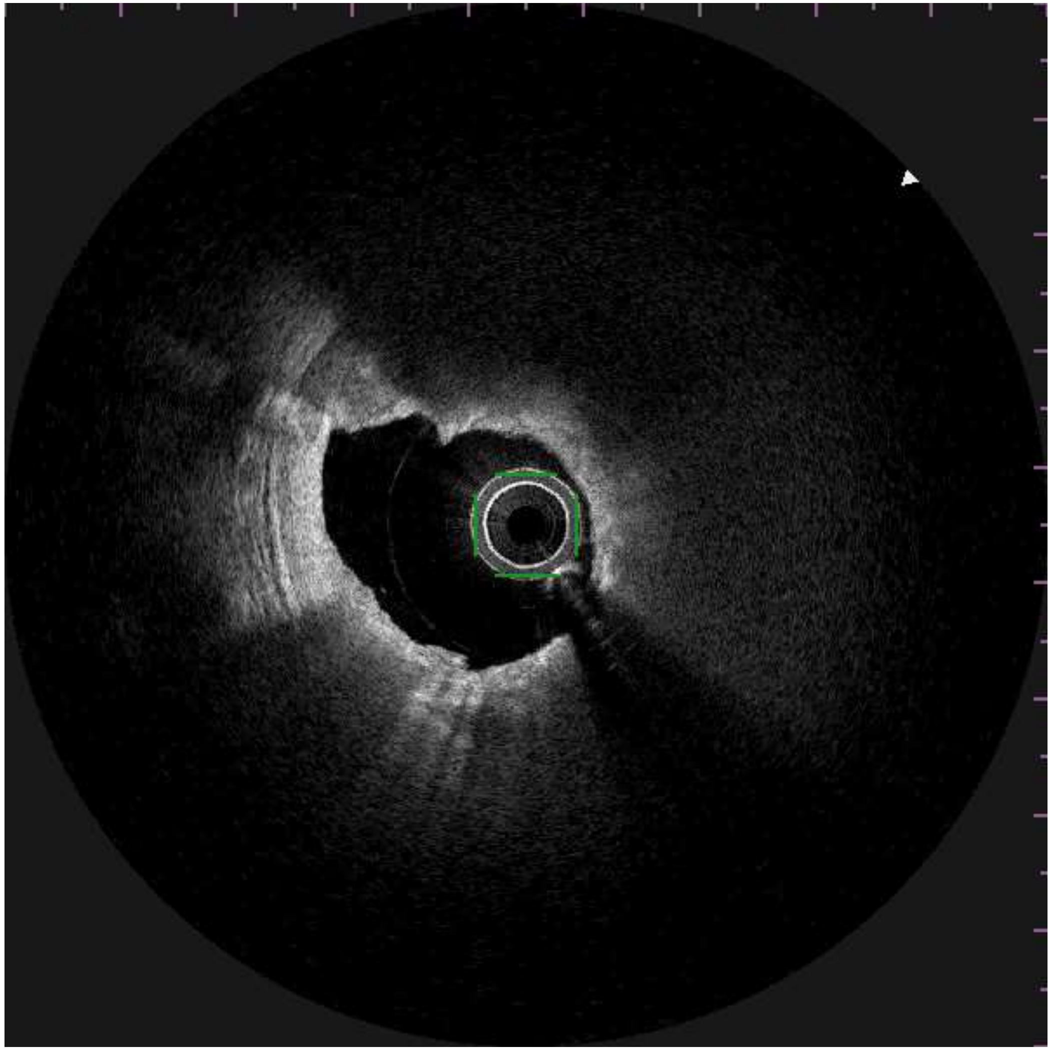


DCB 3.0*30 mm



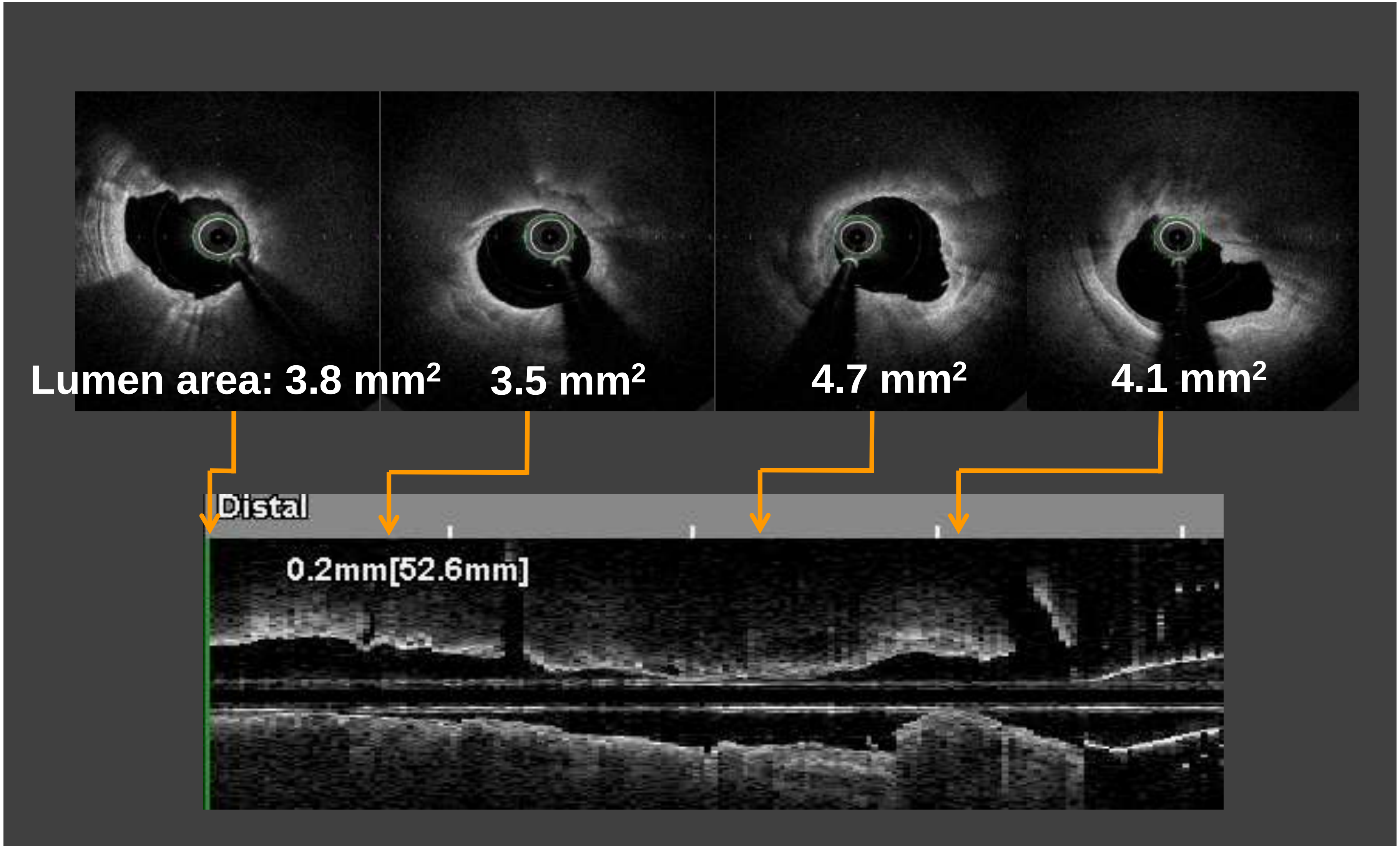
FD-OCT after Rota 2.0mm + DCB 3.0x30mm

FD-OCT

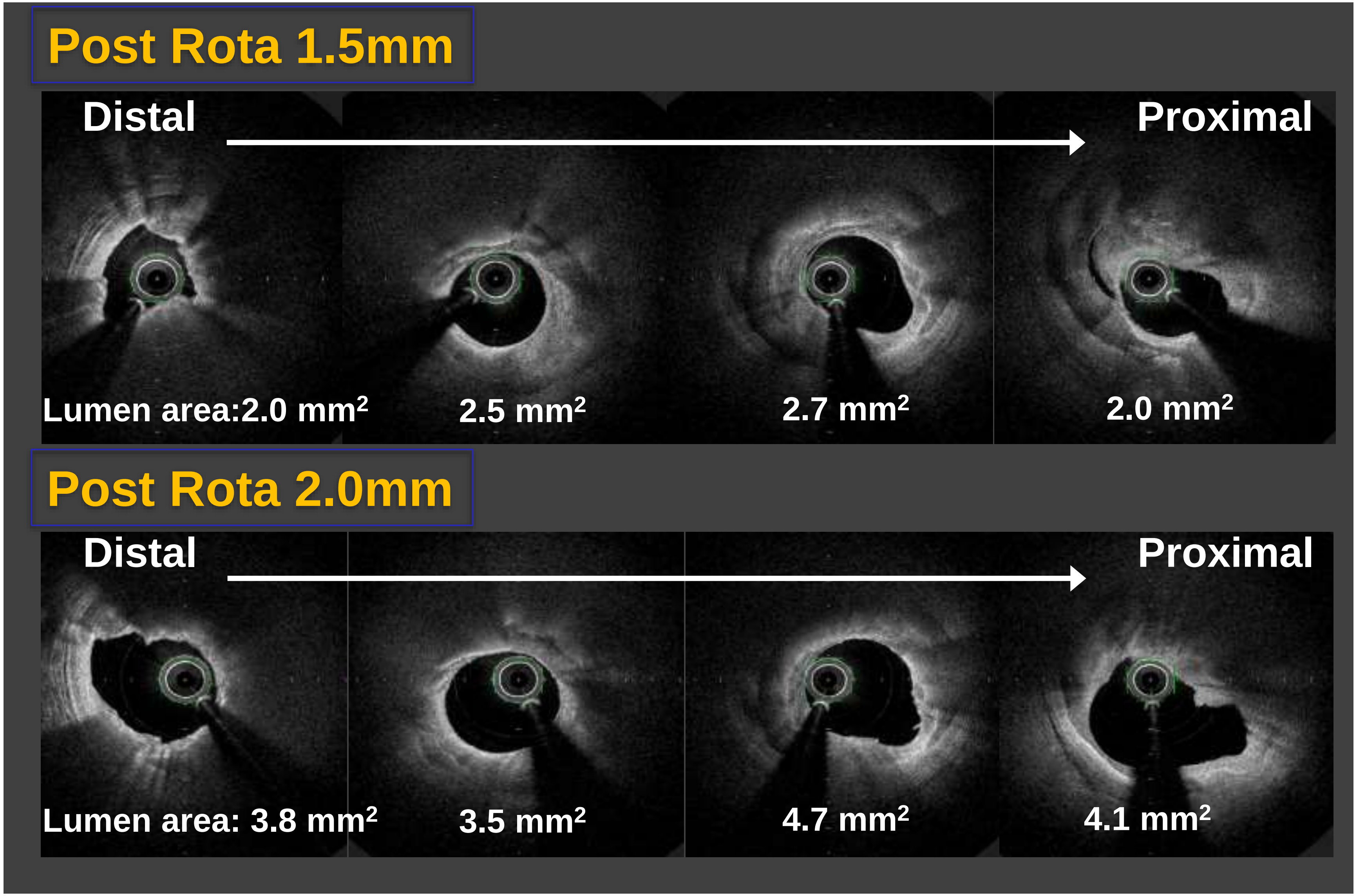


FD-OCT

Post Rota 2.0 mm

