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GENERAL HOSPITAL

HEART CENTER

OCT: Basics, Advances, and Interpretation Tips

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Disclosure

FINANCIAL DISCLOSURE:

Grants/Research Support: LightLab Imaging/St. Jude Medical, Medtronic, Astra Zeneca, InfraReDx

Consulting: LightLab Imaging/St. Jude, Japan Stent Technology

OCT

- **Background**
- **Ex Vivo Validation**
- **Coronary Plaque Characterization**
- **Limitations**
- **Recent Development**
- **Future Research**

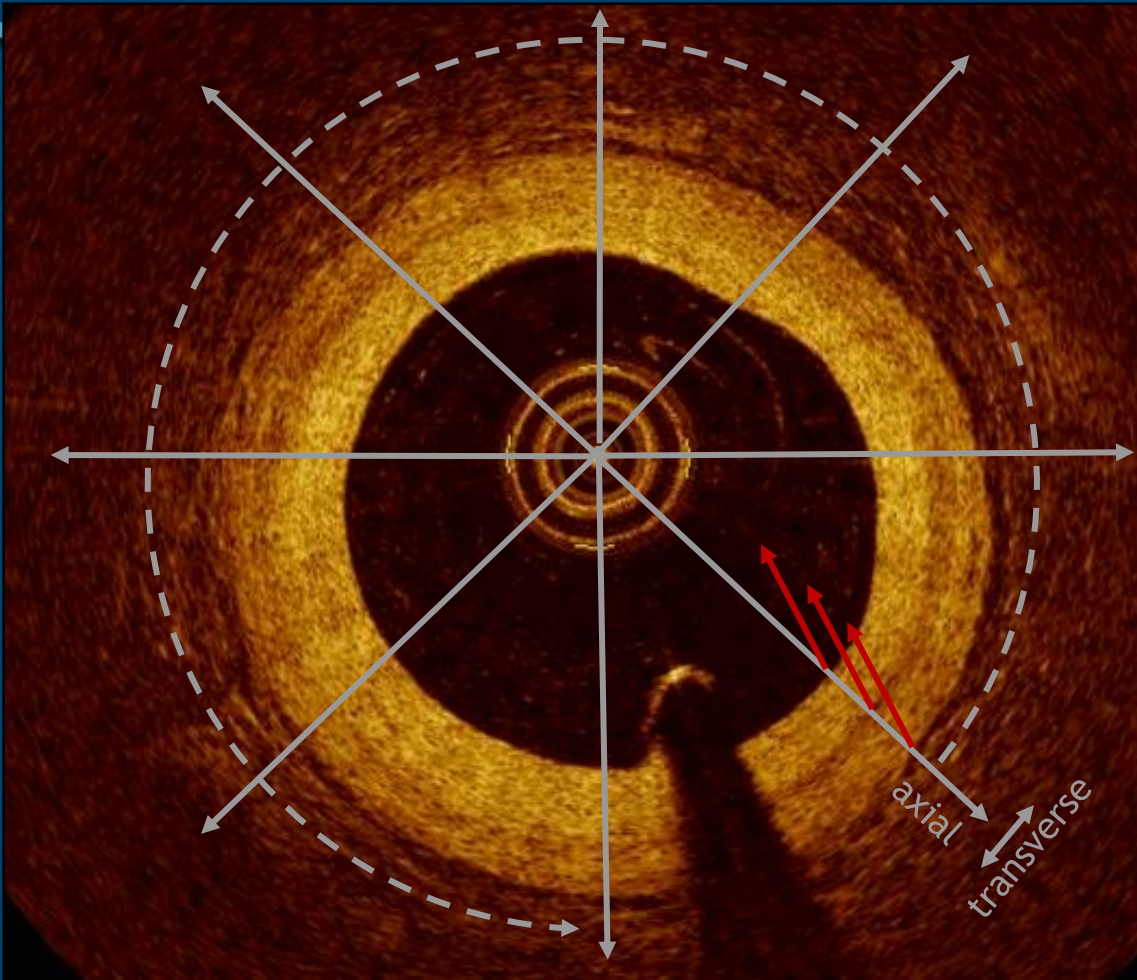


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Image Generation



- Measure echo time delay of reflected light waves
- One pixel 5 x 19 μm
- One axial line 1024 pixels
- One frame 500 axial lines
- *Optical resolution* 15 axial, 20 to 40 μm transverse

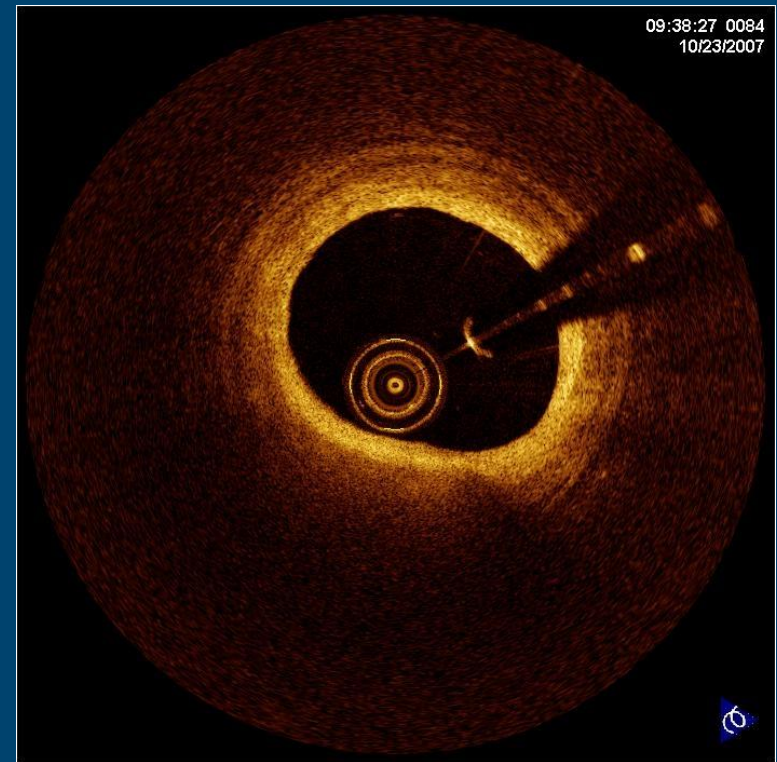


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Optical Coherence Tomography

- Optical analog of ultrasound
- Cross-sectional imaging
- 10 μm resolution
- 2 mm penetration depth
- Blood free zone



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Ex Vivo Study Results

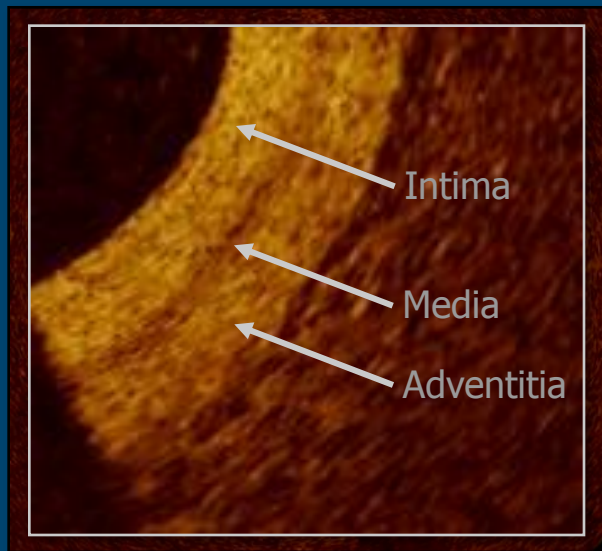
Fibrous	SENS	.87	PPV	.88
	SPEC	.97	NPV	.96
Calcific	SENS	.95	PPV	1.0
	SPEC	1.0	NPV	.95
Lipid pool	SENS	.92	PPV	.81
	SPEC	.94	NPV	.97

Yabushita, .. Jang, Bouma, Tearney. Circulation 2002

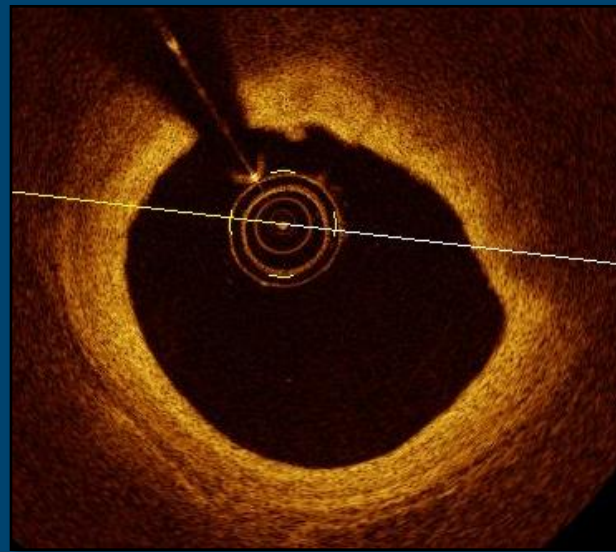


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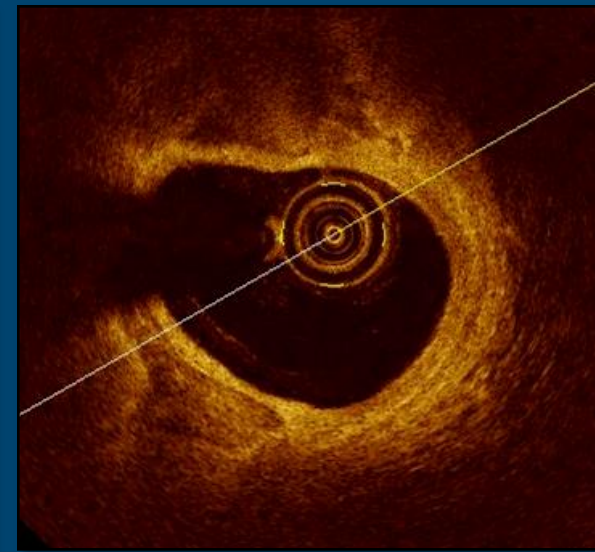
Plaque Characterization



