Lessons from a Modern Atherectomy Trial: ECLIPSE

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ECLIPSE Clinical Trial

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Financial Conflict of Interest Disclosure

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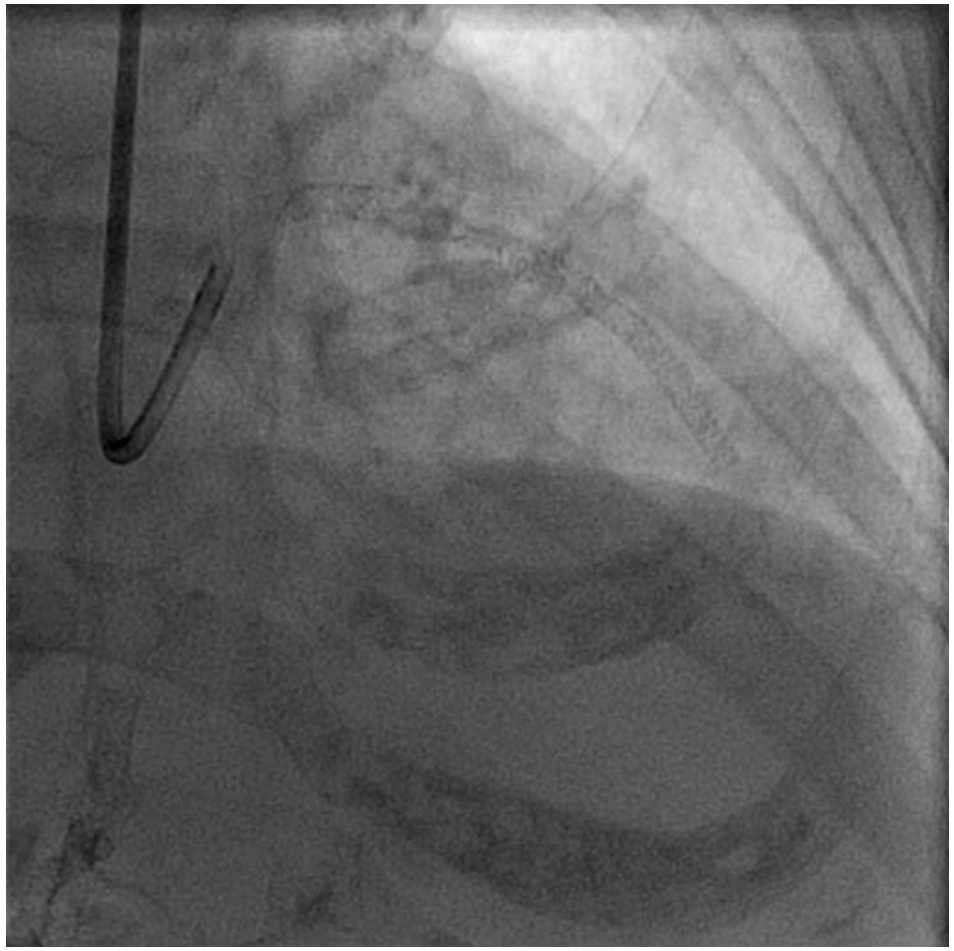
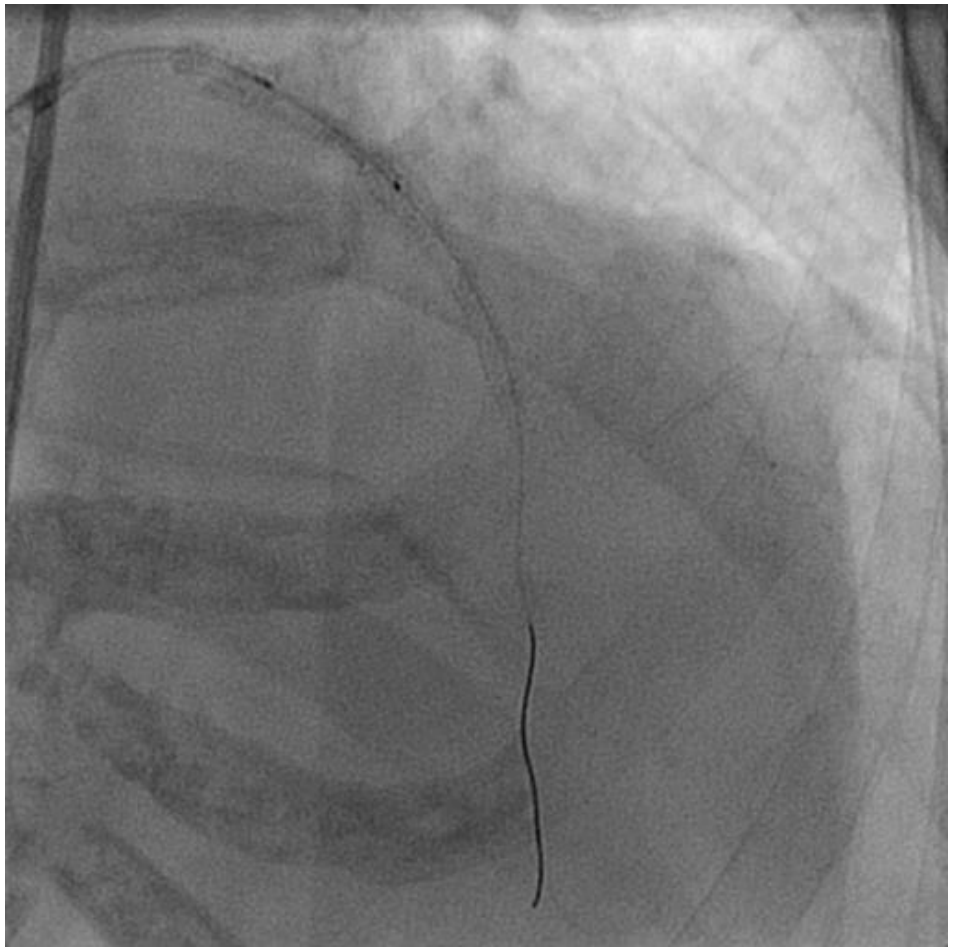
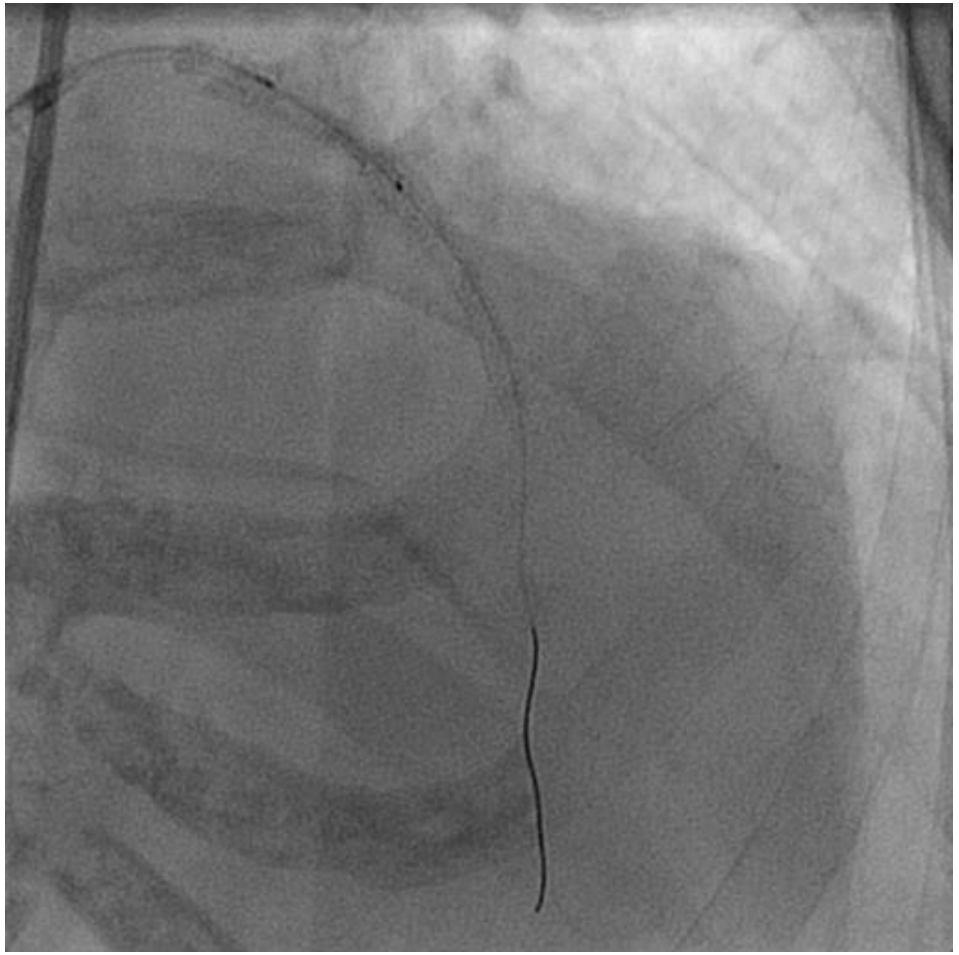
The Underexpanded Stent: This is a Real Problem



