OCT vs. IVUS : When, How, Why?

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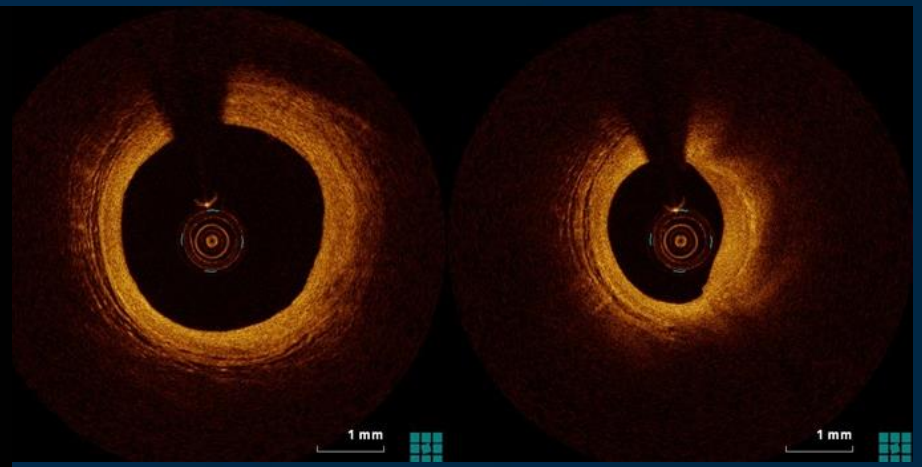
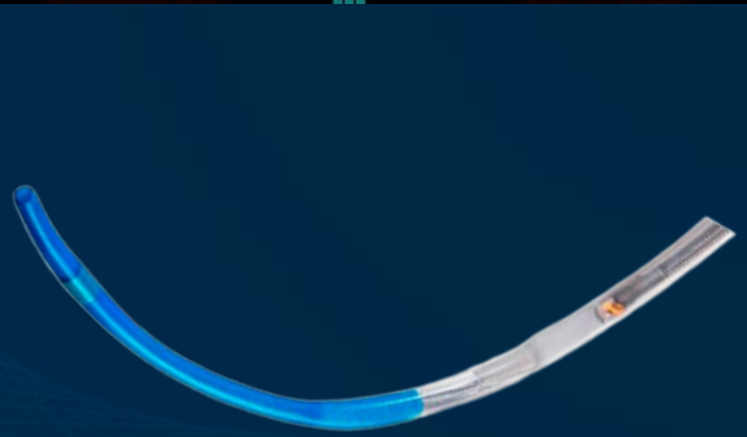
Disclosure

- I, Do-Yoon Kang, DO NOT have a conflict of interest related to this presentation.

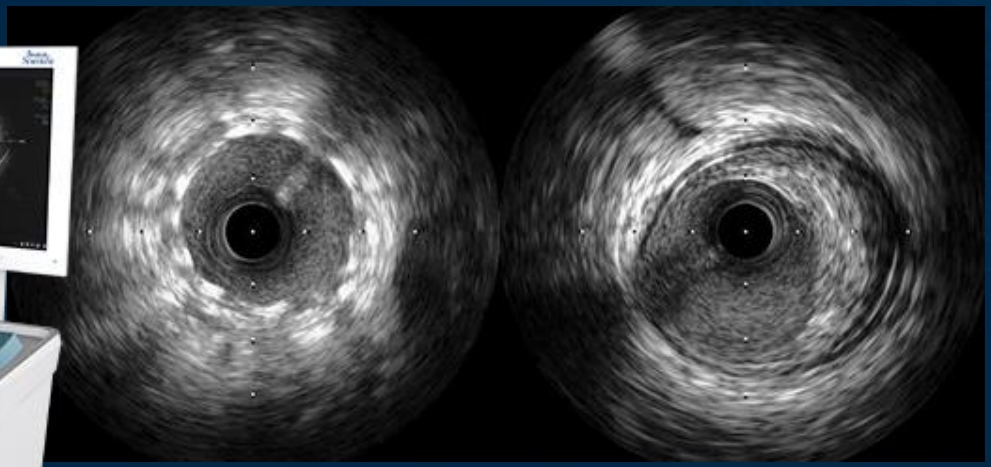
Intracoronary Imaging for PCI Guidance

Optical Coherent Tomography





Intravascular Ultrasound



2021 ACC/AHA PCI Guideline for Intracoronary Imaging

	COR	LOE
➢ In patients undergoing coronary stent implantation, IVUS can be useful for procedural guidance, particularly in cases of left main or complex coronary artery stenting, to reduce ischemic events	IIa	B-R
➢ In patients undergoing coronary stent implantation, OCT is a reasonable alternative to IVUS for procedural guidance, except in ostial left main disease	IIa	B-R
➢ In patients with stent failure, IVUS or OCT is reasonable to determine the mechanism of stent failure	IIa	C

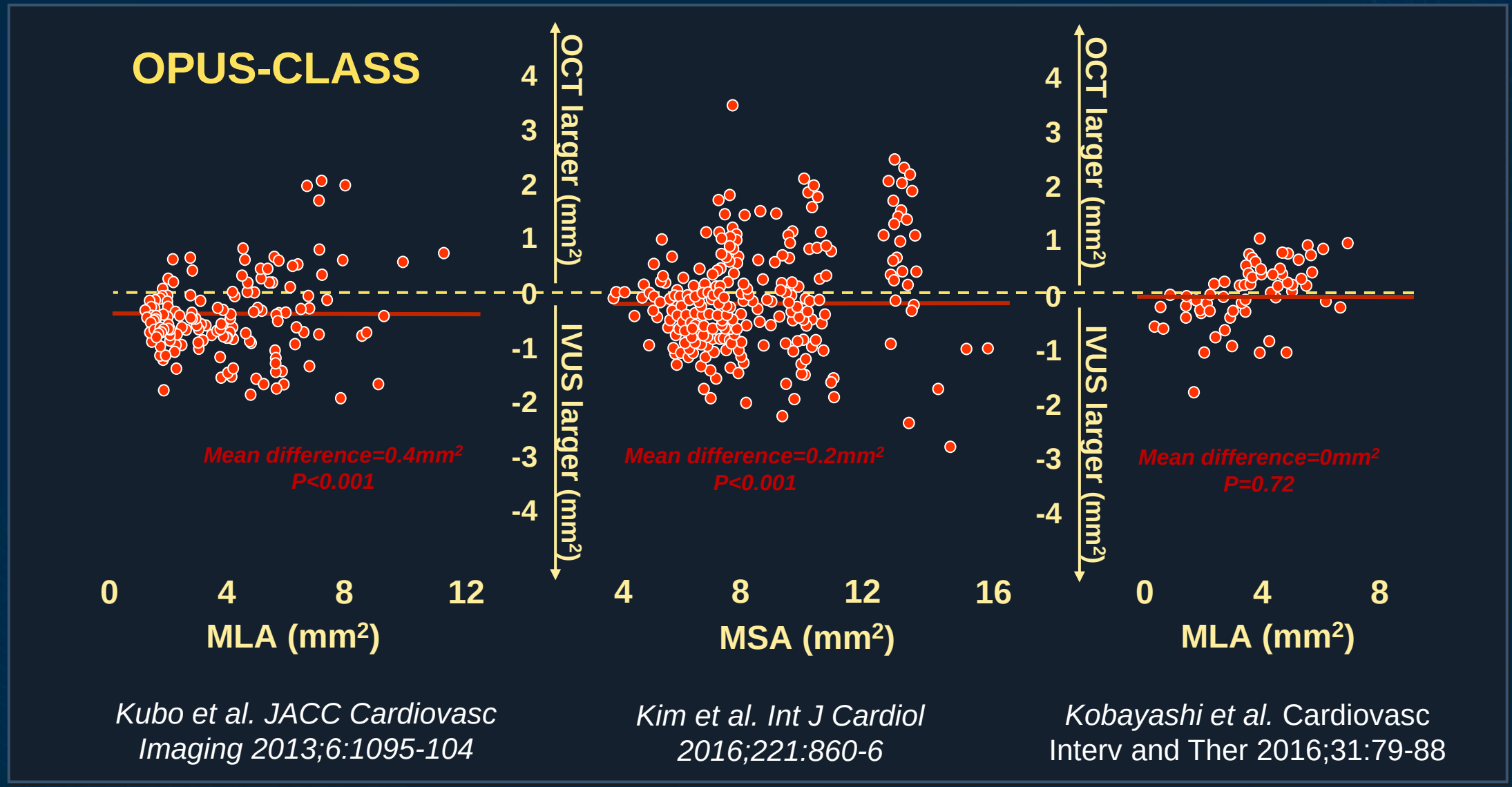
Lawton JS et al. JACC 2021.

OCT vs. IVUS

	OCT	IVUS
Wave source	Near-infrared light	Ultrasound
Axial resolution, μm	15-20	38-46
Penetration depth in soft tissue, mm	1-2	>5
Blood clearance	Needs Contrast	Not required
Plaque burden at lesion	-	+
Aorto-ostial visualization	-	+
Cross-sectional calcium evaluation	Thickness, Angle	Angle only
Lipidic plaque evaluation	Lipidic plaque, Cap thickness	Attenuated plaque

Maehara A et al., J Am Coll Cardiol Img 2017;10:1487-503
Koganti S et al., Interv Cardiol 2016;11:11-16

In vivo comparison of OCT vs IVUS



Kubo et al. JACC Cardiovasc Imaging 2013;6:1095-104

Kim et al. Int J Cardiol 2016;221:860-6

Kobayashi et al. Cardiovasc Interv and Ther 2016;31:79-88

Gary S. Mintz, presented at TCT 2017.

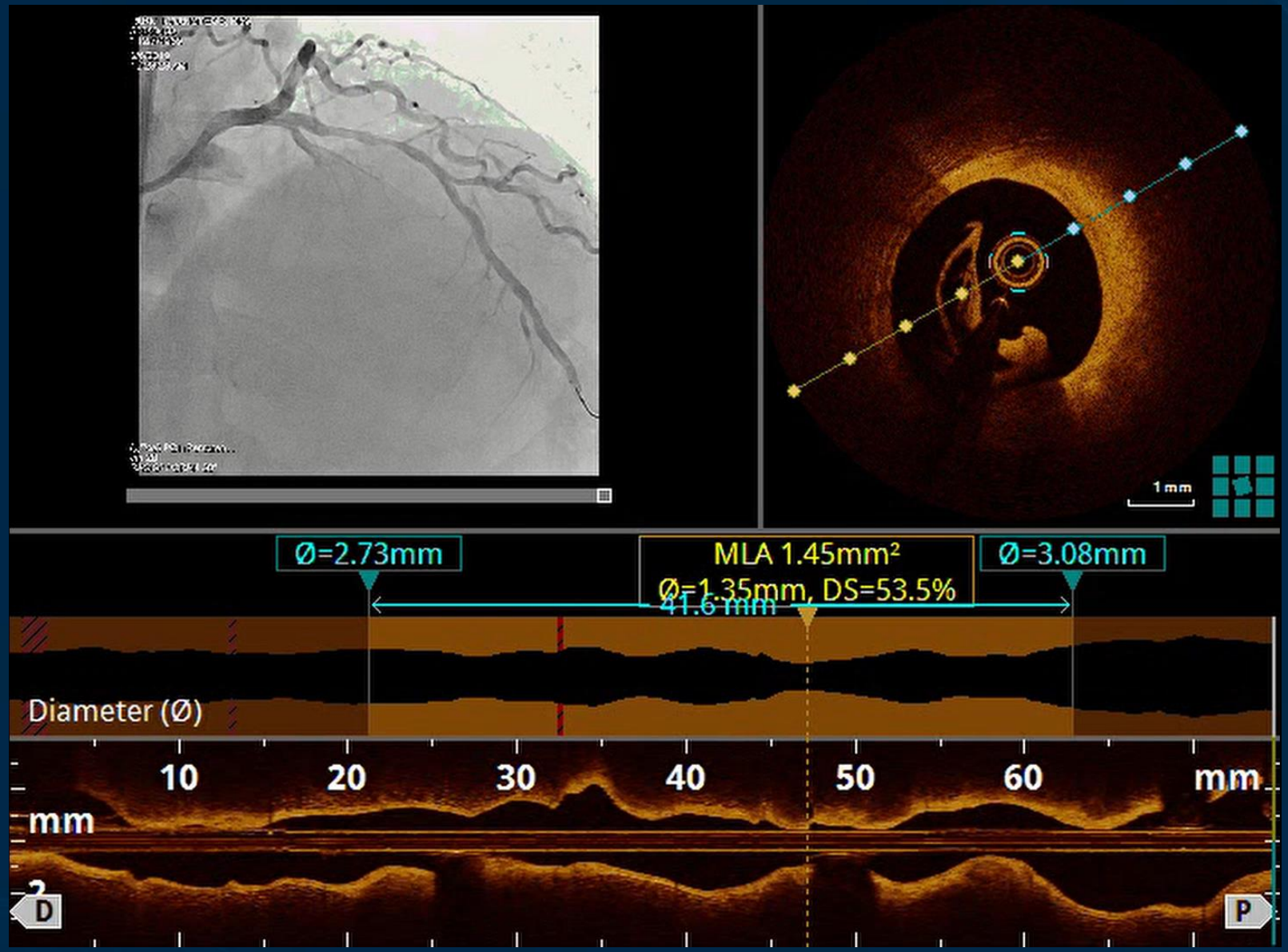
When is the OCT Better?

