2nd
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Fundamental and IVUS measurement

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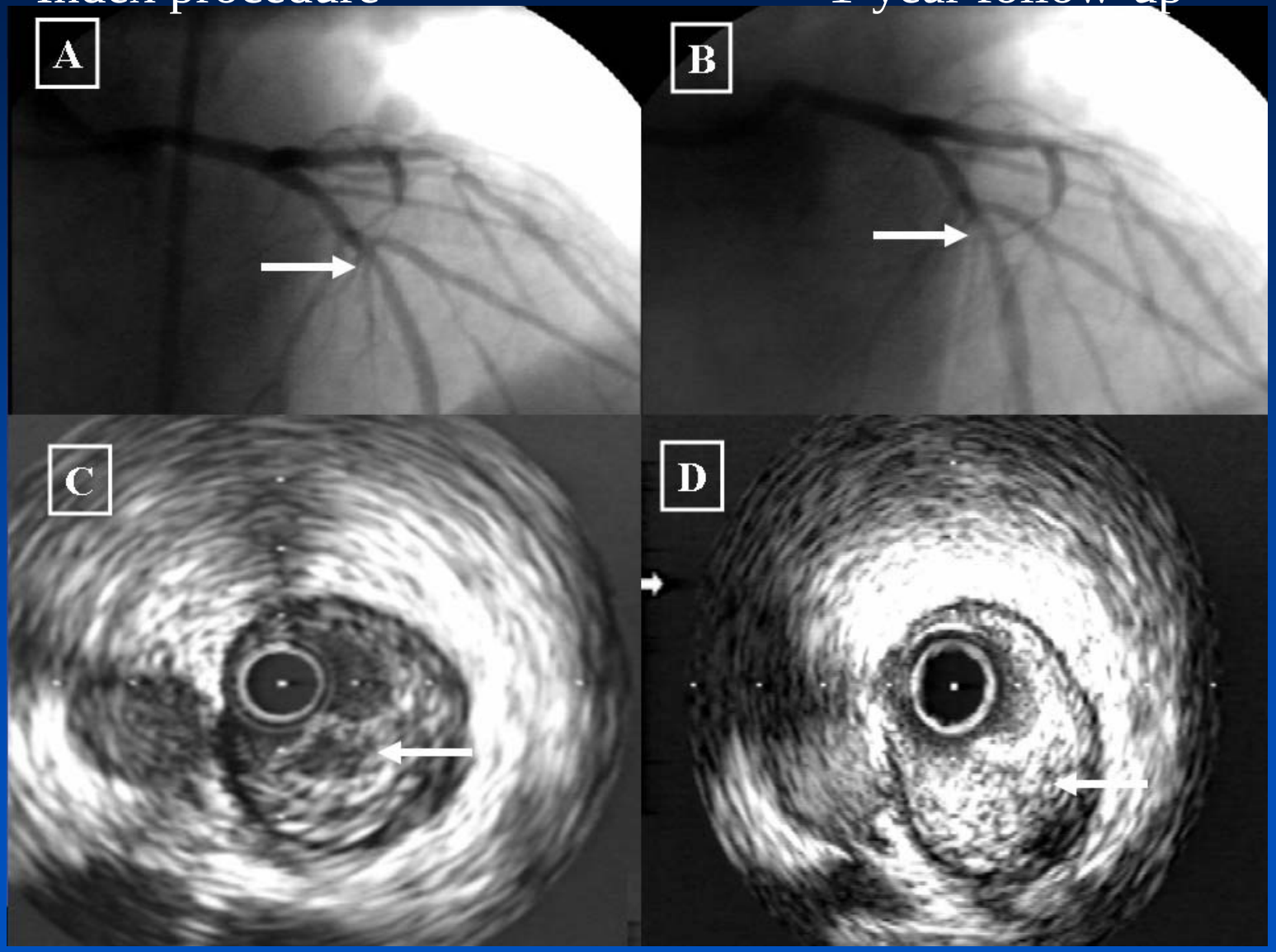
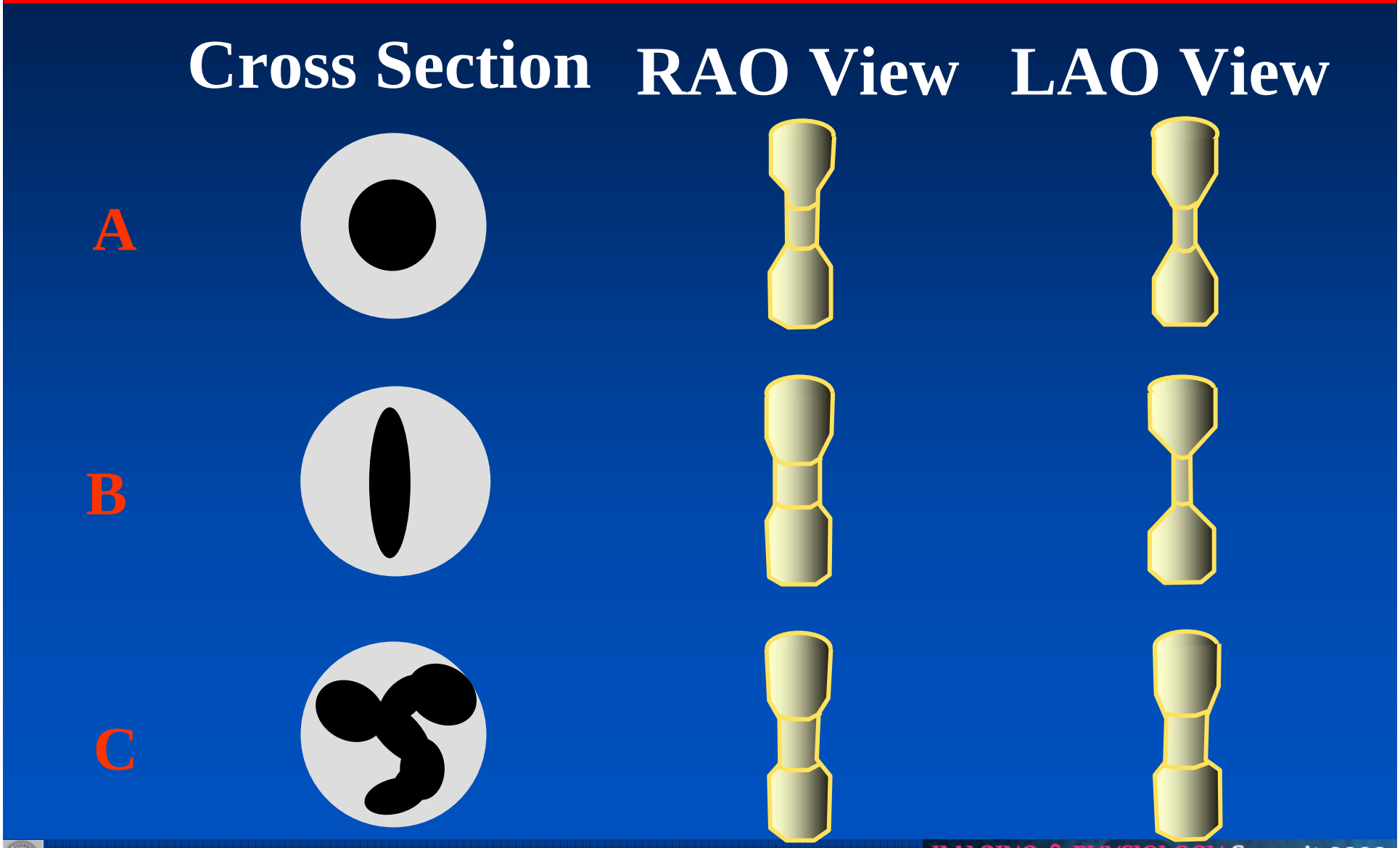
We needed another method

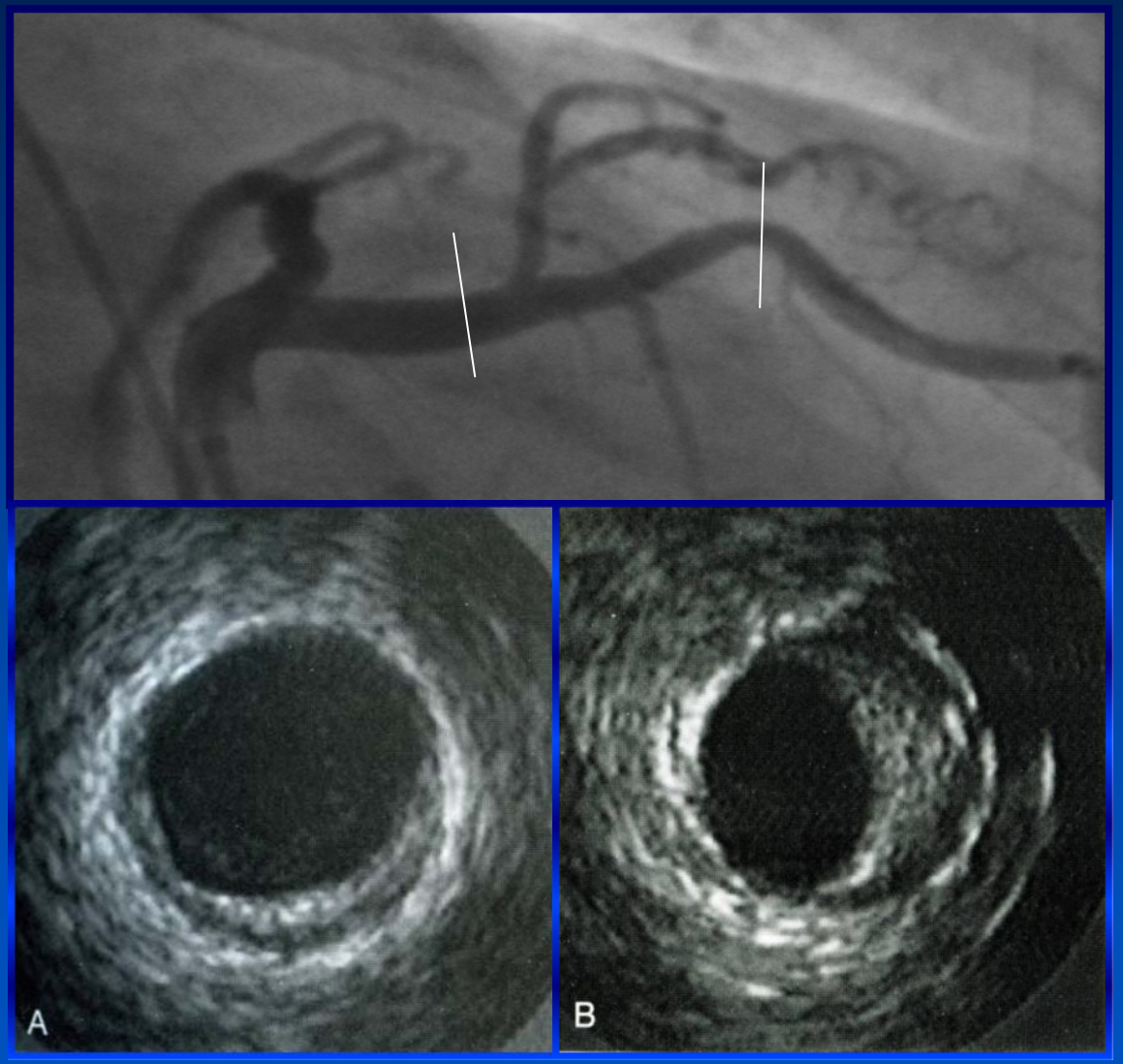
Index procedure 1-year follow-up



We needed another method



IVUS is a solution!



Contents

- Basic Physics and Equipment
- Image Acquisition and IVUS Artifacts
- Histology
- Quantitative and Qualitative Assessment
- Reporting

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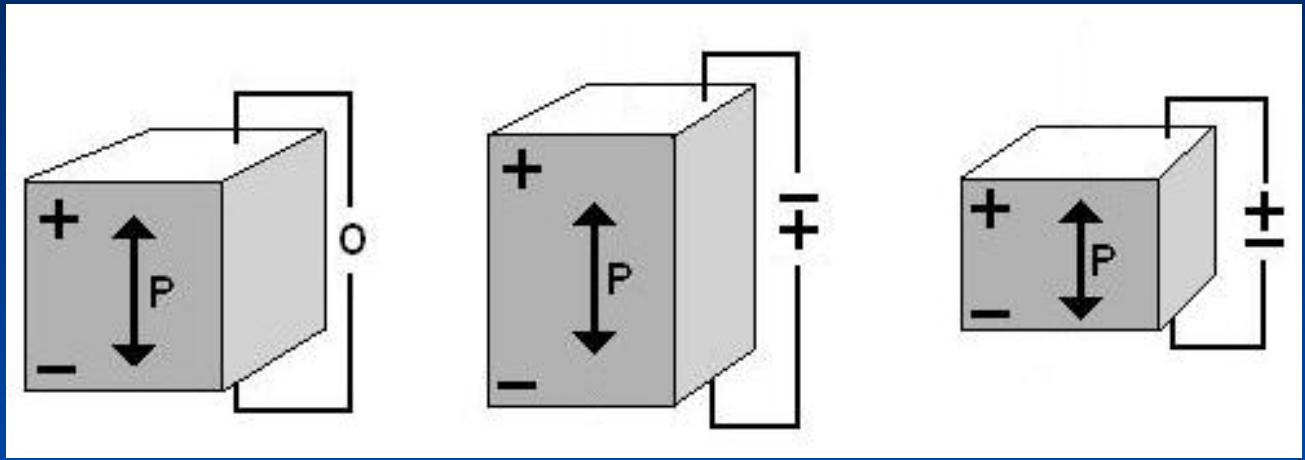
Basic Physics of Sound

- Sound is a physical phenomenon that transfers energy from one point to another.
- Sound can pass only through matter.
- Ultrasound can be focused into small, well-defined beams that can probe the human body and interact with the tissue structures to form images