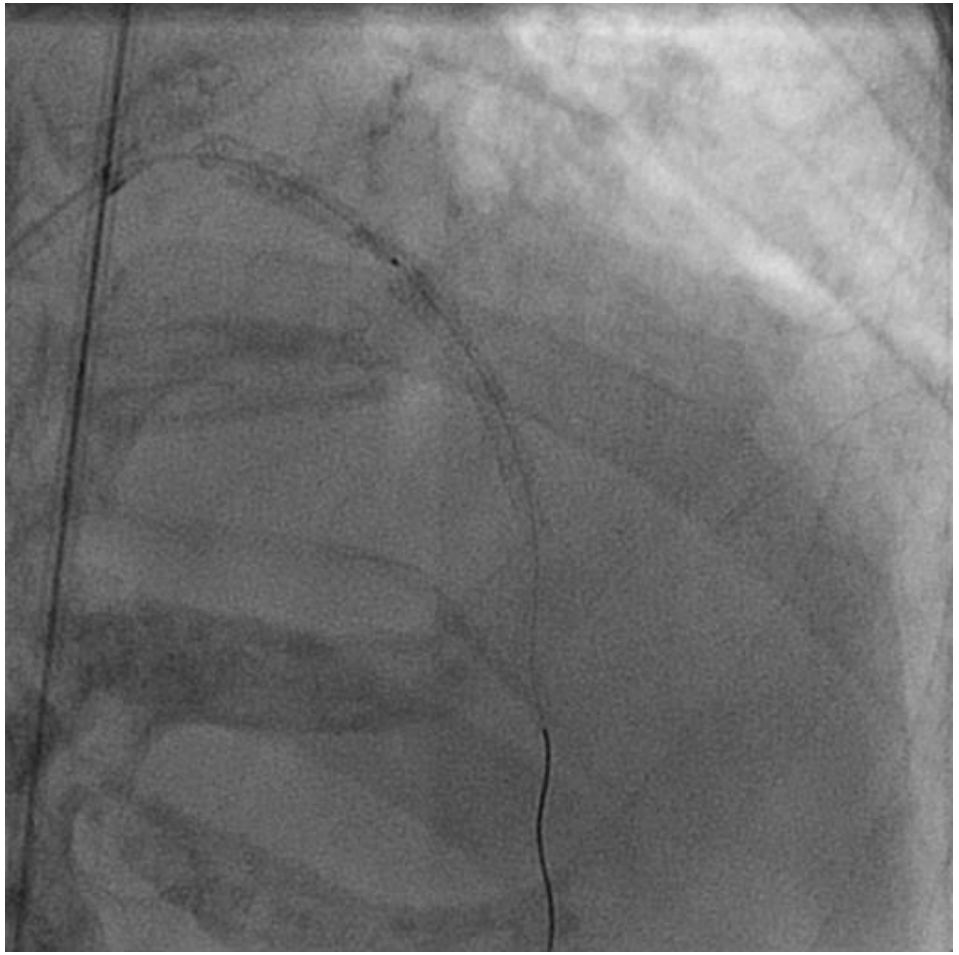
7F EBU 3.5



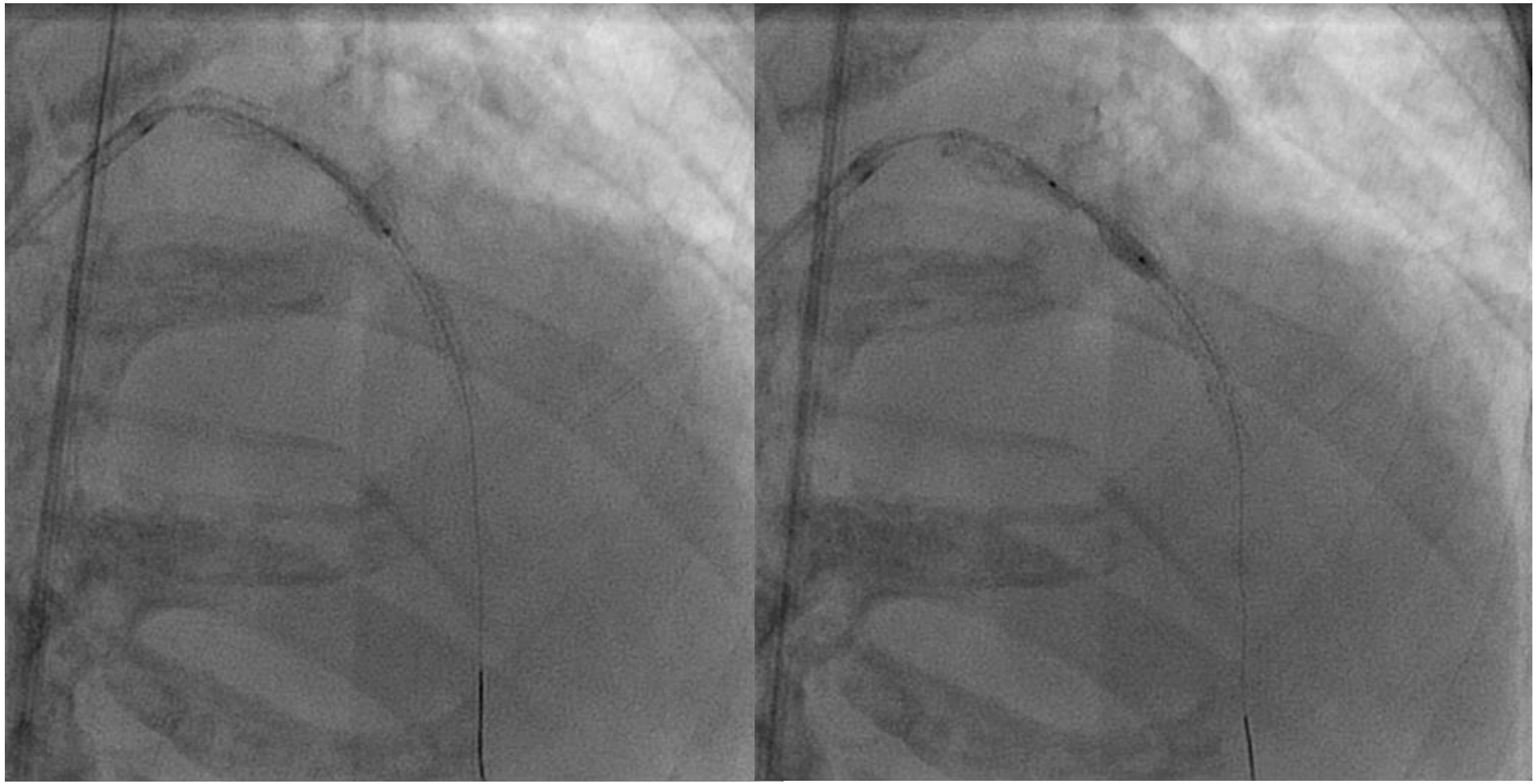
IVUS – Wouldn't cross



2.0 x 15 balloon: would not cross



1.25 x 6 followed by 1.5 mm balloon



NC Quantum 3.0 x 15 @ 30 (x4 times)

NC Euphora 3.0 x 15 @ 30 (x2 times)

How/Why Did This Happen?

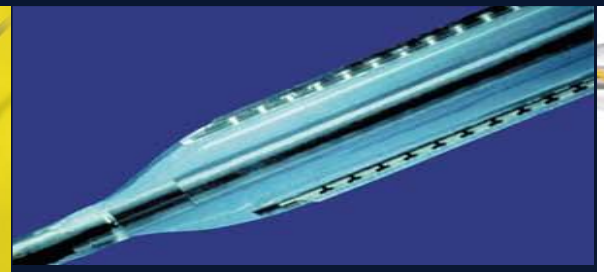
Lesion Preparation = Plaque modification + lumen expansion

- *Facilitates procedural success* when treating calcified/complex lesions
  - enables lesion access for balloons and especially stents
- *Plaque modification*: changing lesion compliance
  - minimizes vessel “trauma” (severe dissections)
  - creates a larger MLD

