

Calcified Nodules in Complex PCI: Are They All the Same and How Should We Treat?

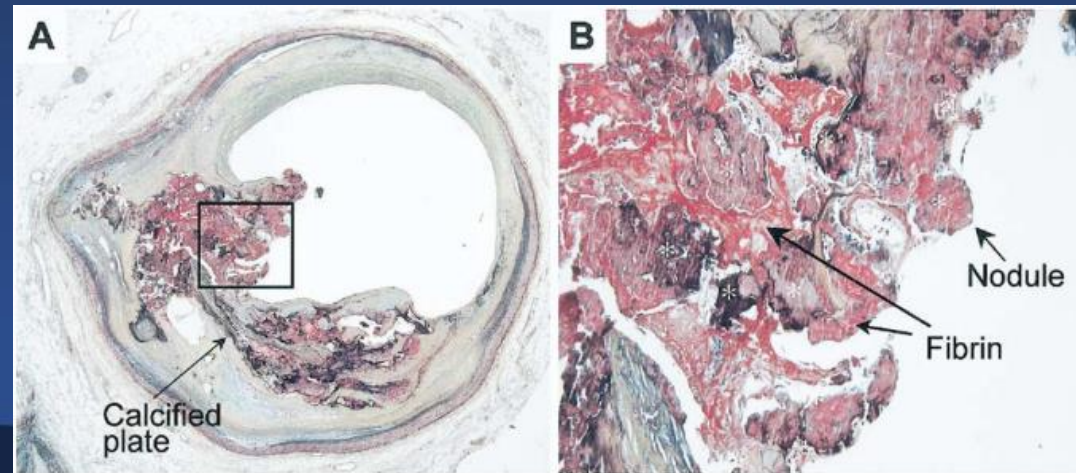
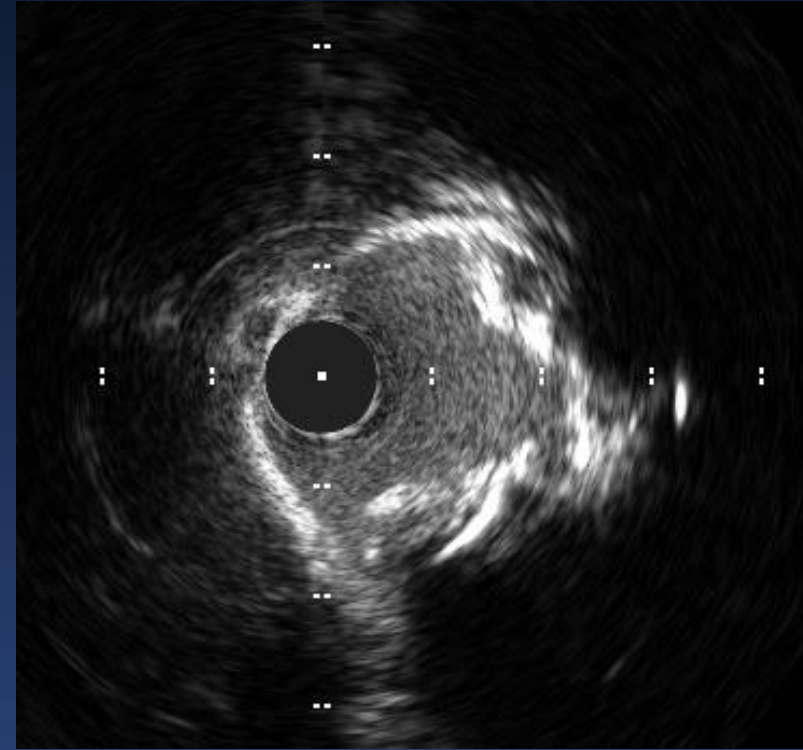
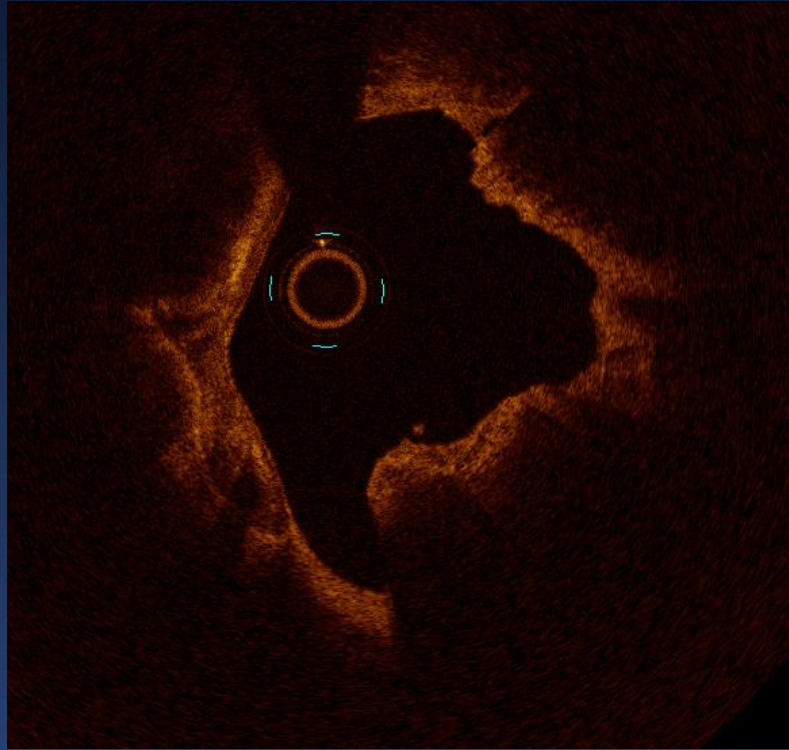
Akiko Maehara, MD

*Columbia University, Cardiovascular
Research Foundation, New York, NY*

DISCLOSURE

- **Consultant: Boston Scientific, Abbott Vascular, Philips**
- **Advisory Board: SpectraWave**
- **Speaker Honoraria: Nipro**

Calcified Nodule



Virmani R et al. J Am Coll Cardiol 18;47:C13-8.

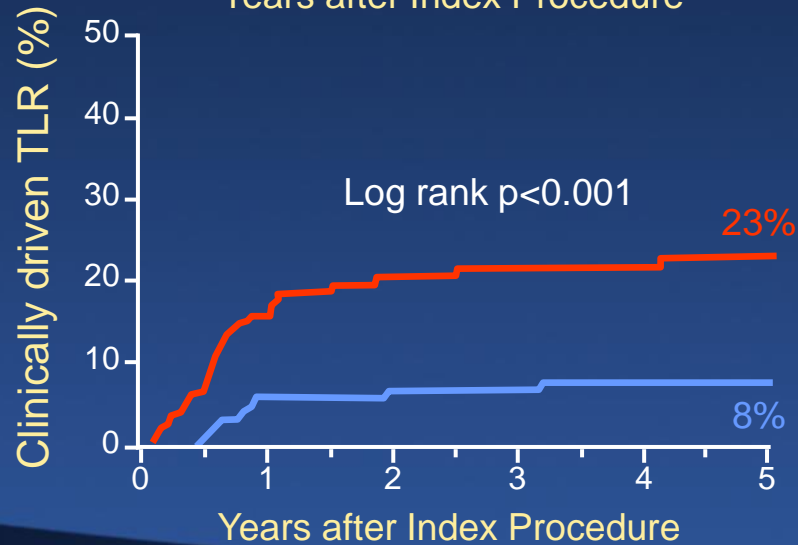
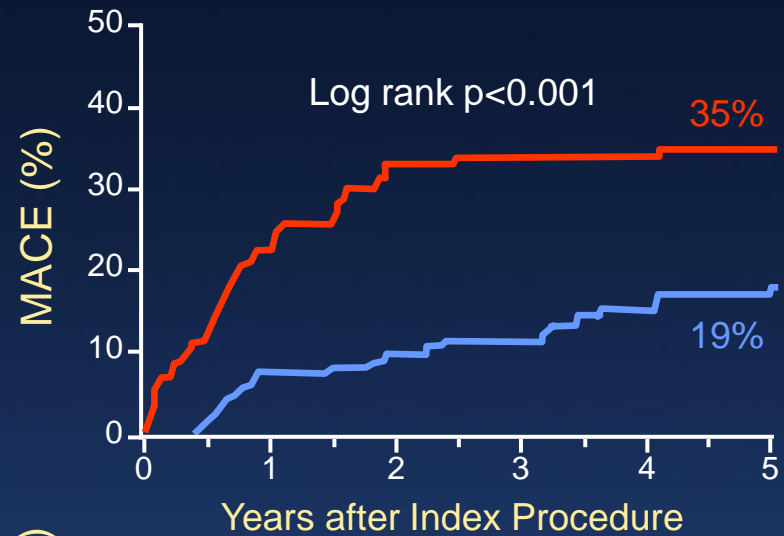
CN: Clinical and Morphological Characteristics

	Calcified Nodule (n=37)	No Calcified Nodule (n=852)	P Value
Age, yrs	73 (65, 79)	66 (58, 73)	0.001
ACS presentation	45.9%	48.2%	0.79
DM	51.4%	33.3%	0.02
Hemodialysis	18.9%	2.6%	<0.001
Δ Angle in lesion	16 (14, 21)	9 (6, 14)	<0.001
OCT Max Ca angle, °	301 (247, 347)	64 (0, 123)	<0.001
Mean Ca angle, °	166 (134, 202)	48 (0, 81)	<0.001
Max Ca thickness, mm	1.18 (0.94, 1.3)	0.21 (0, 0.75)	<0.001