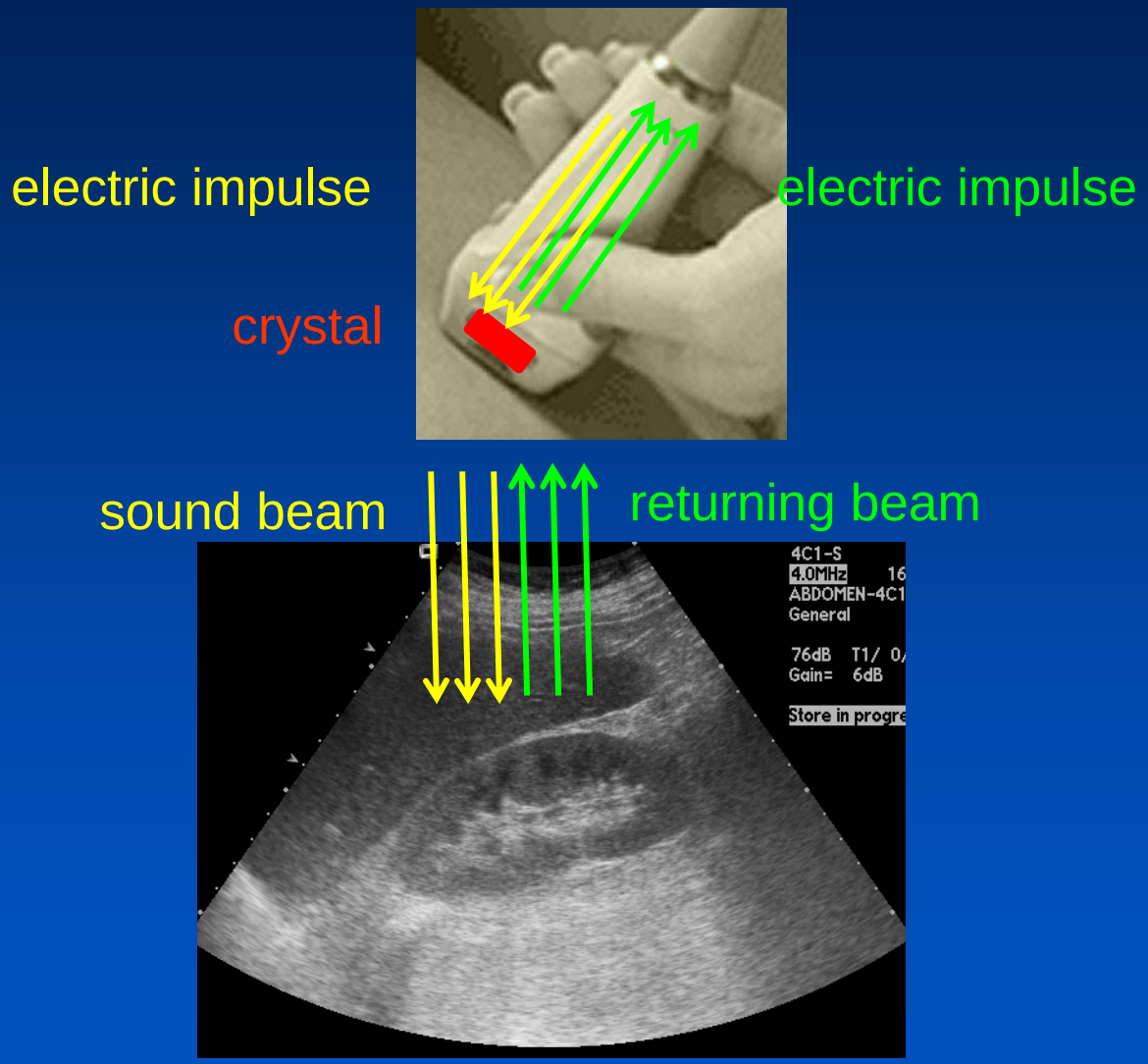
Piezoelectricity

- Piezo- : from piezein (*Greek*), sqeeze or press
- Conversion electricity to sound and vice versa



When a piezoelectric crystal is placed in an electric field, or when charges are applied by external means to its faces, the crystal exhibits strain, i.e. the dimensions of the crystal change.

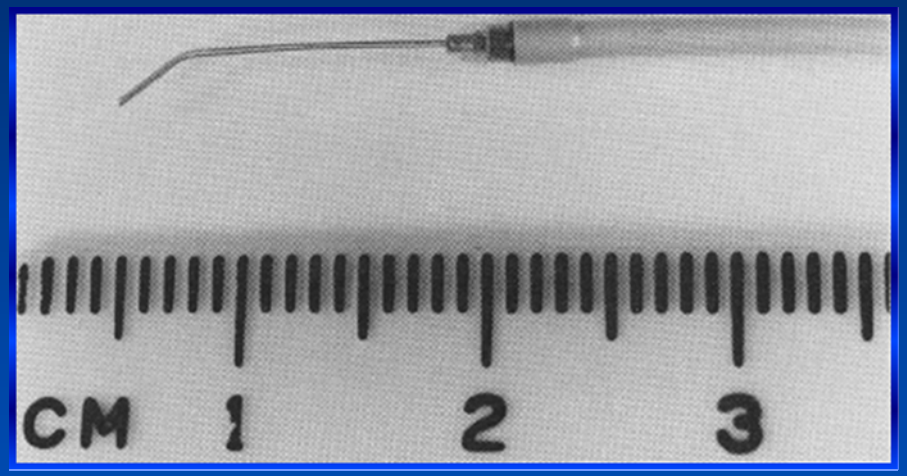
Ultrasound imaging process

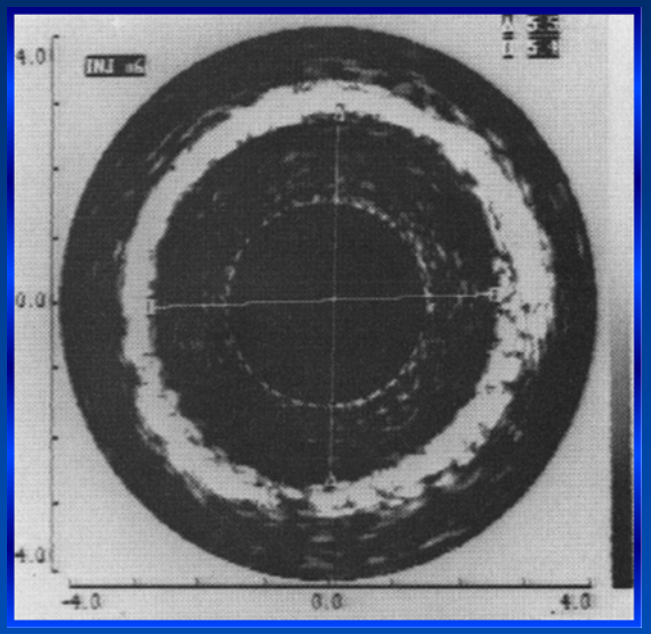


Comparison of IVUS with other ultrasound

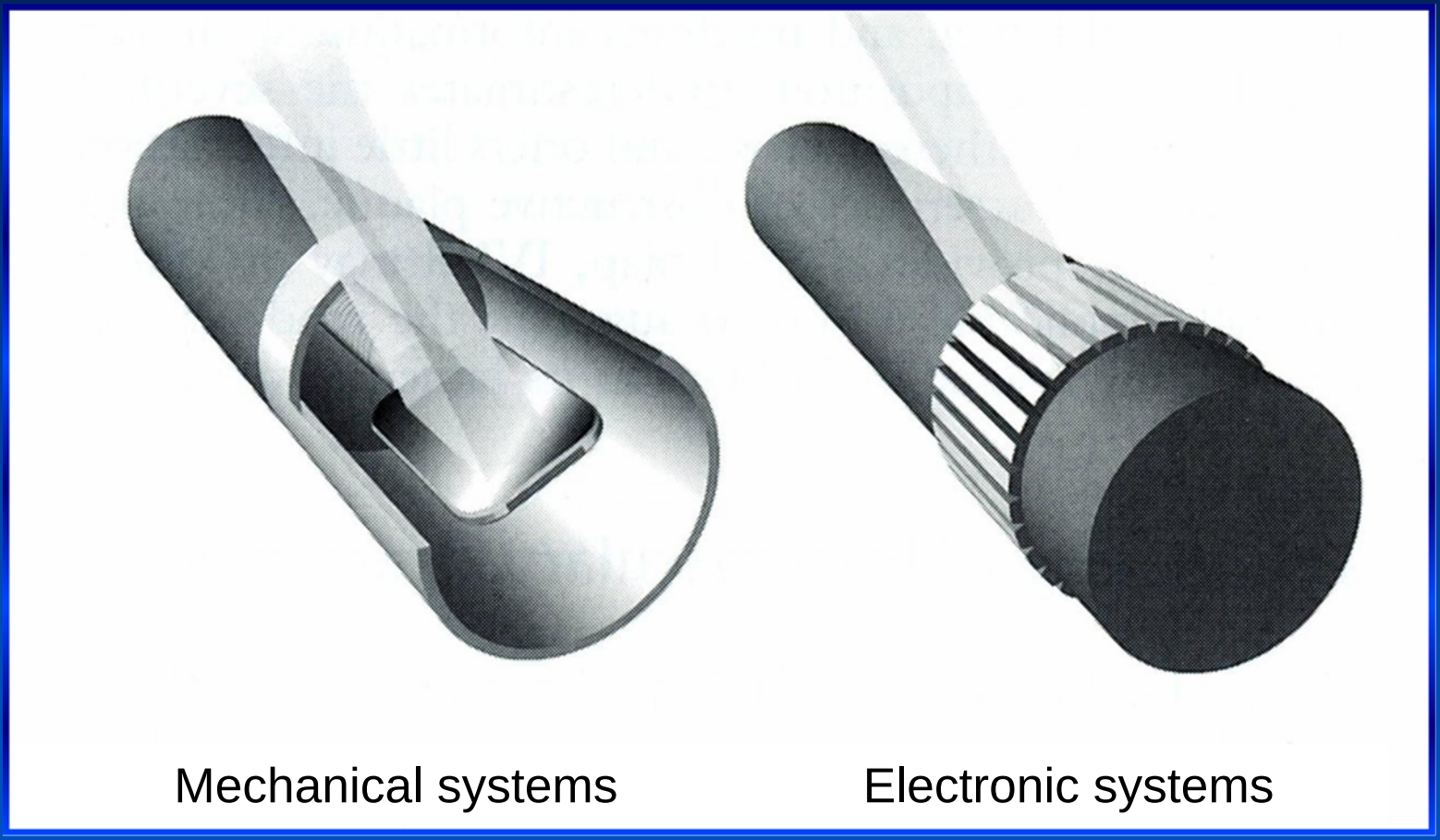
Technique	Transducer size (cm)	Depth (cm)	Intervening tissues
Trans-thoracic	> 2	~3 – 20	Skin, fat, muscle
Trans-esophageal	< 1.2	~2 – 20	Esophagus, atrium
Intravascular	< 0.26	~0.05 – 4	blood

In early period





Equipment



Mechanical systems

Electronic systems

Image quality

- Spatial resolution
  - The ability to discriminate small objects within the ultrasound image
  - Axial : parallel to the beam
  - Lateral : perpendicular to both the beam and the catheter

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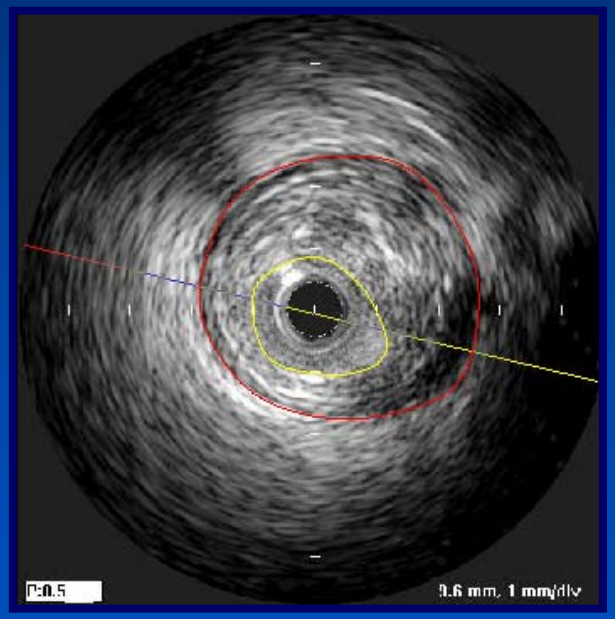
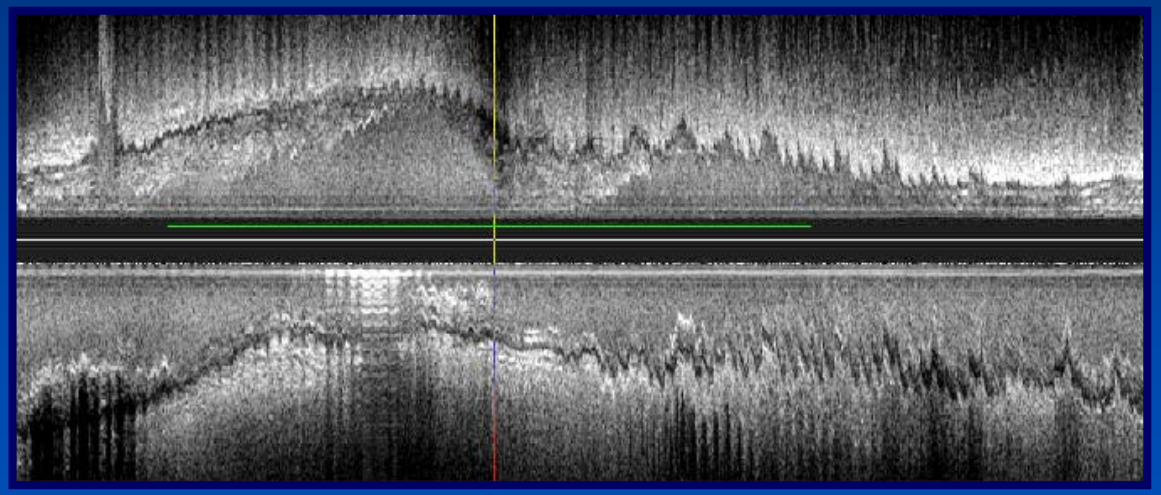
Image Acquisition
pullback method

- Manual pullback
  - to concentrate on specific regions of interest
  - But, possible to skipping over and not to perform precise measurement
  - not reproducible
- Motorized pullback
  - precise, reproducible
  - to reconstruct image (L-mode, 3D)

Image Acquisition
Longitudinal display (L-mode)