Normal artery wall with mild intimal thickening



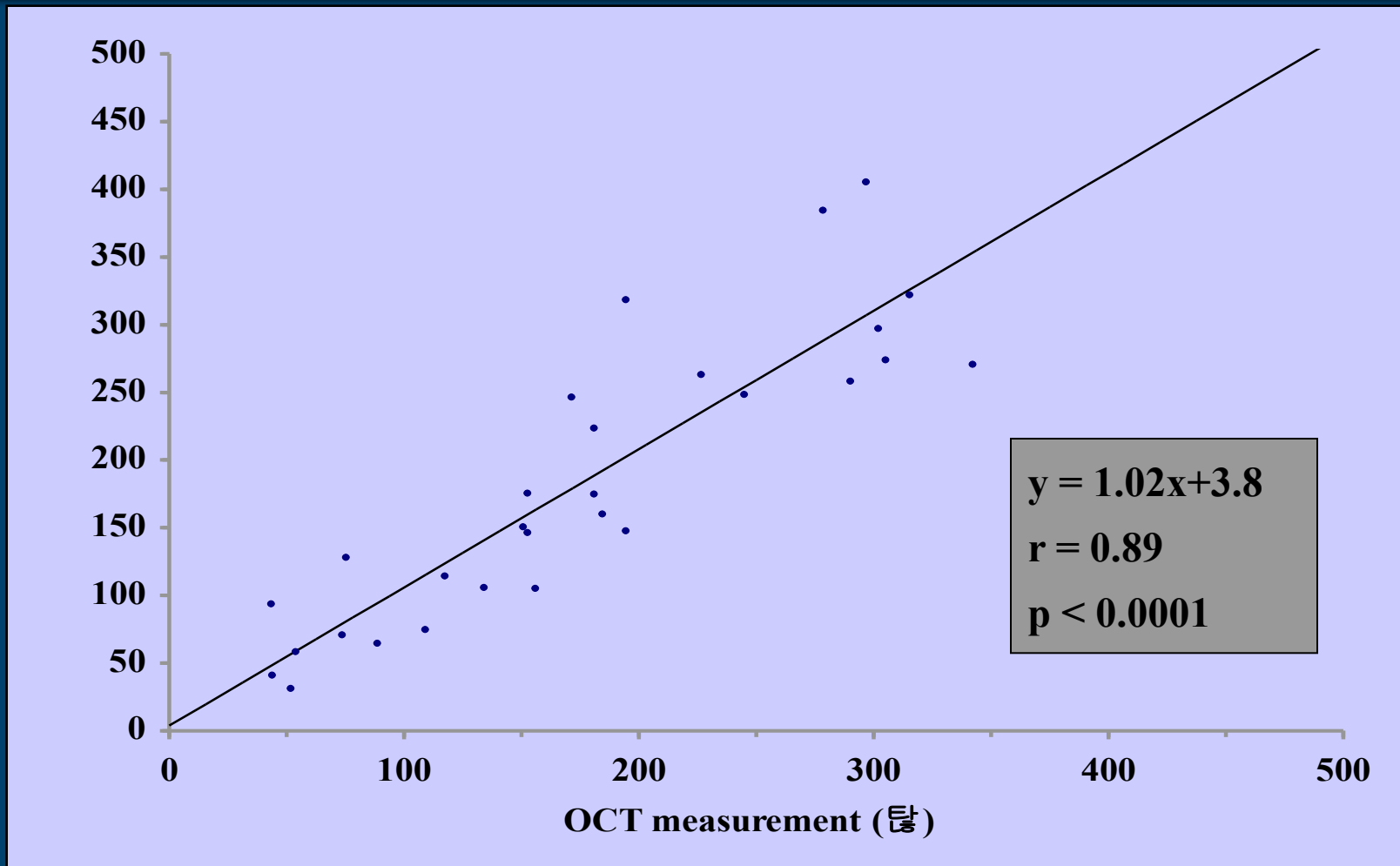
Fibrofatty plaque



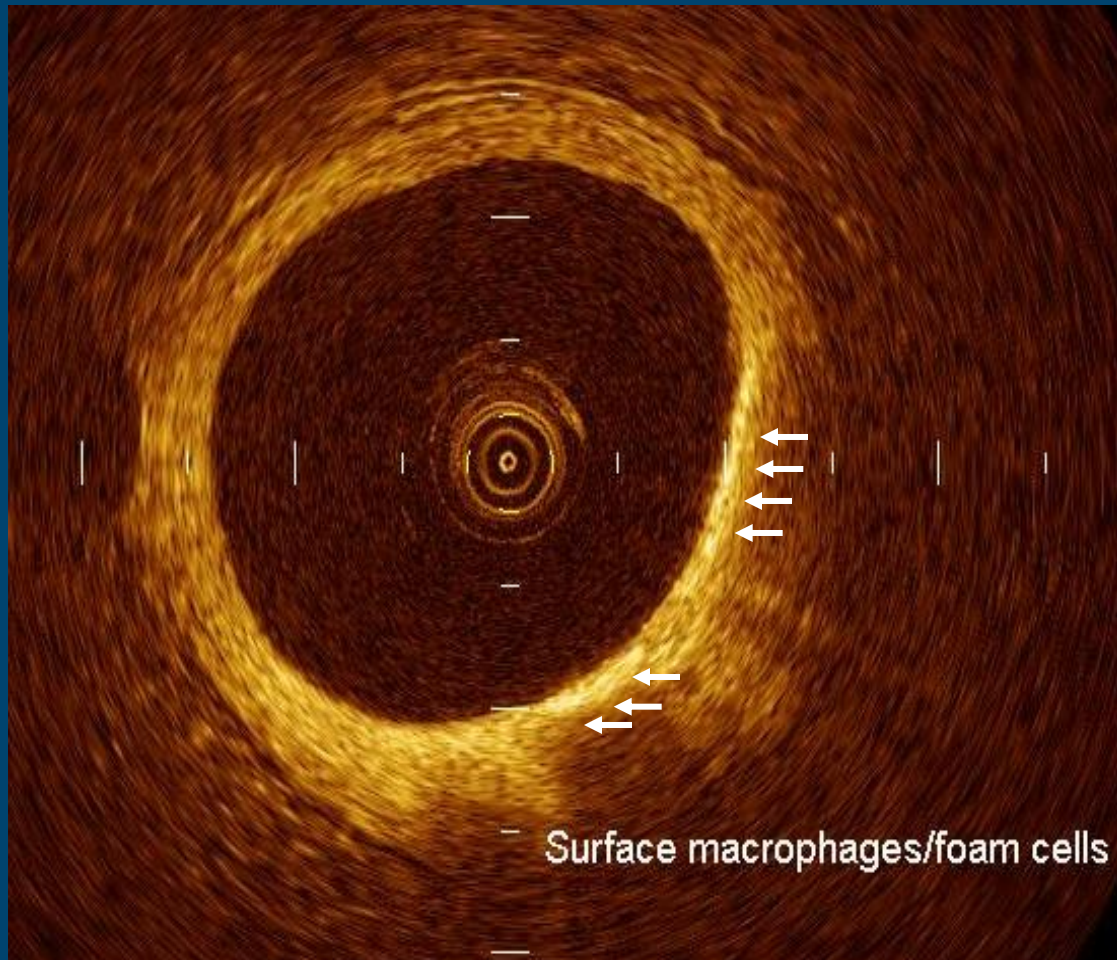
Calcified Plaque

Fibrous cap thickness

Correlation between OCT and histology



Macrophage



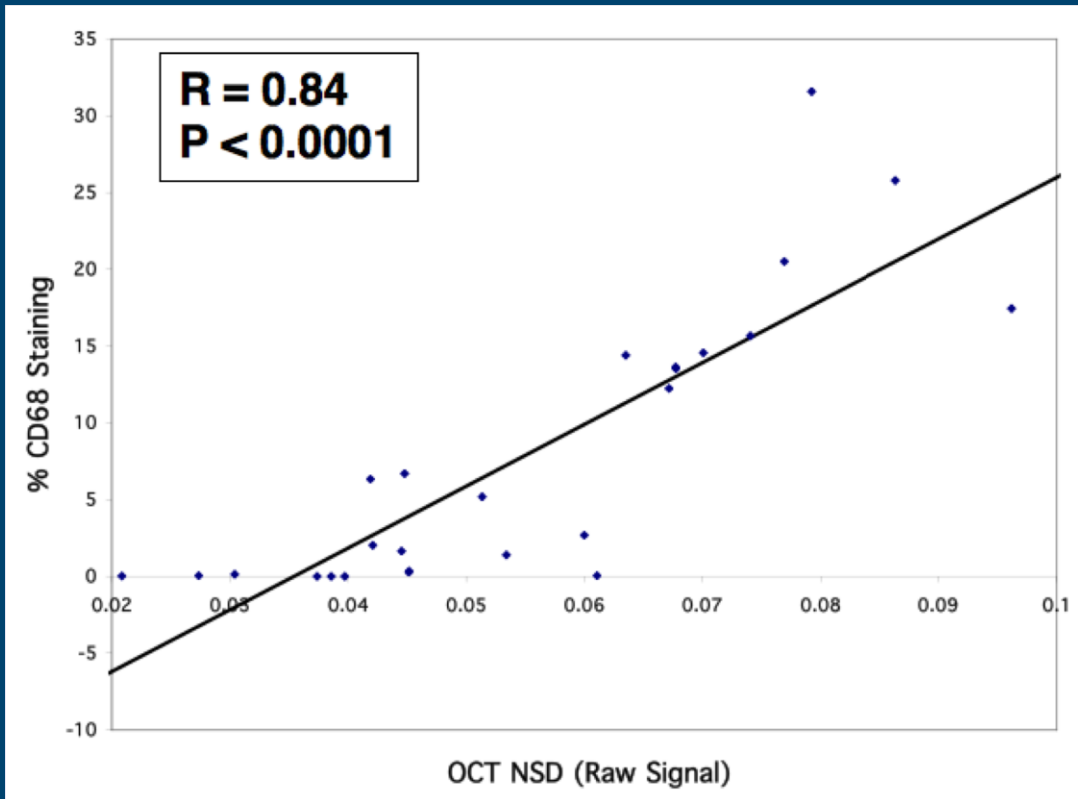
Surface macrophages/foam cells



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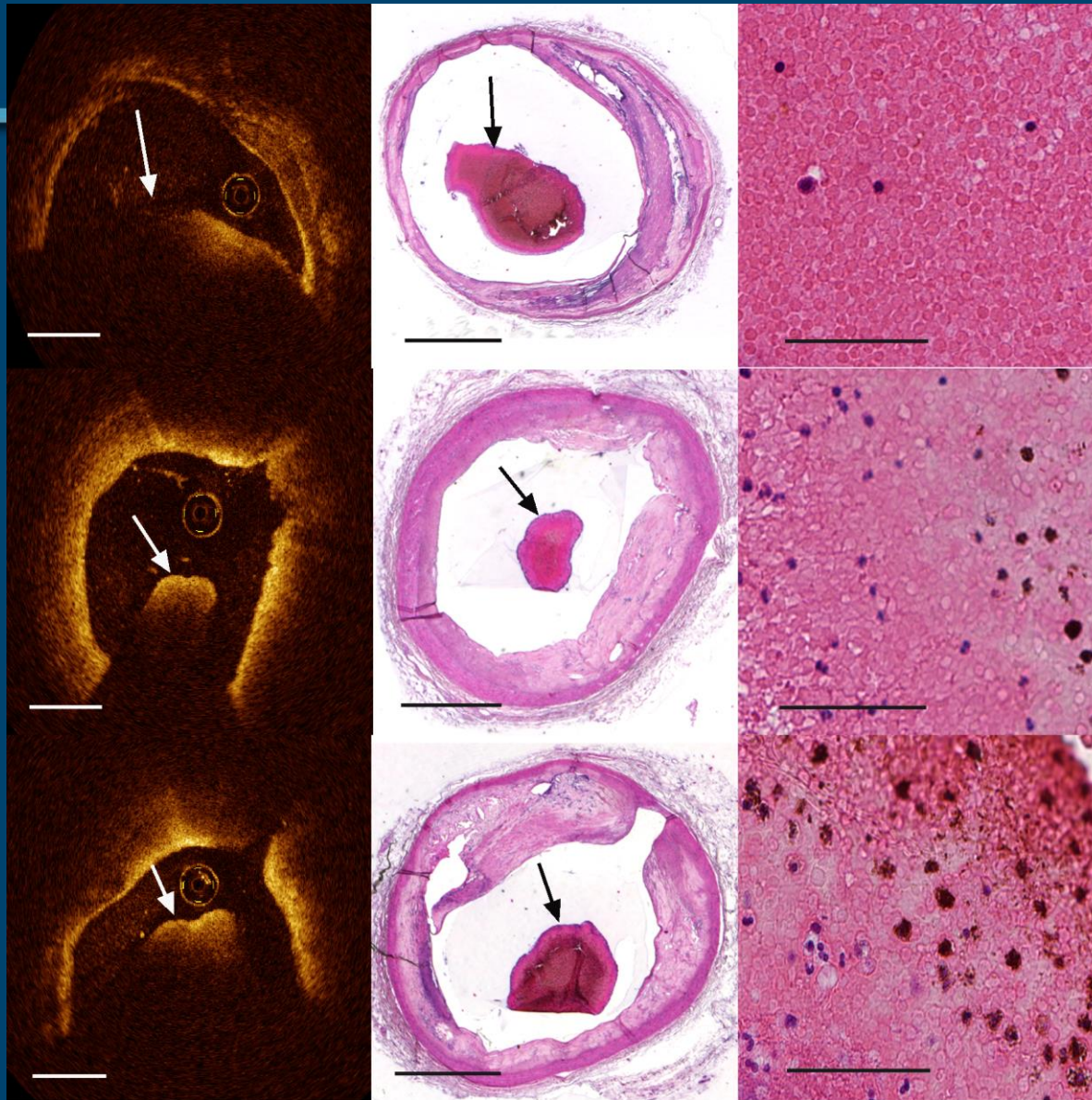
Linear NSD vs. CD68



CD68 % area > 10 % -
NSD cutoff 6.2%

SENS 100% (70-100%)
SPEC 100% (60 -100%)

Red thrombus



White thrombus

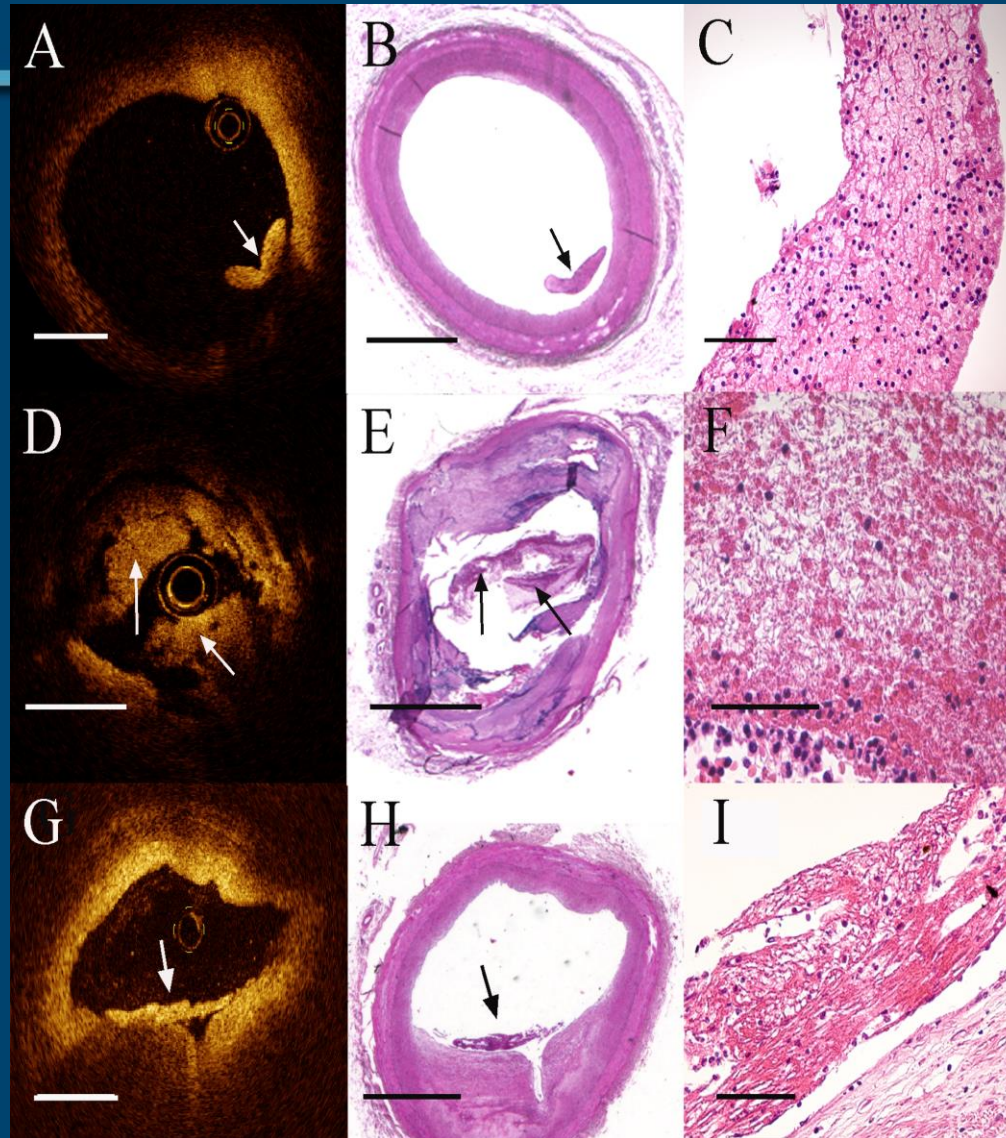


Image Interpretation

<i>Tissue Type</i>	<i>Image Characteristics</i>	
	<i>OCT</i>	<i>IVUS</i>
Fiber	<ul style="list-style-type: none"> - Homogenous - High reflectivity - Low attenuation 	<ul style="list-style-type: none"> - Homogenous - High reflectivity
Calcium	<ul style="list-style-type: none"> - Sharp edges - Low reflectivity - Low attenuation 	<ul style="list-style-type: none"> - Very high reflectivity - Strong shadowing
Lipid	<ul style="list-style-type: none"> - Diffuse edges - High reflectivity - High attenuation 	<ul style="list-style-type: none"> - Low reflectivity
Red Thrombus	<ul style="list-style-type: none"> - Medium reflectivity - High attenuation 	<ul style="list-style-type: none"> - Medium to high reflectivity
White Thrombus	<ul style="list-style-type: none"> - Medium reflectivity - Low attenuation 	<ul style="list-style-type: none"> - Medium to high reflectivity
Foam Cells	<ul style="list-style-type: none"> - Very high reflectivity - Coarse texture - Uneven shadowing 	<ul style="list-style-type: none"> - Not resolvable



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AMI v ACS v SAP: OCT Findings

	AMI (n=20)	ACS (n=20)	SAP (n=17)	P value
Lipid-rich plaque	90%	75%	58%	0.09
FCT, μm	47	53.8	102.6	0.03
TCFA	72%	50%	20%	0.01

