It is Time for Practical Use of High-Resolution IVUS

Akiko Maehara, MD

Cardiovascular Research Foundation

Columbia University Medical Center

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 organization(s) listed below.

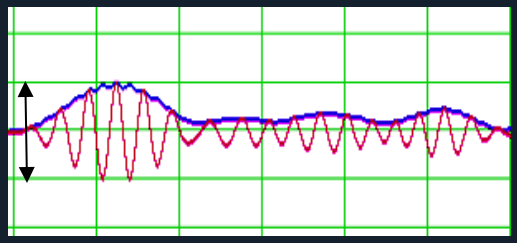
Affiliation/Financial Relationship	Company
• Grant/Research Support	• Boston Scientific Corporation
• Consulting Fees/Honoraria	• Boston Scientific Corporation, ACIST, St Jude Medical

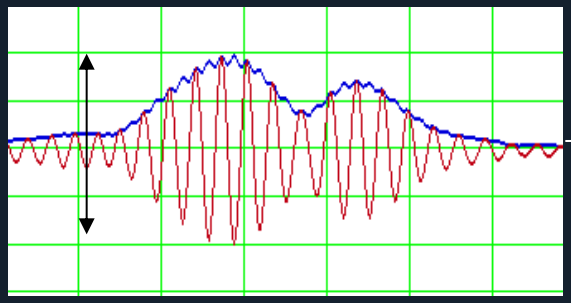
Gray Scale IVUS Tissue Characterization

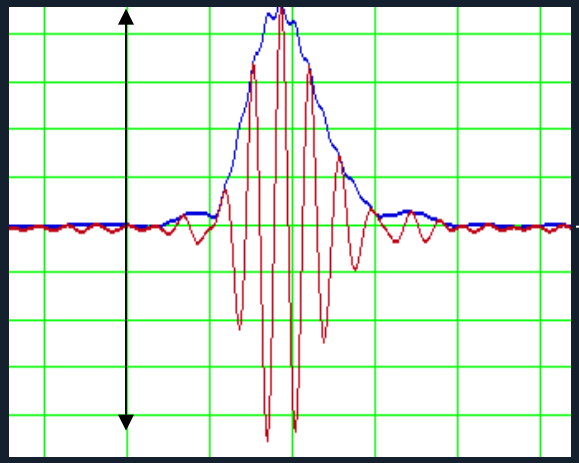
Ultrasound Wave

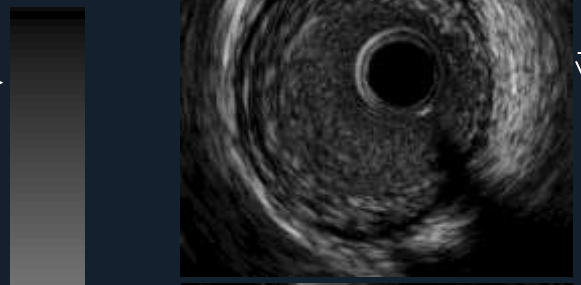
Gray Scale

Pathology





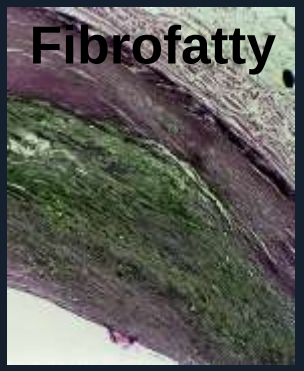




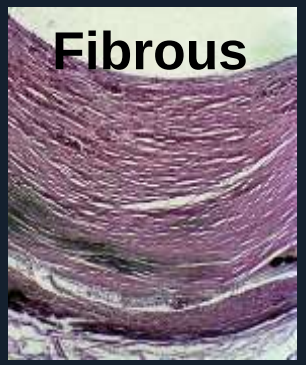
Hypo

Iso/Hyper

Hyper with Shadow



Fibrofatty



Fibrous

Calcium

Five Companies Are Working on Next Generation IVUS Systems

- ACIST, 60MHz (purchased SVMI - has been working on next generation IVUS since 2007)
- Boston Scientific, 60MHz
- Volcano, FACT
- InfraReDx, 50MHz
- OCT Medical Imaging Inc, 60MHz

Available

Under development

Intravascular Imaging System Comparison

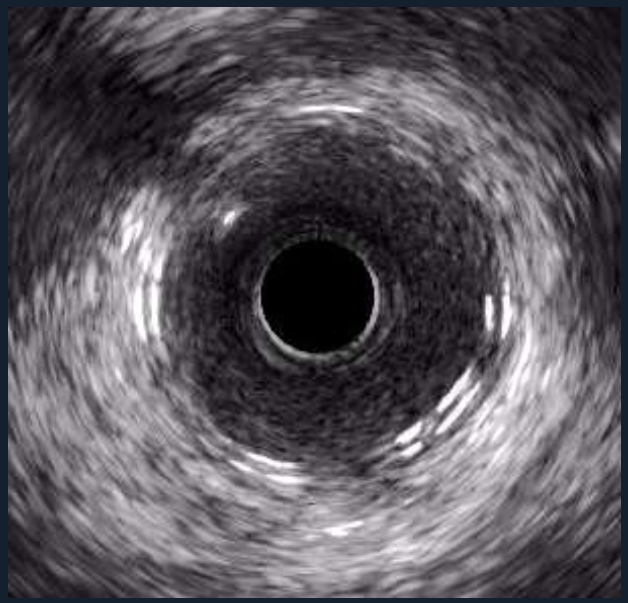
Feature	ACIST HDi / Kodama	Boston Scientific	Volcano FACT	InfraReDx	St Jude Medical OCT
Frequency or Wavelength	60 MHz	55 MHz	40 MHz	50 MHz	1.3 µm
Nature of the Energy	Ultrasound				Optical
Axial Resolution	40 µm	22 µm	<50 µm	20 µm	15 µm
Lateral Resolution	90 µm	50-140 µm	100-200 µm	<200 µm	40 µm
Soft Tissue Penetration	> 2.5 mm	>3.5 mm			0.8-1.2 mm*
Blood Penetration	> 3.4 mm	>4.0 mm			≤ 1.2 mm
Pullback Speed (mm/s)	0.5, 1.0, 2.5, 5.0, 10	0.5,1.0		0.5	20
Pullback Length (mm)	130	100		150	75

* Soft Tissue Penetration with contrast injection to achieve blood clearing.

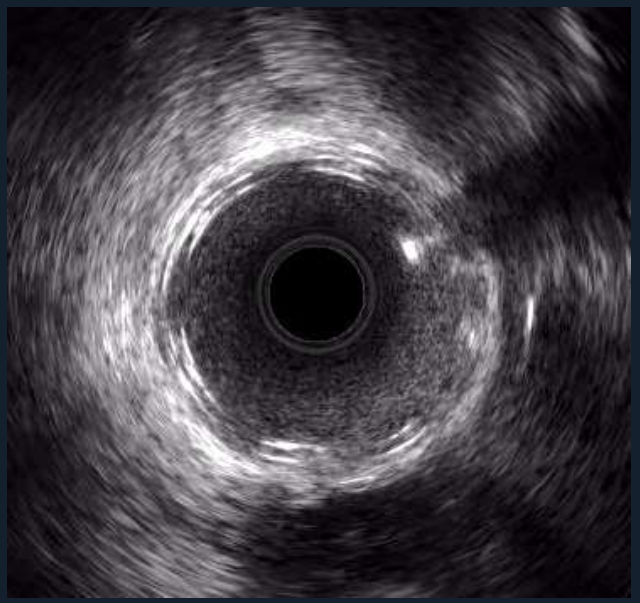
Boston Scientific: HD-IVUS and Bioresorbable Vascular Scaffolds