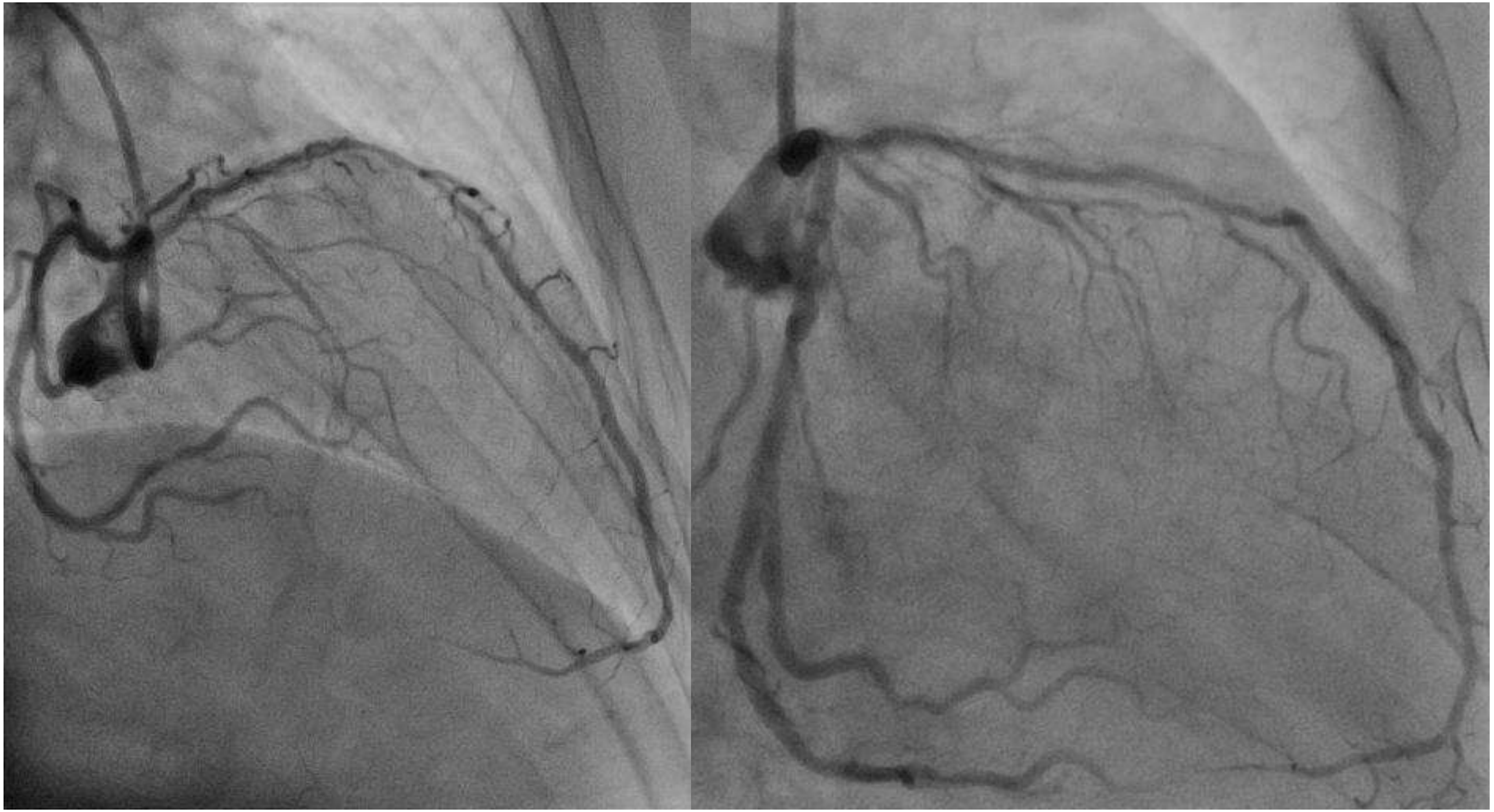


FD-OCT: comparison pre- & post-rota

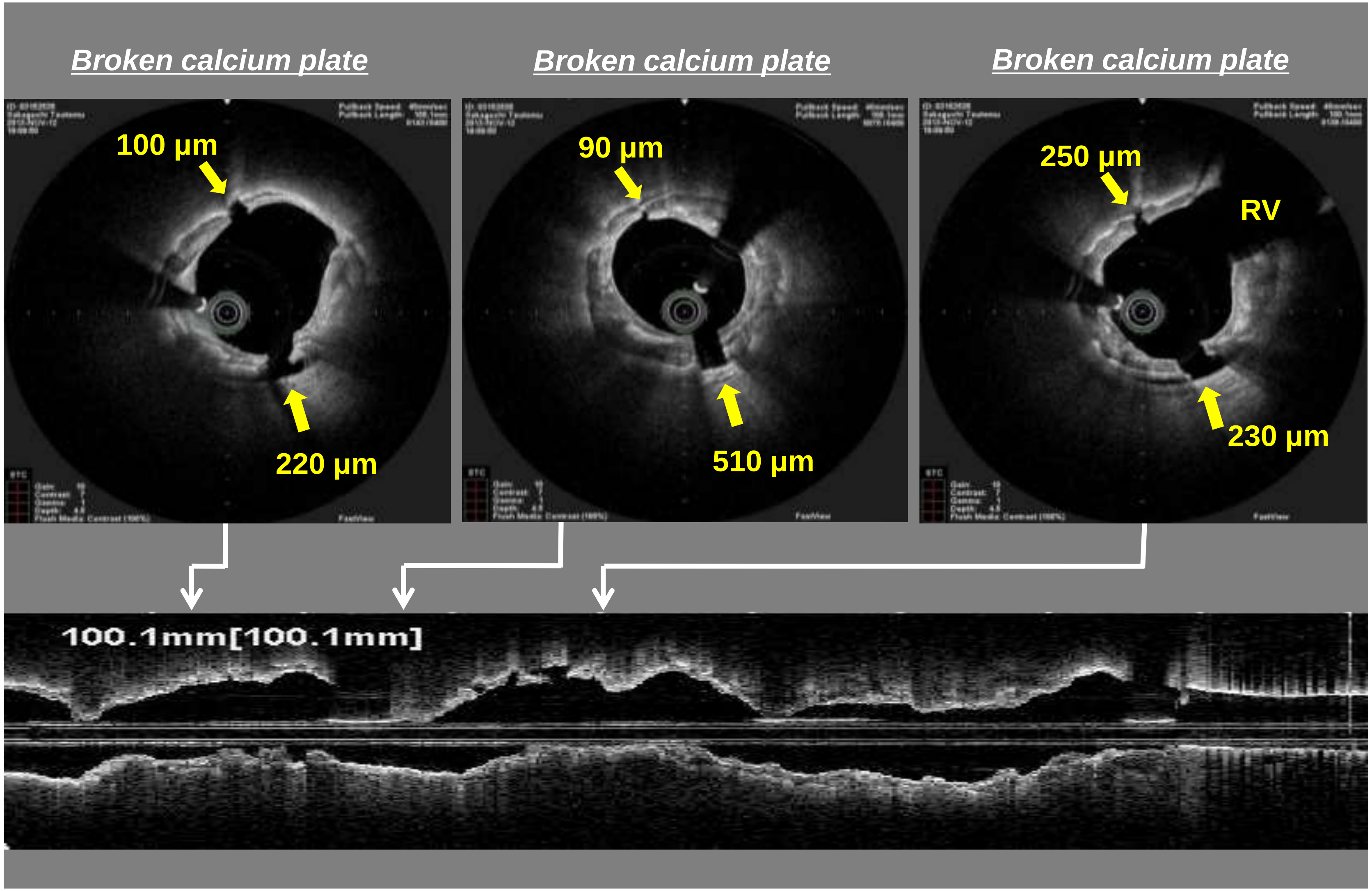


Final Angiography

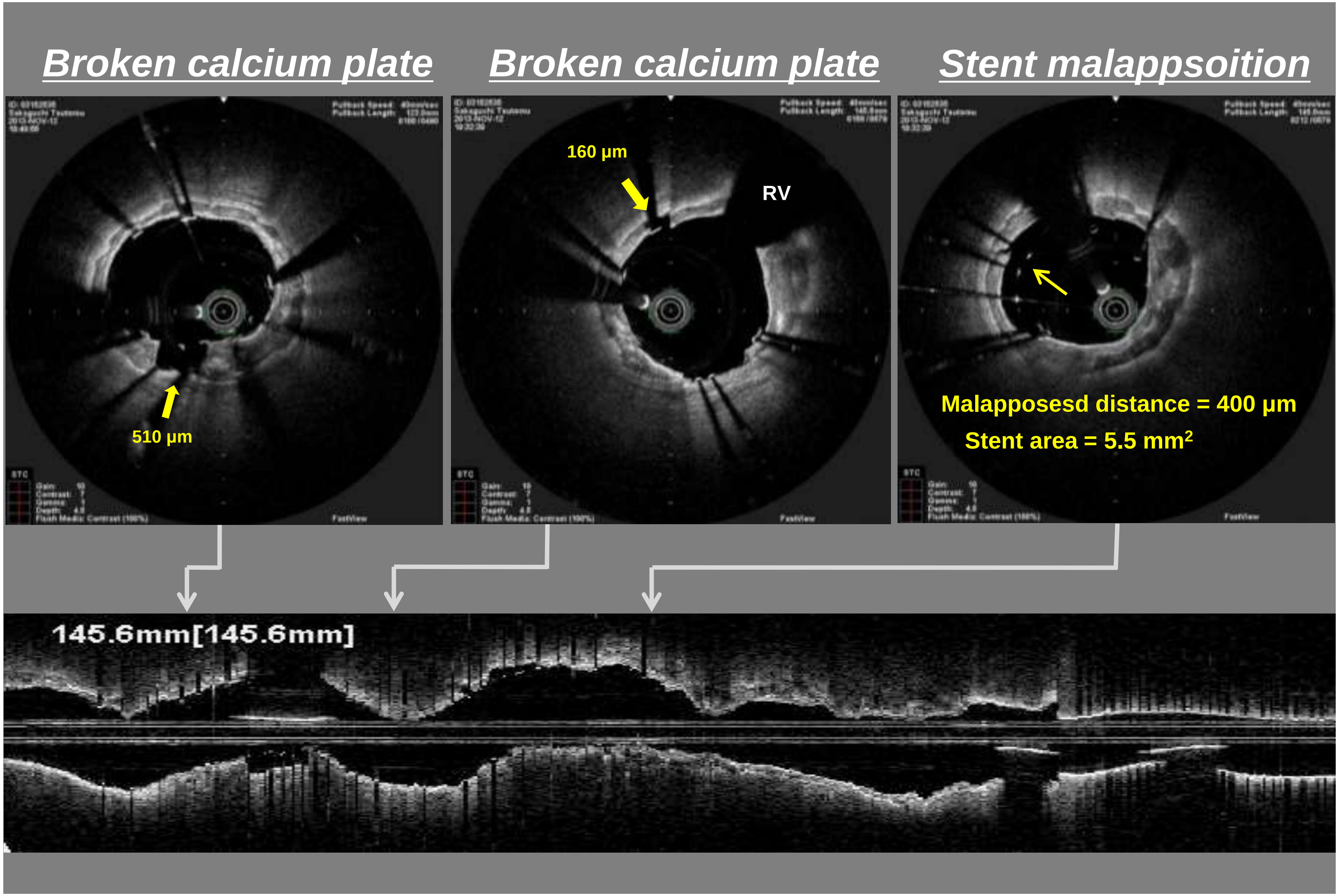
Final Angiography