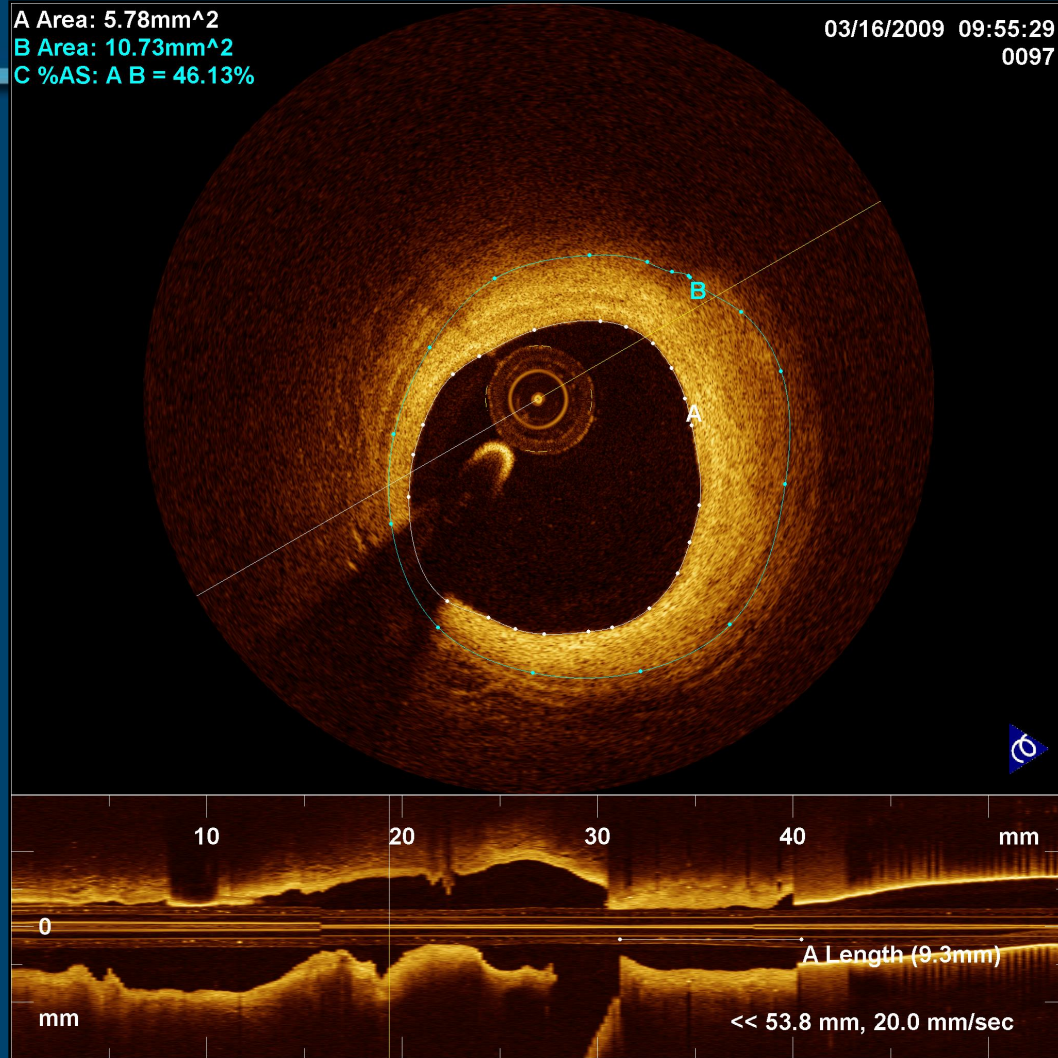
PCI



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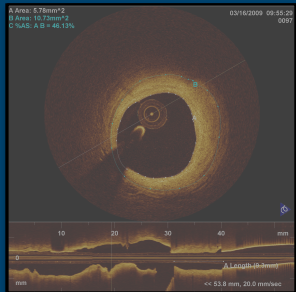
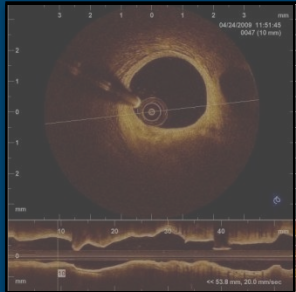
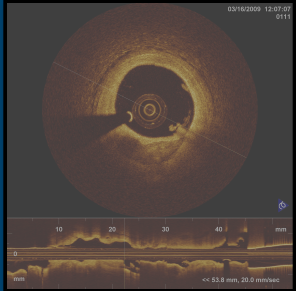
Pre-Intervention Imaging



Calcified +
Thrombus

Lipid

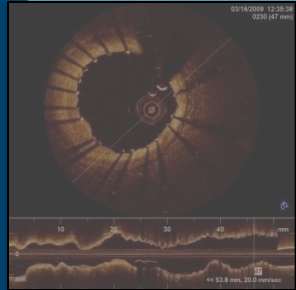
Fibrotic



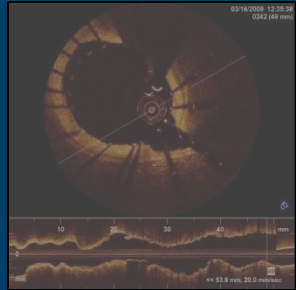
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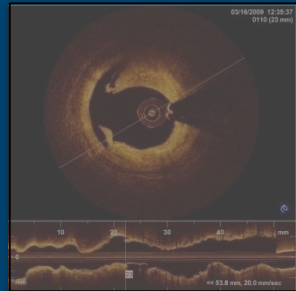
Post-Intervention Imaging