Comparison of CNs between ACS vs Stable CAD

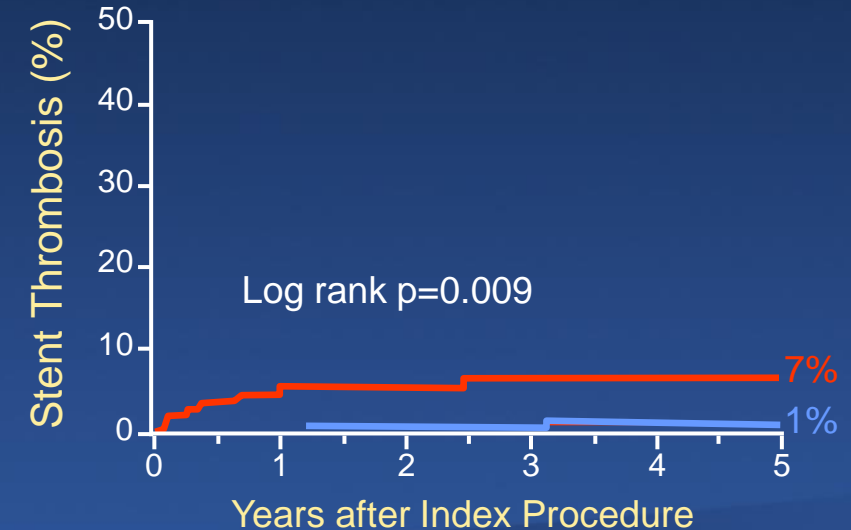
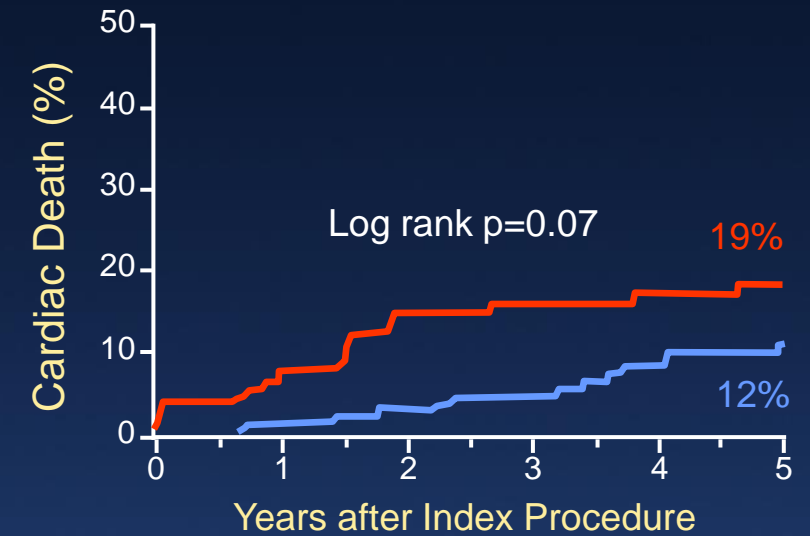
	ACS (n=17)	Stable CAD (n=20)	P value
RCA ostial location	17.6%	0%	0.09
RCA mid location	29.4%	35.0%	0.99
Δ Angle in the lesion	16 (14, 20)	16 (14, 21)	0.90
Minimum lumen area, mm ²	1.04 (0.69, 1.26)	1.61 (1.03, 2.06)	0.02
Thrombus	82.4%	20.0%	<0.001
Maximum calcium arc, °	273 (233, 332)	304 (252, 347)	0.50
Calcium length, mm	17 (14, 26)	18 (15, 27)	0.94
Adjacent TCFA	5.9%	5.3%	0.99

IVUS-CN (n=128) vs no IVUS-CN (n=144) in heavily calcified lesions treated with RA+stenting



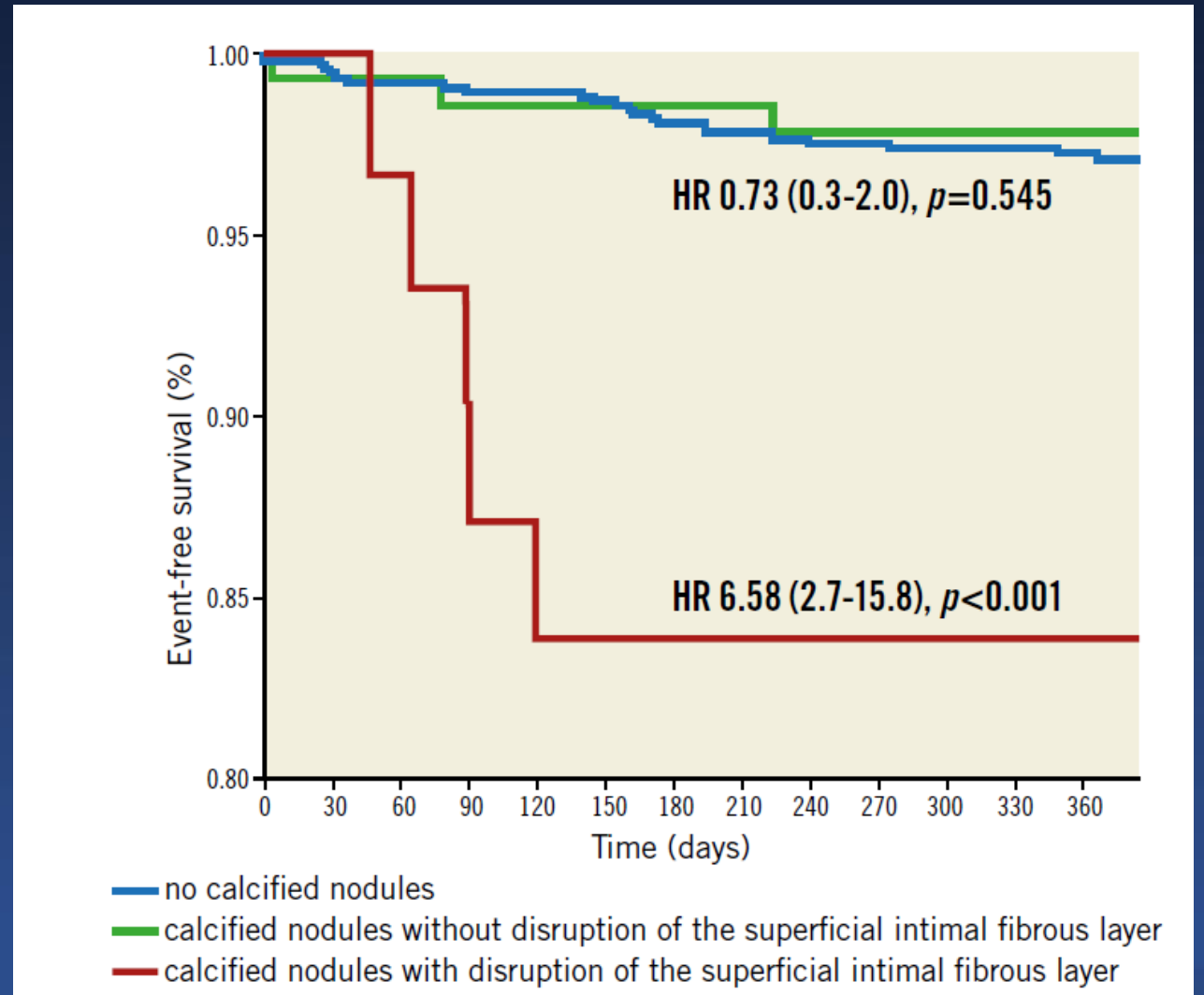
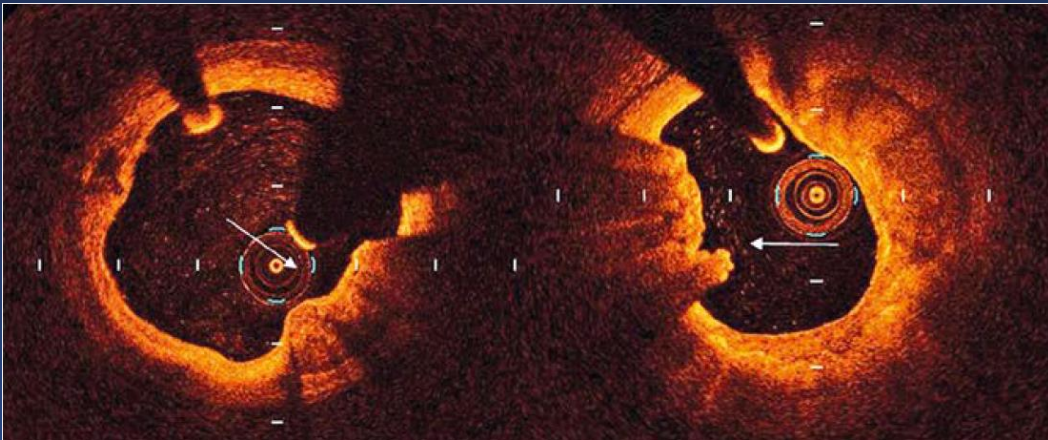
IPW Adjustment		
	HR	P-value
MACE	2.52	<0.001
CD-TLR	4.13	<0.001
ST	8.53	0.04
Cardiac death	1.49	0.3

Independent risk factors of 5 yr MACE included hemodialysis, CN, ostial or RCA lesion, and LVEF



CLIMA: Eruptive vs non-eruptive CN

- Prevalence of CN=12.5% (222/1776) LADs
- Endpoint: cardiac death or target lesion MI
- Main difference was due to more cardiac death in eruptive vs non-eruptive (13.3% vs 2.0%) at 1 year



10061 vessels in 9097 patients that underwent OCT at St Francis Hospital (NY)

4508 vessels in 4294 patients without pre- or post-PCI OCT image

5553 vessels in 4803 patients who underwent OCT

1260 vessels in 1260 patients with in-stent restenosis
122 vessels in 122 patients with coronary bypass graft
190 vessels in 190 patients with poor image quality