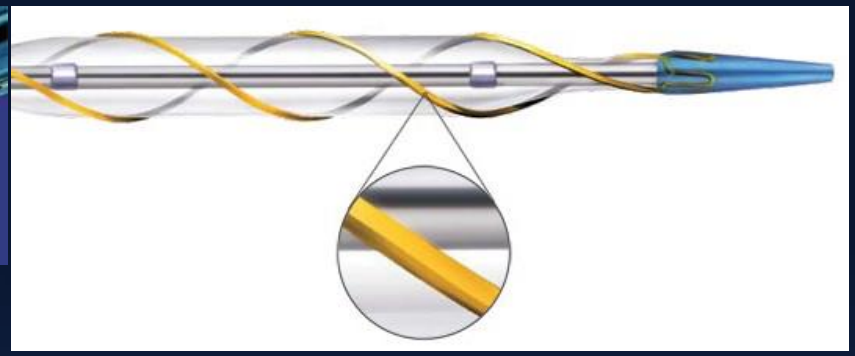
Treatment of Calcified Lesions: Options

NC Balloons

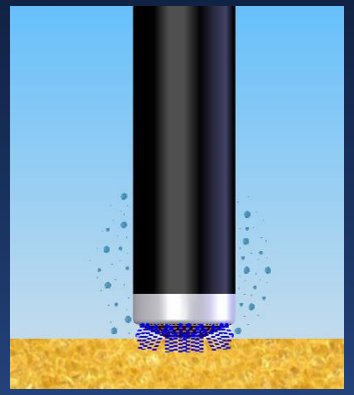
Cutting Balloon



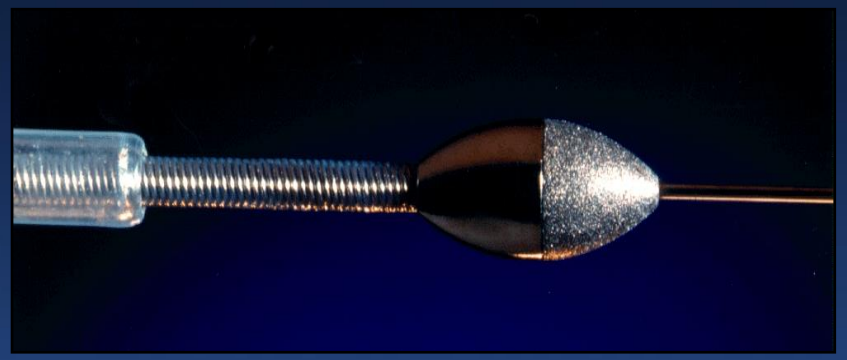
Angiosculpt



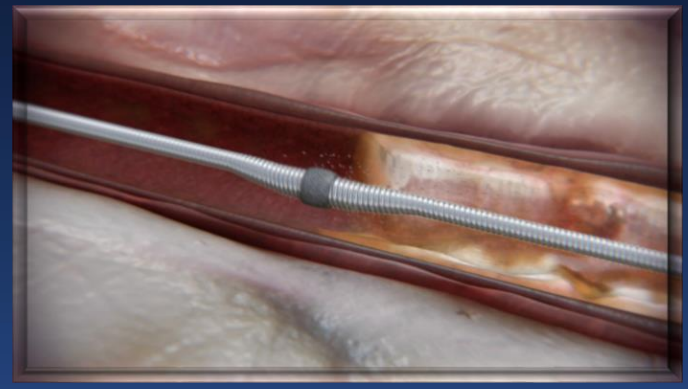
Laser



Rotational Atherectomy



Orbital Atherectomy



Intravascular Lithotripsy

Background and Objectives

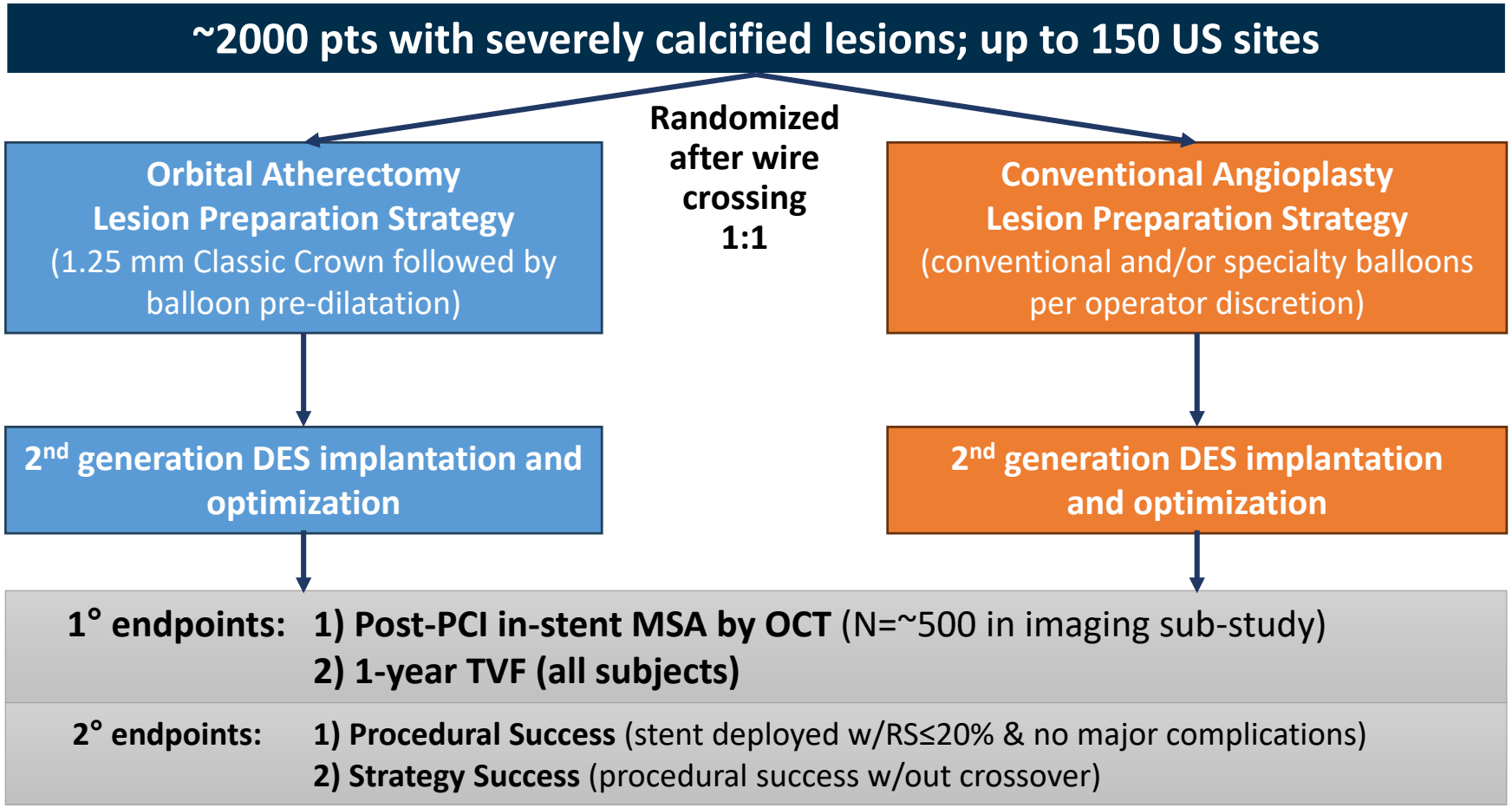
- Coronary lesion calcification is associated with greater PCI complexity, stent under-expansion, and increased rates of early/late adverse events
- Coronary atherectomy can ablate and fracture calcium – improving lesion compliance and facilitating stent delivery and expansion – and is an essential tool to treat balloon-uncrossable or non-dilatable calcified lesions
- *Whether advanced calcium modification strategies improve clinical outcomes compared with conventional balloon angioplasty is unknown*

We conducted a large-scale randomized trial comparing orbital atherectomy with conventional balloon angioplasty for treatment of severely calcified coronary lesions prior to DES implantation

Study Design

Key Entry Criteria:

- CCS, NSTEACS or stabilized post-STEMI
- *De novo* lesion with severe calcium
  - Via angiogram: opacities w/o cardiac motion involving both sides of wall w/total Ca^{++} ≥15 mm and extending into the target lesion, or
  - Via IVUS/OCT: ≥270° Ca^{++} in ≥1 cross section
- Equipoise regarding strategies (i.e. either no absolute requirement for or contraindication to atherectomy)



Patients with severely calcified lesions were enrolled by physician determination according to a pre-specified definition, with post-procedure calcium severity confirmed by an independent Core Lab

Funded by Abbott; ECLIPSE ClinicalTrials.gov number NCT03108456

Genereux P, et al. *Am Heart J.* 2022:249:1-11.

Baseline Characteristics

	Orbital Atherectomy (n=1008)	Balloon Angioplasty (n=997)
Age	69.9 ± 8.6	69.9 ± 9.1
Male sex	73.6%	72.4%
Hypercholesterolemia	88.0%	87.2%
Hypertension	90.3%	90.3%
Diabetes mellitus	43.1%	44.8%
Treated with insulin	18.4%	18.0%
History of CKD	23.2%	24.6%
On hemodialysis	6.0%	5.2%
LVEF (%)	55.1 ± 10.6	55.8 ± 9.9
History of PVD	13.7%	14.6%
History of prior PCI	43.7%	46.7%
History of prior CABG	9.1%	10.9%

Baseline Angiographic Characteristics (Core Lab)

	Orbital Atherectomy (n=1008, 1121 lesions)	Balloon Angioplasty (n=997, 1101 lesions)
Target lesion vessel		
LMCA	0.7%	1.2%
LAD	60.1%	61.3%
LCX	12.8%	11.0%
RCA	26.3%	26.5%
Calcification		
None / Mild	1.0%	1.2%
Moderate	1.9%	1.8%
Severe	**97.1%**	**97.0%**
Bifurcation/trifurcation	30.3%	32.2%
QCA		
Reference vessel diameter (mm)	3.0 ± 0.5	2.9 ± 0.4
Minimal lumen diameter (mm)	0.96 ± 0.35	0.95 ± 0.34
Percent diameter stenosis	67.6 ± 10.7	67.4 ± 10.9
Lesion length (mm)	28.9 ± 14.9	28.5 ± 15.3
Calcification length (mm)	42.1 ± 20.2	41.5 ± 19.6

Note: Calcification length may be longer than lesion length due to extension of calcium beyond the stenotic lesion

Procedural Characteristics

	Orbital Atherectomy (n=1008)	Balloon Angioplasty (n=997)	*p*
Number of target lesions treated	1.2 ± 0.5	1.2 ± 0.5	0.44
Femoral access site (any)#	47.6%	46.6%	0.66
Hemodynamic support	0.8%	0.7%	0.81
Temporary pacemaker*	4.5%	1.9%	0.001
Guide extension catheter used	21.4%	22.3%	0.65
Number of guide wires used	2.7 ± 1.4	2.2 ± 1.4	<0.001
Microcatheter or OTW balloon used	42.1%	16.5%	<0.001
Number of balloon catheters used	3.6 ± 2.3	4.0 ± 2.8	0.02
OA attempted	98.9%	3.7%	<0.001
OA performed	98.2%	3.7%	<0.001
Any intravascular imaging performed**	62.1%	62.0%	0.96
OCT	40.3%	41.1%	0.70
IVUS	25.6%	25.6%	0.99
Total contrast volume (mL)	179.4 ± 94.4	160.0 ± 86.9	<0.001
Total procedure time (minutes)	73.2 ± 33.8	60.1 ± 36.5	<0.001

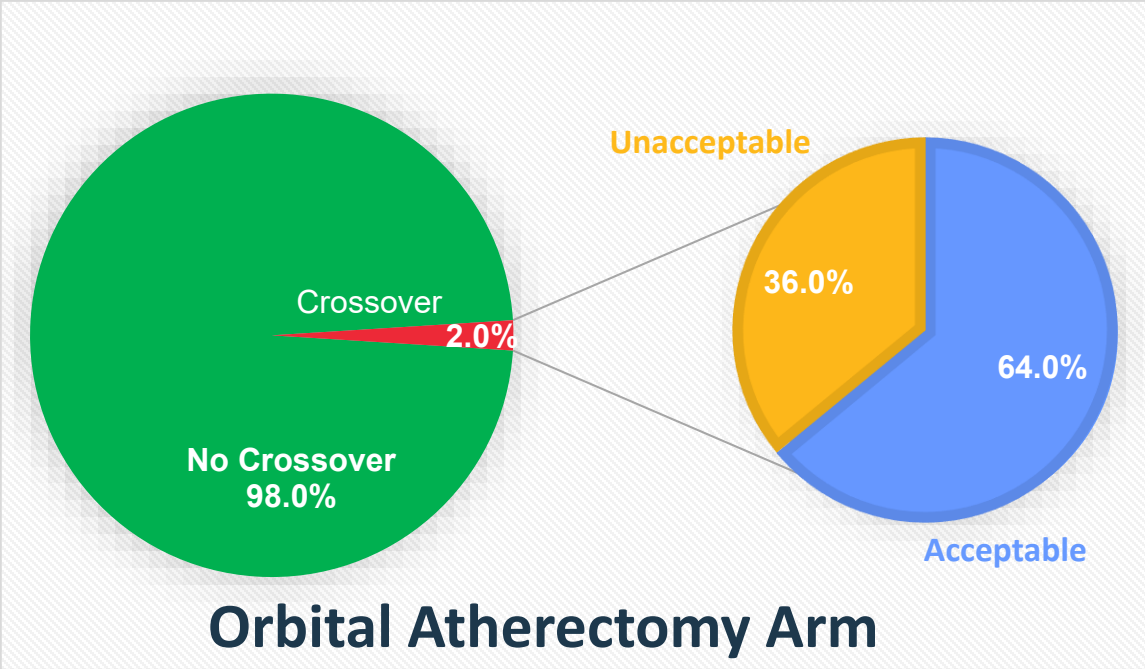
#Any femoral includes access with multiple sites including at least one femoral access.
*43 pacemakers in the OA group and 18 pacemakers in the BA group were placed prophylactically (pre-PCI).
**Both OCT and IVUS were used in some patients.

Procedural Device Usage (Lesion-level)

	Orbital Atherectomy (n=1008, 1250 lesions)	Balloon Angioplasty (n=1008, 1242 lesions)	*p*
Balloon type, all*			
Standard	98.6%	98.4%	0.76
Scoring	2.0%	11.0%	<0.001
Cutting	1.7%	10.1%	<0.001
Other specialty	1.9%	3.9%	0.007
Balloon compliance, all*			
Compliant	19.6%	21.0%	0.47
Semi-compliant	37.4%	43.2%	0.008
Non-compliant	90.9%	87.1%	0.007
Maximum balloon pressure (atm)	19.0 ± 3.8	18.9 ± 4.1	0.46
Orbital atherectomy performed	93.1%	3.8%	<0.001
Number of passes	3.8 ± 2.1	4.5 ± 2.8	0.01
Total pass time (seconds)	88.4 ± 59.9	112.3 ± 86.6	0.01
Orbital atherectomy speed			
Low only	71.9%	63.8%	0.28
Low and high	25.4%	34.0%	0.23
High only	2.8%	2.1%	0.81
Rotational or laser atherectomy	0.3%	0.6%	0.52
Intravascular lithotripsy	0.2%	0.6%	0.14

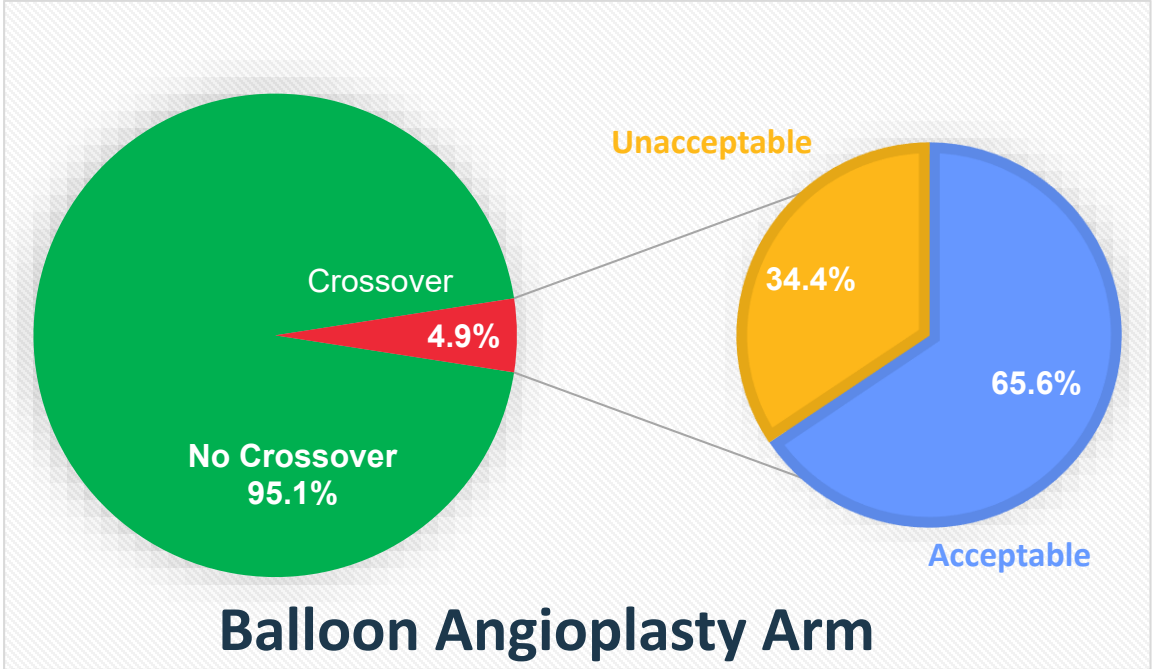
p-values are based on repeated measures modeling to account for clustering in subjects with multiple lesions
*Total is >100% because more than one balloon catheter type was used in some lesions