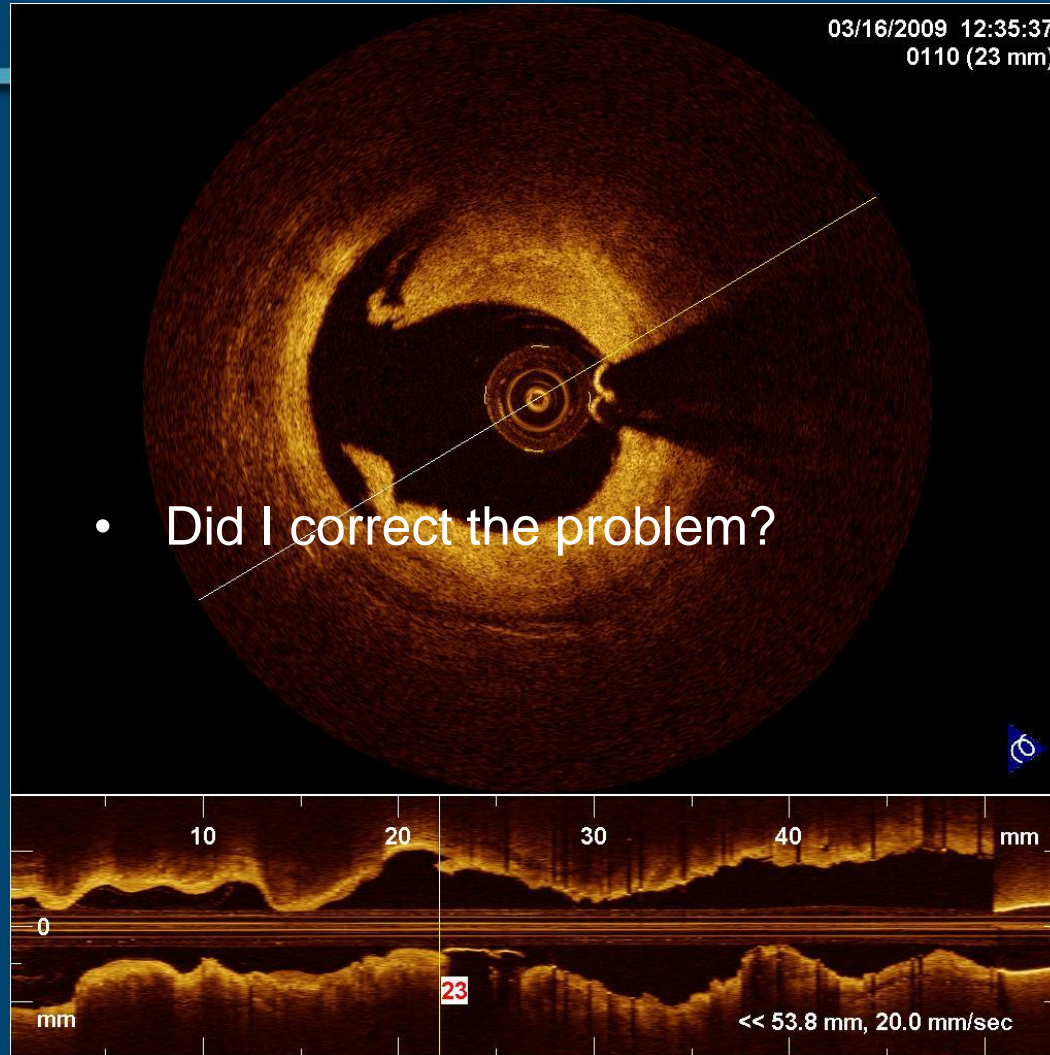
Well-Opposed



Malapposition



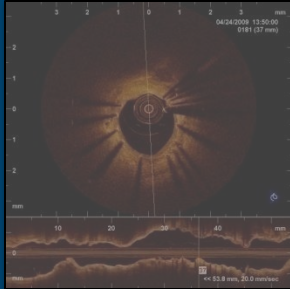
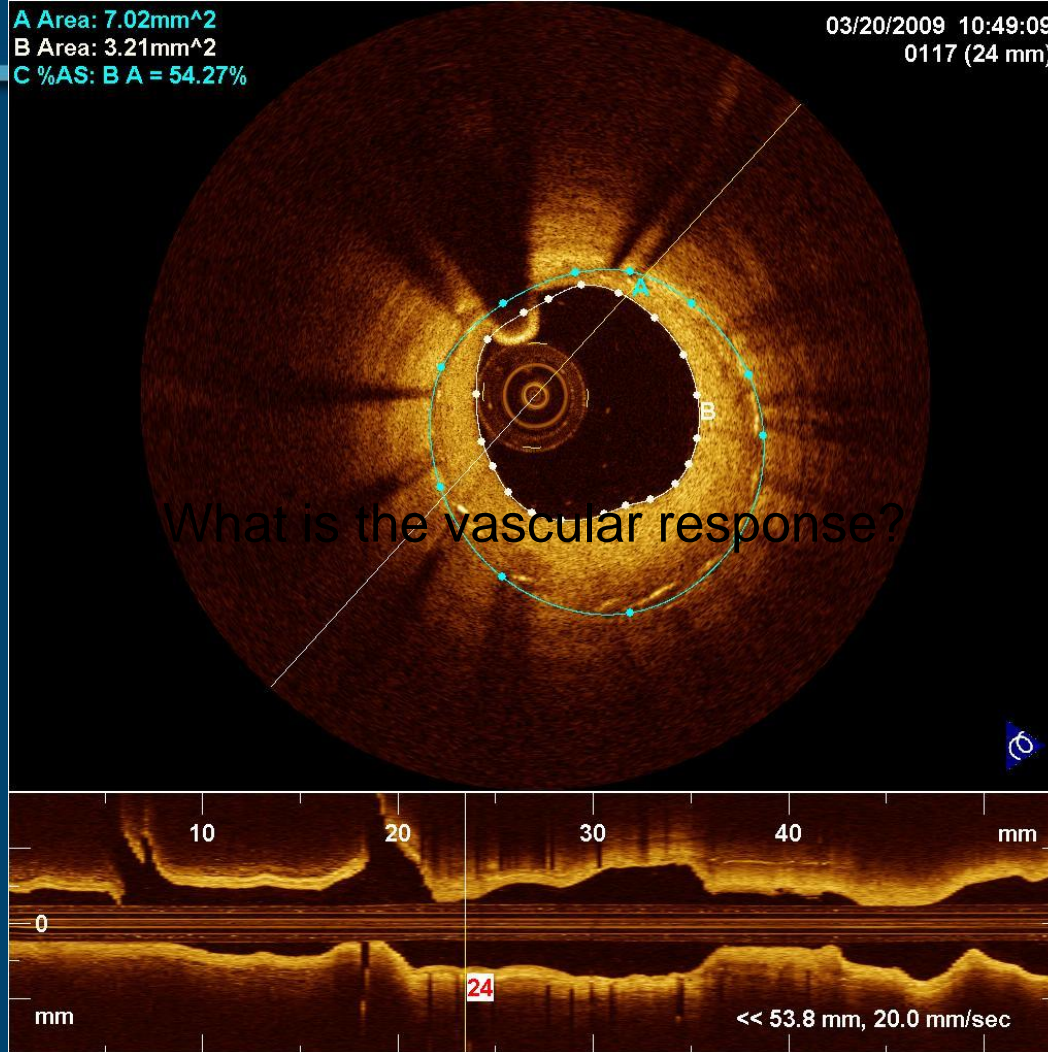
Edge
Dissection



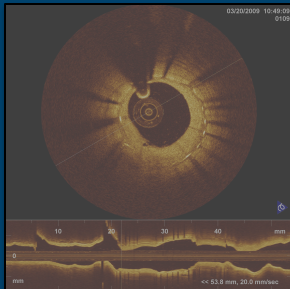
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Follow-Up Imaging



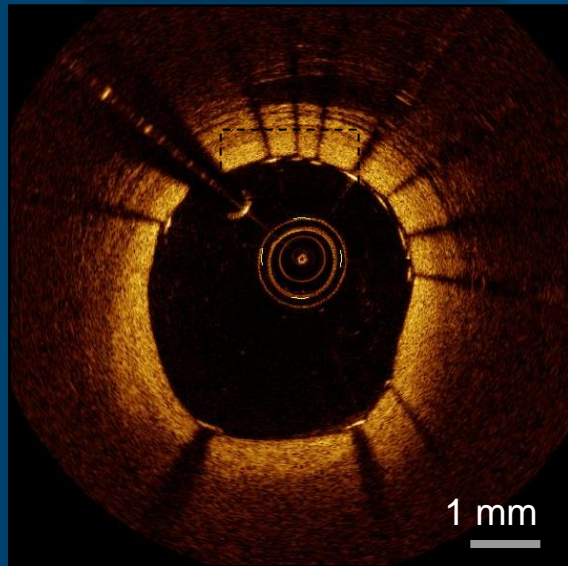
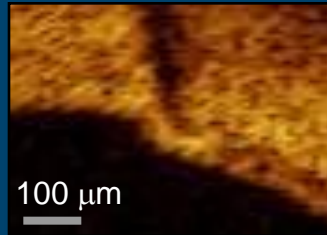
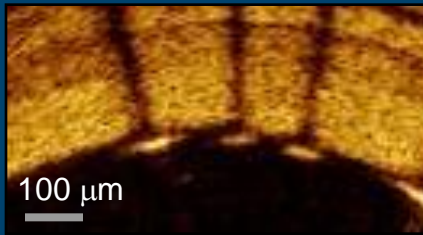
Thin
Neointima



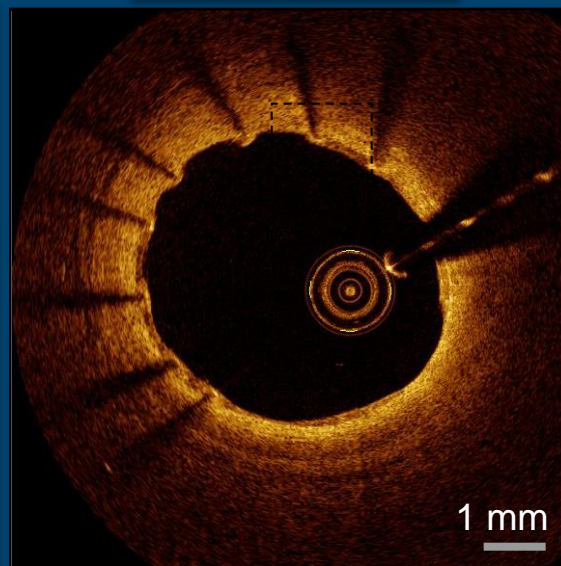
Neointimal
Hyperplasia



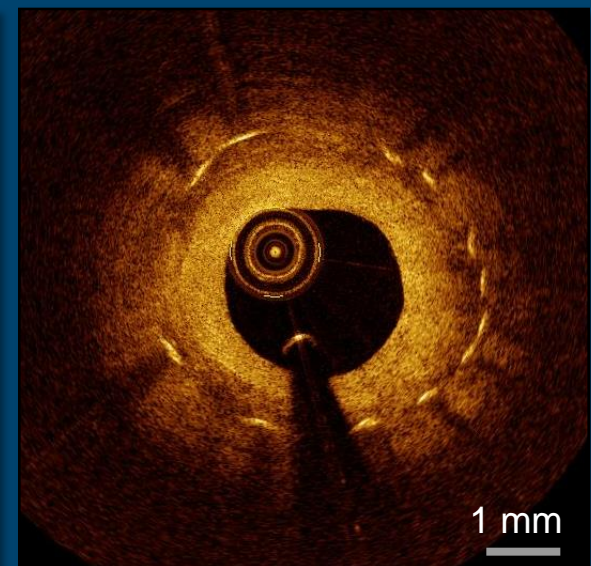
Vascular Response to Stenting



Freshly implanted

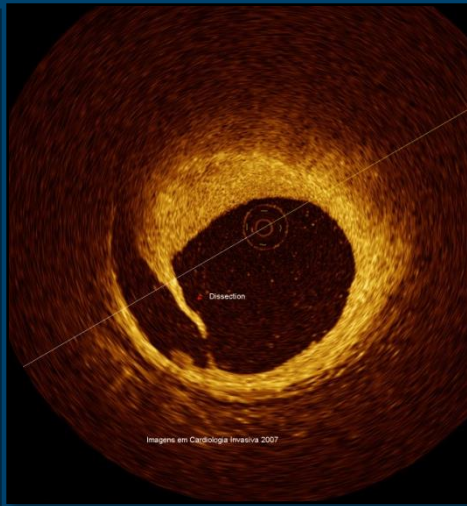
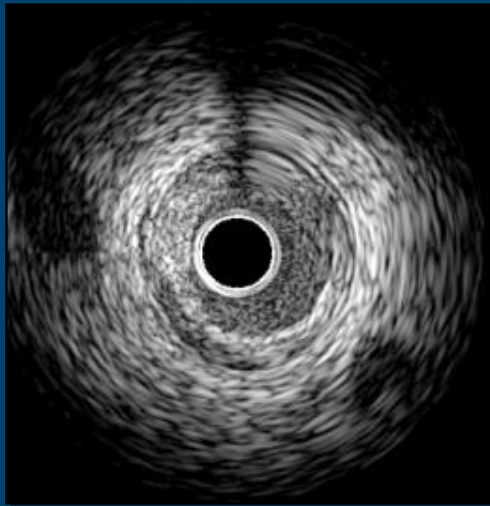


DES follow-up

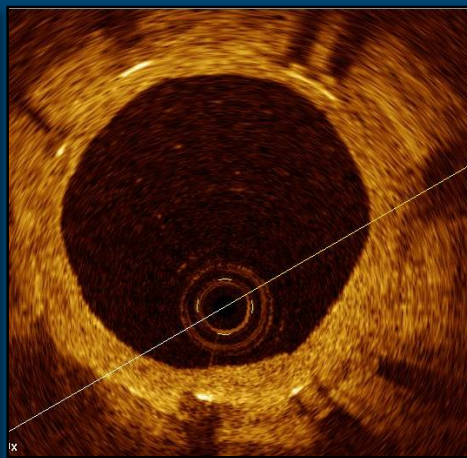
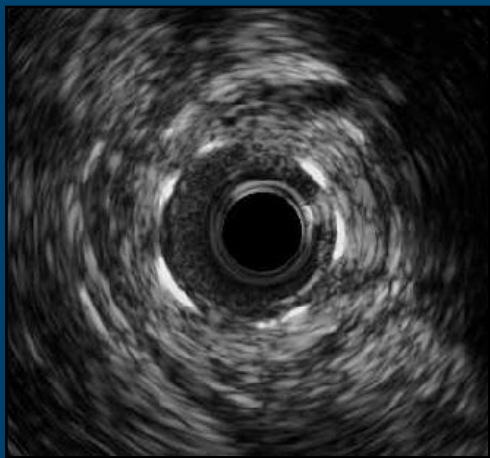