3981 vessels in 3231 patients that underwent OCT for de novo lesions

3745 vessels in 2995 patients without CNs

284 CNs in 240 lesions in 236 vessels of 236 patients that underwent pre- and post- PCI OCT

Prevalence of CN in de novo native coronary arteries

5.9% (236/3981) per vessel

7.3% (236/3231) per patient

6 vessels in 6 patients without ≥ 6 months follow-up

4 secondary lesions in the same vessel with 4 primary lesions

272 CNs in 230 lesions in 230 vessels of 230 patients that underwent pre- and post- PCI OCT

Patients were classified based on dominant CN

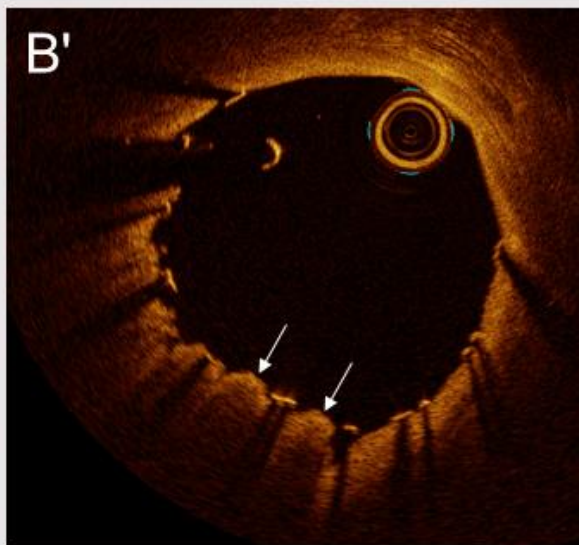
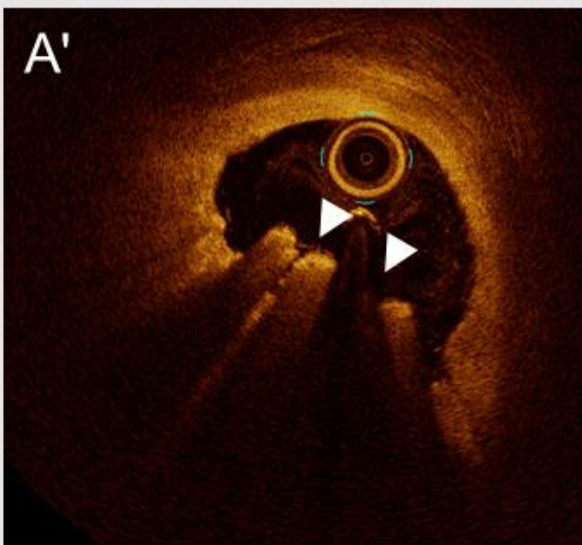
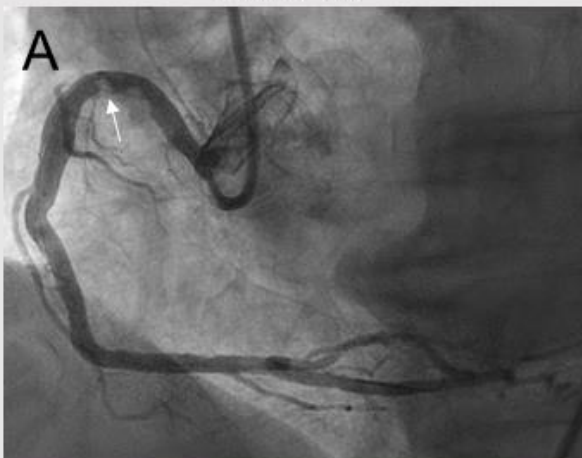
126 patients with Eruptive-CN

104 patients with Non-Eruptive CN

Eruptive Calcified Nodule

Pre-PCI

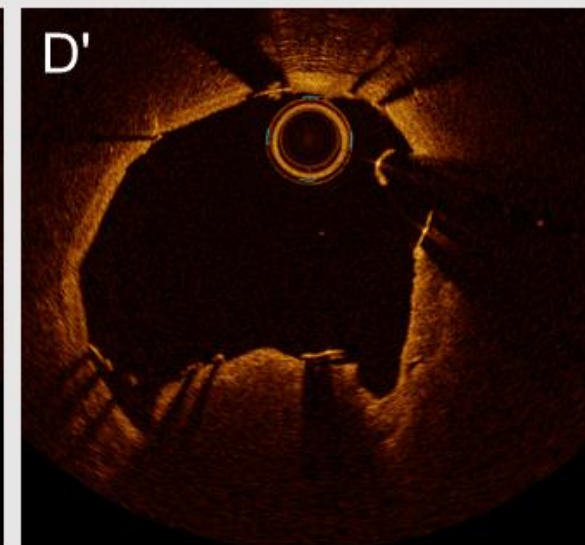
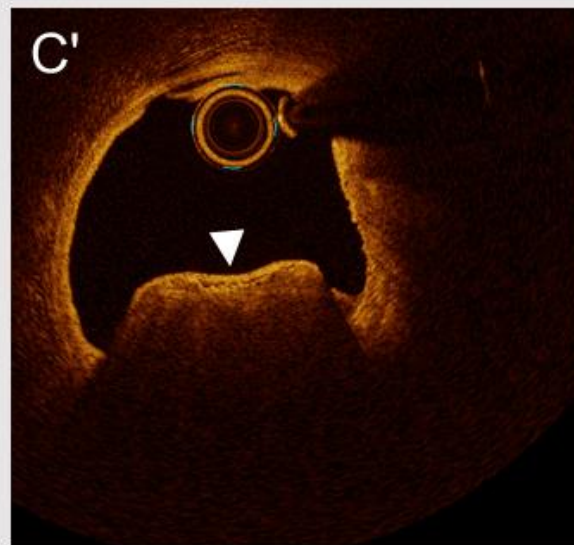
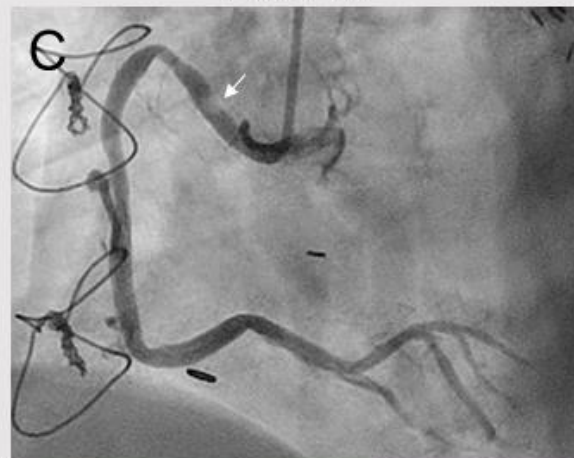
Final