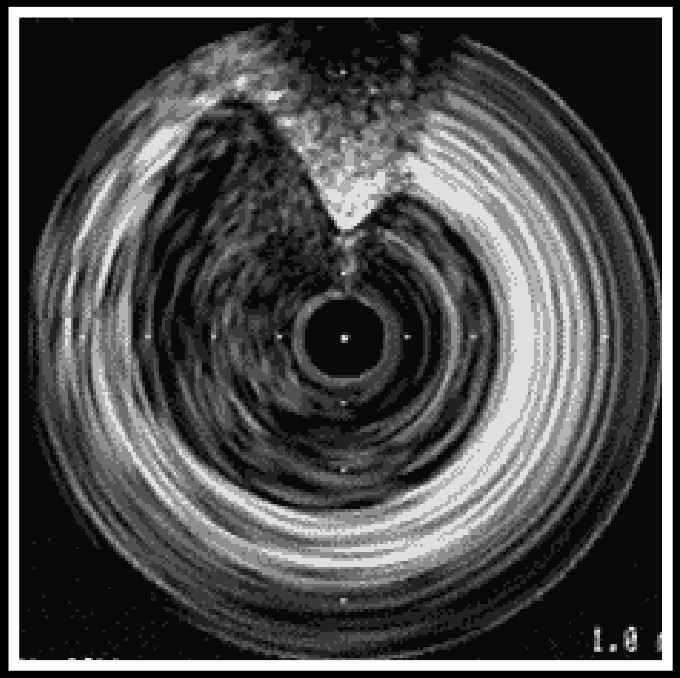
- For spatial orientation, assessment of length, and distribution of plaque



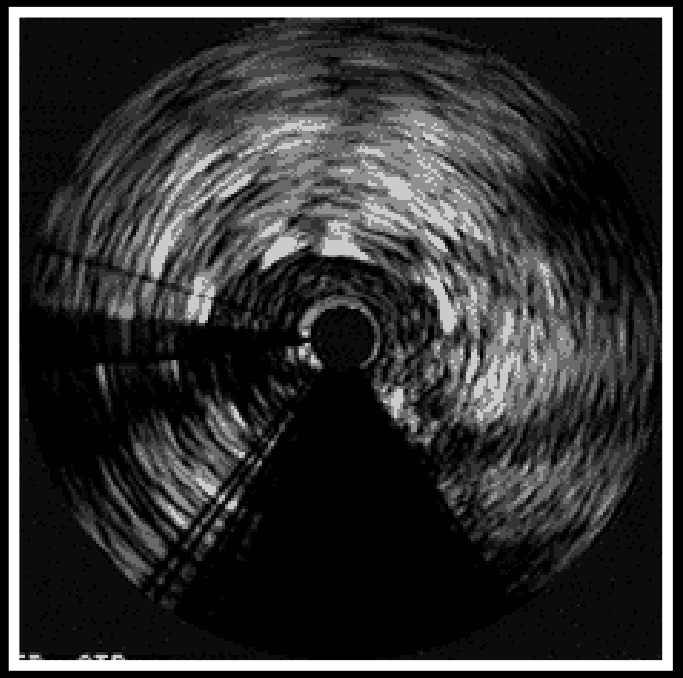


IVUS artifacts

non-uniform rotational distortion (NURD)



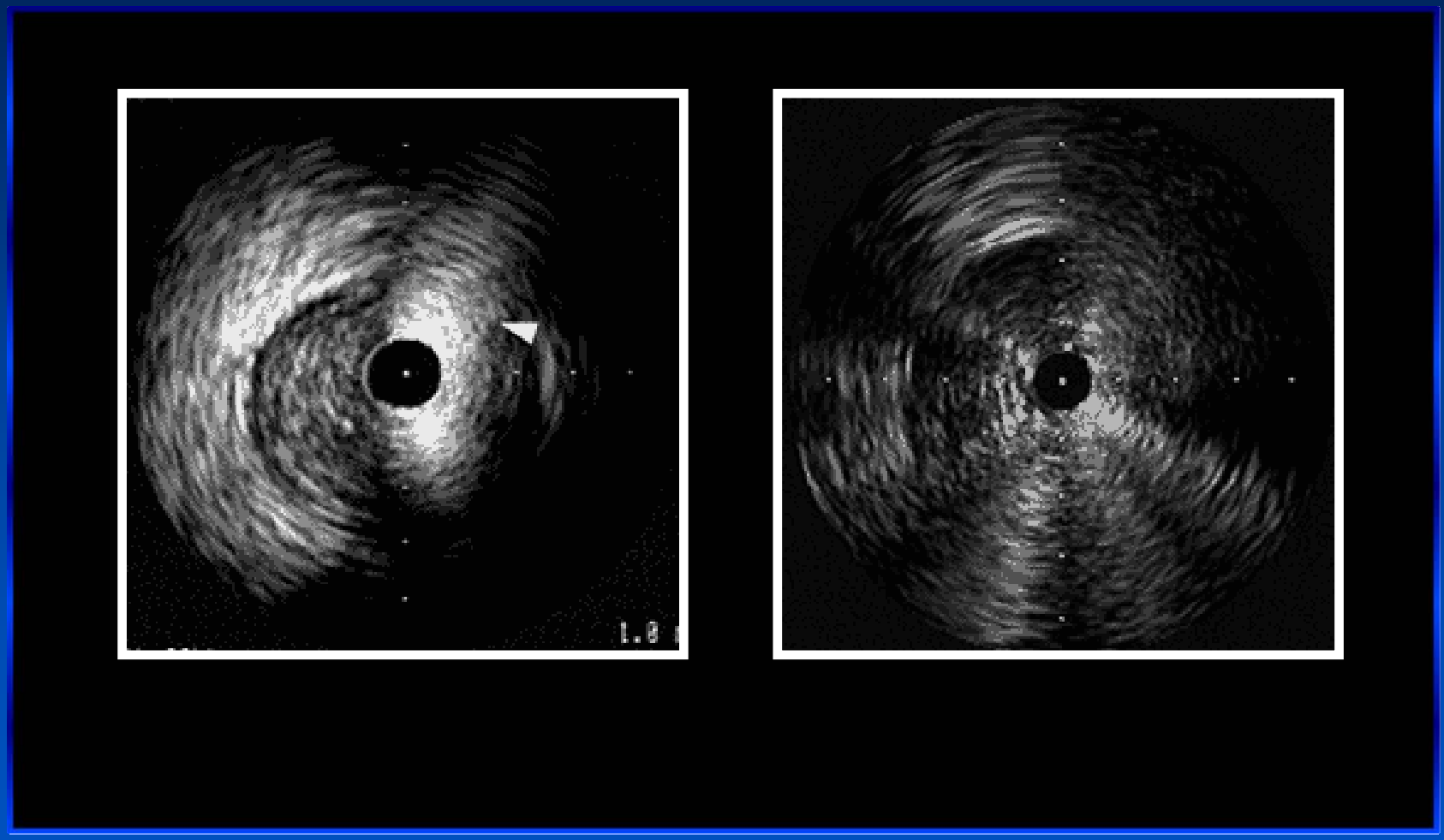
Full sector NURD



Isolated sector NURD

IVUS artifacts

air bubble



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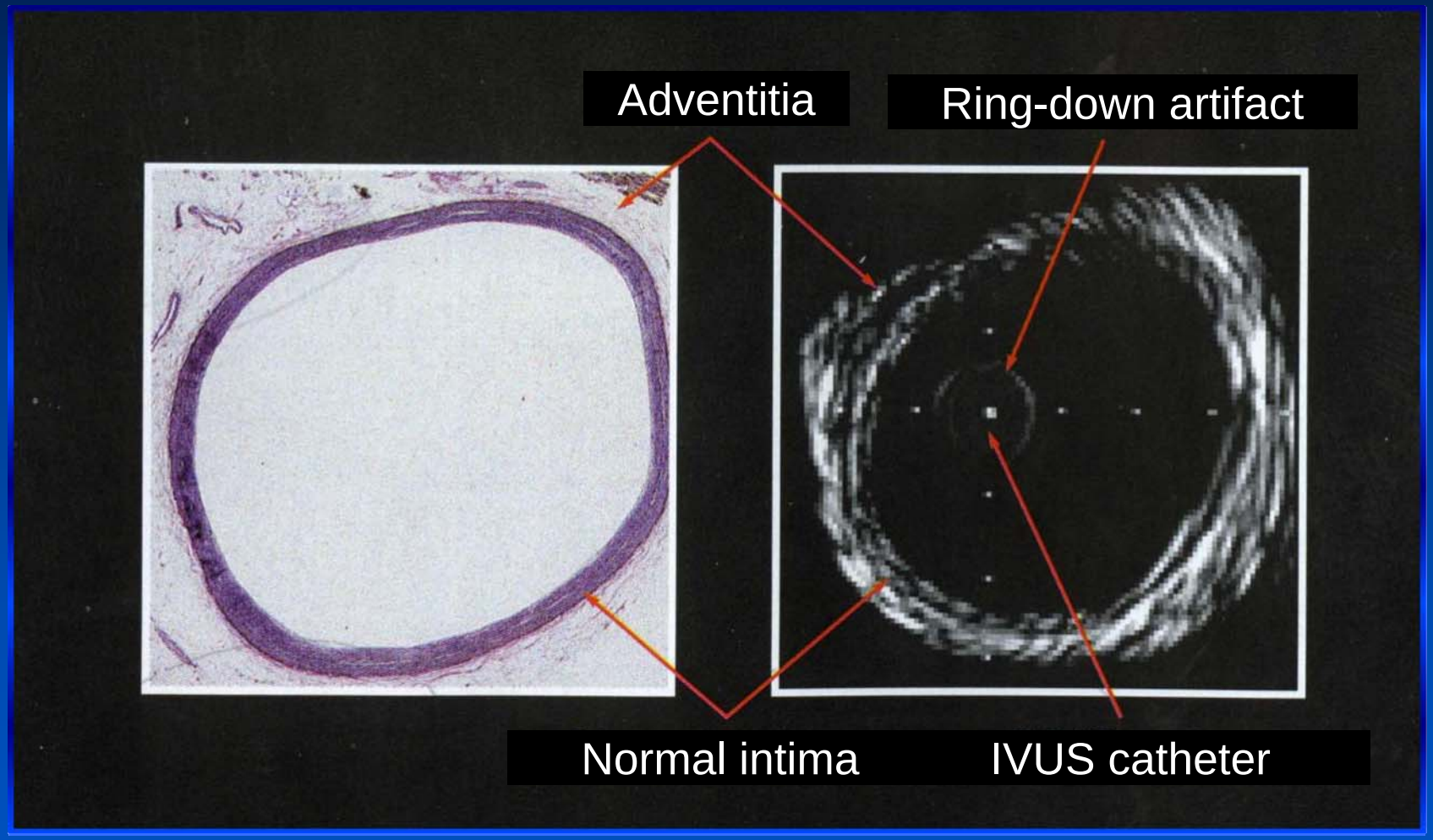
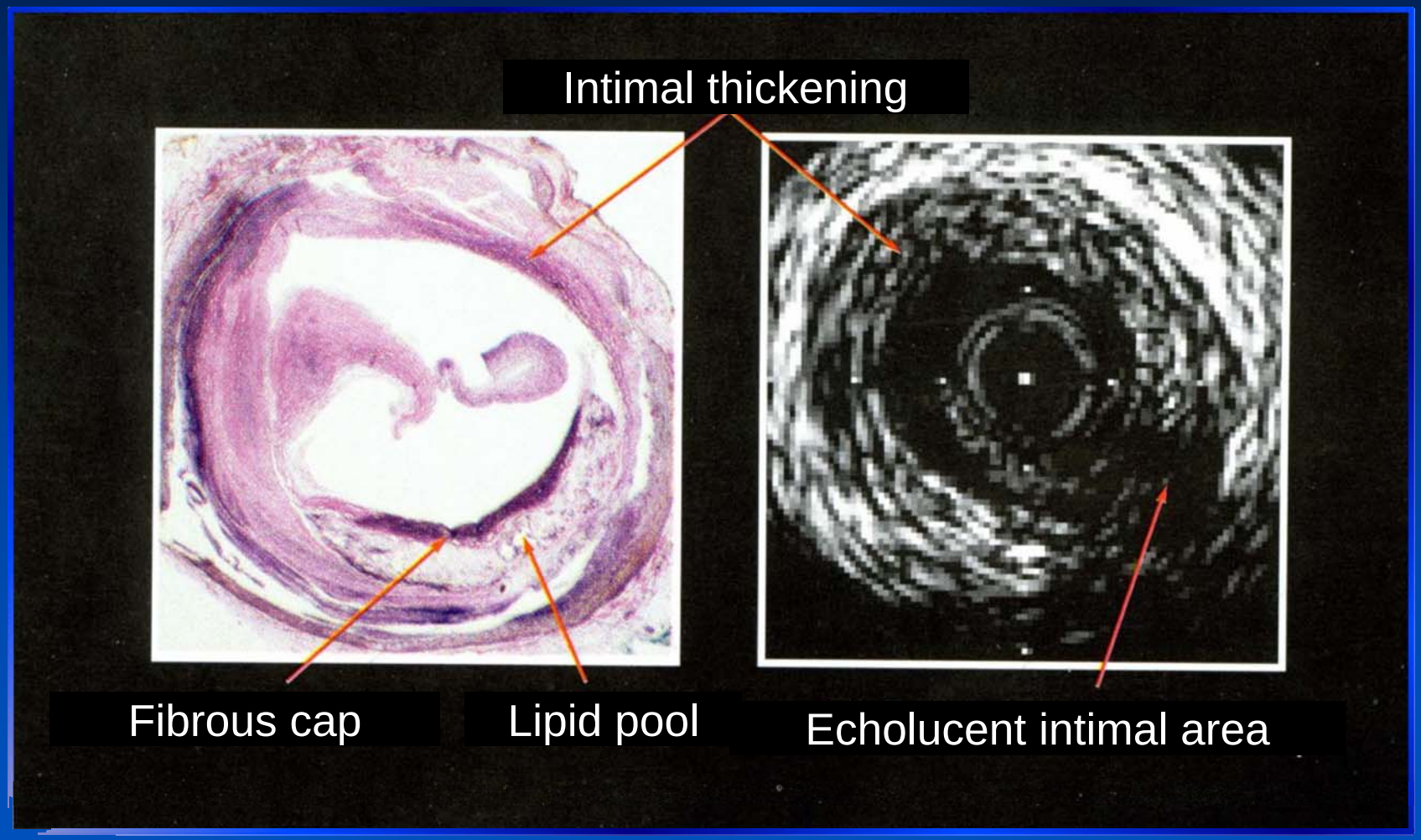
Histology and IVUS