BMS follow-up

FD-OCT vs IVUS



- Edge dissection during stent implantation



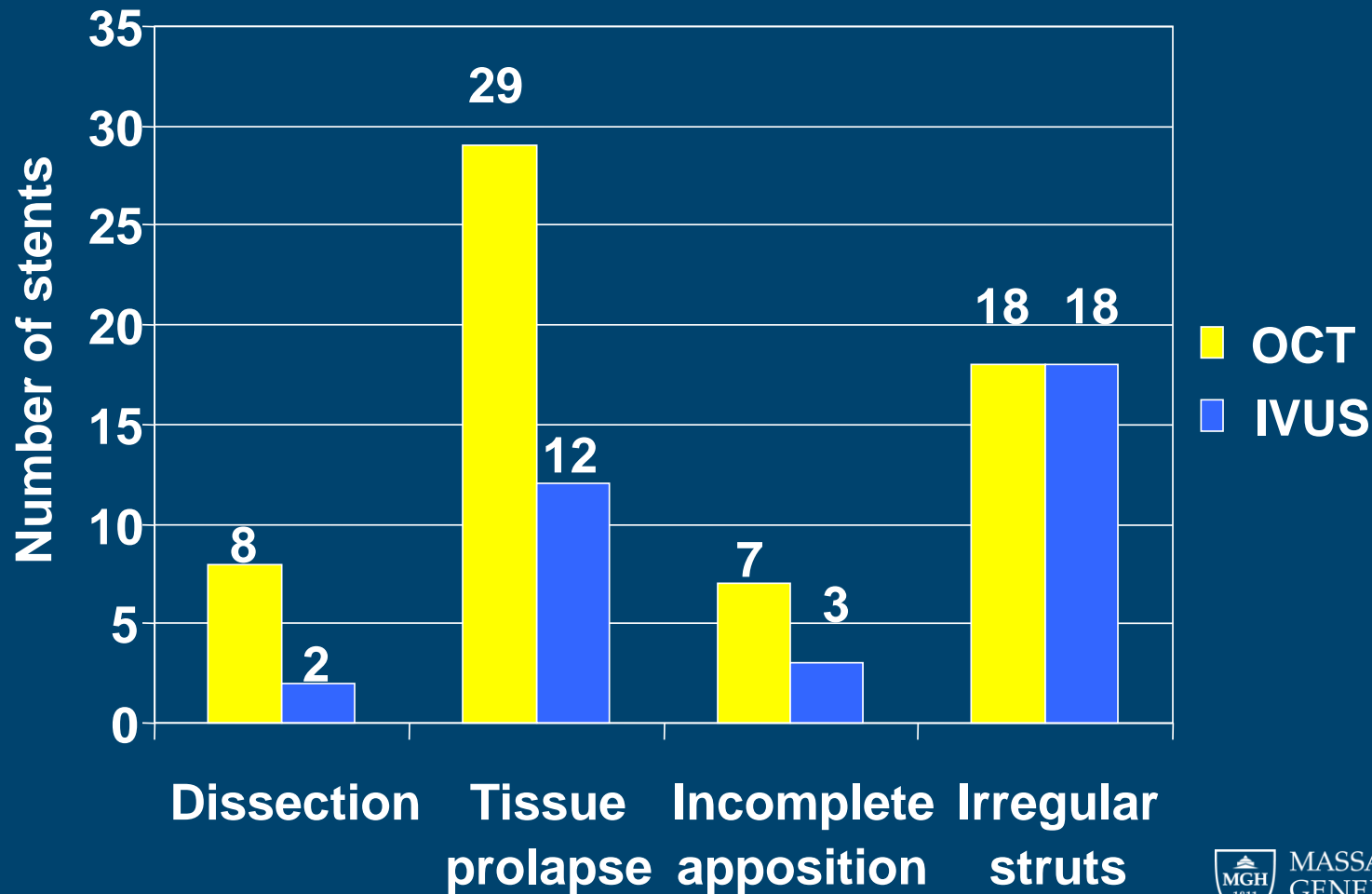
- Neointimal growth on previously implanted stent at follow-up



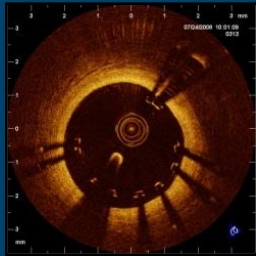
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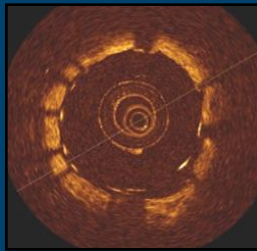
Comparison of OCT and IVUS Findings Post Stenting



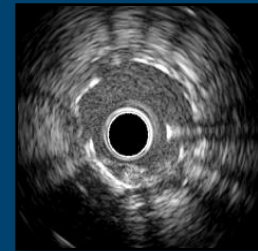
Performance Comparison



C7XR



M2
M3



IVUS

<i>Axial Resolution</i>	12 - 15 mm (axial)	15 - 20 mm (axial)	100 - 200 mm (axial)
<i>Beam Width</i>	20 – 40 mm	20 – 40 mm	200 - 300 mm
<i>Frame Rate</i>	100 frames/s	15 – 20 frames/s	30 frames/s
<i>Pullback Speed</i>	20 mm/s	1 – 1.5 mm/s	0.5 - 1 mm/s
<i>Max. Scan Dia.</i>	10 mm	6.8 mm	15 mm
<i>Tissue Penetration</i>	1.0 - 2.0 mm	1.0 - 2.0 mm	10 mm
<i>Lines per Frame</i>	500	240	256
<i>Lateral Sampling (3mm Artery)</i>	19 um	39 um	225 um



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Limitations of OCT

- 1. Need to create blood free zone**
- 2. Shallow penetration depth**
- 3. No functional (physiologic) information**

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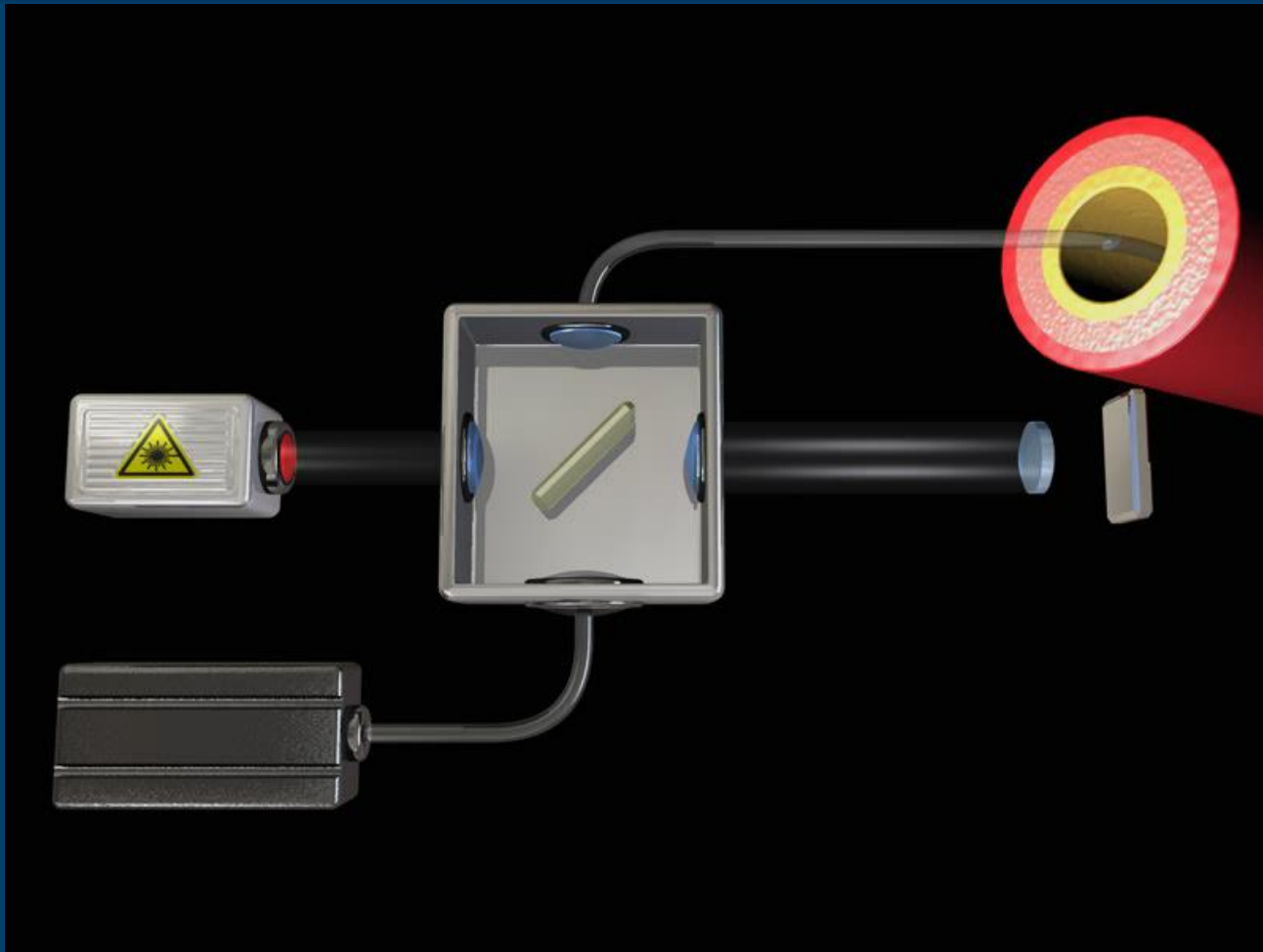
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Fourier Domain OCT