Post-high pressure ballooning



Post-stenting after making calcium plate clacks

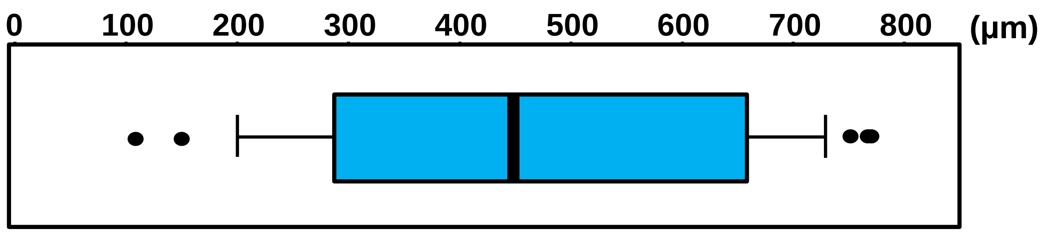


Wakayama Medical University

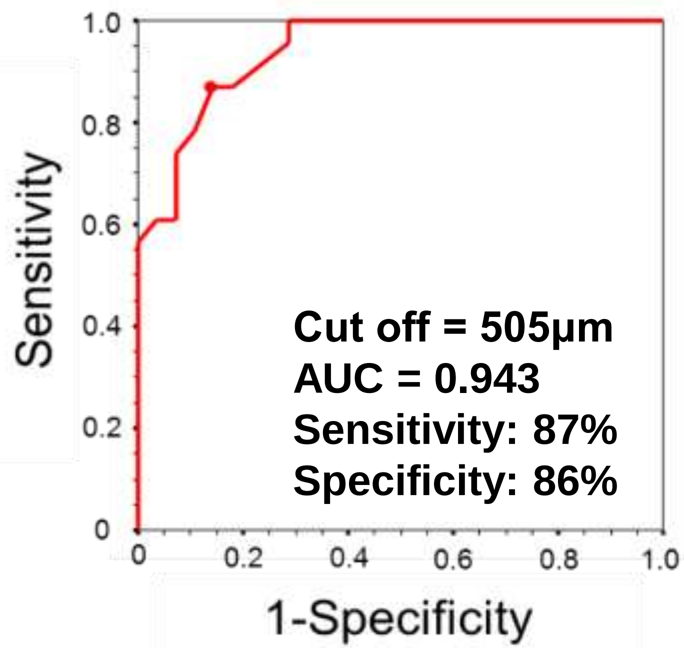
Prediction of calcium plate fracture by ballooning