Better Spatial Resolution to Detect Acute Complication
Data from ILUMIEN III

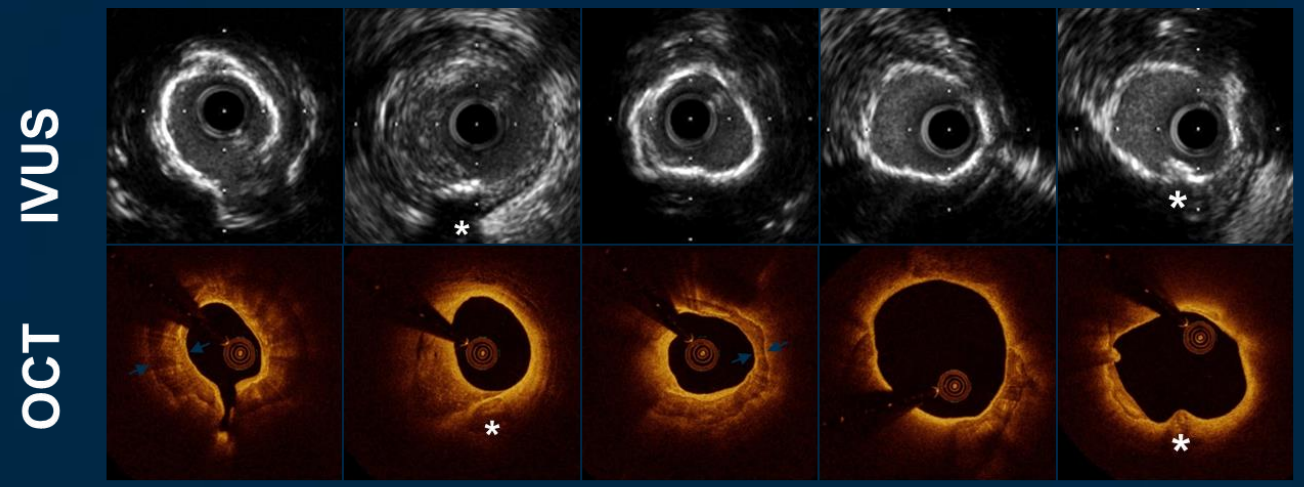
	OCT (n=140)	IVUS (n=135)	*P Value*
Dissection, any	28%	40%	0.04
Major	14%	26%	0.009
Minor	14%	13%	0.84
Malapposition, any	41%	38%	0.62
Major	11%	21%	0.02
Minor	31%	18%	0.01
Tissue Protrusion, any	67%	74%	0.21
Major	19%	20%	0.88
Minor	48%	54%	0.30

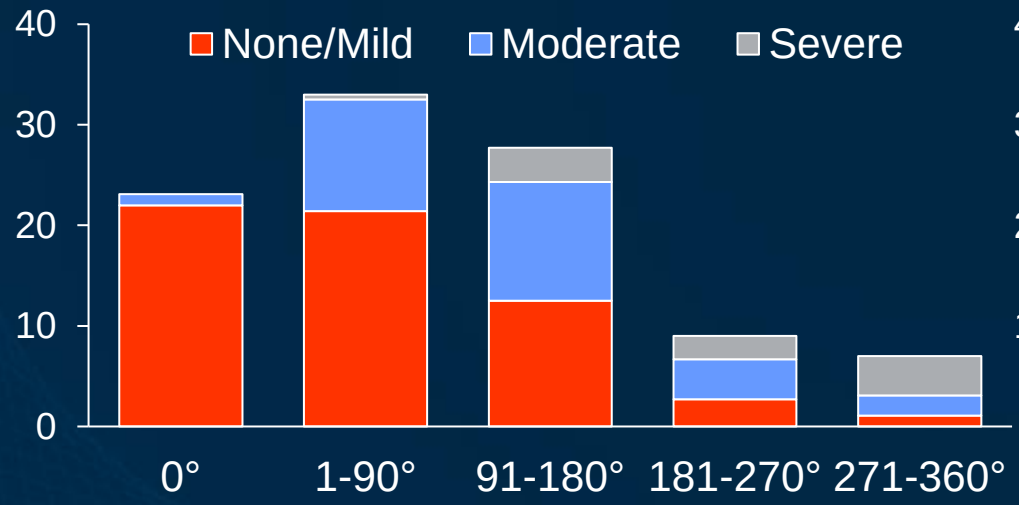
Ali ZA et al. Lancet 2016:388;2618-28

Faster Image Acquisition (74mm, <4 sec) with Co-registration

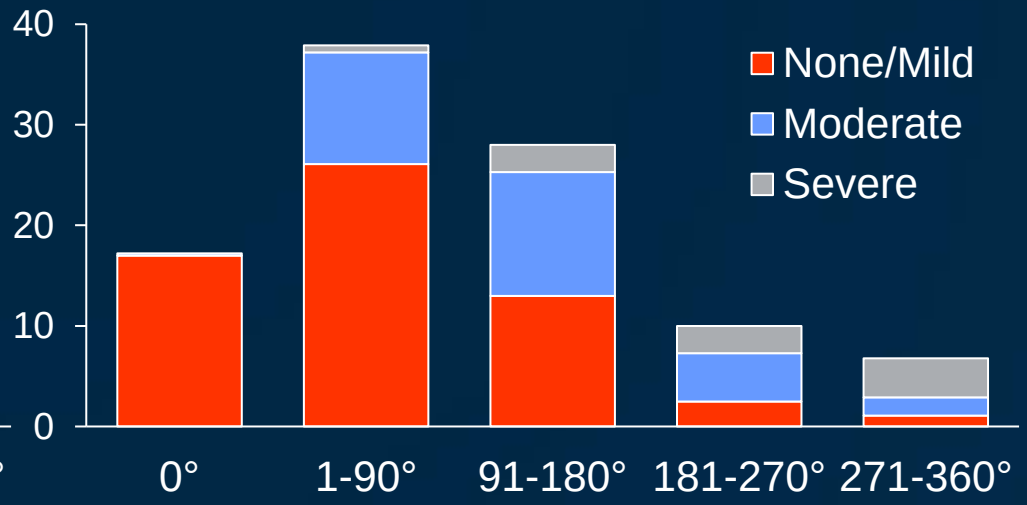


Visualization of Calcium with Thickness





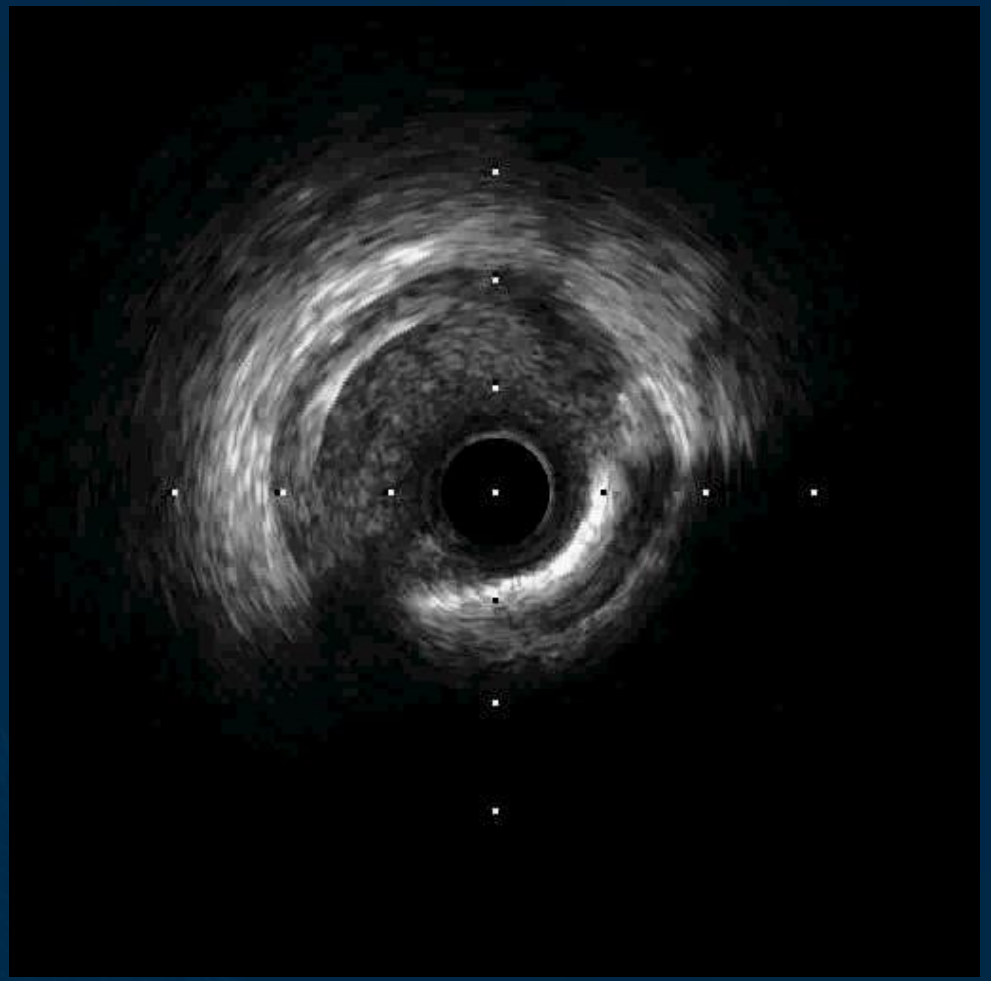
OCT Calcium

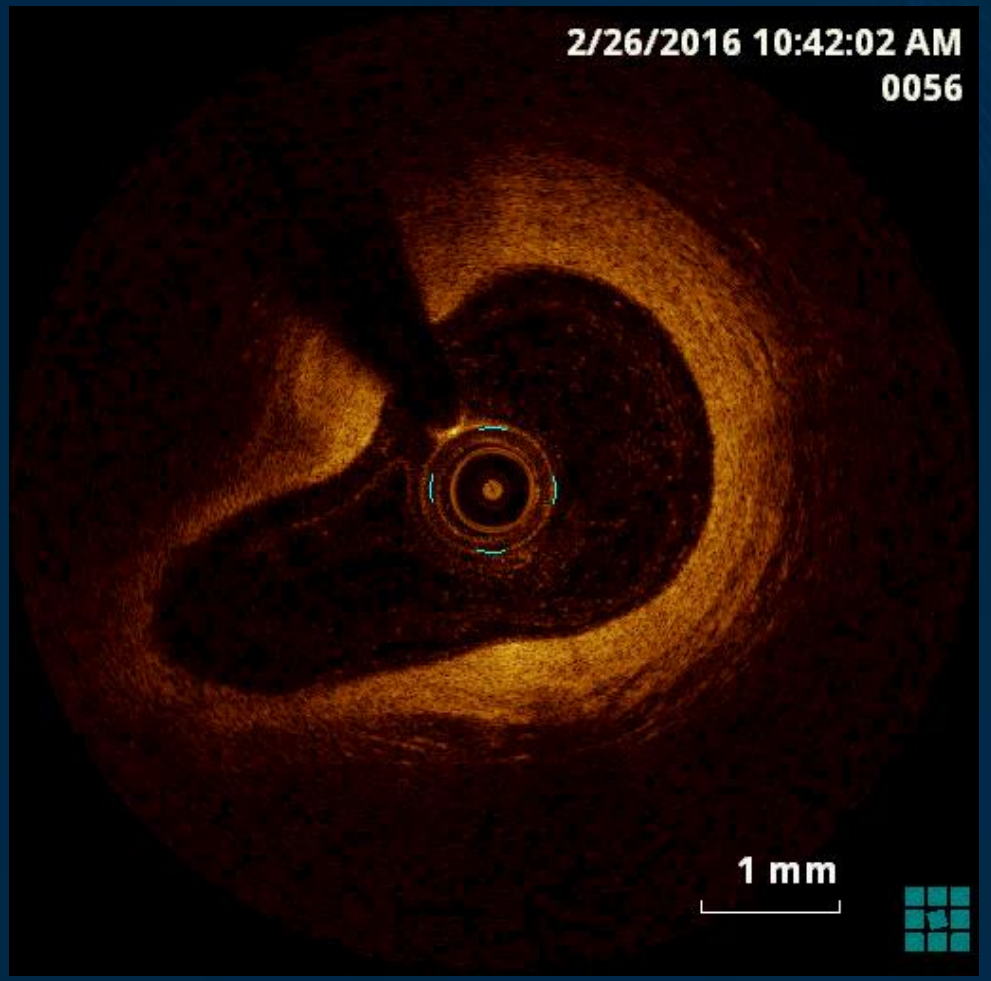


IVUS Calcium

Wang et al. JACC Cardiovasc Imaging 2017;10:869-79
Mintz G and Guagliumi. Lancet 2017;390:793-809

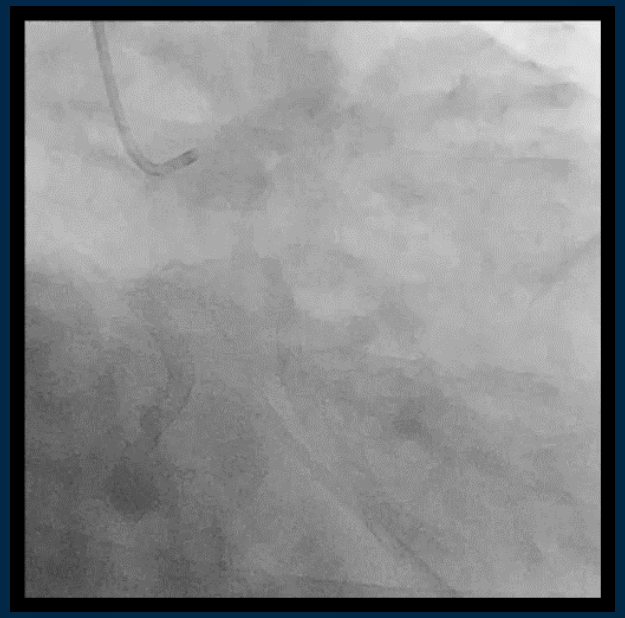
Visualization of Calcium with Thickness

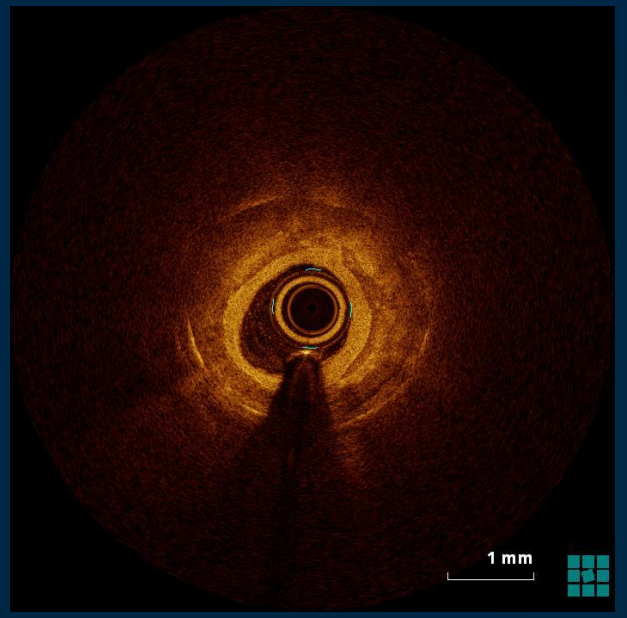


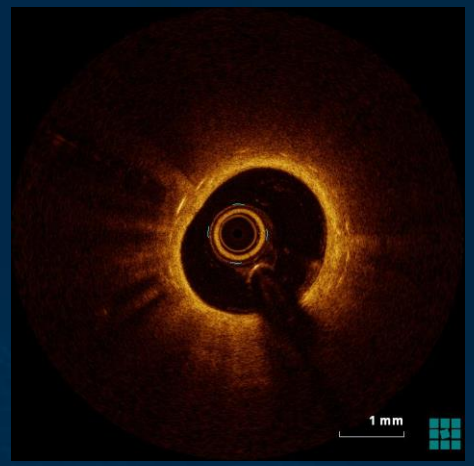


Visualization of In-stent Restenosis

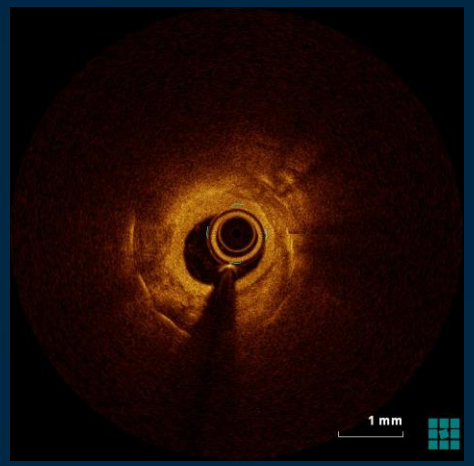
Especially in Calcified Neoatherosclerosis



