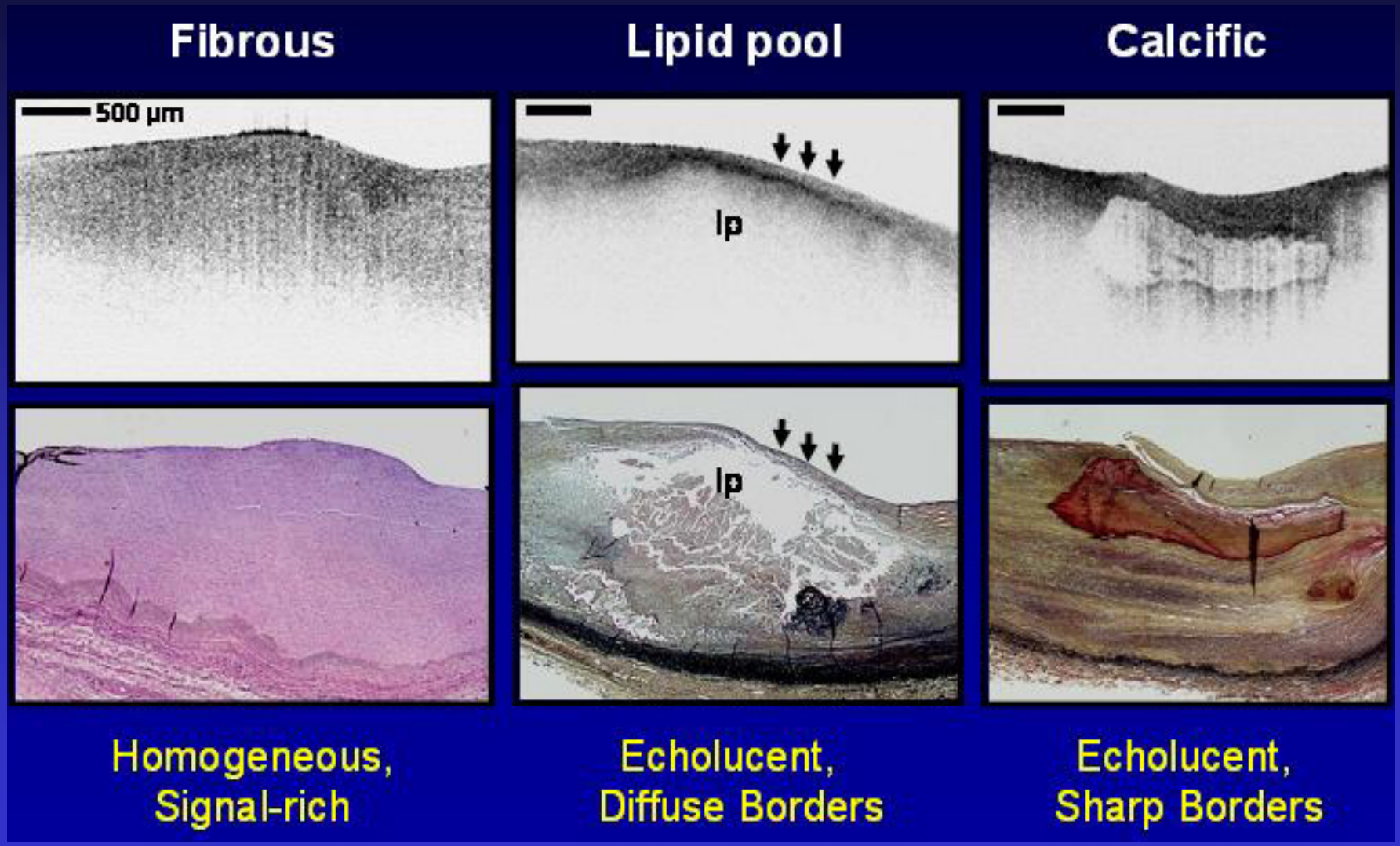
Angioplasty summit 2005

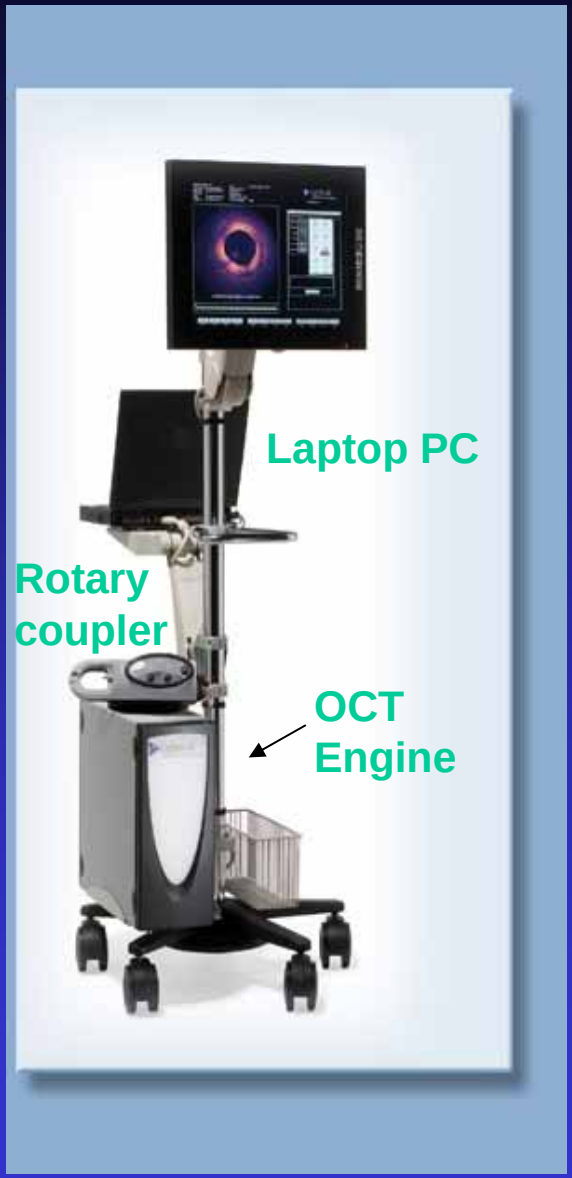
Arterial Plaque Evaluation Using OCT: A comparison with IVUS and histological findings

Takashi Akasaka, MD
Kawasaki Medical School

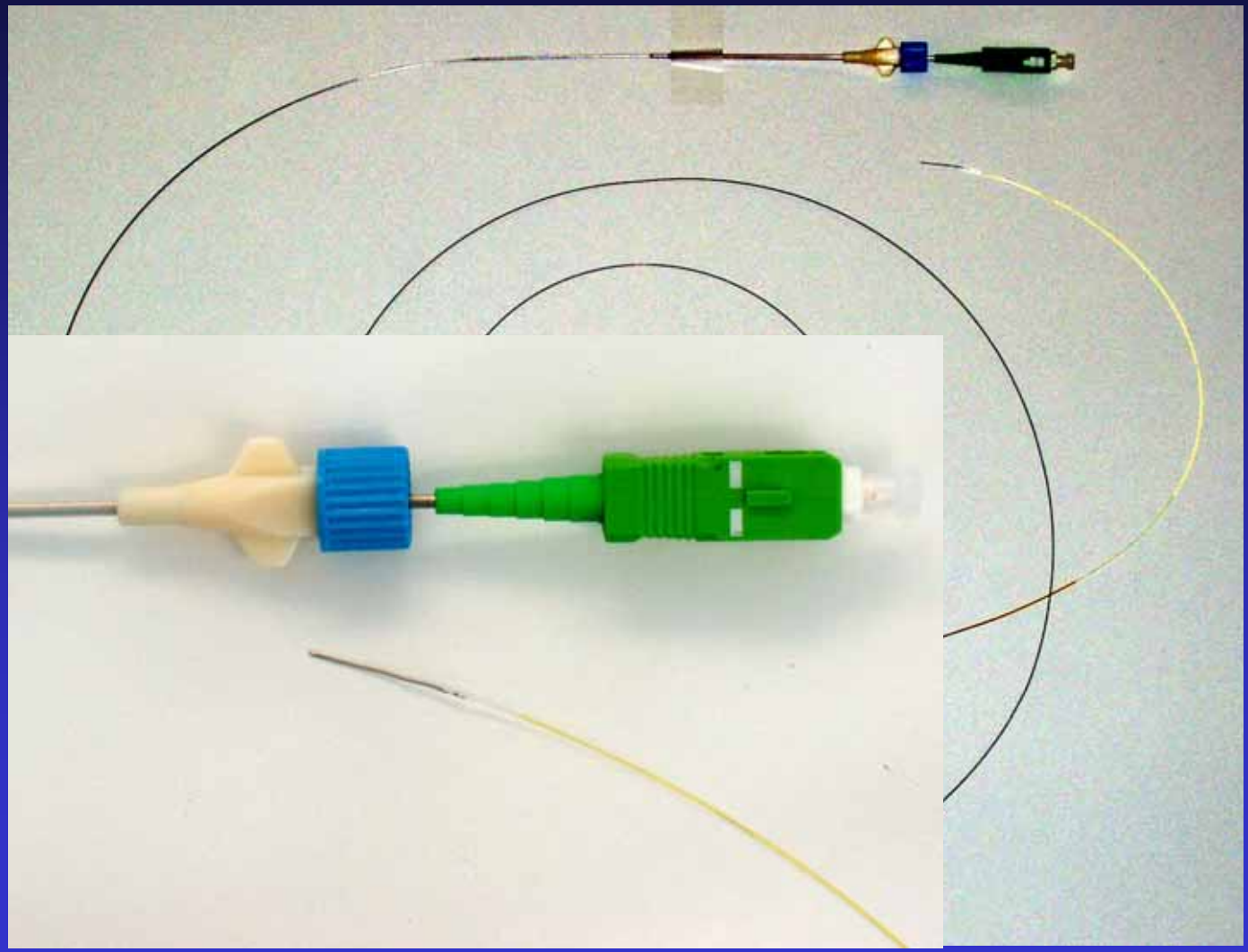
OCT vs histology



OCT system (LightLab prototype)



ImageWire®



Kawasaki Medical School

Purpose

To compare coronary vessel wall structural images obtained by OCT and IVUS with histological findings

Subjects

- 166 coronary lesions (28 autopsy cases）
- Age　72±6 y.o.　(Male / Female:　16 / 12）
  - OMI　1
  - AMI　2
  - Pulmonary embolism　2
  - Liver chirrosis　3
  - Pneumonia　4
  - Leukemia　6
  - carcinoma　7
  - Others　3

Methods 1

OCT & IVUS recordings（37℃ PBS solution, 80mmHg）

↓

Pressure perfusion-fixed in 10% formalin (48 hours)

↓

Paraffin embedding

4 μm thickness cut sections every 400 μm

↓

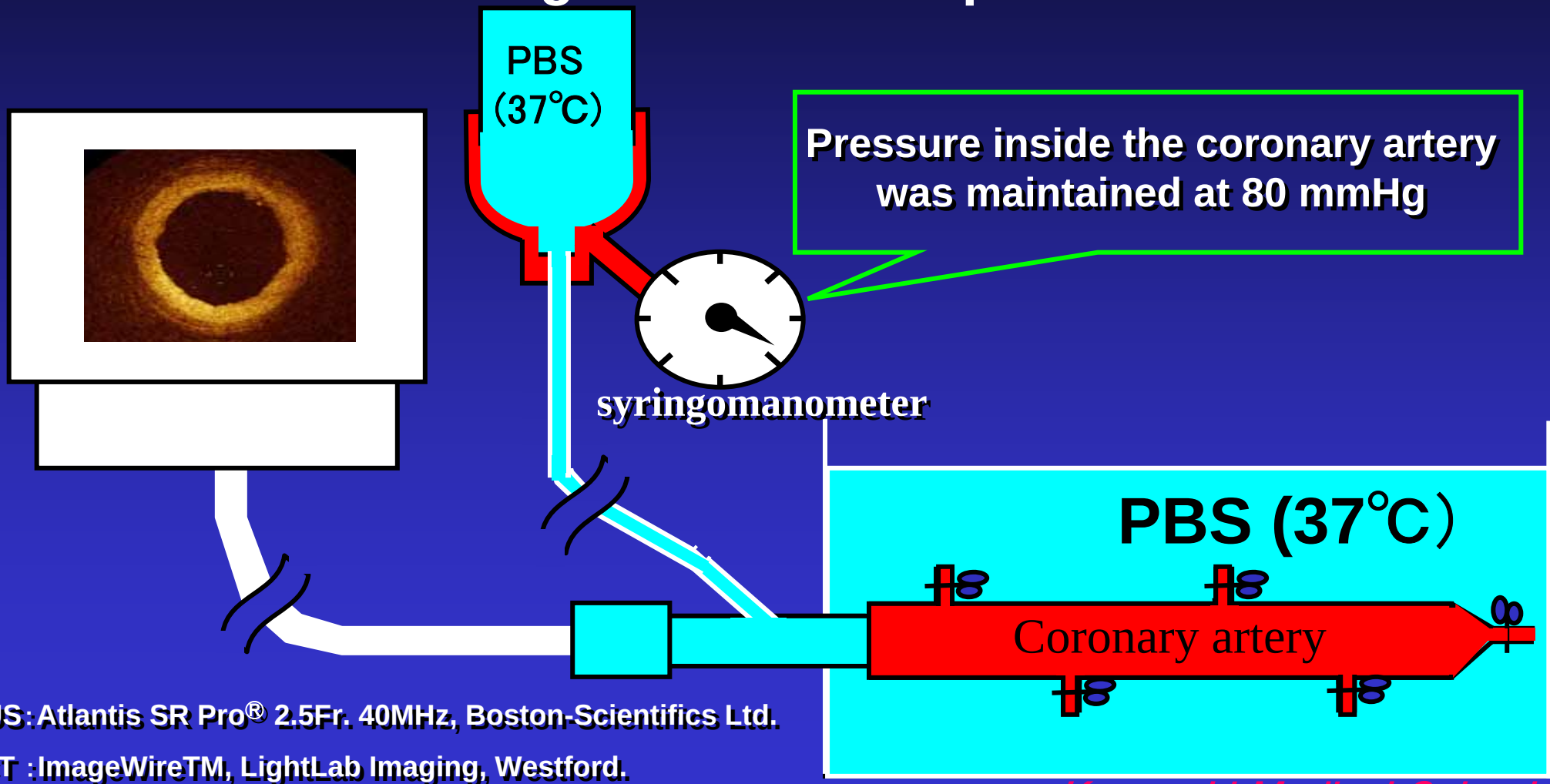
HE・Masson-trichrome・Elastica-van Gieson stains