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



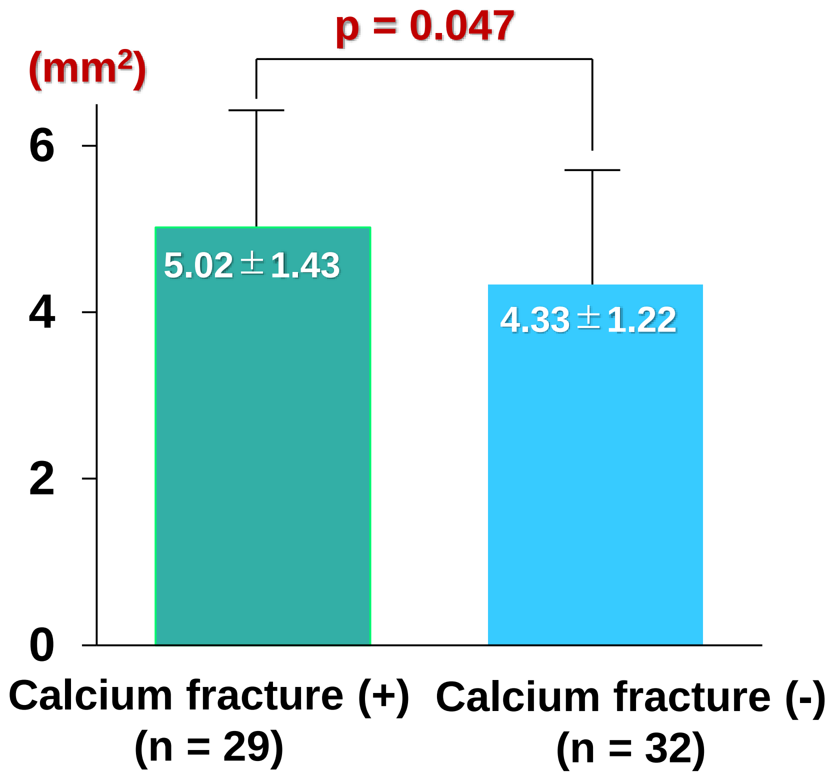
Median = 450μm; Lower quartile = 300μm; Upper quartile = 660μm; Minimum = 110μm; and Maximum = 770μm.



