IVUS vs OCT – Step-by-step
Which one wins?

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Intravascular Imaging Made Easy…..

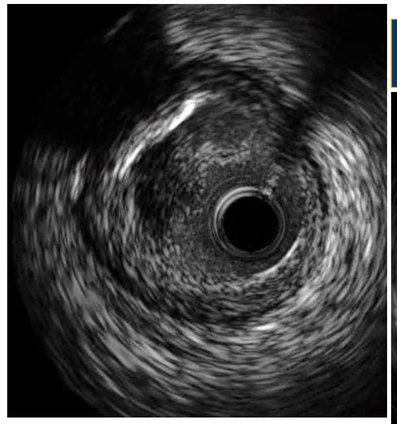
Pre-PCI	Post-PCI
•Morphology	•Medial Dissection
•Length	•Apposition
•Diameter	•eXpansion

MLD MAX

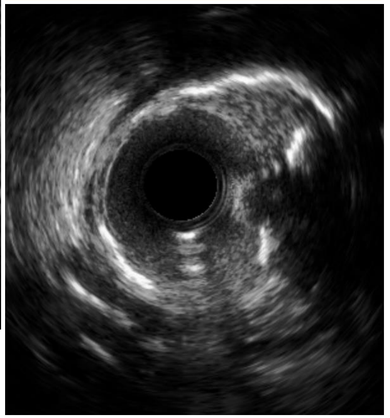
Morphology

IVUS Image Interpretation

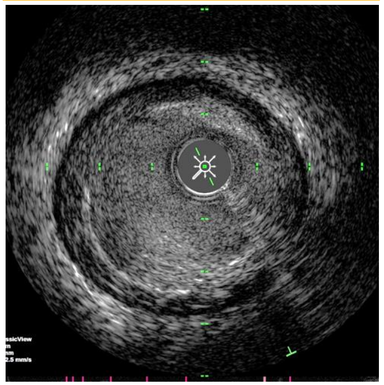
- **Is there plaque?**
  - No → **Normal**
  - Yes → **Is the plaque within the lumen or the wall?**
    - **Lumen**
      - **Hypoechoic** → **Chronic Thrombus**



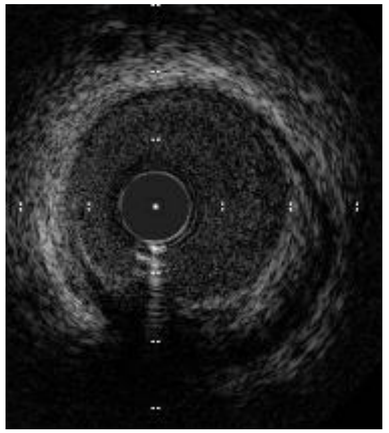
      - **Hyperechoic** → **Is there a shadow?**
        - Yes → **Ca Nodule**



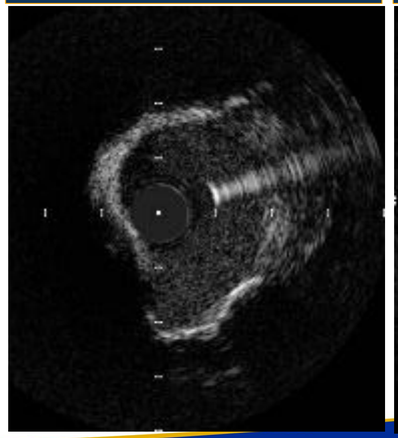
        - No → **Acute Thrombus**



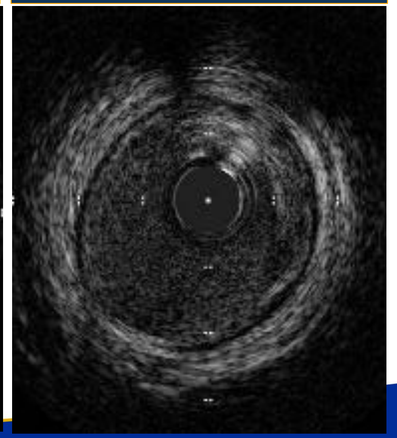
    - **Wall**
      - **Hypoechoic** → **Lipid**



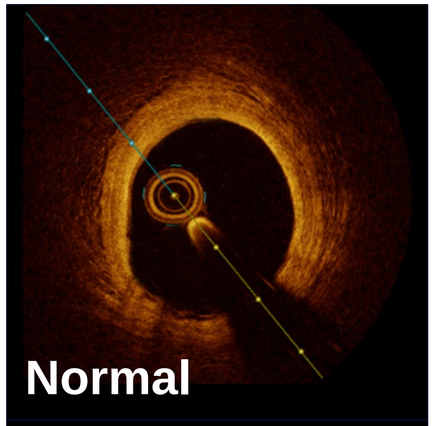
      - **Hyperechoic** → **Is there a shadow?**
        - Yes → **Calcium**

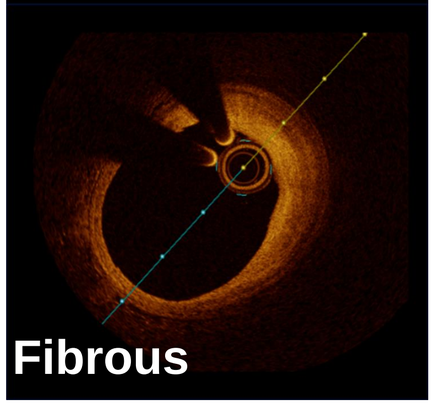


        - No → **Fibrotic**



OCT Image Interpretation





Can the EEL and Adventitia be visualized?

Yes

No

Is the signal change in the lumen or the wall?