Pro/iCross 40 MHz
43 micron axial

OptiCross 40 MHz
38 micron axial

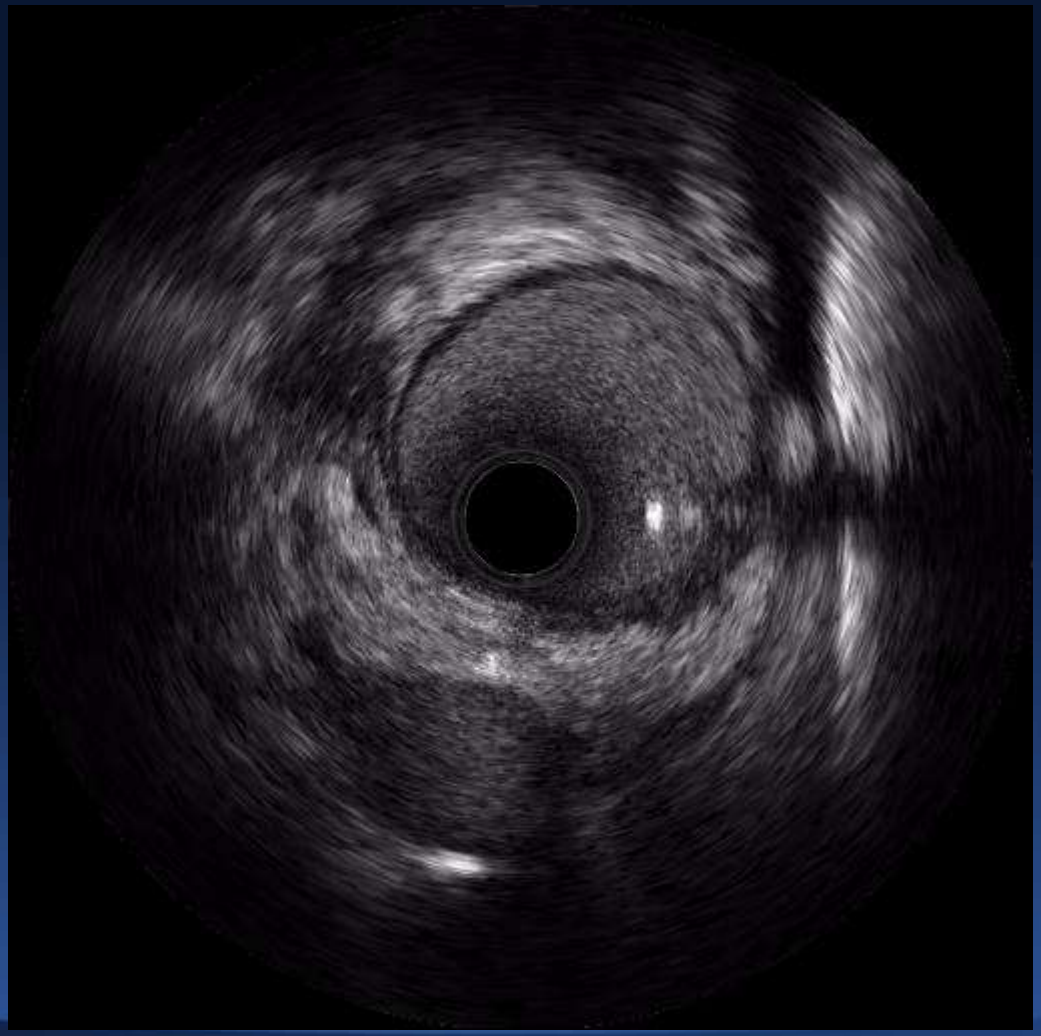


Next Gen IVUS 55 MHz
22 micron axial

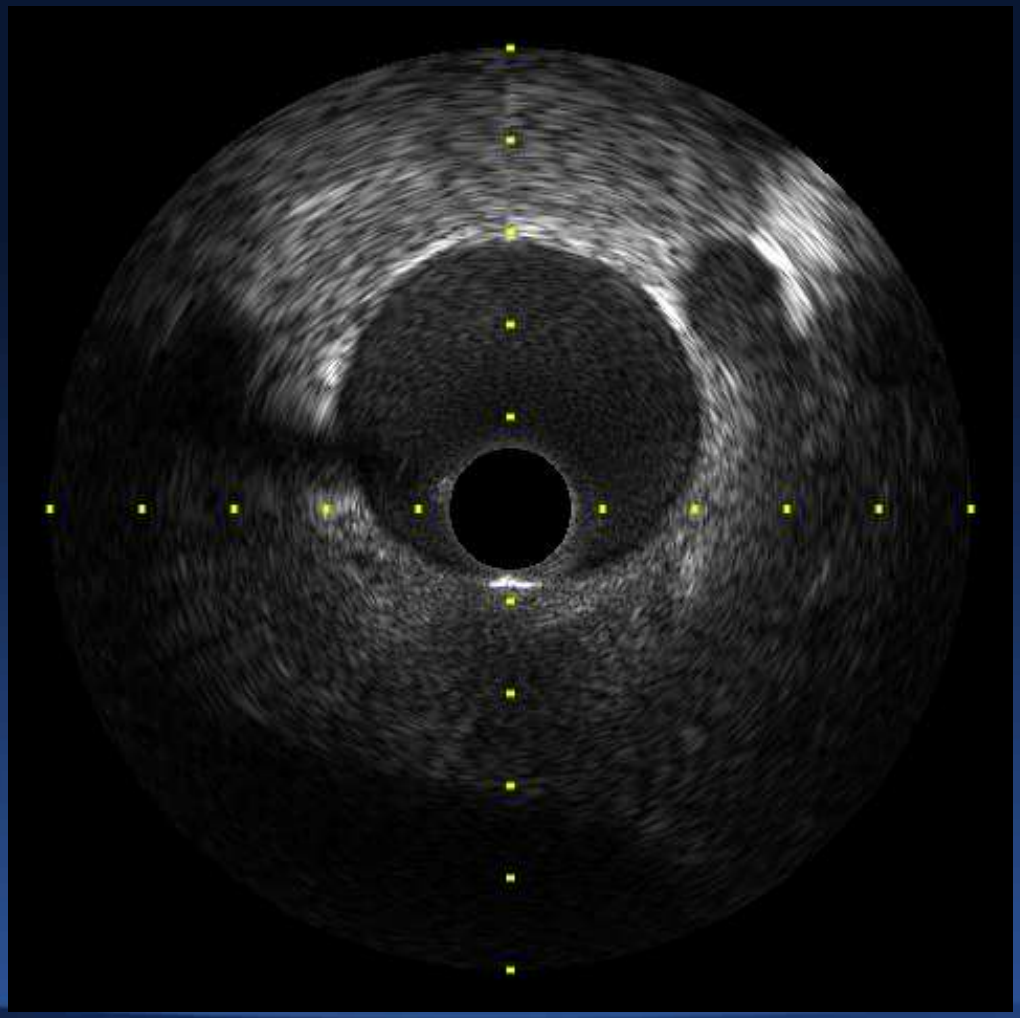


Improving IVUS Resolution without Compromising Penetration

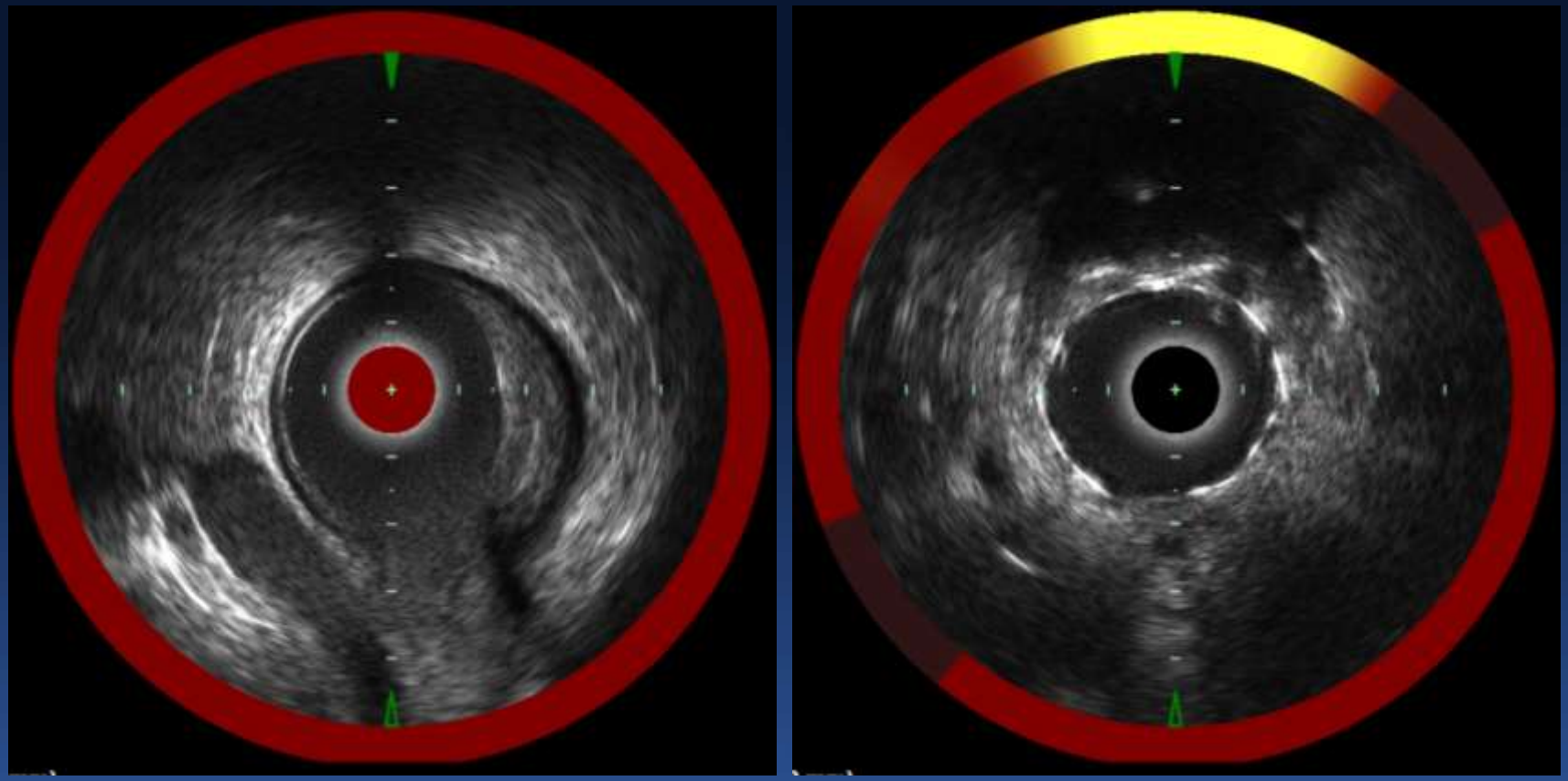