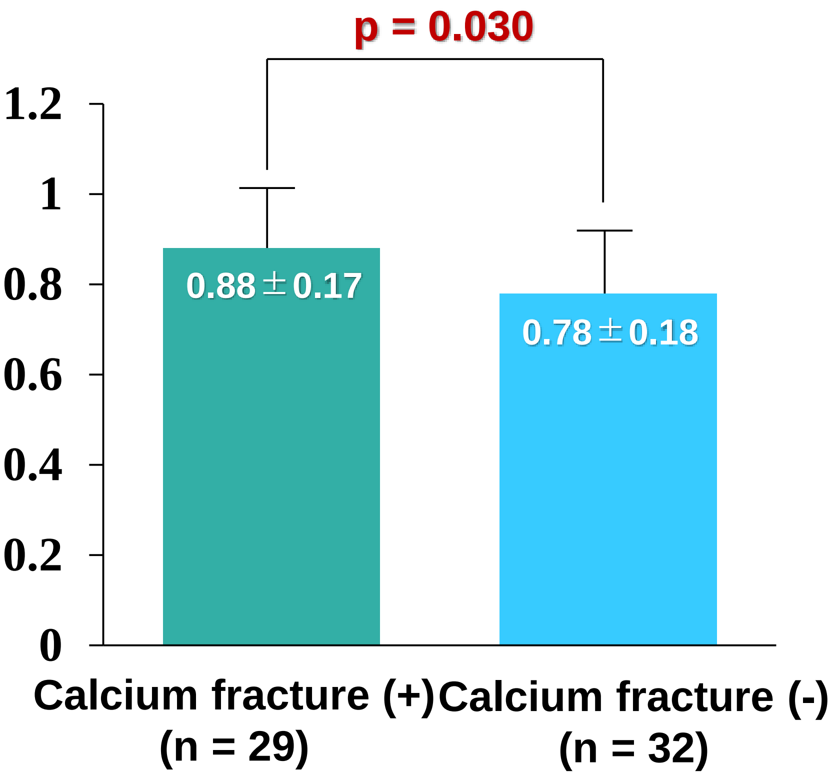
Conclusion: A calcium plate thickness < 505 μm was the corresponding cut-off value for predicting calcium plate fracture by high pressure ballooning.

Stent expansion at post-PCI

Minimum stent area



Stent expansion index

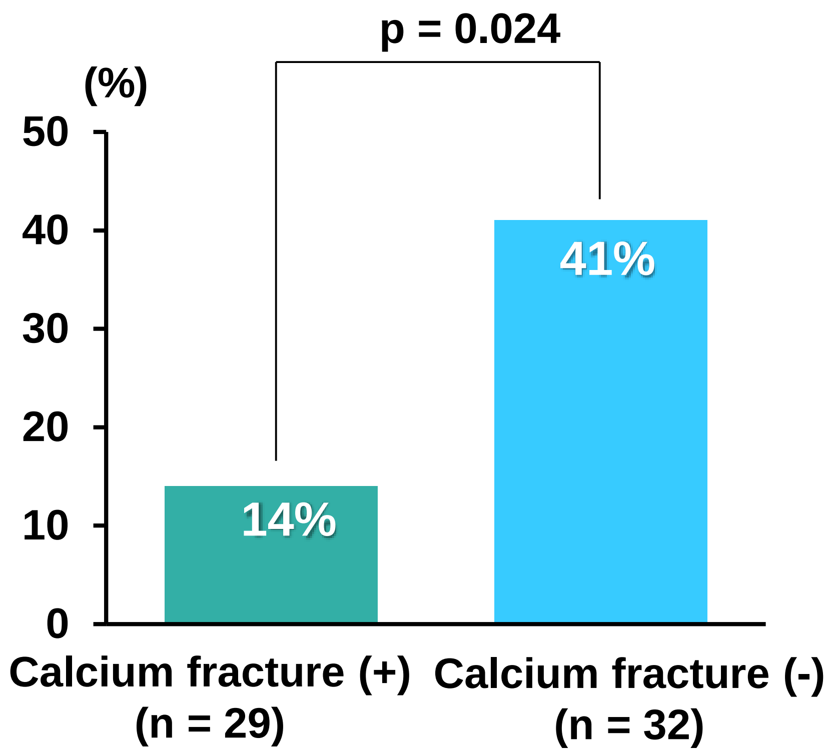


Minimum stent area and stent expansion index were significantly greater in the group with calcium fracture compared with the group without calcium fracture.

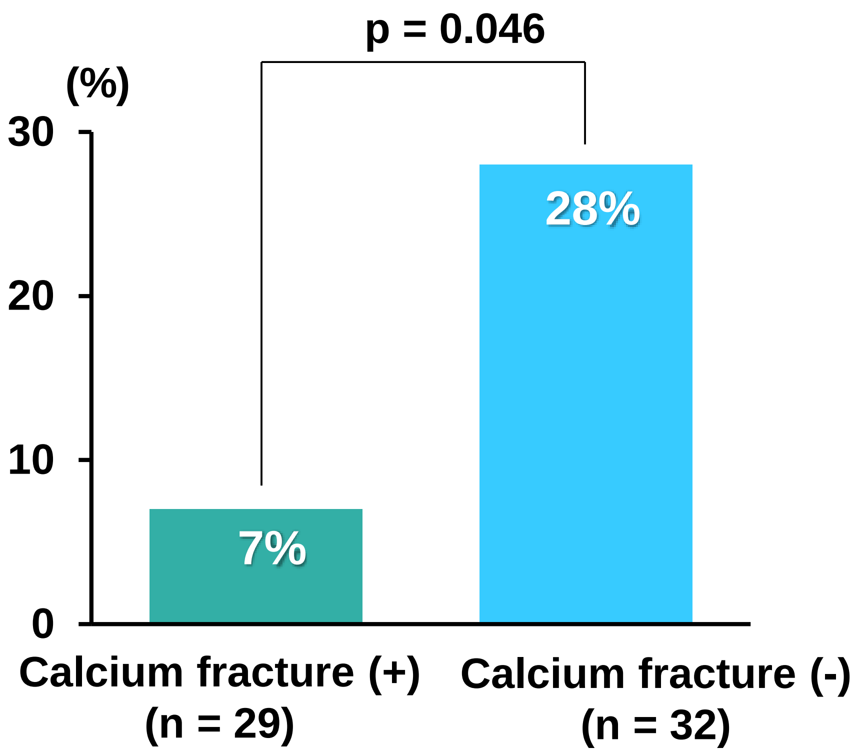
Kubo T, Akasaka T, et al. JACC Imag 2015;8:1228-9