Adjudication of Crossovers (Lesion-Level)



Orbital Atherectomy Arm

Reason for crossover as determined by the Crossover Committee*	
Lesion couldn't be crossed with support catheter, guide extension, or more supportive guide catheter	44.0%
OAS wouldn't advance/cross | unable to attempt due to safety	20.0%
Use of rotational atherectomy or laser or IVL	28.0%
Other**	48.0%



Balloon Angioplasty Arm

Reason for crossover as determined by the Crossover Committee*	
Lesion couldn't be crossed with ≥2 guidewires AND balloons, or guide extension catheter	32.8%
Lesion couldn't be dilated despite ≥2 balloons at ≥16 atm AND attempted use of scoring/cutting balloon at ≥12 atm	41.0%
IVUS/OCT showed ≥270° calcification with residual MLA <3 mm^2	32.8%
Use of rotational atherectomy or laser or IVL	24.6%
Other**	13.1%

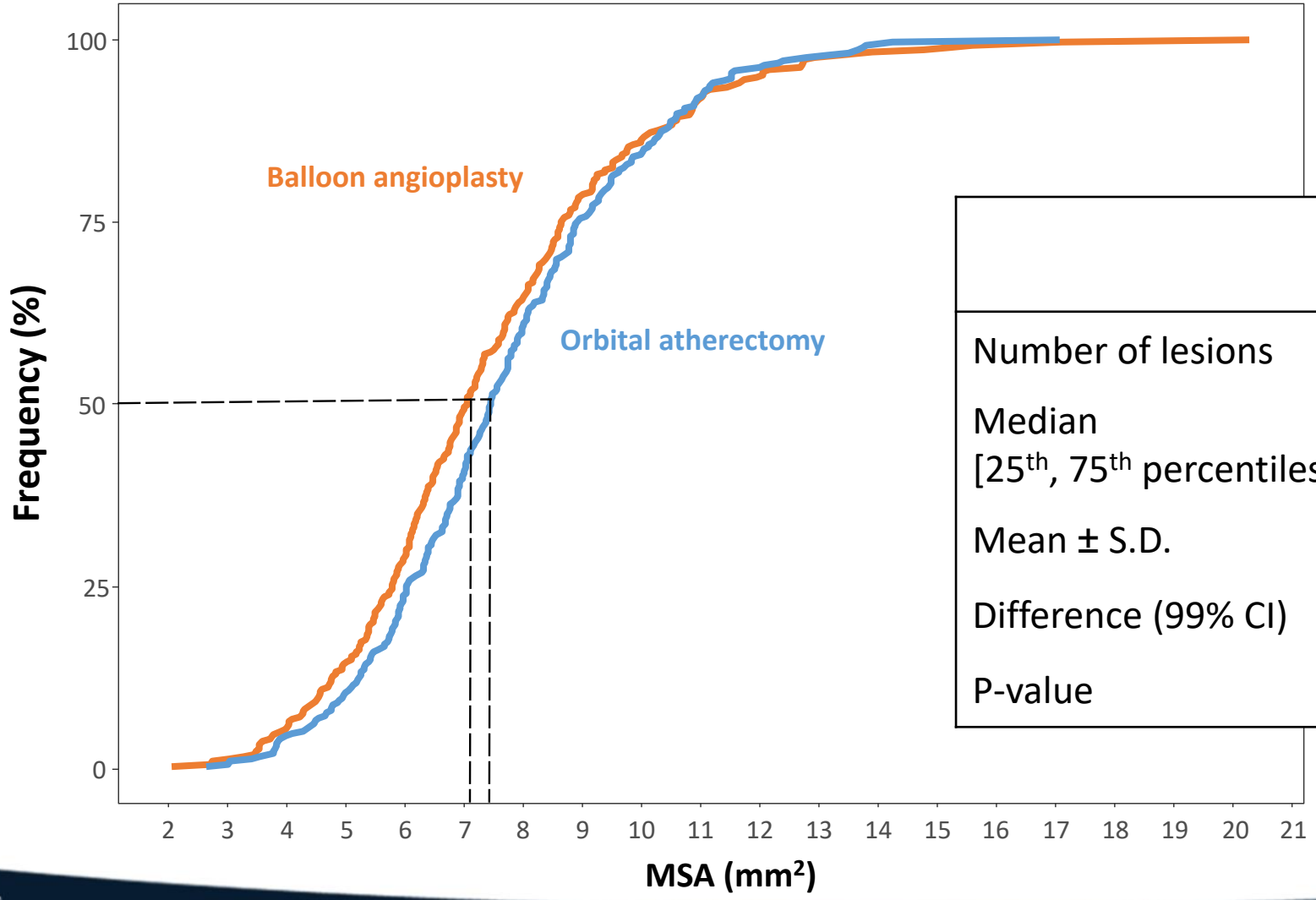
*Multiple conditions were present in some lesions
**Reason for crossover was present other than the pre-specified criteria.

Procedural Complications

	Orbital Atherectomy (n=1008)	Balloon Angioplasty (n=997)	*p*
Thrombus	5 (0.5%)	3 (0.3%)	0.73
Spasm	30 (3.0%)	21 (2.1%)	0.22
Abrupt closure	6 (0.6%)	2 (0.2%)	0.29
No reflow	3 (0.3%)	1 (0.1%)	0.62
Slow flow	14 (1.4%)	4 (0.4%)	0.03
Type C-F dissection	70 (6.9%)	63 (6.3%)	0.57
Distal embolization	2 (0.2%)	2 (0.2%)	1.0
Perforation	18 (1.8%)	10 (1.0%)	0.14
Ellis I	5 (0.5%)	1 (0.1%)	0.30
Ellis II	4 (0.4%)	4 (0.4%)	
Ellis III	9 (0.9%)	5 (0.5%)	

Primary Imaging Endpoint (OCT Cohort)

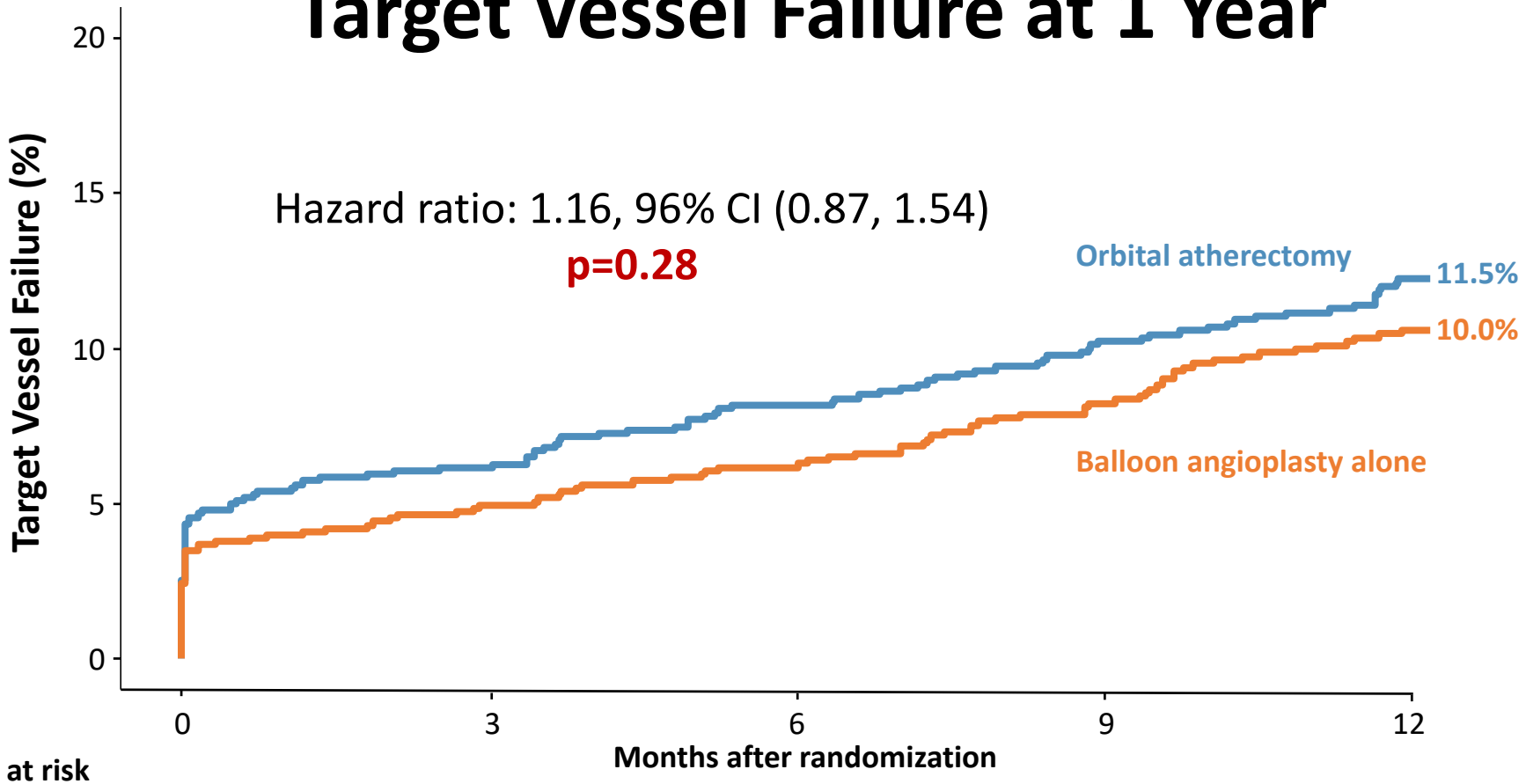
Minimal stent area at maximum calcium site



	Orbital atherectomy	Balloon angioplasty
Number of lesions	286	292
Median [25th, 75th percentiles]	**7.44** [6.03, 8.94]	**7.05** [5.78, 8.66]
Mean ± S.D.	**7.67** ± 2.27	**7.42** ± 2.54
Difference (99% CI)	**0.26** (-0.31, 0.82) mm²	
P-value	**0.08**	

Overall MSA: 6.13 ± 2.01 with Orbital Atherectomy vs. 5.87 ± 2.04 with Balloon Angioplasty; p=0.10

Primary Clinical Endpoint
Target Vessel Failure at 1 Year



Number at risk					
Orbital Atherectomy	1008	927	883	860	838
Balloon Angioplasty	997	928	891	862	834