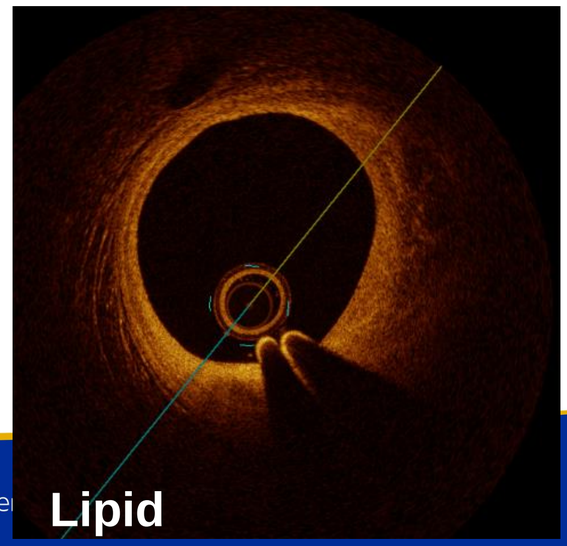
Lumen

Wall

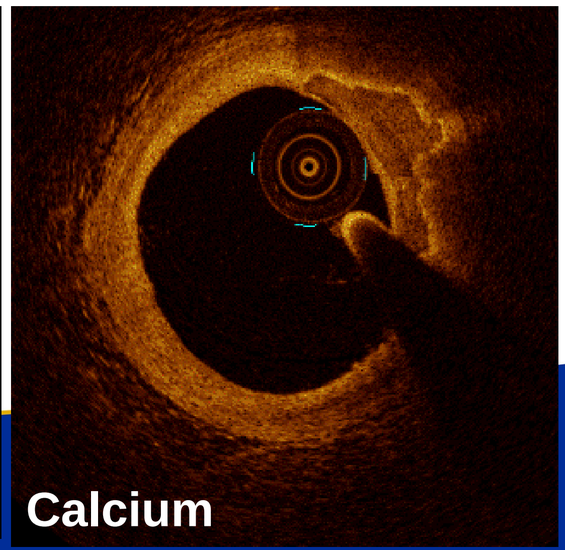
High Attenuation

Low Attenuation

High Attenuation

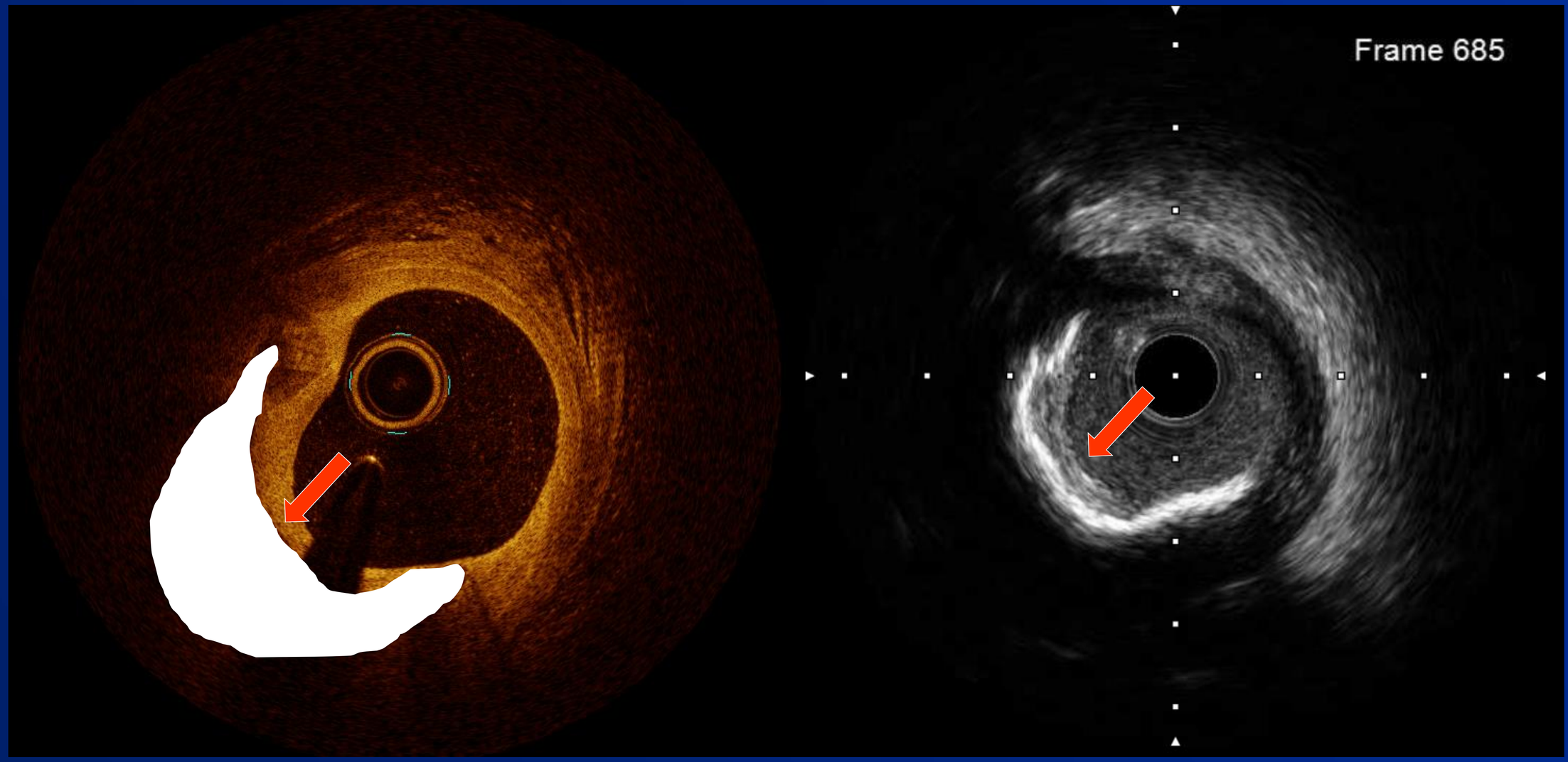


Low Attenuation



IVUS versus OCT

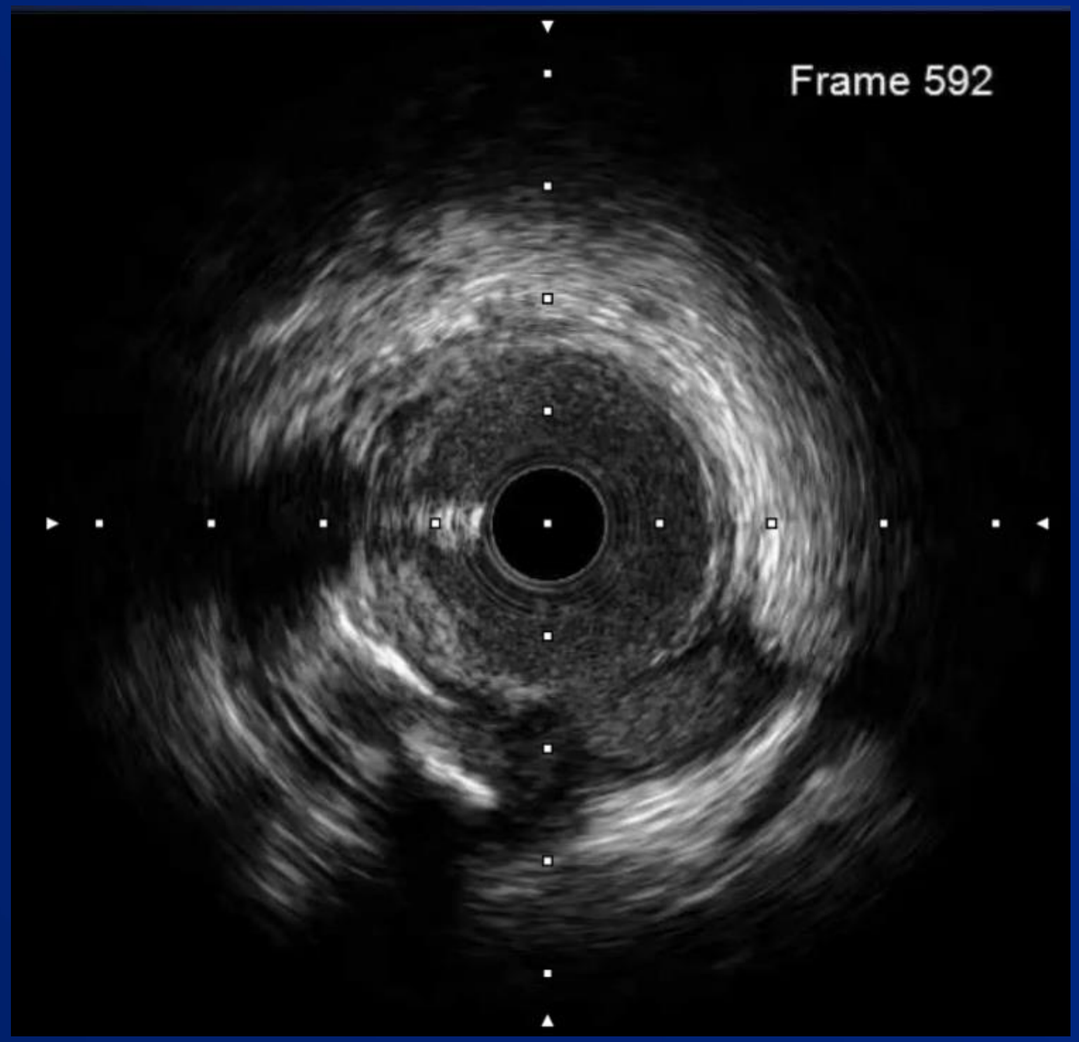
OCT Penetrates Calcium

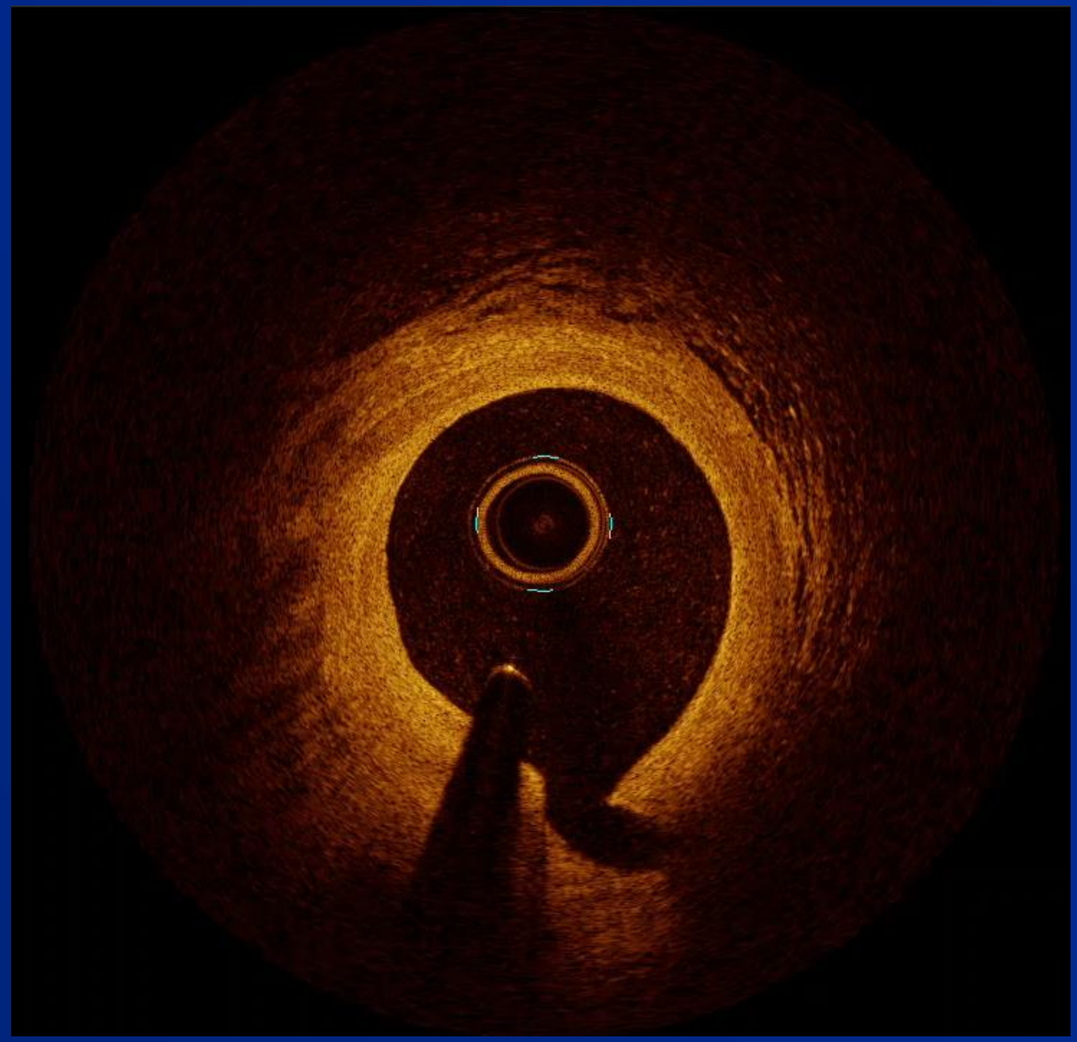


Light penetrates through calcium crystal

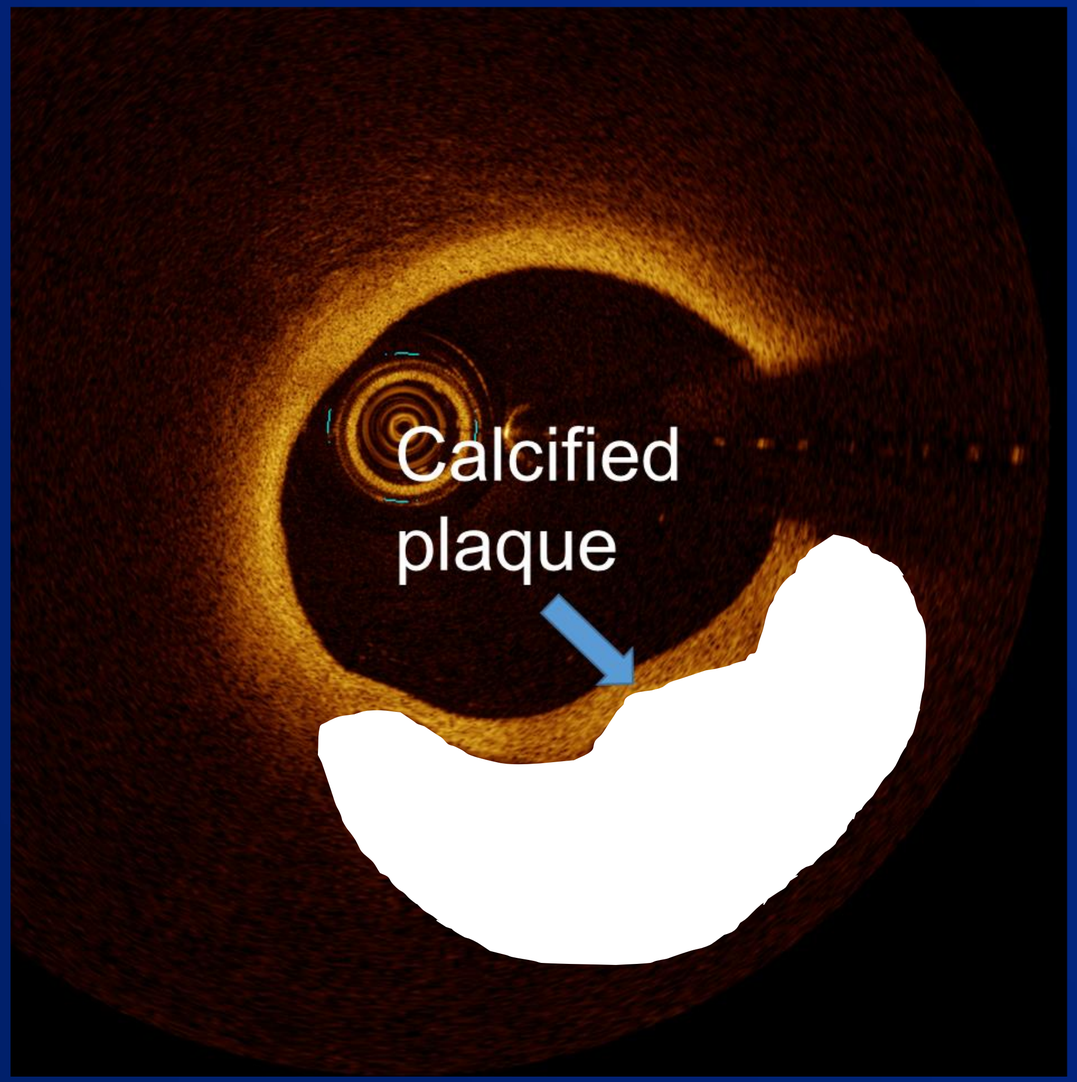
Sound is reflected by calcium crystal

OCT versus IVUS in severe calcification

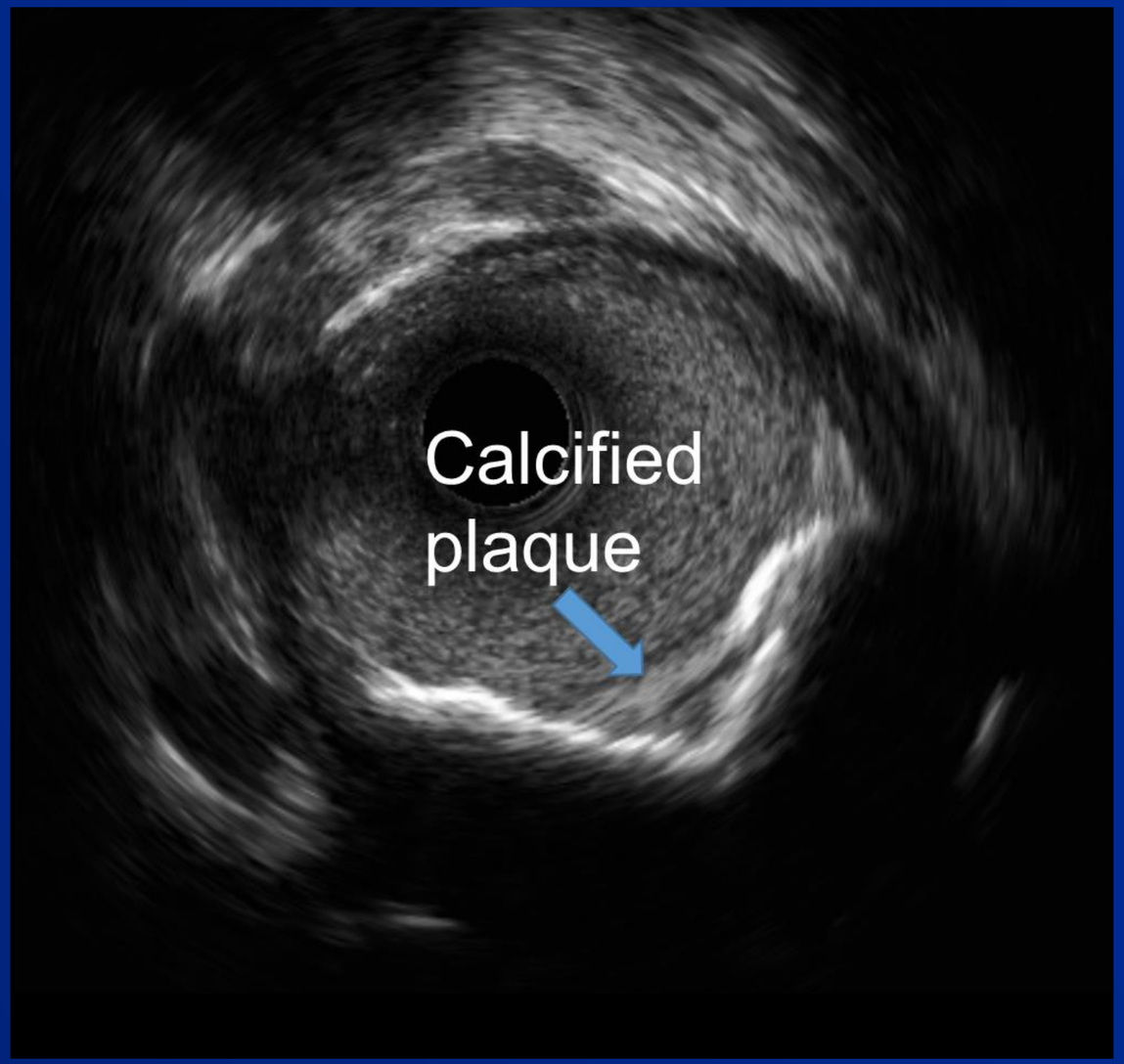




Thick Calcium

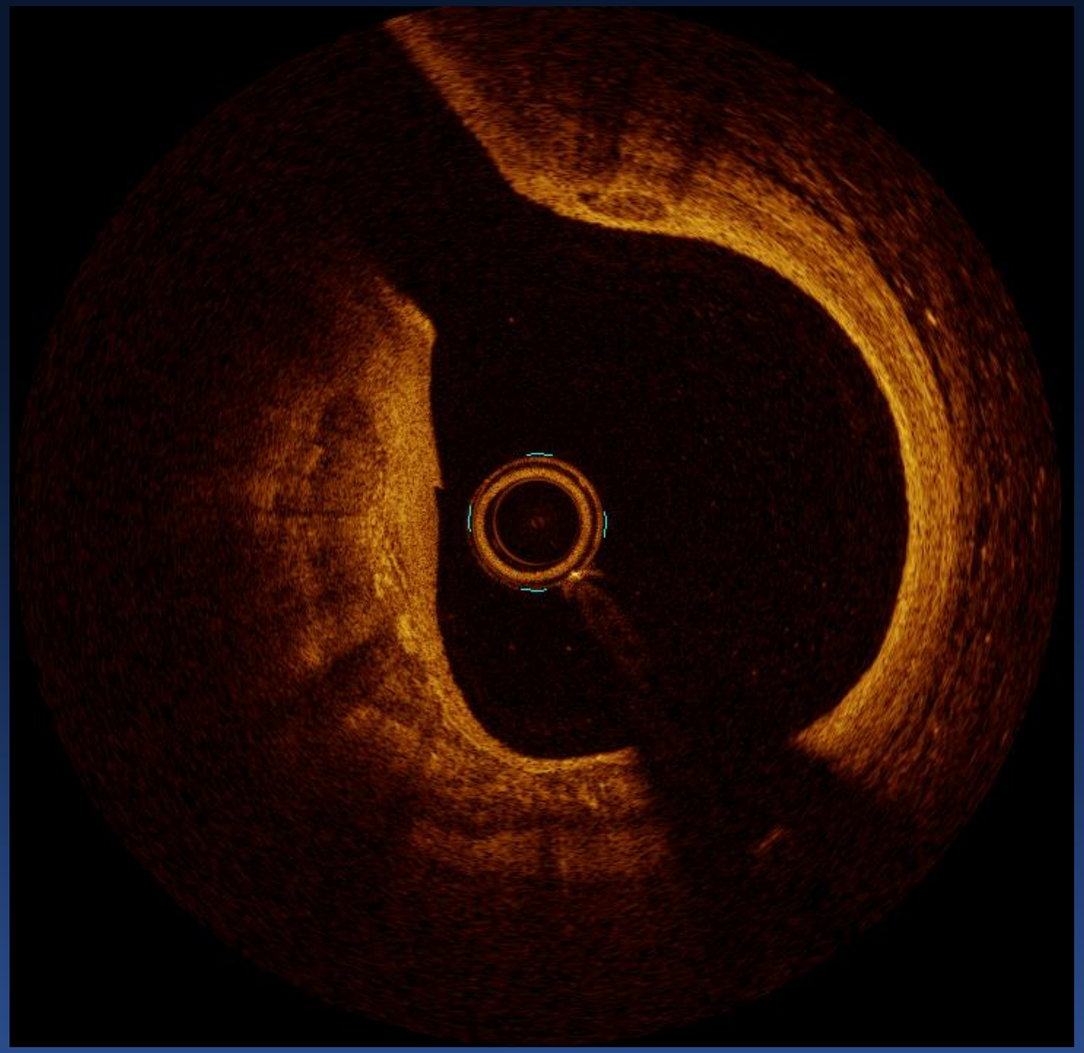


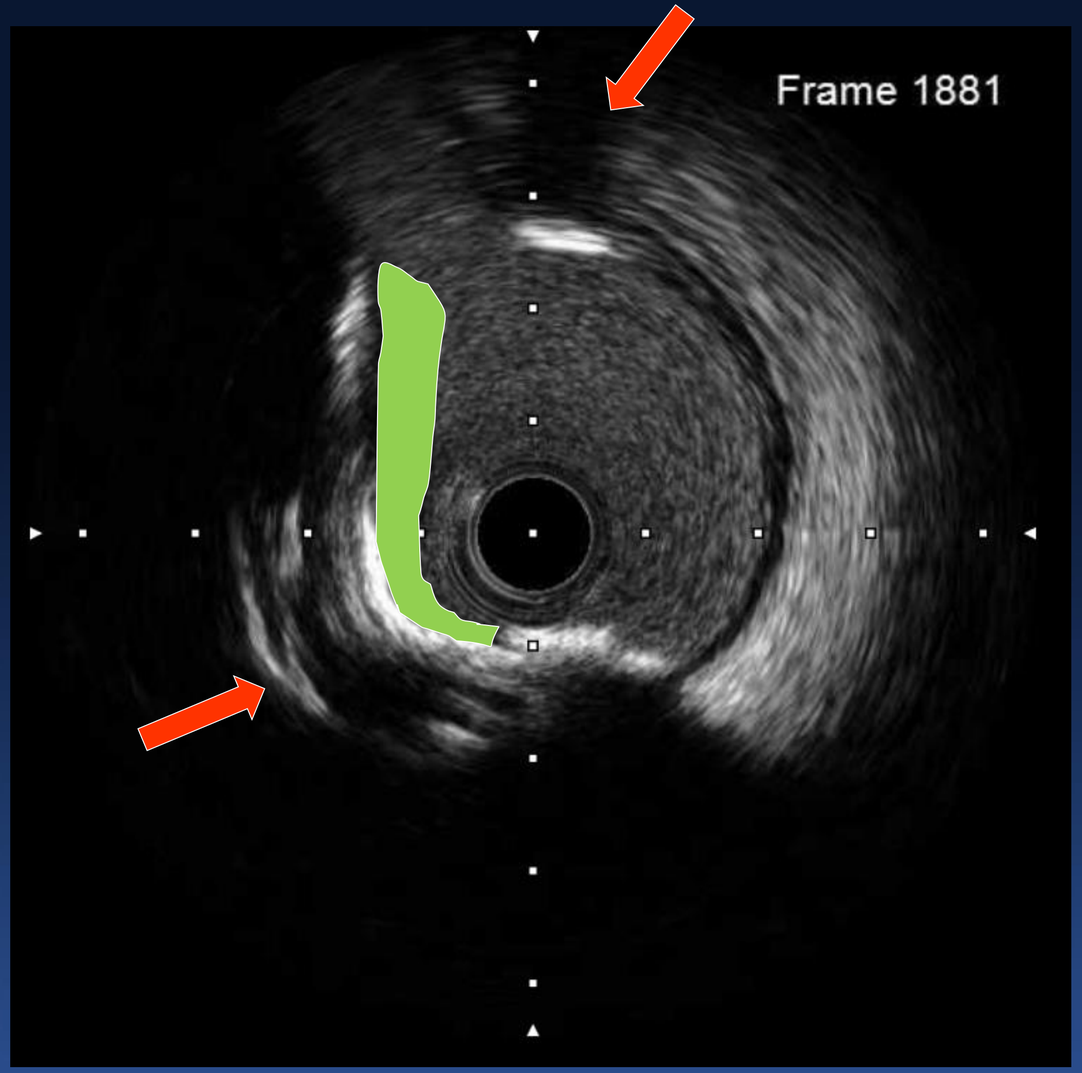
Light dissipates in very thick/deep calcium