Restenosis and TLR at 10 months follow-up

Binary restenosis



Target lesion revascularization



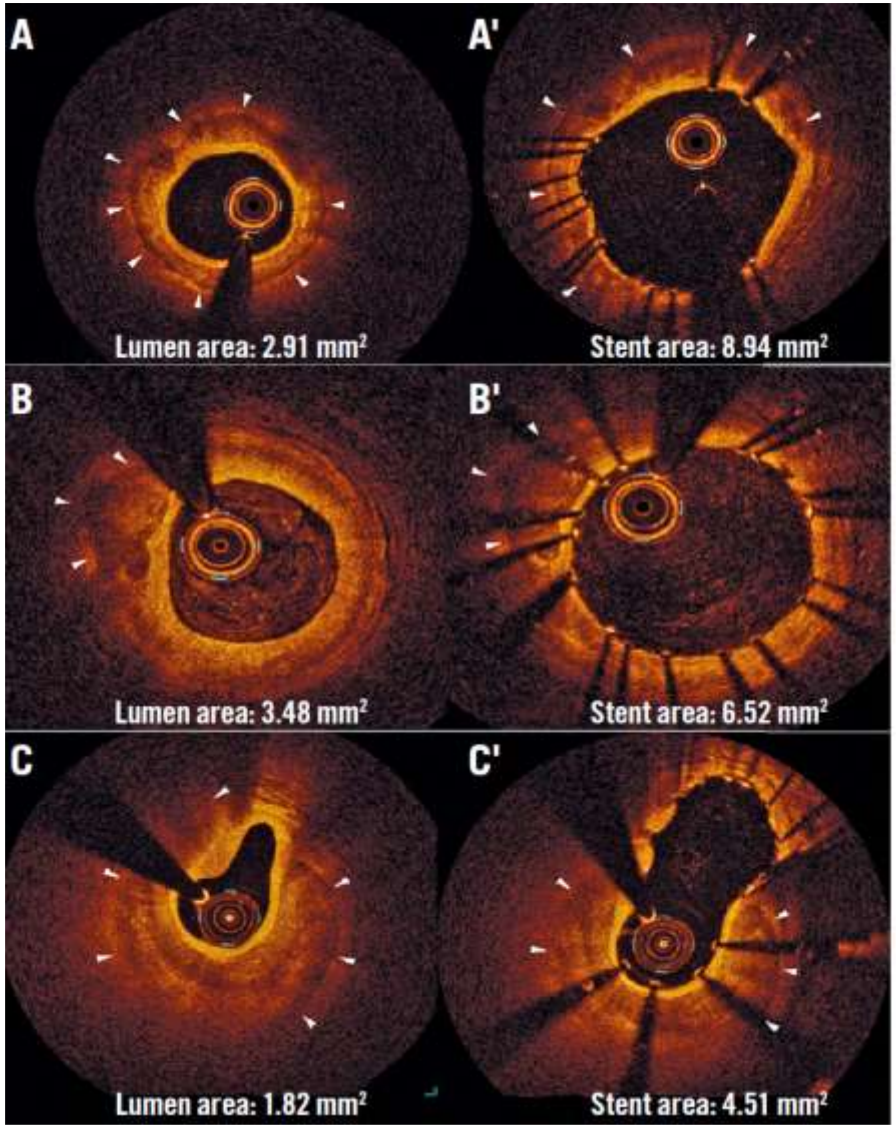
The frequency of binary restenosis and target lesion revascularization was significantly lower in the group with calcium fracture compared with the group without calcium fracture.

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

Wakayama Medical University

Calcium eccentricity, thickness & length and stent expansion

Baseline **Final**



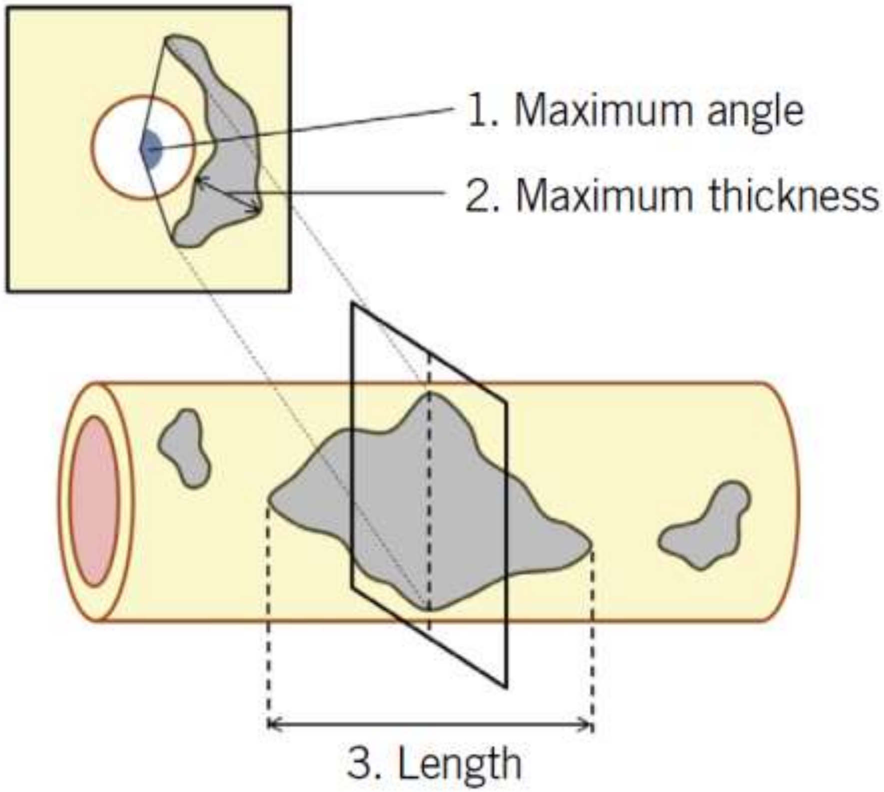
Angle: 360°
Thickness: 0.48 mm
Length: 3.8 mm
Calcium score: 2 points
Expansion: 99%

Angle: 75°
Thickness: 1.1 mm
Length: 4.3 mm
Calcium score: 1 point
Expansion: 97%

Angle: 312°
Thickness: 1.4 mm
Length: 11.0 mm
Calcium score: 4 points
Expansion: 68%

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

OCT based calcium scoring system



OCT-based calcium score	
1. Maximum calcium angle (°)	≤180° ➡ 0 point >180° ➡ 2 points
2. Maximum calcium thickness (mm)	≤0.5 mm ➡ 0 point >0.5 mm ➡ 1 point
3. Calcium length (mm)	≤5.0 mm ➡ 0 point >5.0 mm ➡ 1 point
Total score	**0 to 4 points**