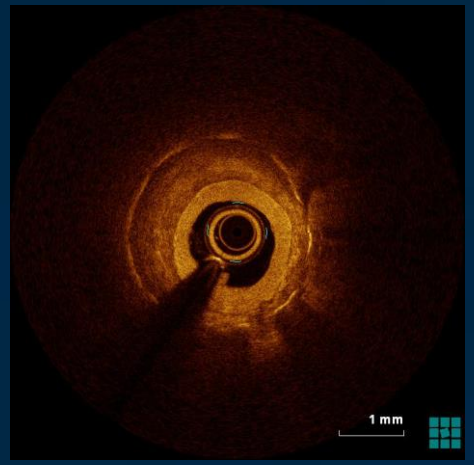




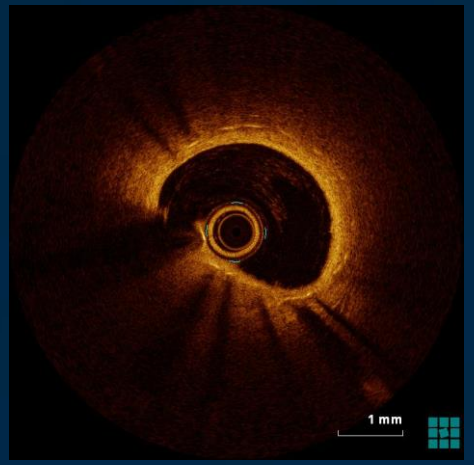
Distal reference



MLA: 1.13mm²



Lumen area: 1.35mm²

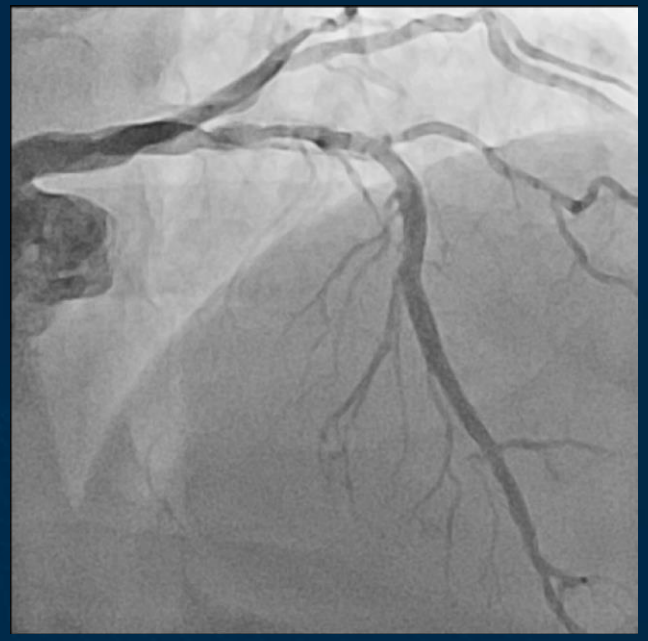


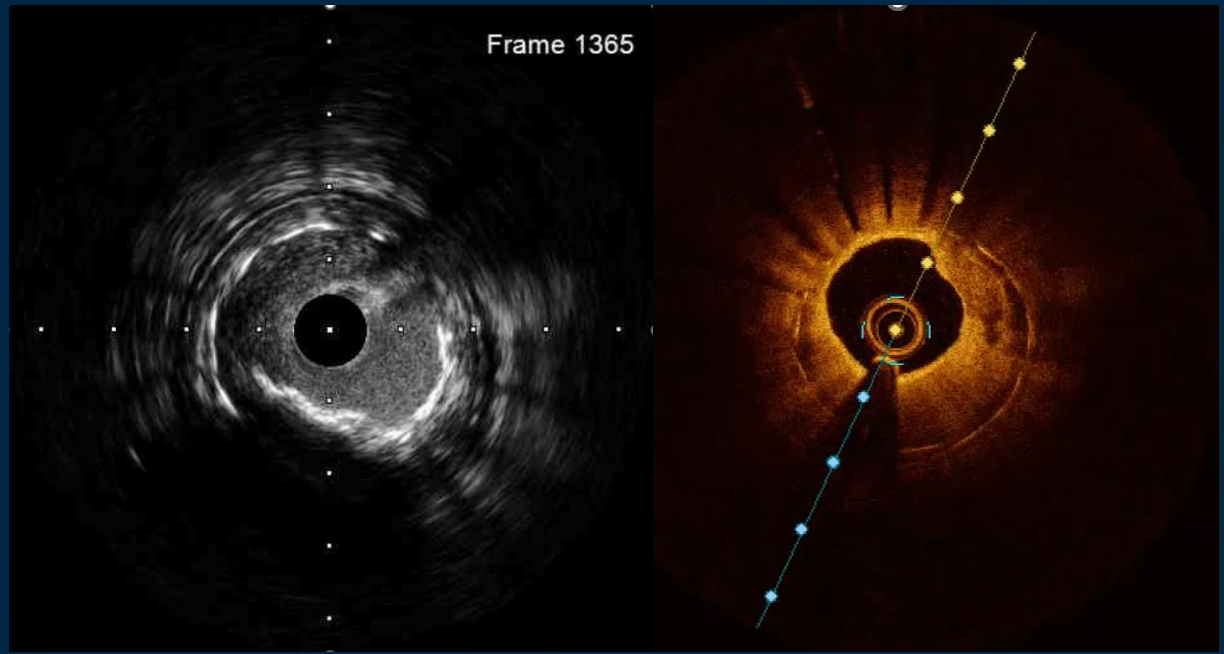
Proximal reference

Visualization of In-stent Restenosis

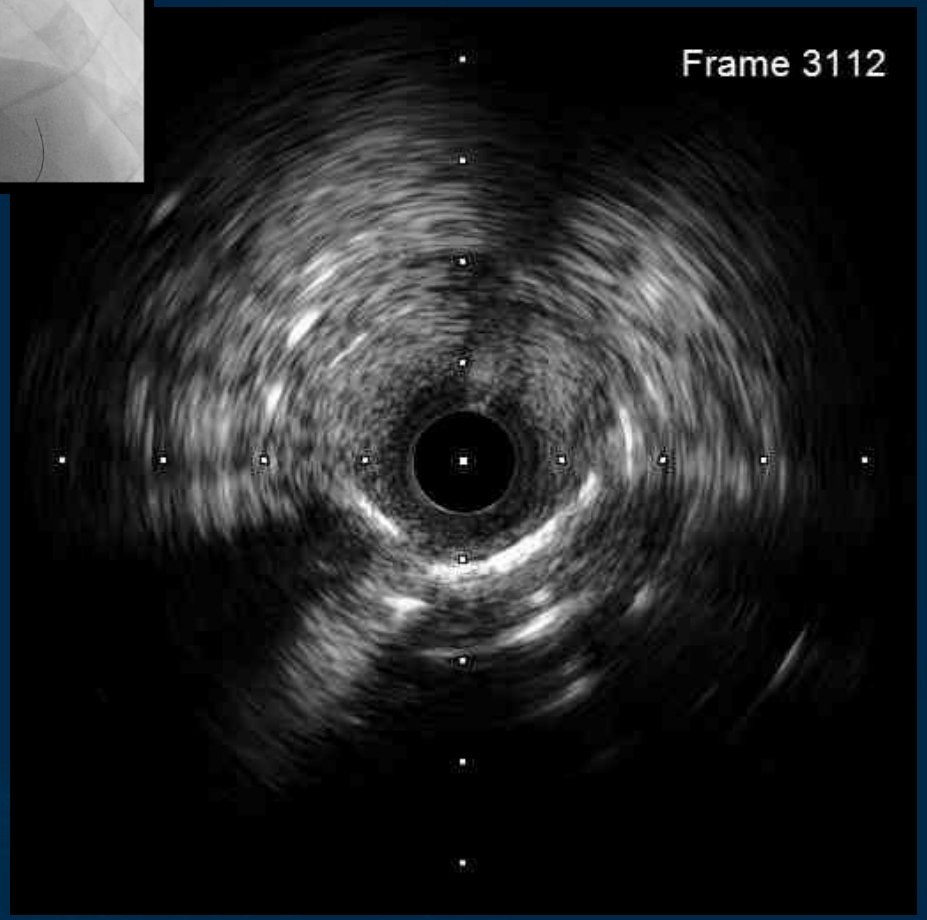
OCT can visualize in more detail,

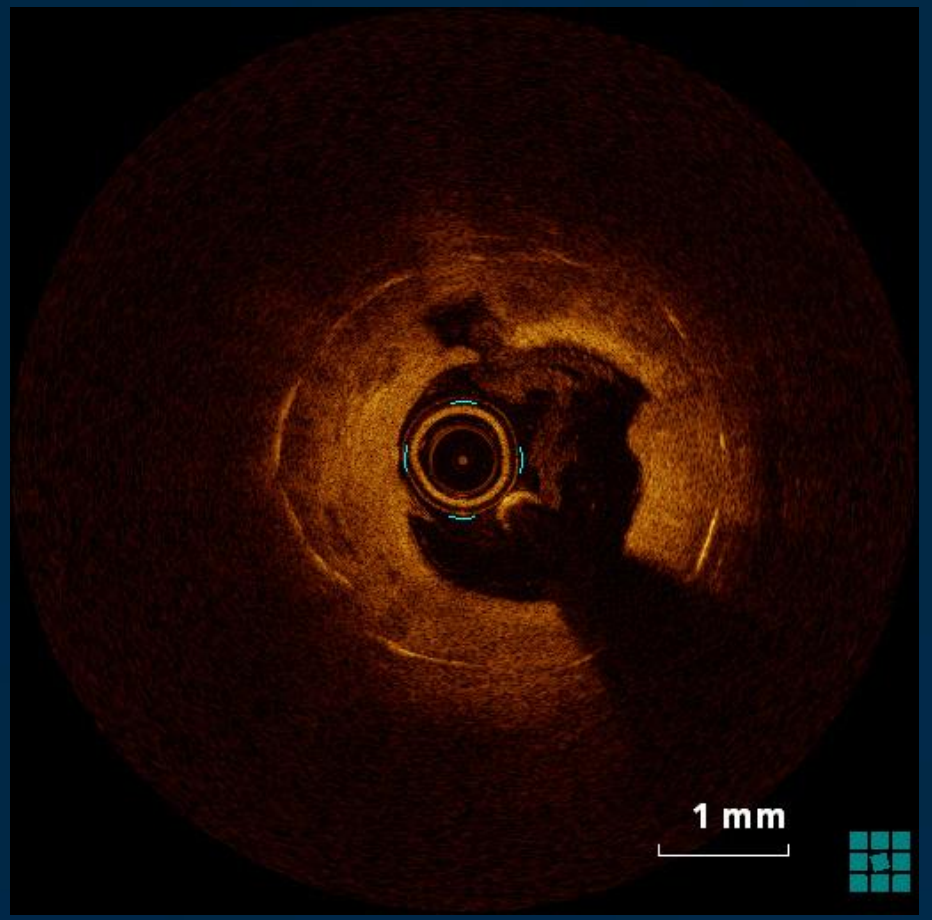
- Stent strut coverage,
- Discrimination between stent and calcium,
- In-stent dissection, edge problem, or other complications,
- Bioresorbable scaffold



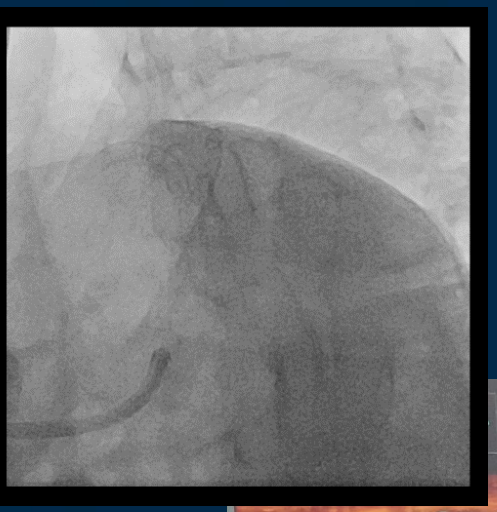


Visualization of In-stent Restenosis





Delicate Bifurcation PCI with 3D Image



From LAD

From Diagonal Branch

Is OCT Better?

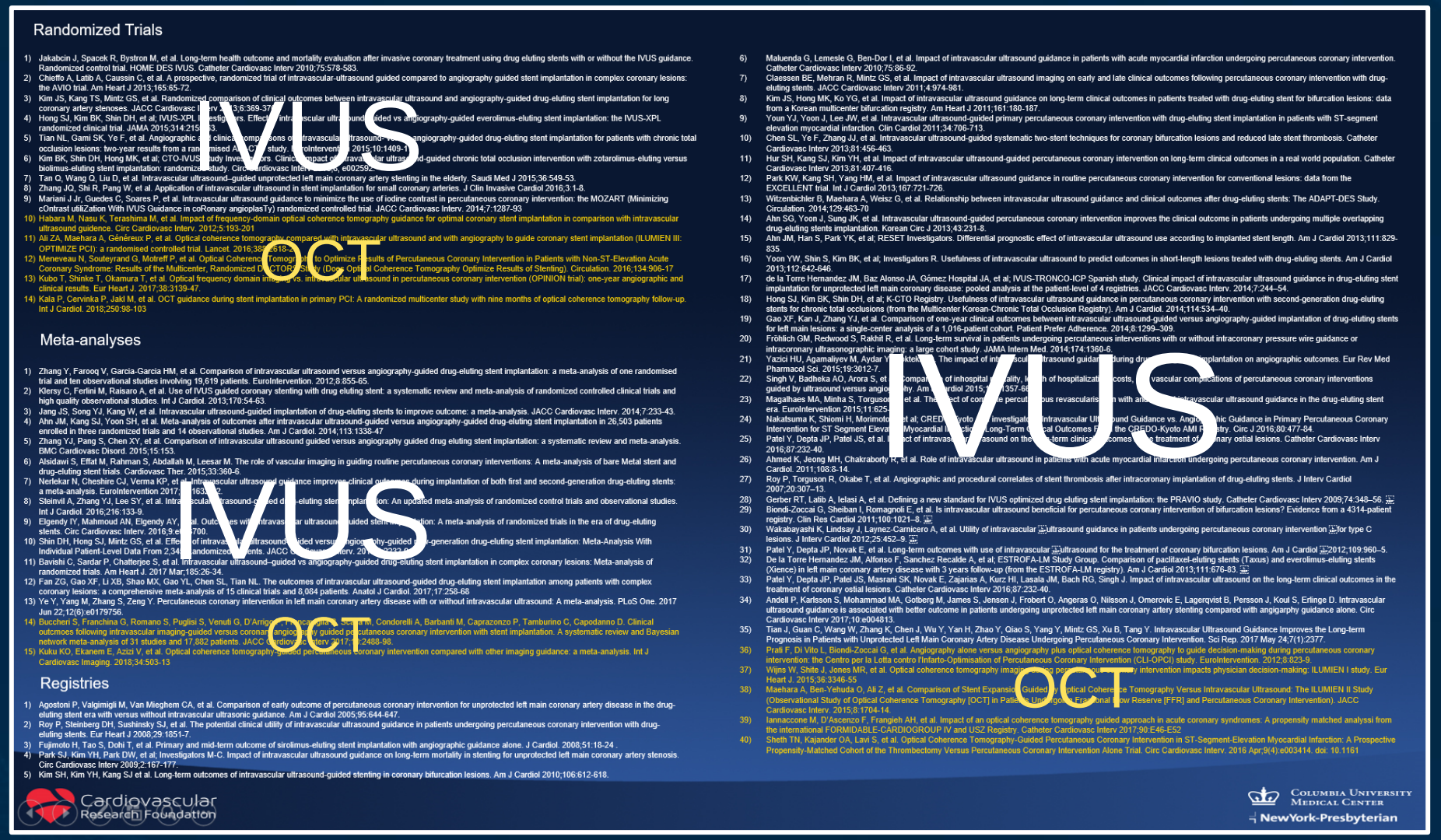
- OCT-angiography co-registration
- Faster imaging acquisition
- Well visualized calcium / in-stent neoatherosclerosis
- Delicate 3D-view, especially for bifurcation PCI

But,

- Sometimes it can not visualize reference vessel
- Poor visualization of ostium
- Need contrast agent (Alternatives: Dextran)

When is the IVUS Better?