Sound is reflected by calcium crystal

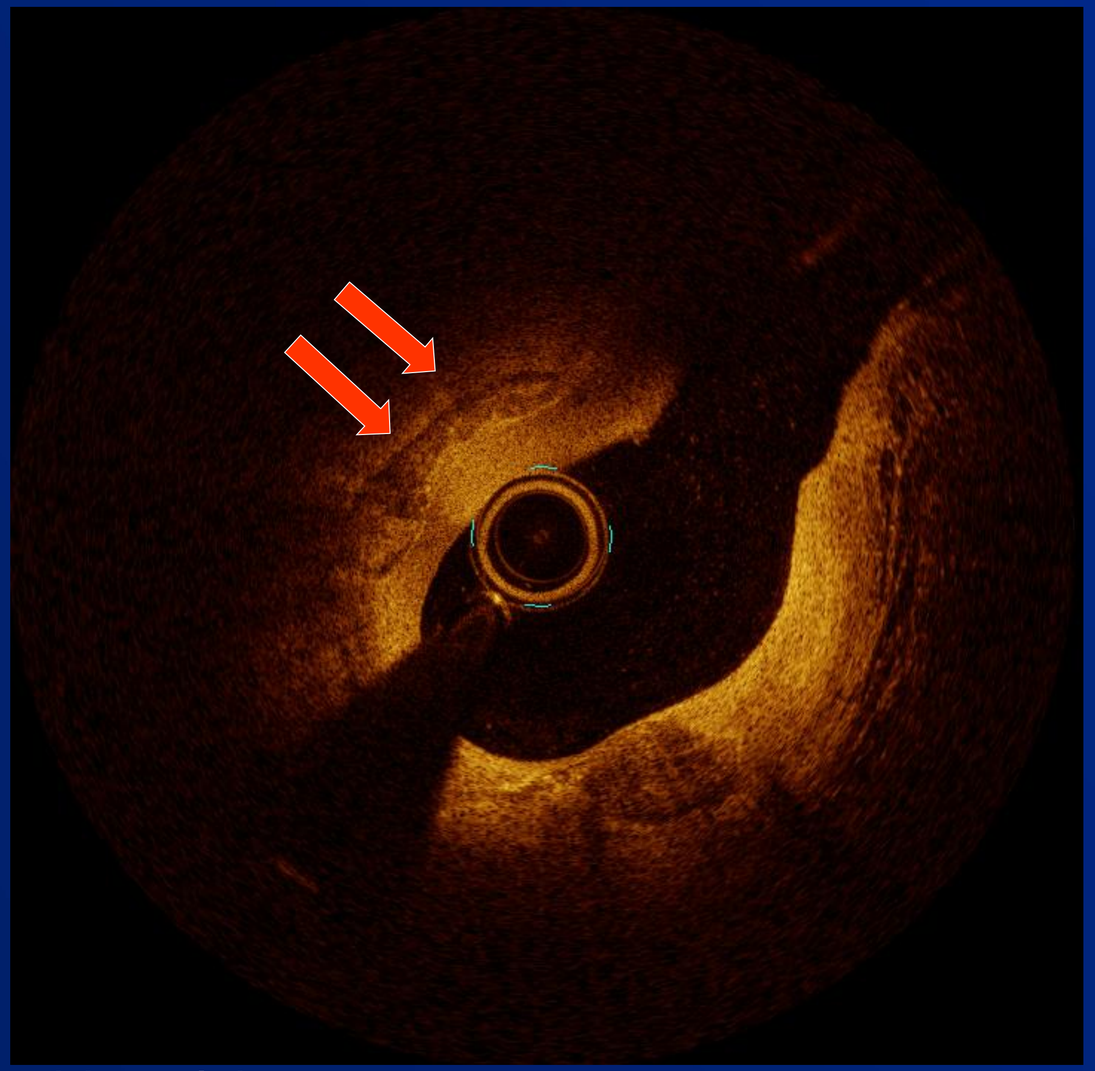
Thin Calcium



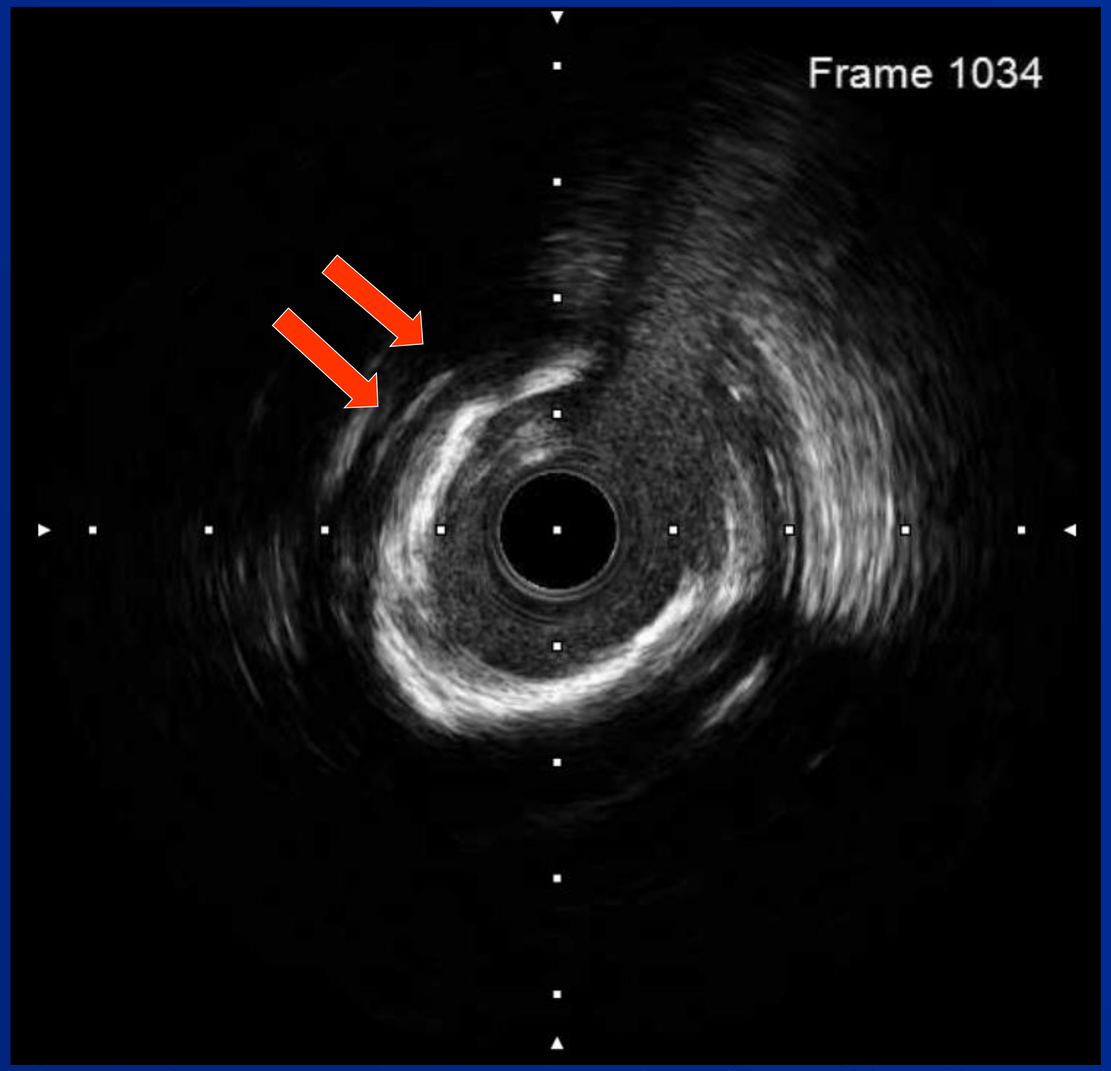


Reflection (echo) of sound obscures intima

Thin Calcium

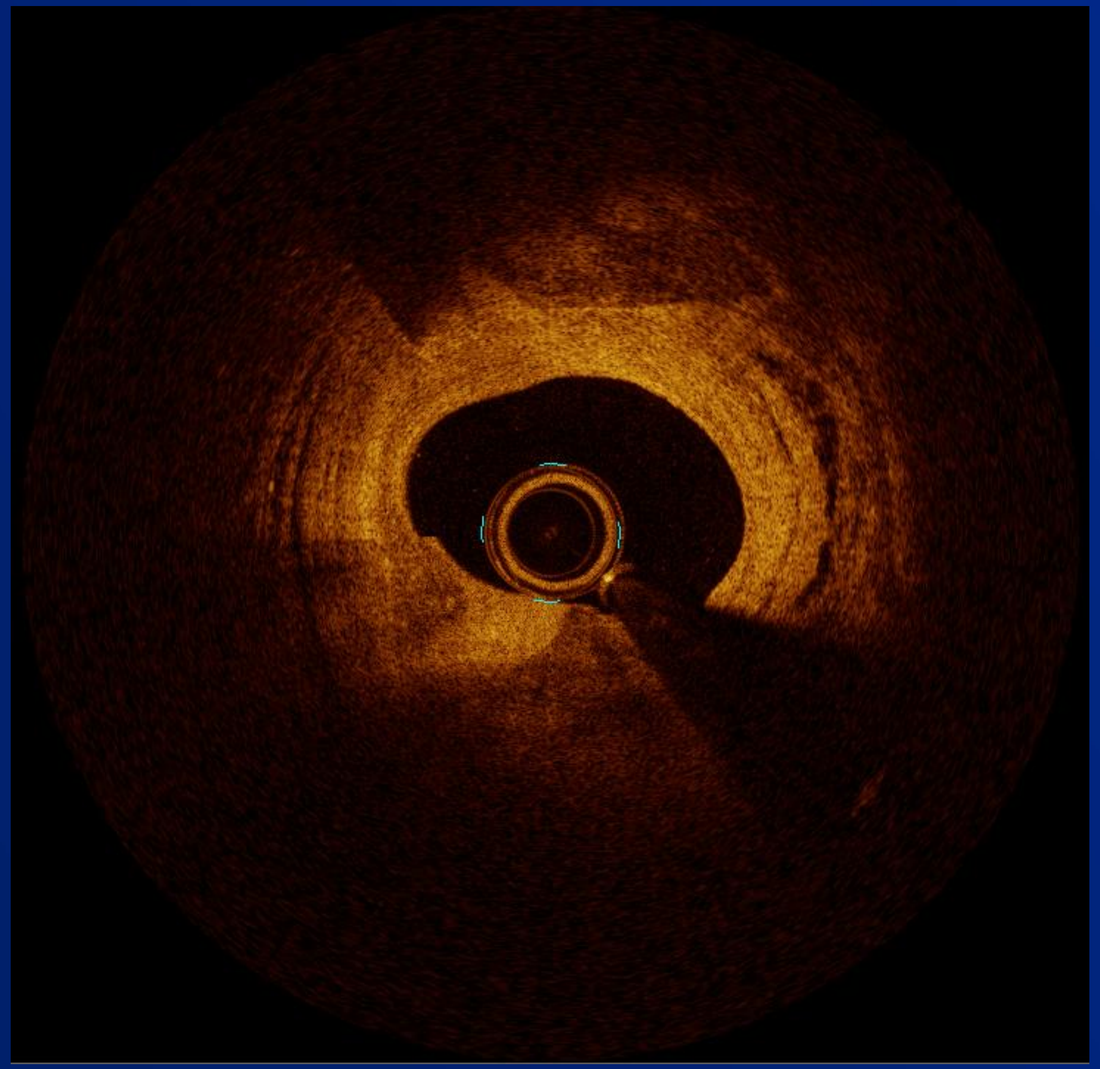


Thin calcium

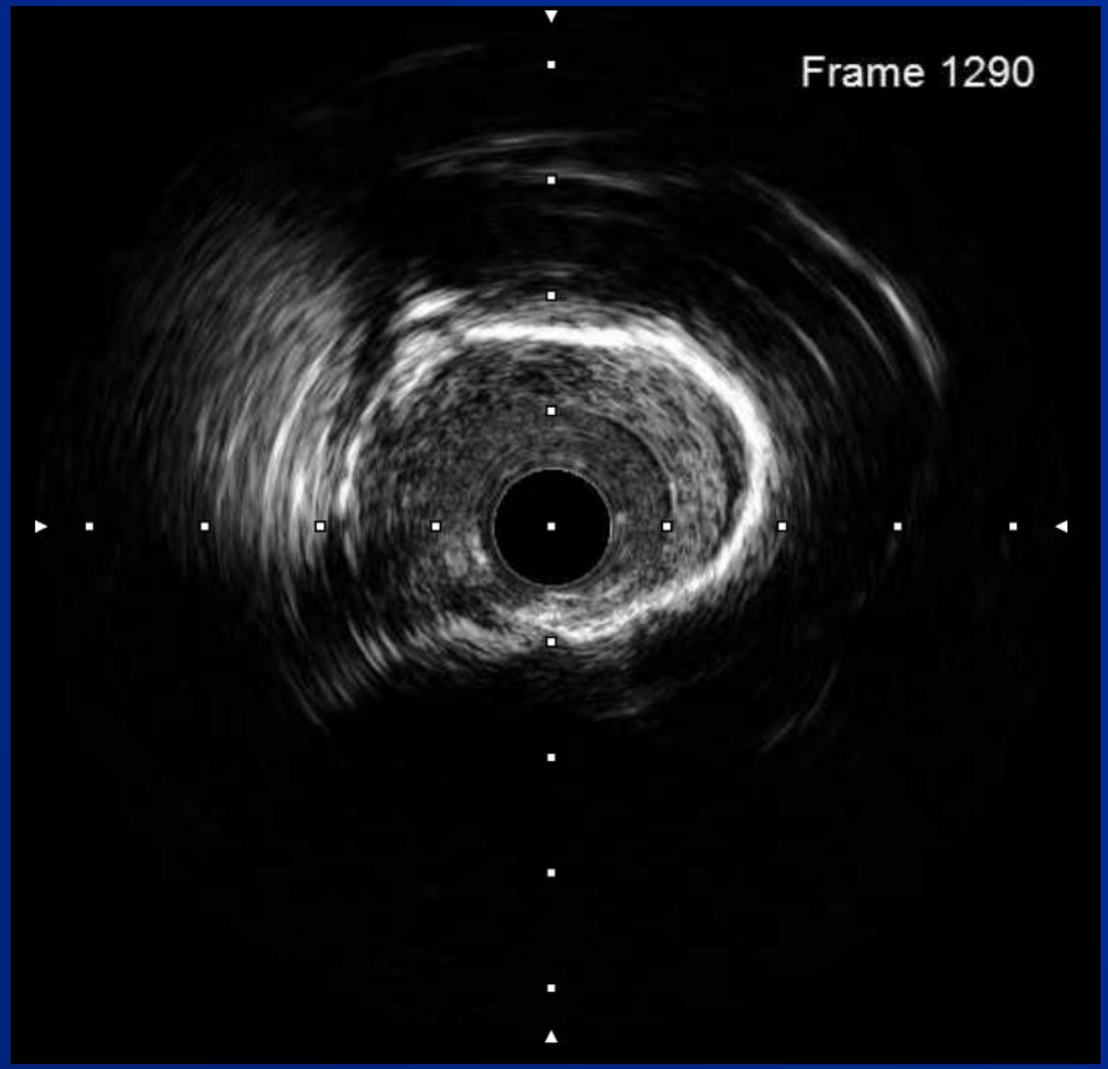


Sound may penetrate or circulate thin Ca

Deep (Thick Cap) Calcium

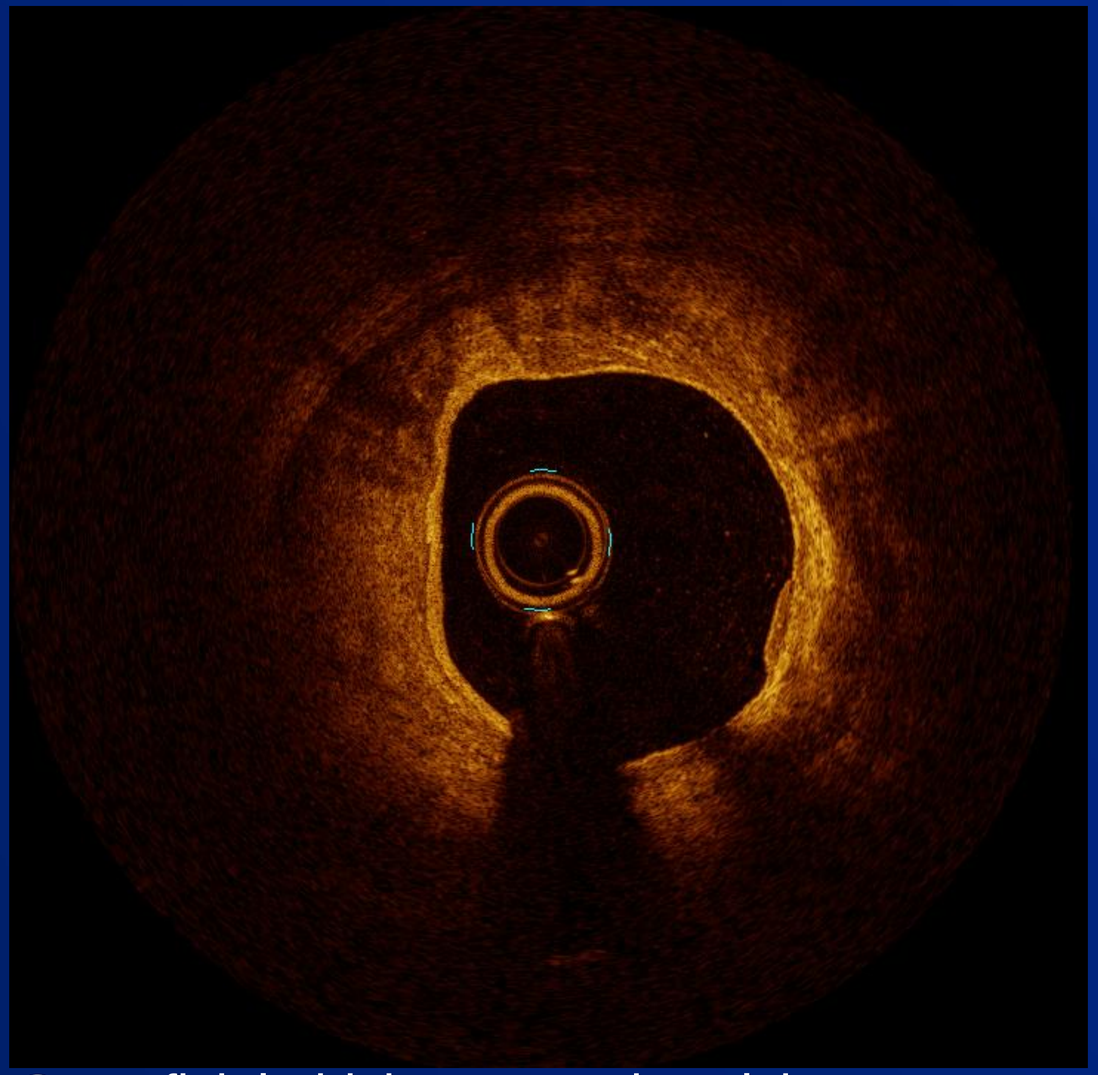


“Deep”, thick cap, calcium

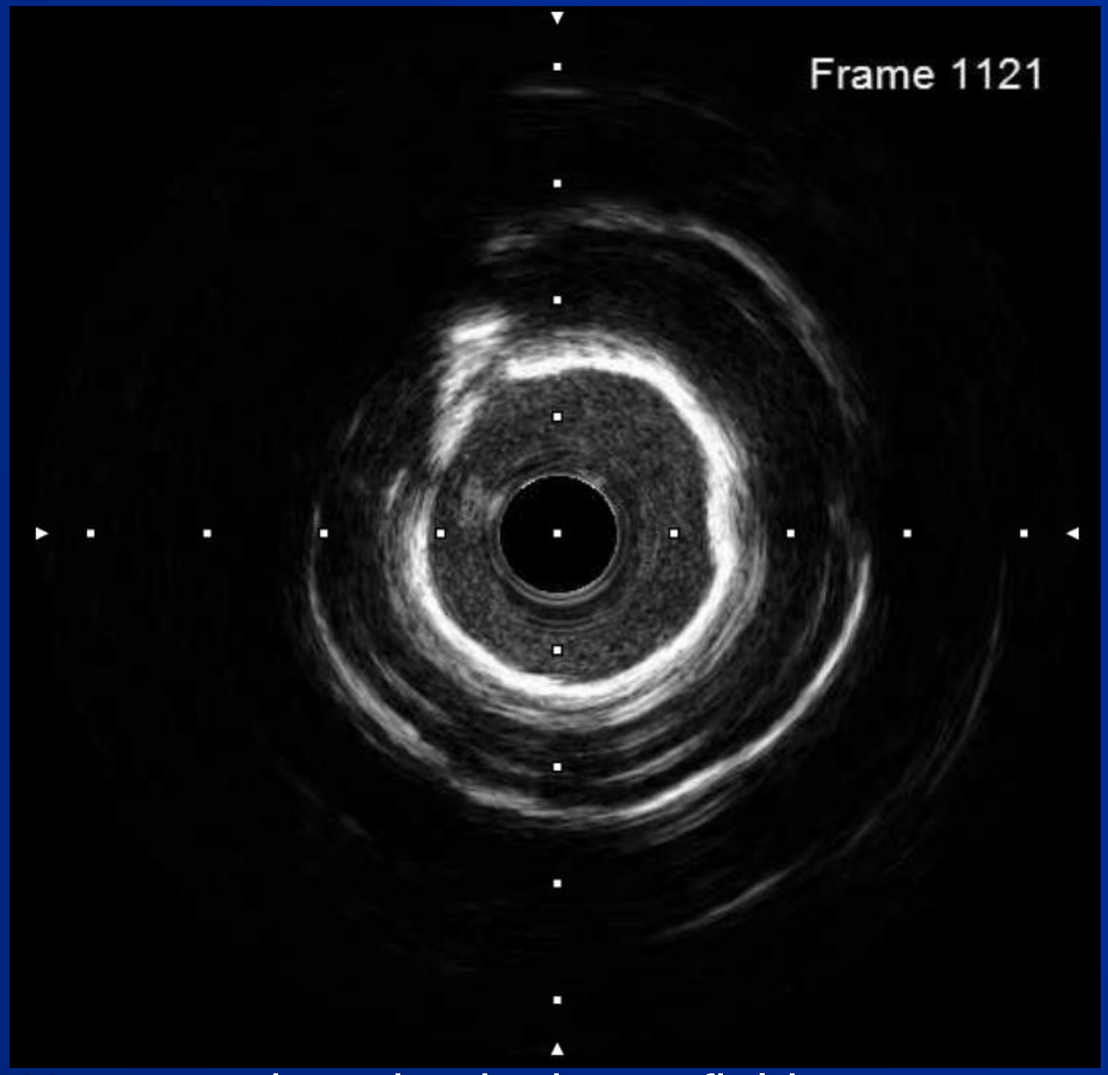


Deep Ca appears closer than it appears

Superfical (Thin Cap) Calcium

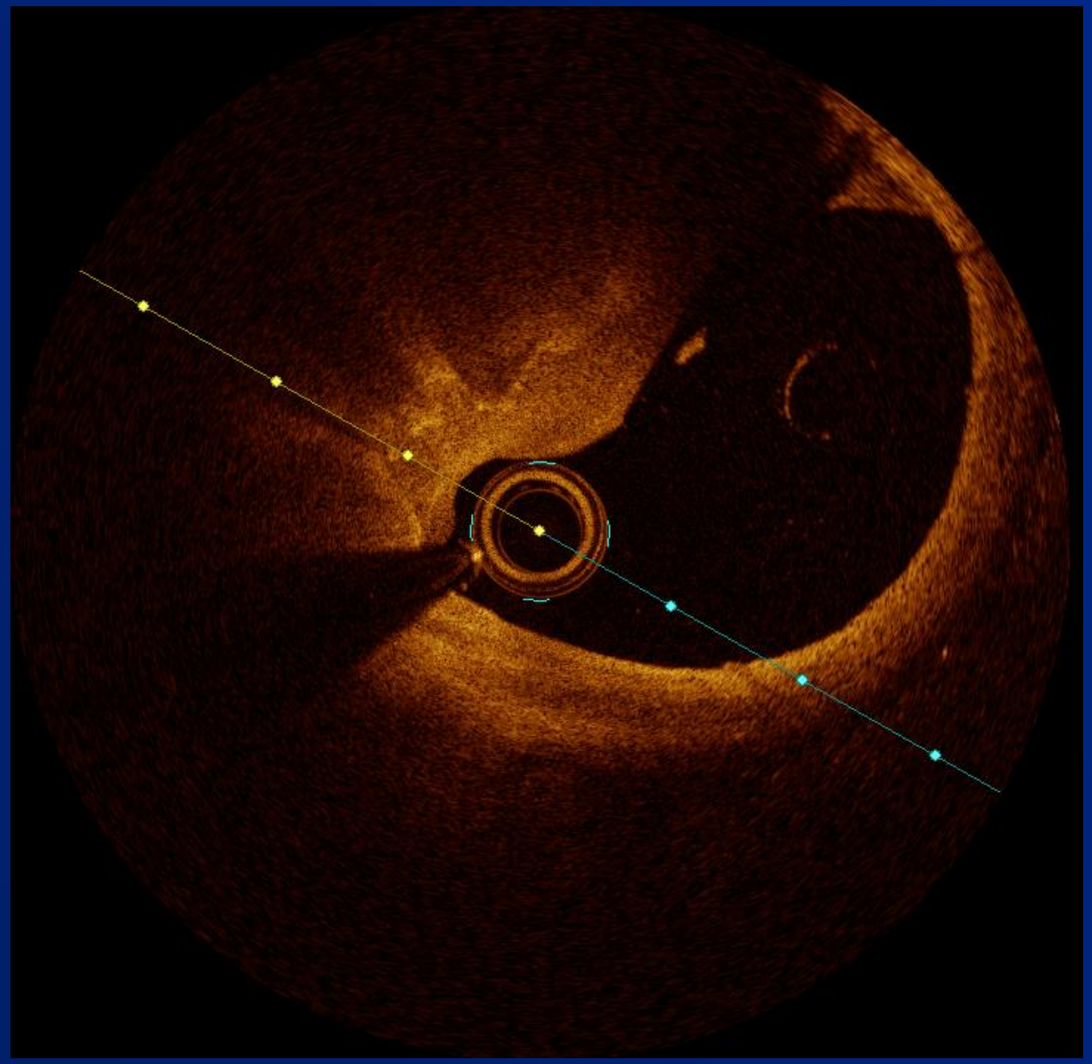


Superficial, thick concentric calcium

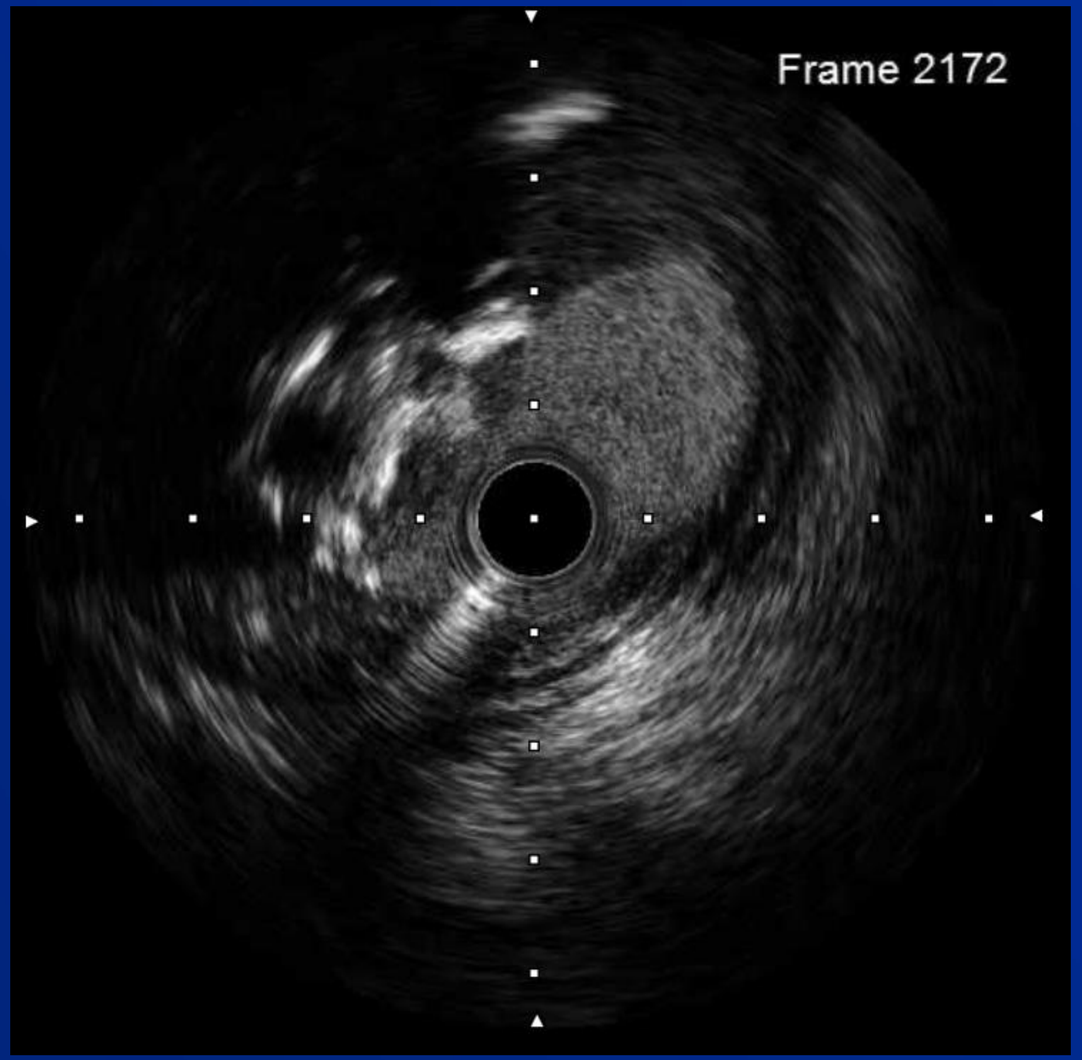


Note reverberation in the outfield

Calcified Nodule

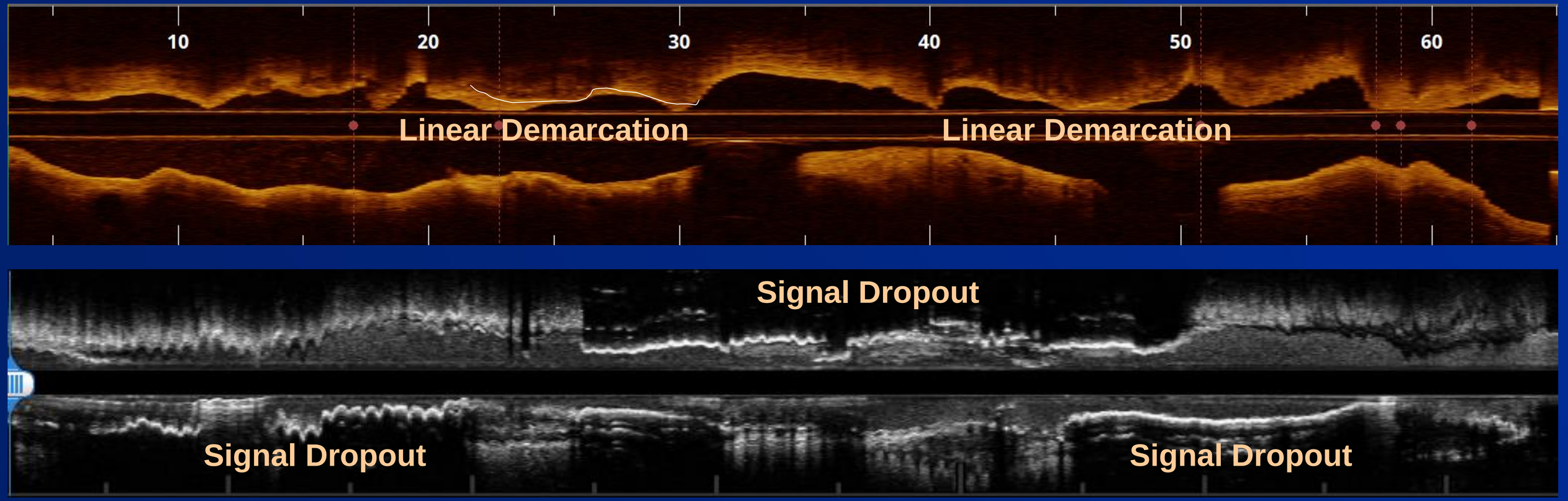


Calcified nodule with overlying intima

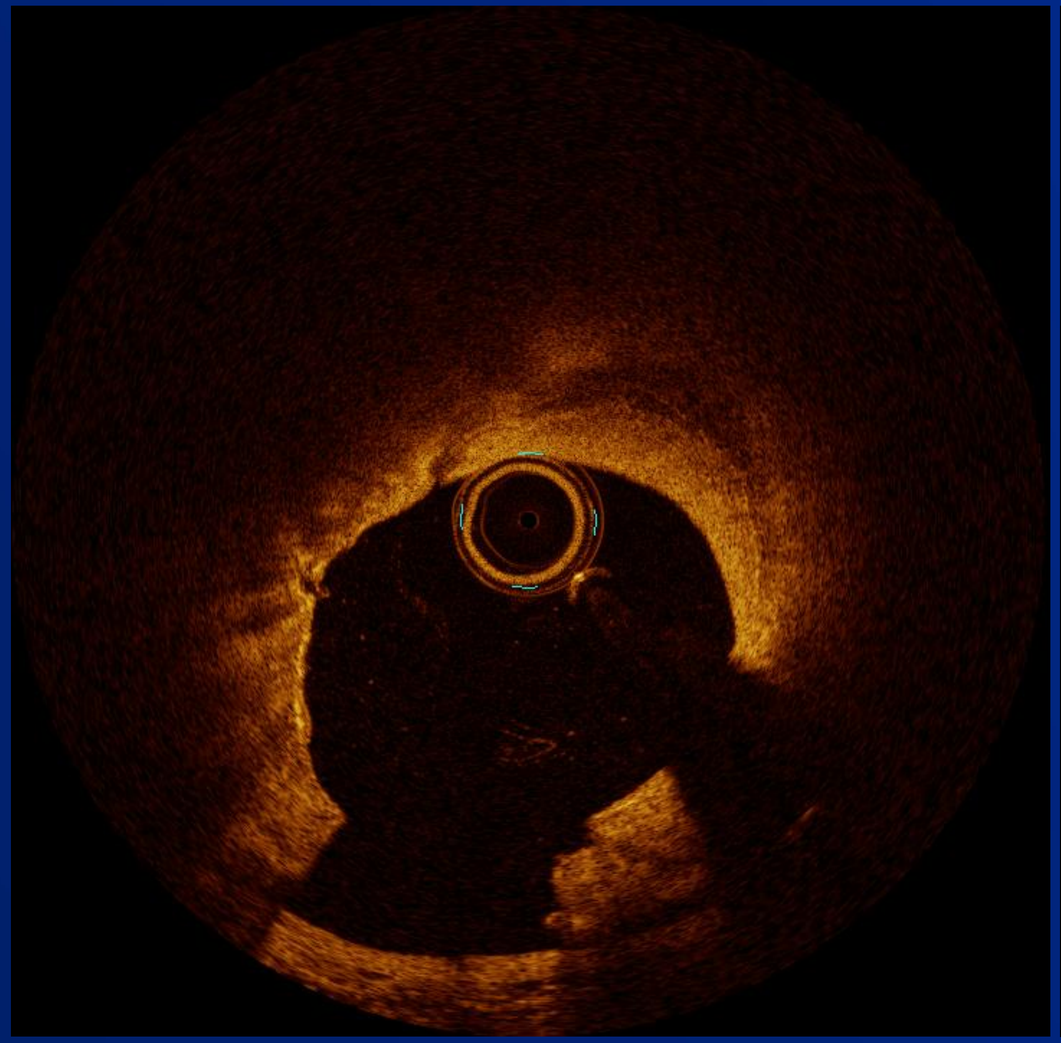


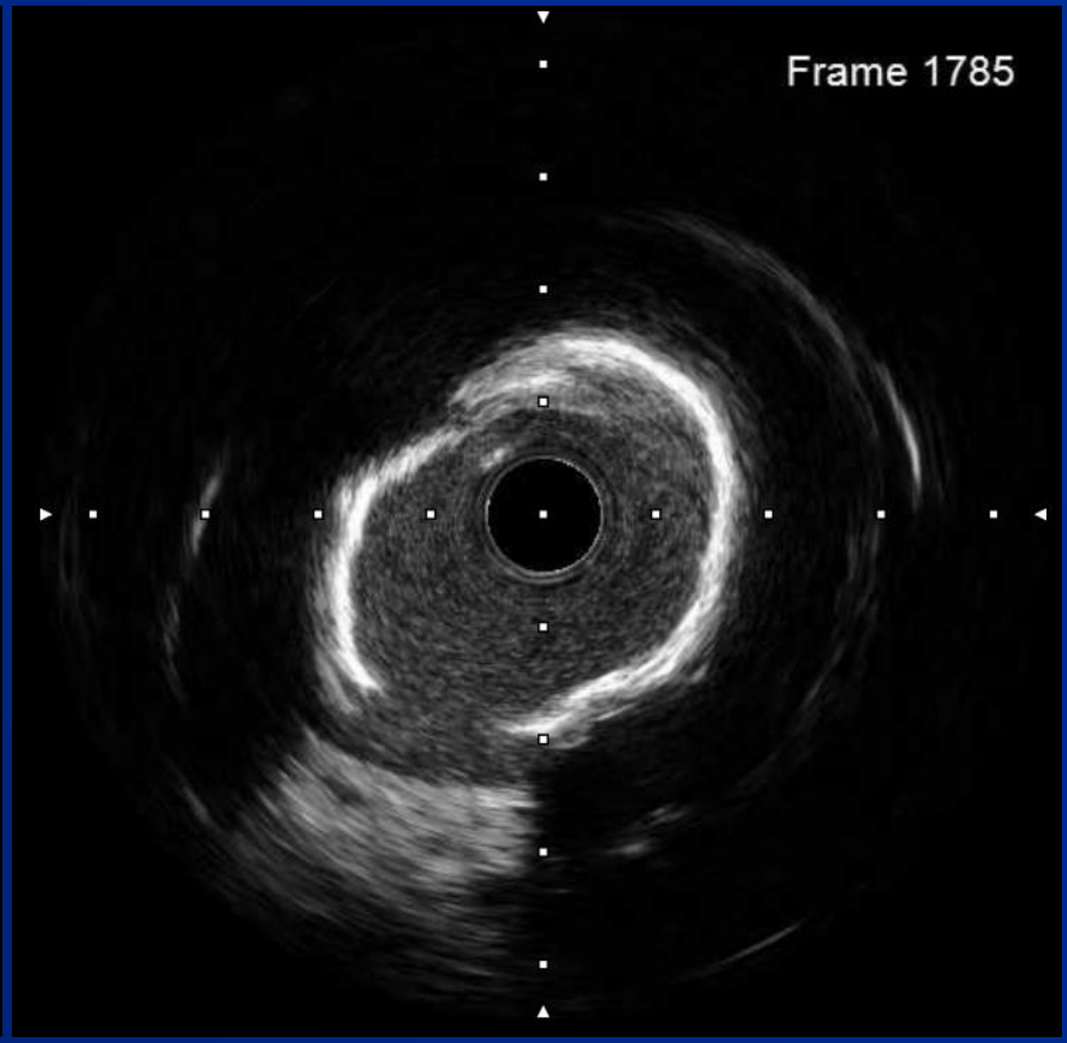
Luminal reflectivity with shadow

Calcium Length

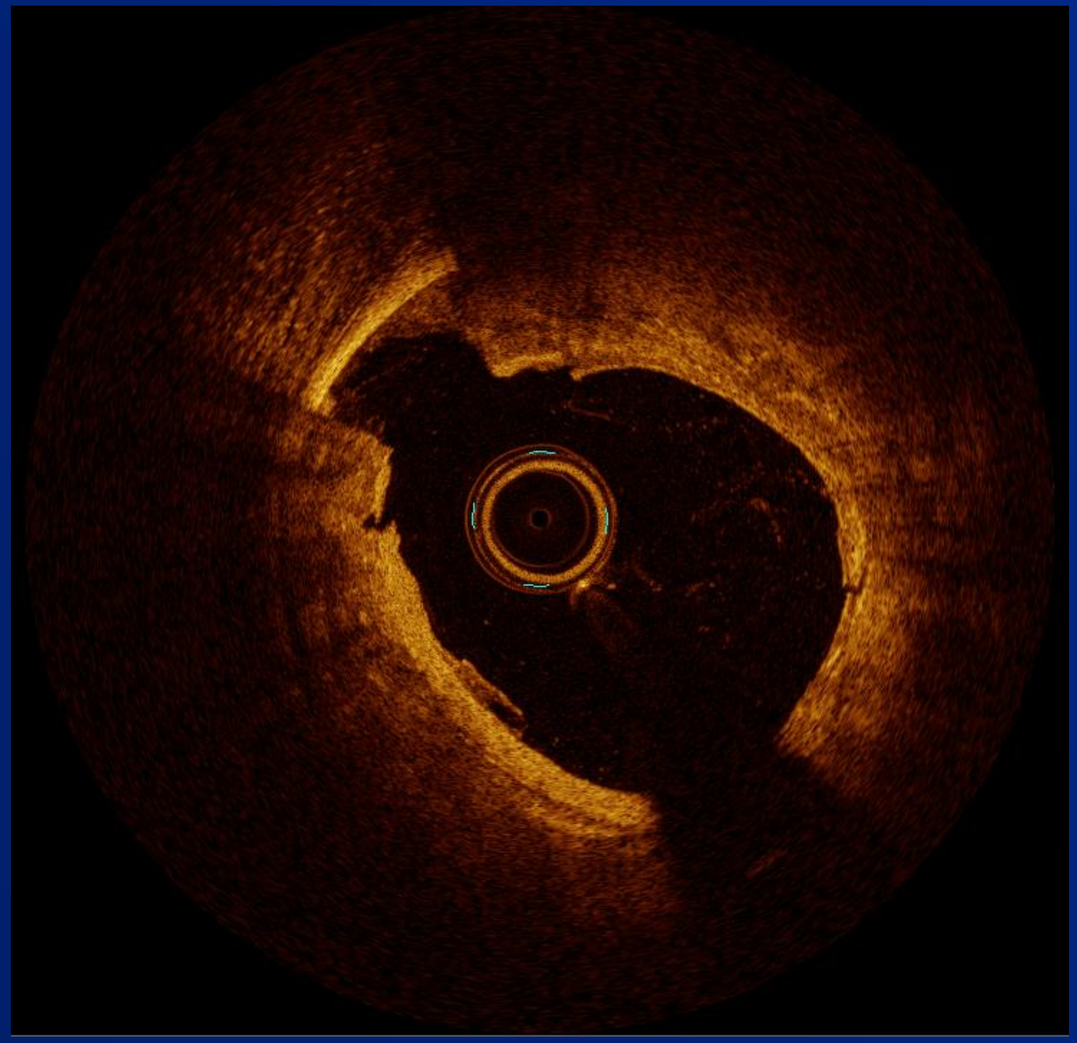


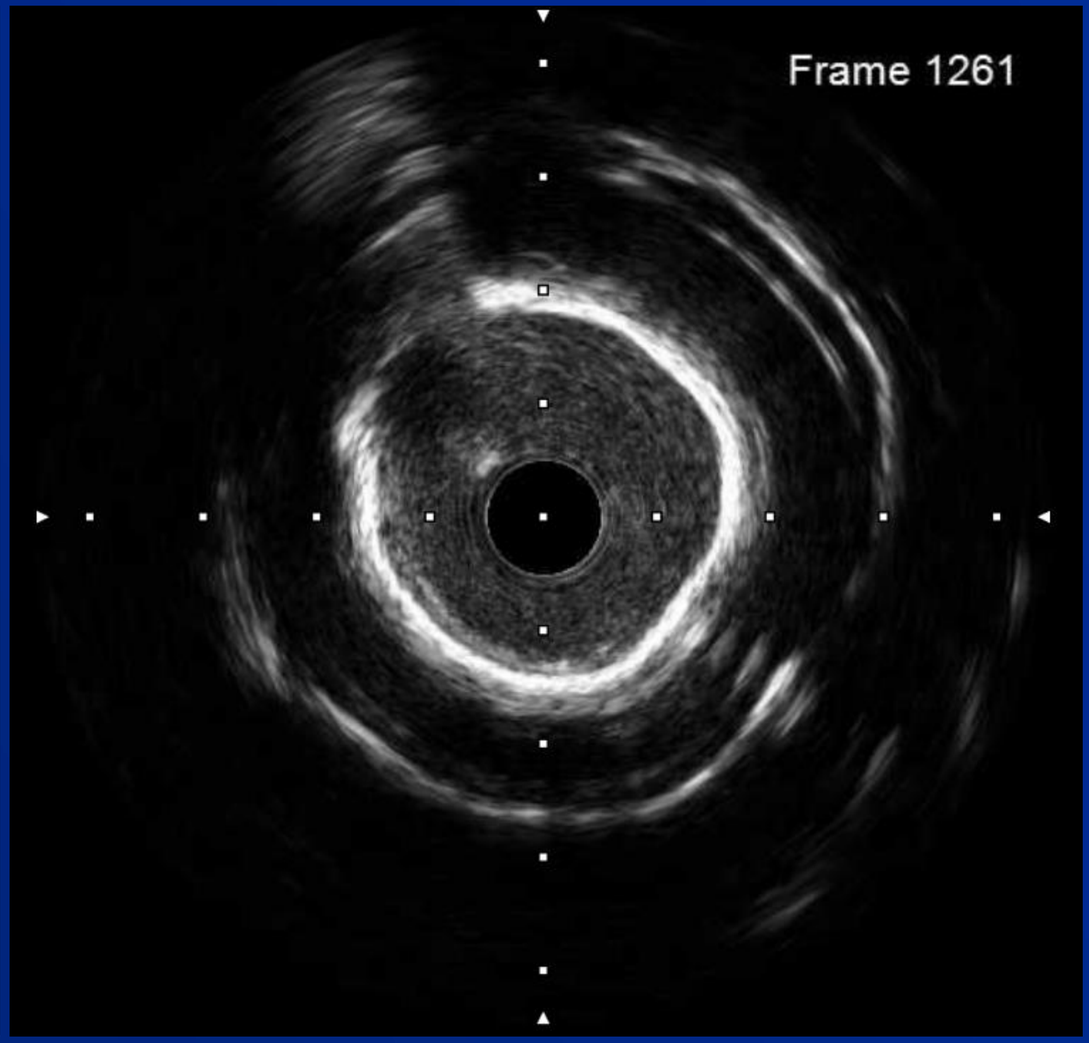
Calcium Fracture