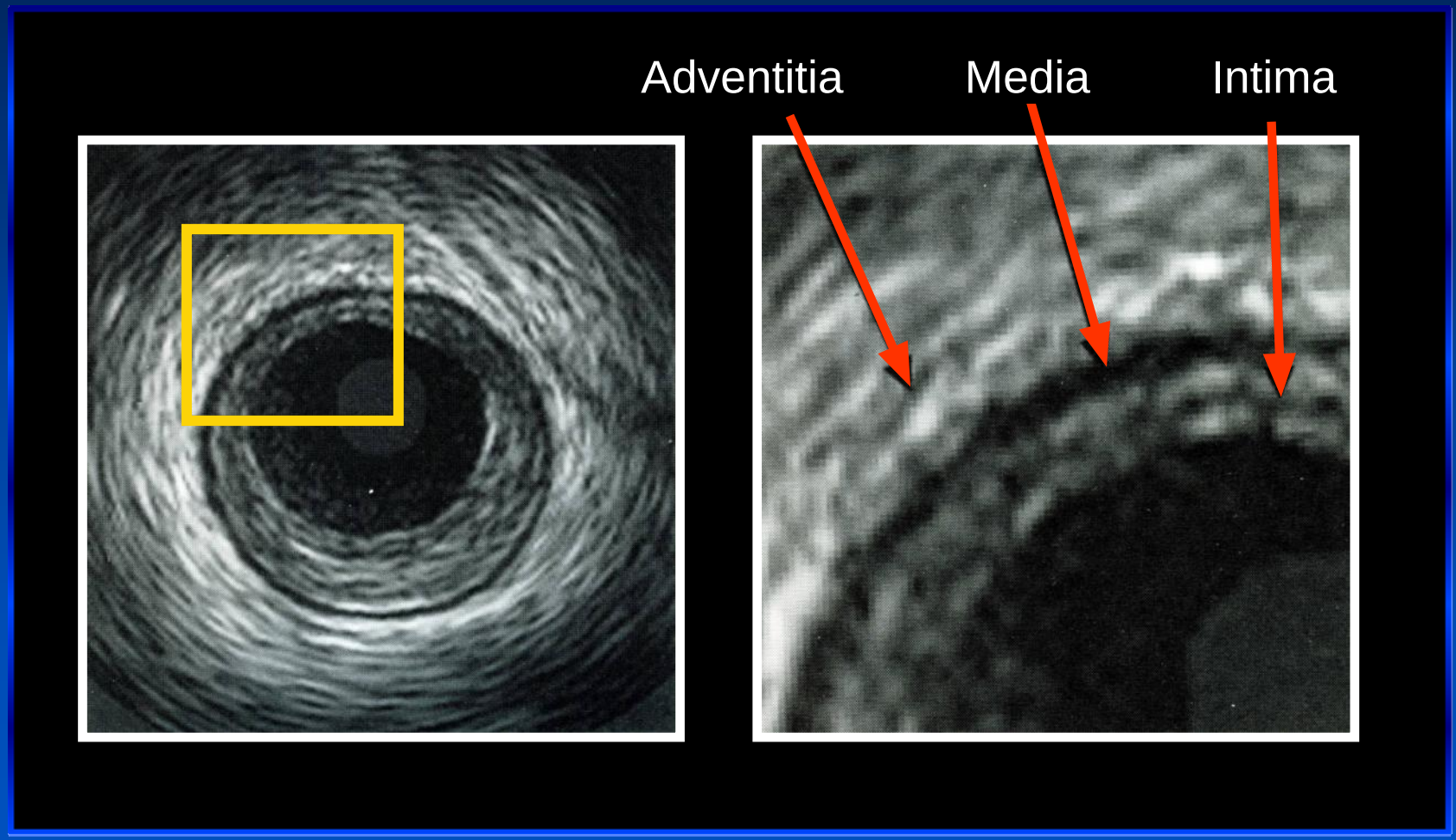


Histology and IVUS



The Three-Layered Appearance

border identification



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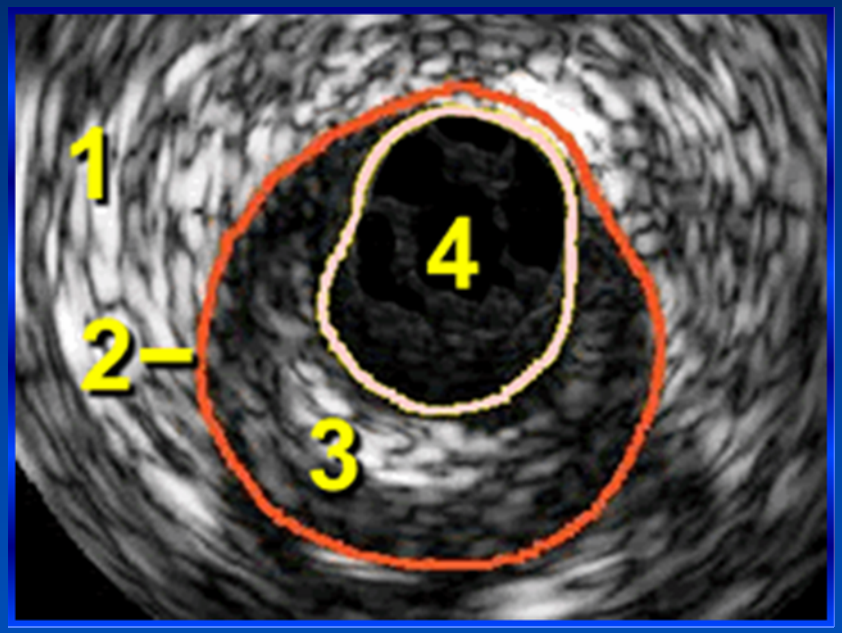

1. **Adventitia** : the outer covering of the artery

2. **Media** : the actual wall of the artery

3. **Intima** : a layer of endothelial and other cells that make direct contact with the blood inside the artery

4. **Lumen** : the actual open channel of the artery through which the blood flows.

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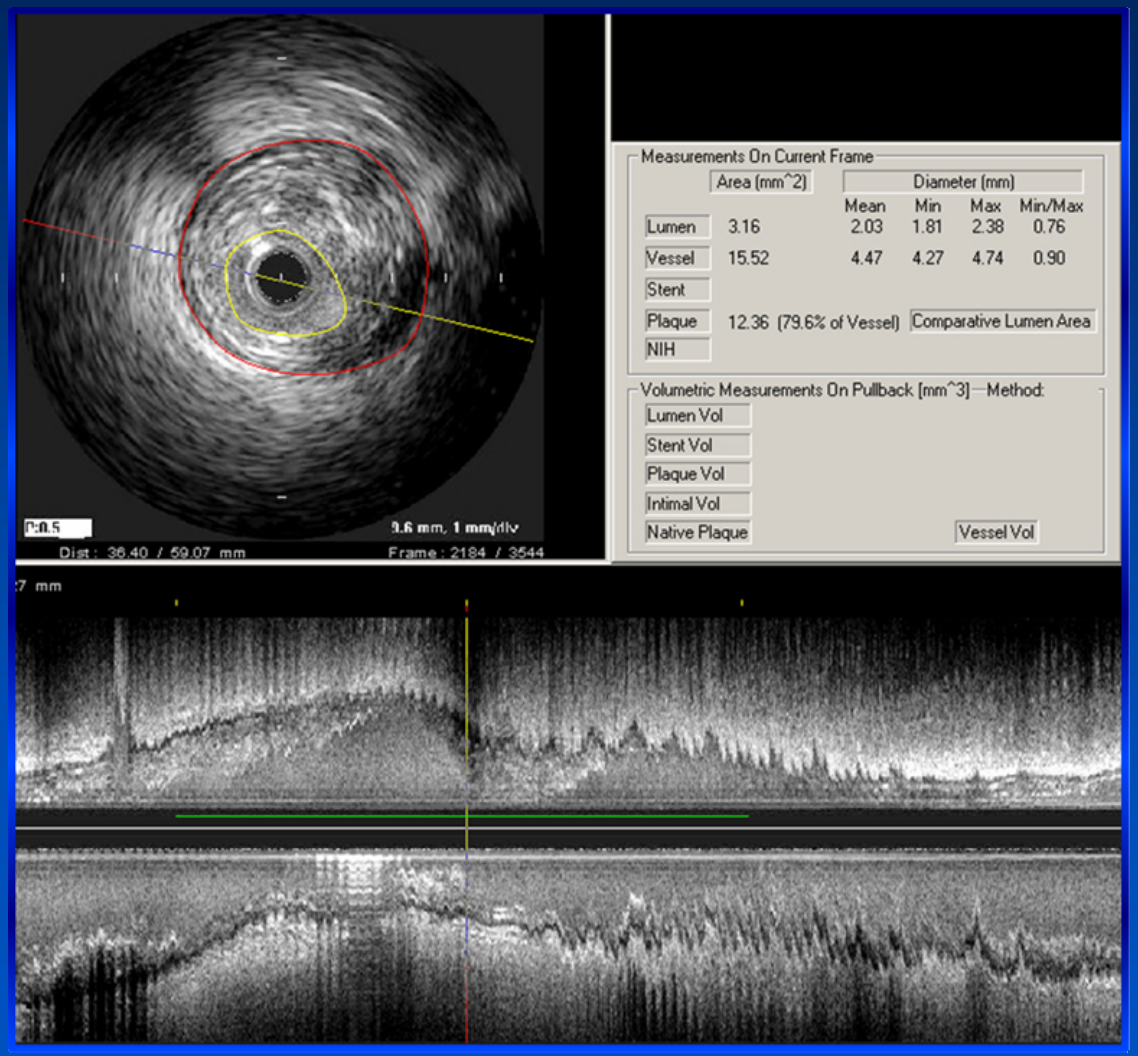
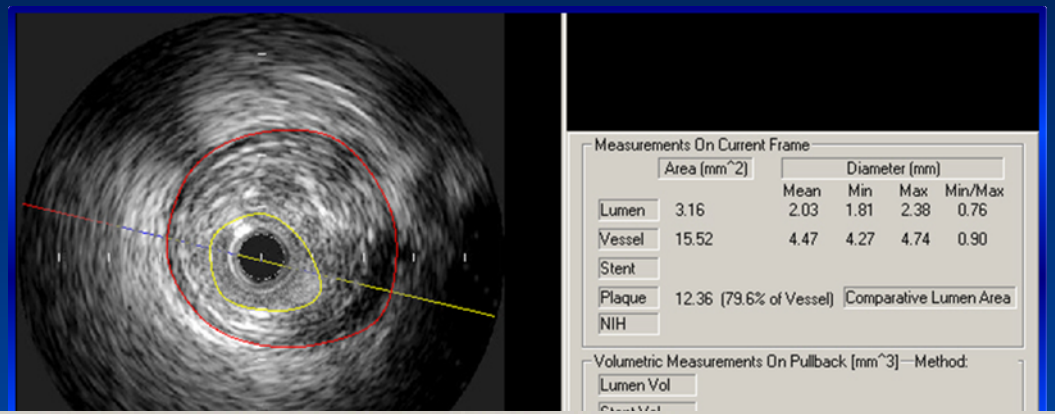
Quantitative measurement

lumen measurements



Quantitative measurement

lumen measurements

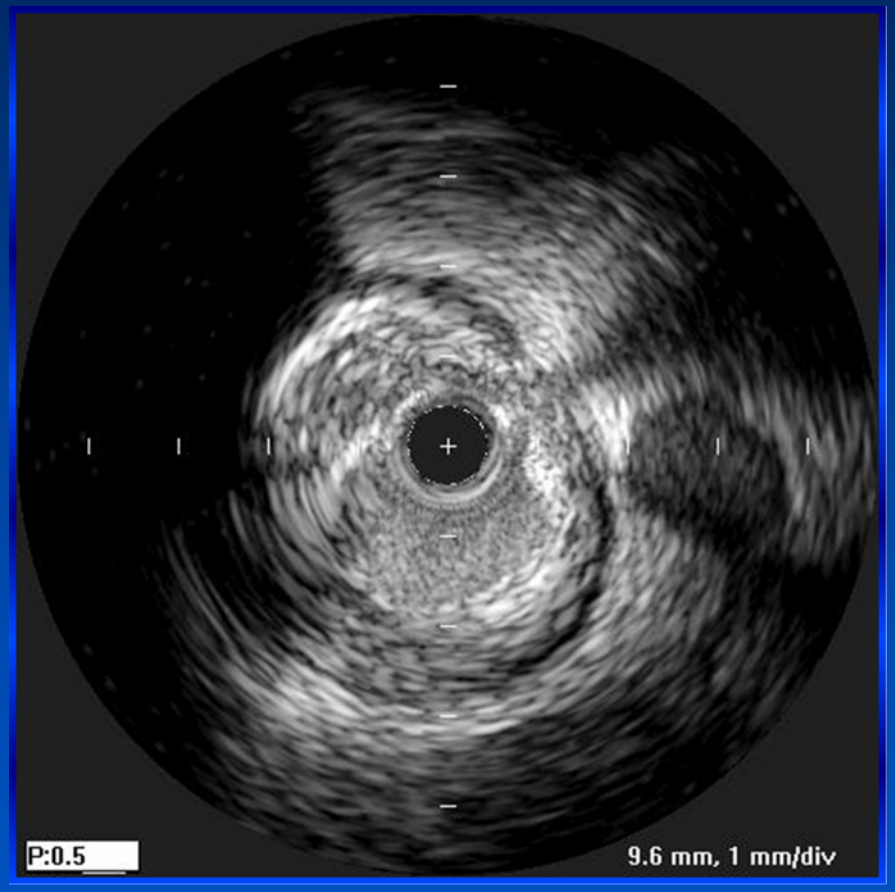


Measurements On Current Frame

	Area (mm^2)	Diameter (mm)			
		Mean	Min	Max	Min/Max
Lumen	3.16	2.03	1.81	2.38	0.76
Vessel	15.52	4.47	4.27	4.74	0.90
Stent					
Plaque	12.36 (79.6% of Vessel)	Comparative Lumen Area			
NIH					