↓

Comparison between OCT & IVUS images with histology in 166 coronary lesions

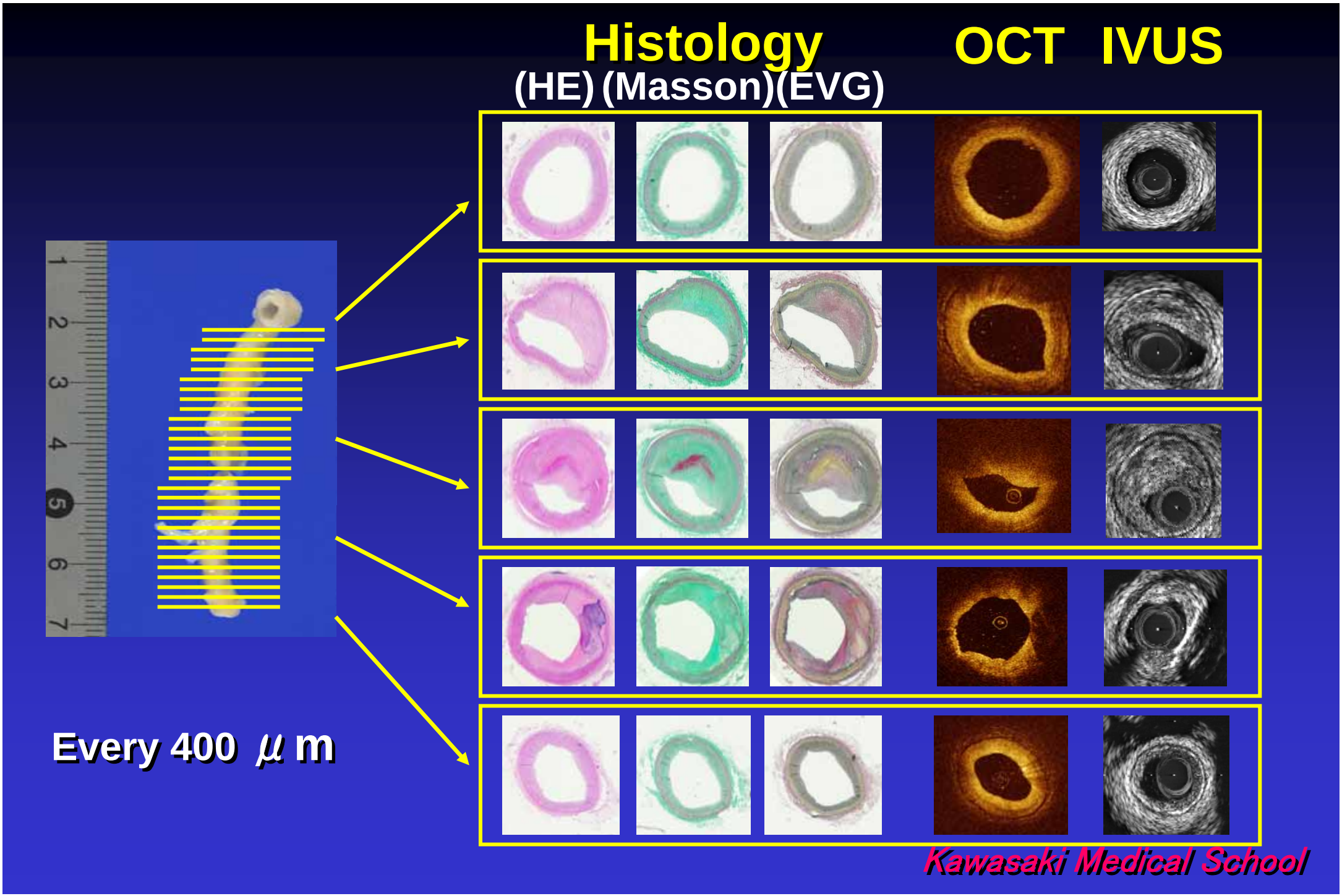
Methods 2

*** Serial images of OCT and IVUS were obtained using an automatic pullback device.**



IVUS：Atlantis SR Pro® 2.5Fr. 40MHz, Boston-Scientifics Ltd.

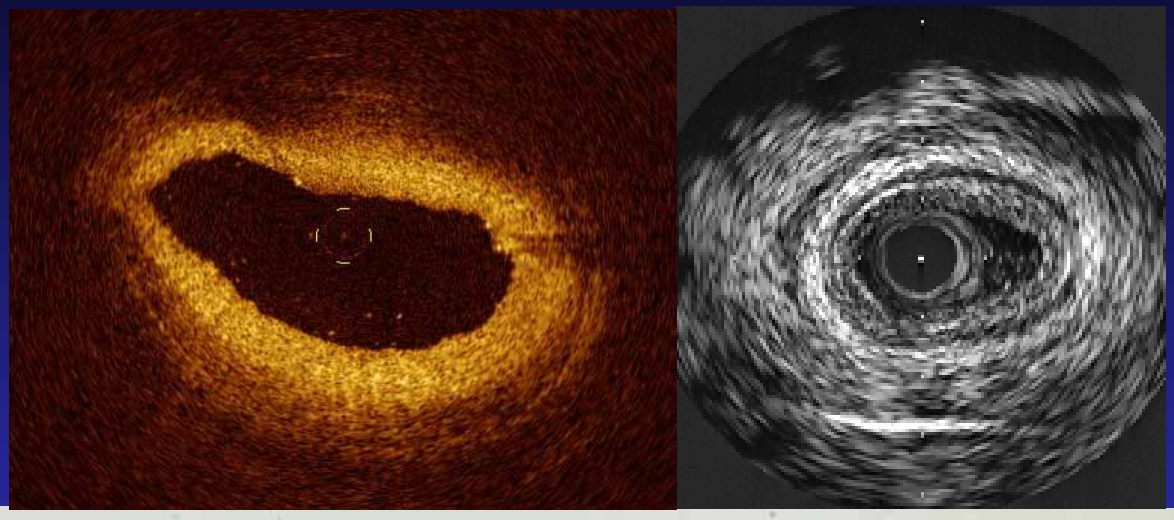
OCT ：ImageWireTM, LightLab Imaging, Westford.