Greater Number of Scientific Evidence



Randomized Trials

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37) Wijns W, Shite J, Jones MR, et al. Optical coherence tomography imaging during percutaneous coronary intervention impacts physician decision-making: ILUMIEN I study. Eur Heart J. 2015;36:3346-55
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39) Iannaccone M, D'Ascenzo F, Frangieh AH, et al. Impact of an optical coherence tomography guided approach in acute coronary syndromes: A propensity matched analyssi from the international FORMIDABLE-CARDIOGROUP IV and USZ Registry. Catheter Cardiovasc Interv 2017;90:E46-E52
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Cardiovascular Research Foundation

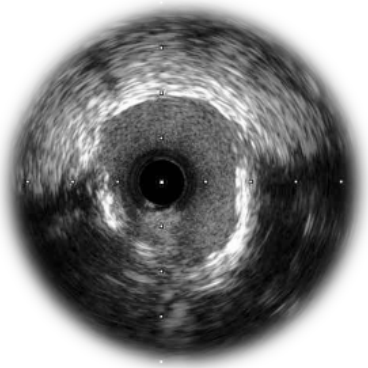
Columbia University Medical Center
NewYork-Presbyterian

Courtesy of Dr. Mintz GS

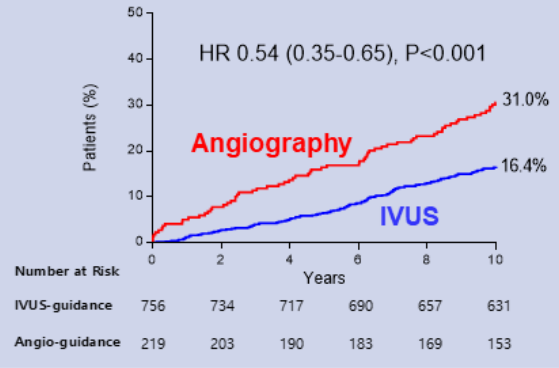
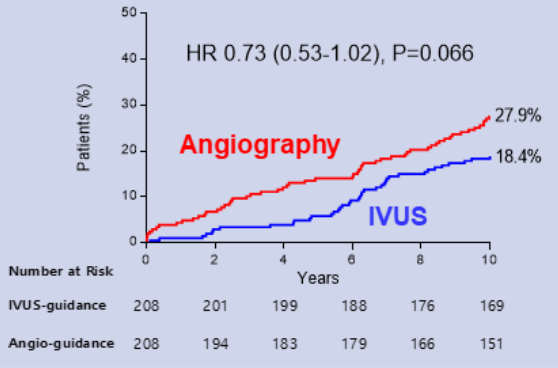
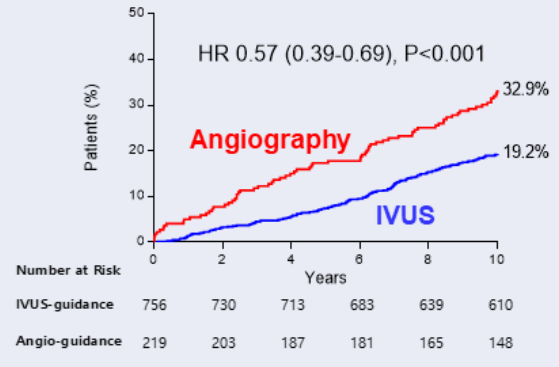
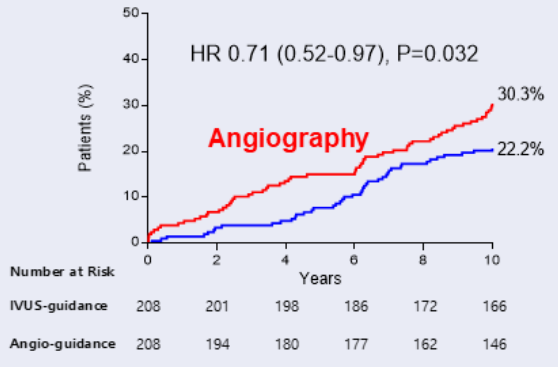
Strong Scientific Evidence, Especially in LM PCI

Left Main Disease

IVUS-guided PCI

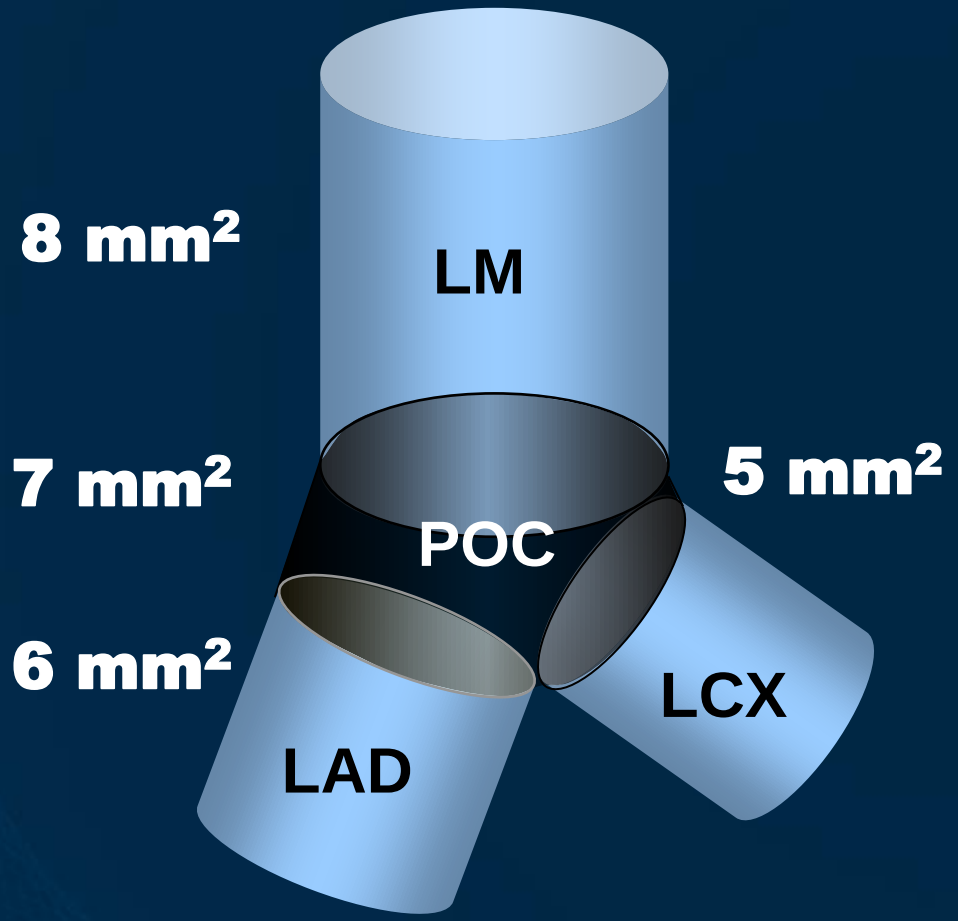


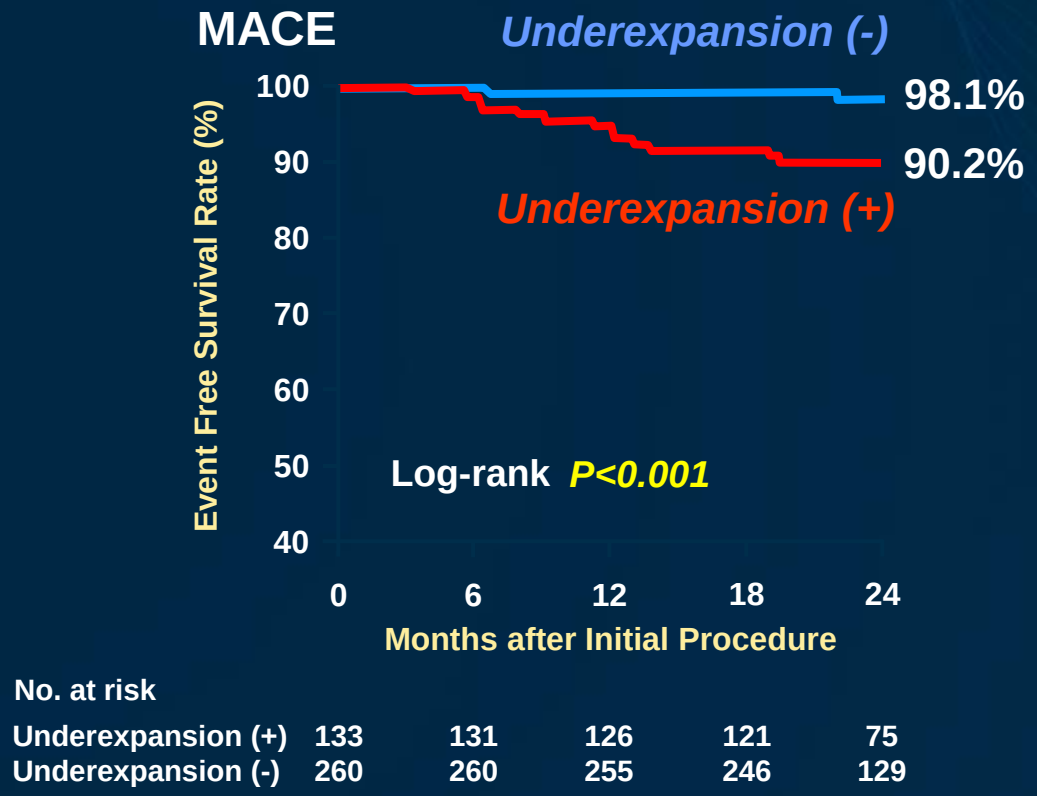
10-Year Follow-up

	Overall Population	After Propensity-score Matching
All-cause death		
Composite of all-cause death, Q-wave MI, or stroke		

Kang DY et al, Circ Cardiovasc Interv. 2021.

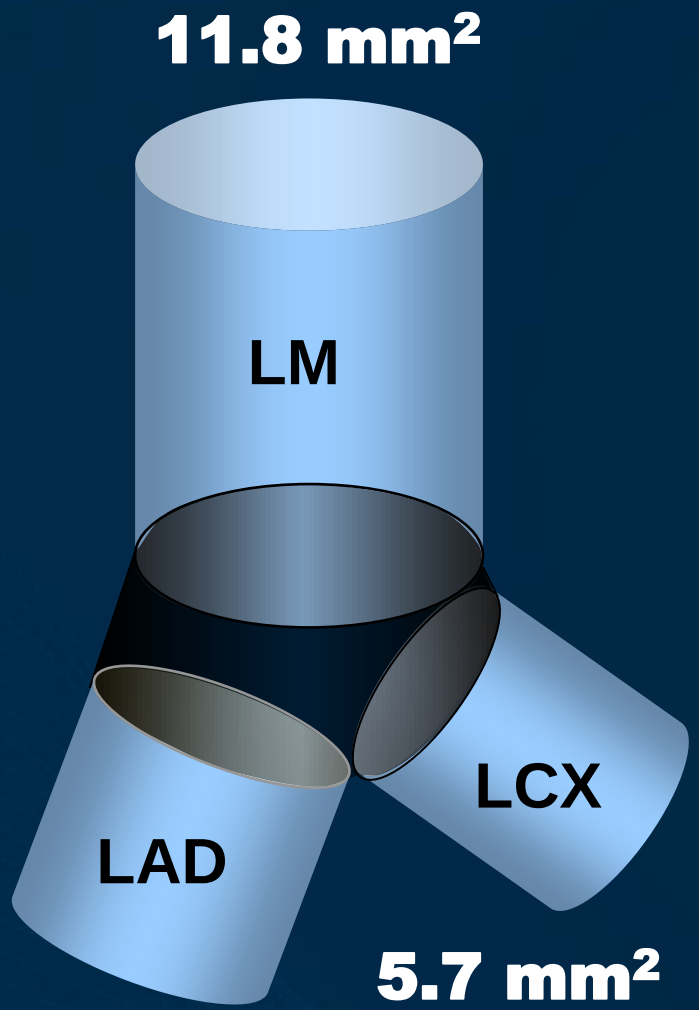
Strong Scientific Evidence, Especially in LM PCI

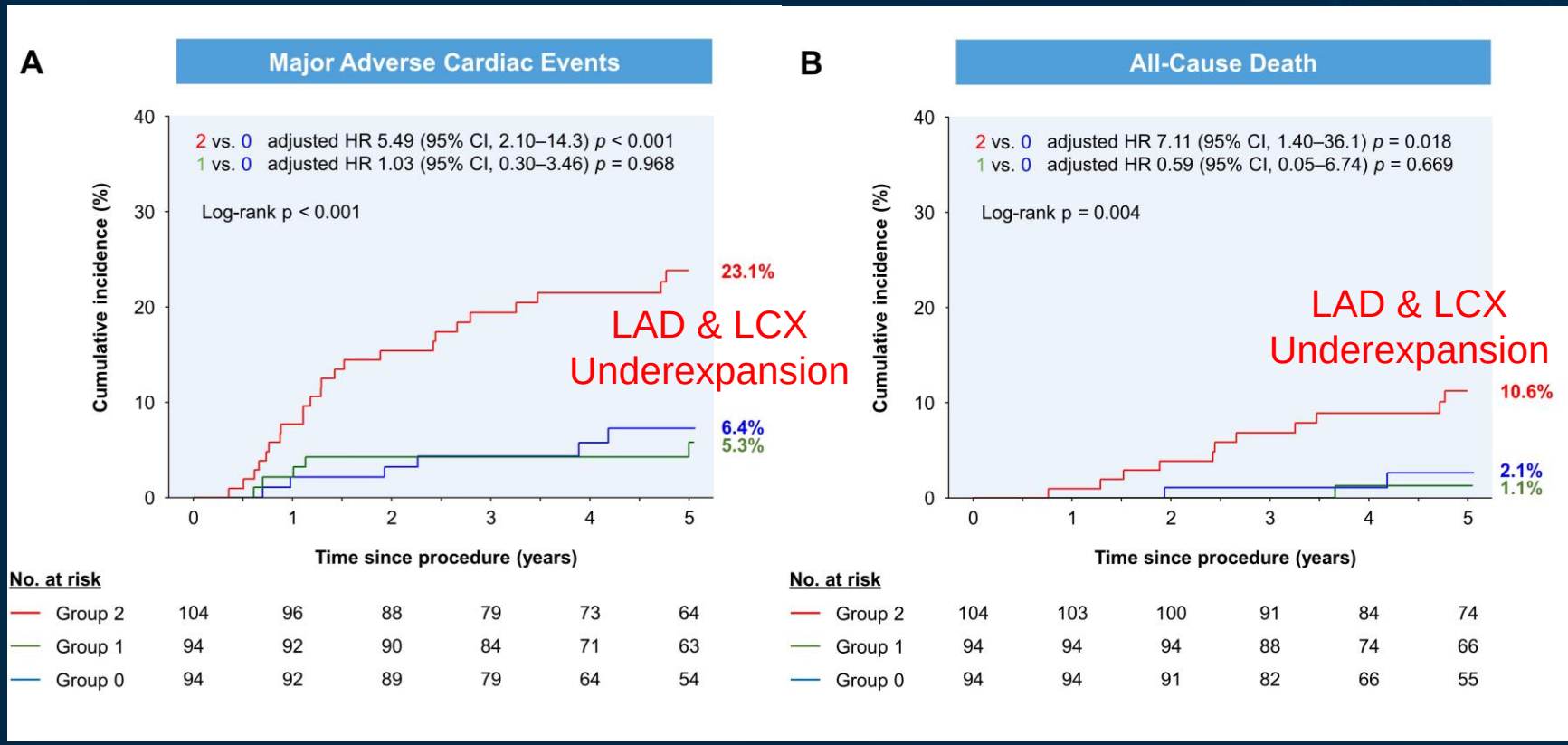




Kang SJ et al. Circ Cardiovasc Interv 2011;4:562-9.