30-Day Clinical Outcomes

	Orbital Atherectomy (n=1008)	Balloon Angioplasty (n=997)	*p*
All-cause death	10 (1.0%)	3 (0.3%)	0.05
Cardiac	8 (0.8%)	0 (0.0%)	0.005
Vascular	1 (0.1%)	0 (0.0%)	0.32
Non-cardiovascular	1 (0.1%)	3 (0.3%)	0.32
All MI	50 (5.0%)	41 (4.1%)	0.36
Procedural	41 (4.1%)	34 (3.4%)	0.44
Non-procedural	9 (0.9%)	7 (0.7%)	0.62
Target-vessel	42 (4.2%)	35 (3.5%)	0.45
Non-target-vessel	8 (0.8%)	6 (0.6%)	0.60
Ischemia-driven revasc	15 (1.5%)	12 (1.2%)	0.57
Ischemia-driven TVR	6 (0.6%)	6 (0.6%)	0.99
Ischemia-driven TLR	6 (0.6%)	6 (0.6%)	0.99
Stent thrombosis	7 (0.7%)	3 (0.3%)	0.21
Definite	4 (0.4%)	3 (0.3%)	0.71
Probable	3 (0.3%)	0 (0.0%)	0.08

CEC adjudication of 8 cardiac deaths in the orbital atherectomy arm:

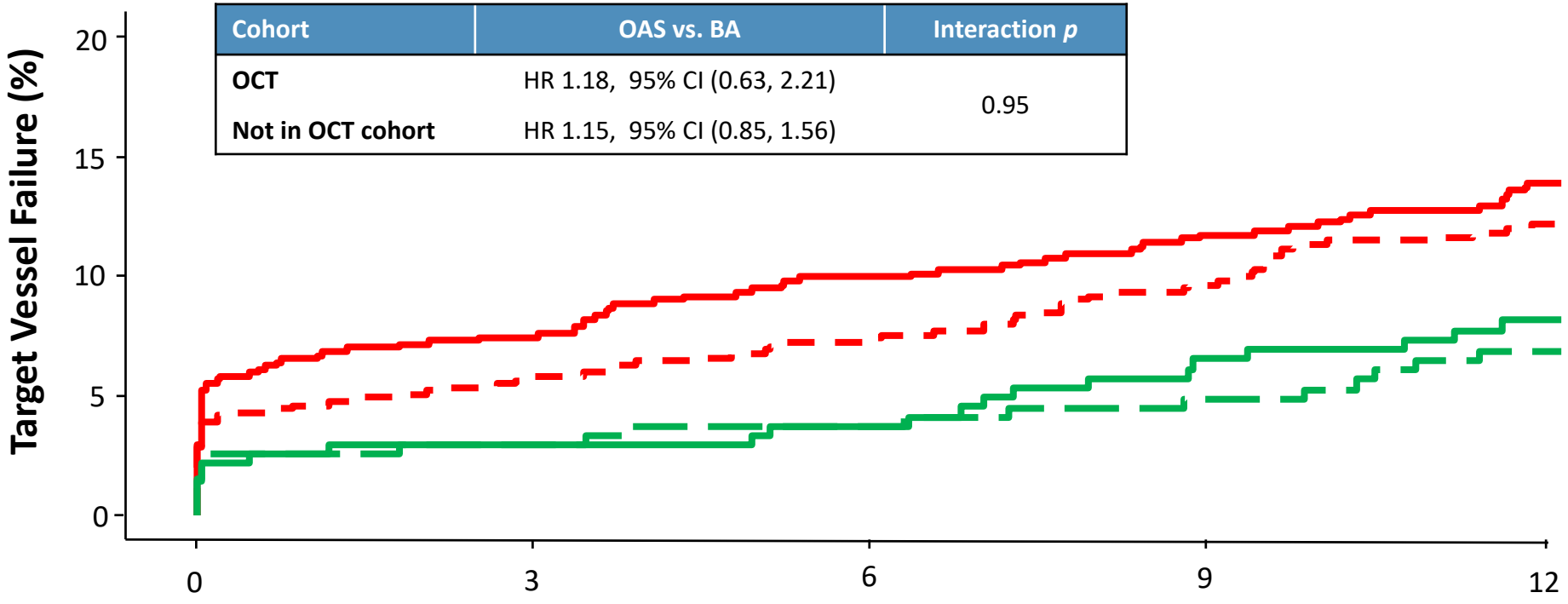
Related to device: 2
Possibly related: 2
Not related: 4

1-Year Clinical Outcomes

	Orbital Atherectomy (n=1008)	Balloon Angioplasty (n=997)	*p*
All-cause death	61 (6.2%)	53 (5.5%)	0.48
Cardiac	39 (4.0%)	26 (2.7%)	0.12
Vascular	4 (0.4%)	2 (0.2%)	0.43
Non-cardiovascular	18 (1.9%)	25 (2.6%)	0.28
All MI	80 (8.1%)	74 (7.6%)	0.65
Procedural	41 (4.1%)	34 (3.4%)	0.45
Non-procedural	41 (4.3%)	40 (4.2%)	0.94
Target-vessel related	55 (5.6%)	43 (4.4%)	0.24
Non-target-vessel related	27 (2.8%)	32 (3.4%)	0.49
Ischemia-driven revasc	81 (8.5%)	76 (8.1%)	0.70
Ischemia-driven TVR	40 (4.2%)	41 (4.4%)	0.88
Ischemia-driven TLR	32 (3.4%)	32 (3.4%)	0.98
Stent thrombosis	11 (1.1%)	4 (0.4%)	0.08
Definite	8 (0.8%)	4 (0.4%)	0.26
Probable	3 (0.3%)	0 (0.0%)	1.00

TVF Stratified by Enrollment Cohort
Orbital Atherectomy vs. Balloon Angioplasty

Cohort	OAS vs. BA	Interaction *p*
OCT	HR 1.18, 95% CI (0.63, 2.21)	0.95
Not in OCT cohort	HR 1.15, 95% CI (0.85, 1.56)	



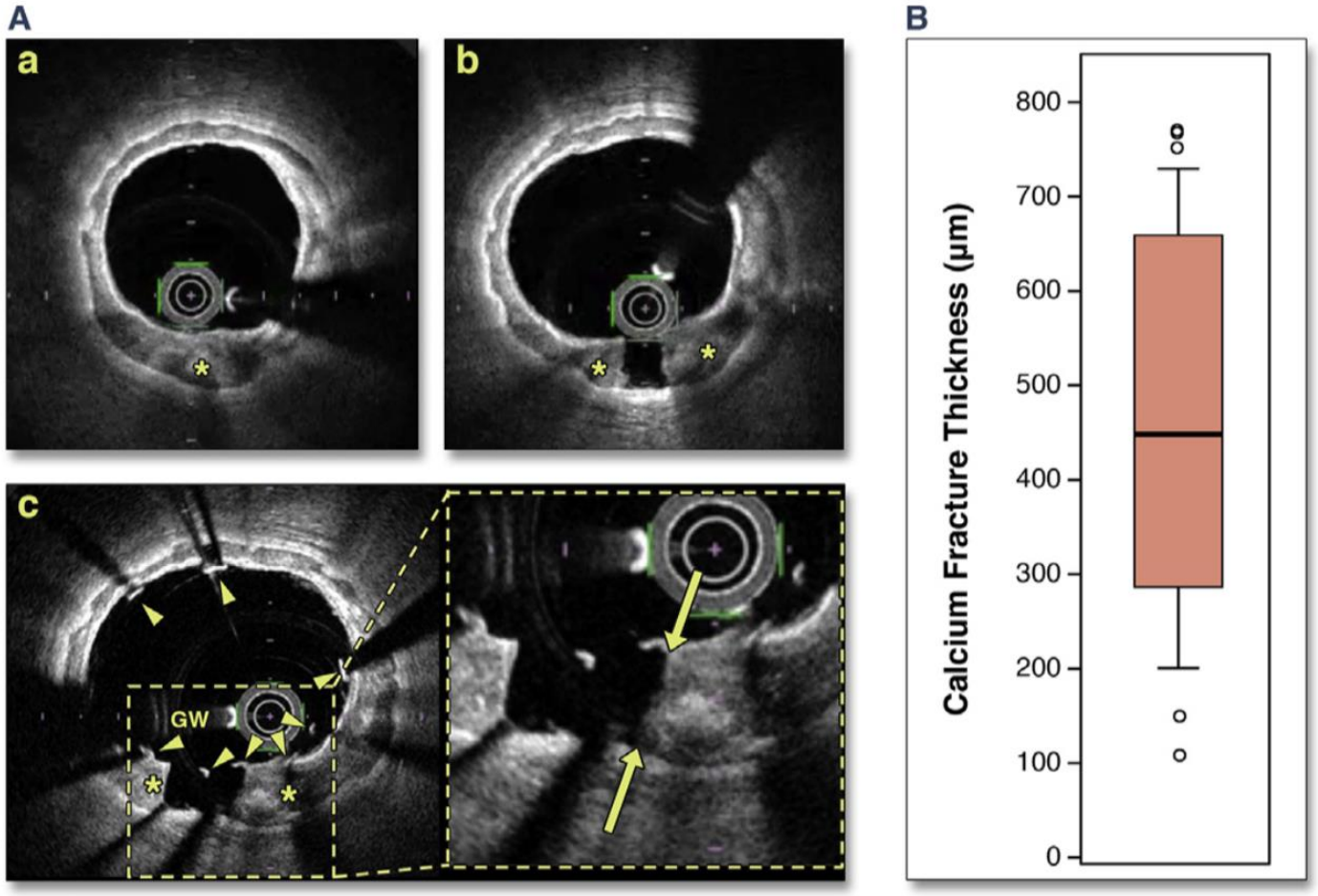
Number at risk					
BA not in OCT Cohort	718	661	631	608	585
BA in OCT Cohort	279	267	260	254	249
OA not OCT Cohort	732	664	625	611	593
OA in OCT Cohort	276	263	258	249	245

Conclusions and Context

- **The routine use of orbital atherectomy did not improve MSA or reduce TVF** at 1 yr compared w/conventional balloon angioplasty for preparation of severely calcified coronary lesions prior to DES implantation
  - *It's NOT that atherectomy didn't work… it's that balloons worked FAR better than anticipated!*
- Extremely calcified lesions that would be balloon-uncrossable or -undilatable (i.e. would require atherectomy) were excluded
  - Only 4.9% of lesions randomized to balloon crossed over
- Most lesions were qualified based upon angio, but use of intravascular imaging was high (62%), with better outcomes in both groups