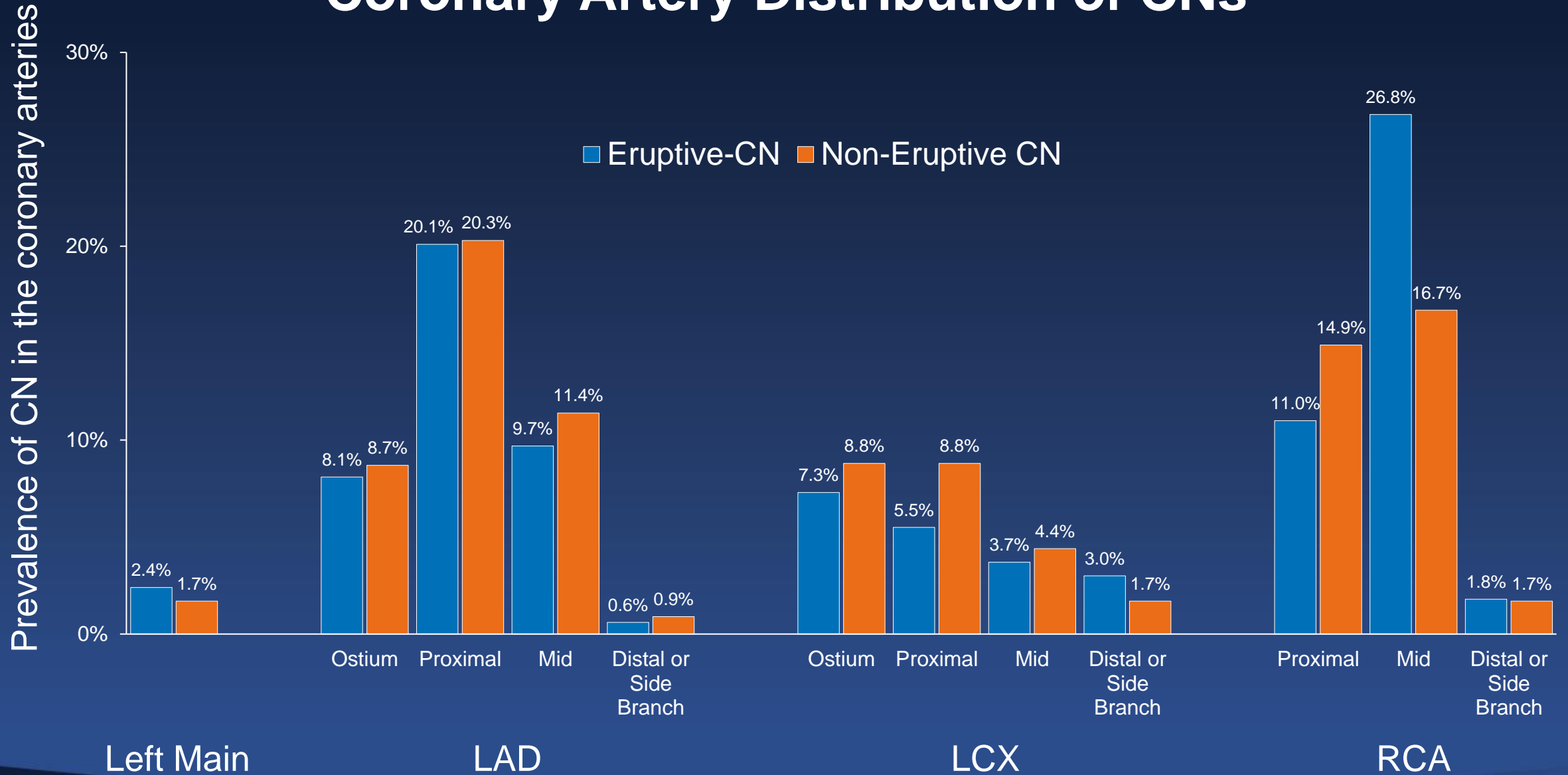
Non-Eruptive Calcified Nodule

Pre-PCI

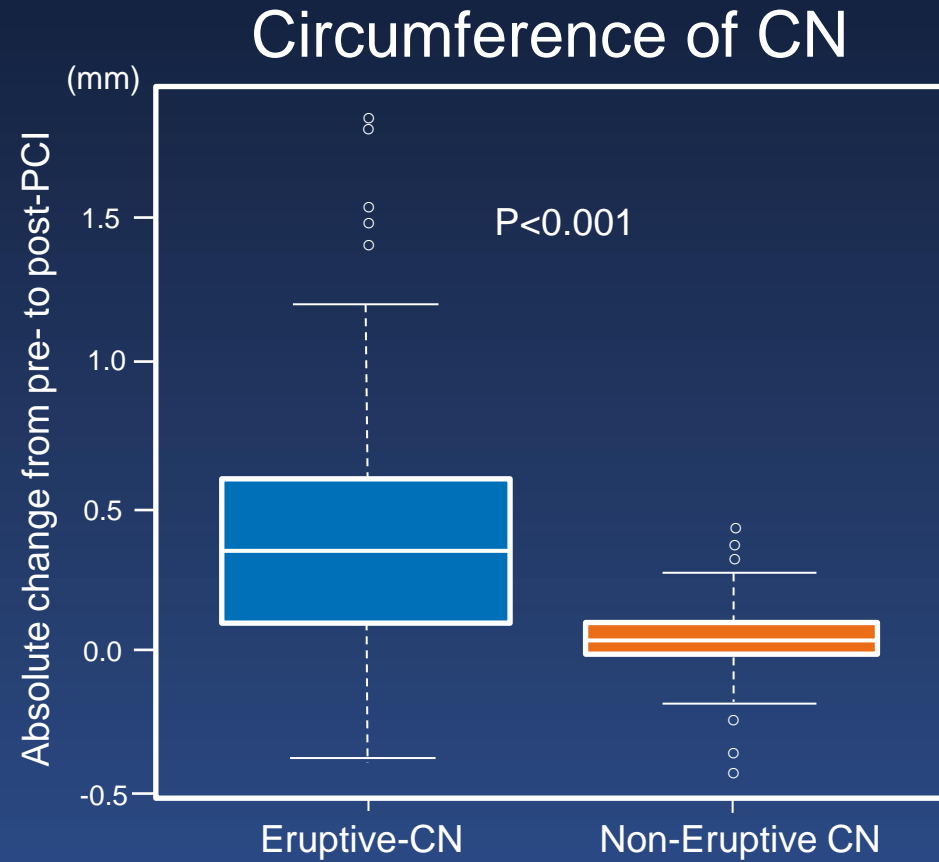
Final



Coronary Artery Distribution of CNs

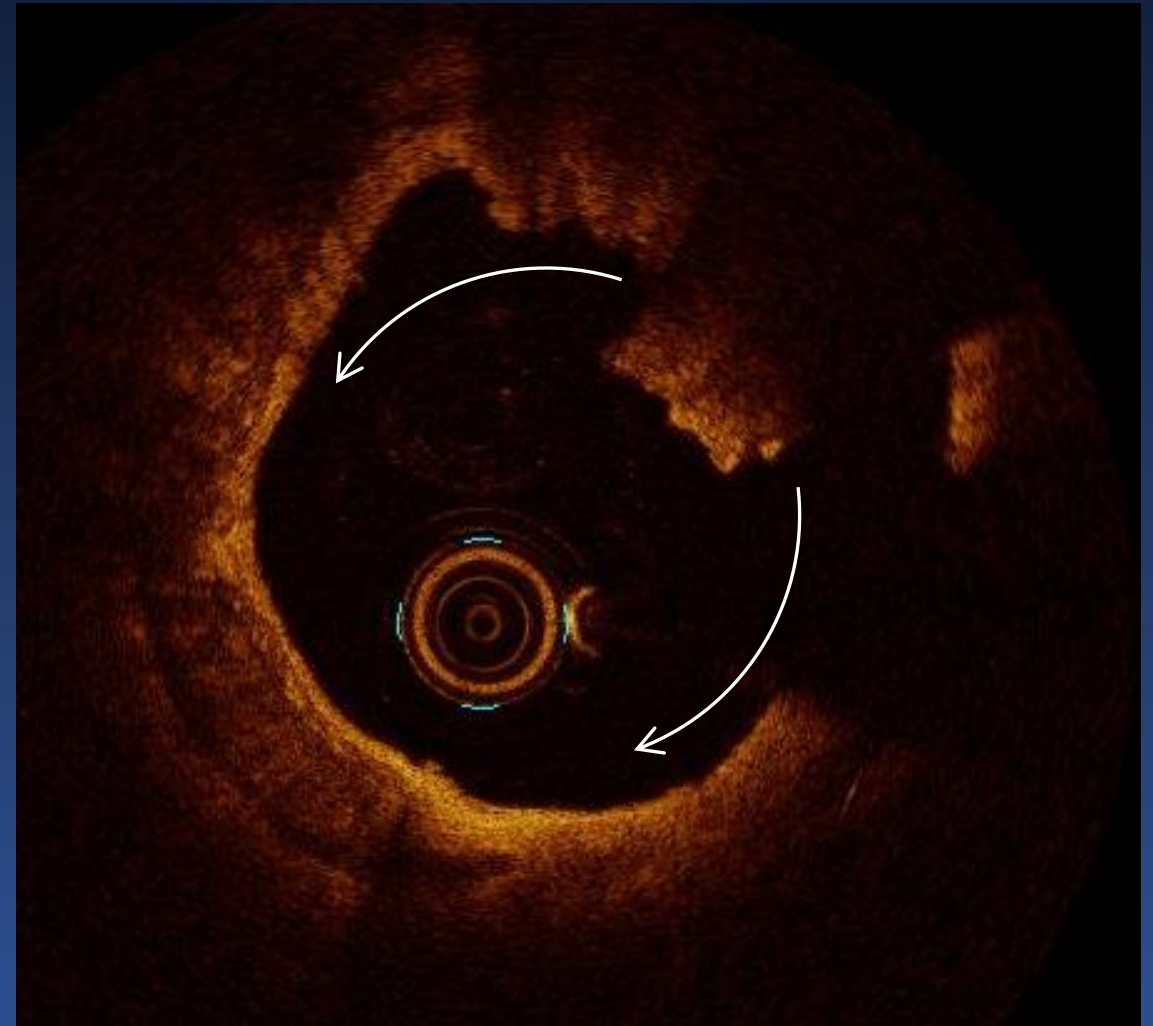


Disruption (Re-distribution) of Eruptive CNs



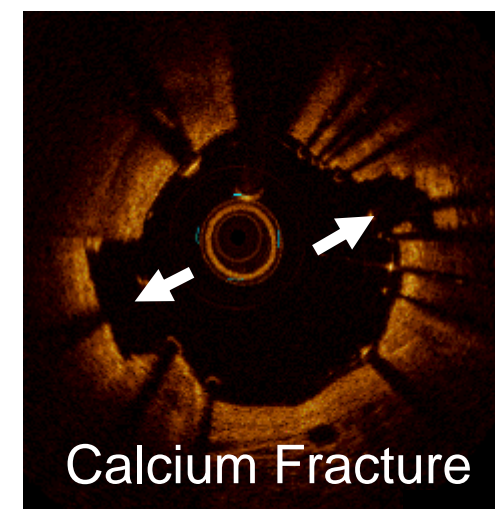
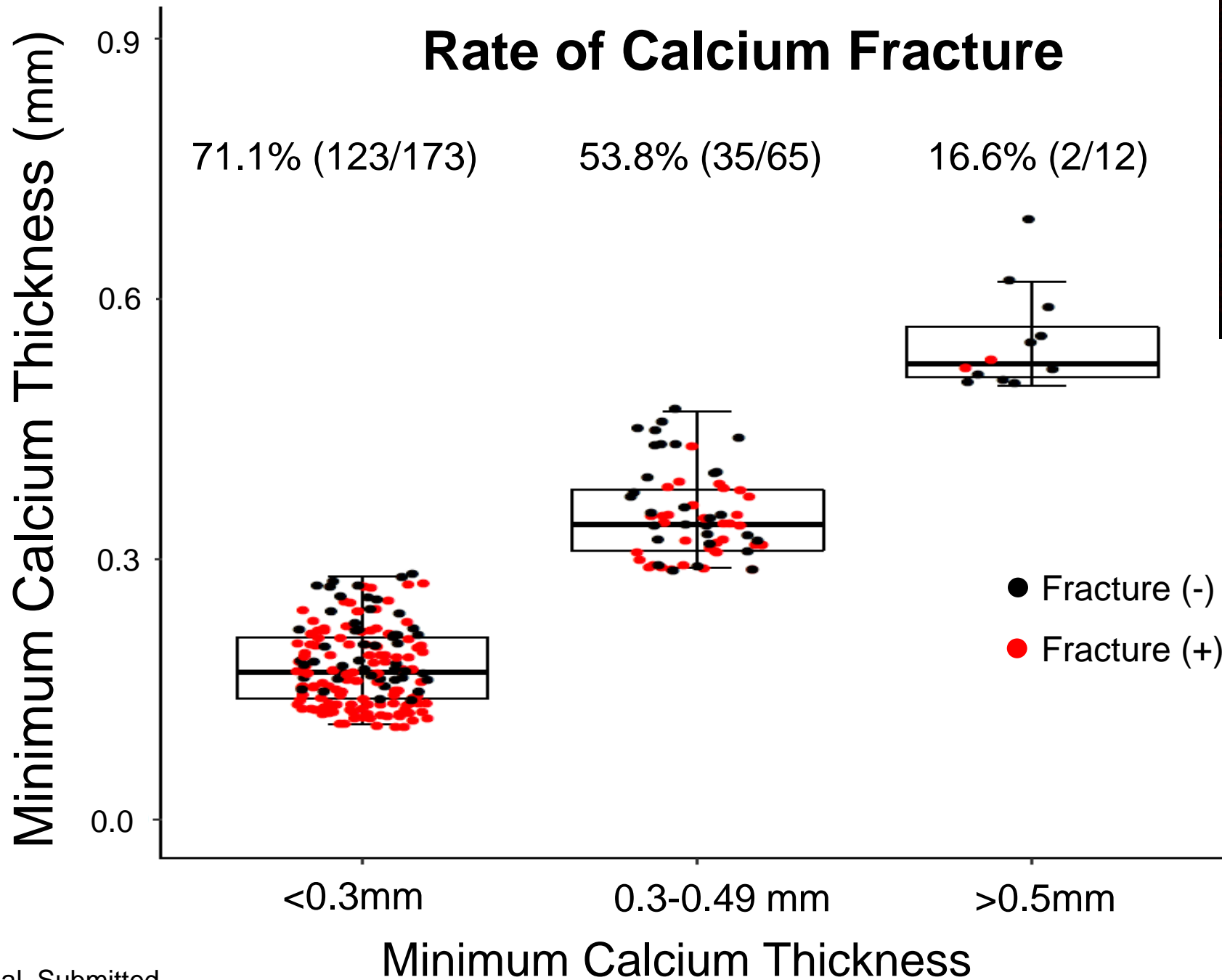
Median (Q1, Q3) 0.33 (0.13, 0.58)

0.03 (-0.02, 0.11)



Better Stent Expansion in Eruptive CNs than non-Eruptive CN

	Regression coefficient (95% CI)	p value
Eruptive-CN vs. Non-eruptive CN (reference)	9.7 (4.0, 15.5)	0.001
Circumference of CN (mm)	-5.7 (-10.6, -0.8)	0.02
Surrounding calcium arc at CN site (per 90°)	-5.3 (-9.8, -0.1)	0.02
Minimum calcium thickness within non-CN site (mm)	-16.1 (-32.4, 0.1)	0.04
Negative remodeling at CN site	-9.3 (-16.6, -2.0)	0.01
Pre-PCI minimum lumen area at CN site (mm ²)	1.3 (-0.1, 2.9)	0.08
The use of orbital atherectomy, rotablator, or lithotripsy	4.6 (-1.3, 10.6)	0.10
Balloon/artery ratio	14.7 (-7.2, 36.6)	0.19
Maximum balloon pressure (atm)	0.1 (-0.7, 0.9)	0.79



Angiographic Calcium?