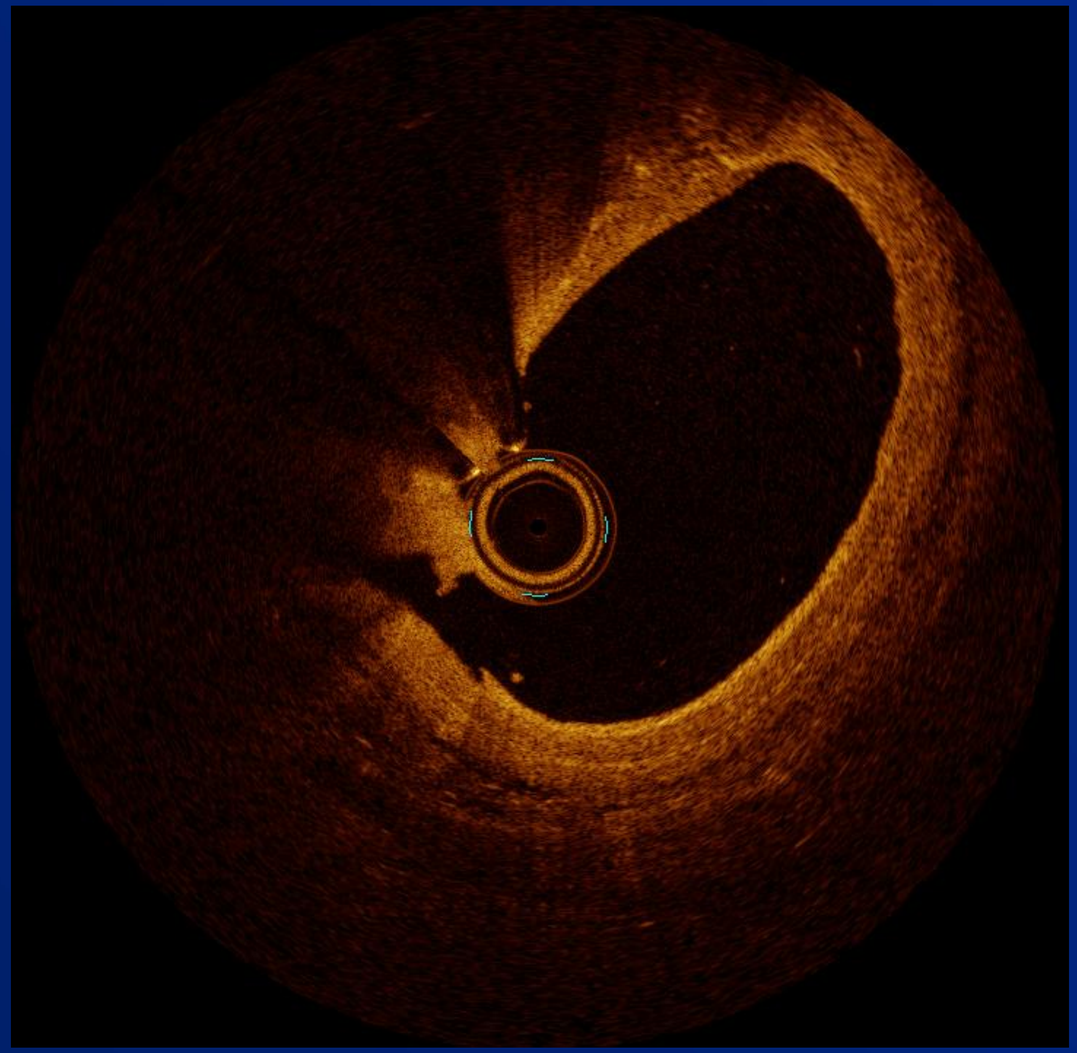


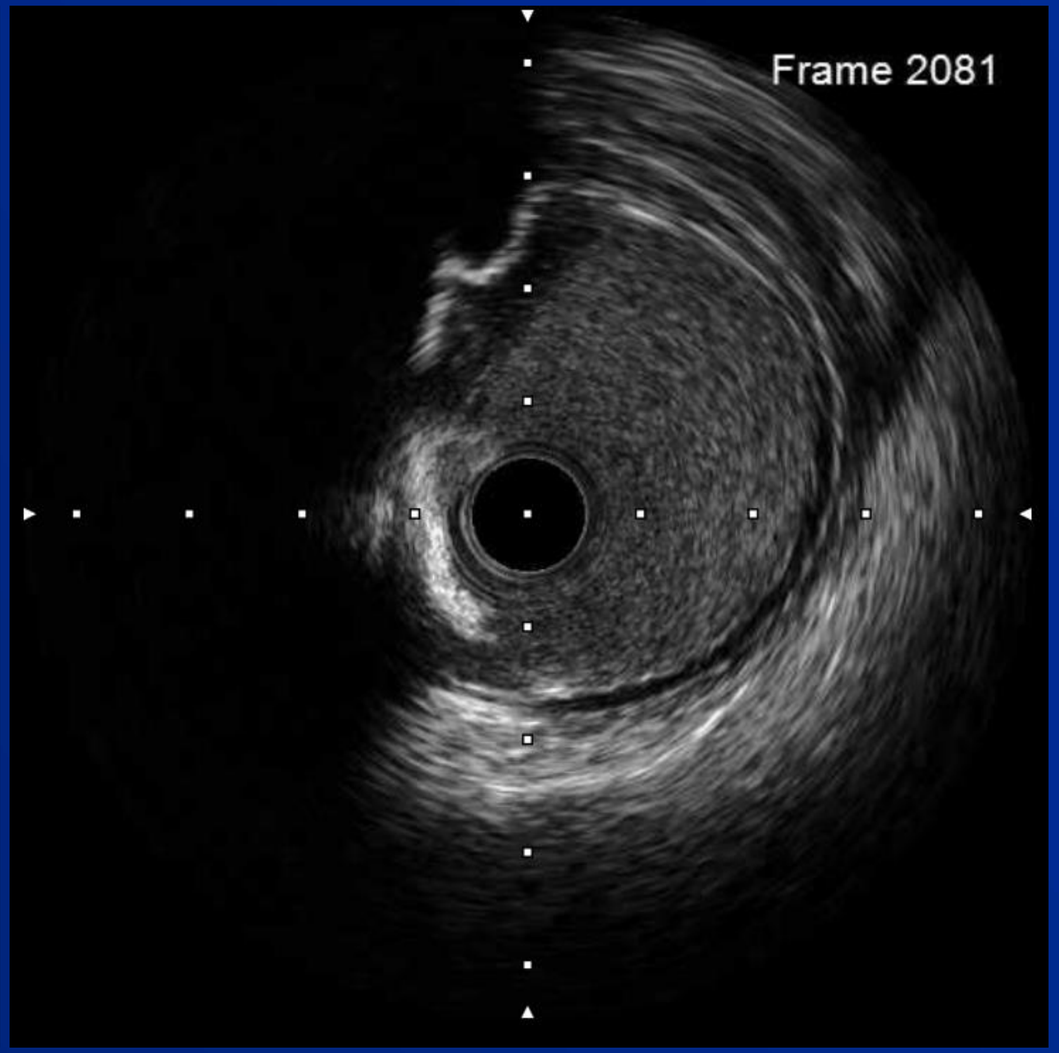
Calcium Fracture





Calcium Nodule Fracture

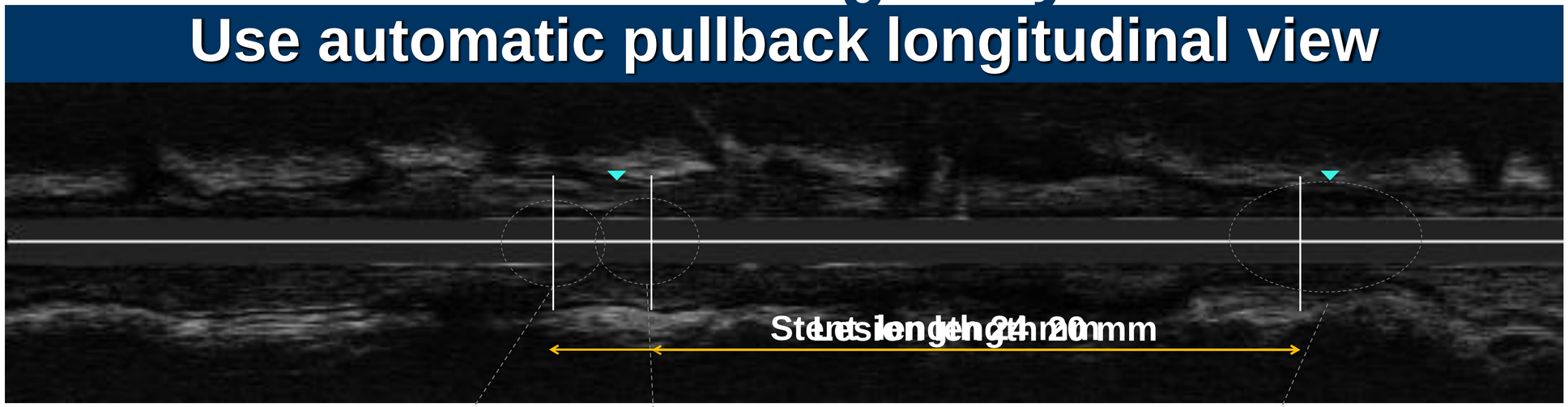




Length

Determine Length by IVUS

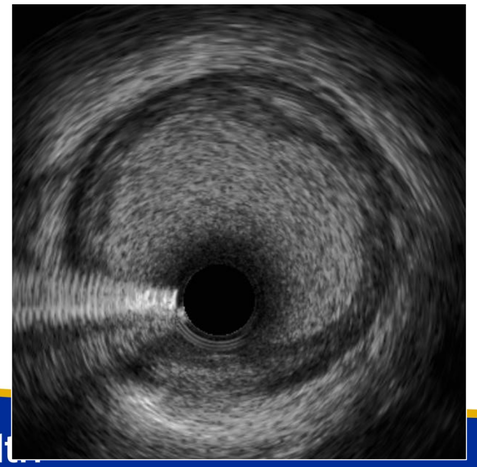
Use automatic pullback longitudinal view

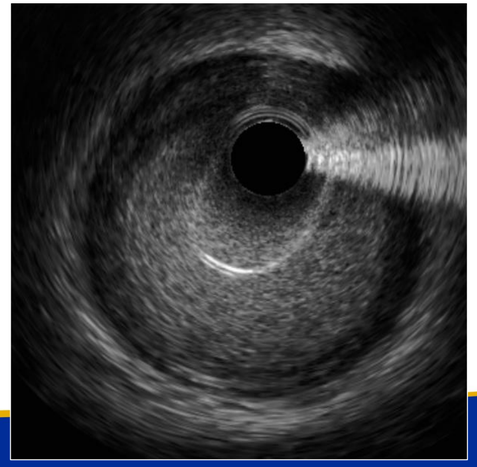


1) Scroll reference vessel markers to proximal and distal lesion edges by approximation.

2) Identify segments of vessel proximally and distally within where plaque burden <50%, if necessary

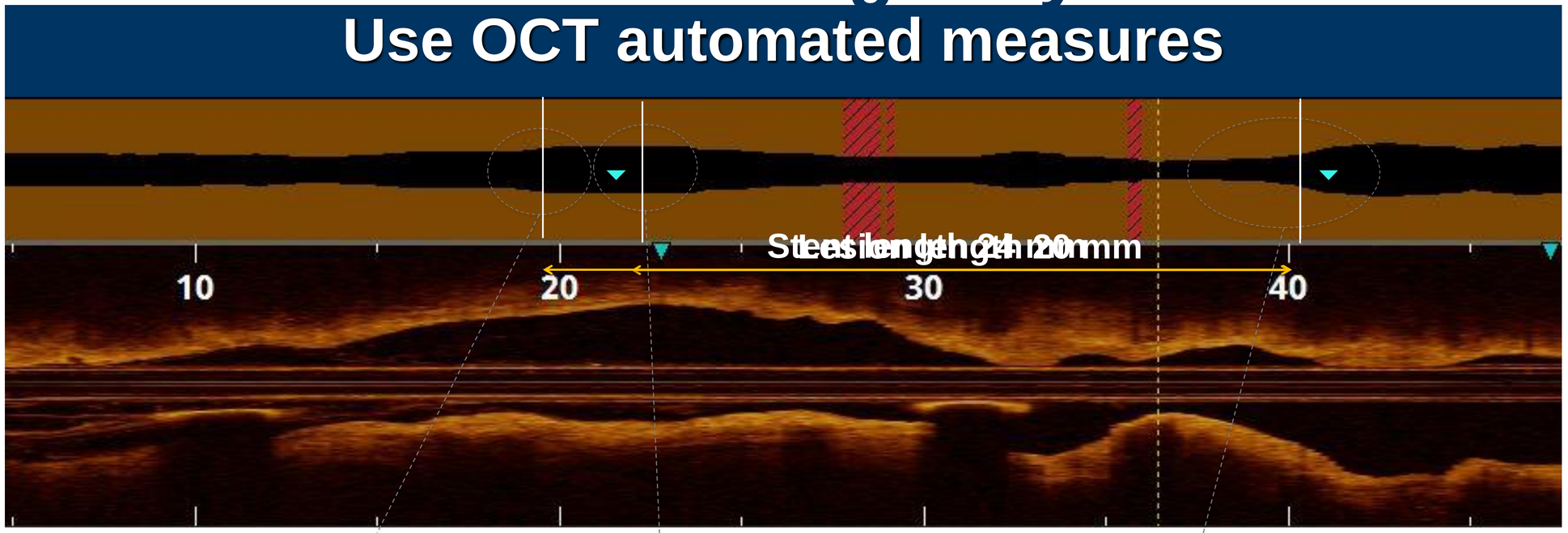
3) Reposition reference scroll marker accordingly





Determine Length by OCT

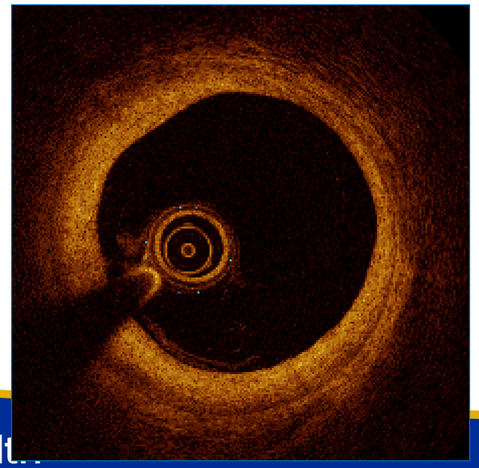
Use OCT automated measures

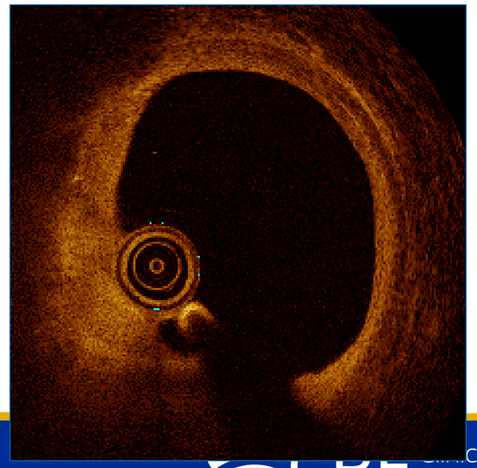


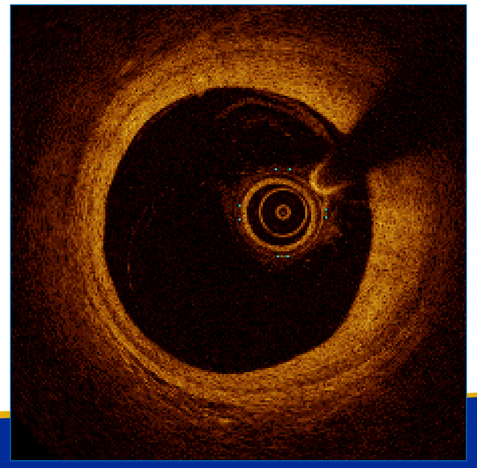
1) Scroll reference vessel markers to proximal and distal lesion edges per OCT lumen profile

2) Identify segment of vessel proximally and distally where the EEL is visible enough to make a diameter measurement