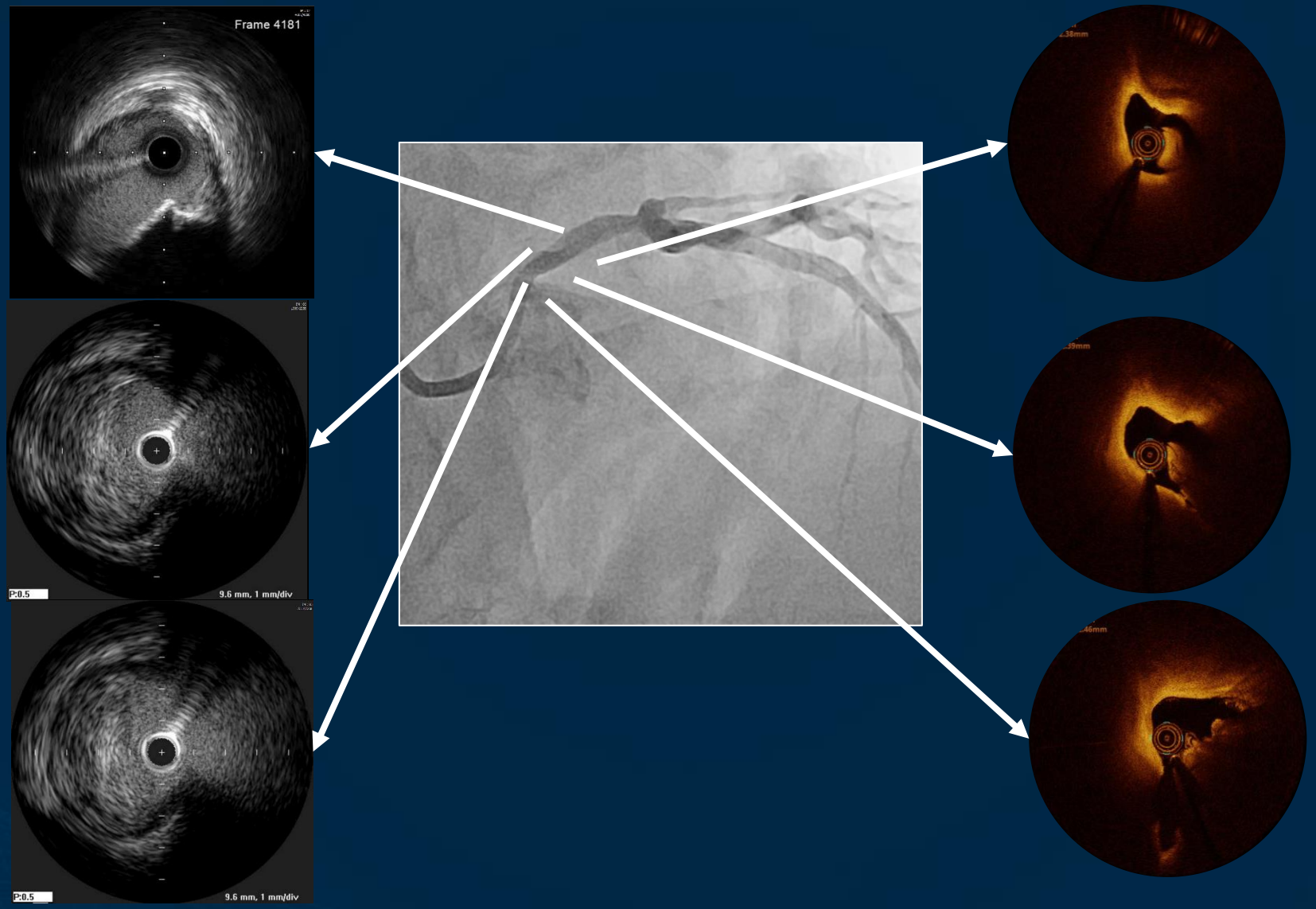
Strone Scientific Evidence, Especially in LM PCI





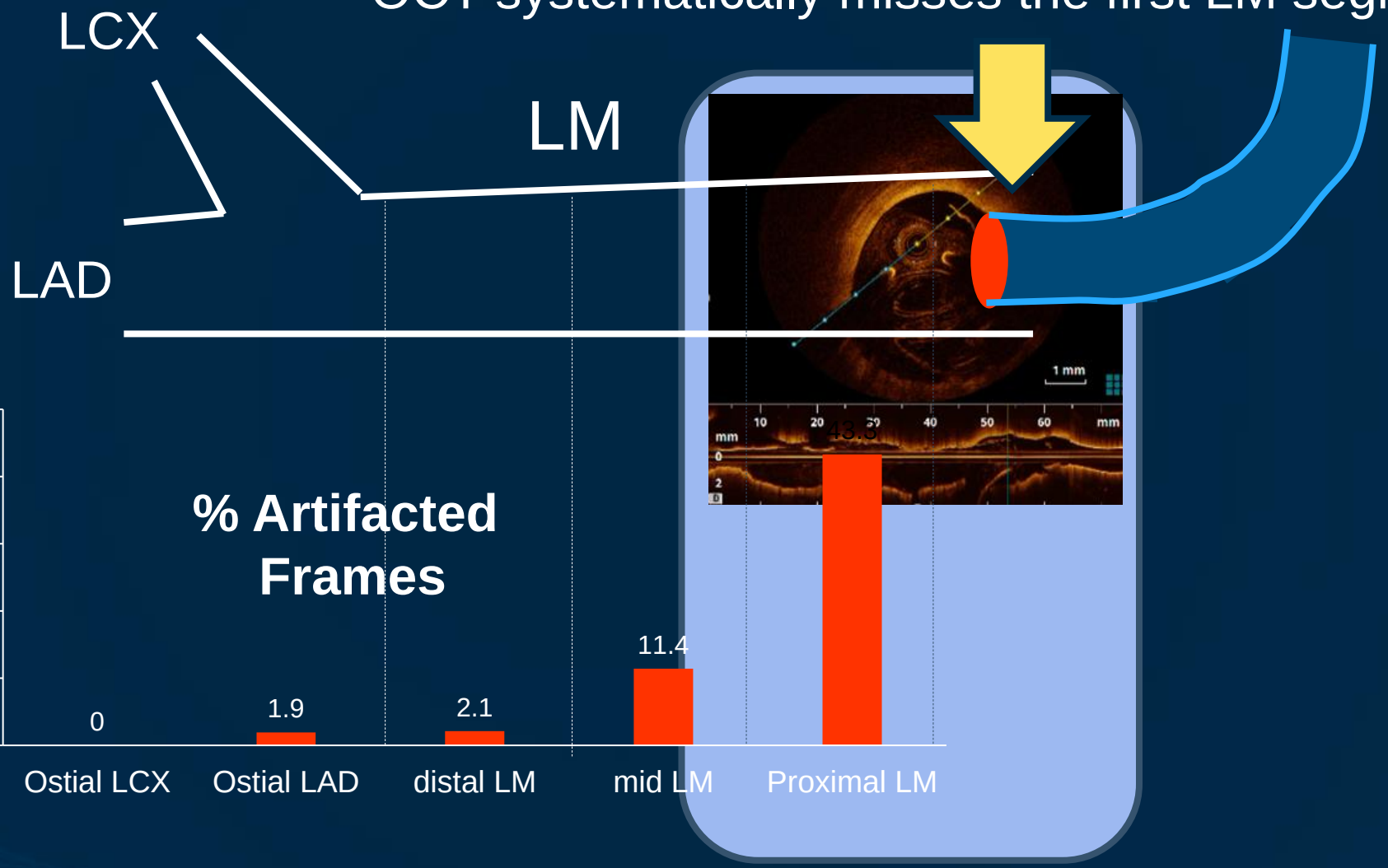
Unpublished data from IRIS-LM

Better Ostial Visualization



Better Ostial Visualization

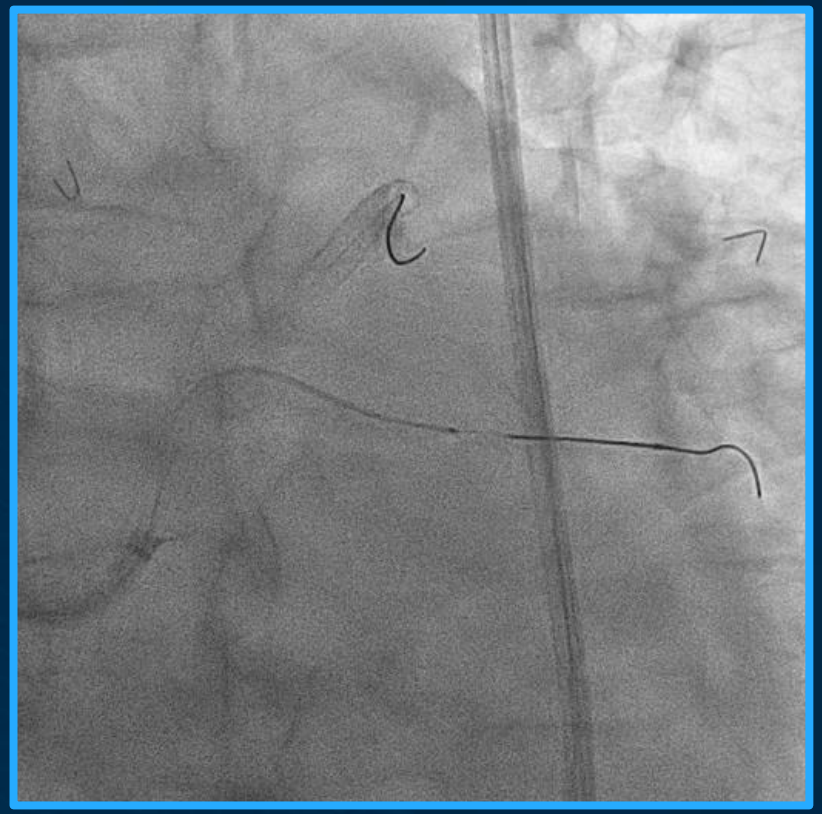
OCT systematically misses the first LM segments

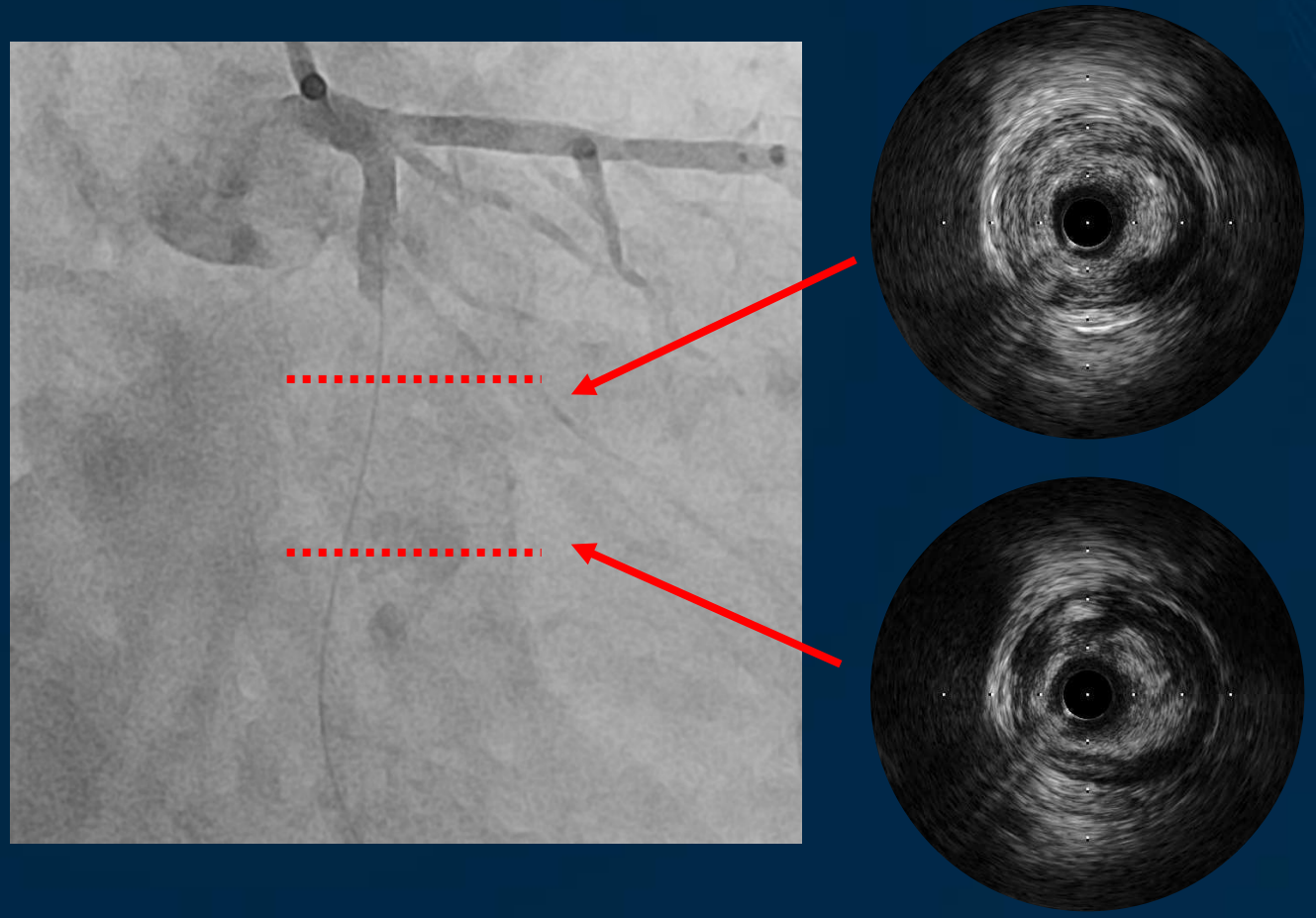


Burzotta F et al. Eurointervention 2015 Jan;10(9):e1-8

PCI for Non-visualized Vessel (CTO, No-reflow…)

Even I Can Not See Distal Even After Repeated Balloon,
I Can See Vessel by IVUS





PCI for Non-visualized Vessel (CTO, No-reflow…)