Boston Scientific: 55MHz IVUS in Animal Normal Coronary Artery



InfraReDx: 50MHz IVUS in Animal Normal Coronary Artery

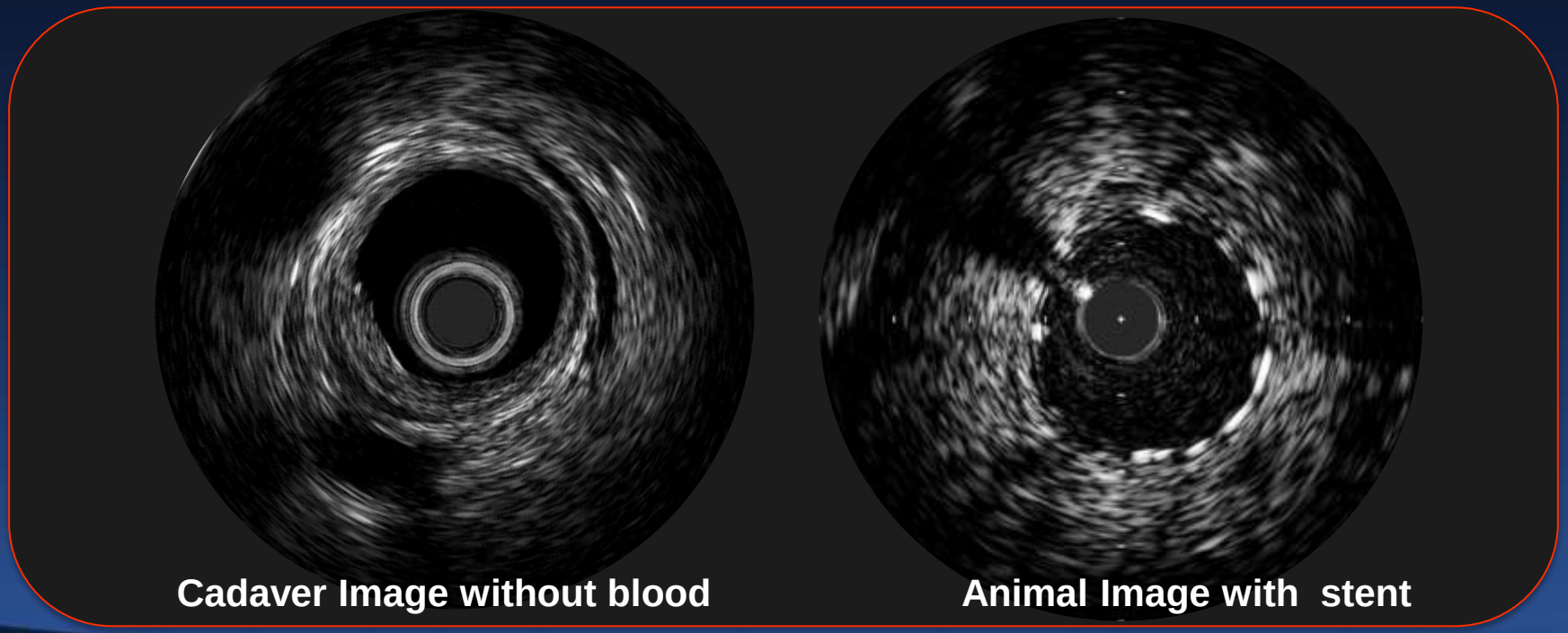


InfraReDx: 50MHz IVUS Human Coronary Artery



Volcano: FACT (Focused Acoustic Computed Tomography)