Histology
(HE) (Masson)(EVG)
OCT IVUS
Every 400 μm
Kawasaki Medical School

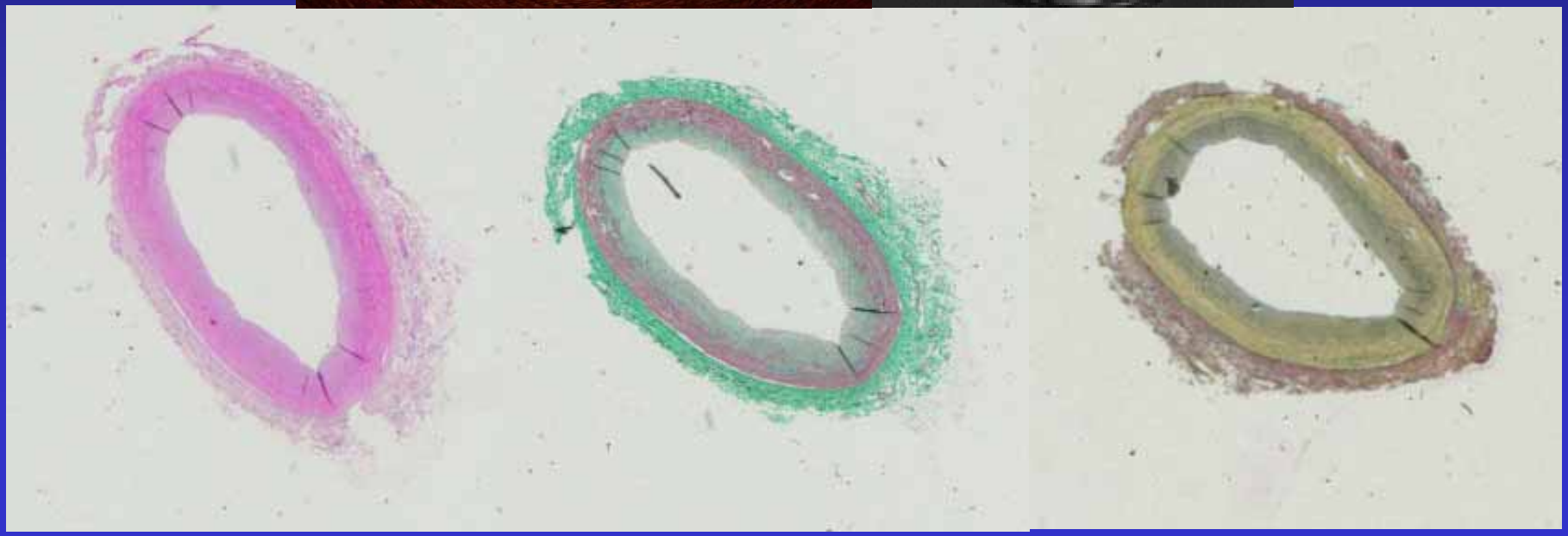
Fibrous plaque

Homogenous

Signal-rich

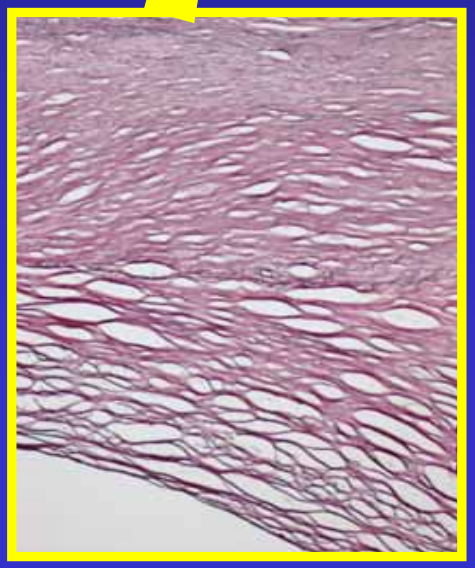


High-echoic



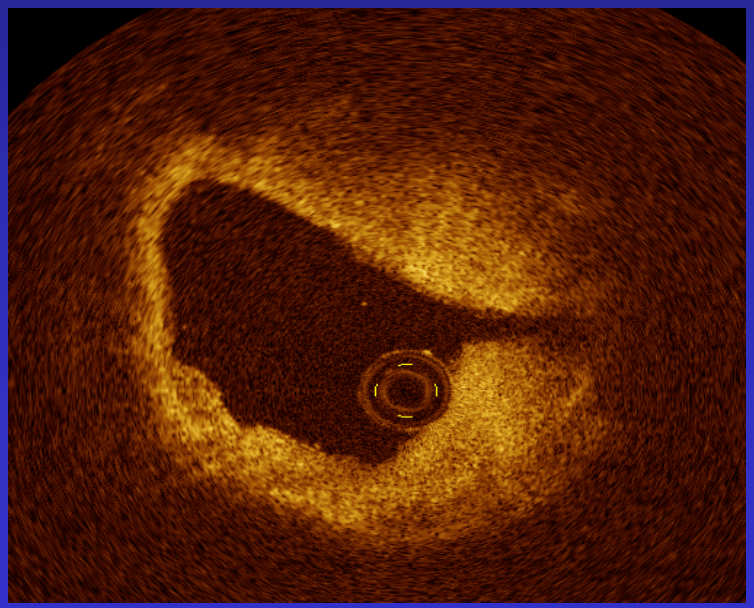
Kawasaki Medical School

Fibrous plaque



High-echoic

Attenuation

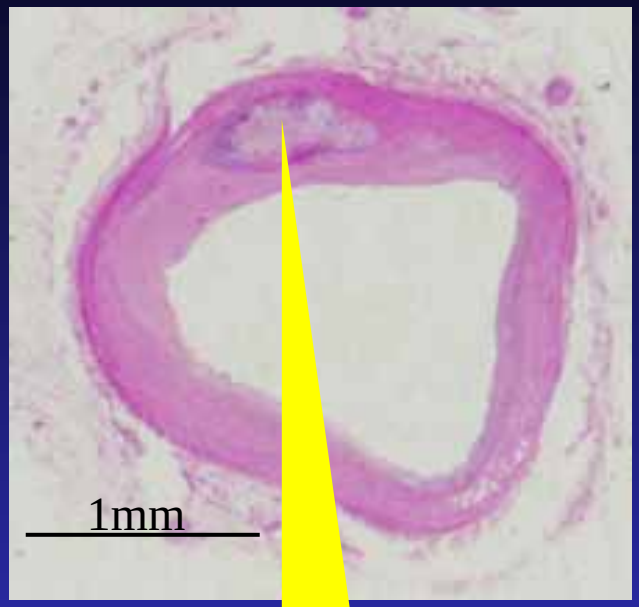


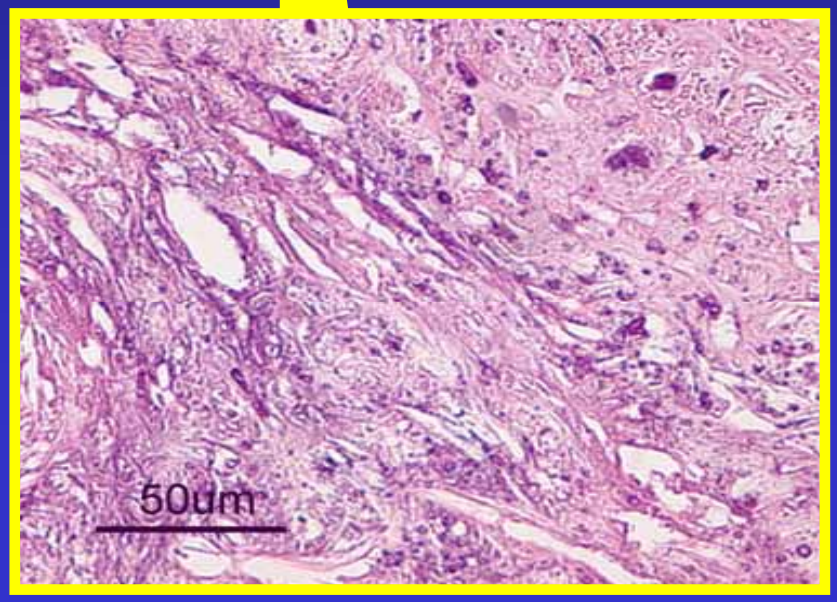
Signal-rich

Homogenous

Kawasaki Medical School

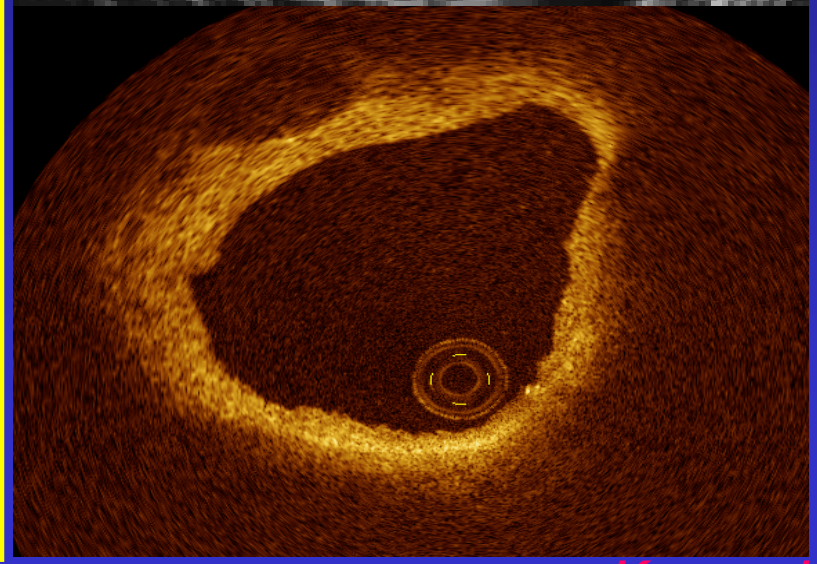
Fibrocalcific plaque





High-echoic

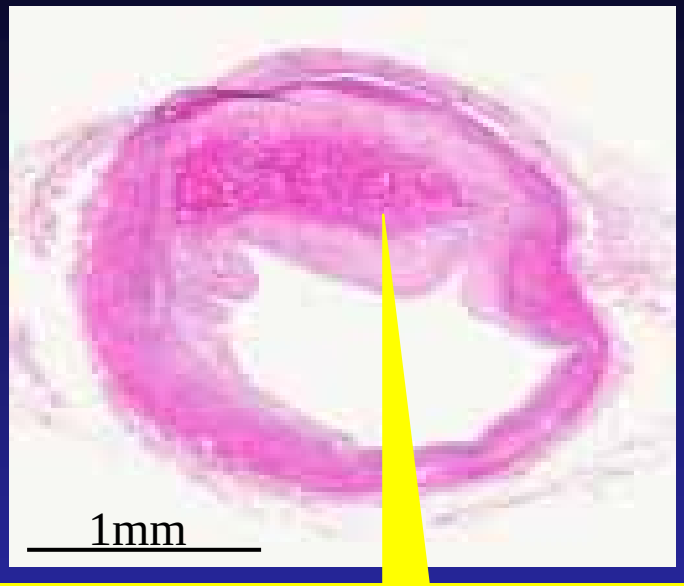
Shadowing

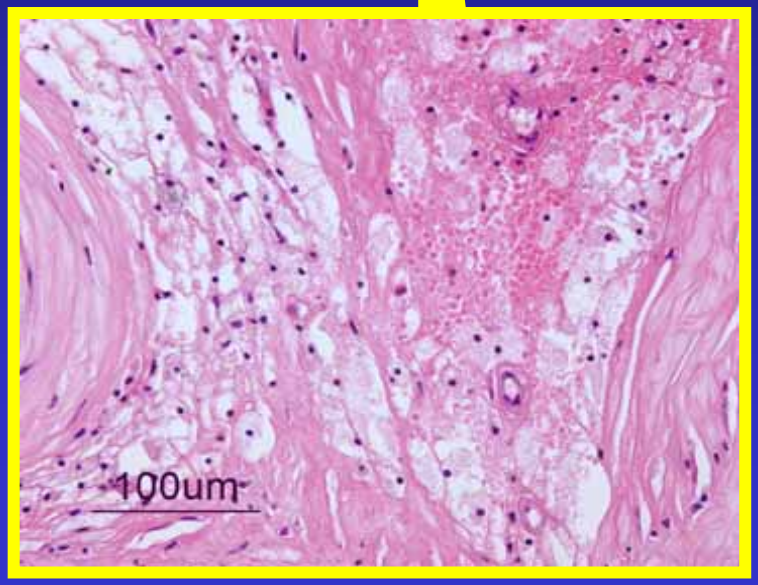


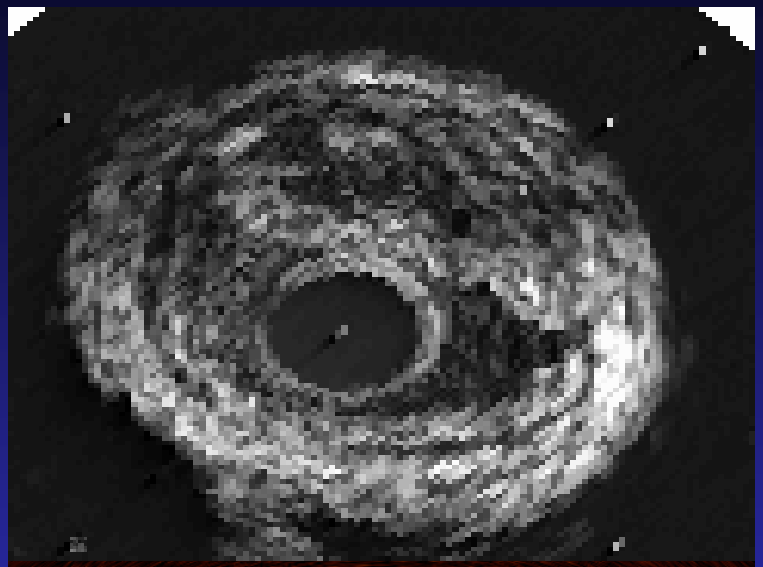
Echolucent

Sharp borders

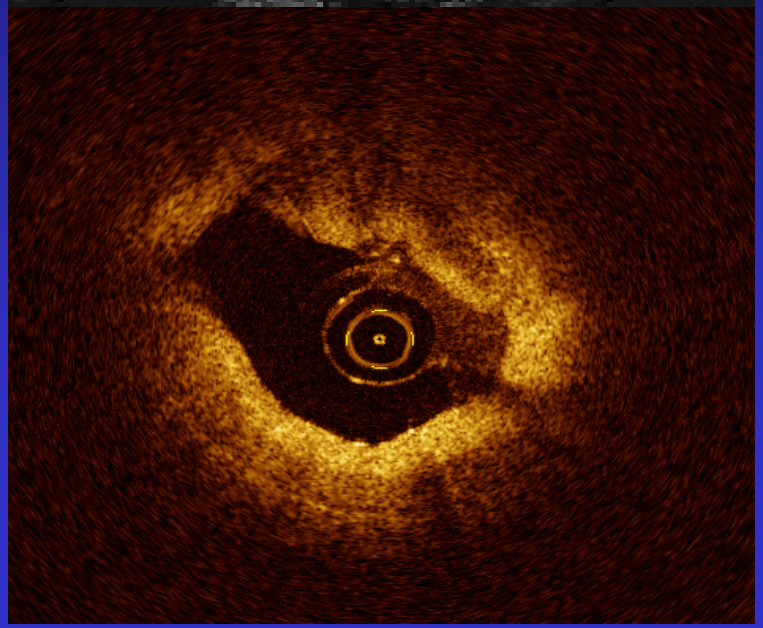
Lipid-rich plaque







Echolucent



Echolucent

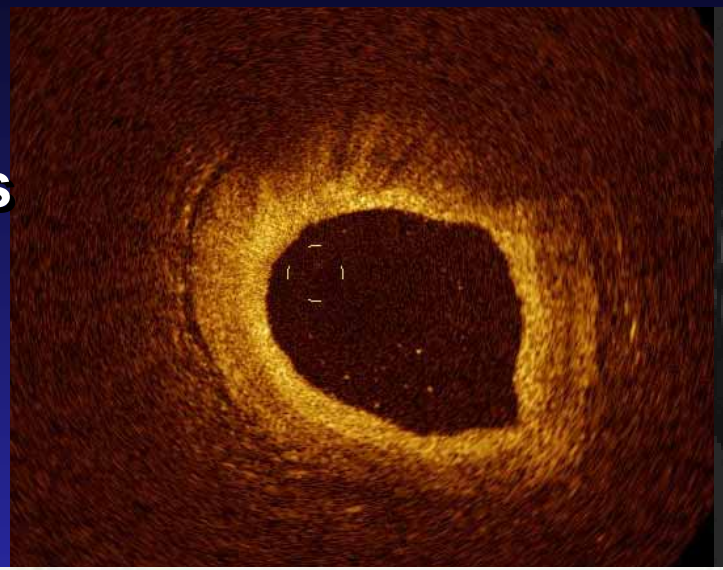
Diffuse borders

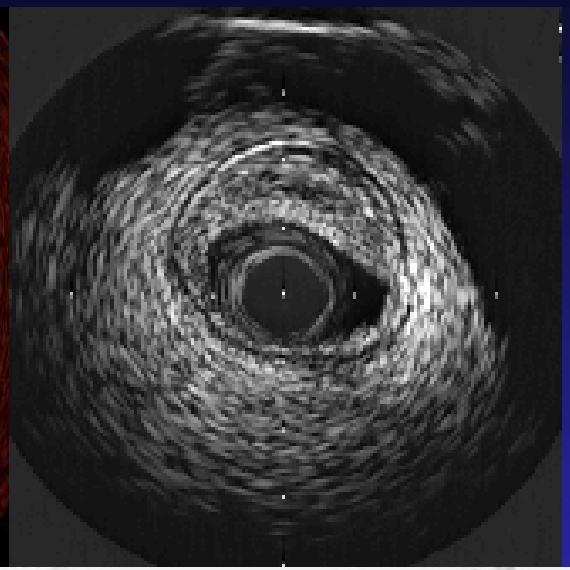
Fibro-lipidic plaque

Echolucent

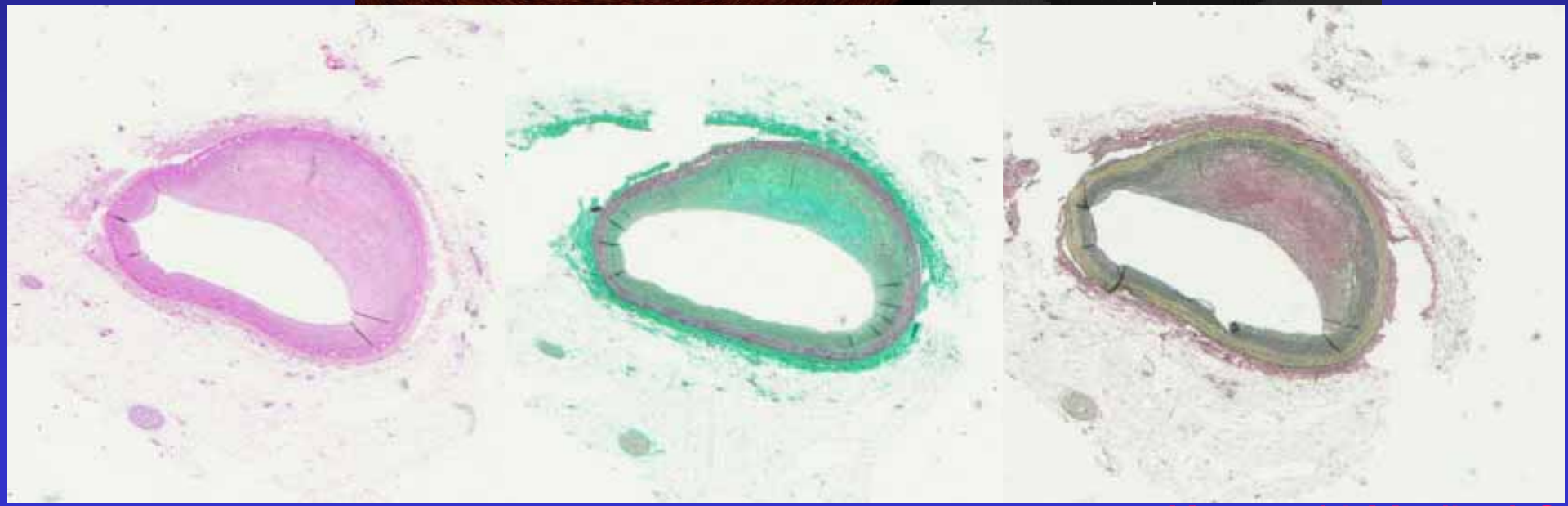
Diffuse borders

within signal-rich homogenus





Partially echolucent



Comparison between OCT and IVUS with histology

HIstopathologic Diagnosis	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
OCT image				
Fibrous (n=43)	79	99	97	93
Fibrocalcific (n=82)	96	88	89	96
Lipid (n=41)	85	94	83	95
IVUS image				
Fibrous (n=43)	88	86	69	95
Fibrocalcific (n=82)	98	96	96	98
Lipid (n=41)	59 *	97	86	87

Data are percentages. * $p < 0.05$ vs. OCT image.