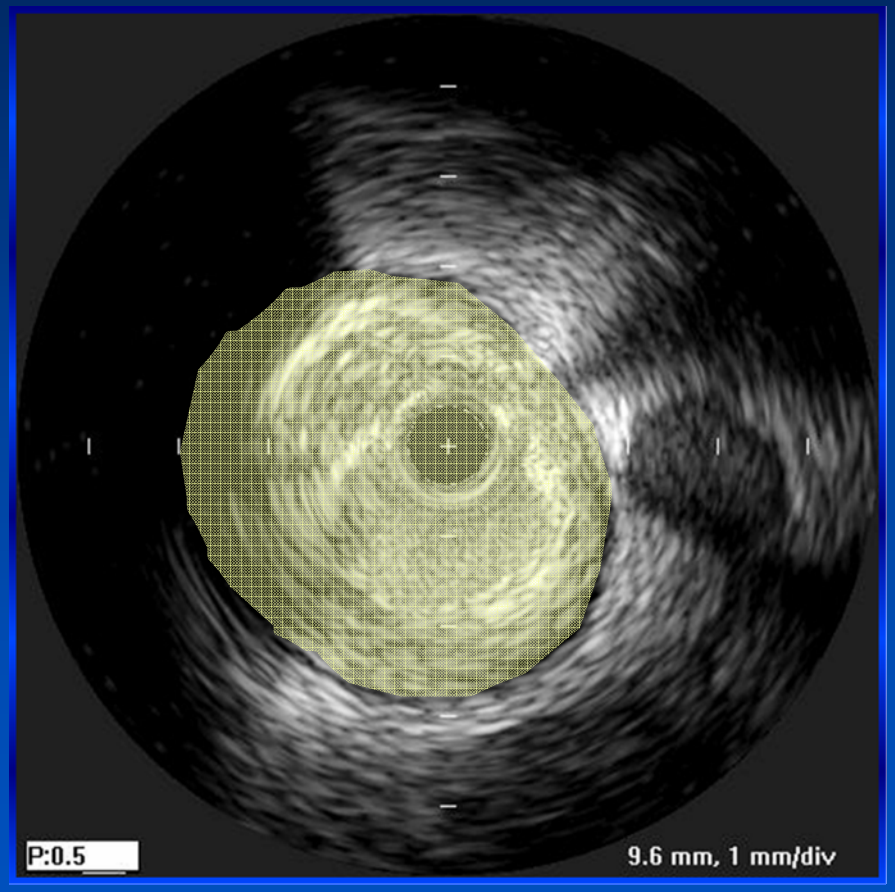
Quantitative measurement

atheroma measurements



Quantitative measurement

atheroma measurements

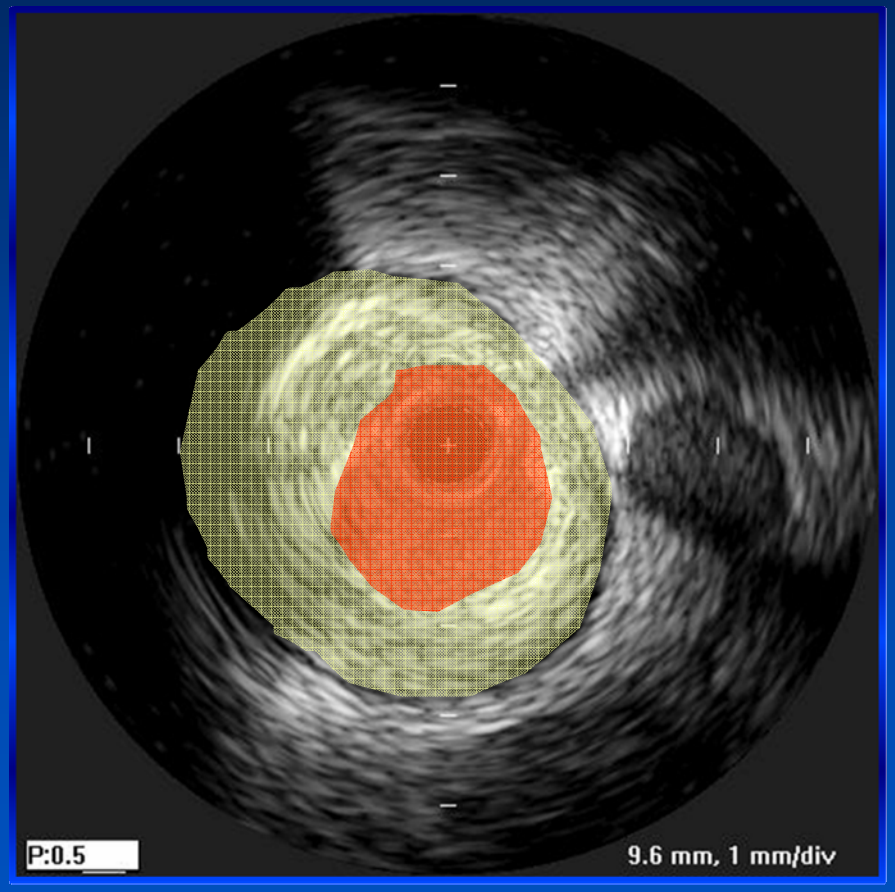


Atheroma

= EEM

Quantitative measurement

atheroma measurements

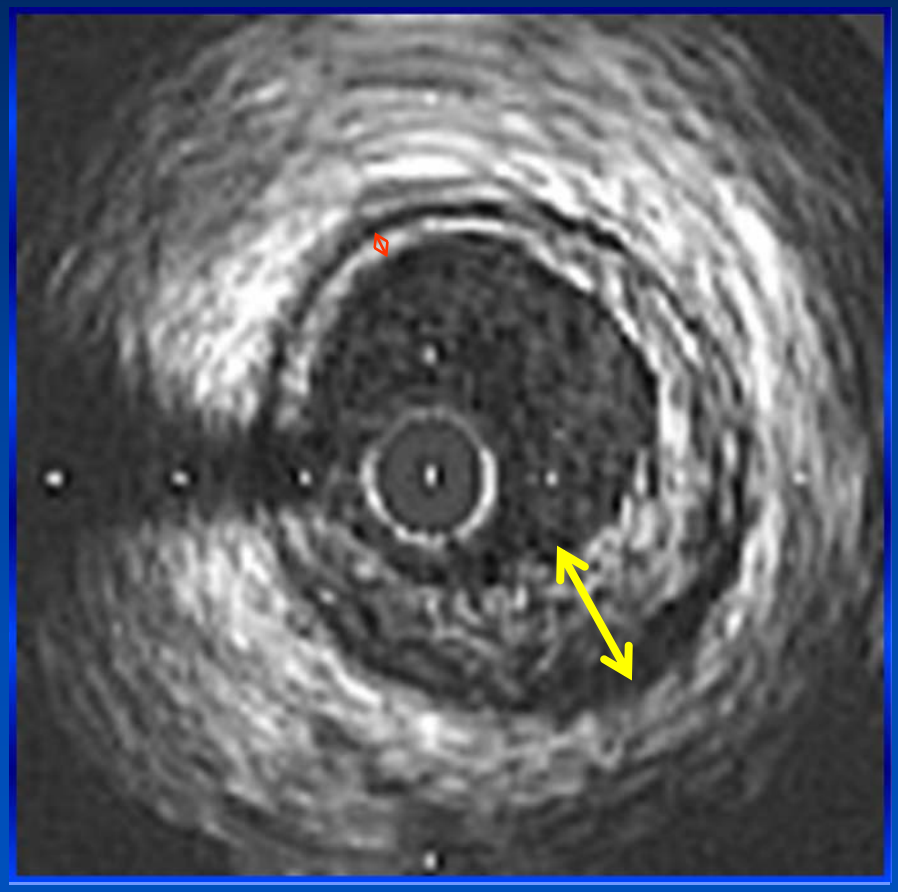


Atheroma

= EEM - Lumen

Quantitative measurement

atheroma measurements

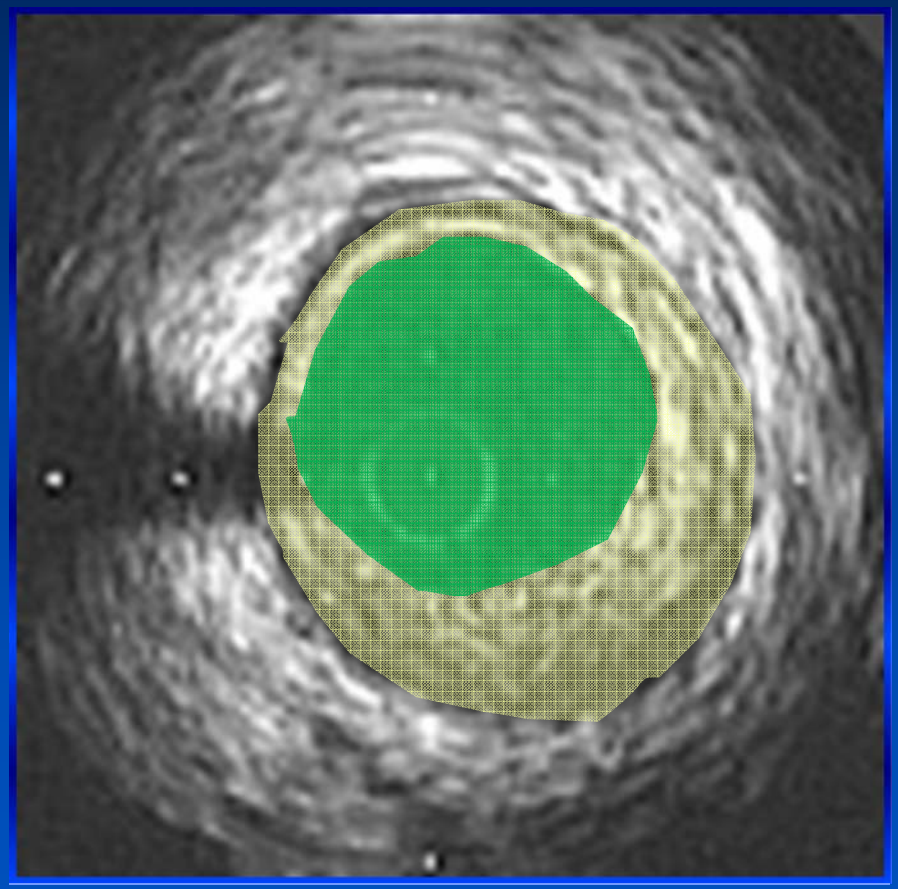


Atheroma eccentricity

= A – B / A

Quantitative measurement

atheroma measurements