3) Reposition reference scroll marker accordingly







Diameter

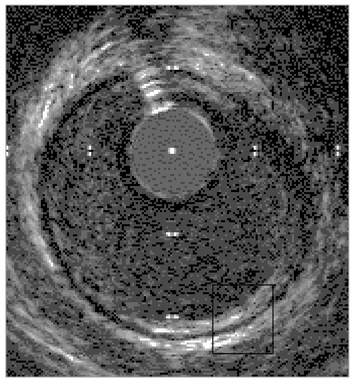
IVUS Stent Sizing Algorithm

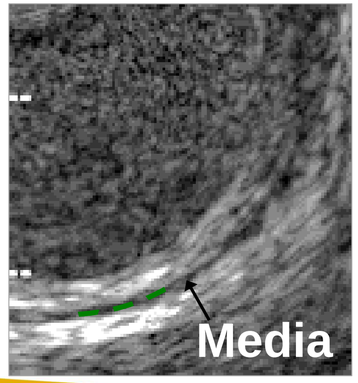
Pre-PCI IVUS

Measure the media-media at both proximal and distal reference segments.

Is the plaque burden at the distal reference segment <50%?

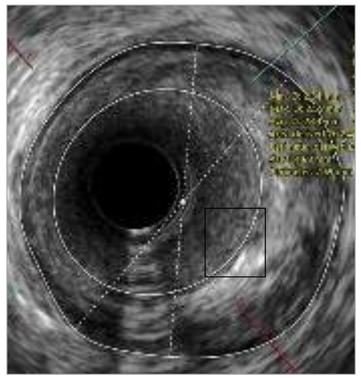
Yes

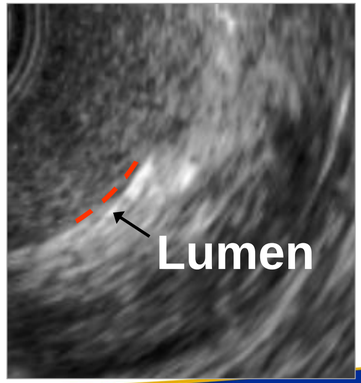




Stent diameter decided by IVUS measurement of mean media to media diameter rounded down to nearest stent size

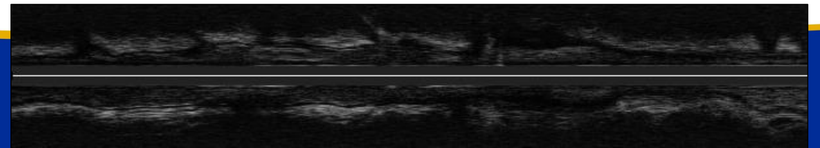
No





Stent diameter decided by IVUS measurement of mean lumen diameter rounded up to nearest stent size

Reference stent length decided by IVUS measurement adjusted to available DES size.



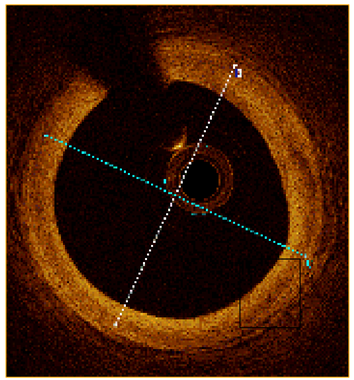
OCT Stent Sizing Algorithm

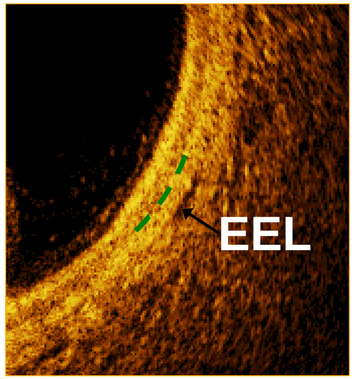
Pre-PCI OCT

Measure the EEL at both proximal and distal reference segments, if possible.

Can the EEL be identified at the distal reference segment to allow vessel diameter measurement?