Summary 1

OCT findings of plaque morphology

1. Fibrous plaques were observed as homogenous signal-rich findings.

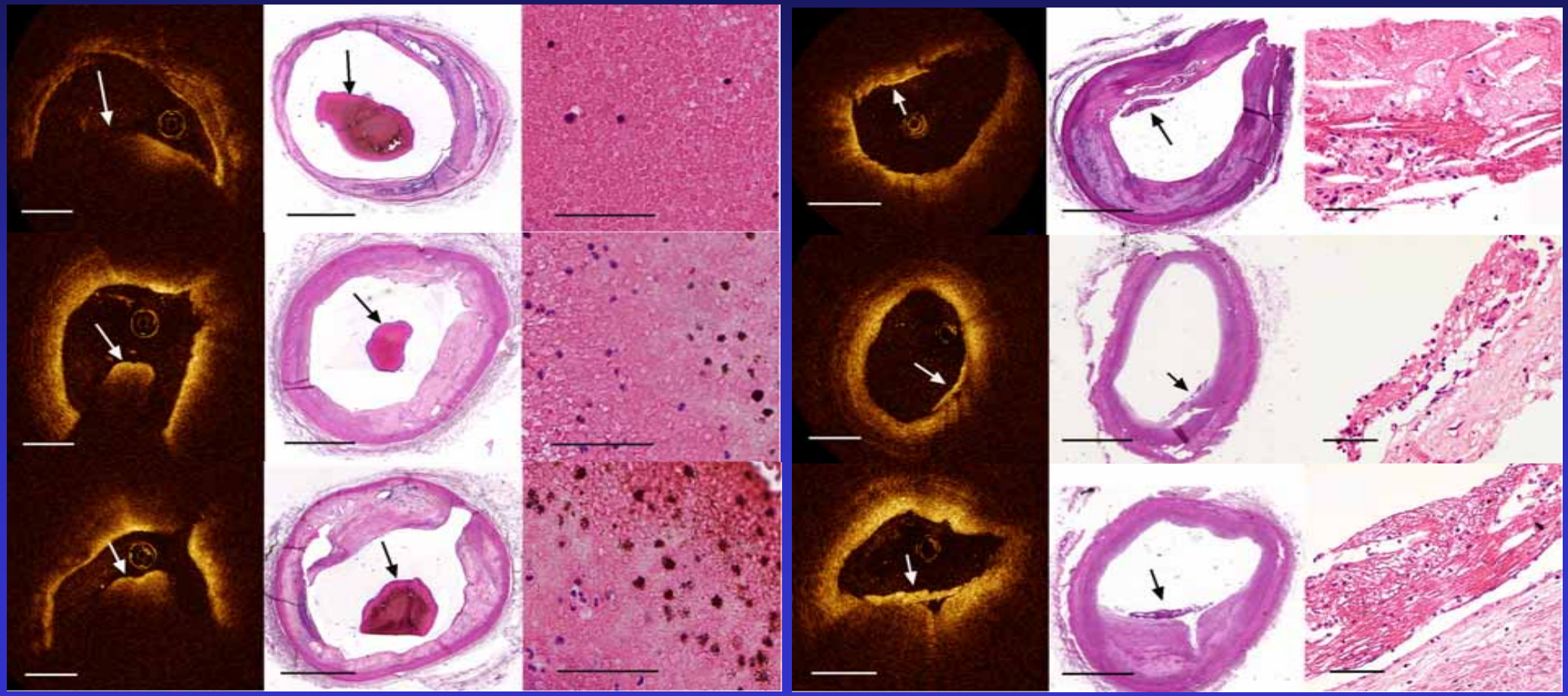
2. Calcific plaques were recorded as echo-lucent images with sharp borders.

3. Lipid rich plaques were demonstrated as echo-lucent images with diffuse borders.

Thrombus

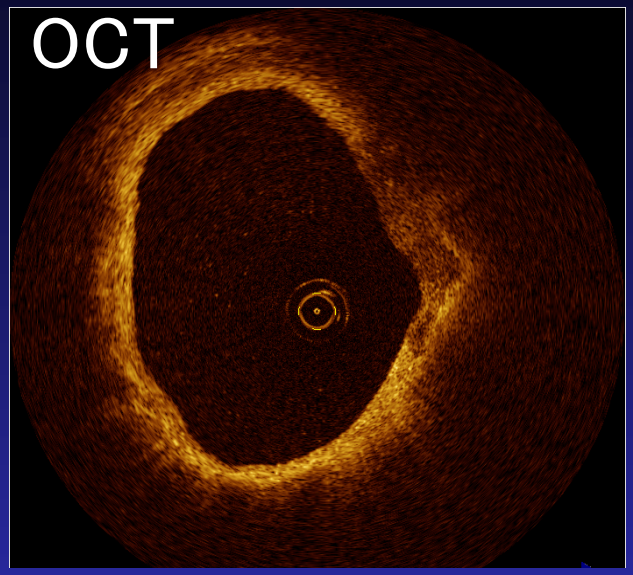
Red thrombus

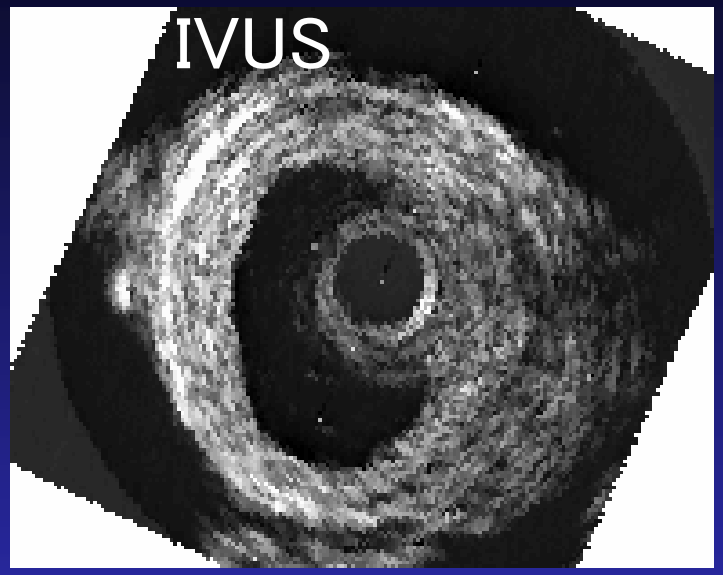
White thrombus

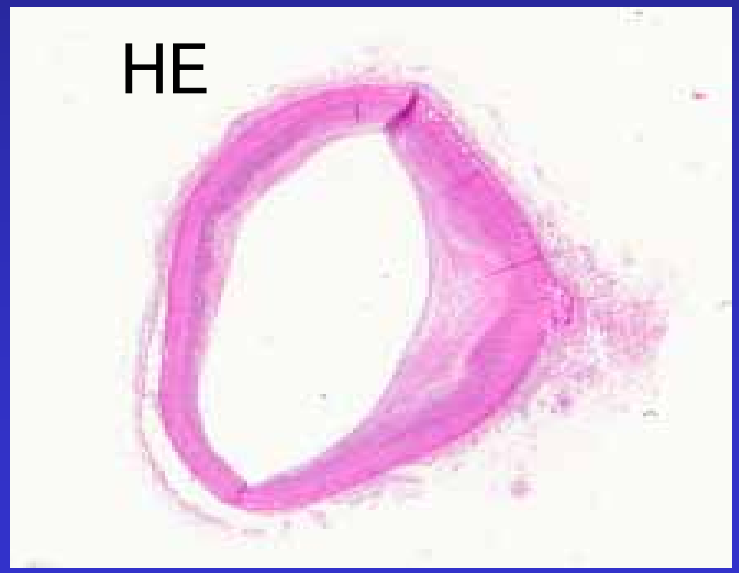


Kawasaki Medical School

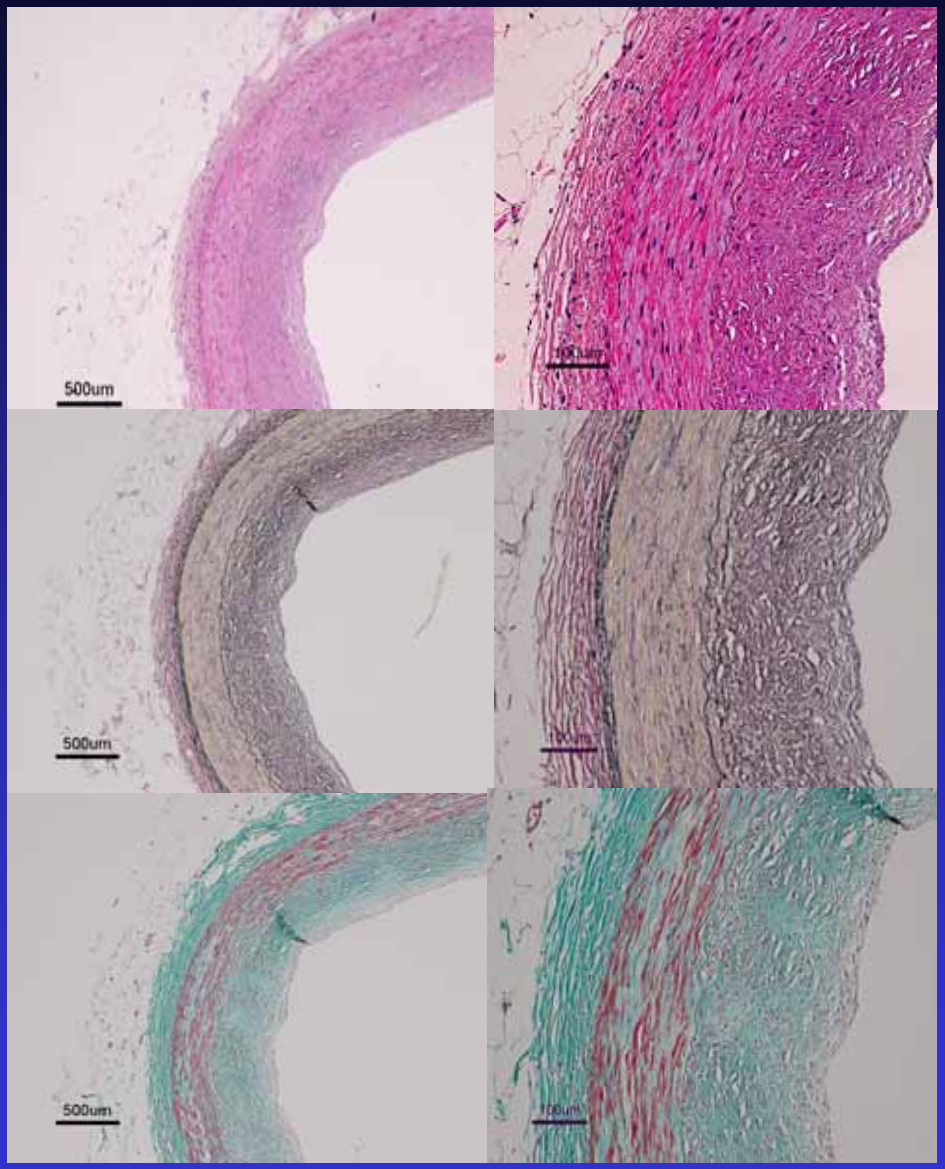
Thin fibrous cap (vulnerable plaque)

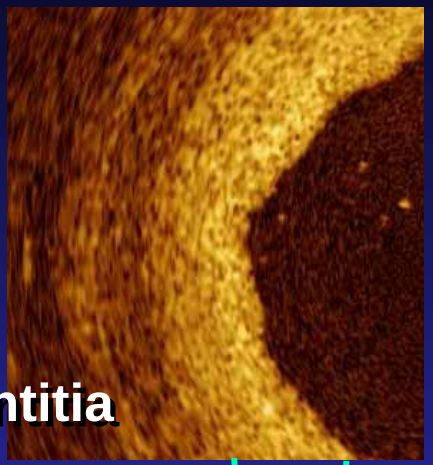


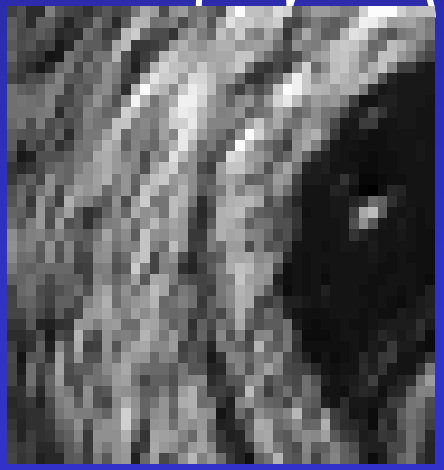




IMT (OCT vs IVUS)