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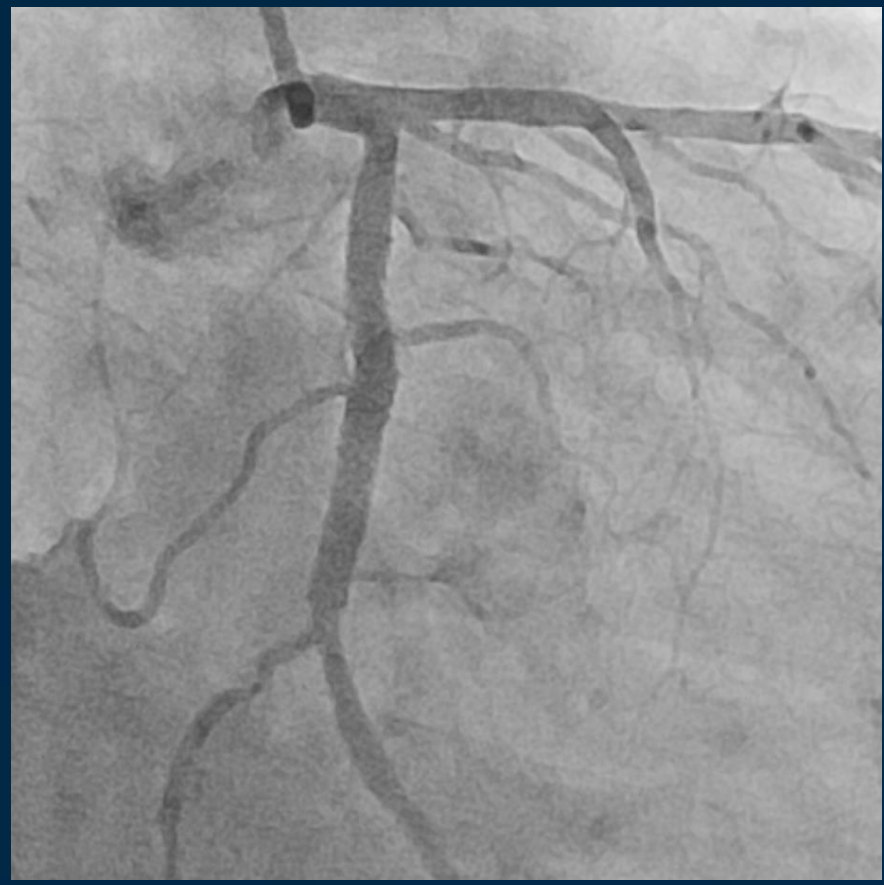
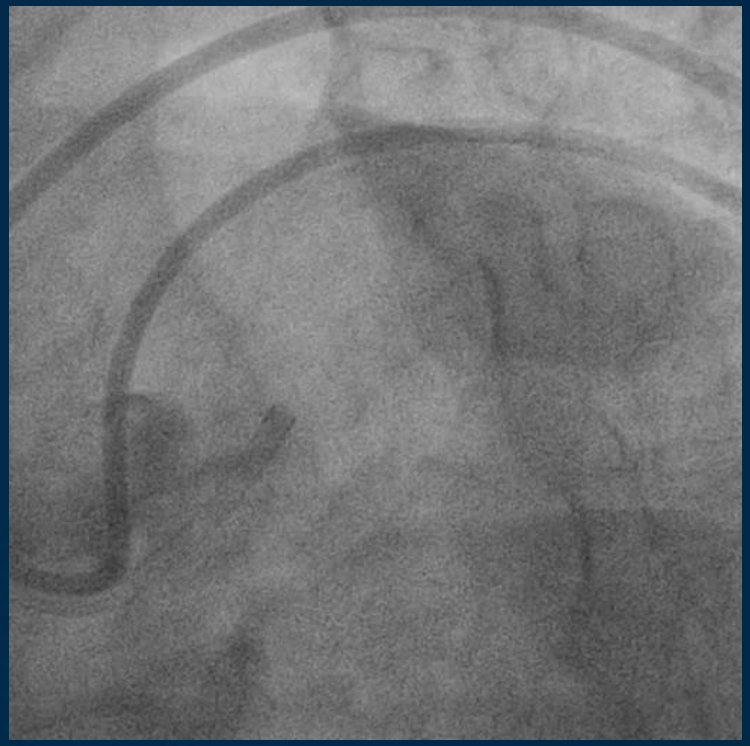
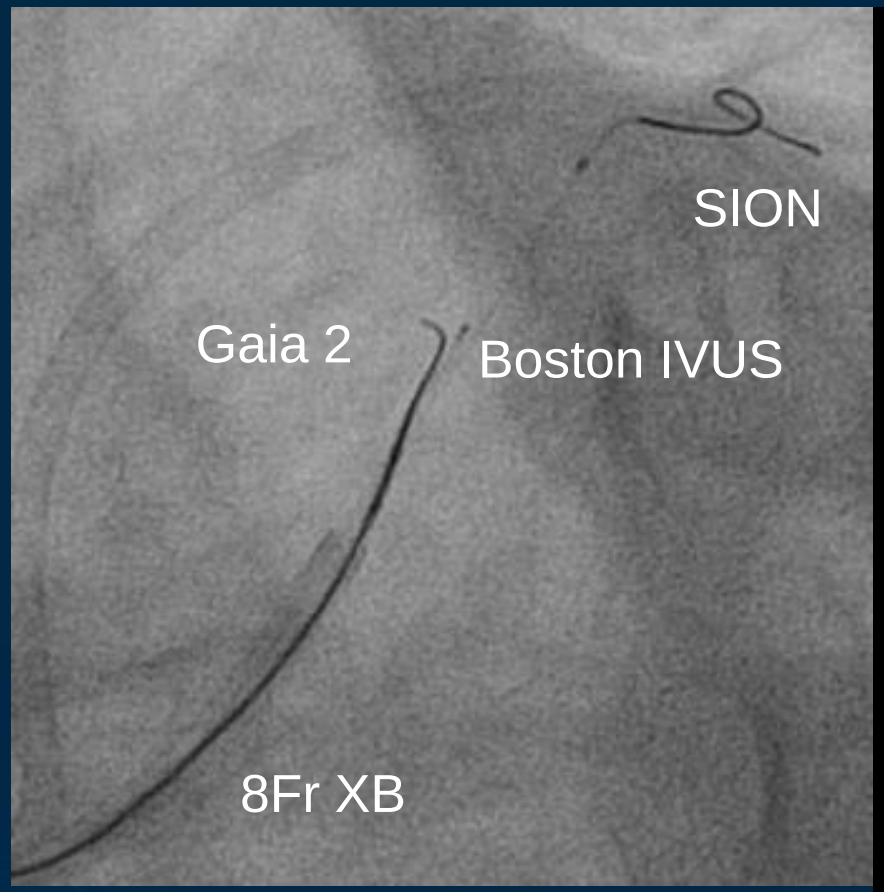
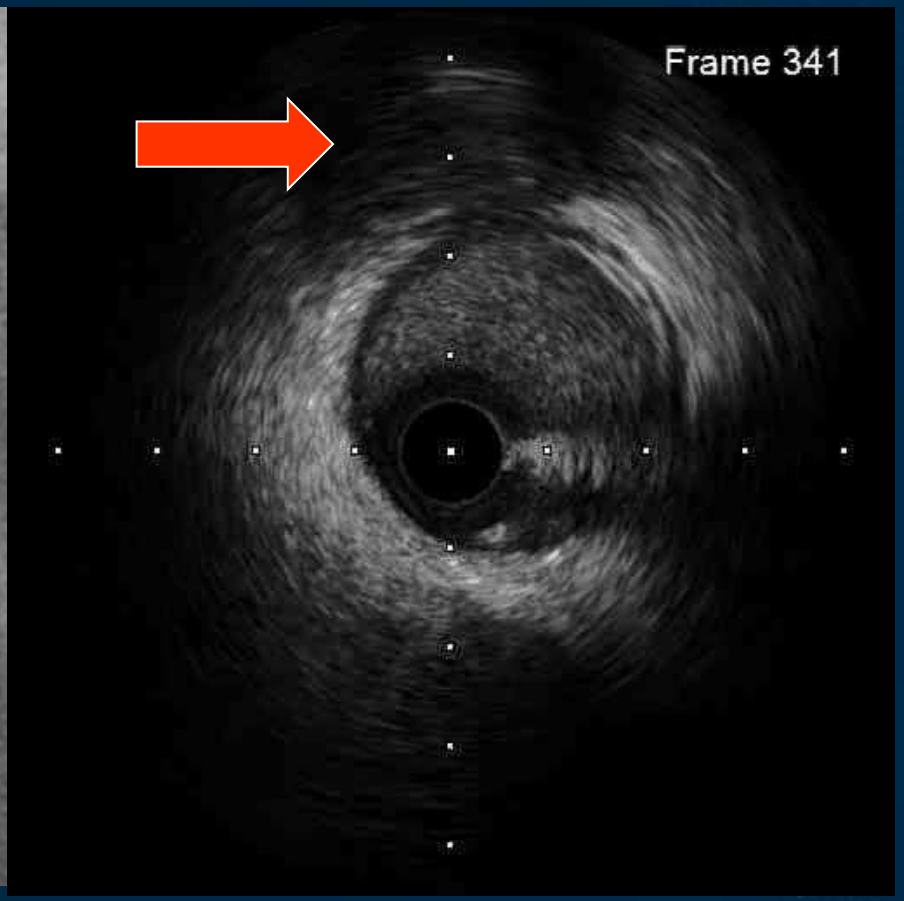


Real-Time Guidance for CTO PCI



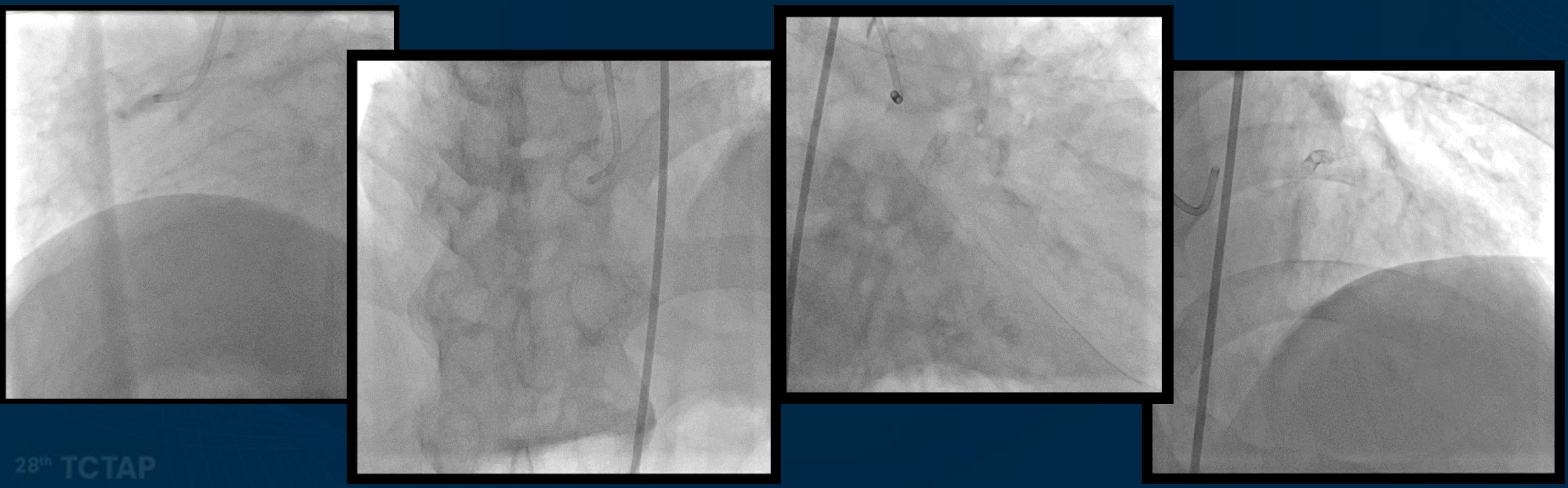




Minimal Contrast Procedure Available

M/65, Angina, Diabetes, CKD (Cr 7.5), Not on dialysis

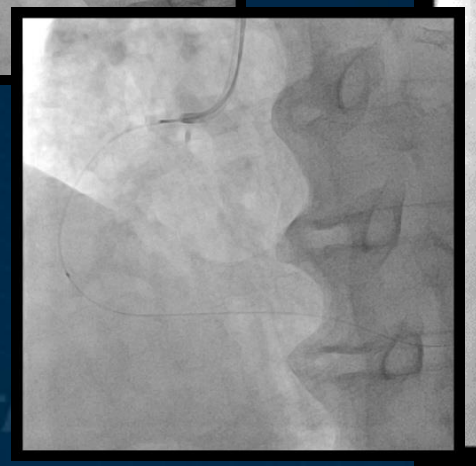
Biplane angiography with minimal contrast

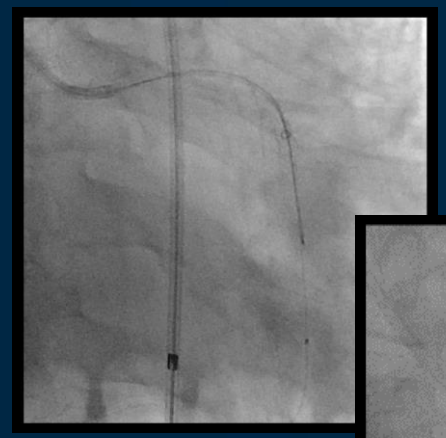


Minimal Contrast Procedure Available

M/65, Angina, Diabetes, CKD (Cr 7.5), Not on dialysis

2-vessel PCI with < 10 cc contrast





Is IVUS Better?