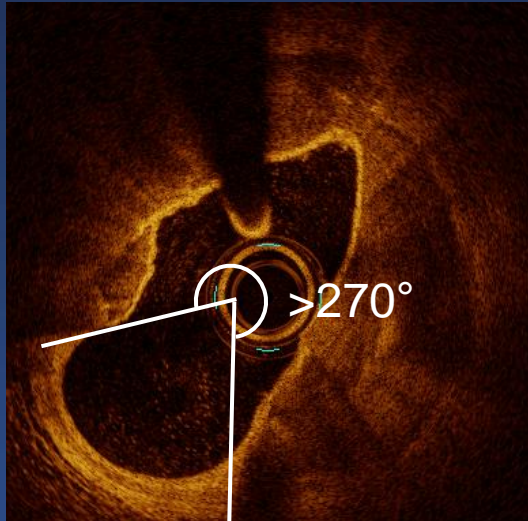
Yes ↓

OCT: Maximum Superficial Calcium >270°?

Yes ↓

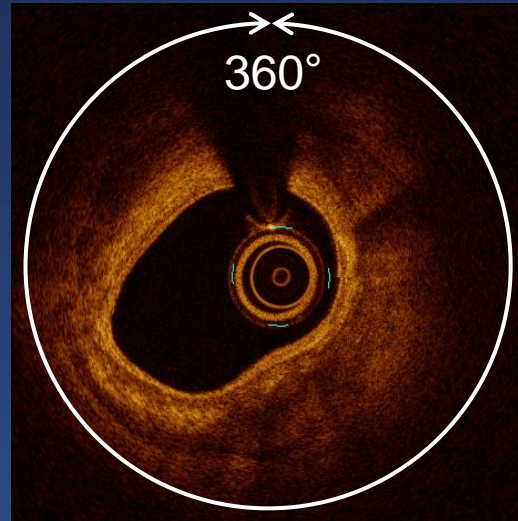
OCT Calcium Score

Calcium >270°
that was ≥3mm in Length



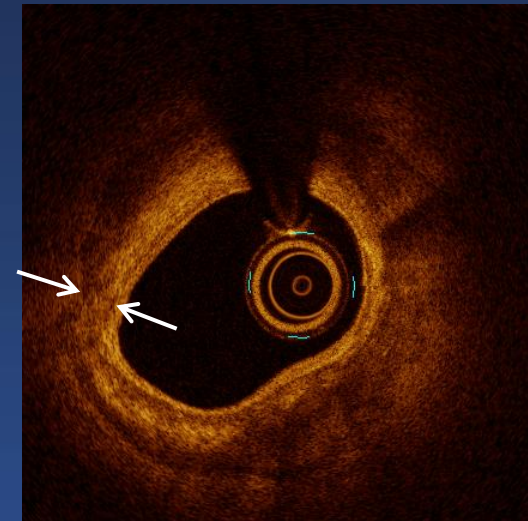
Yes=1, No=0

360° of Calcium



Yes=1, No=0

Minimum Calcium
Thickness >0.3mm



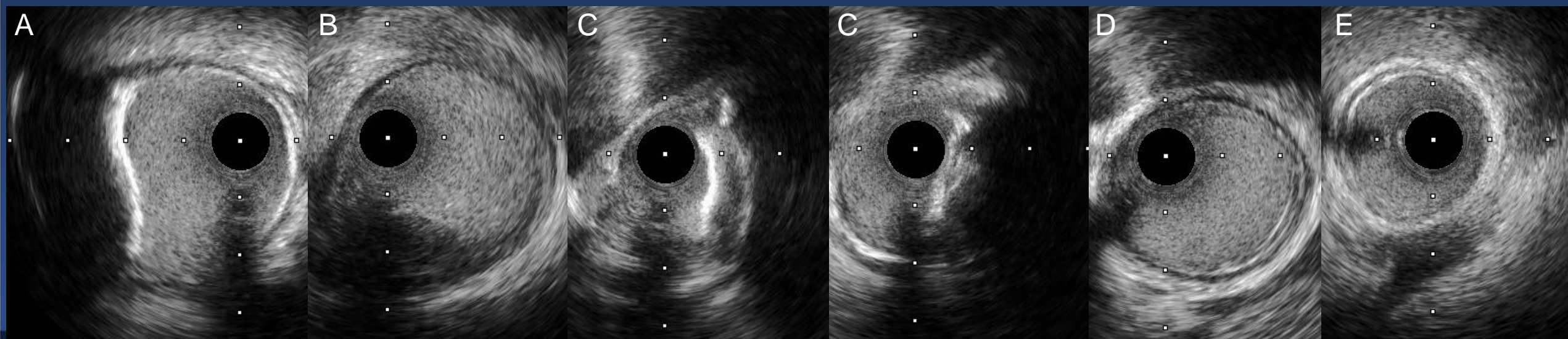
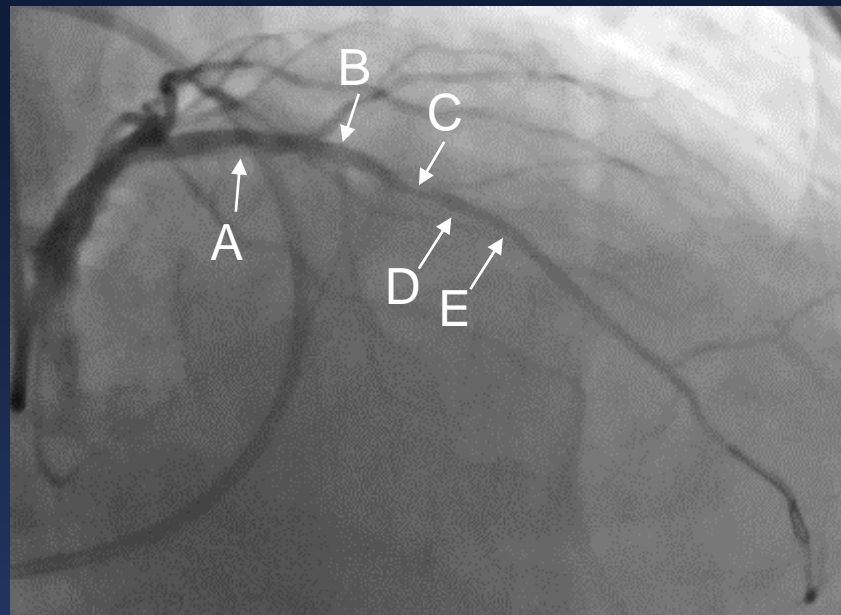
Yes=1, No=0