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

OCT-based calcium score & Final PCI result

Variables	Calcium score					*p*-value
	0 (n=27)	1 (n=45)	2 (n=34)	3 (n=3)	4 (n=24)	
Pre-intervention (Angiographic findings)						
Any calcification	37.0% (10)	40.0% (18)	67.6% (23)	33.3% (1)	87.5% (21)	<0.01
Moderate calcification	33.3% (9)	37.8% (17)	44.1% (15)	0% (0)	33.3% (8)	<0.01
Severe calcification	3.7% (1)	2.2% (1)	23.5% (8)	33.3% (1)	54.2% (13)	<0.01
Pre-intervention (OCT findings)						
Maximum calcium angle, °	62 (41, 77)	79 (56, 121)	129 (114, 162)	198 (187, 237)	279 (233, 308)	<0.01
Maximum calcium thickness, mm	0.38 (0.26, 0.46)	0.77 (0.61, 0.91)	1.0 (0.82, 1.22)	0.59 (0.58, 0.65)	0.97 (0.76, 1.1)	<0.01
Calcium length, mm	2.4 (2.0, 3.6)	3.8 (3.1, 4.7)	8.7 (6.4, 13.5)	4.4 (3.0, 4.7)	17.4 (9.9, 28.5)	<0.01
Minimum lumen area, mm^2	1.7 (0.8, 2.4)	1.3 (0.9, 1.6)	1.2 (0.90, 1.7)	1.1 (0.7, 5.4)	1.1 (0.96, 1.7)	0.75
Procedural results						
Total stent length, mm	20 (18, 33)	26 (20, 33)	34 (22, 43)	22 (18, 23)	35 (22, 40)	0.15
Total number of stents used	1 (1, 1)	1 (1, 1)	1 (1, 2)	1 (1, 1)	1 (1, 2)	0.47
Maximum device diameter, mm	3.5 (3.0, 4.0)	3.5 (3.0, 3.5)	3.5 (3.0, 3.5)	3.5 (3.25, 3.5)	3.5 (3.0, 3.5)	0.30
Maximum inflation pressure, atm	14 (14, 18)	15 (14, 18)	18 (14, 20)	14 (14, 18)	18 (15, 20)	0.09
Balloon to artery ratio	1.09 (0.97, 1.16)	1.02 (0.97, 1.16)	1.05 (0.98, 1.17)	1.06 (0.97, 1.17)	1.06 (0.96, 1.12)	0.75
Post-intervention (OCT findings)						
MSA, mm^2	7.2 (5.4, 9.2)	6.3 (5.2, 8.4)	5.9 (4.8, 8.0)	6.7 (5.8, 7.1)	5.7 (4.4, 7.4)	0.21
Stent expansion at target lesion calcium, %	99 (93, 108)	98 (86, 109)	86 (77, 100)	98 (83, 104)	78 (70, 86)	<0.01
Stent expansion at MSA, %	91 (84, 95)	85 (78, 93)	80 (73, 93)	80 (73, 85)	69 (60, 77)	<0.01

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

Comparison Between the 3 FDA-Approved Atherectomy Devices

	Rotational	Orbital	Laser
Balloon noncross	+++	++	++
Nondilatable lesion	+++	++	+
Eccentric calcium	+	++	–
Rapid exchange	–	–	+++
6F guide	++	+++	++
Underexpanded stent	+	–	++

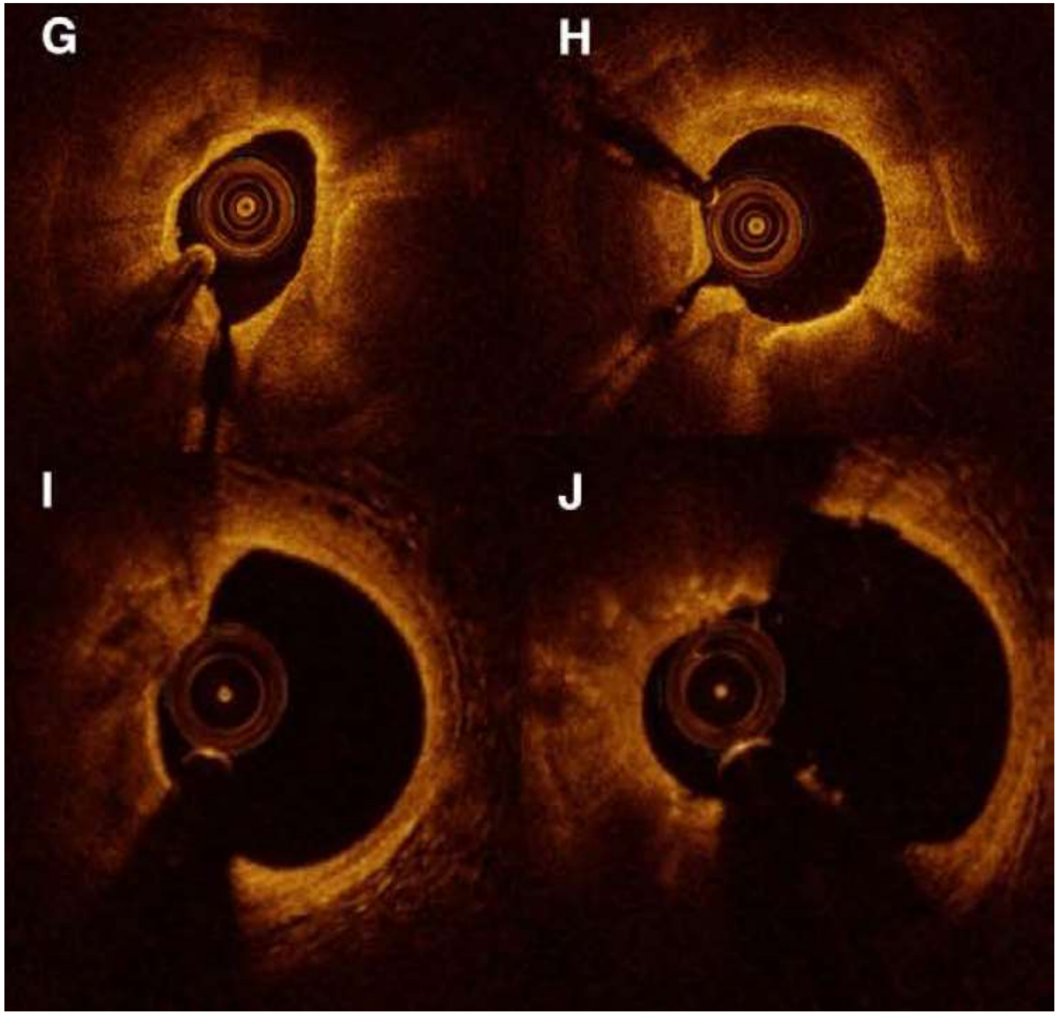
Mehanna E, et al. Circ Cardiovasc Interv 2018;11:e006813, DOI:10.1161/CIRCINTERVENTIONS.118.006813.