A Teaching Affiliate
of Harvard Medical School

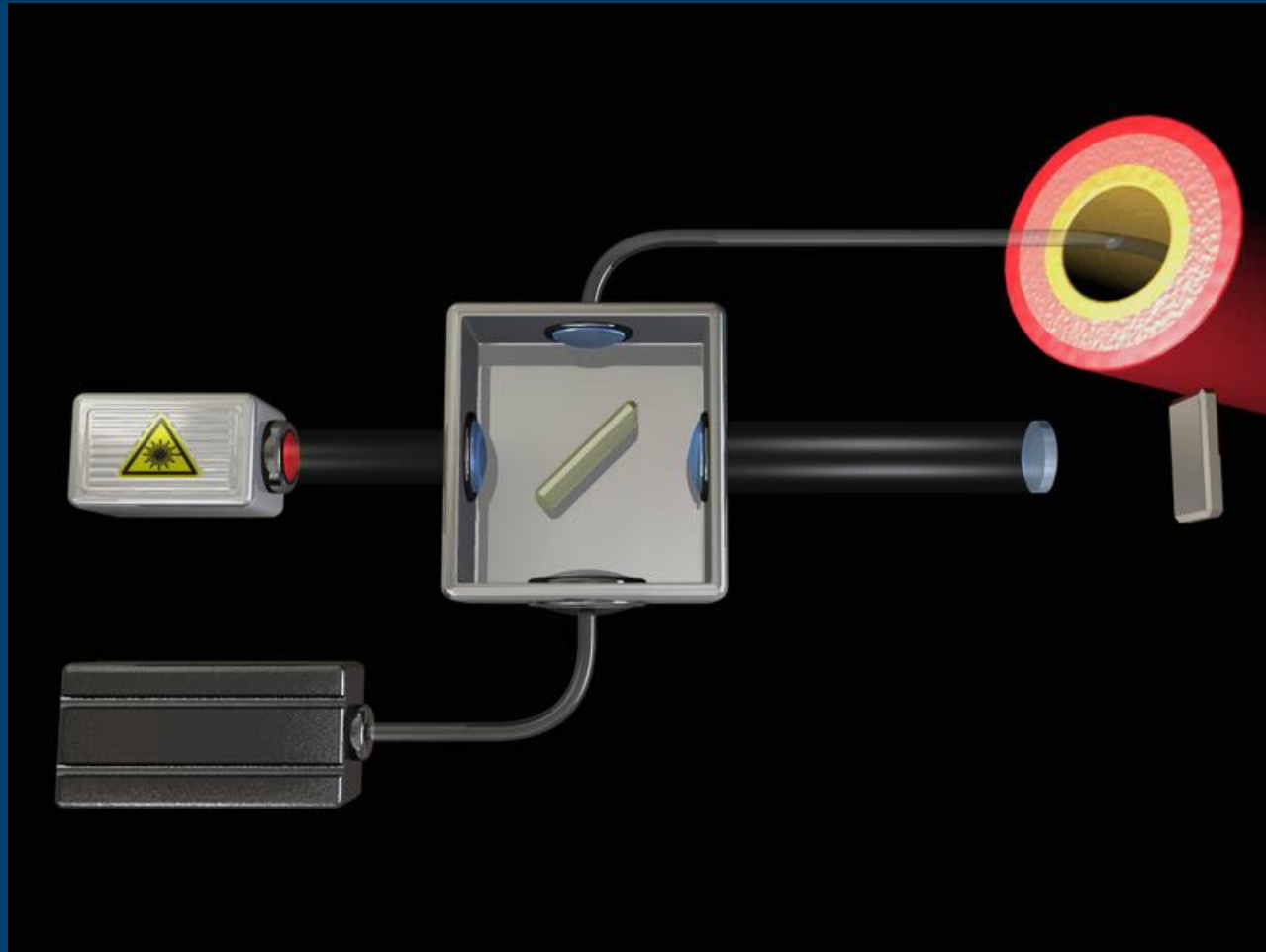
Time-Domain OCT



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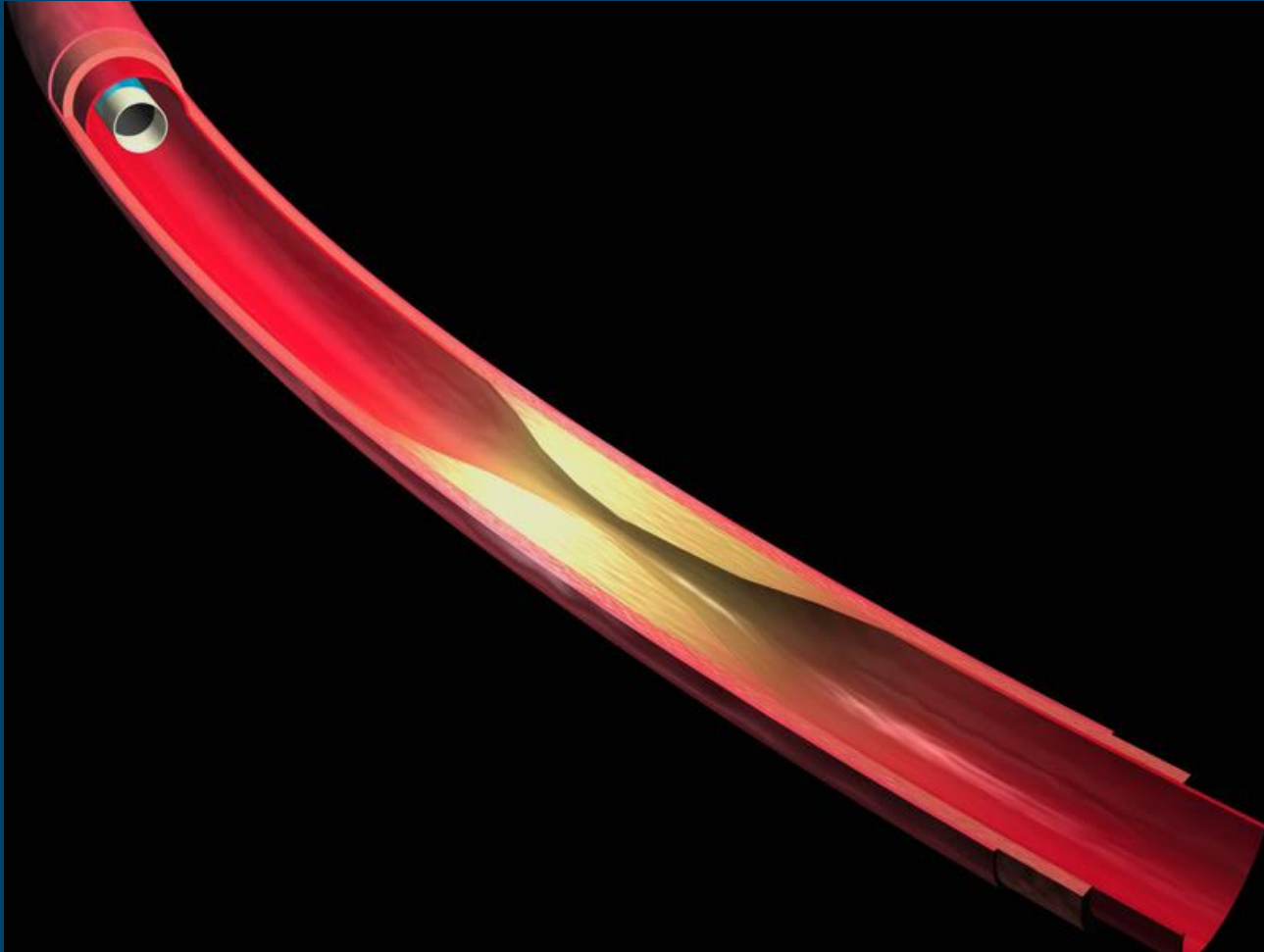
Frequency-Domain OCT



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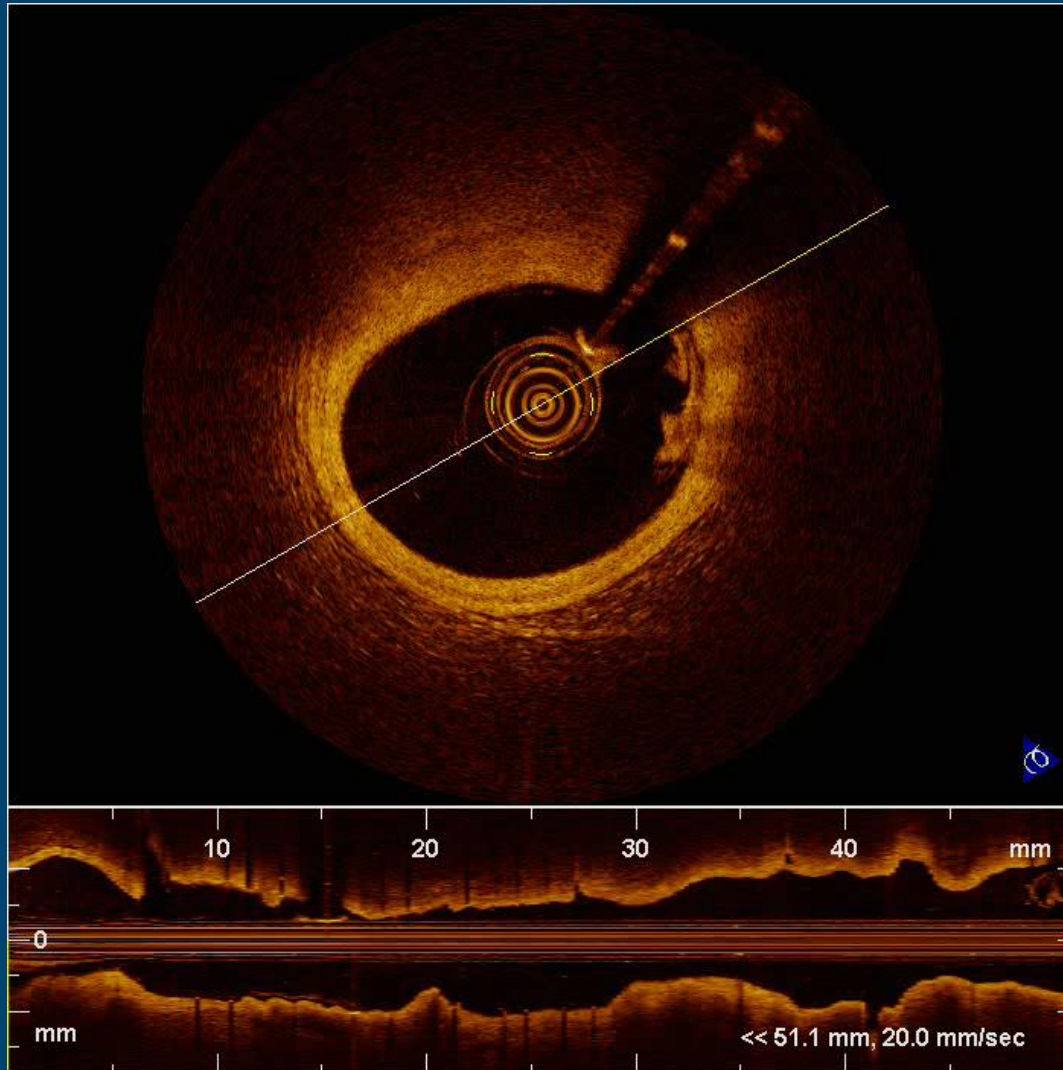
FD OCT