- Stronger Evidence
- Vessel Size, Ostial Visualization
- Visualize Vessel Even without Flow
- Real Time Guidance and Manual Pull-Back
- No Contrast Needed

But,

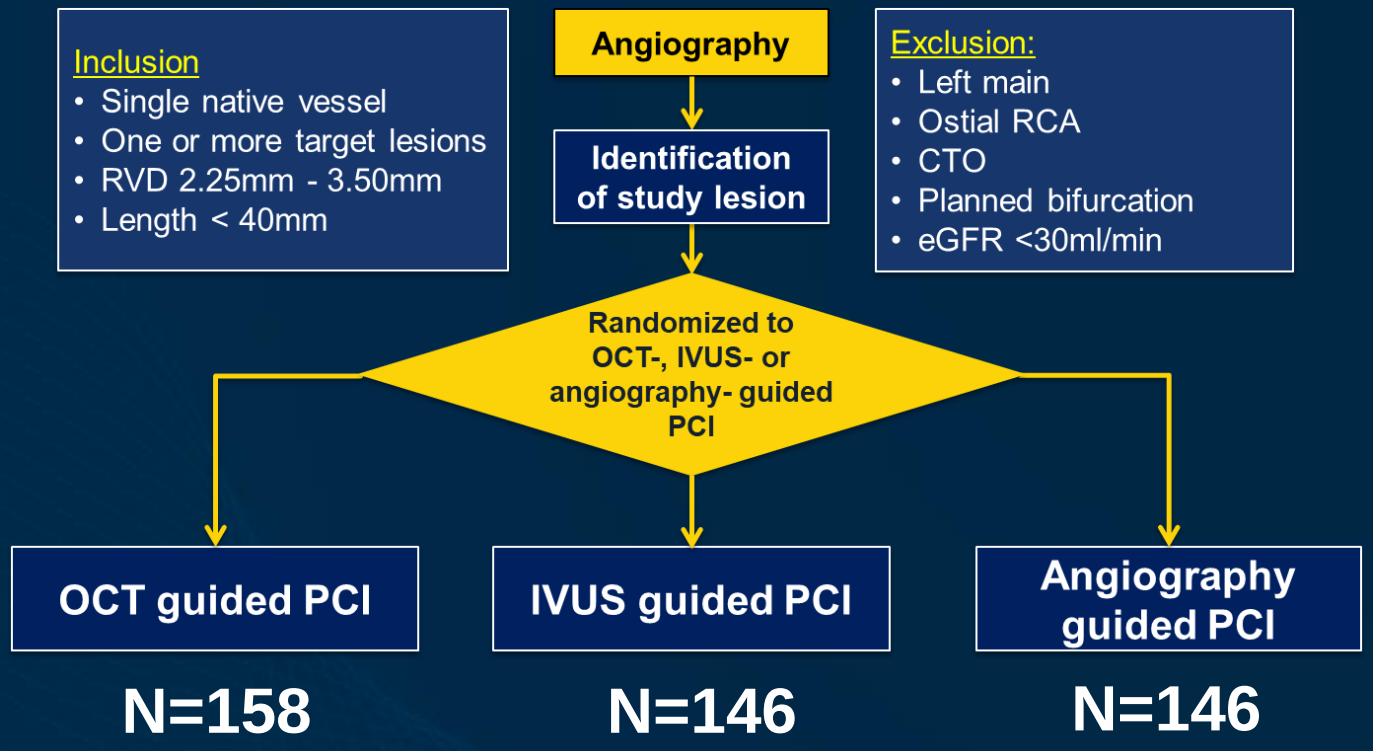
- Time consuming, No co-registration
- Difficult evaluation of Thick Calcium or In-stent neoatherosclerosis

My Thoughts : OCT vs. IVUS for Guiding PCI

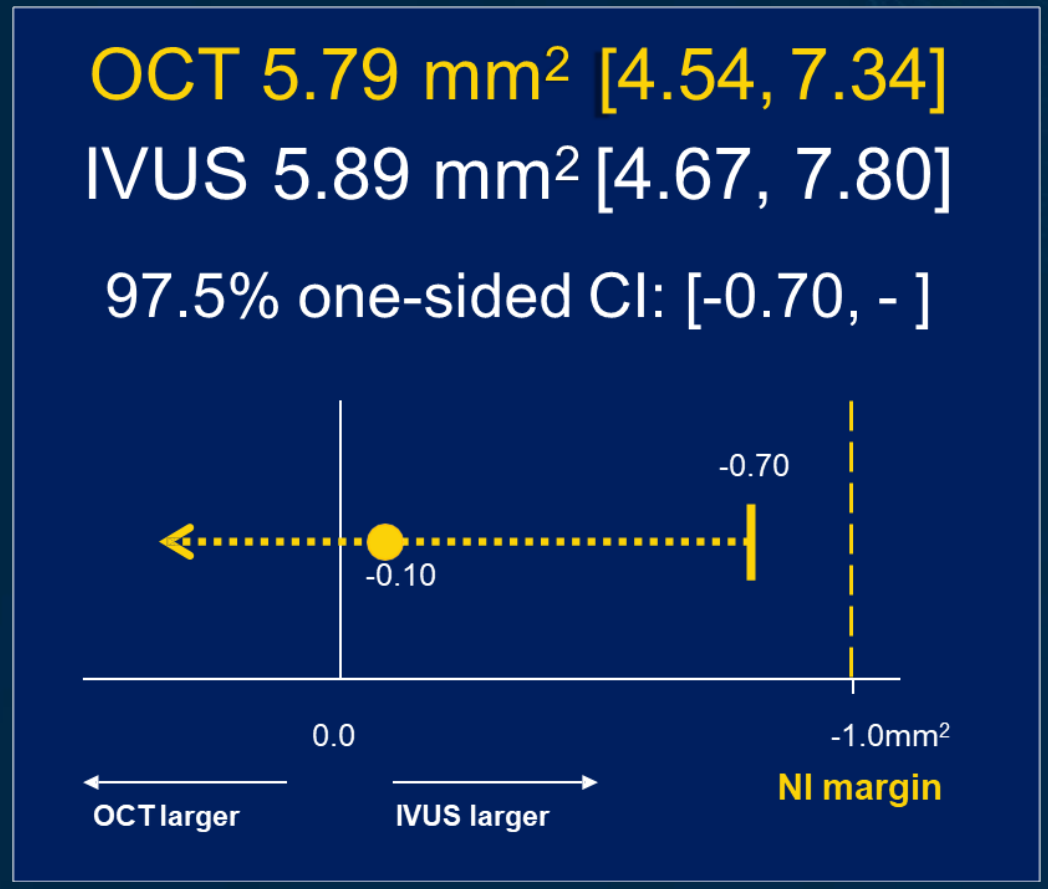
	OCT	IVUS
Simple Lesion	≈	
LM disease		Better
Ostial lesion		Better
Bifurcation	Delicate	Convenient
Calcification	Better	
Long lesion	Save time	
CTO		Better
In-stent restenosis	Better	
STEMI	Erosion	Shock, No reflow
Renal dysfunction or CHF		Better

RCT of OCT vs. IVUS for PCI Guidance (1)

ILUMIEN III – OPTIMIZE PCI



Primary endpoint : Final post-PCI MSA by OCT



Ali ZA et al. Lancet 2016:388;2618-28

$P_{noninferiority} = 0.001$

RCT of OCT vs. IVUS for PCI Guidance (2)

Exclusion:
- 3VD, LM, Ostial, CTO, graft, ISR,
- CHF, eGFR <30

OPINION

Patients scheduled for PCI using DES
Jun 2013 – Jul 2014, n = 800

1:1

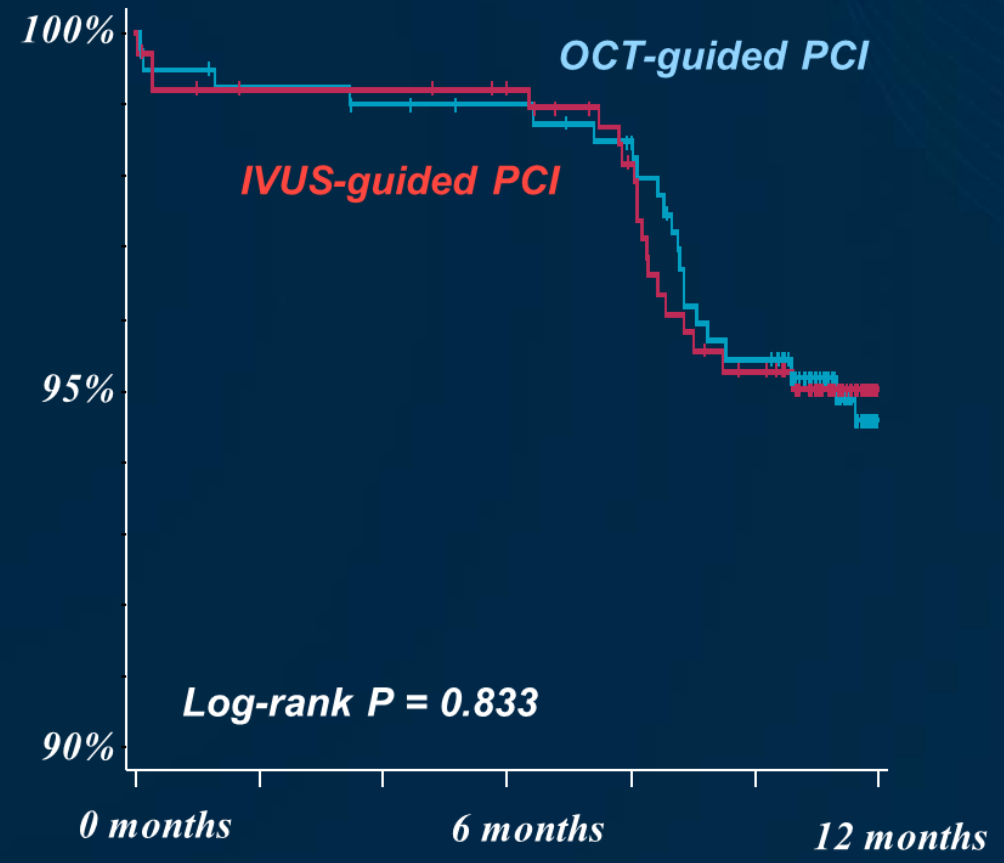
OCT-guided PCI
n = 400

IVUS-guided PCI
n = 400

8 months: Follow-up coronary angiography

12 months: Clinical follow-up

Primary endpoint
: Target Vessel Failure at 12 mo



Kubo T et al., Eur Heart J 2017:38;3139-47

$P_{noninferiority} < 0.05$

RCT of OCT vs. IVUS for PCI Guidance (3)

Exclusion:
- LM, CTO, ISR Bifurcation, Long, Calcification
- Recent ACS, HF, eGFR <45

MISTIC-1

Patients scheduled for PCI using DES*
Jun 2014 – Aug 2016, n = 109

1:1

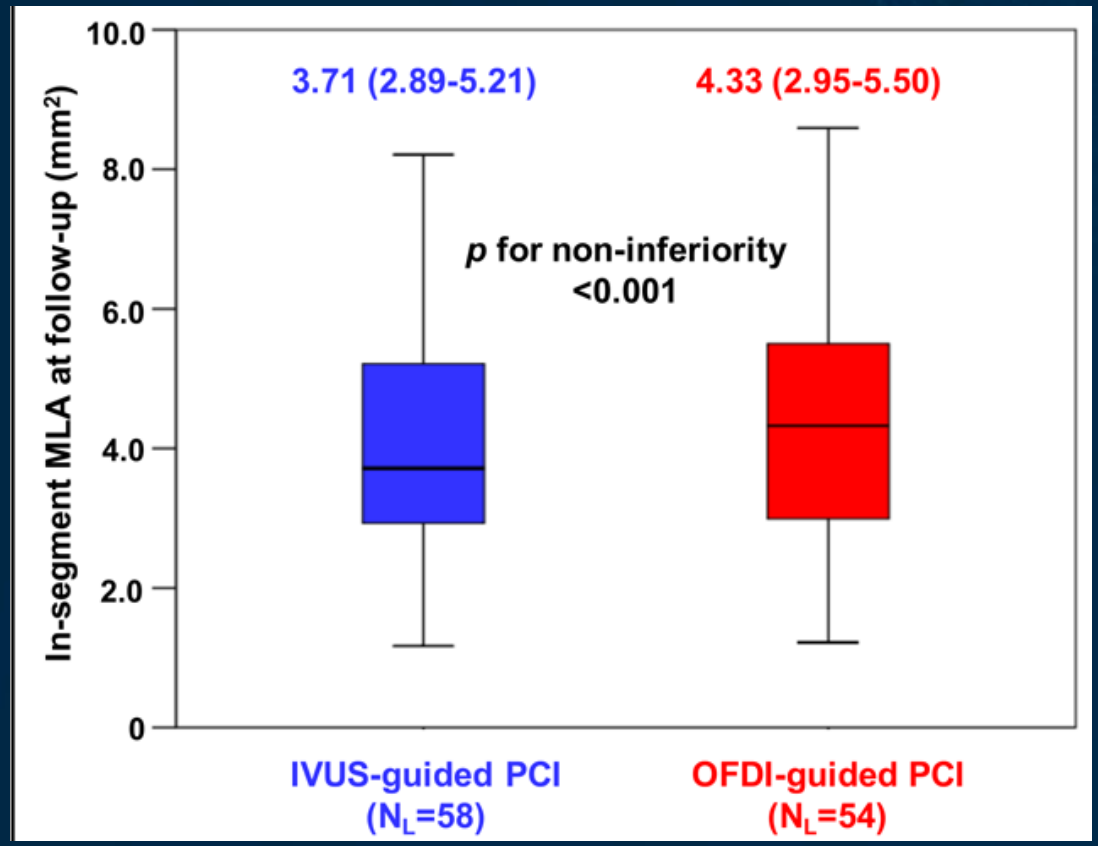
OCT-guided PCI
n = 54

IVUS-guided PCI
n = 55

8 months: Follow-up coronary angiography

36 months: Clinical follow-up

Primary endpoint
: In-segment MLA by OCT at 8 mo



Muramatsu T et al., Circ CV Interv 2020:13;e009314

$P_{noninferiority} < 0.001$

Limitations of Prior 3 RCTs

- **Relatively small number of participants**
  - 158 (ILUMIEN-3), 400 (OPINION), 54 (MISTIC-3) in OCT group
  - Underpowered for clinical outcome

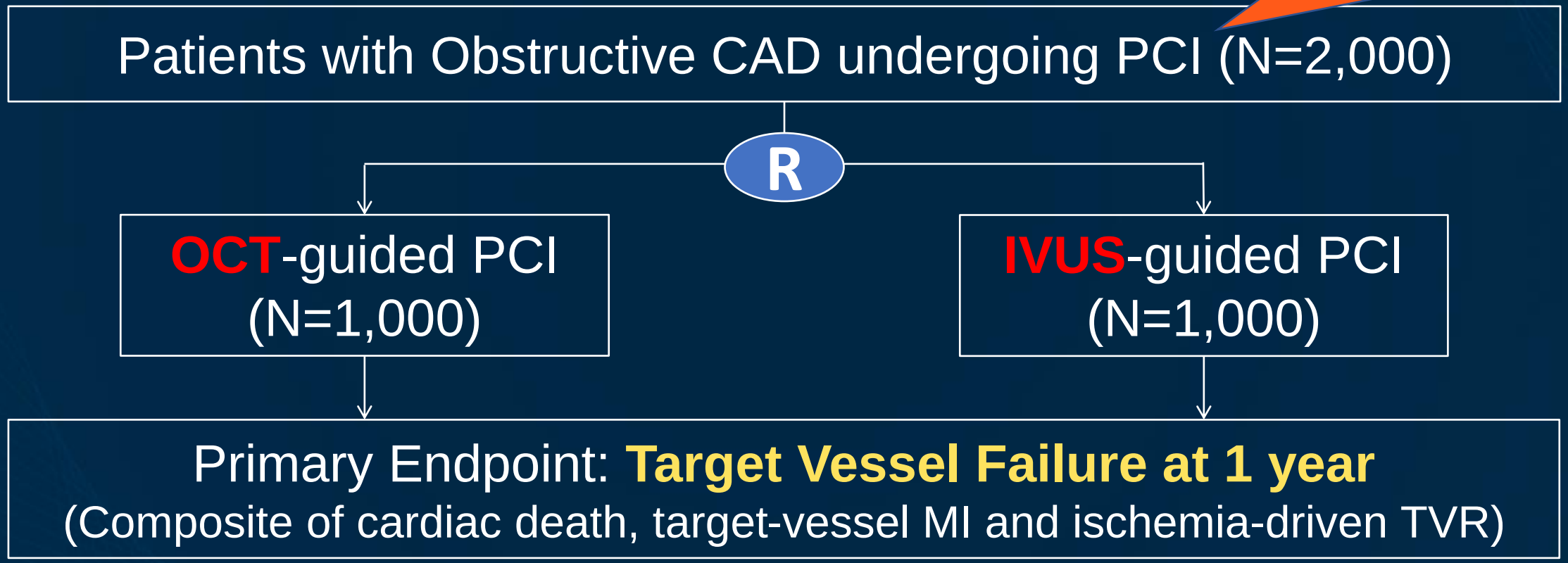
- **Complex lesions were excluded**
  - LM or 3VD, Ostial lesion, CTO, In-stent restenosis, bypass graft

- **Follow-up angiography was performed (OPINION, MISTIC-3)**

Optical Coherence Tomography versus Intravascular Ultrasound Guided Percutaneous Coronary Intervention

OCTIVUS Trial

Primary results will be announced this year !!