OCT Calcium Score = 2 or 3 ? If yes, consider calcium modification

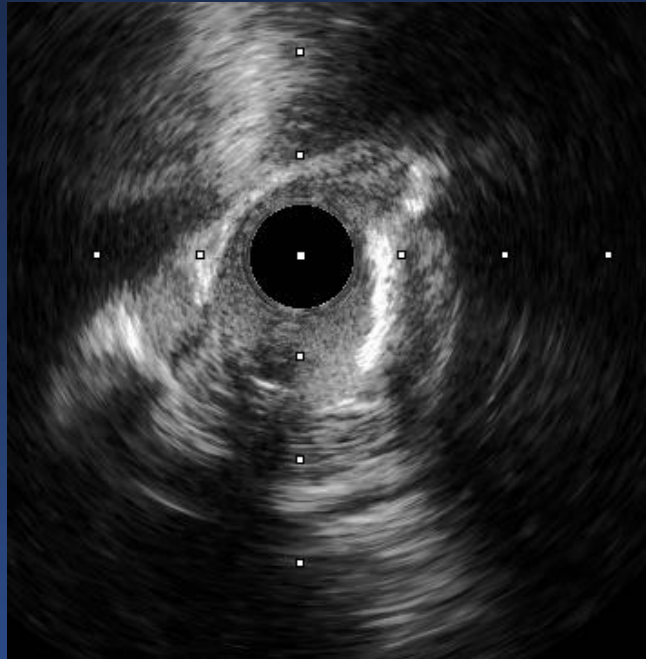
Sato T et al. Submitted

Eccentric nodular calcium with negative remodeling

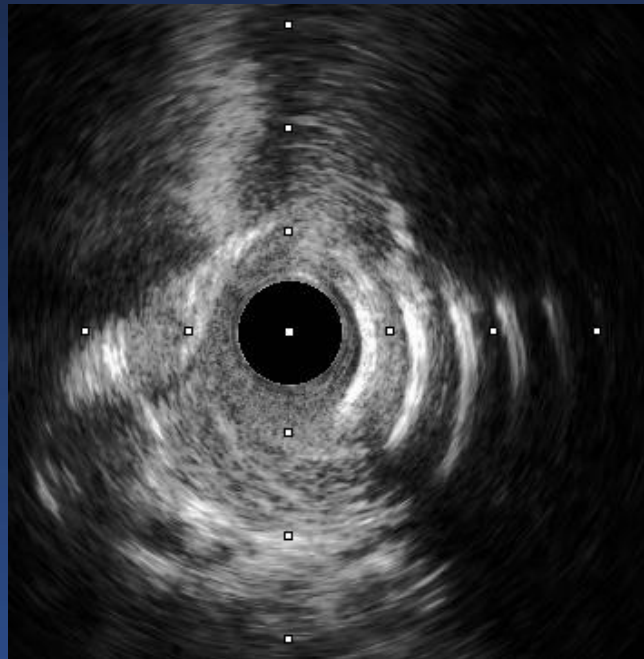


Change of Lesion Morphology

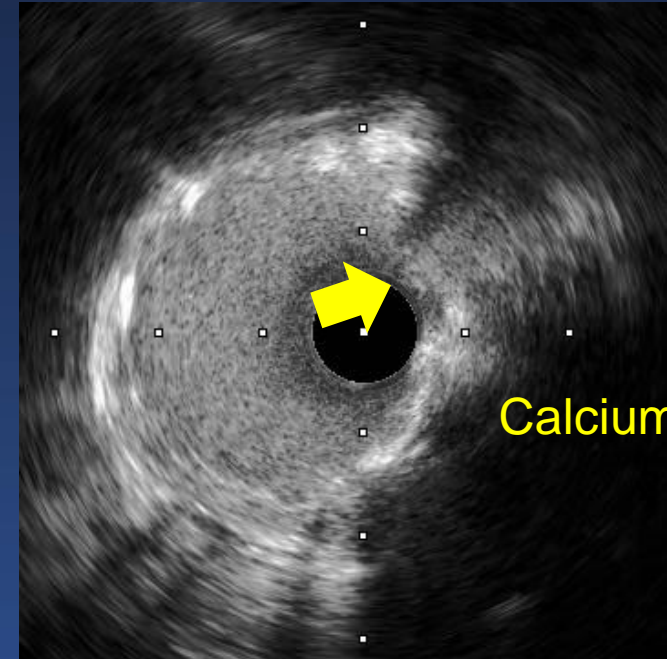
Pre-PCI



Post-OAS



Post-Stent



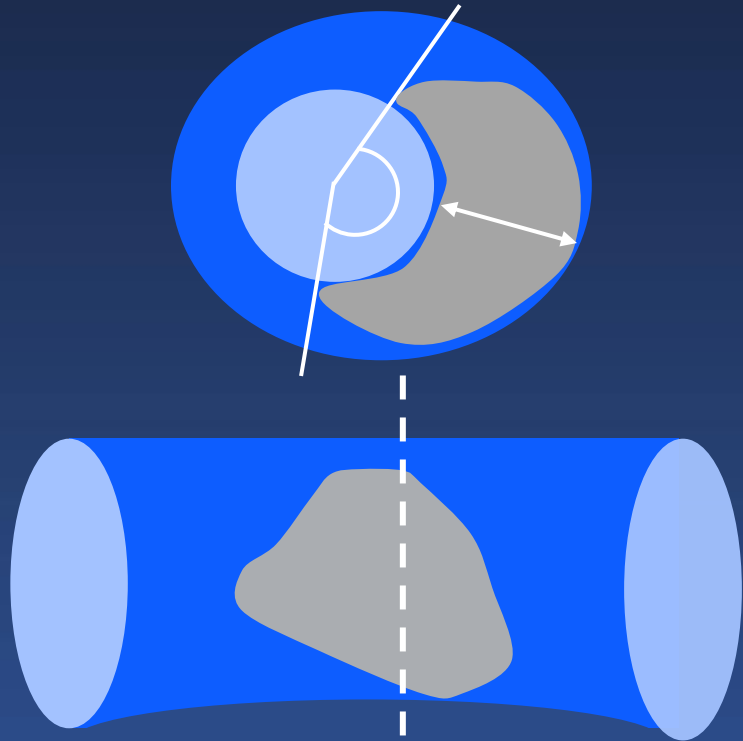
Calcium Fracture

Minimum Stent Area=7.2mm²

Factors for Stent Underexpansion

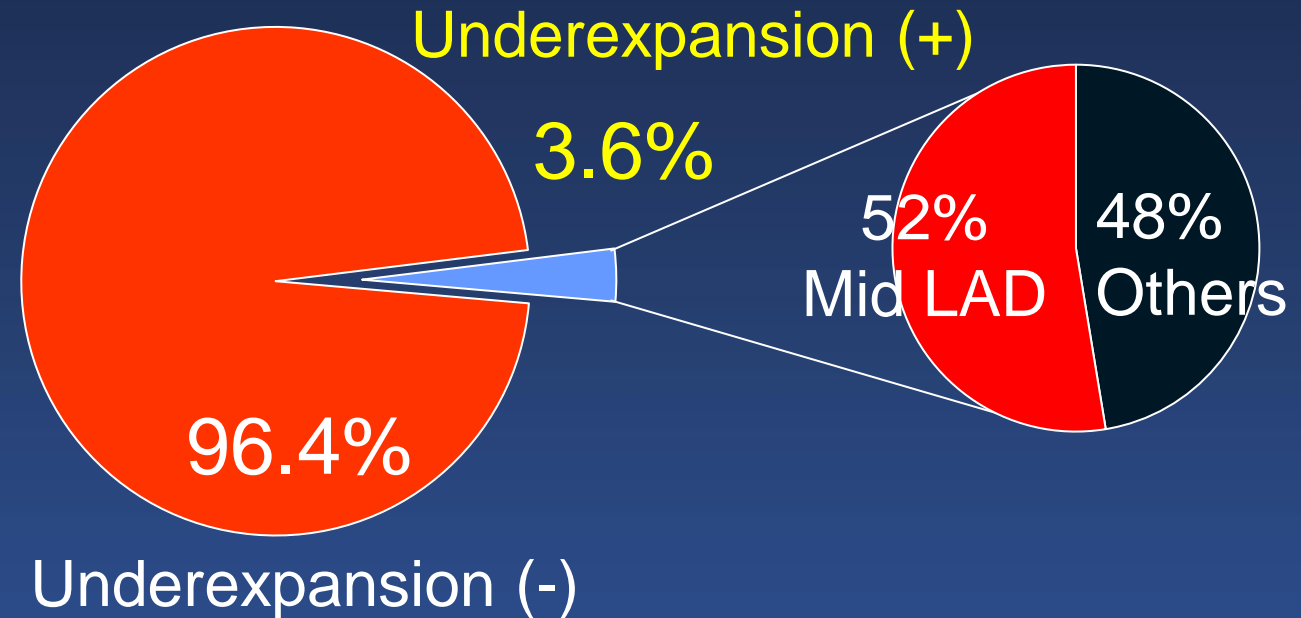
in none/mild calcified lesions, calcium arc <math><180^\circ</math>