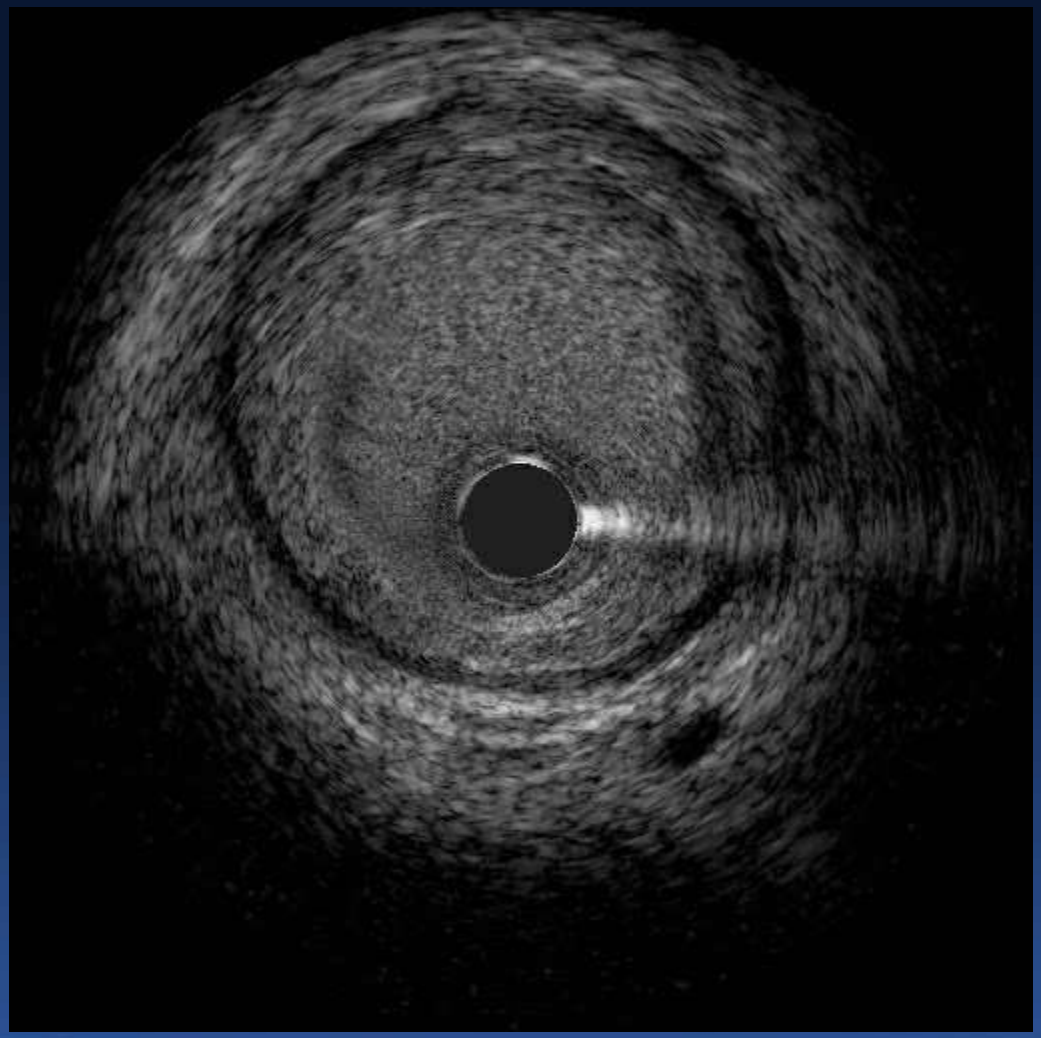
FACT ultrasound transducer intended to generate a "cleaner" signal than traditional piezoelectricity, near field resolution close to OCT.