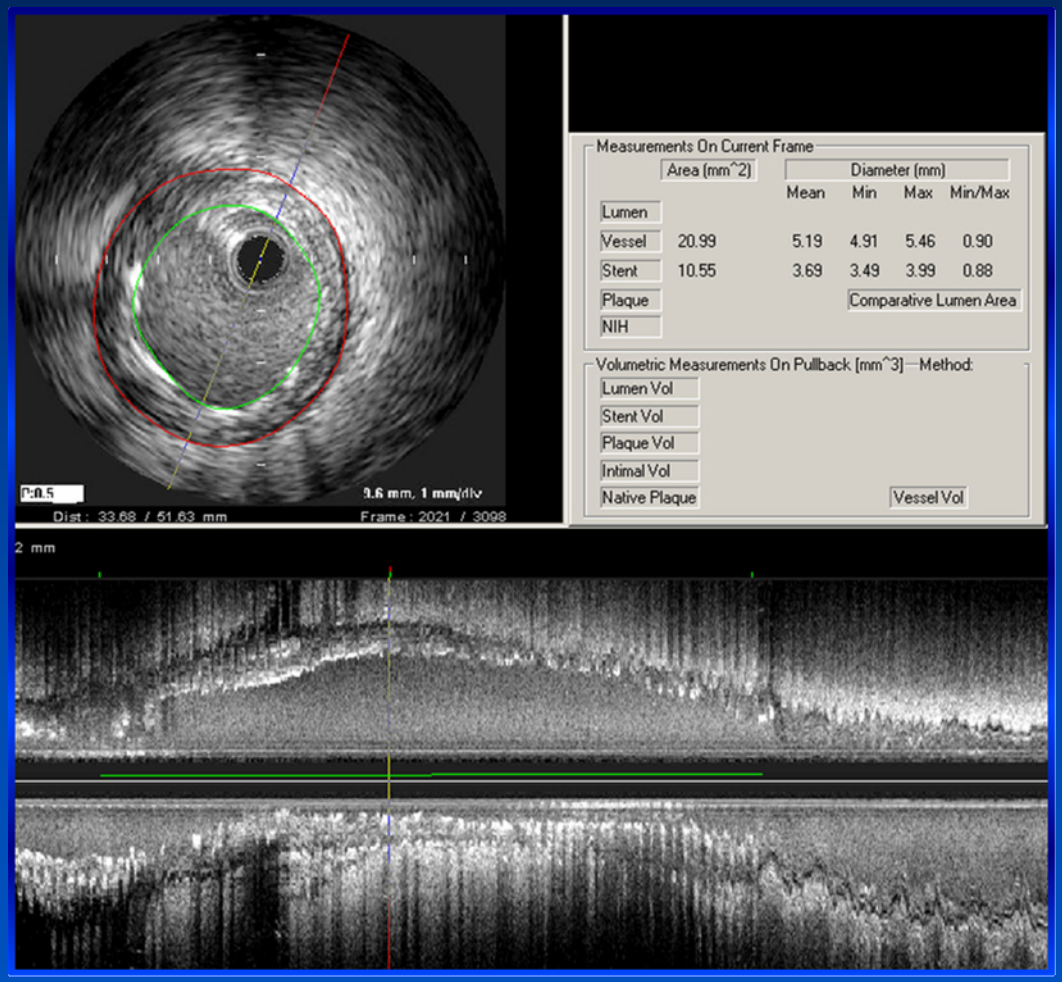


Atheroma burden

= C – D / C

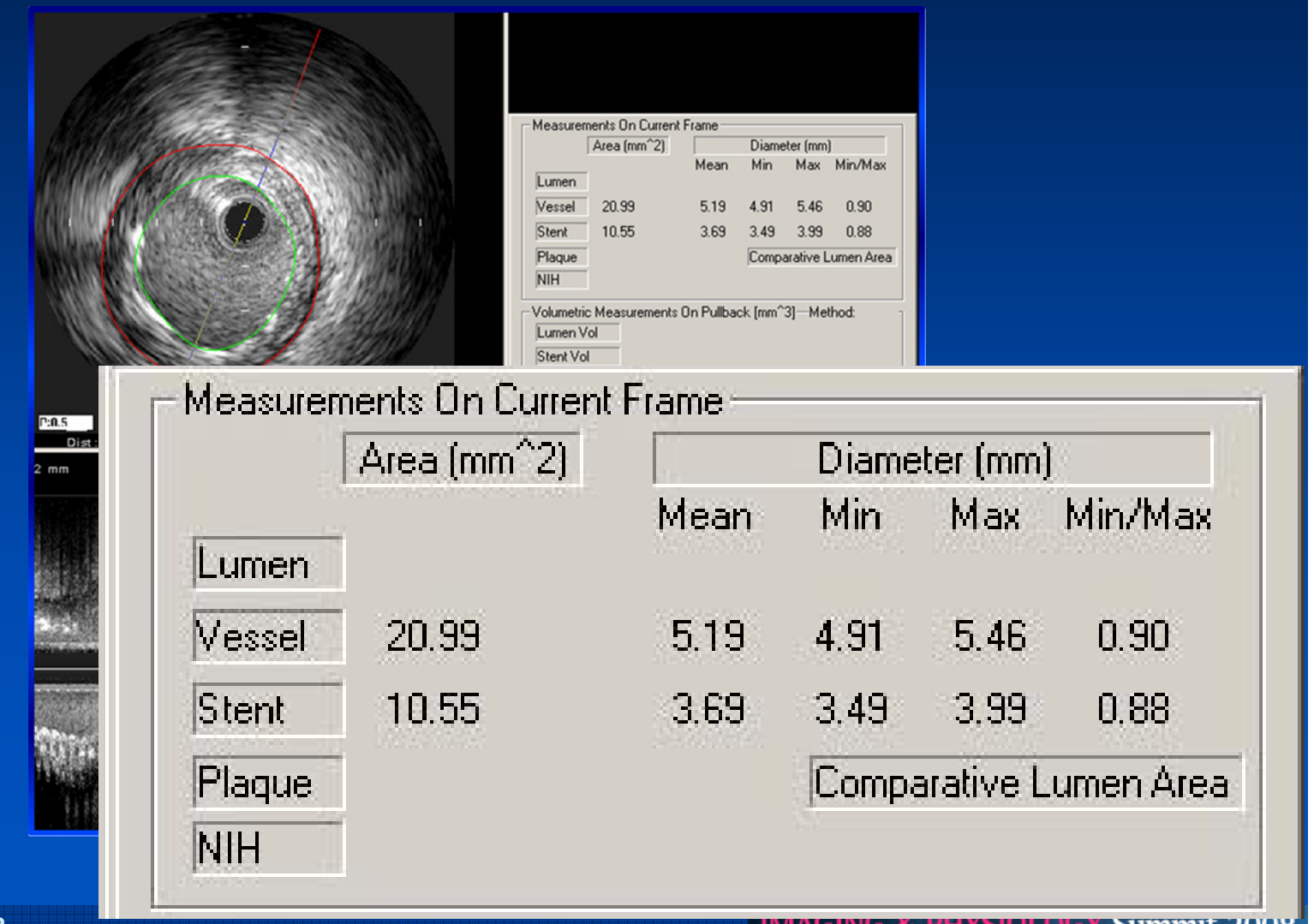
Quantitative measurement

stent measurements

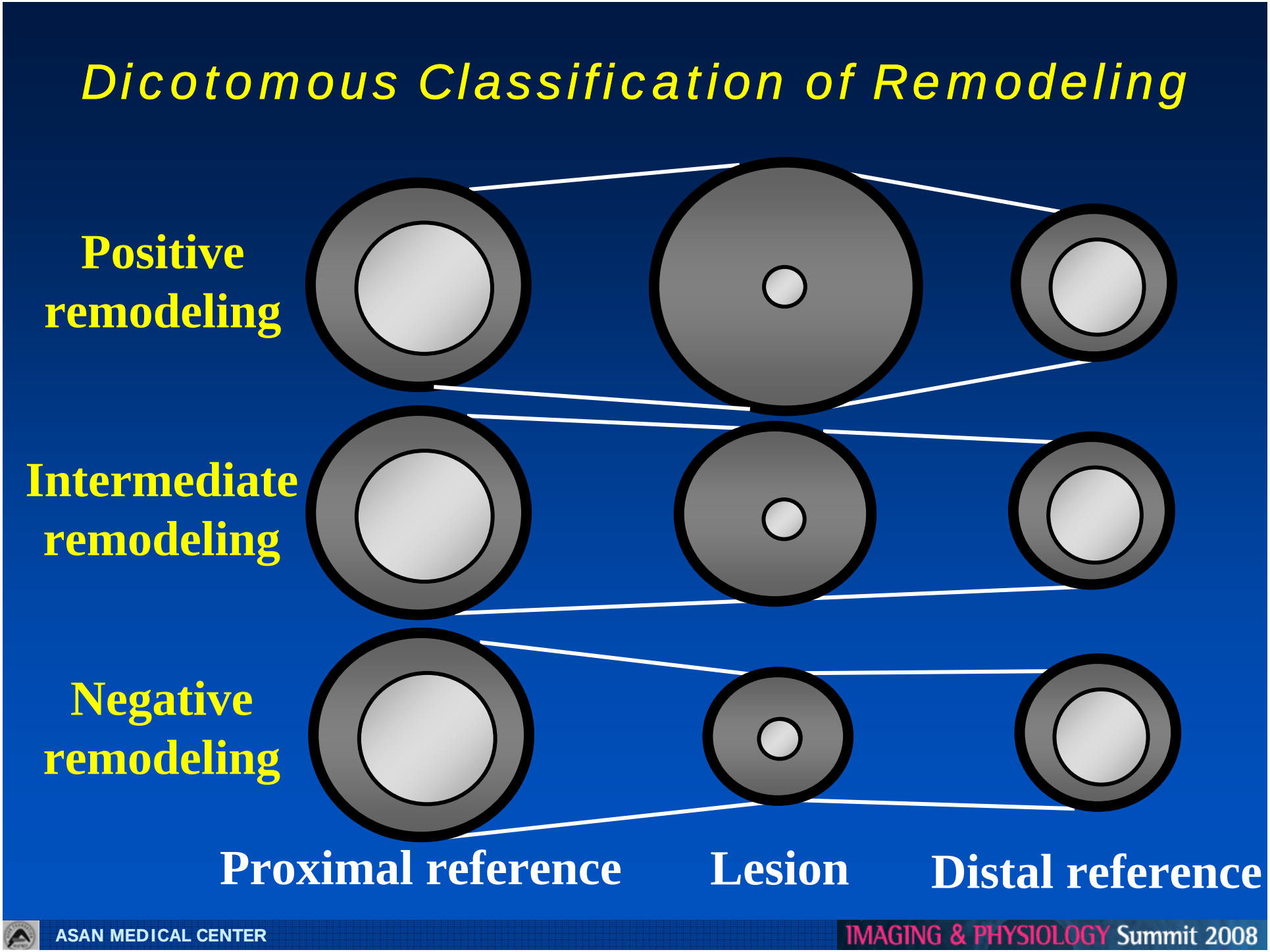


Quantitative measurement

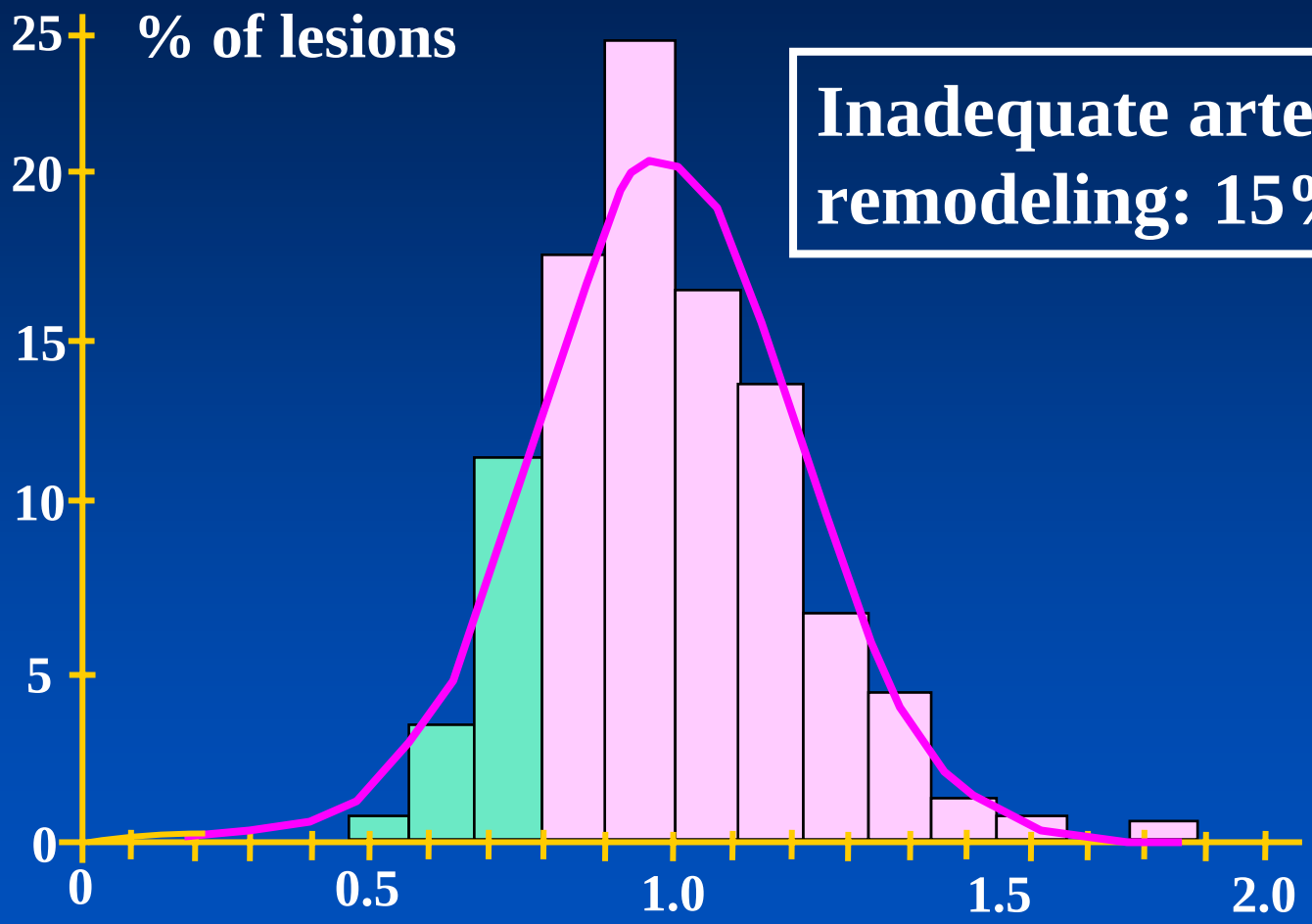
stent measurements



Dicotomous Classification of Remodeling

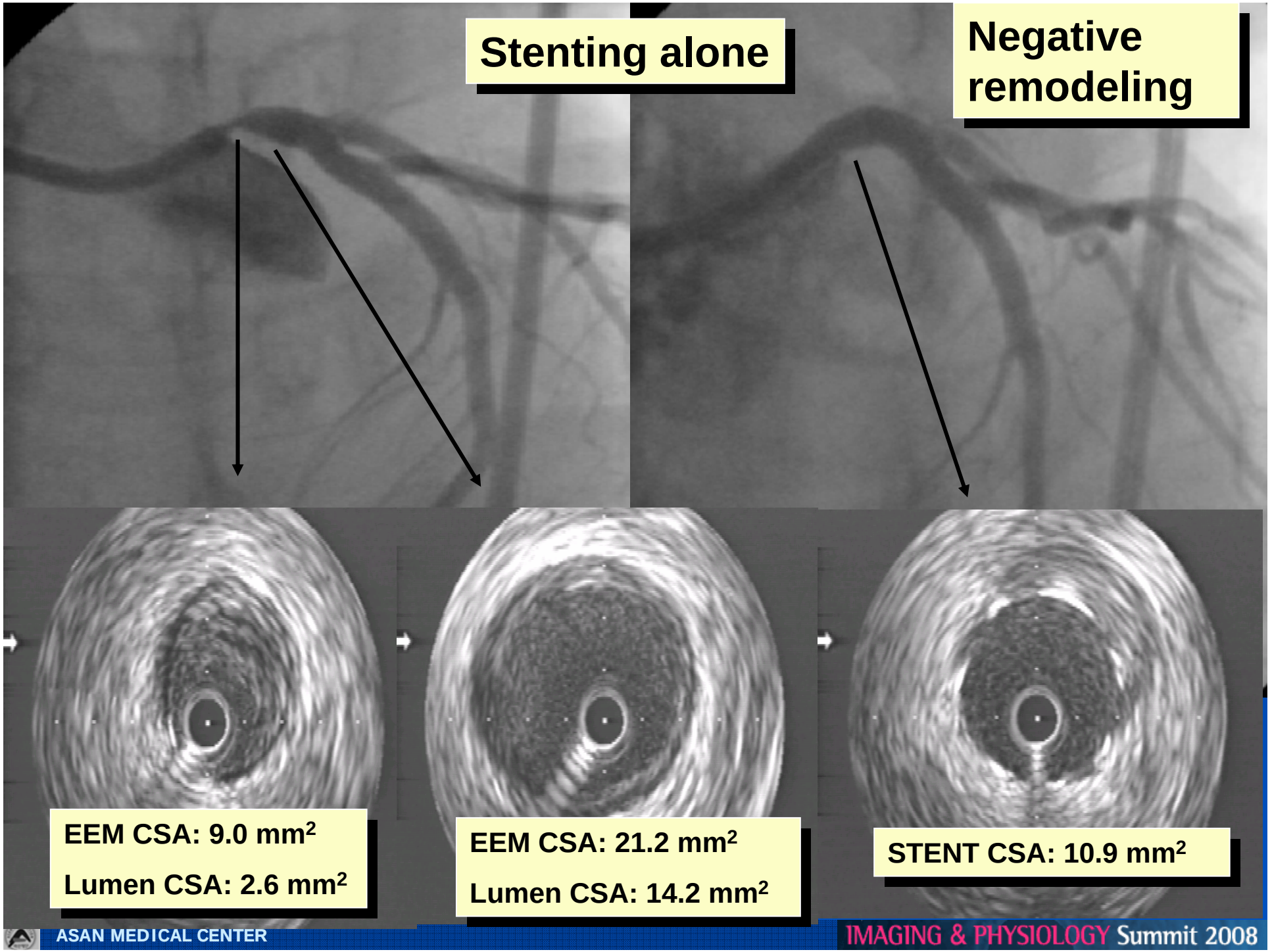


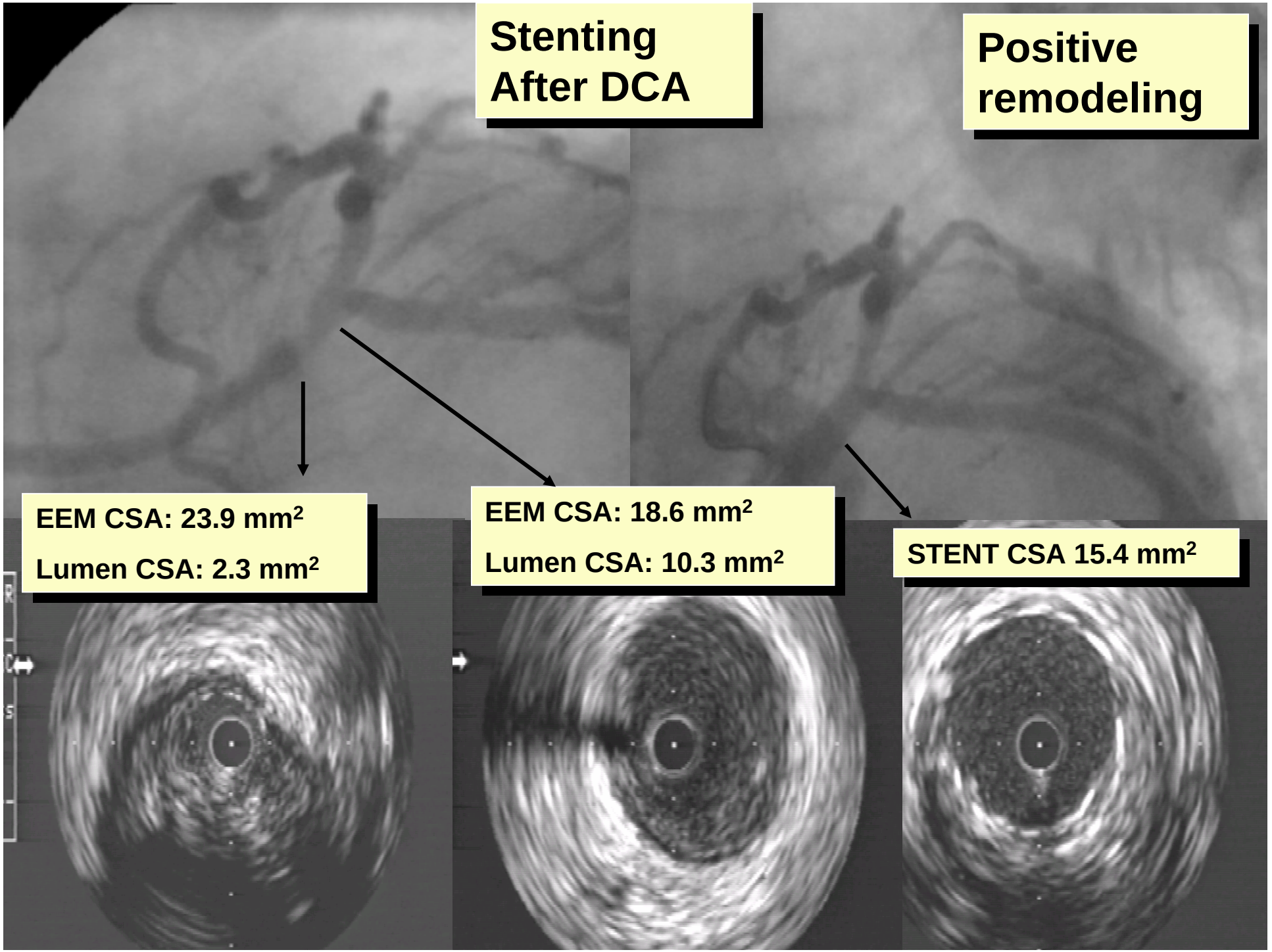
Contribution of inadequate arterial remodeling to the development of focal coronary artery stenoses: an IVUS study