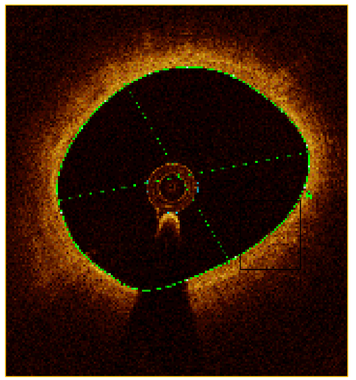
Yes

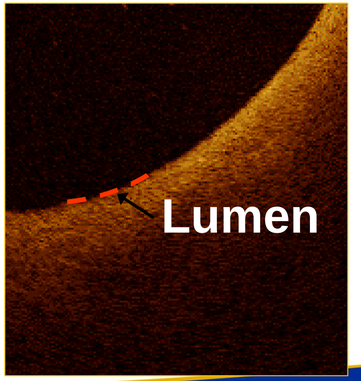




Stent diameter decided by OCT measurement of mean EEL to EEL diameter rounded down to nearest stent size

No



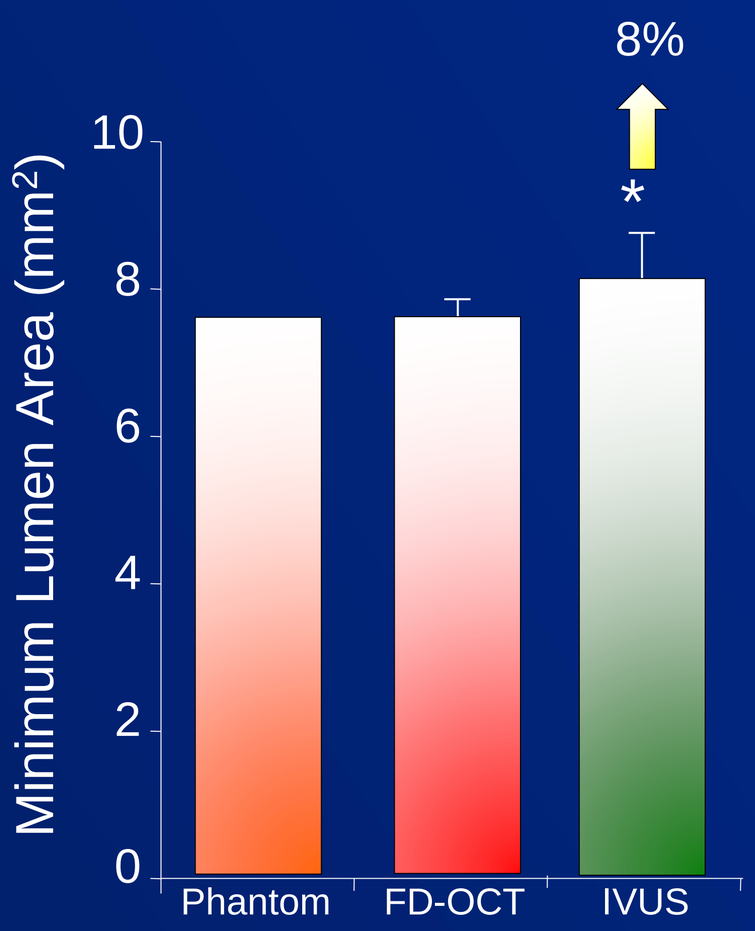


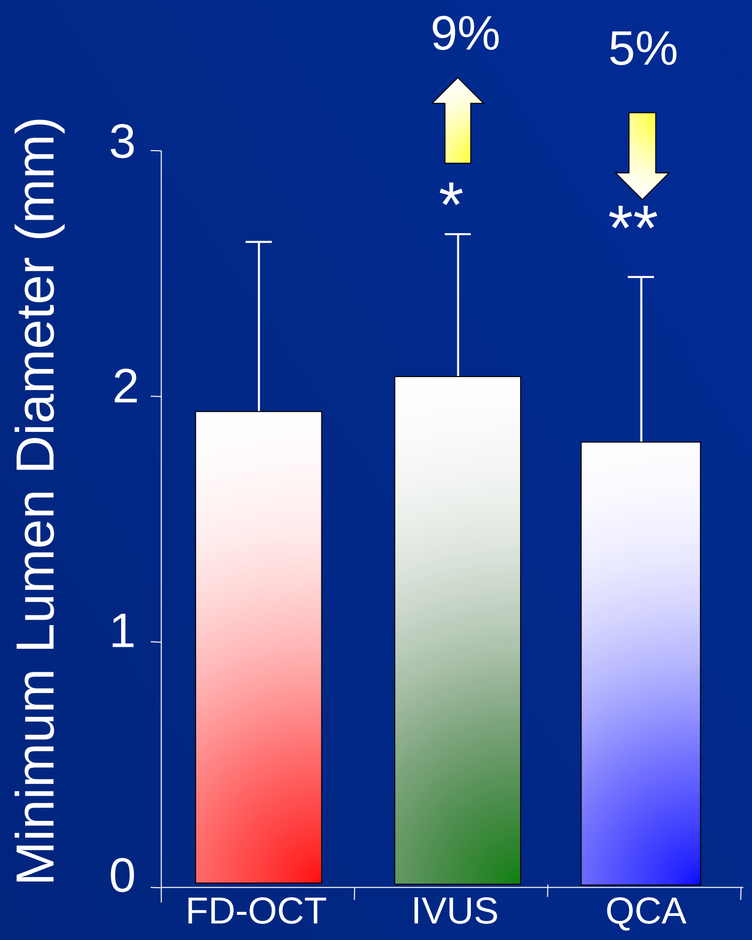
Stent diameter decided by OCT measurement of mean lumen diameter rounded up to nearest stent size

Reference stent length decided by OCT Automation adjusted to available DES size.

IVUS Oversizing

OPUS-CLASS (Phantom vs OCT vs IVUS)





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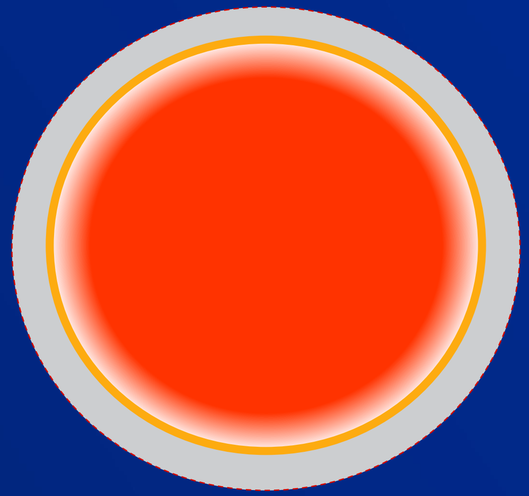
OPTIMIZING PCI
INTRAVASCULAR IMAGING & CORONARY PHYSIOLOGY

IVUS Oversizing

Histology

MLD 3.0mm

IVUS



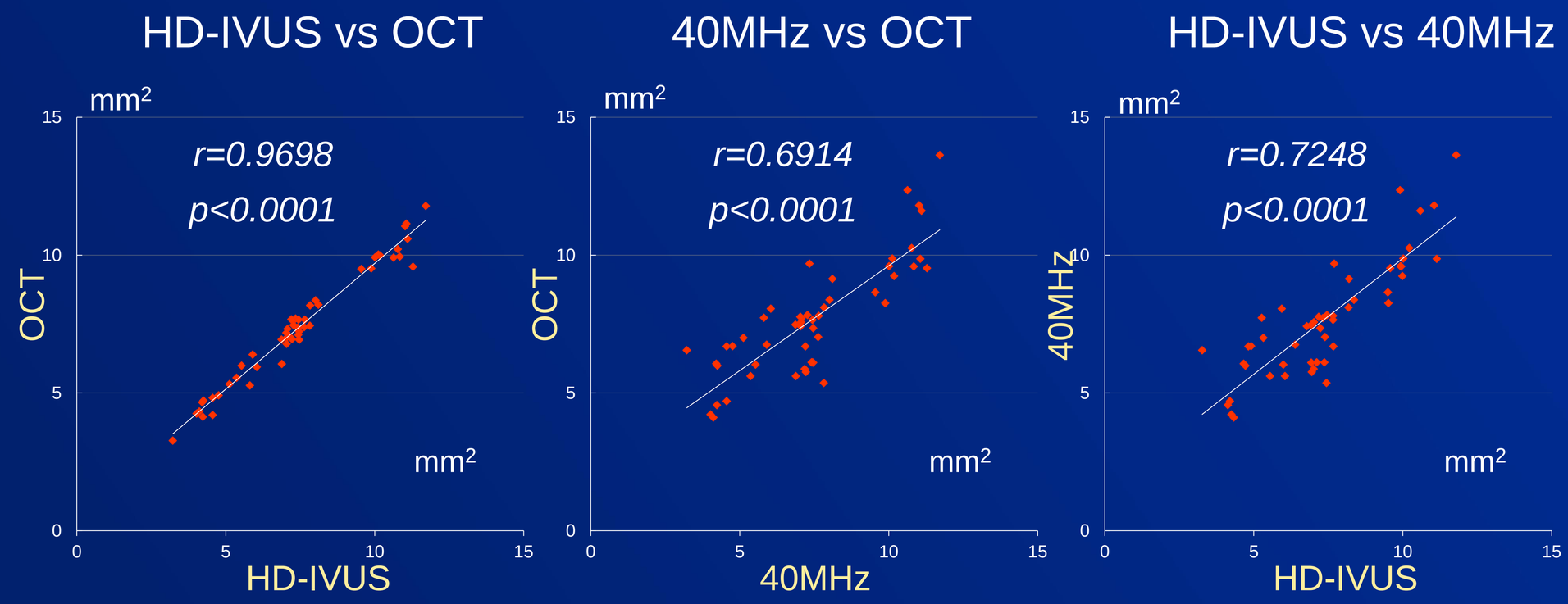
MLD 3.3mm

3.25mm stent

8.5mm^2

In Vitro Correlation of Lumen Area

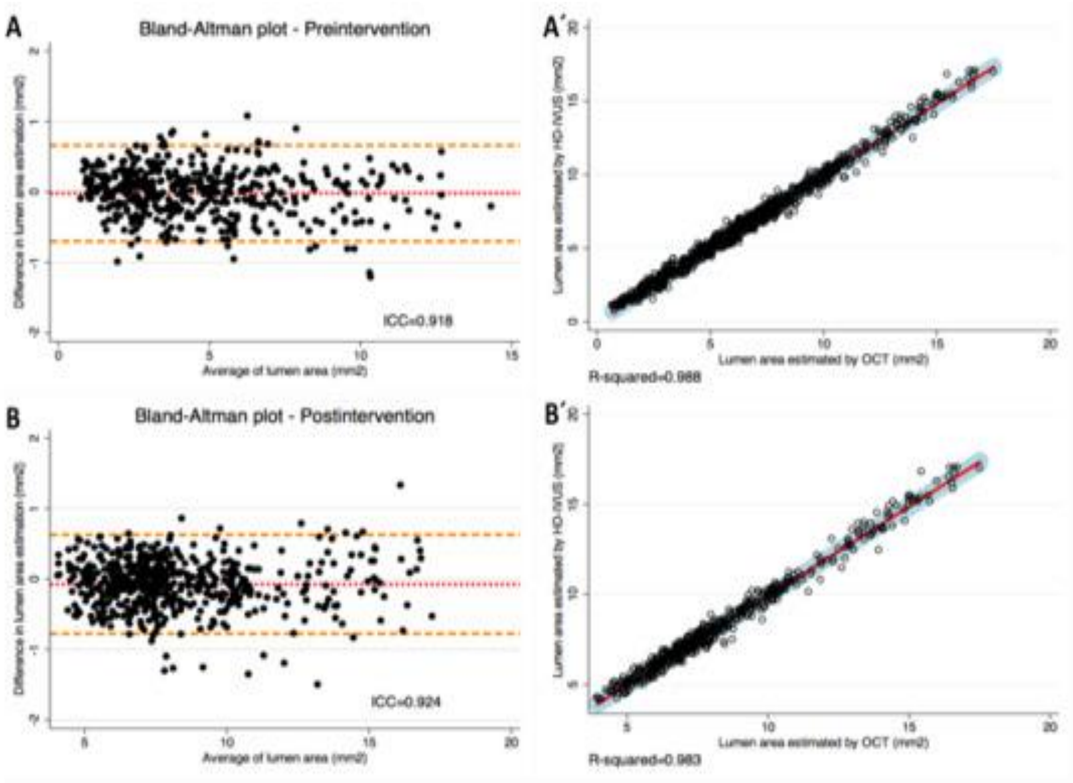
HD-IVUS vs 40 MHz IVUS and OCT



In Vivo Correlation of Lumen Area
HD-IVUS vs and OCT

HD-IVUS;

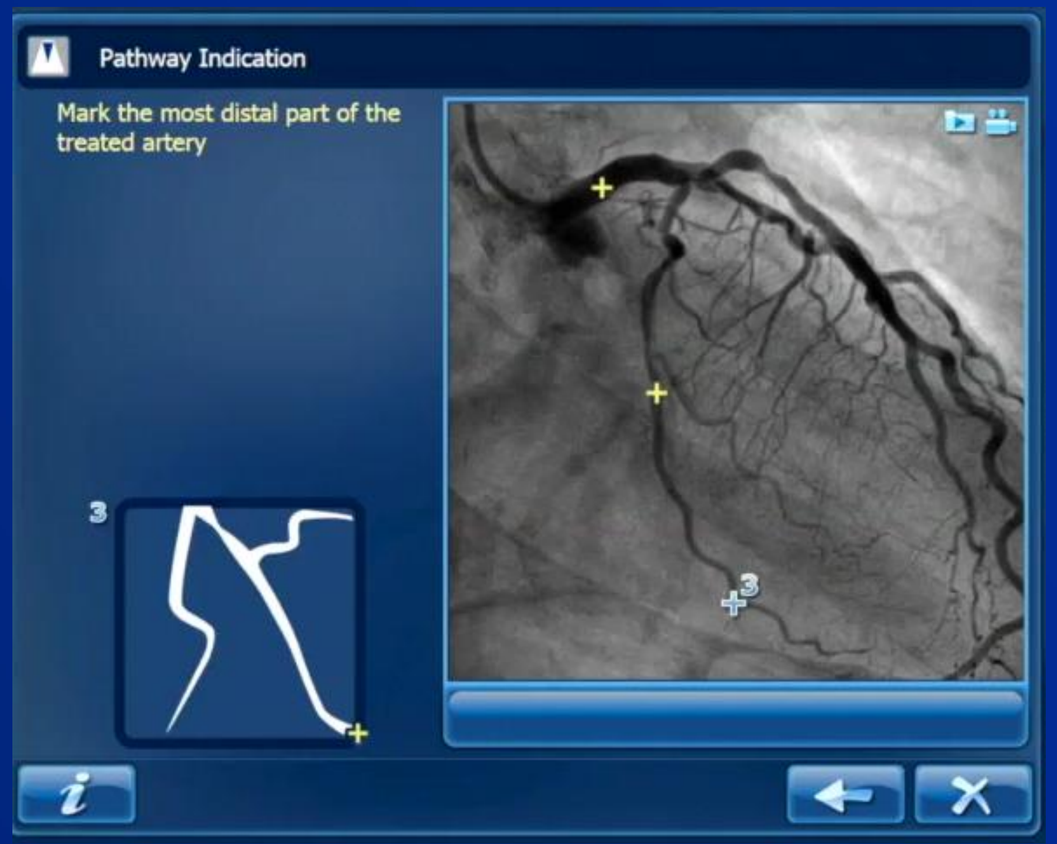
- Superior for EEM
  325±59º vs 200±61º
- Comparable LA
  6.6±3.3 vs 6.6±3.3mm^2
- Mean difference
  0.05±0.35mm^2



Garcia-Guimaraes et al. iJACC. 2019 Oct 11

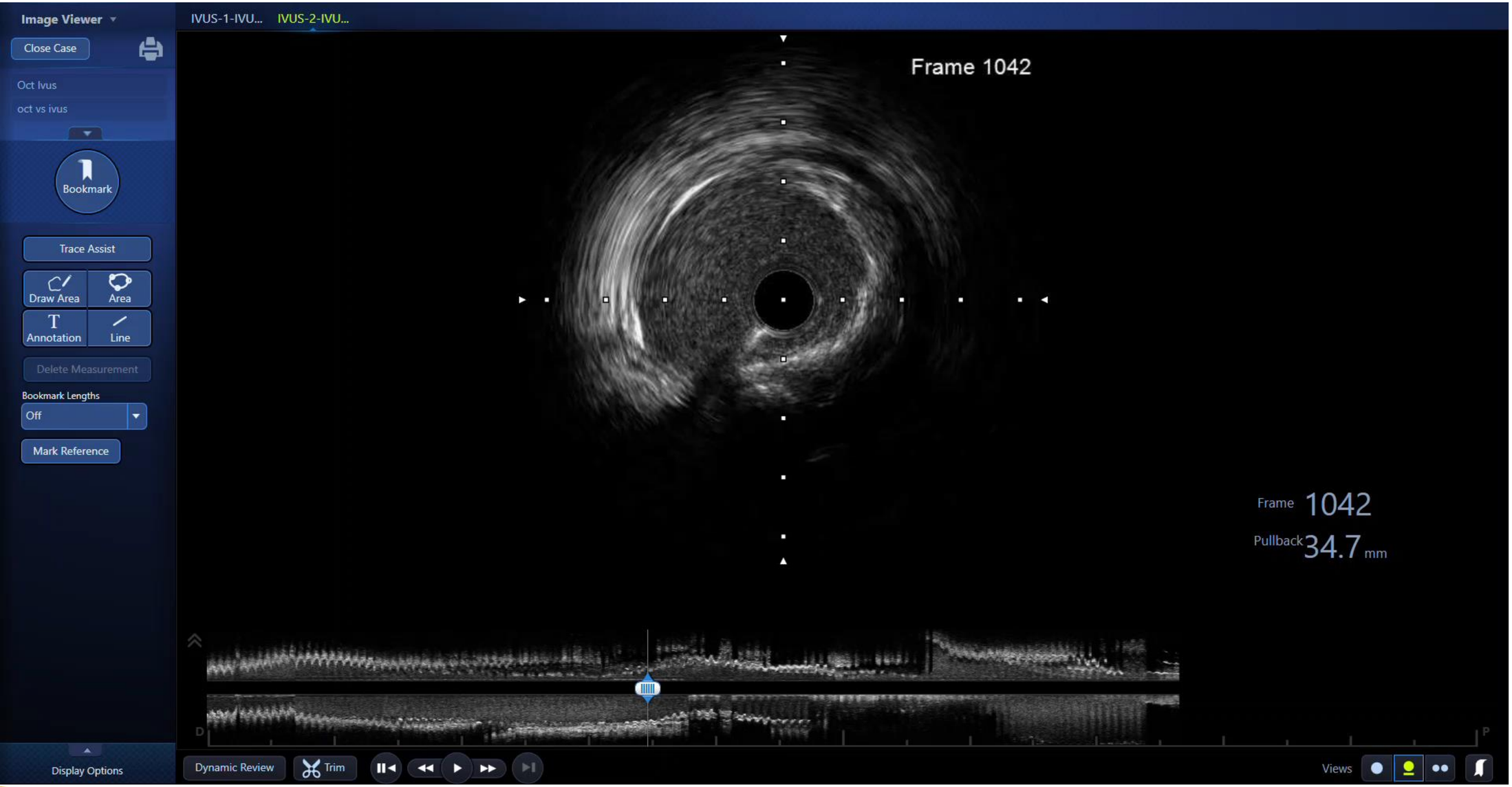
Co-Registration

Angiographic Co-registration



Medial Dissection

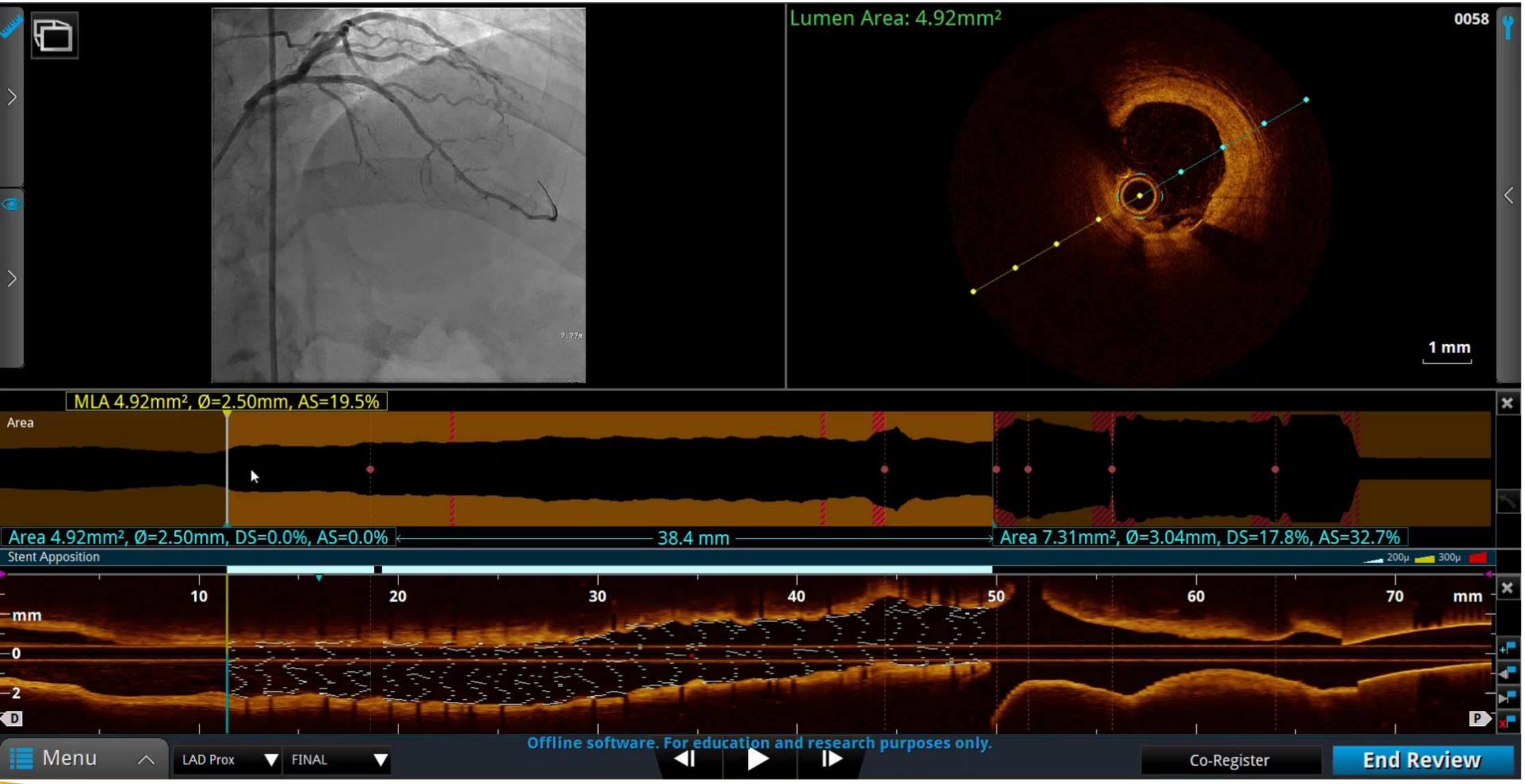
Post-PCI – Medial Dissection IVUS



Identify Edge Dissection;