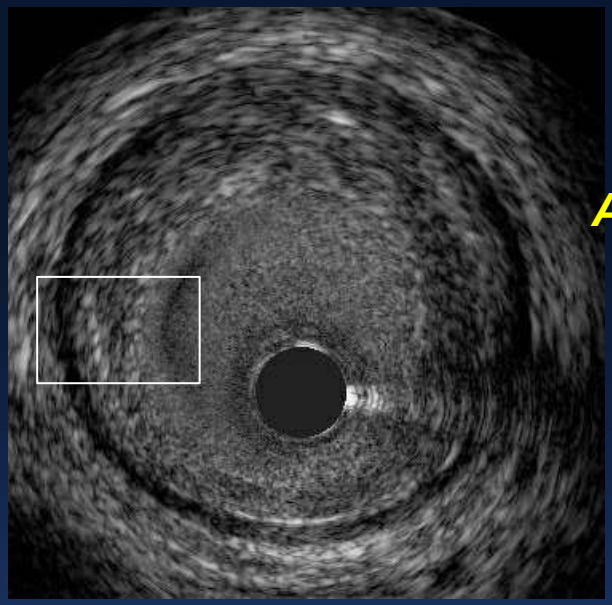
Cadaver Image without blood

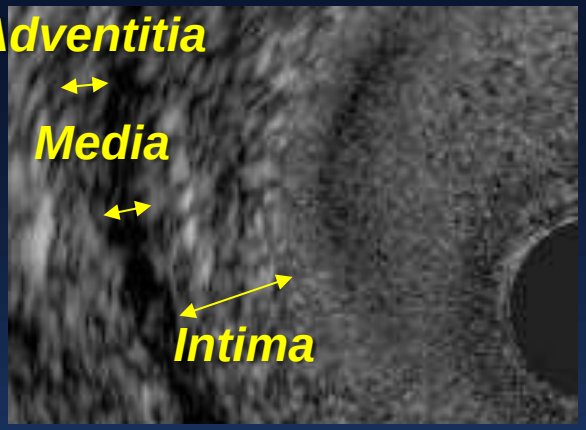
Animal Image with stent

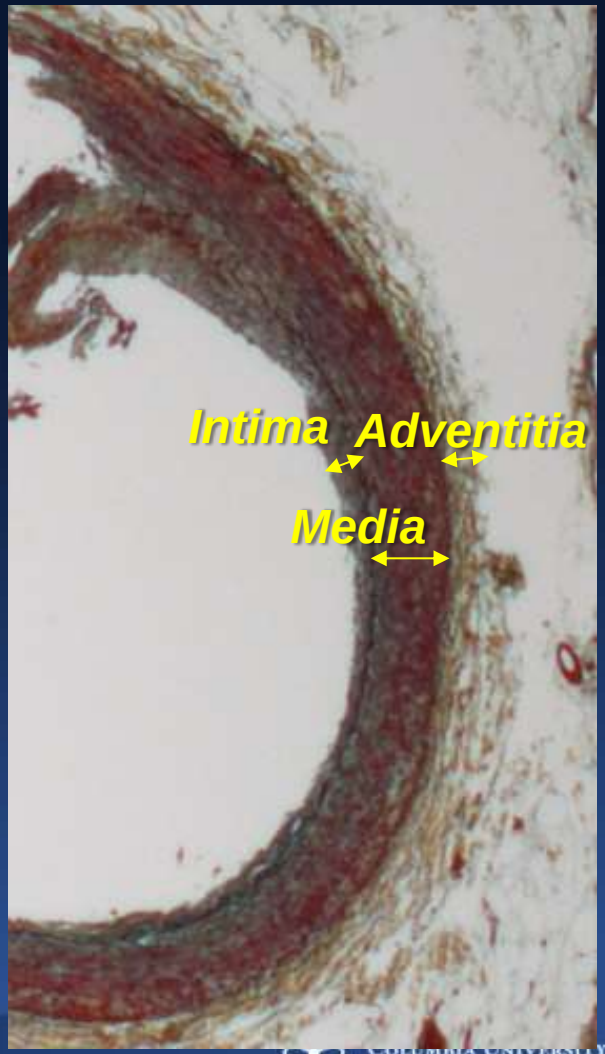
ACIST 60MHz IVUS



Three Layers Appearance

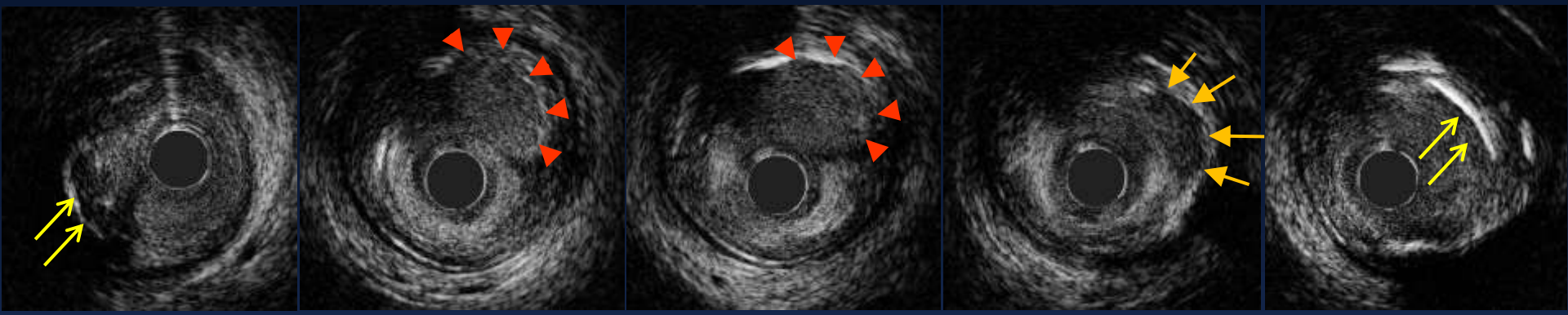


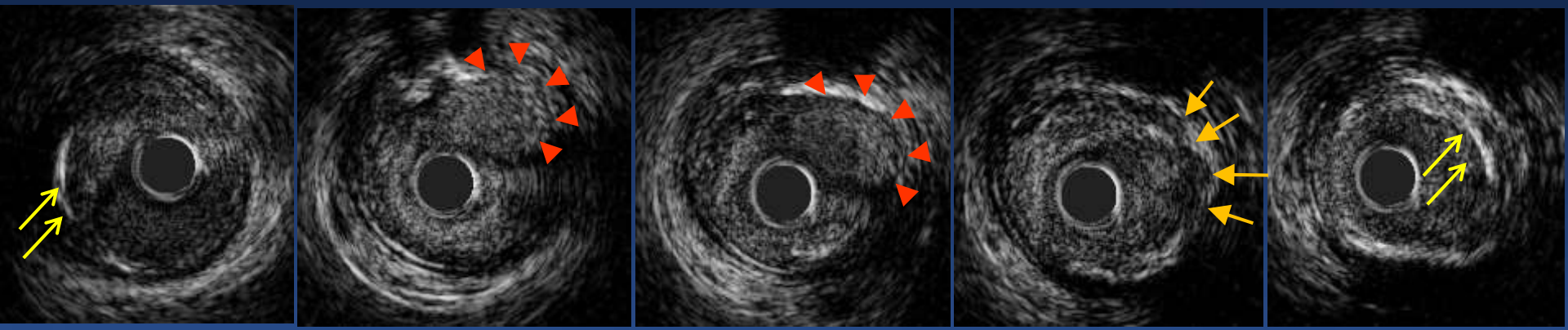




Ruptured Plaque

60MHz

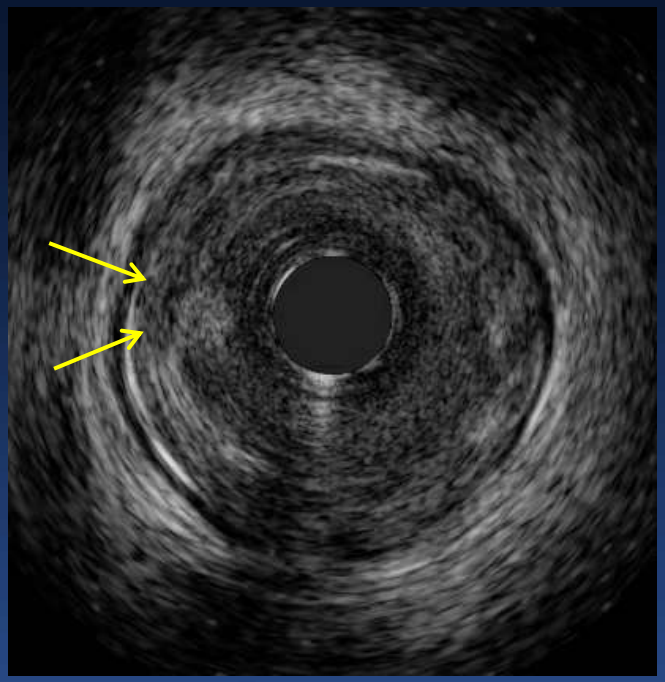




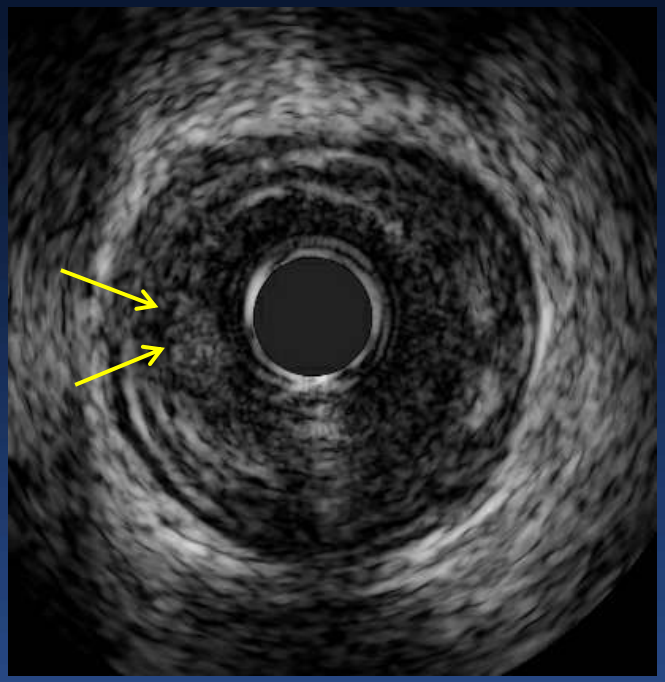
40MHz

Thrombus

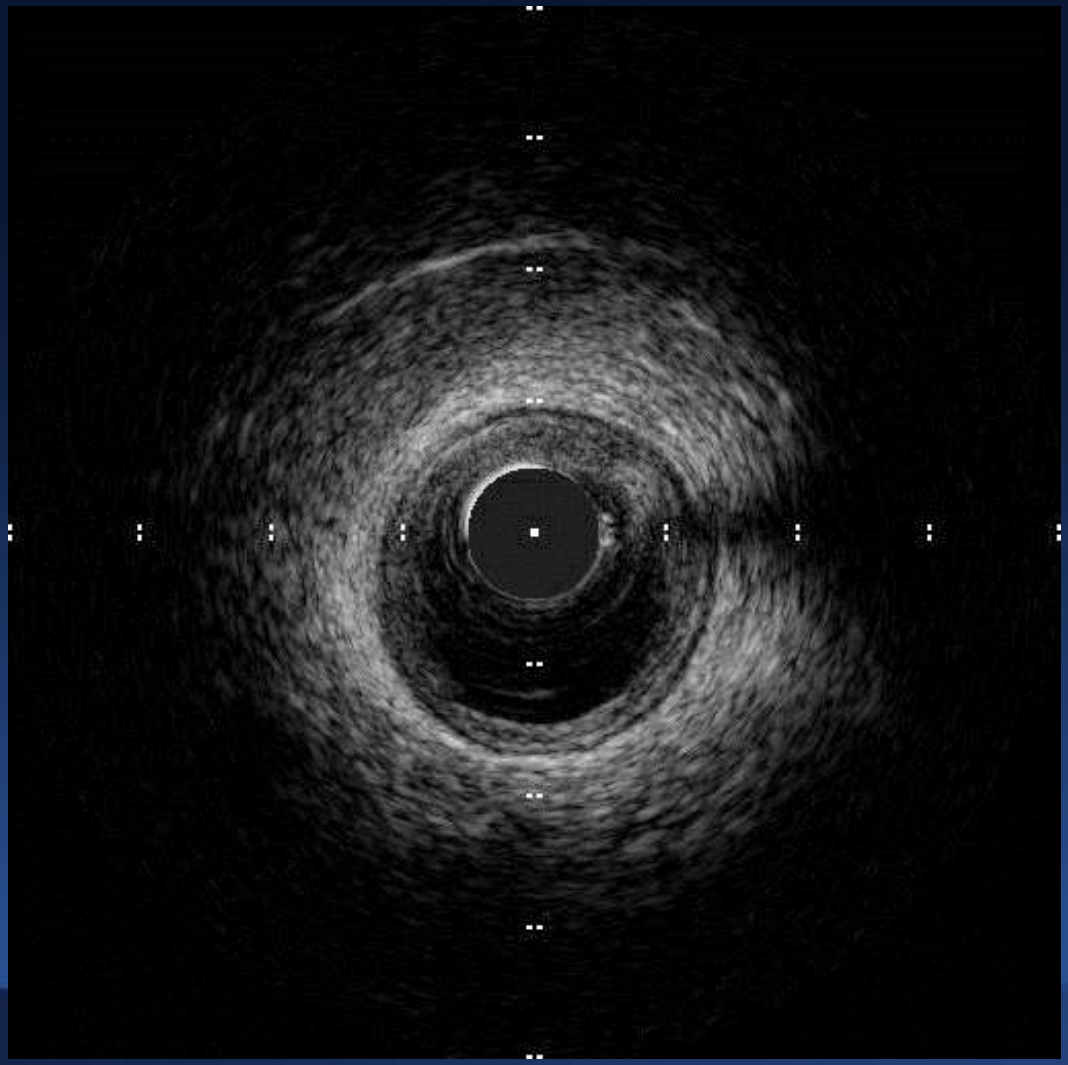
60MHz