Inadequate arterial remodeling: 15%

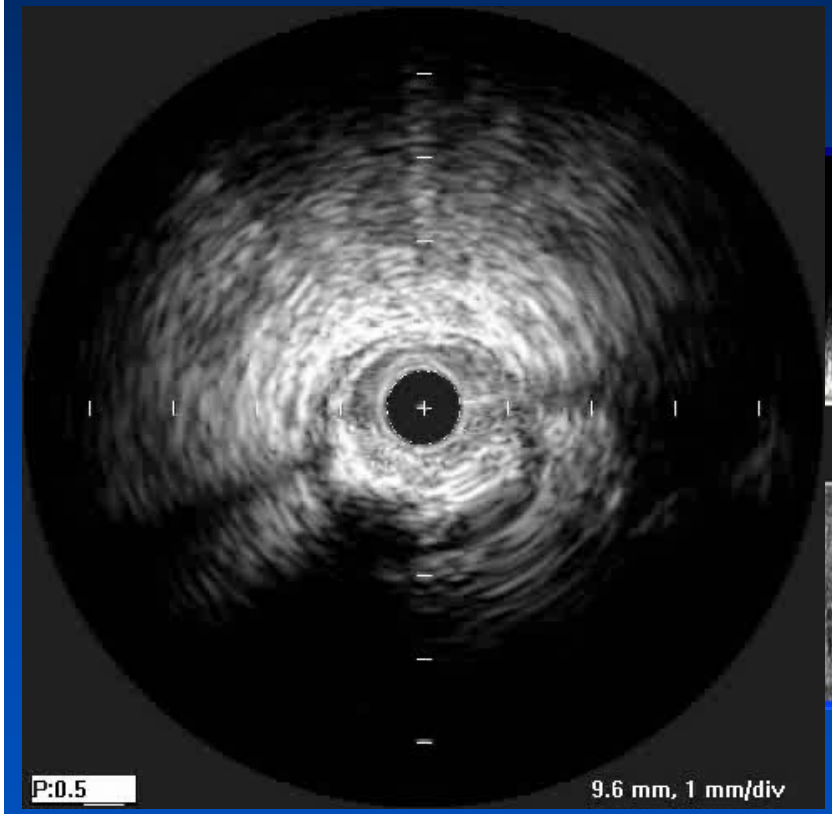
Mintz GS, et al. Circulation 1997;95: 1791-98

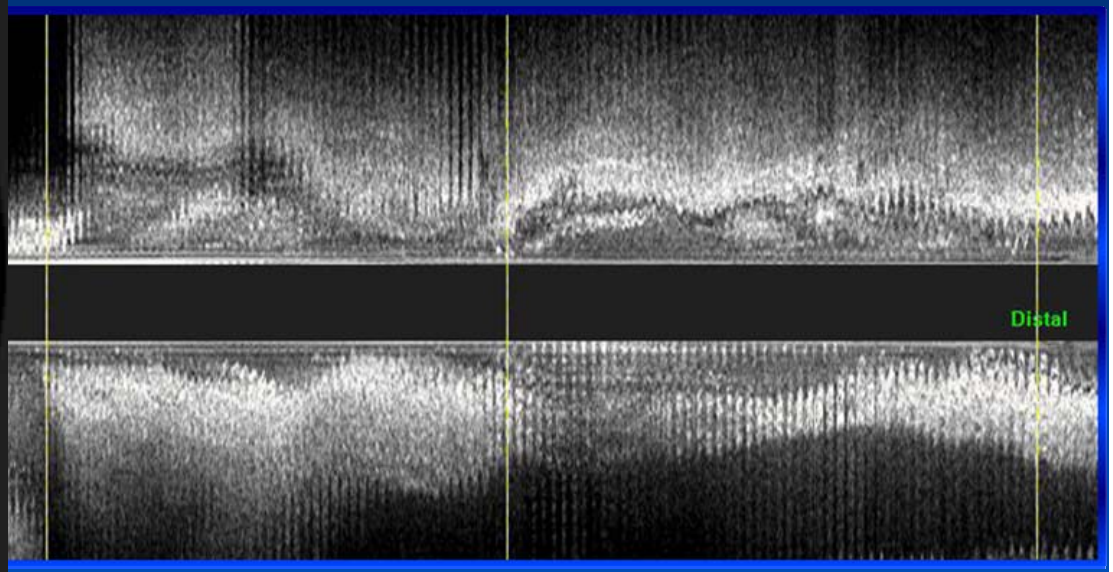

Stenting alone
Negative remodeling
EEM CSA: 9.0 mm²
Lumen CSA: 2.6 mm²
EEM CSA: 21.2 mm²
Lumen CSA: 14.2 mm²
STENT CSA: 10.9 mm²


Stenting
After DCA
Positive
remodeling
EEM CSA: 23.9 mm²
Lumen CSA: 2.3 mm²
EEM CSA: 18.6 mm²
Lumen CSA: 10.3 mm²
STENT CSA 15.4 mm²