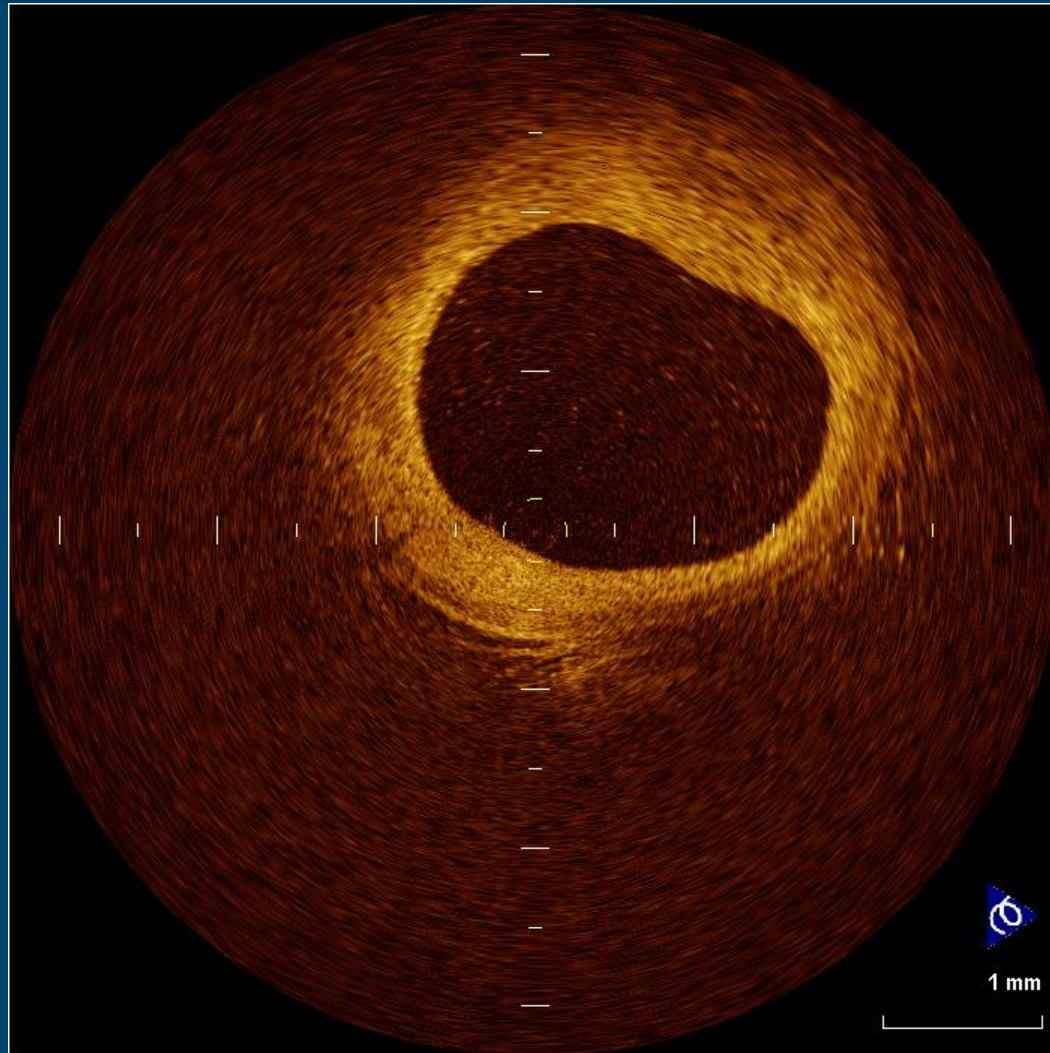
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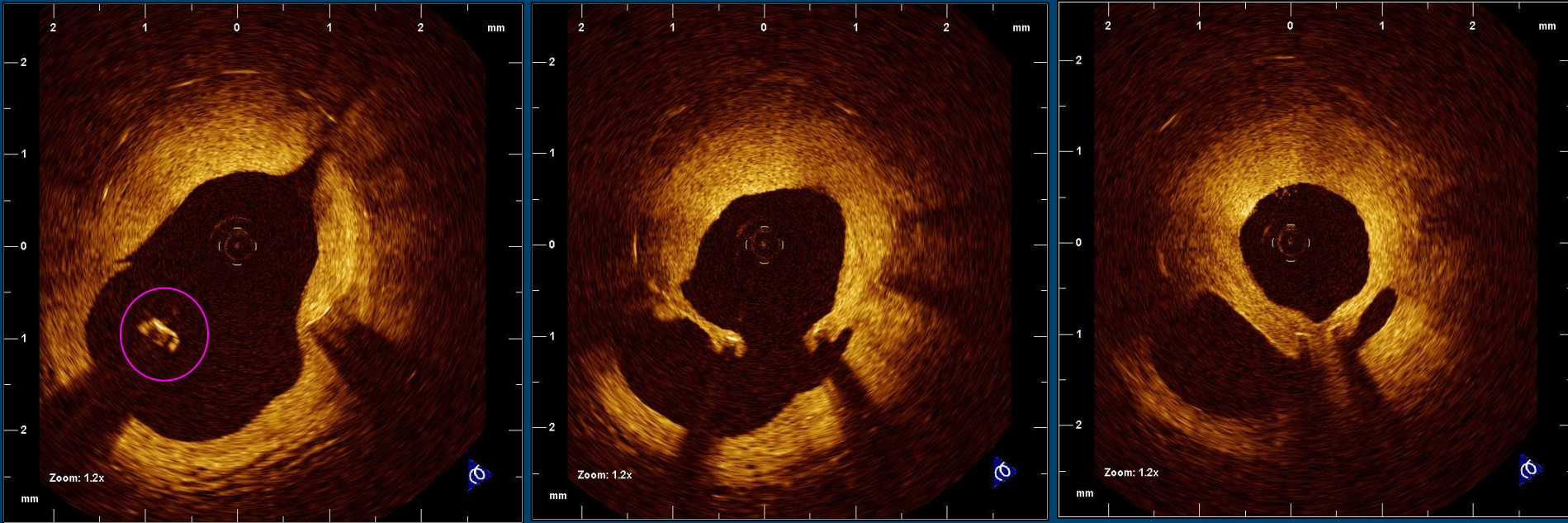
FD OCT Pullback



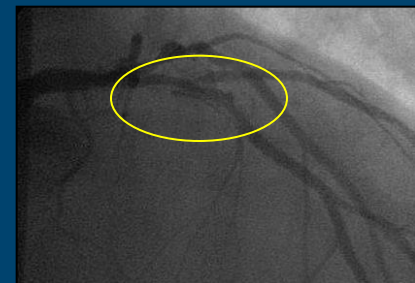
FD OCT Pullback



ISR after bifurcation stenting



Courtesy of E. Regar, Rotterdam



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Issue

**Lack of correlation between OCT
finding and clinical outcome!**



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MGH OCT Registry

- Target #: 3000 (~ 5000) patients
- Follow up: 3-5 years
- Start: June 1, 2010
- Sites: 20

<http://www.massgeneral.org/octregistry>



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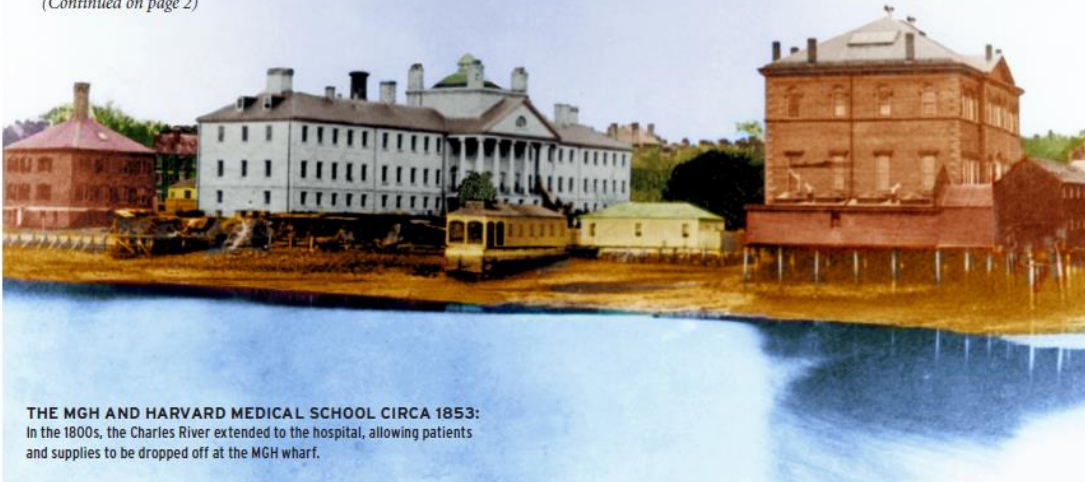
Thank You



MGH history book to commemorate bicentennial

AS PART OF the MGH's bicentennial celebrations, a commemorative book covering the hospital's unique beginnings and illustrious history will be published in 2011. "Something in the Ether, A Bicentennial History of Massachusetts General Hospital, 1811 to 2011," was written by author and publisher Webster Bull. Much of the content was drawn from interviews with longtime MGH staff and countless hours of research of historical records and archival material. The book is scheduled to be released in March and will be available at the MGH General Store and select booksellers.

(Continued on page 2)



THE MGH AND HARVARD MEDICAL SCHOOL CIRCA 1853:
In the 1800s, the Charles River extended to the hospital, allowing patients and supplies to be dropped off at the MGH wharf.



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