40MHz

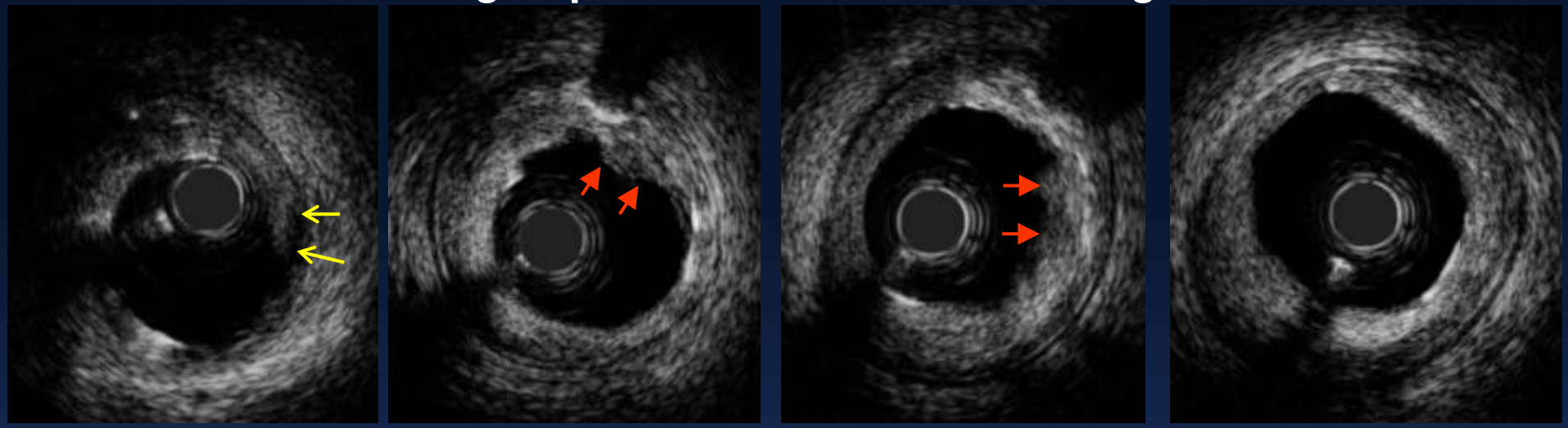


High Speed Pullback (10mm/sec) with Flushing

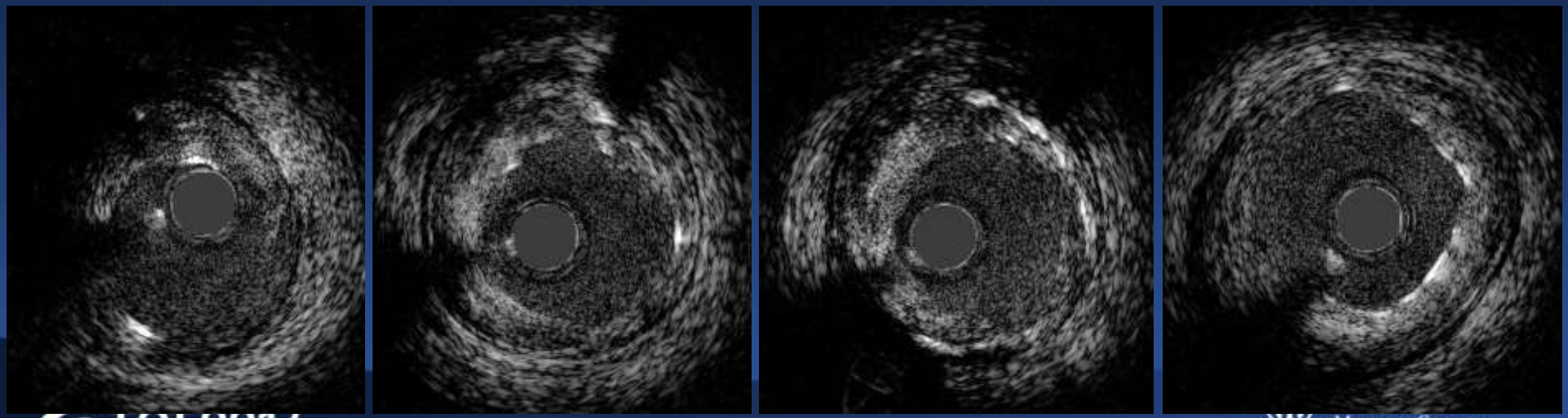


Comparison with vs without Flush

High Speed Pullback with Flushing

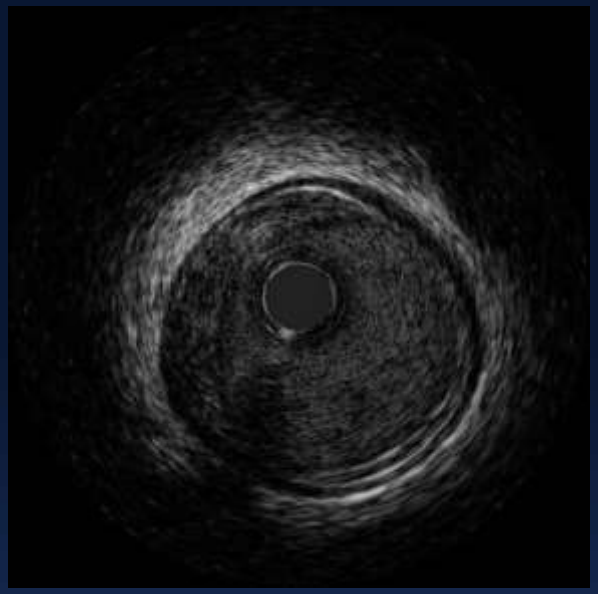


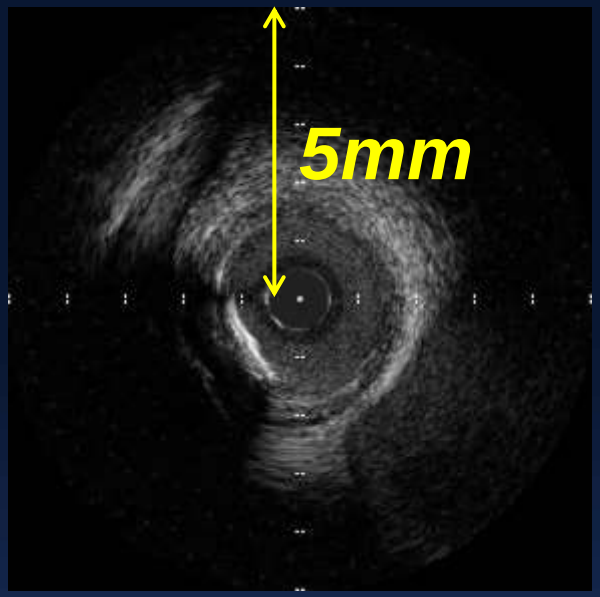
Normal Pullback



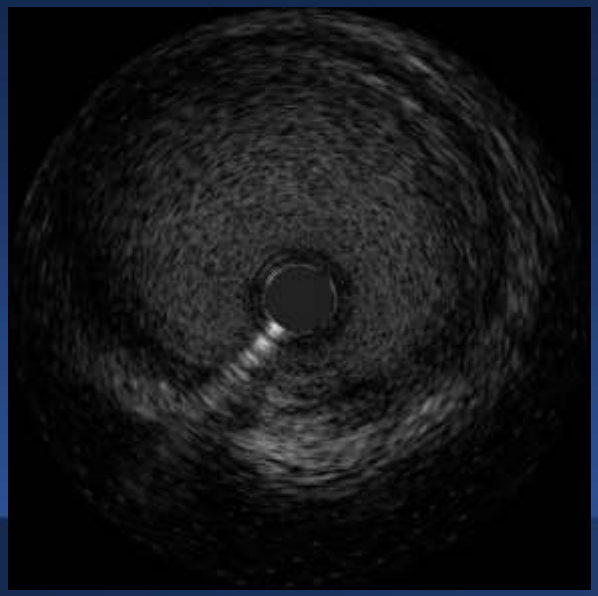
Penetration

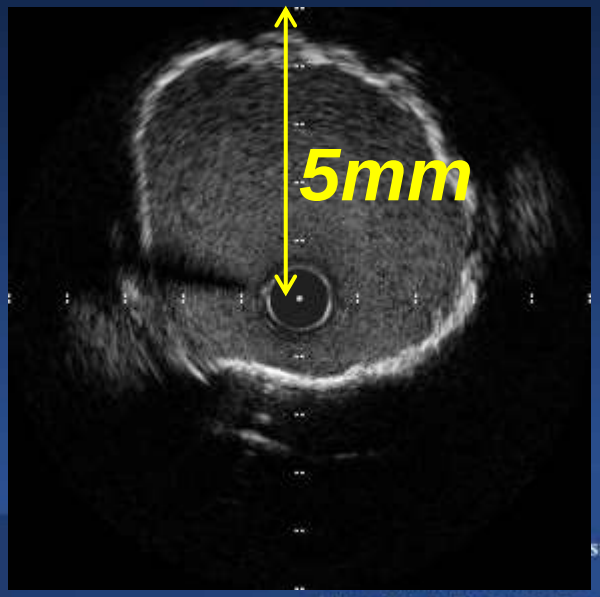
Soft Tissue Penetration

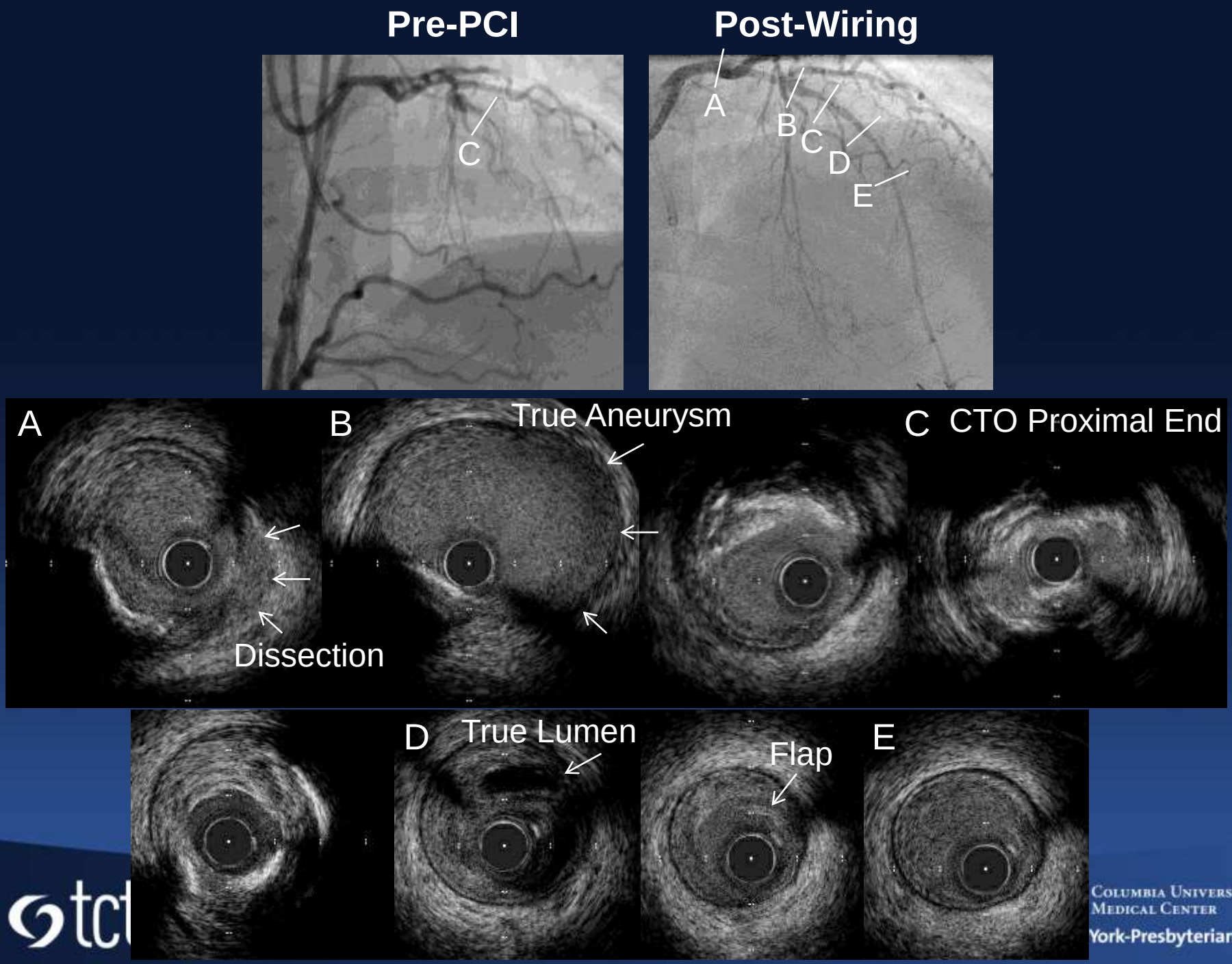