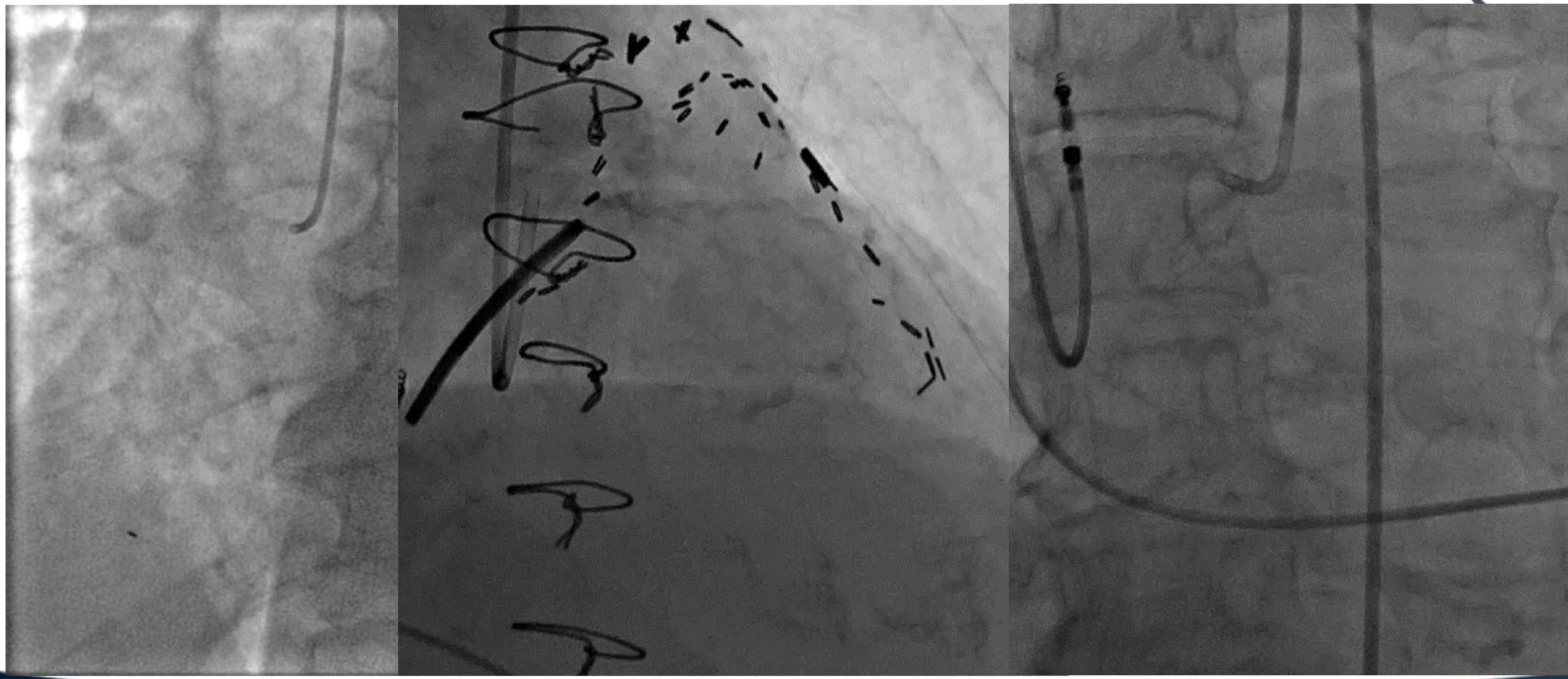
Calcium Fracture and Relation to Outcomes

61 pts with heavily calcified lesions studied serially with OCT
Fracture was seen in 48% (more frequently with CB or atherectomy)