Large and Thick Eccentric Calcium



Negative Remodeling

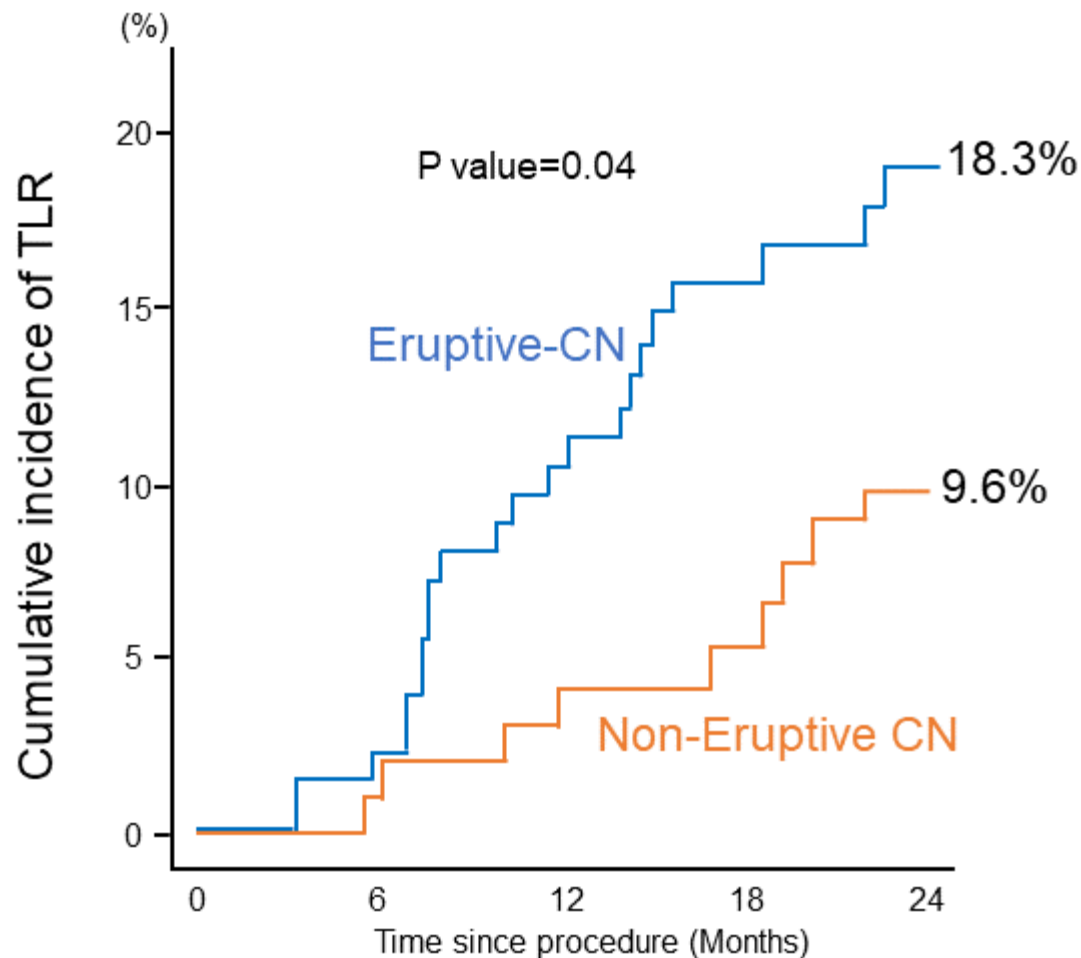
Mid LAD Location



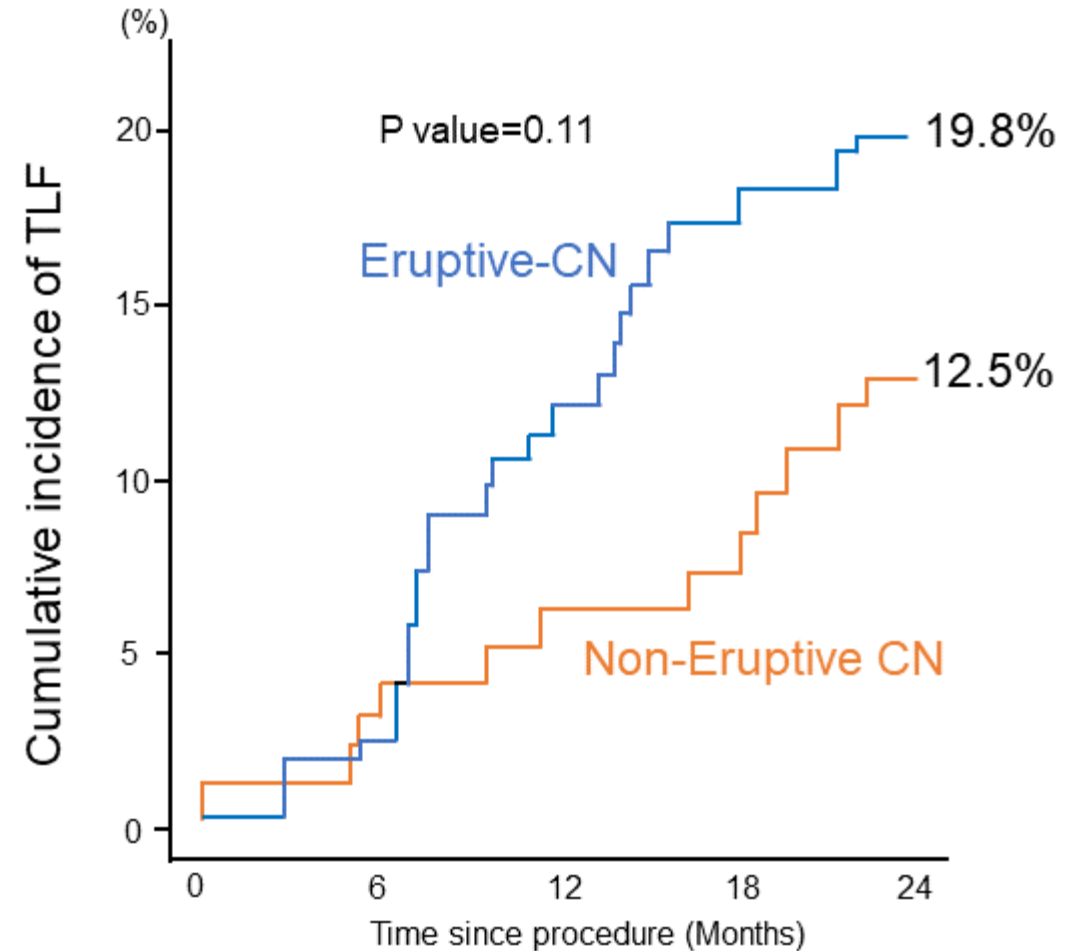
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Worse Post-PCI Outcome in Eruptive CN



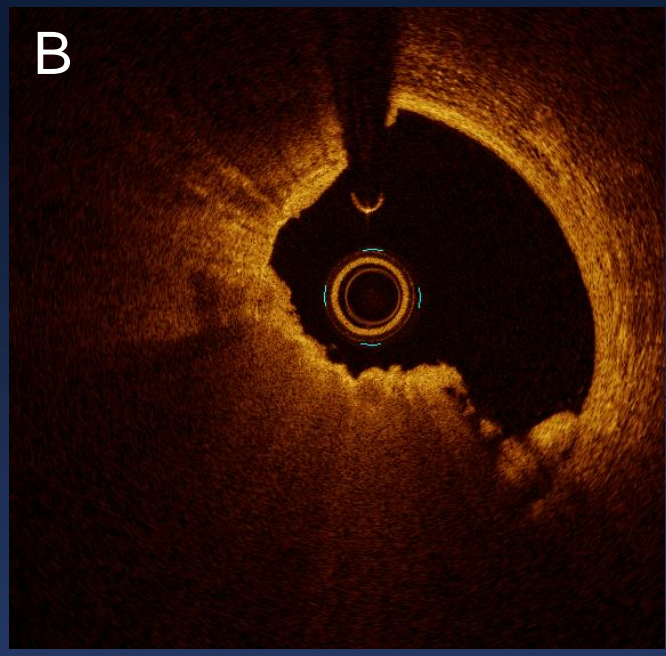
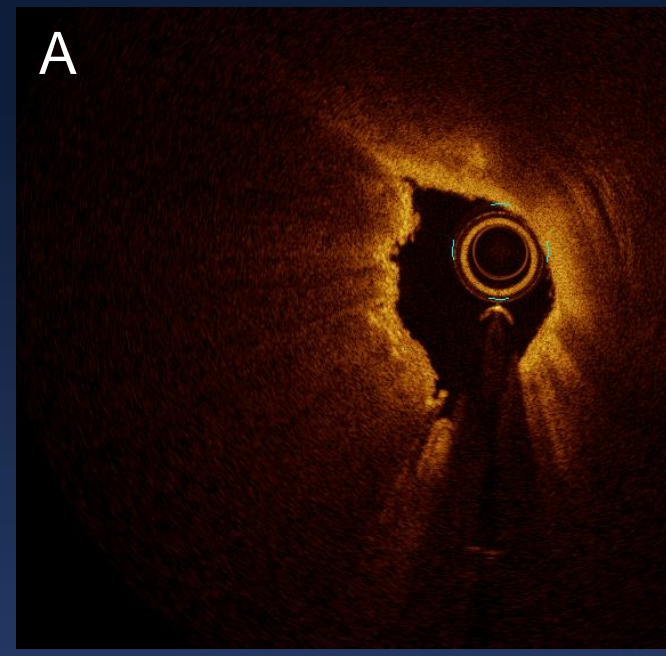
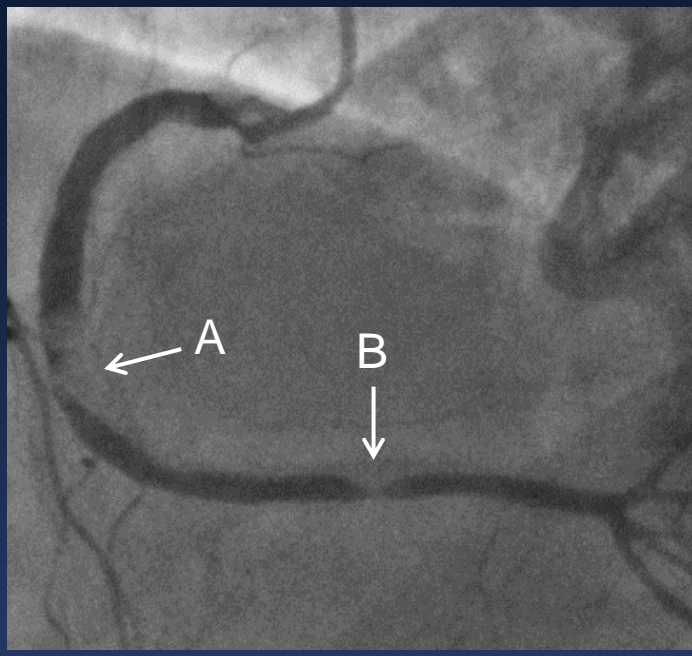
Number at risk:		0	6	12	18	24
Eruptive-CN	126	120	101	81	61	
Non-Eruptive CN	104	101	91	73	58	



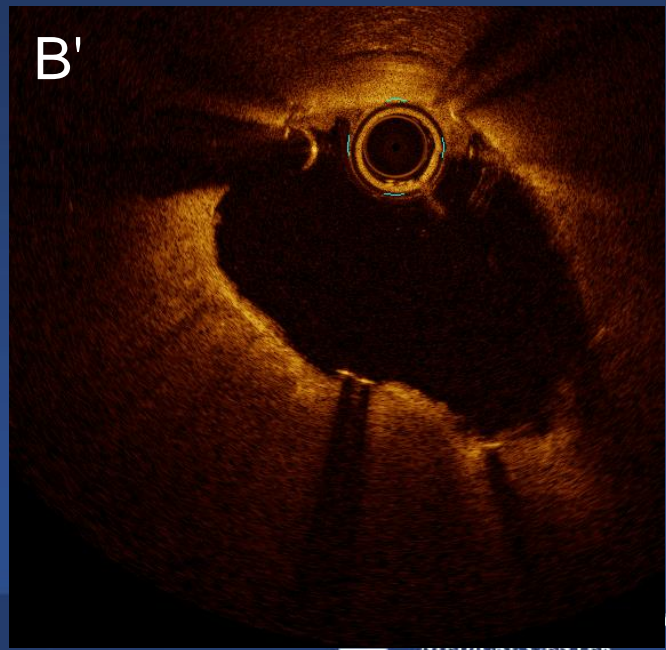
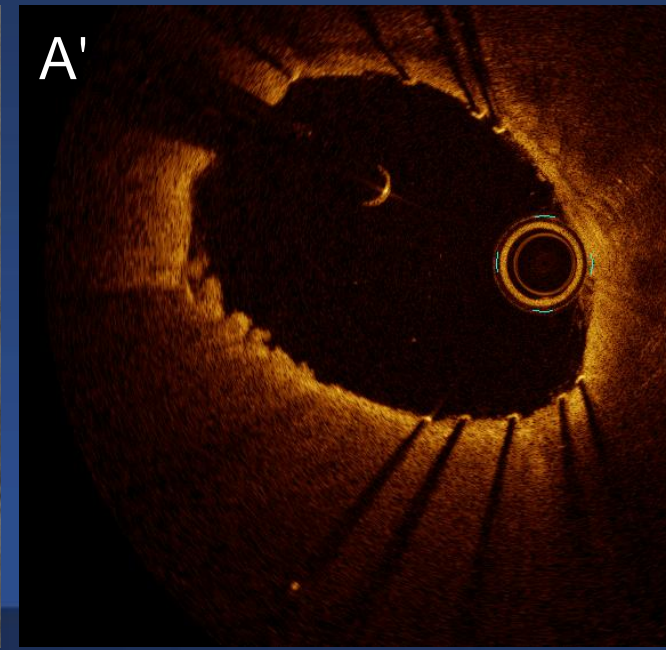
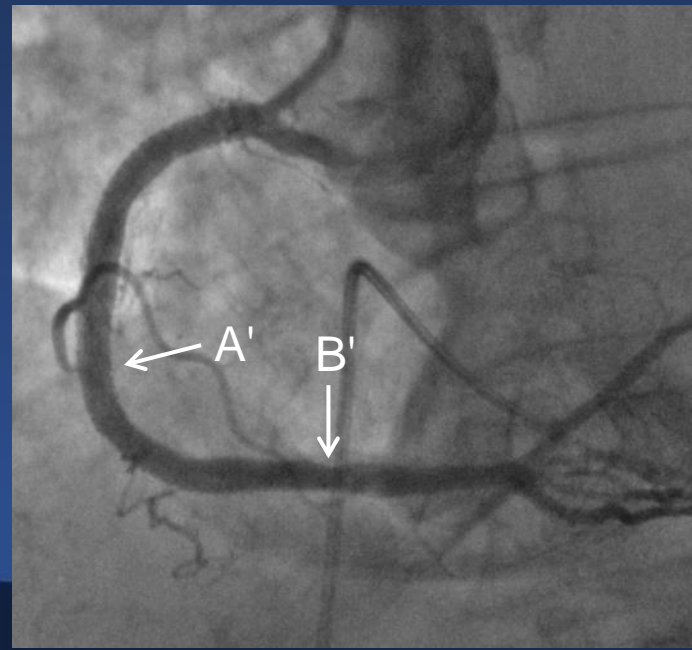
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Index Procedure