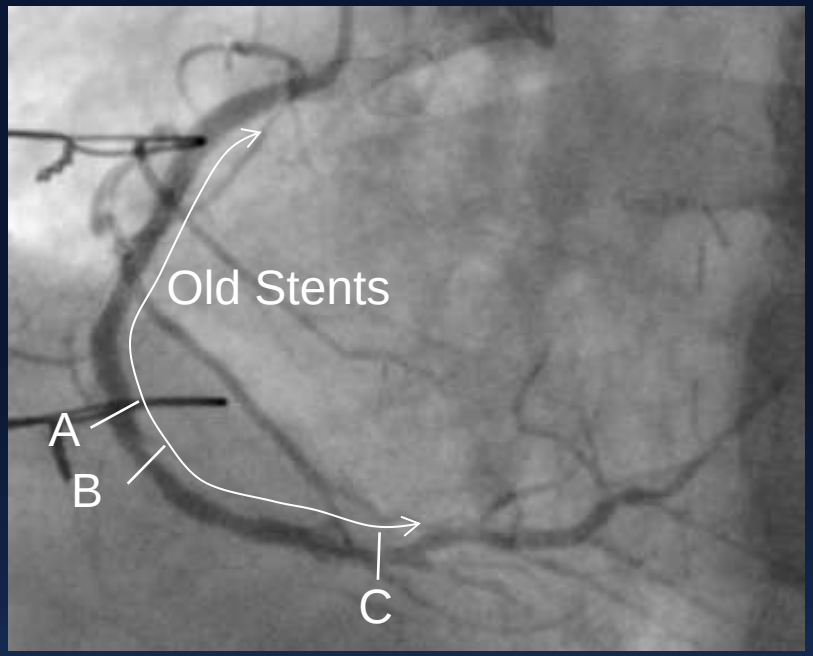


Blood Penetration

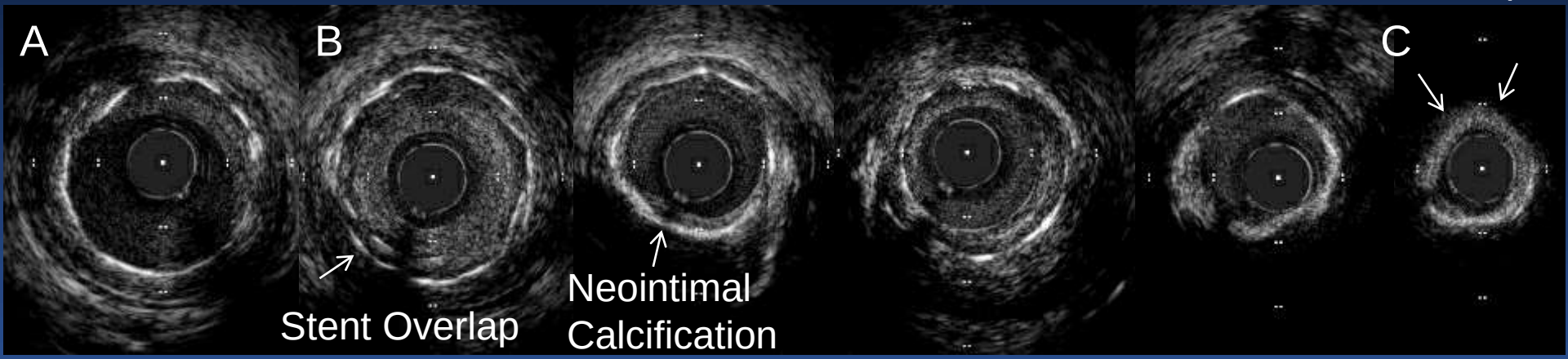




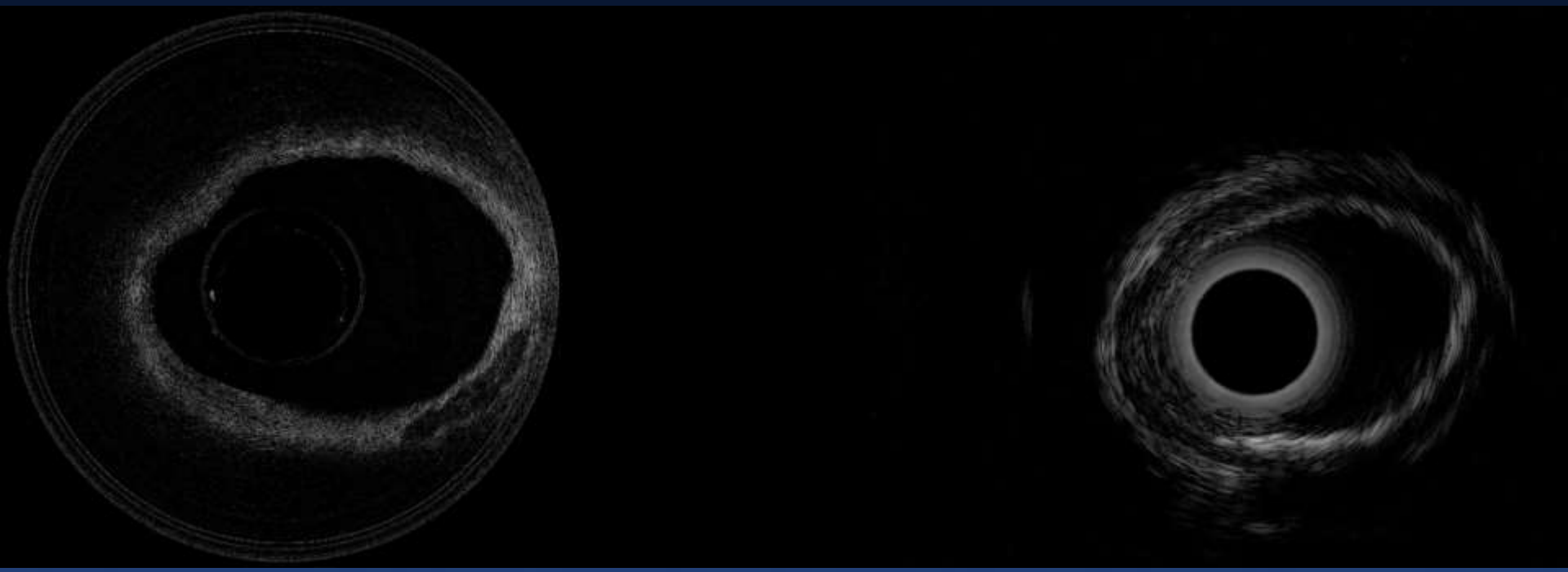




Neointimal
Attenuated Plaque



OCT/IVUS Combined Catheter

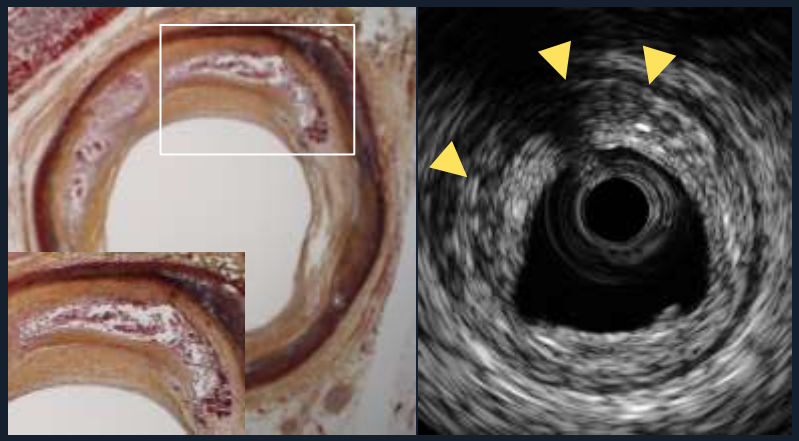


Courtesy for Pranav Patel & Zhongping Chen University of California, Irvine; Ram Ramalingam OCT Medical Imaging Inc.

What we are looking for more?

- Intraplaque Hemorrhage
- Thrombus
- Macrophage
- Bioabsorbable stent, stent fracture
- Edge dissection

Intraplaque Hemorrhage



Macrophage?

Soest G et al, JACC Img 2011; 4:810-3.

Summary

1. New generation of high definition (frequency) of IVUS will provide better resolution (close to OCT) with clinically enough penetration (vessel size evaluation is possible).
2. Clinically useful easier diagnosis such as under-expansion and dissection will be expected.
3. Understanding of plaque vulnerability (intraplaque hemorrhage, macrophage, thrombus) would be promising.