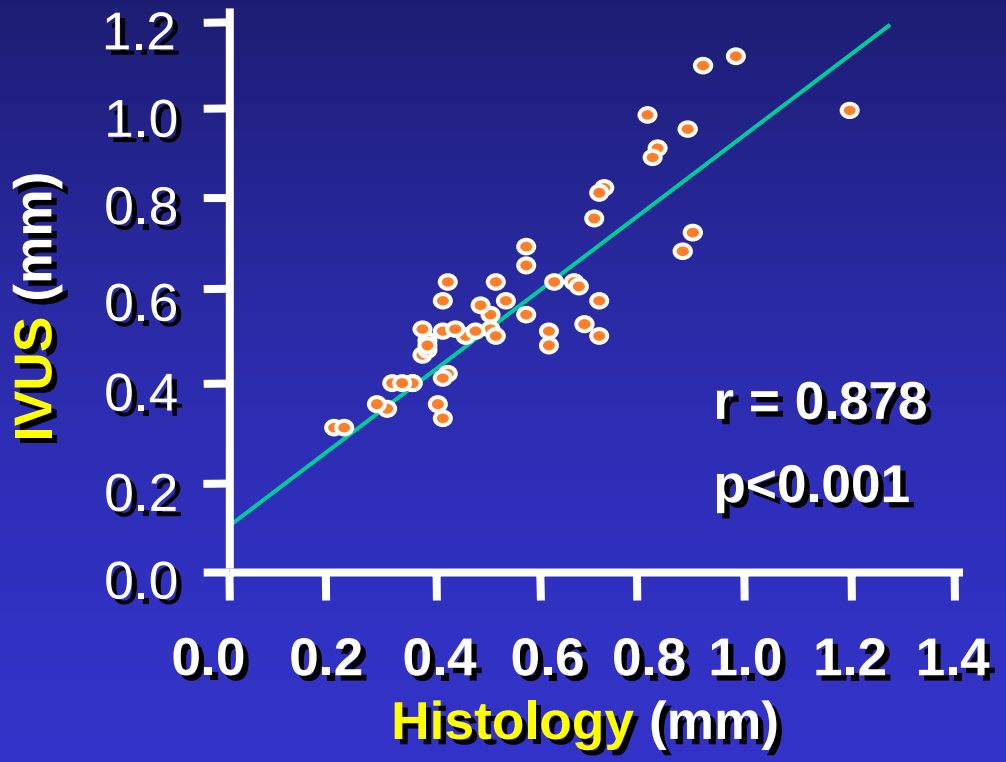


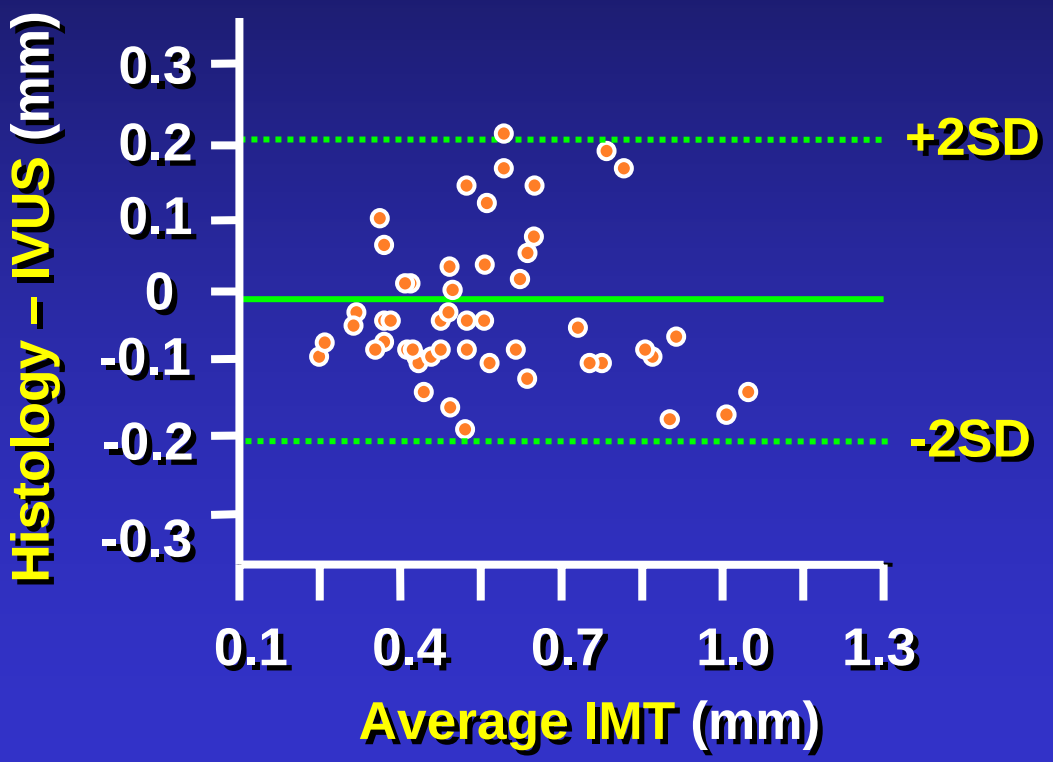




Kawasaki Medical School

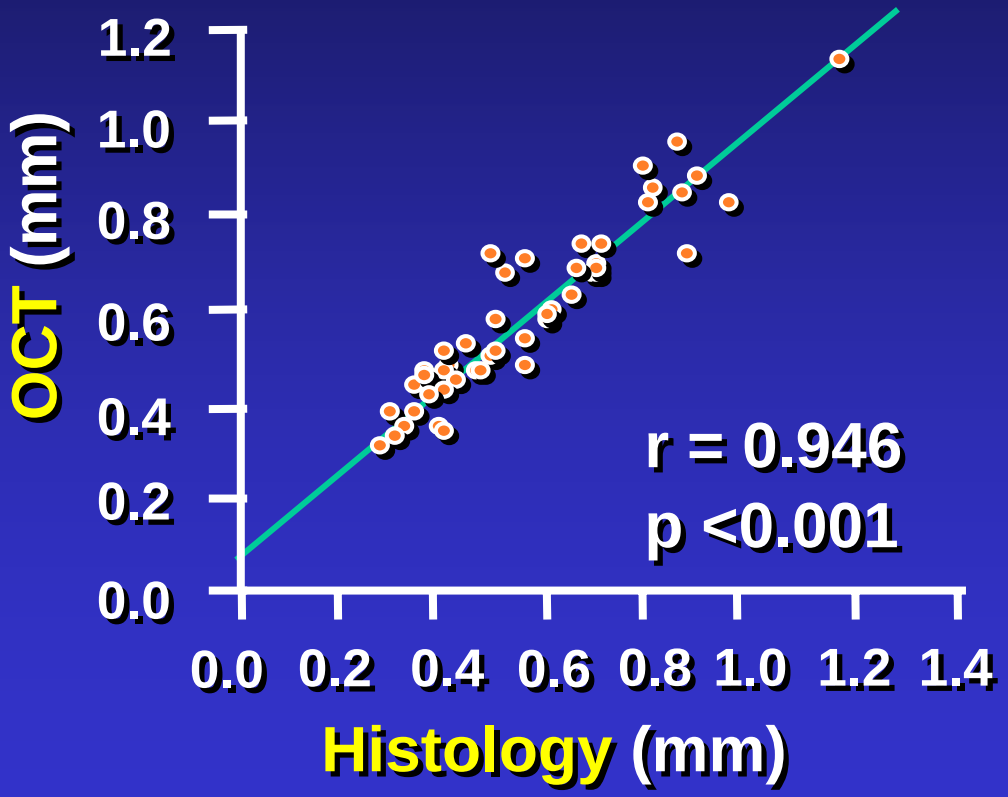
Intima-Media Complex Thickness (IMT)
Histology vs IVUS

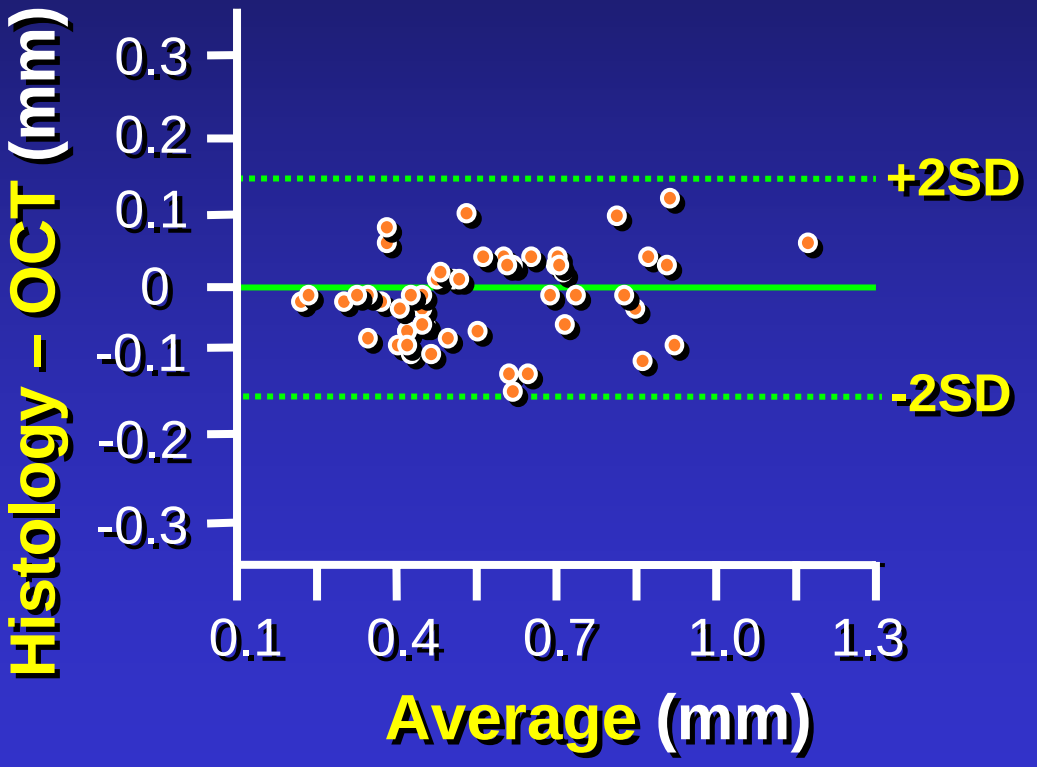




Kawasaki Medical School

Intima-Media Complex Thickness (IMT)
Histology vs OCT





Kawasaki Medical School

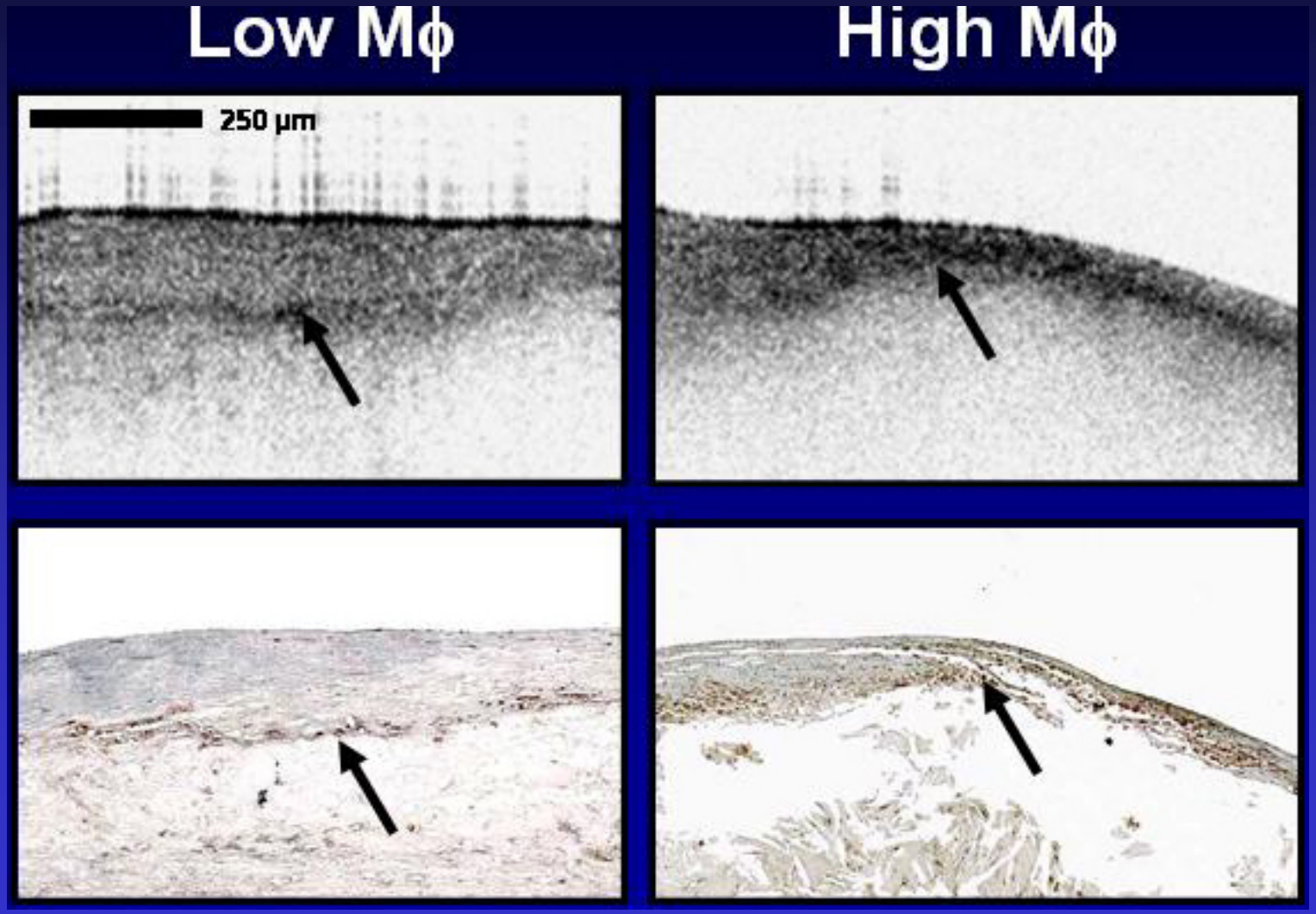
Summary 2

1. Lumen area and diameter could be measured correctly by OCT as those measured by IVUS.

2. OCT could identify three layers of the coronary artery wall clearly compared with IVUS.

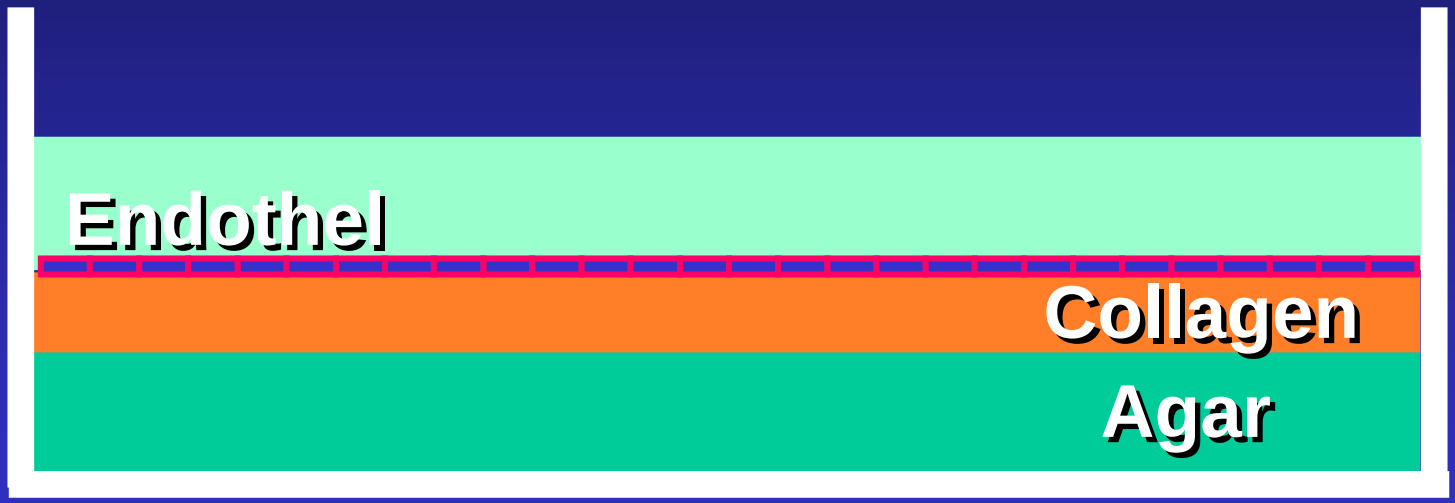
3. Thickness of intima-media complexes could be measured more accurately by OCT compared with IVUS.