- Edge Dissection
- ≥ 1 quadrant
- Penetrates the media

Post-PCI – Medial Dissection OCT

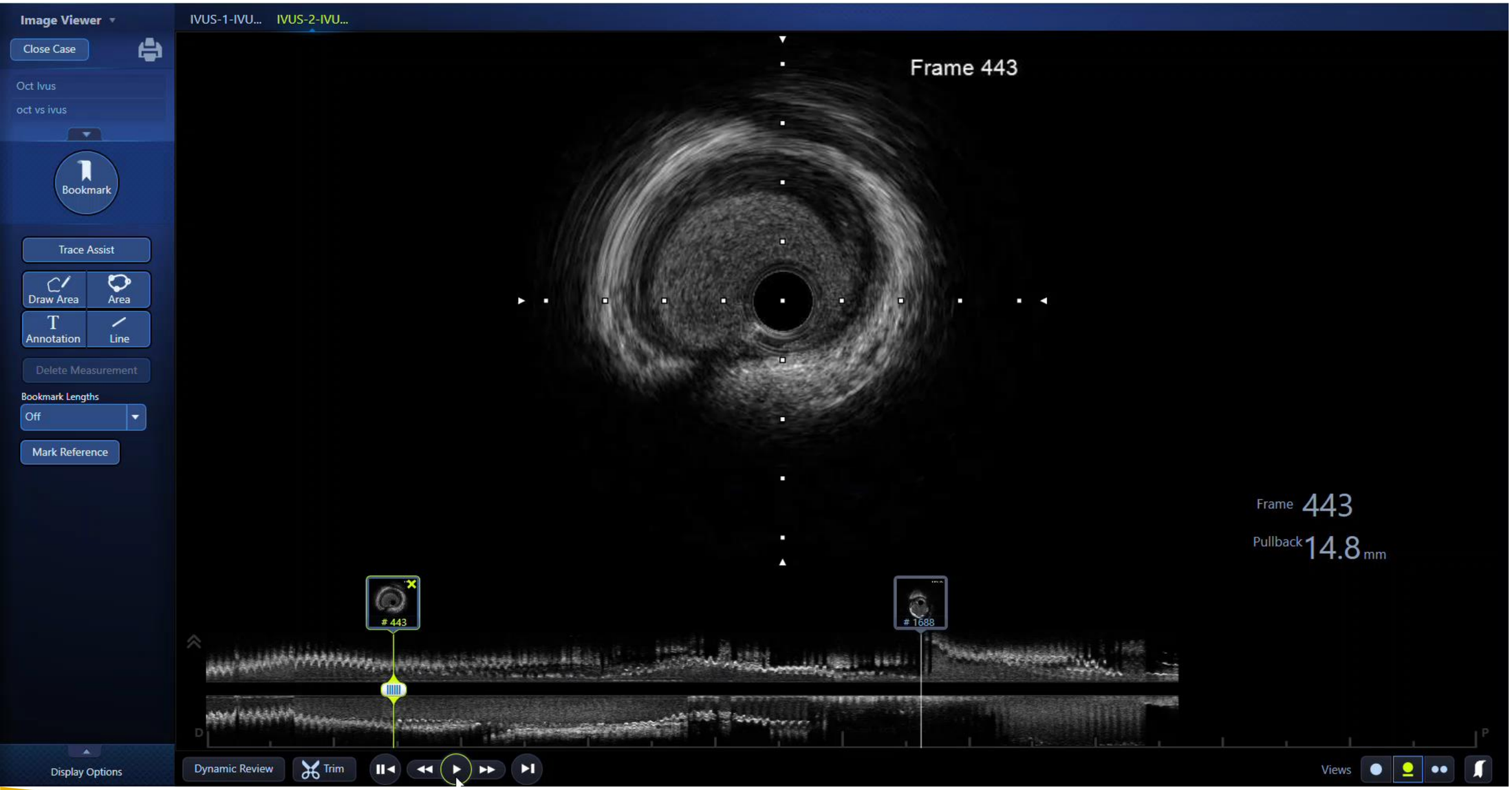


Identify Edge Dissection;

- Edge Dissection
- ≥ 1 quadrant
- Penetrates the media

Apposition

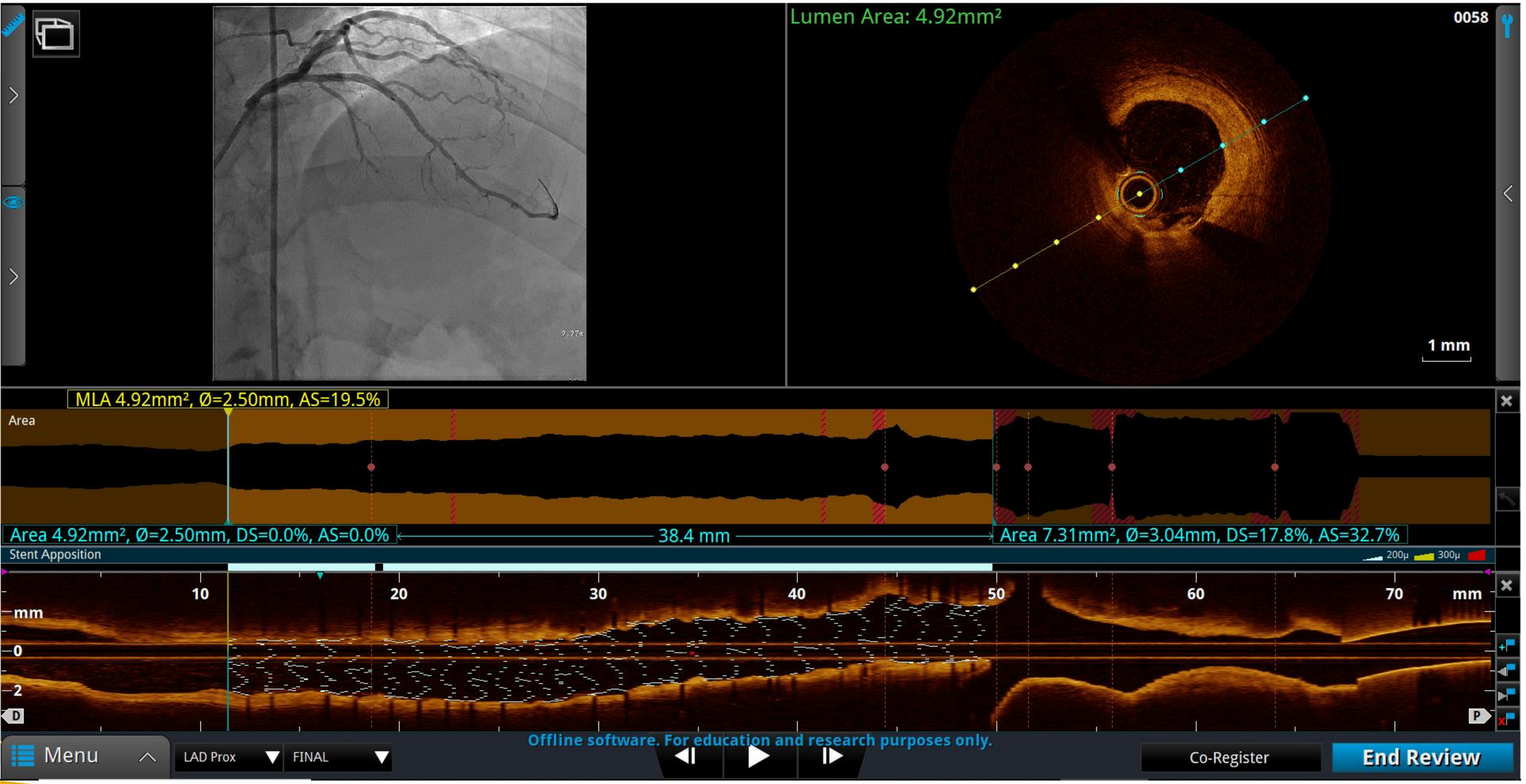
Post-PCI – Apposition IVUS



Identify Malapposition;

- Proximal malapposition that may interfere with re-wiring, or gross malapposition for long segments (>3mm identified on automated malapposition indicator)

Post-PCI – Apposition OCT

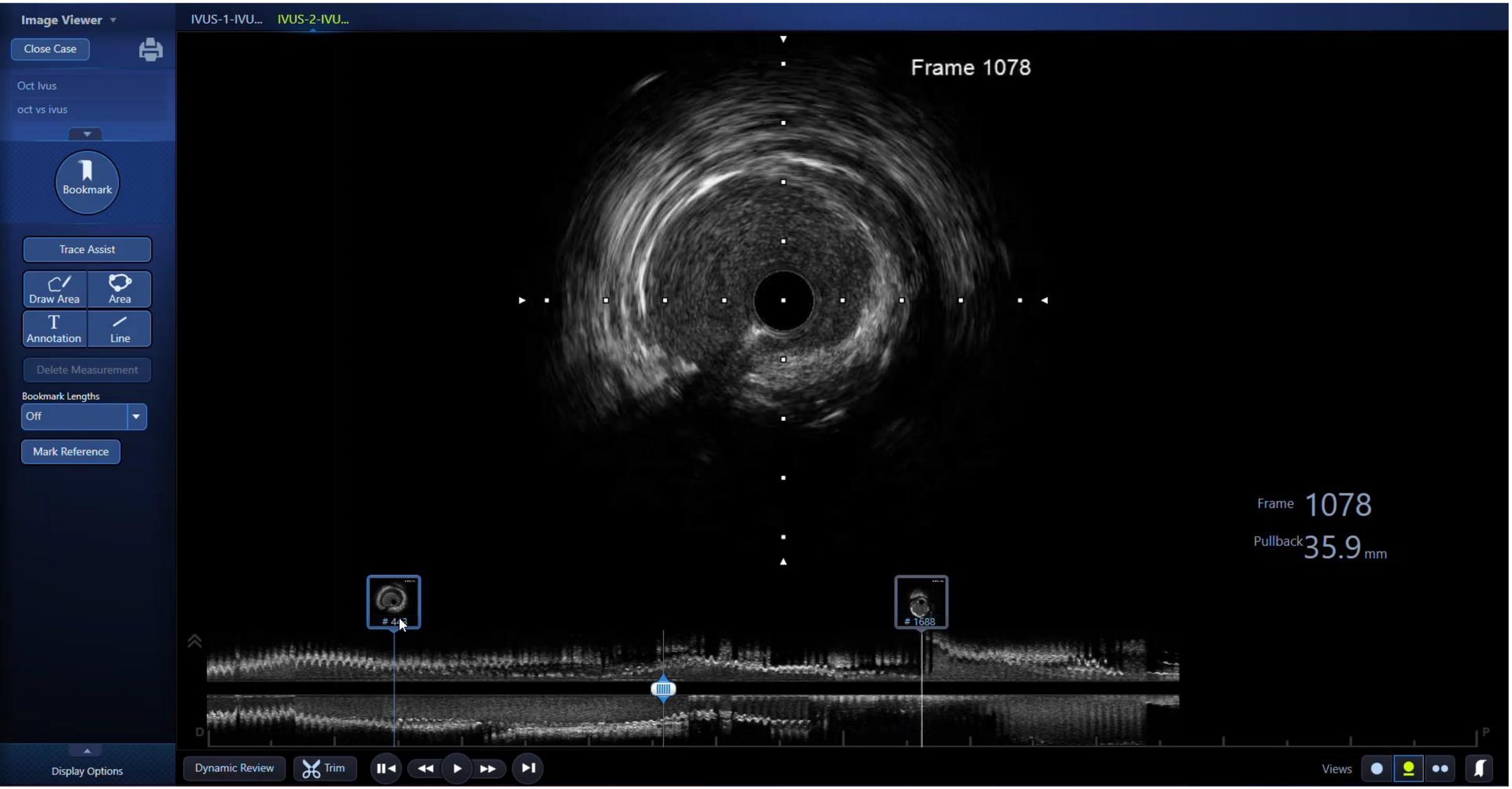


Identify Malapposition;

- Proximal malapposition that may interfere with re-wiring, or gross malapposition for long segments (>3mm identified on automated malapposition indicator)

eXpansion

Post-PCI – Expansion IVUS

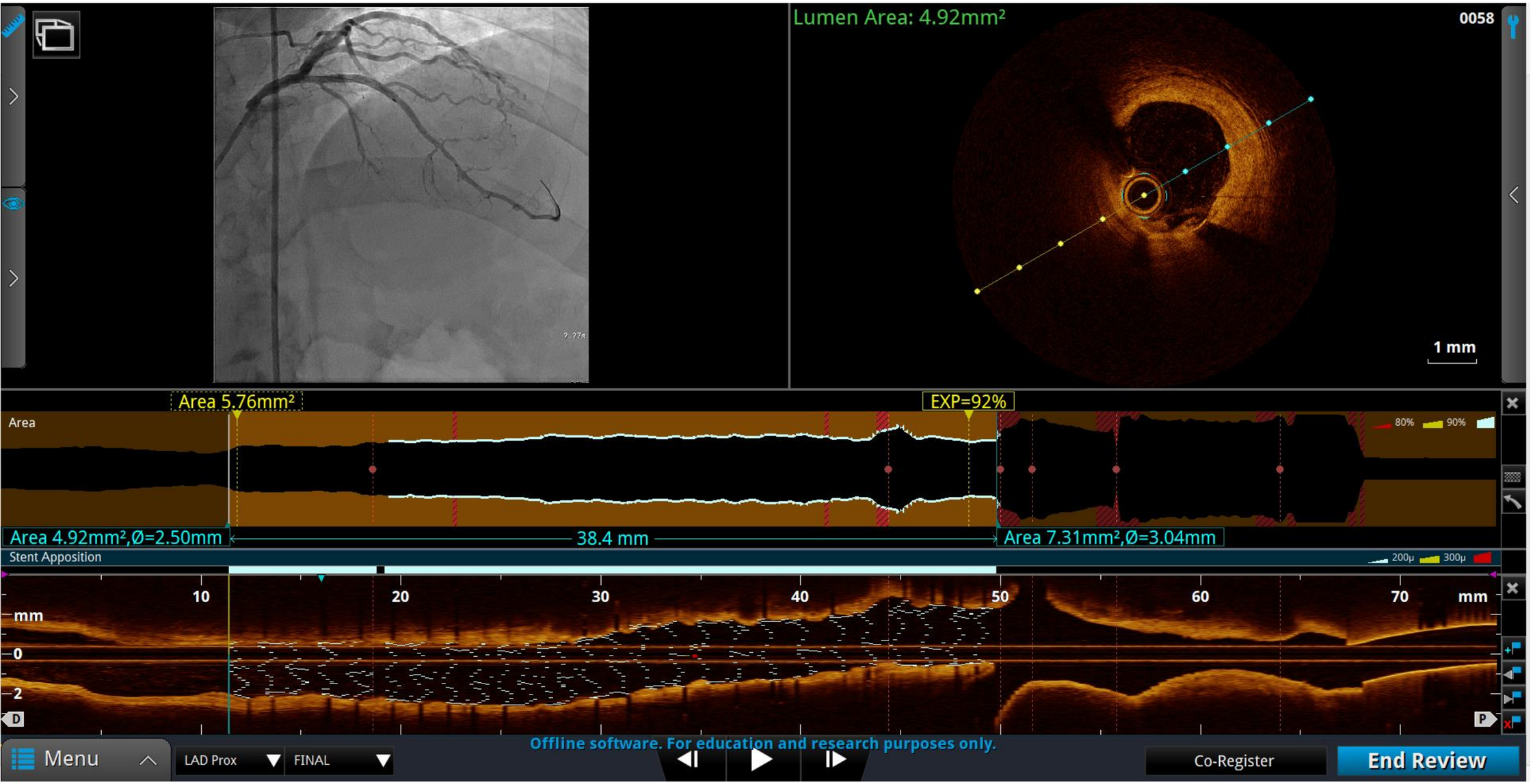


Identify Underexpansion;

- MSA < distral reference area

At the distal reference the lumen area = 6.56mm^2 ➔ The minimal stent area = 5.88mm^2
(5.88mm^2/ 6.56mm^2)x100 = 90% stent expansion

Post-PCI – Expansion OCT



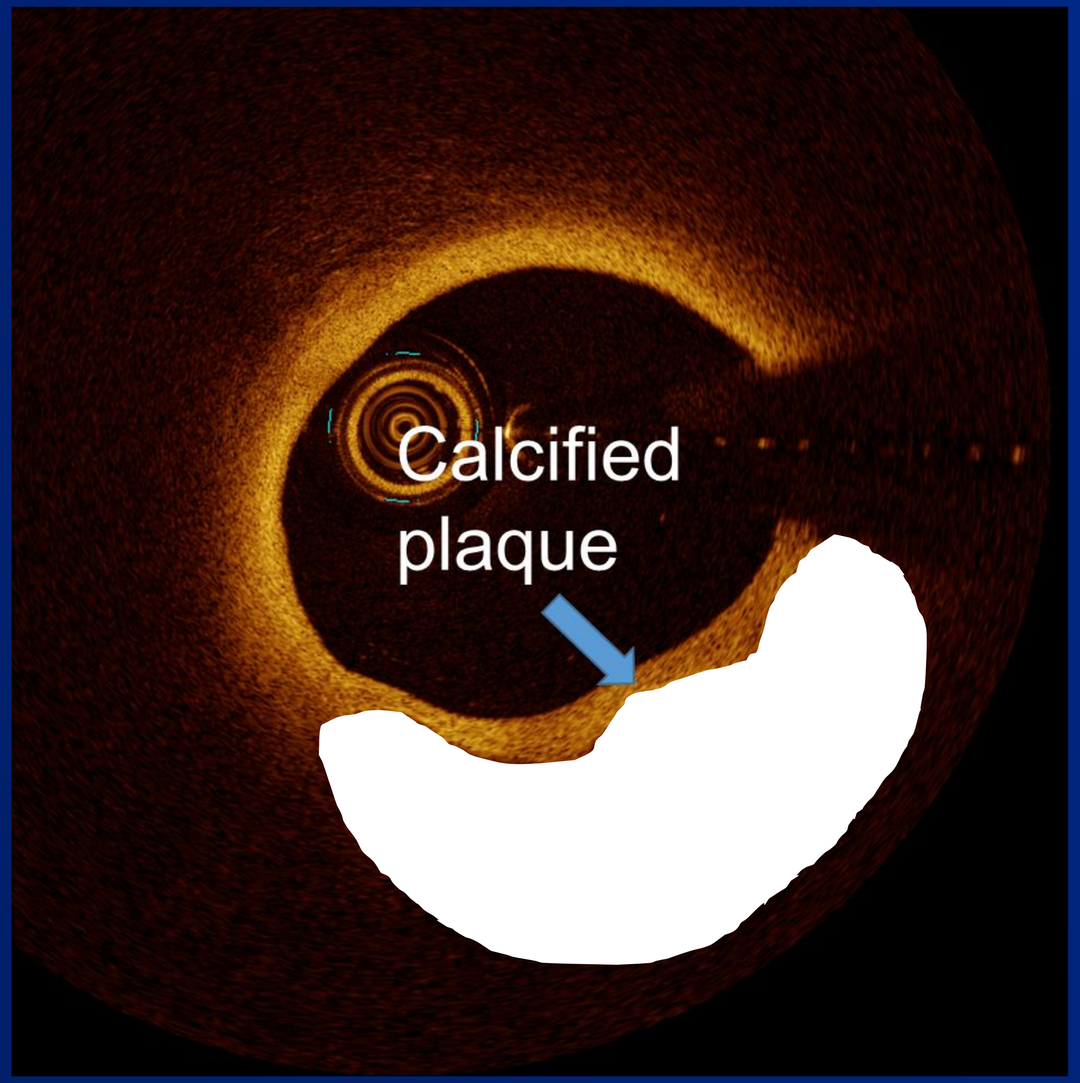
Identify Underexpansion;