Pre-PCI

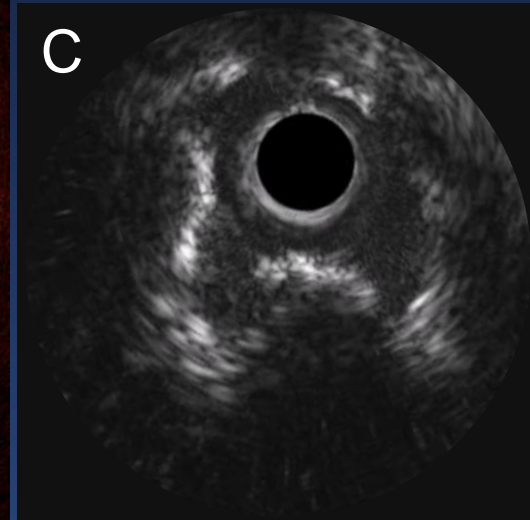
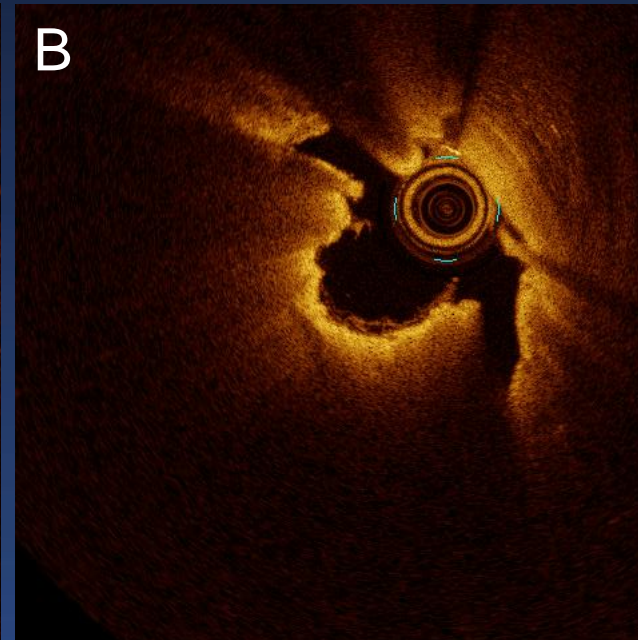
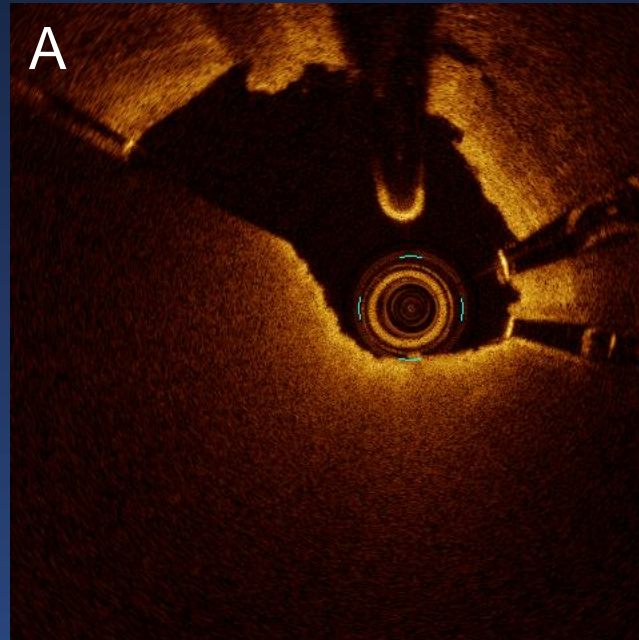
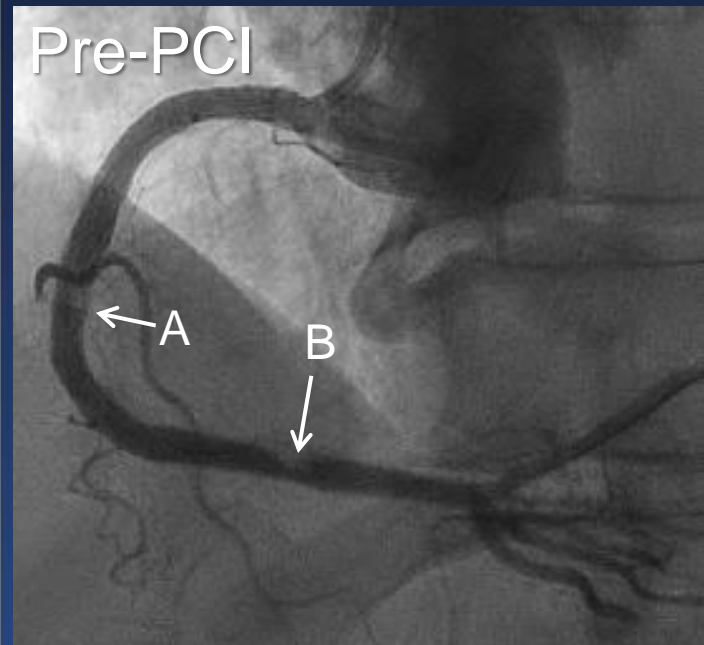


Post-PCI



Recurrent CN

5 weeks later during staged procedure for LAD



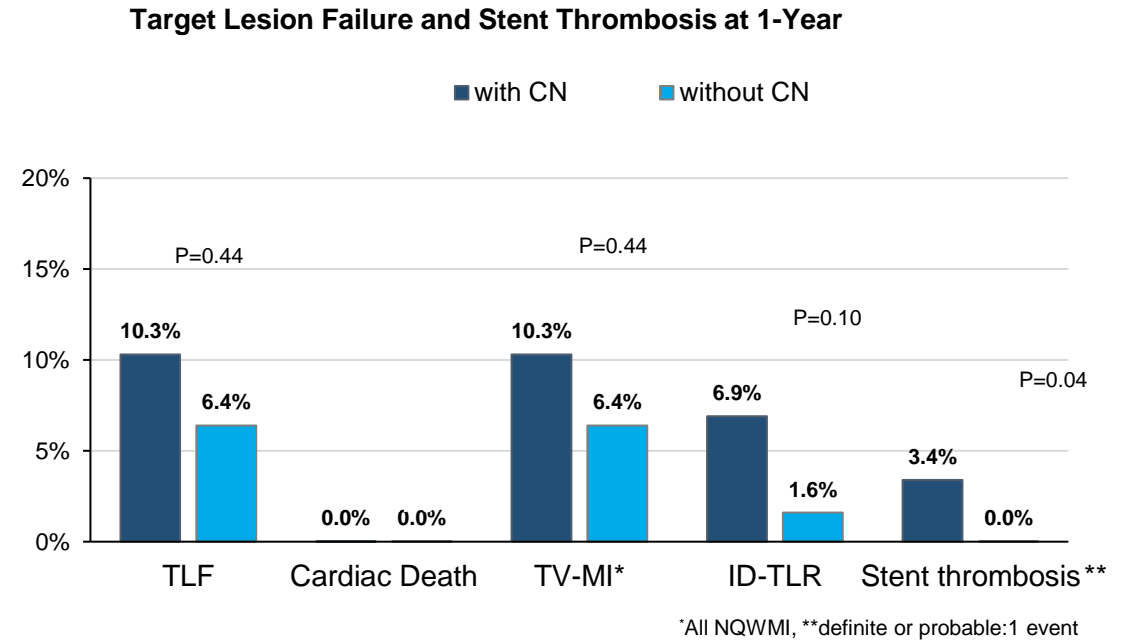
Factors Associated with 2-Year TLF

	HR (95% CI)	p value
Eruptive CN vs noneruptive CN (reference)	2.07 (1.01, 4.50)	0.048
Circumference of CN, per mm	1.65 (1.01, 2.71)	0.047
Δ Angle in lesions, per 10°	2.43 (1.63, 3.63)	0.00001
Stent area at CN site, per mm ²	0.78 (0.63, 0.94)	0.009
Age, per 10 years	0.66 (0.42, 1.03)	0.07
Diabetes mellitus	1.40 (0.68, 2.89)	0.35
Chronic kidney disease	1.59 (0.65, 3.87)	0.30

IVL Nodular Outcomes Promising at One Year

Consistent Outcomes in Patients With or Without Nodules

Post-stent Outcomes Core lab adjudicated	+ CN N=26	- CN N=128	P-value
MLA, mm ²	6.5 ± 2.0	6.2 ± 1.9	0.51
Area stenosis, %	21 ± 15	17 ± 21	0.34
MSA, mm ²	6.2 ± 2.0	6.1 ± 1.9	0.80
Stent expansion @max calcium site, %	98 ± 27	103 ± 30	0.54
Mean stent expansion, %	101 ± 18	107 ± 31	0.59
Any malapposition strut, %	4.6 ± 3.3	3.3 ± 4.2	0.006



Summary

- 1. Stent implantation deformed an eruptive CN more than a noneruptive CN.**
- 2. Non-eruptive CN, greater CN, greater surrounding calcium, negative remodeling were associated with poor stent expansion**
- 3. TLR increased at 6 months post-PCI in the eruptive CN group than non-eruptive CN group.**
- 4. An eruptive CN, greater CN, greater hinge motion, small stent area were associated with worse 2- year TLF.**