Kang DY et al. Am Heart J. 2020 Oct;228:72-80.

However,

What's Really Important is *NOT* OCT vs. IVUS.

However,

What's Really Important is *NOT* OCT vs. IVUS.

The really important thing is

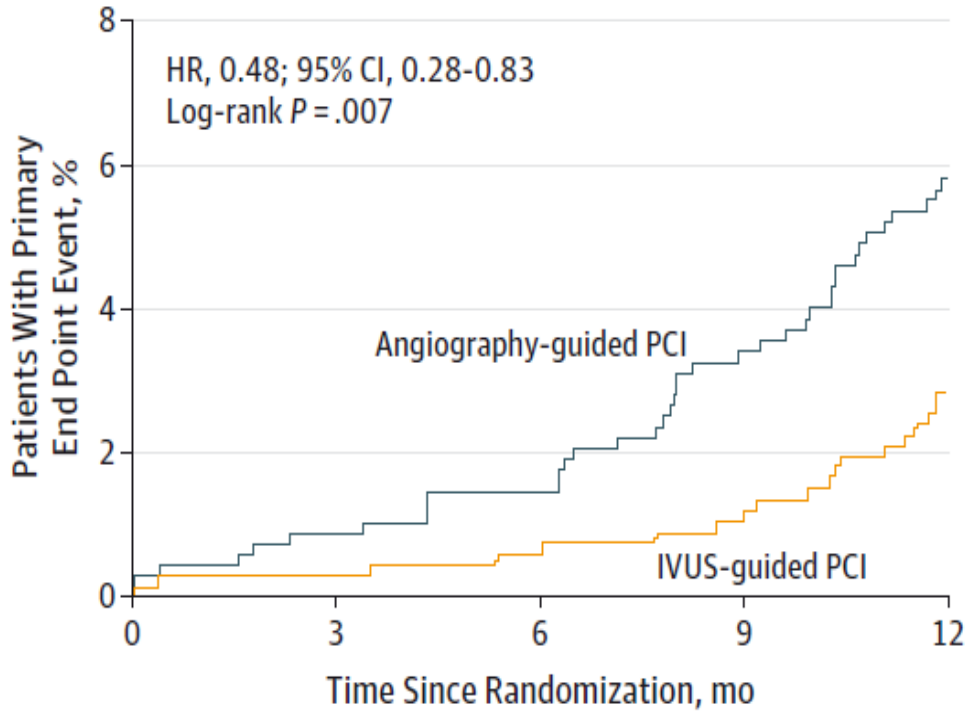
To Use *Any Intravascular Imaging for Guiding PCI*,

especially in complex PCI !

IVUS Improved Clinical Outcomes in Large RCTs

IVUS-XPL (Long lesions)

MACE (CD+TL-MI+ID-TLR)

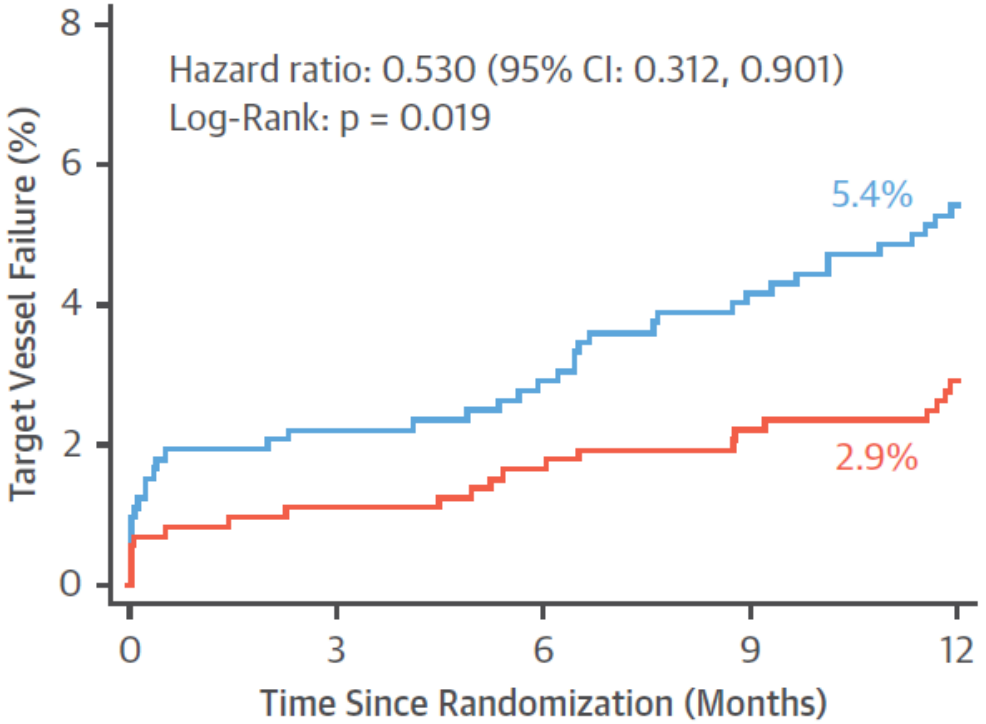


Angiography-guided	700	673	660	643	624
IVUS-guided	700	671	665	654	641

Hong SJ, Hong MK et al. JAMA 2015;314:2155-63.

ULTIMATE (All-comer)

TVF (CD+TV-MI+CD-TVR)



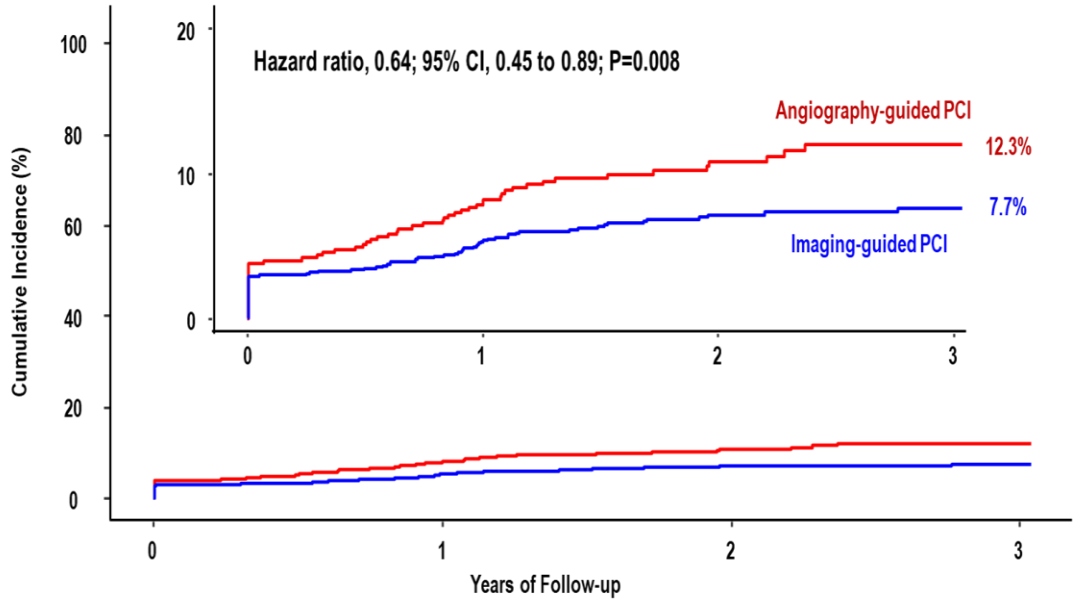
Number at risk					
Angiography	724	706	698	685	676
IVUS	724	715	710	704	696

Zhang J et al. J Am Coll Cardiol 2018;72:3126-27.

Any Imaging Improved Clinical Outcomes in Complex PCI

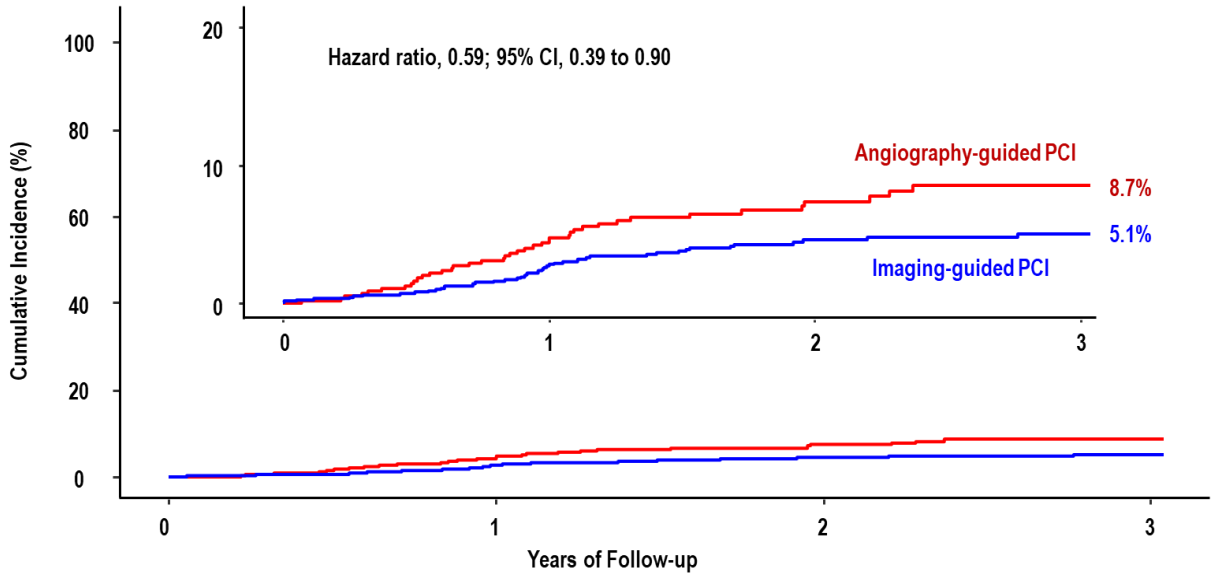
RENOVATE-COMPLEX-PCI
(Bifurcation, CTO, LM, Long, MV, ISR, Calcification)

Target Vessel Failure



Number at risk				
Angiography-guided PCI	547	496	280	120
Imaging-guided PCI	1092	1023	591	255

TVF excluding PMI

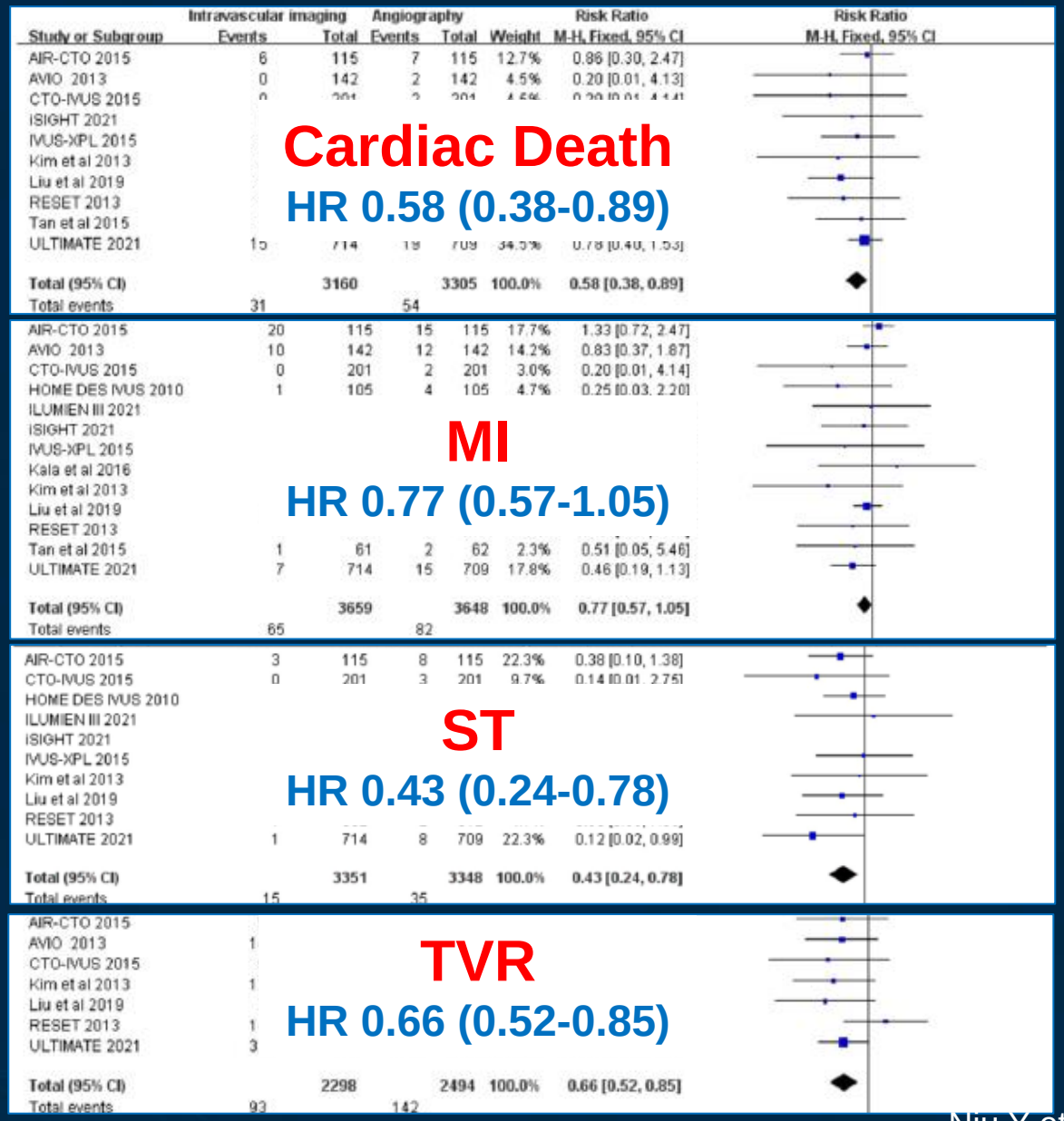


Number at risk				
Angiography-guided PCI	547	516	284	121
Imaging-guided PCI	1092	1051	596	256

Lee JM, Choi KH et al. NEJM 2023, Mar 5.

Meta-analysis of 10 RCTs Showed Clinical Benefit of IVUS

← Imaging Better



Angiography Better →

Niu Y et al, BMC Cardiovasc Disord. 2022;22(1):327.

With Intravascular Imaging,

I Can Implant Bigger Stent,

With Higher Pressure Post-dilation,

Safely.

Small Details Make a Big Difference !

Conclusion

- OCT vs. IVUS, Which is better? They are different with their own advantages and limitations.

- The OCTIVUS trial will show the comparative efficacy and safety of OCT- versus IVUS- guided PCI strategies in all-comer PCI.

- Just remember to **use Intracoronary imaging in the complex PCI.**

  It is the evidence-based approach for the best clinical outcome.