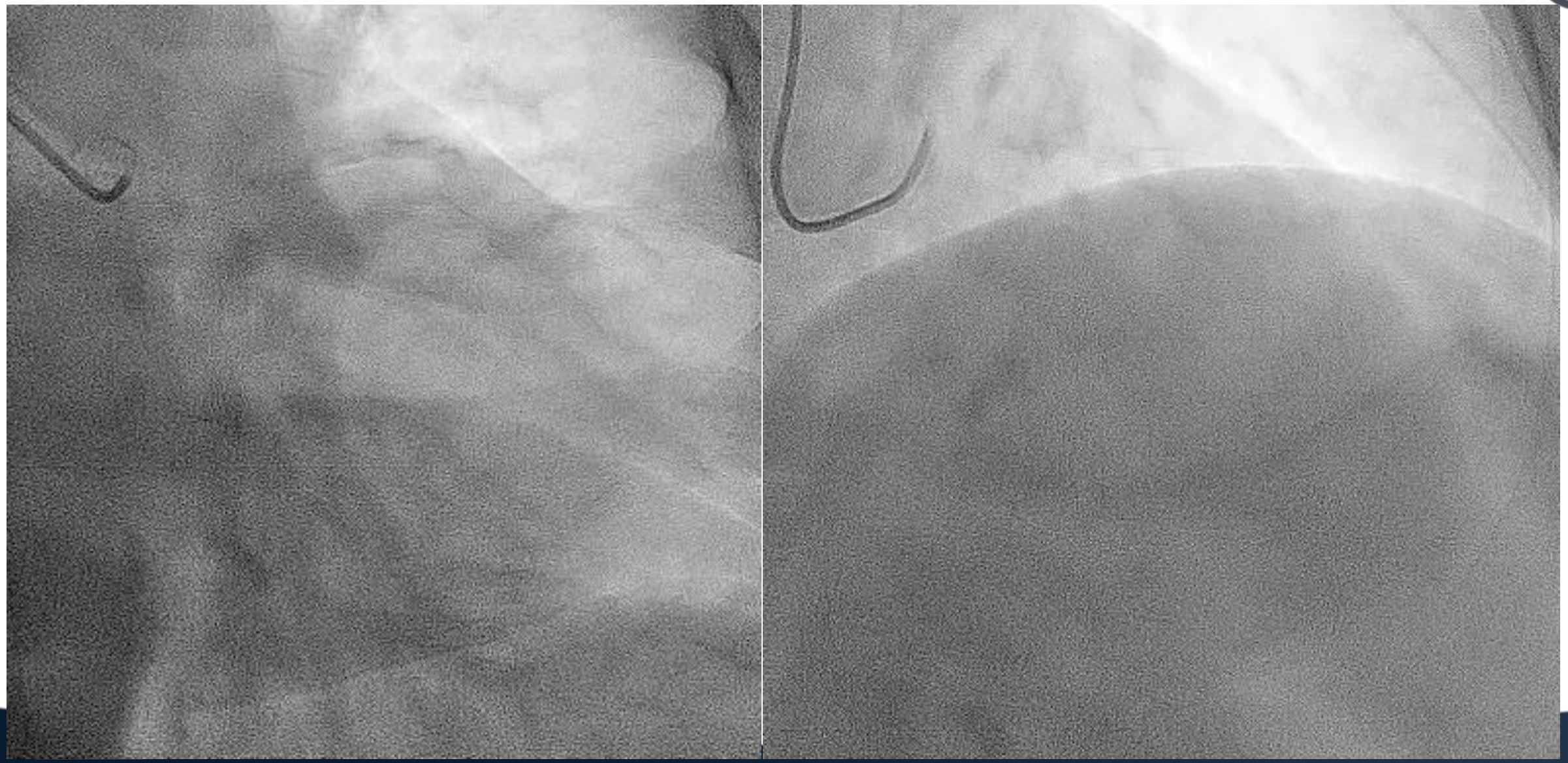


Fracture was associated with greater MSA and less restenosis/ID-TLR

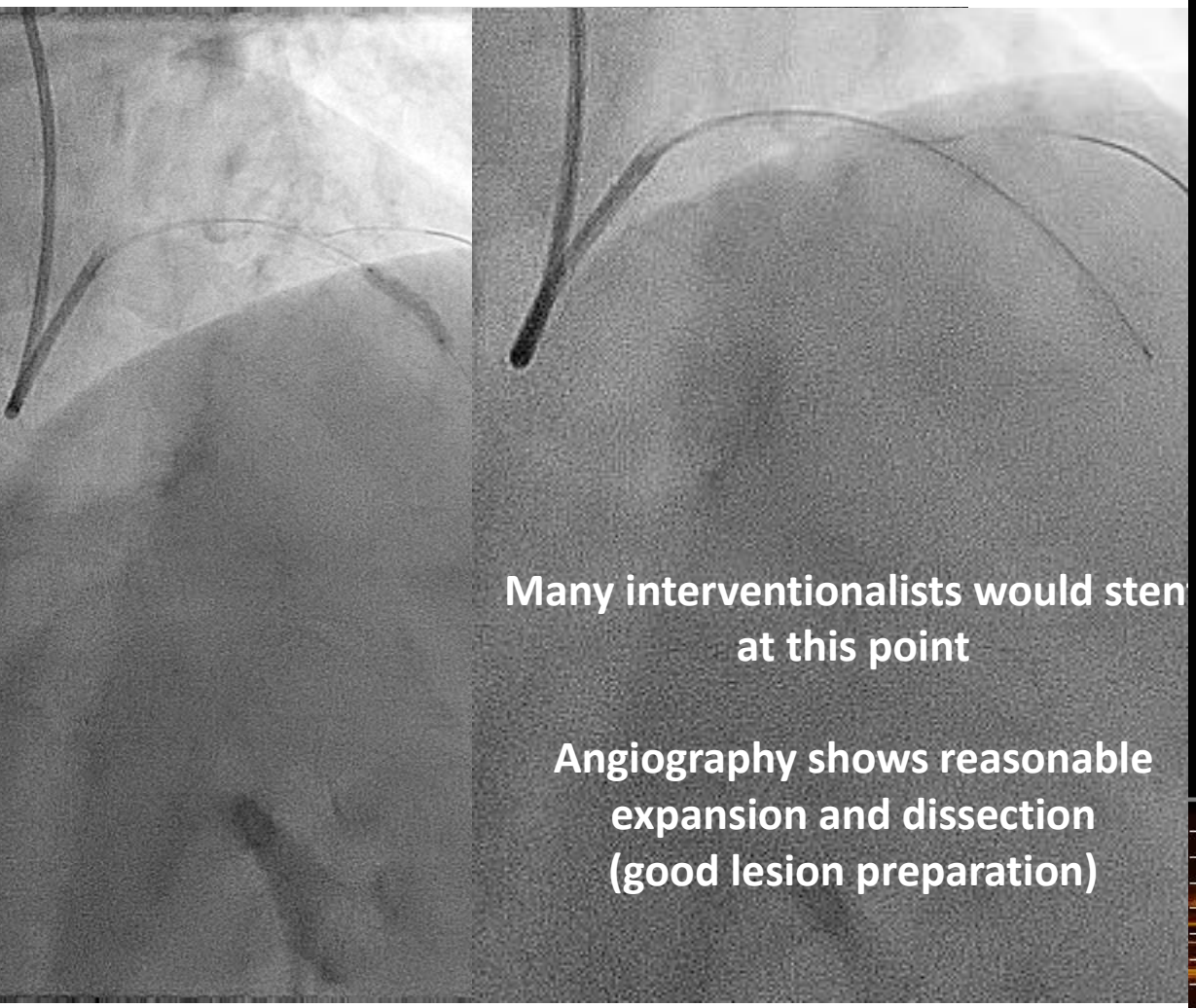
Examples of Lesions Randomized



Case Example: Calcified LAD, randomized to balloon

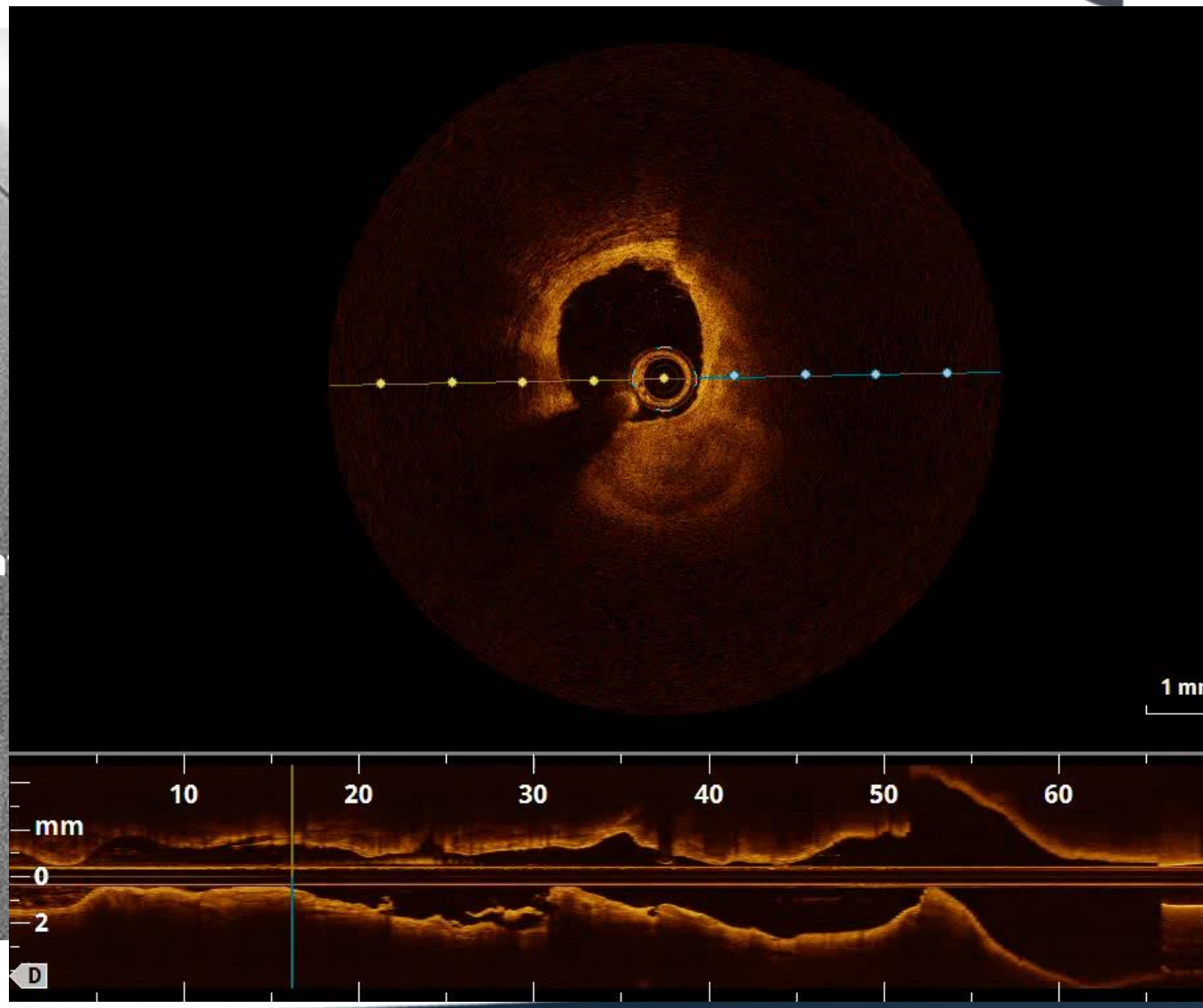


Predilation: 3.0 mm NC balloon at 20 atm



Many interventionalists would sten
at this point

Angiography shows reasonable
expansion and dissection
(good lesion preparation)



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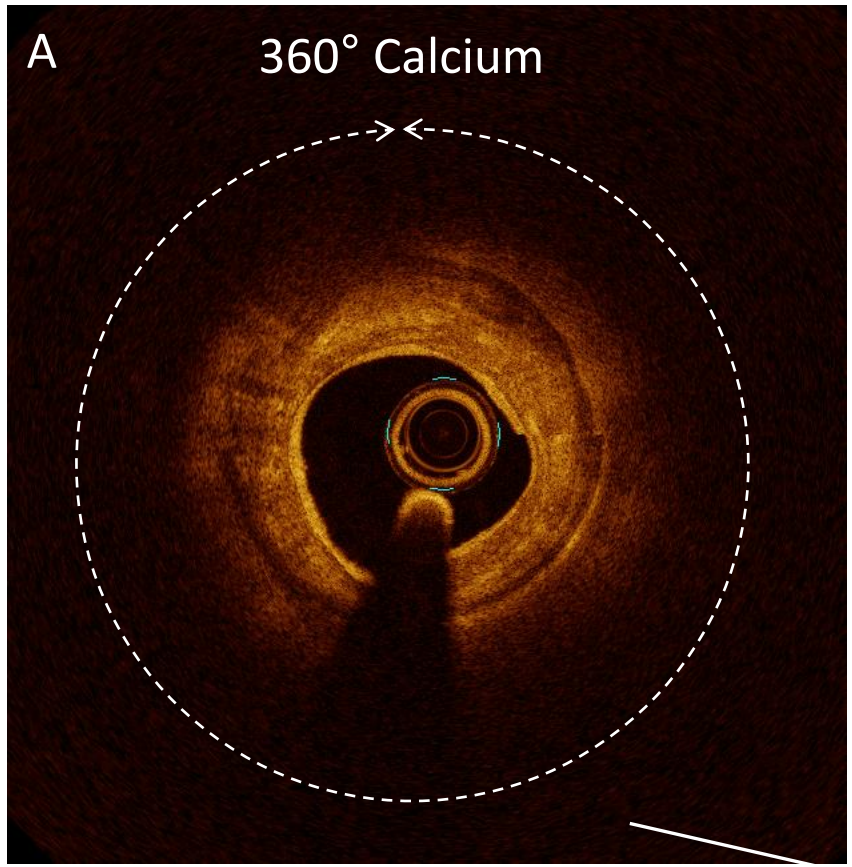
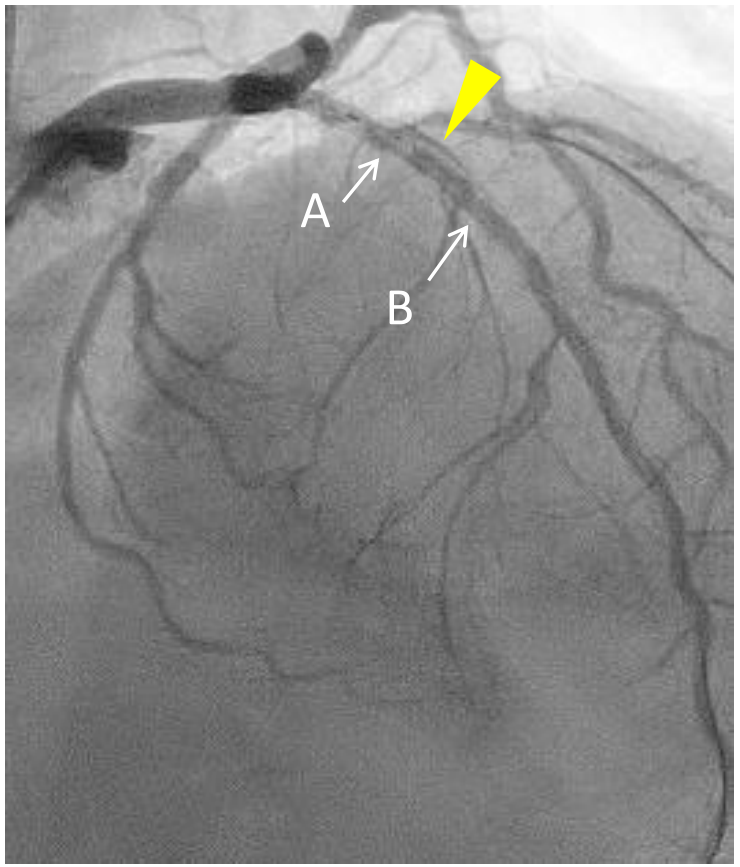
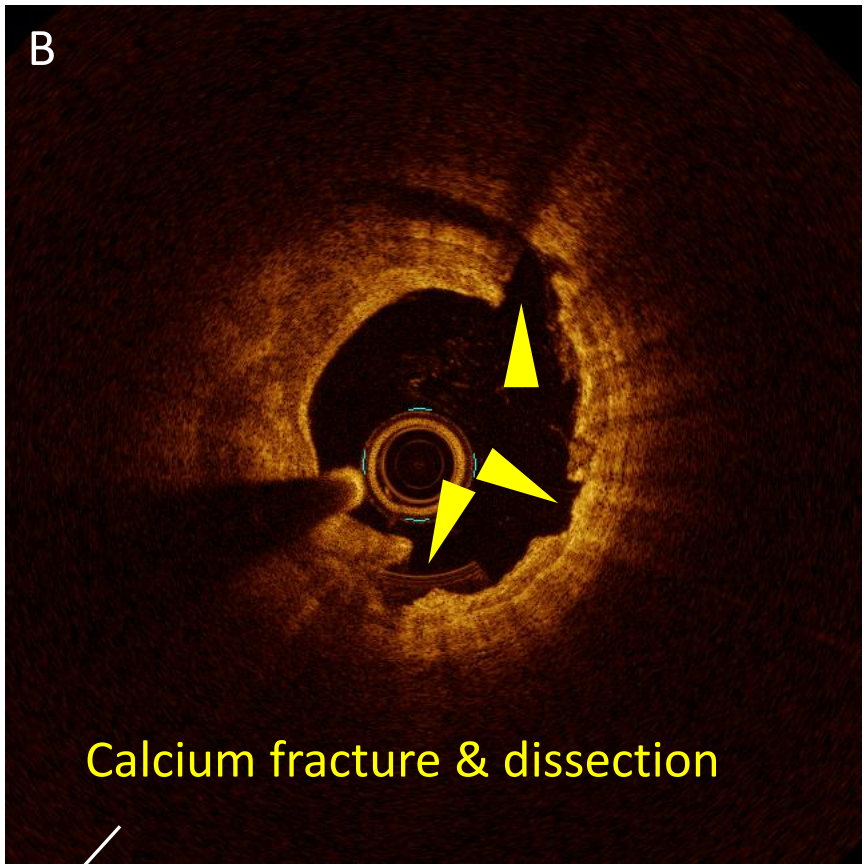
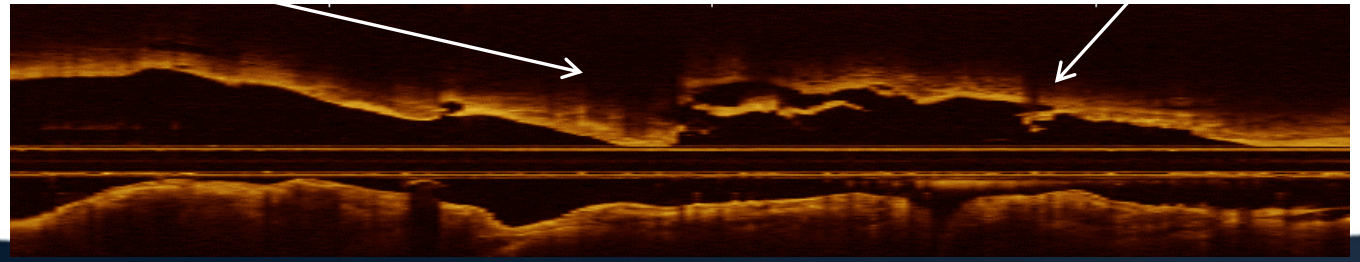