OCT findings

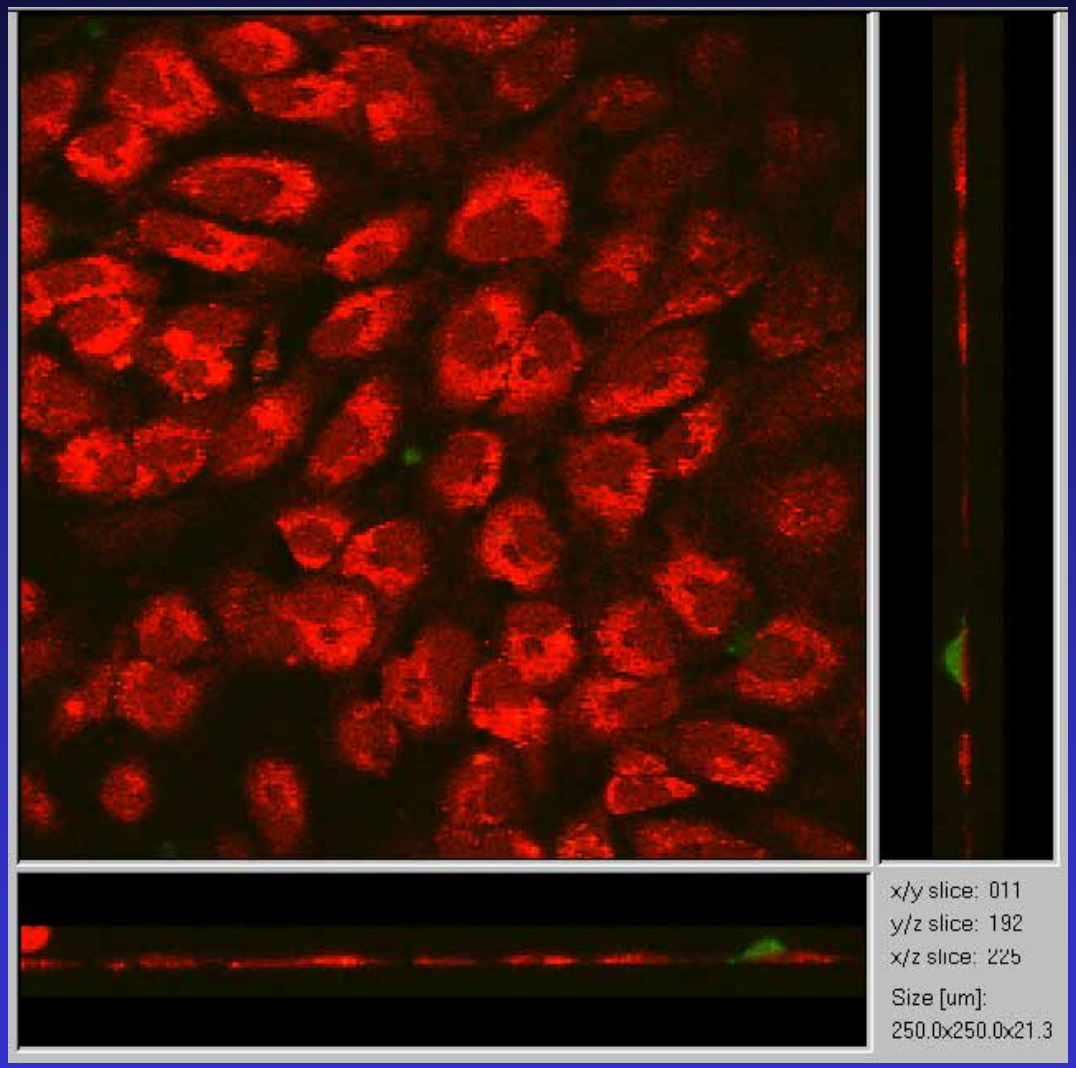


Kawasaki Medical School

Endothel

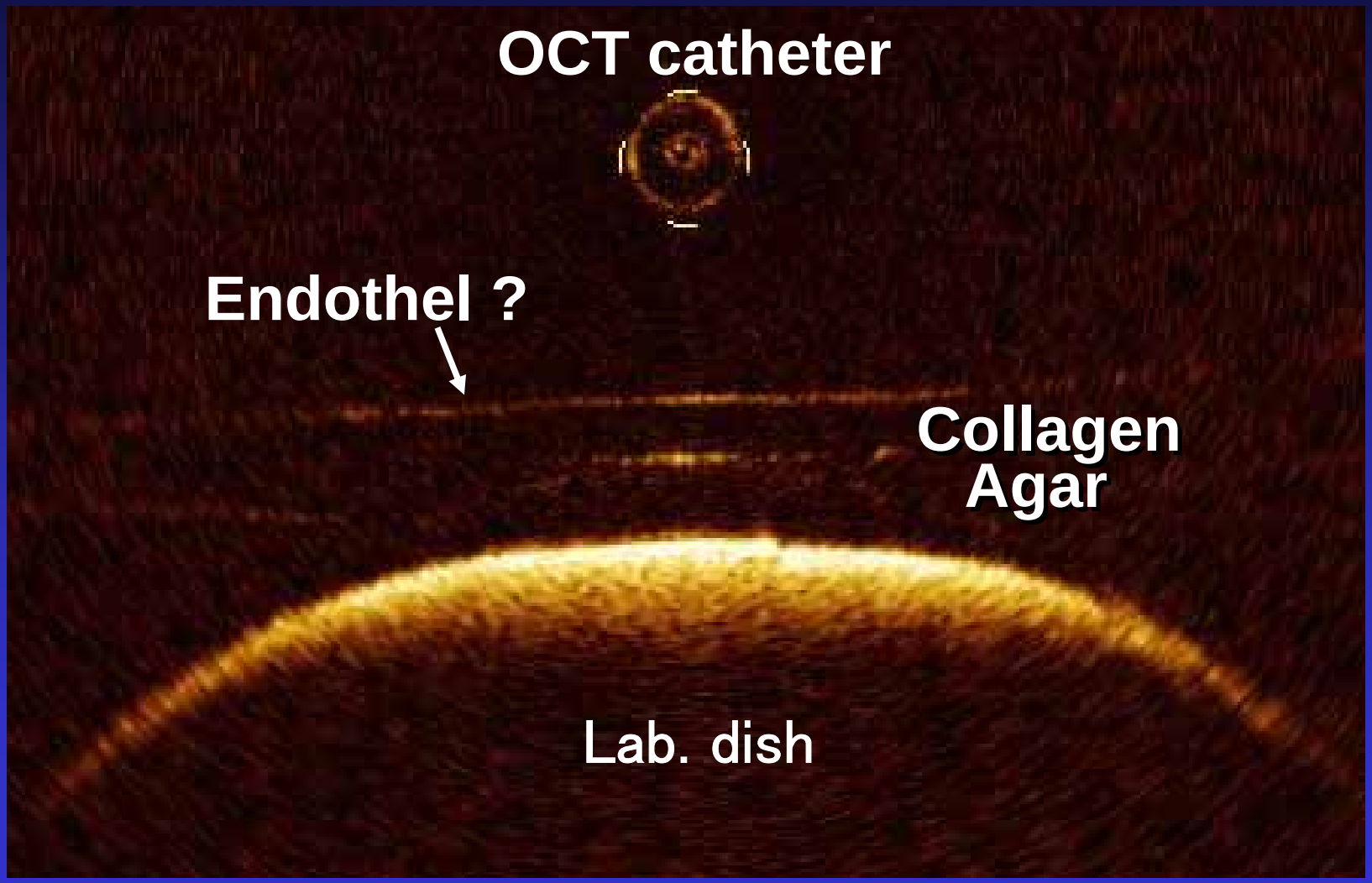


Endothel

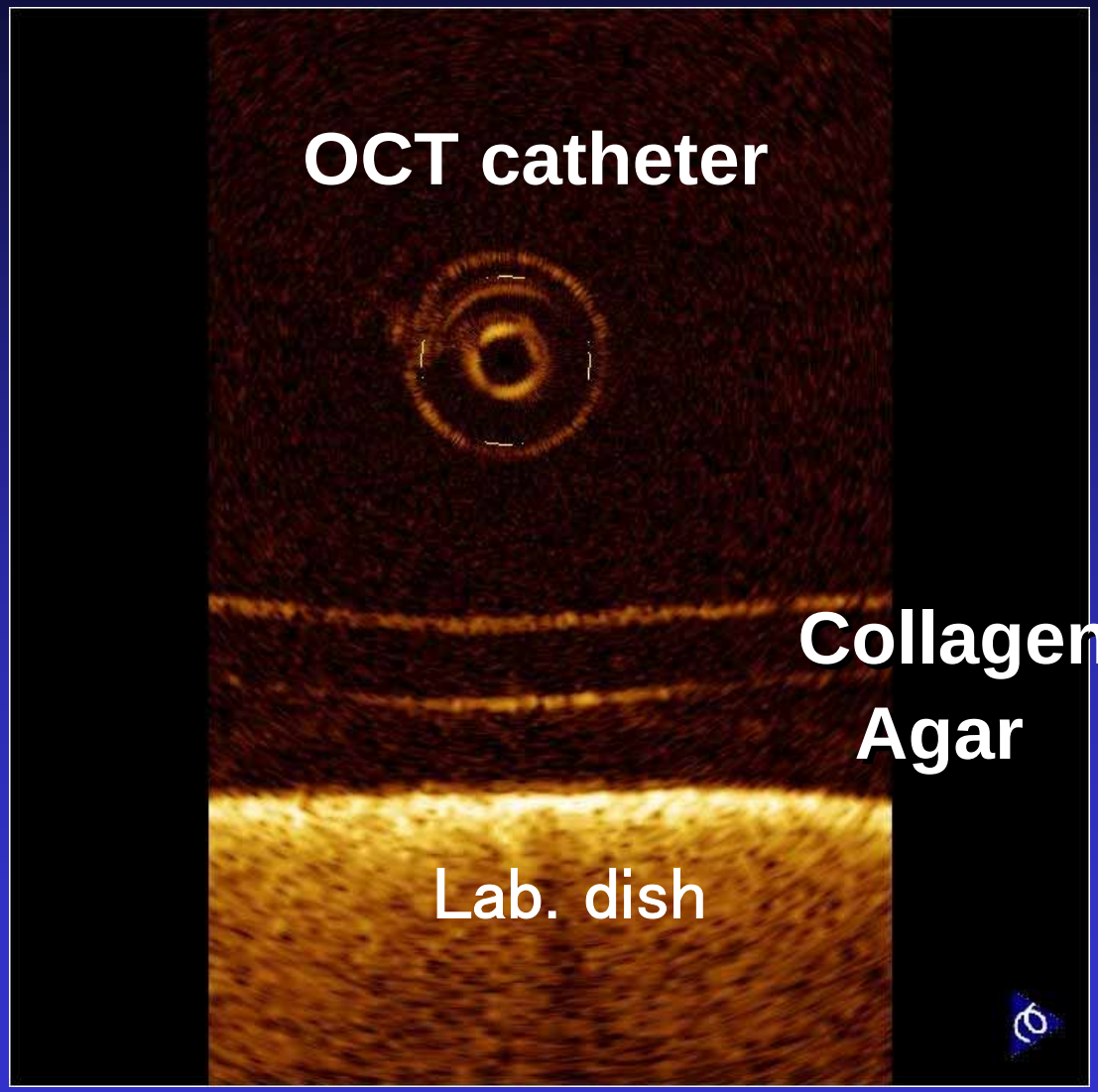


Kawasaki Medical School

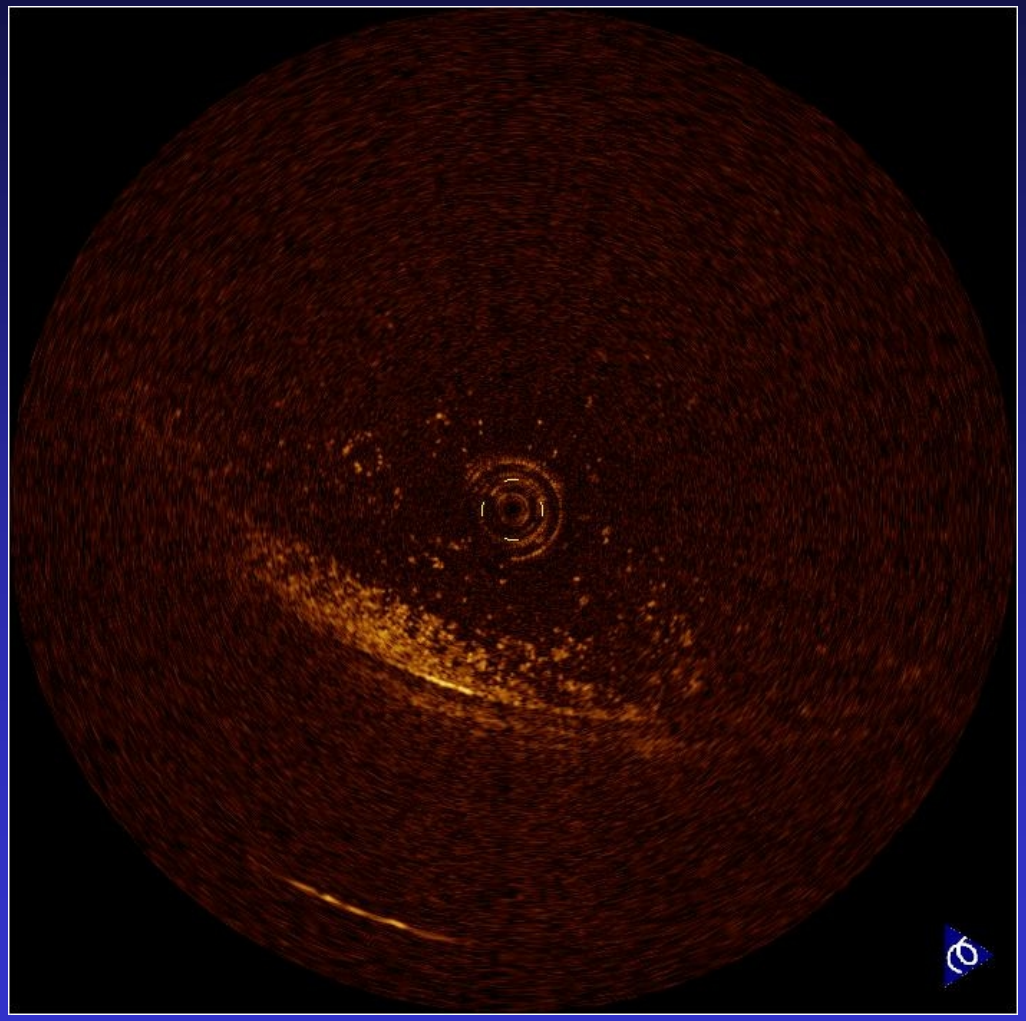
Endothel (+)