Comparison Between Rotational & Orbital Atherectomy

Pre PCI | Post PCI

Rotational atherectomy

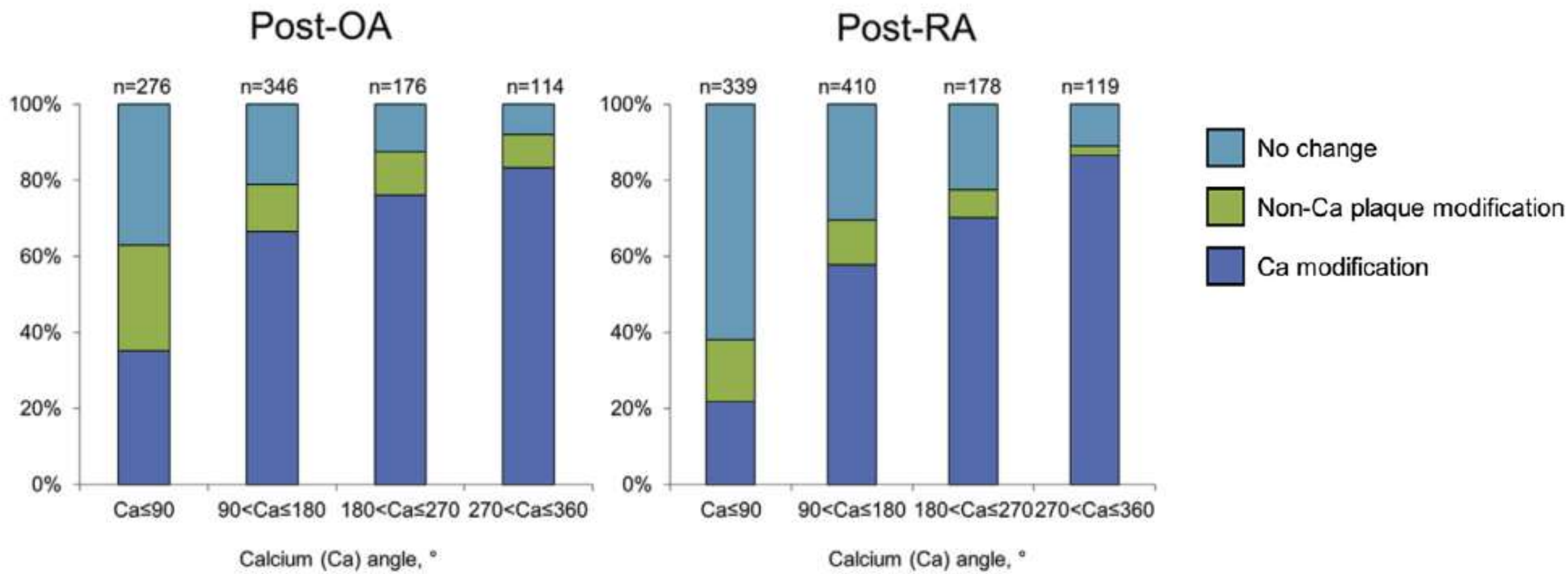
Orbital atherectomy



Mehanna E, et al. Circ Cardiovasc Interv 2018;11:e006813,
DOI:10.1161/CIRCINTERVENTIONS.118.006813.

Comparison Between Orbital & Rotational Atherectomy

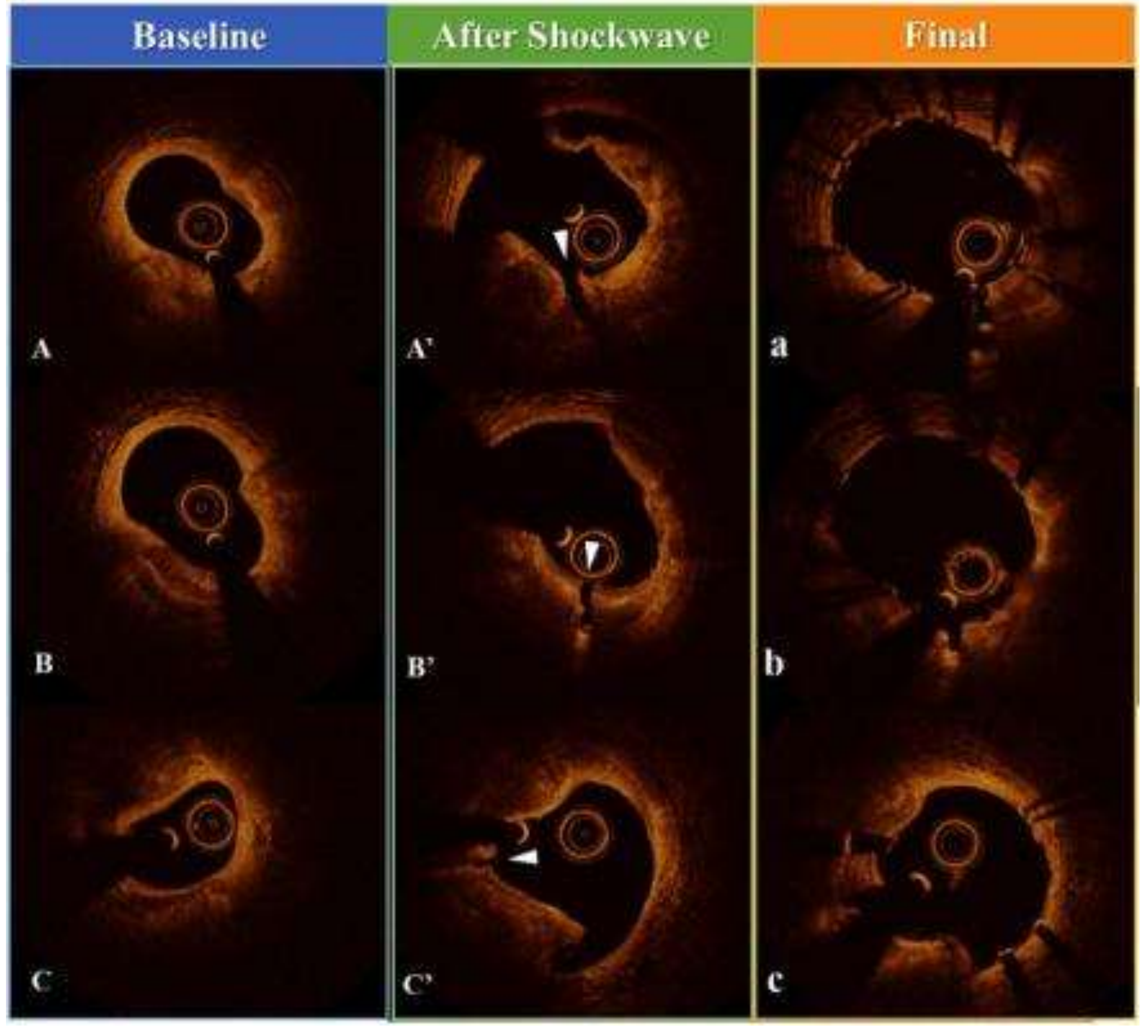
Prevalence of calcium or noncalcified plaque modification



Compared with RA, OA creates more calcium modification, especially in a more noncalcified plaque modification.

Mehanna E, et al. Circ Cardiovasc Interv 2018;11:e006813, DOI:10.1161/CIRCINTERVENTIONS.118.006813.

Shockwave Intravascular Lithotripsy



Take home message

In cases with heavily calcified lesion,

- Rotational atherectomy with small bar size would be recommended if any imaging devices could not be pathed through the tight lesion.
- OCT may allow us to demonstrate clearly the position and thickness of calcium.
- Lesion modification can be observed after rotational atherectomy, and the burr size may easily decided based on the OCT findings.
- Step by step burr size up would be recommended for ablating calcium safely.
- Calcium plate fracture can be made by high pressure ballooning if the thickness of it become less than 500μm.
- Enough stent expansion and less instent restenosis could be expected if calcium plate fracture can be obtained after high pressure ballooning following step by step rotational atherectomy.