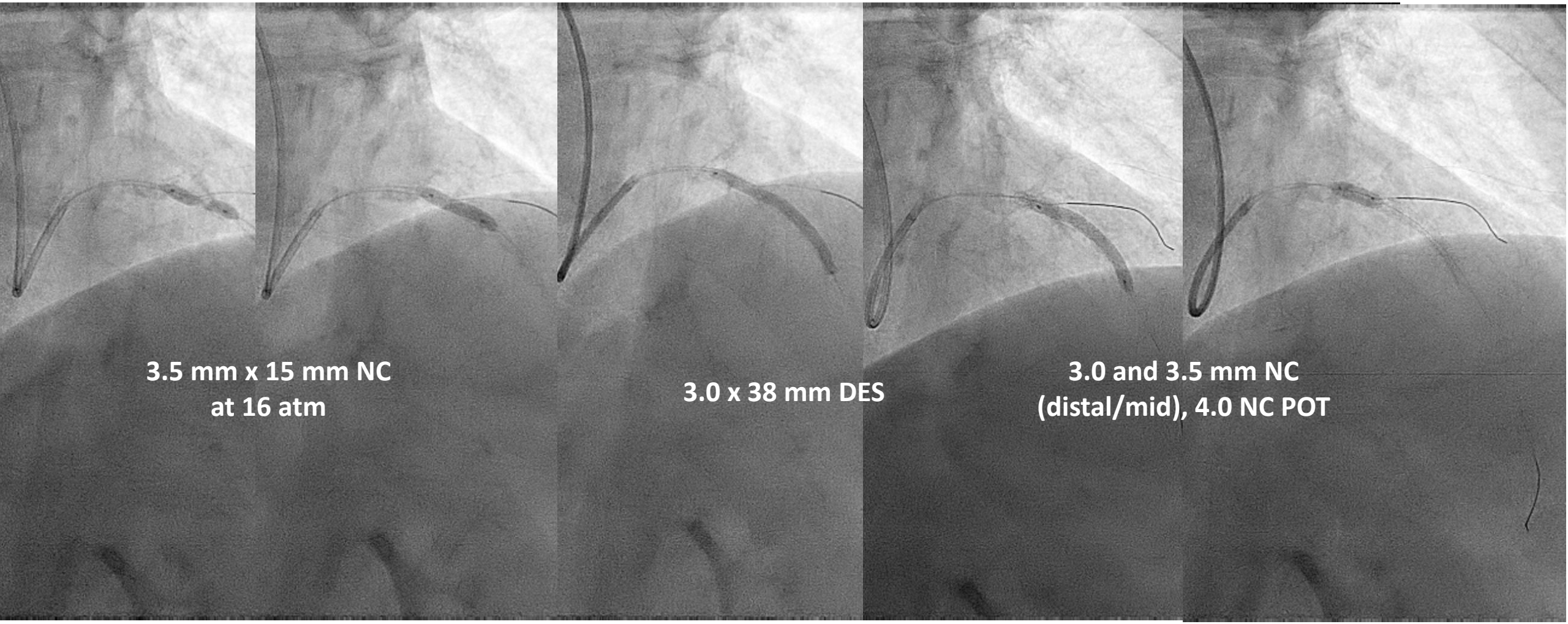


proximal



distal

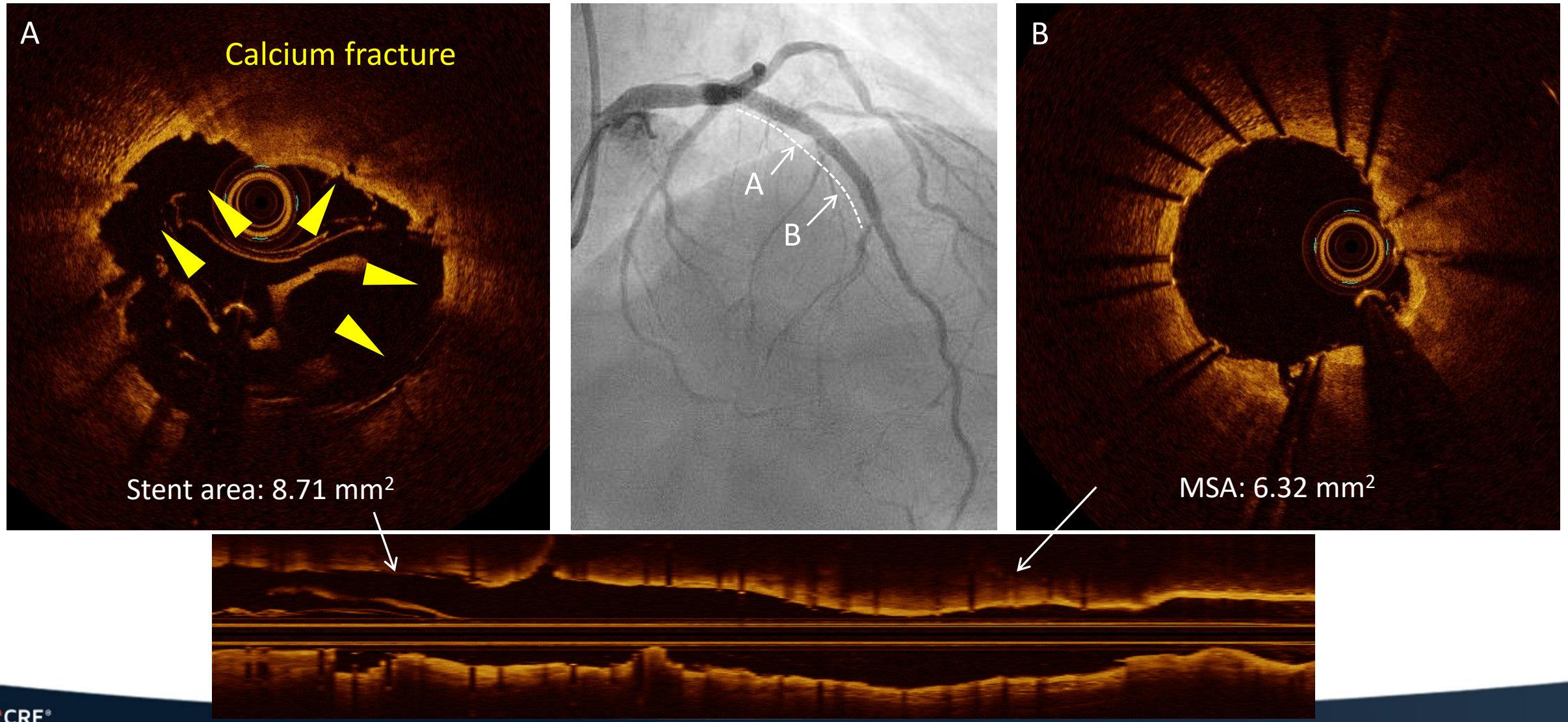
Further Lesion Prep / Stenting / Optimization



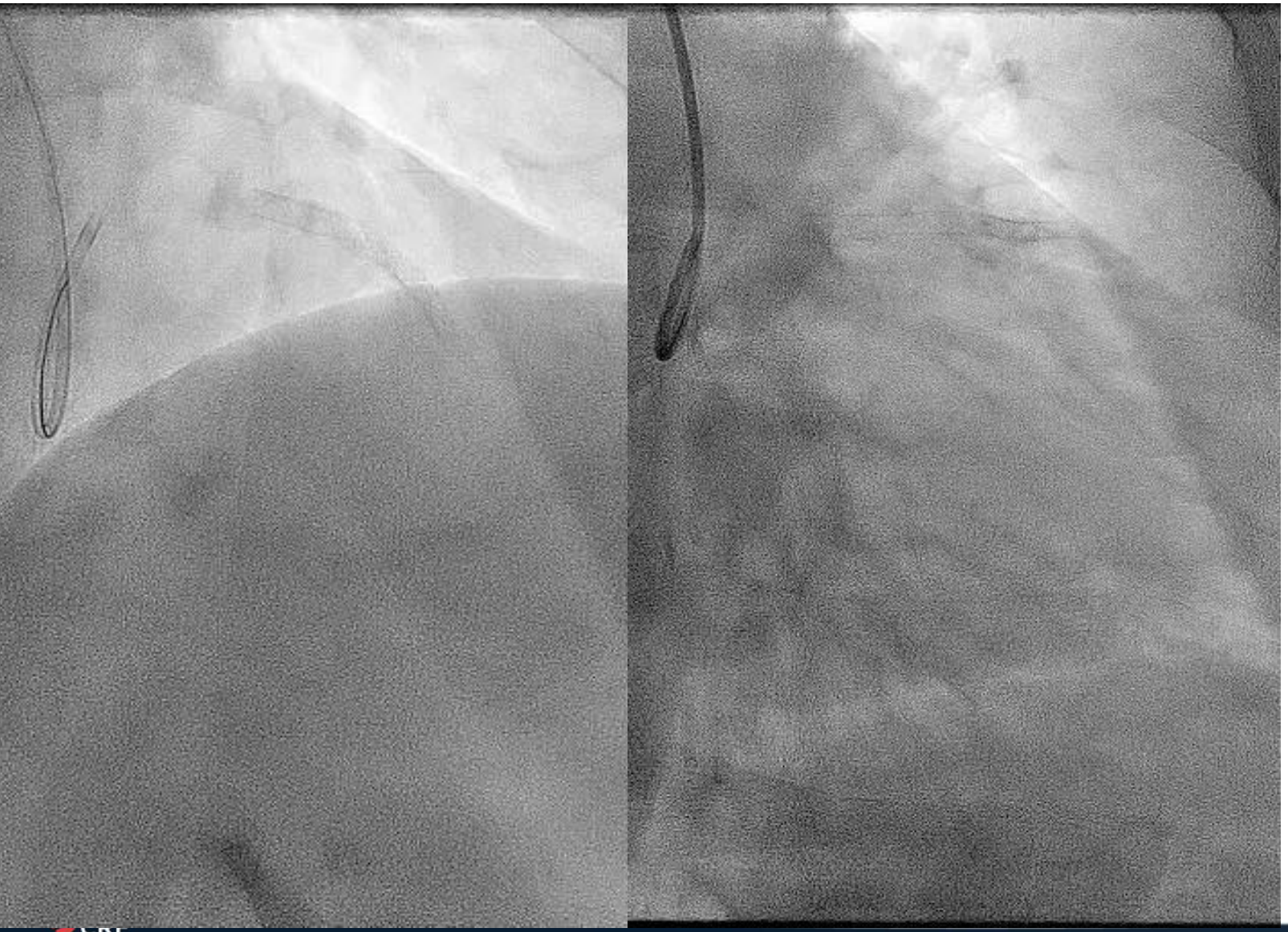
Final OCT

360° Calcium Site

MSA Site



Final Angiography and Lessons from ECLIPSE



1. **ECLIPSE shows that for lesions like this, using conventional balloons is a wholly reasonable first approach**
2. The initial angiogram recognized calcium, *but was not sufficient to optimize lesion preparation*
3. The use of intraprocedural imaging allowed me to confirm adequate lesion preparation prior to stent implantation (preventing stenting an unprepped site), and also facilitated safe optimization of my stents

My Take Home Messages

Adequate stent expansion and low rates of adverse outcomes are achievable with conventional balloon angioplasty in a substantial proportion of severely calcified lesions if meticulous attention (including IV-imaging) is paid to lesion preparation

RCTs are essential to inform treatment strategies in this space…

(Especially with the areas observed in the OCT cohort of patients,this result could have happened with any technology)