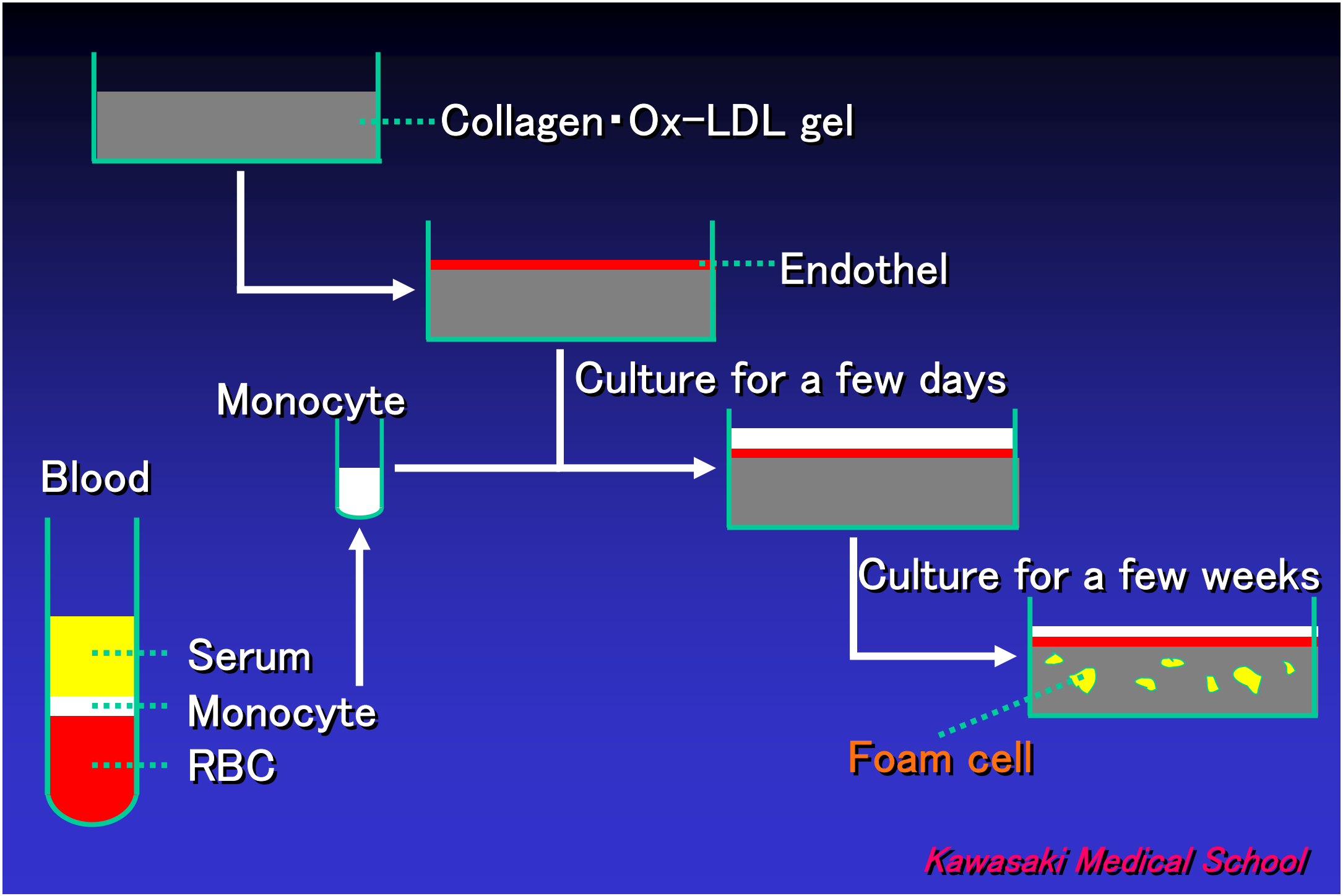
Endothel (－)



Macrophages

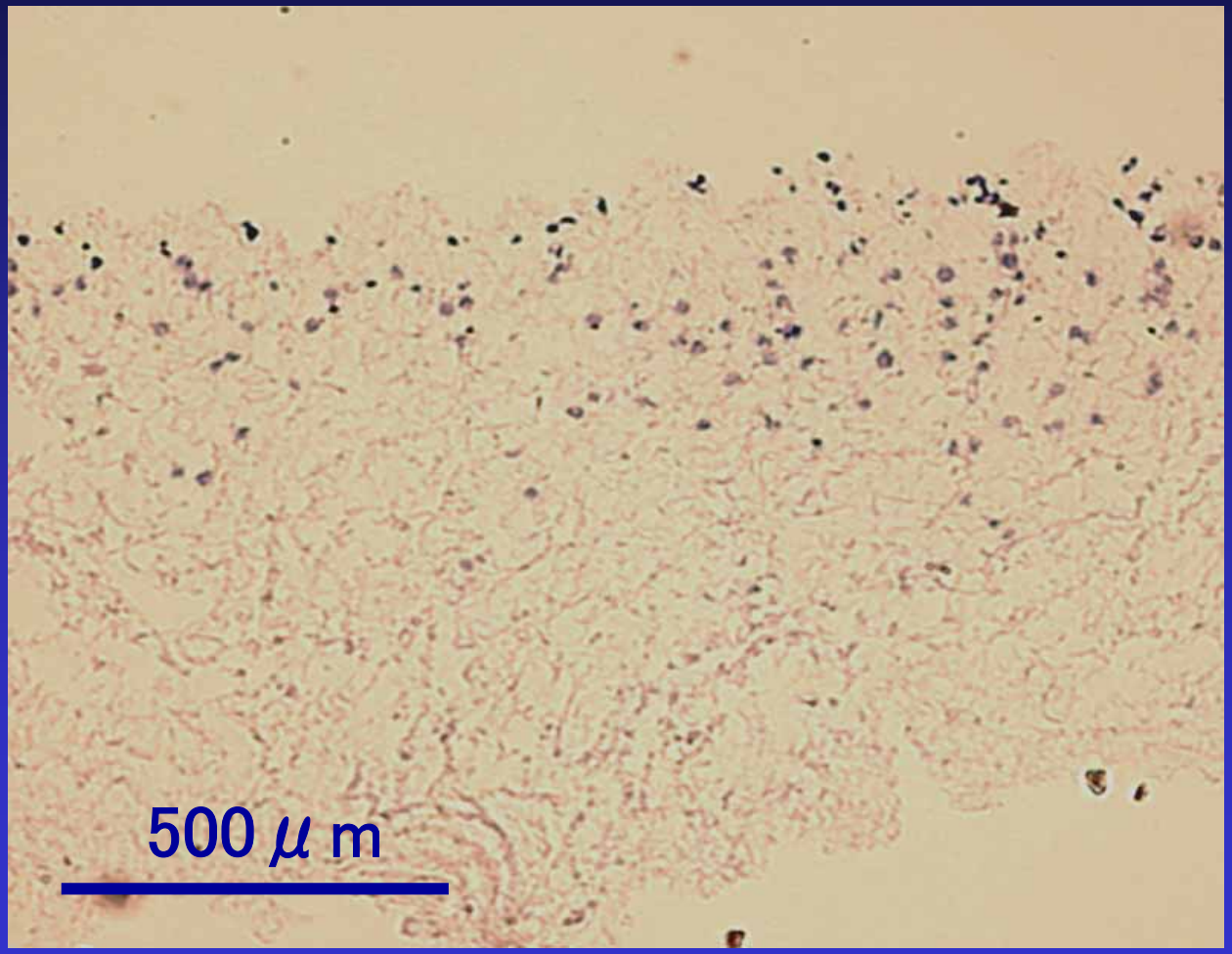


Kawasaki Medical School


Collagen・Ox-LDL gel
Endothel
Culture for a few days
Monocyte
Blood
Serum
Monocyte
RBC
Culture for a few weeks
Foam cell
Kawasaki Medical School