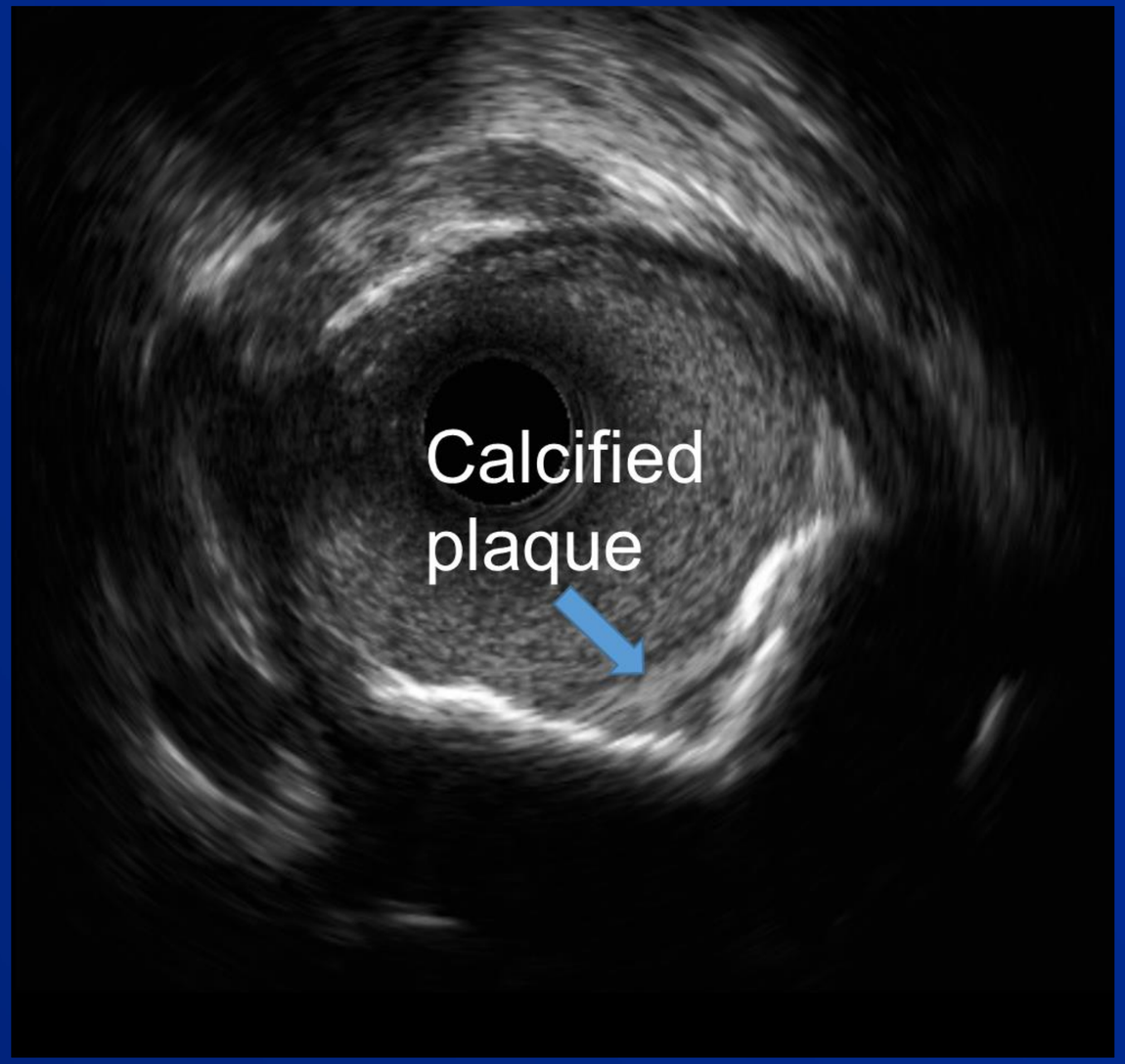
- MSA < distal reference area

At the distal reference the lumen area = 5.76mm^2 ➔ The minimal stent area = 5.76mm^2
Automated stent expansion = 92% stent expansion

Calcium

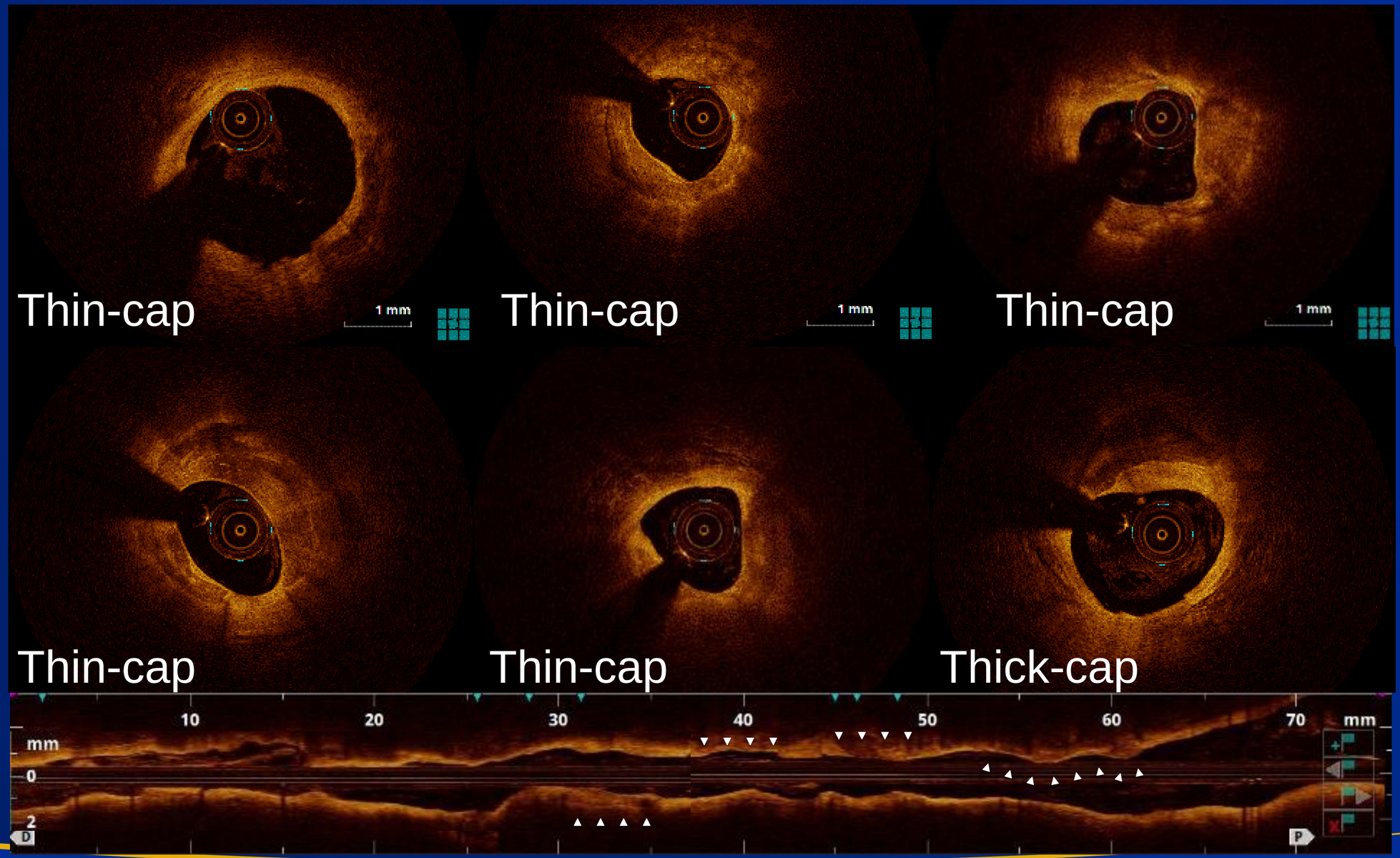
OCT Penetrates Calcium





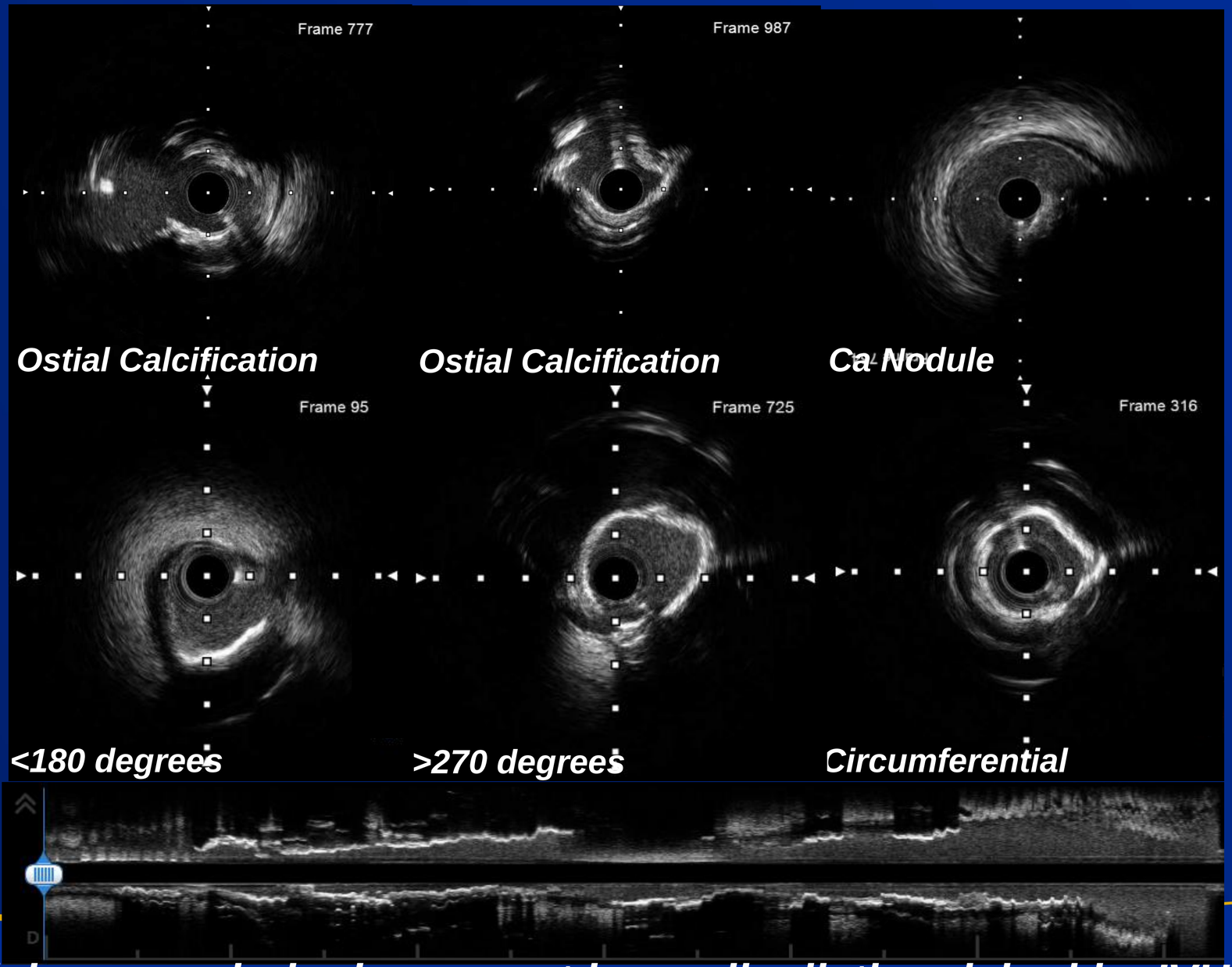
Chin & Ali. JACC Cardiovasc Interv 2016. 1305-6

Calcium Morphologies



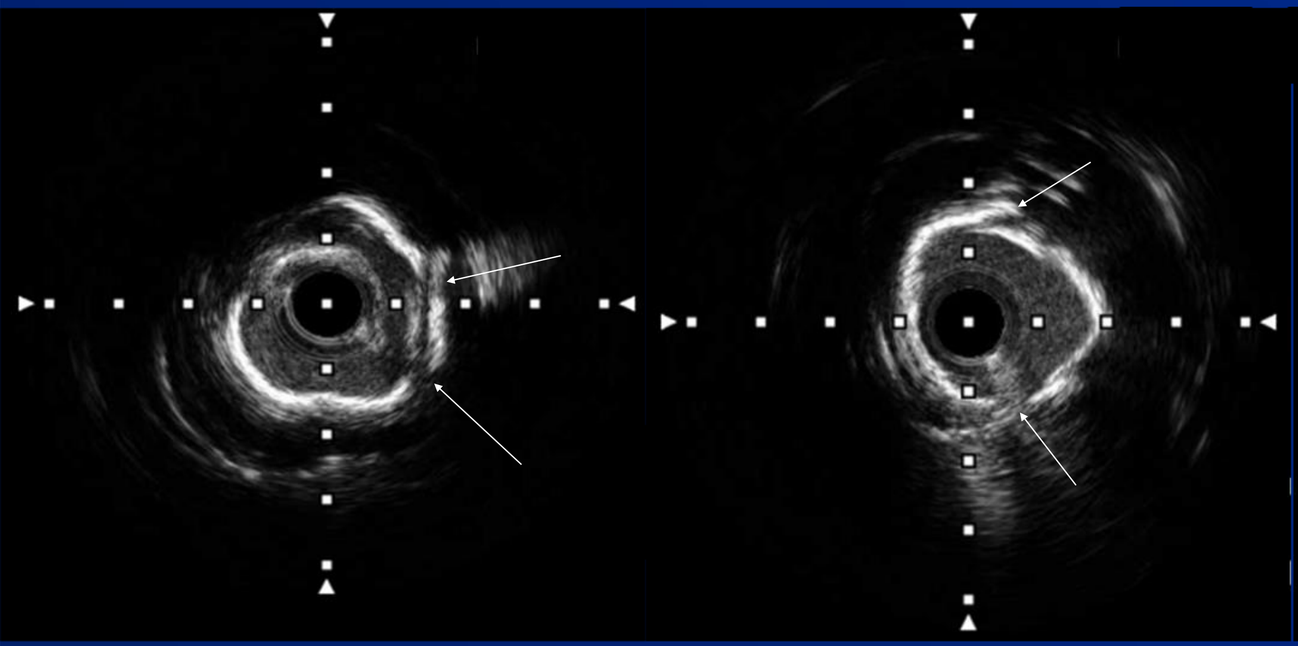
Calcium morphologies can be easily distinguished by OCT

Calcium Morphologies IVUS

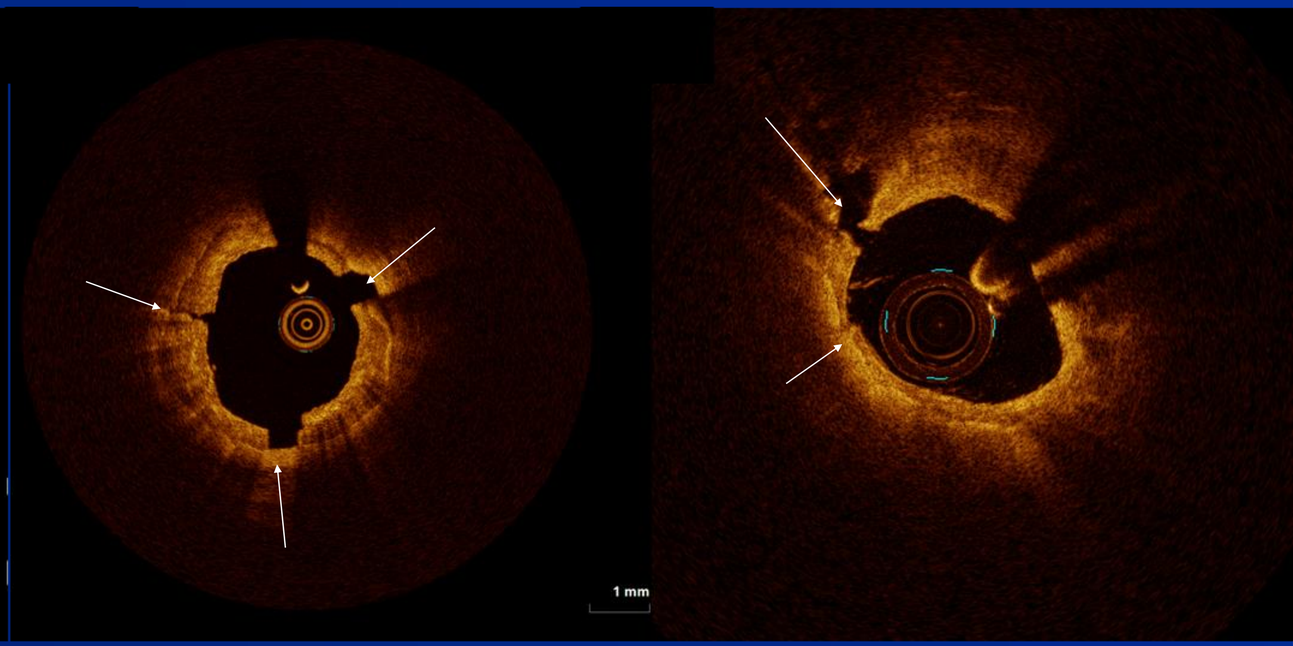


Calcium morphologies cannot be easily distinguished by IVUS

Calcium Fracture



IVUS calcium fracture



OCT calcium fracture

IVUS versus OCT – When to use what?

ESC European Society of Cardiology
European Heart Journal (2018) **39**, 3281–3300
doi:10.1093/eurheartj/ehy285
FASTTRACK CLINICAL RESEARCH
Coronary artery disease

Clinical use of intracoronary imaging. Part 1: guidance and optimization of coronary interventions. An expert consensus document of the European Association of Percutaneous Cardiovascular Interventions

- **IVUS-guided PCI improves clinical outcomes.**
- **IVUS and OCT-guided PCI are equally effective in imaging endpoints.**
- **IVUS and OCT are likely to provide similar clinical benefits.**

Eur Heart J. 2018;39(35):3281-3300

	IVUS	OCT
PCI Guidance*	++	+++
Morphology	++	+++
Length	++	+++
Diameter	++	+++
Co-registration	+	+++
Medial Dissection	+	+++
Apposition	+	+++
Expansion	+	+++
Severe Calcification	+	+++
CTO	+++	+
LMCA	+++	+
Ostial Lesion	+++	+
Advanced CKD	+++	+

*PCI-guidance by IVUS improves with improved resolution from 20-60MHz
**Authors' opinion