Histological findings

Infiltration of monocytes to collagen gel layer

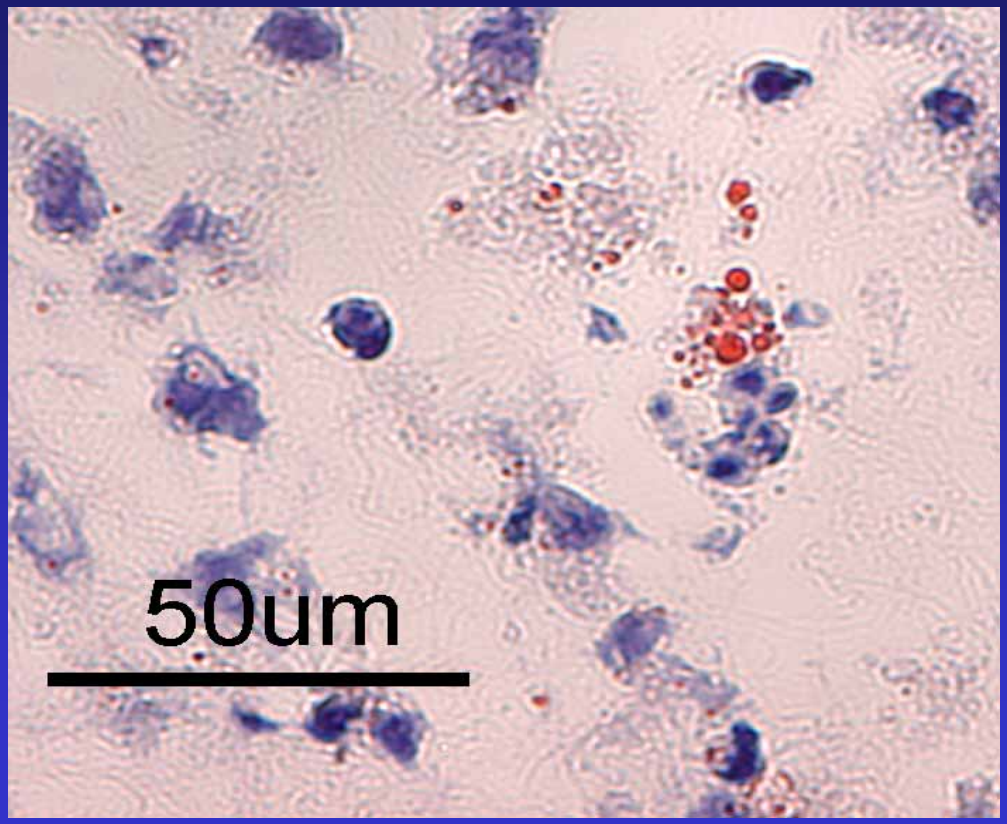


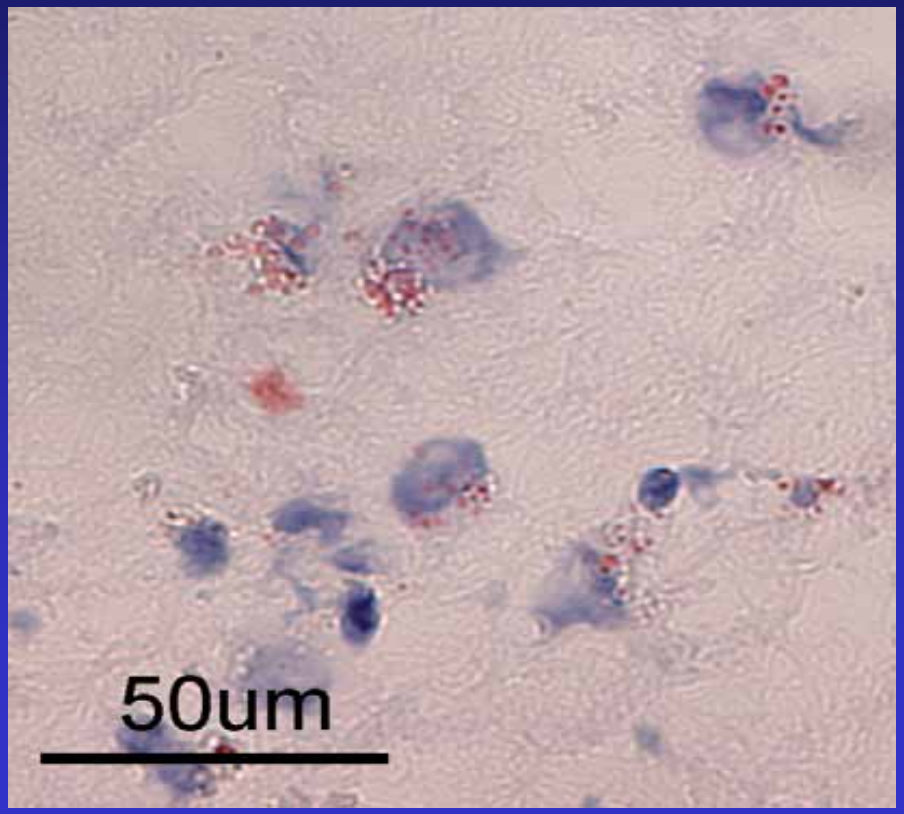
Collagen-gell layer

Kawasaki Medical School

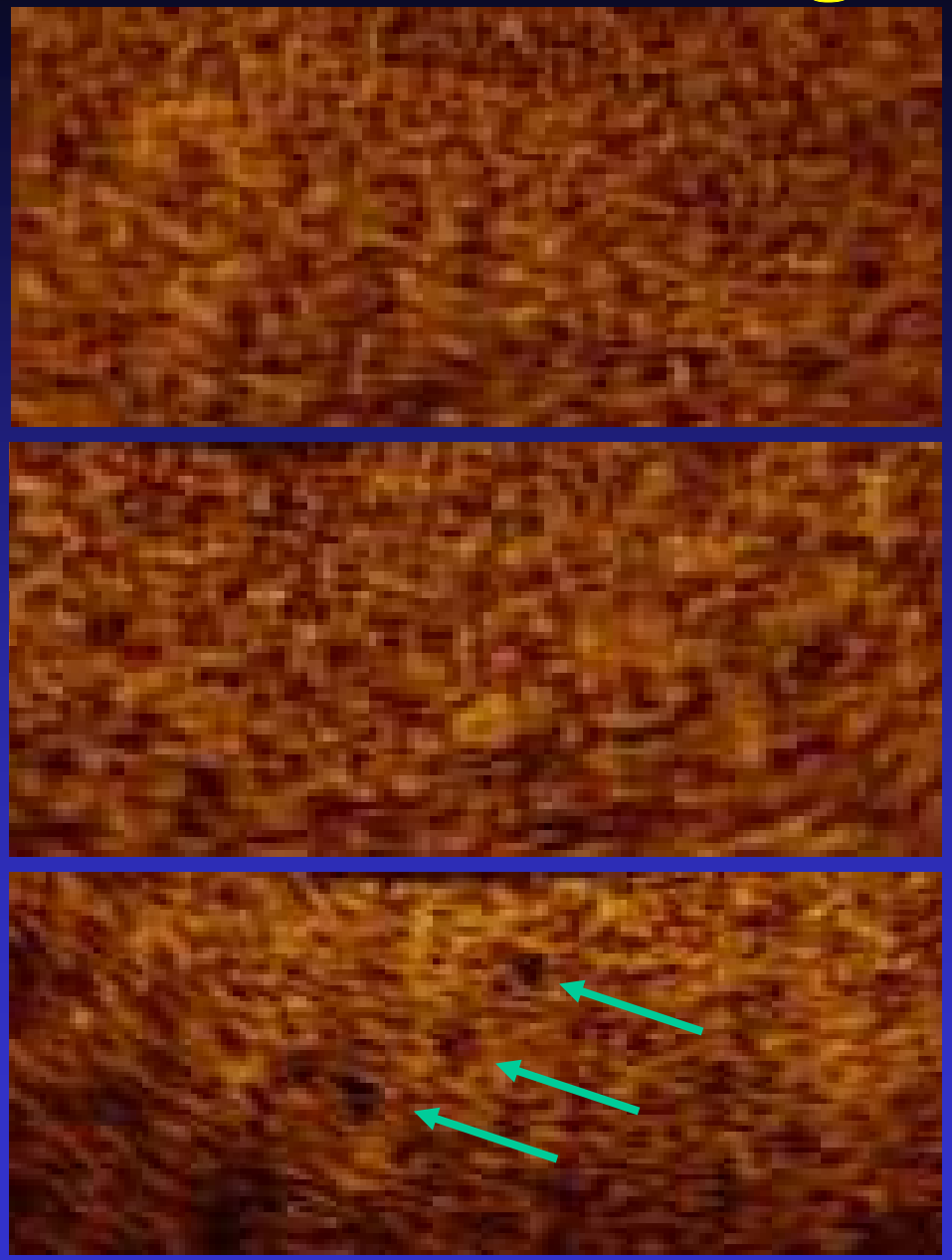
Histrogical findings

Foam cell formations of monocytes by phagocytosis of Ox-LDL can be observed in the collagen gel layer 3 weeks after cell culture as demonstrated below.





OCT findings



Before

1 week later

3 weeks later

Kawasaki Medical School

Summary 3

1. OCT could identify the different tissues by the reflections between the layer of the different tissue components.

2. Endothelial cell could not be demonstrated by OCT directly.

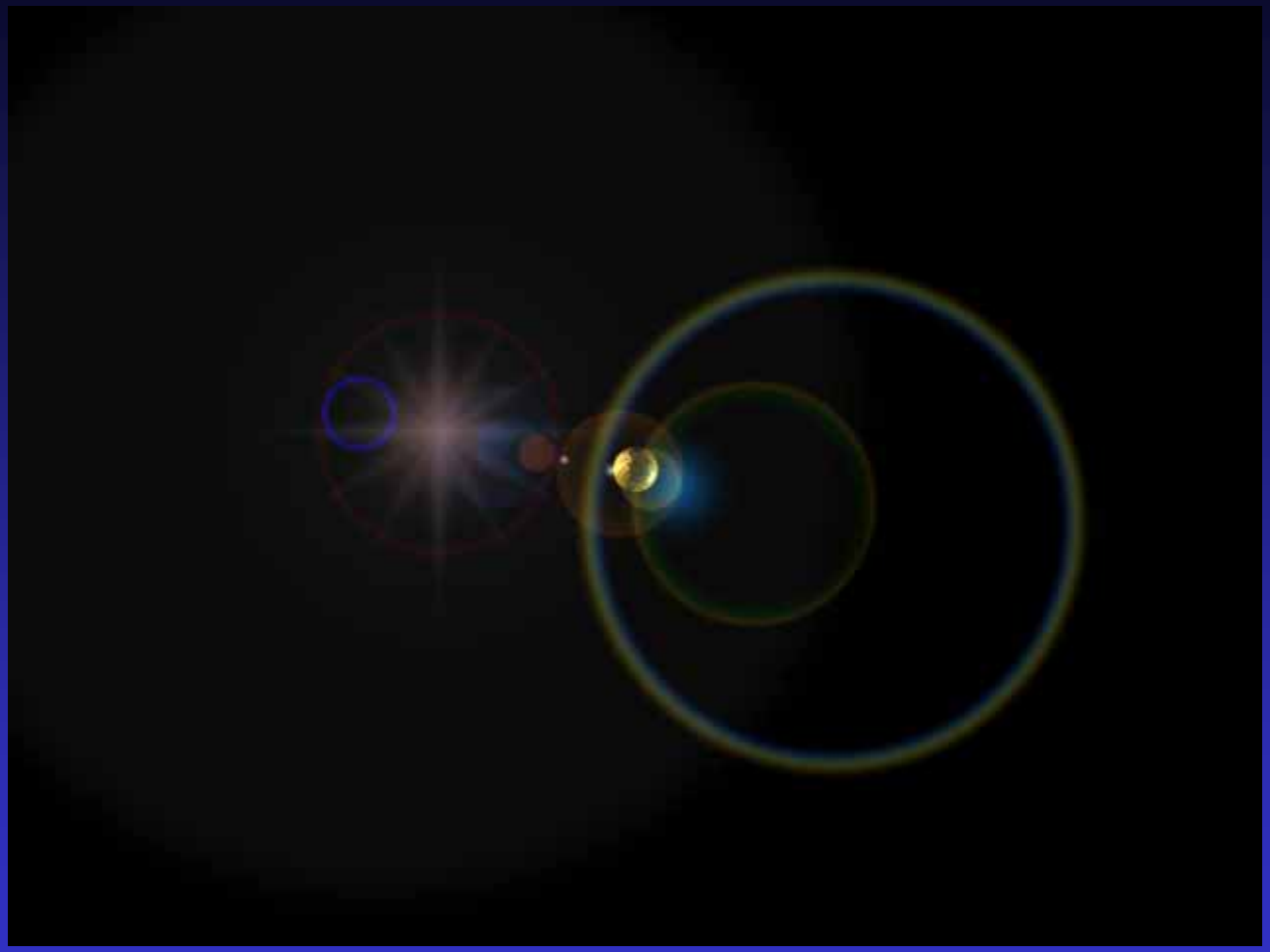
3. OCT may have a possibility to identify the accumulation of macrophages within the fibrous cap of vulnerable plaques as the different light reflections.

Conclusions

1. OCT may allow us to identify tissue characterization more accurately than IVUS.

2. OCT might have a limitation in the depth of beam penetration.

3. OCT may have a possibility to identify vulnerable plaques by the findings of the accumulation of macrophages within the fibrous cap.



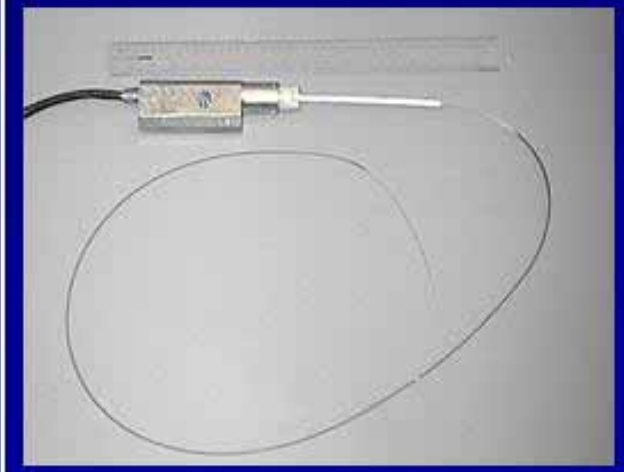
Thank you for your attention !!

Kawasaki Medical School

MGH OCT System

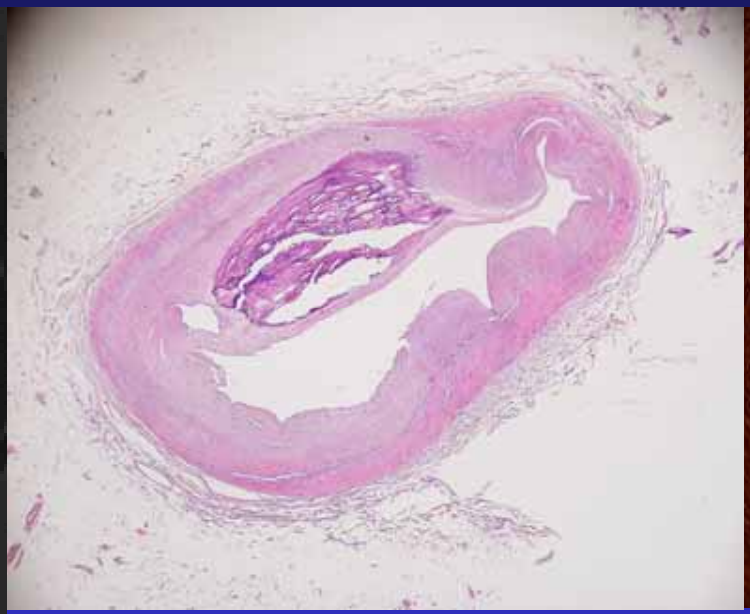
Technical Data

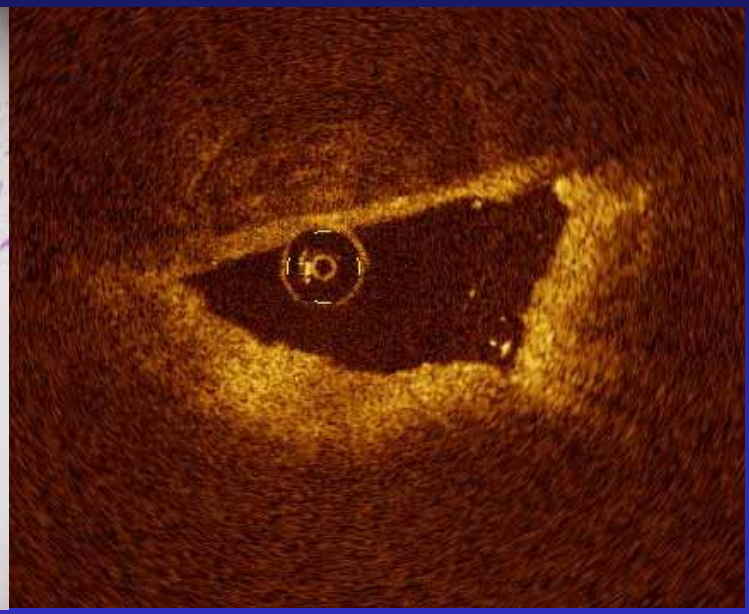
Image acquisition rate :	4-8 images / sec
Axial Resolution :	10 μm
Transverse Resolution :	25 μm
Data storage :	Digital
Optical wavelength :	1300 nm
Power incident on tissue :	5.0 mW



Kawasaki Medical School

Superficial calcification





High-echoic

Shadowing

Echolucent

Sharp borders