Quantitative measurement

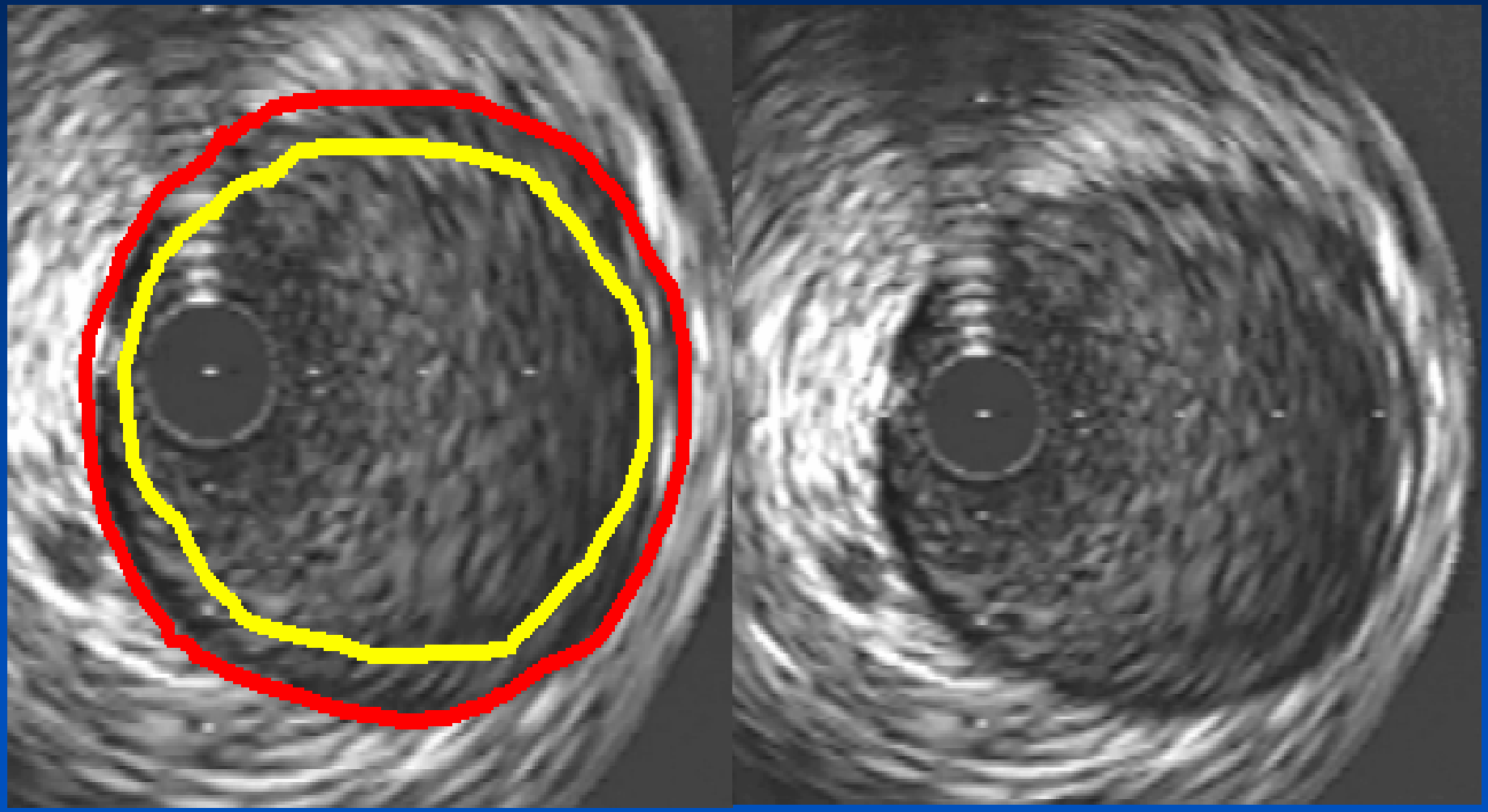
negative remodeling





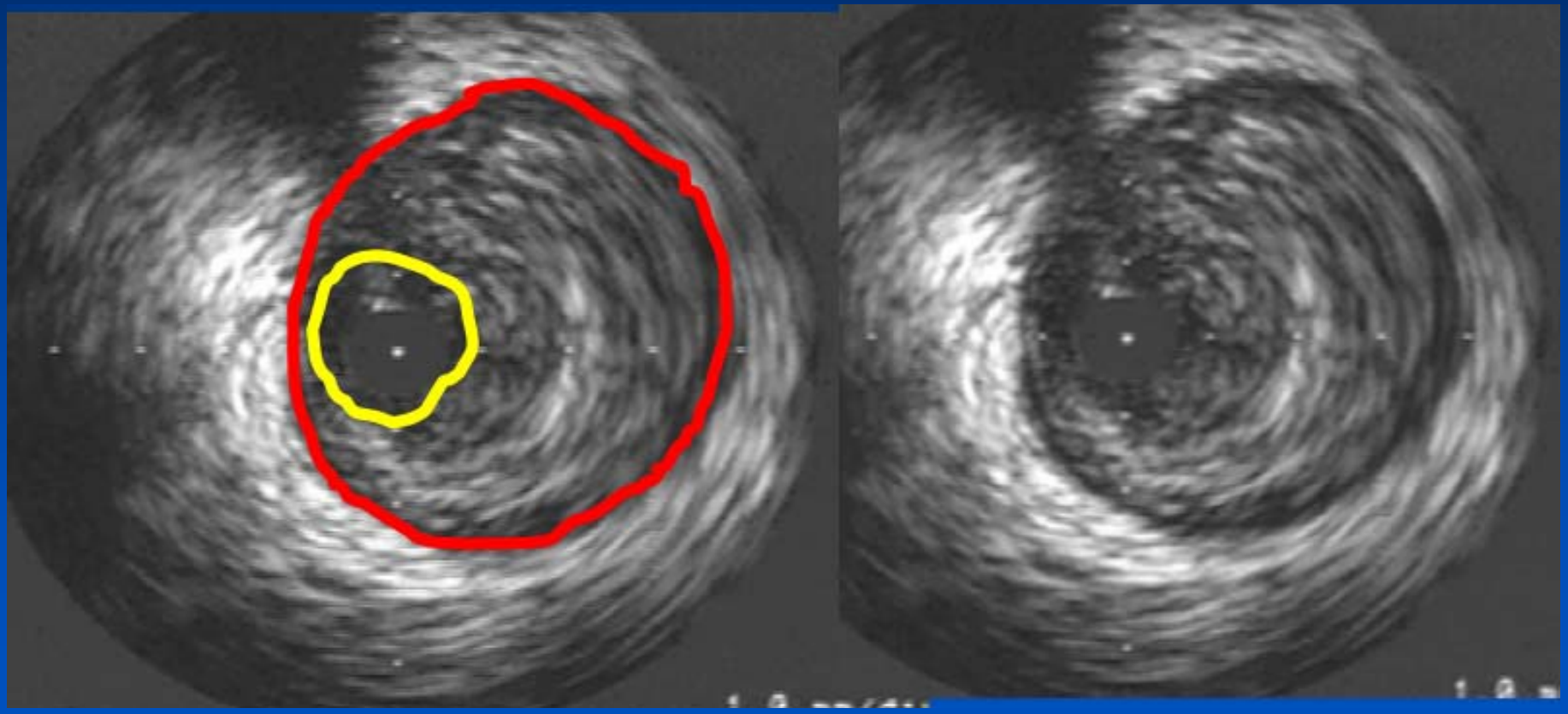
Atheroma Morphology

Normal



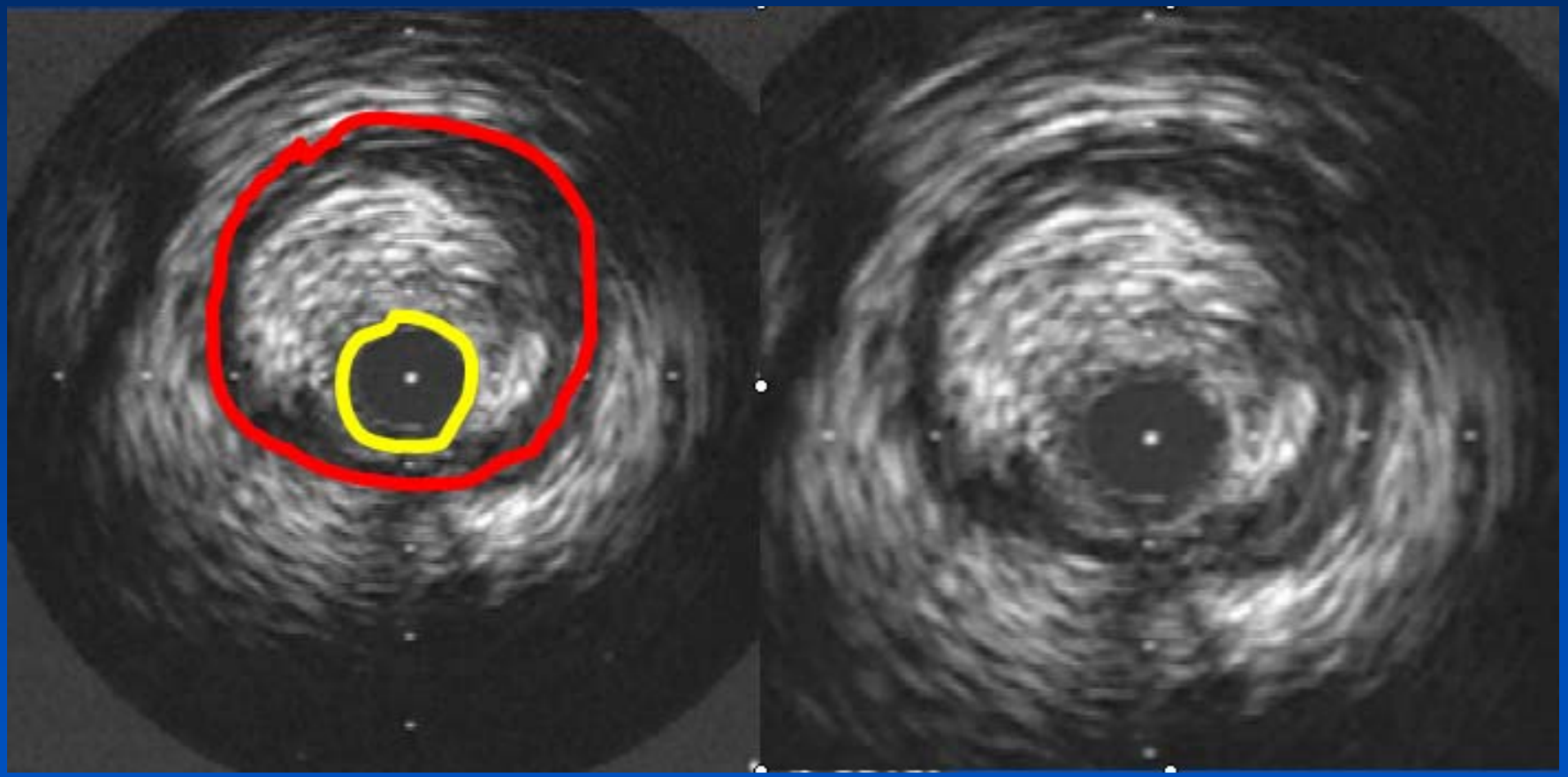
Atheroma Morphology

Soft plaque



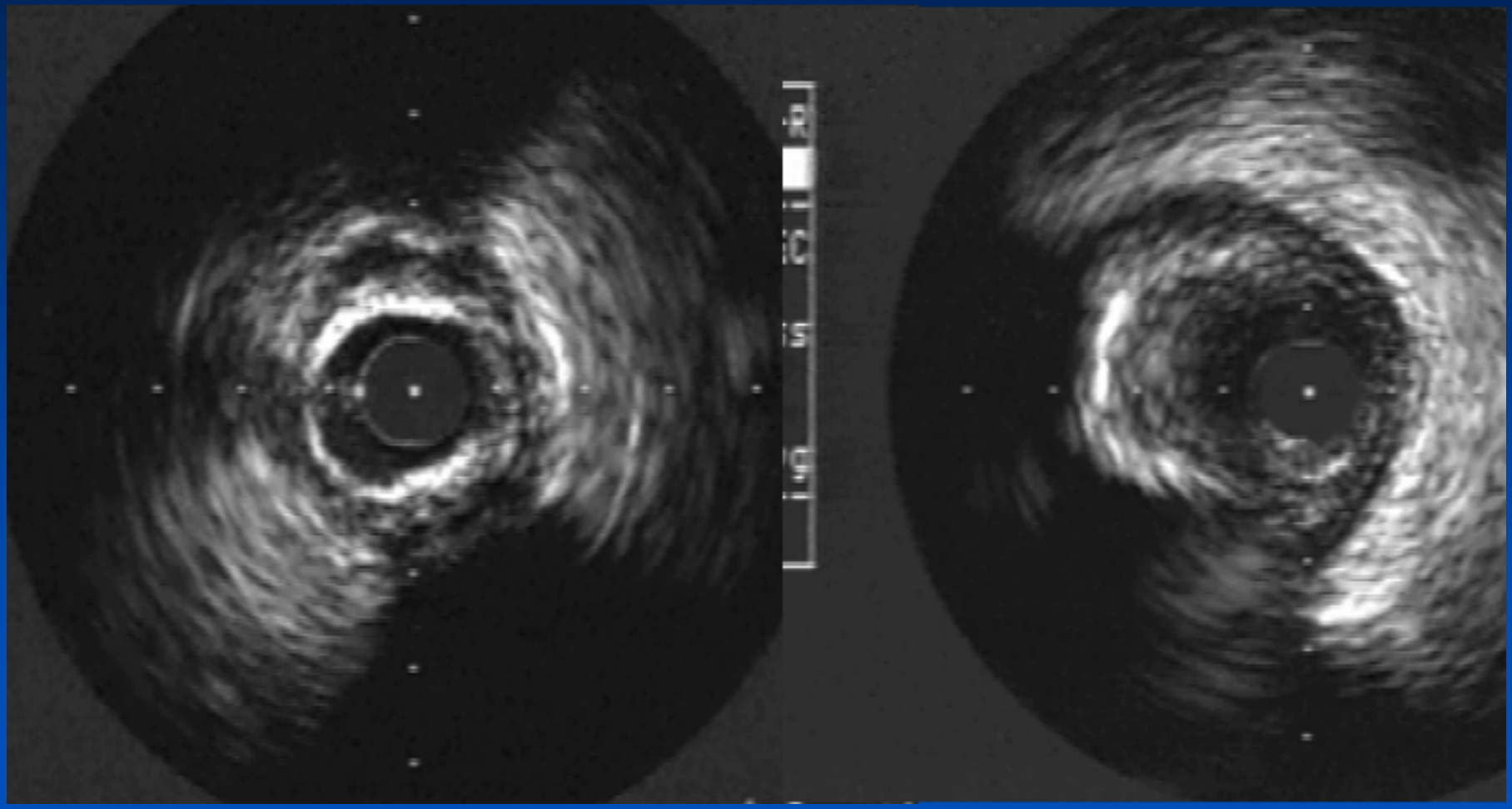
Atheroma Morphology

fibrotic plaque



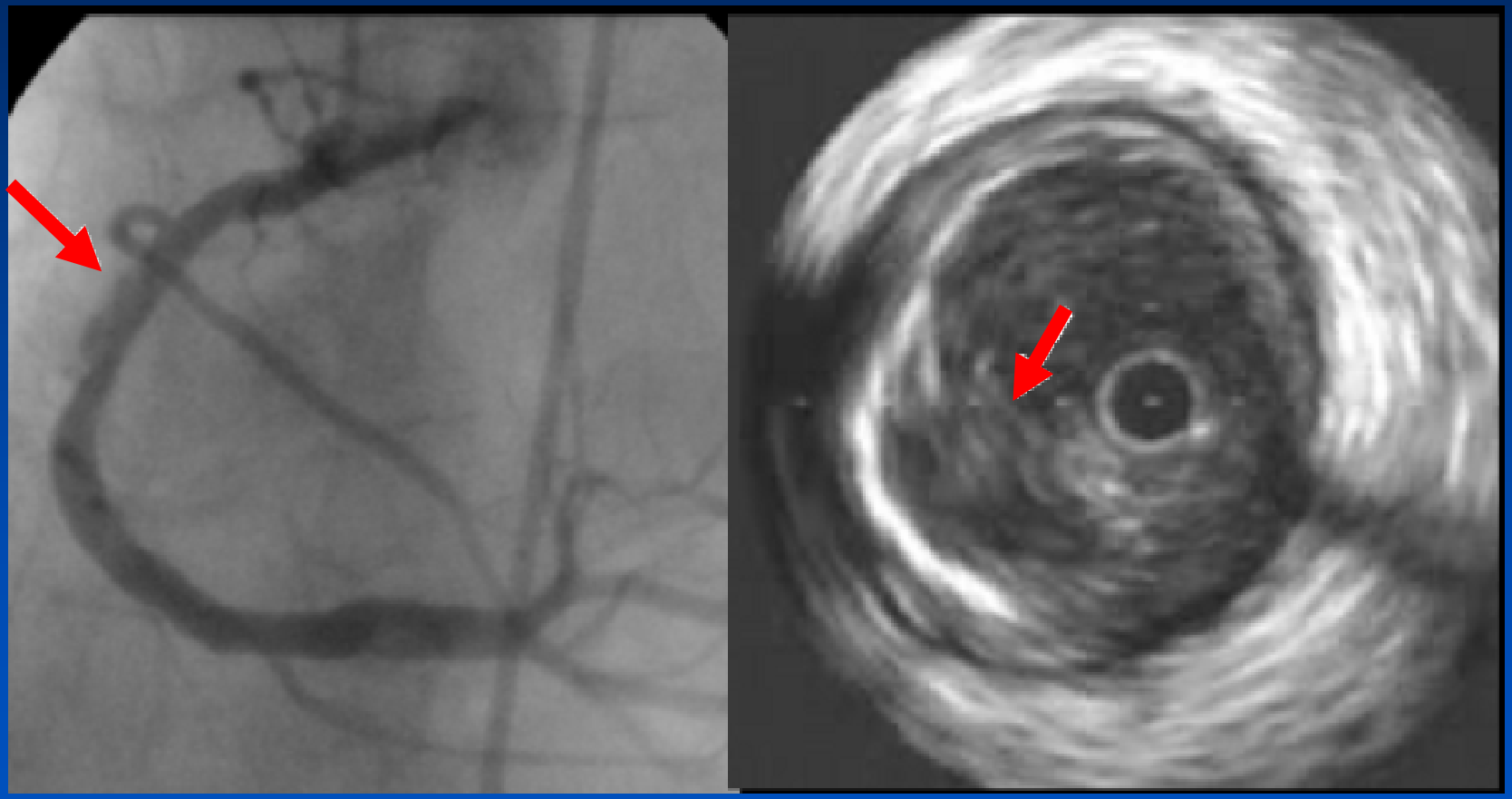
Atheroma Morphology

Calcium



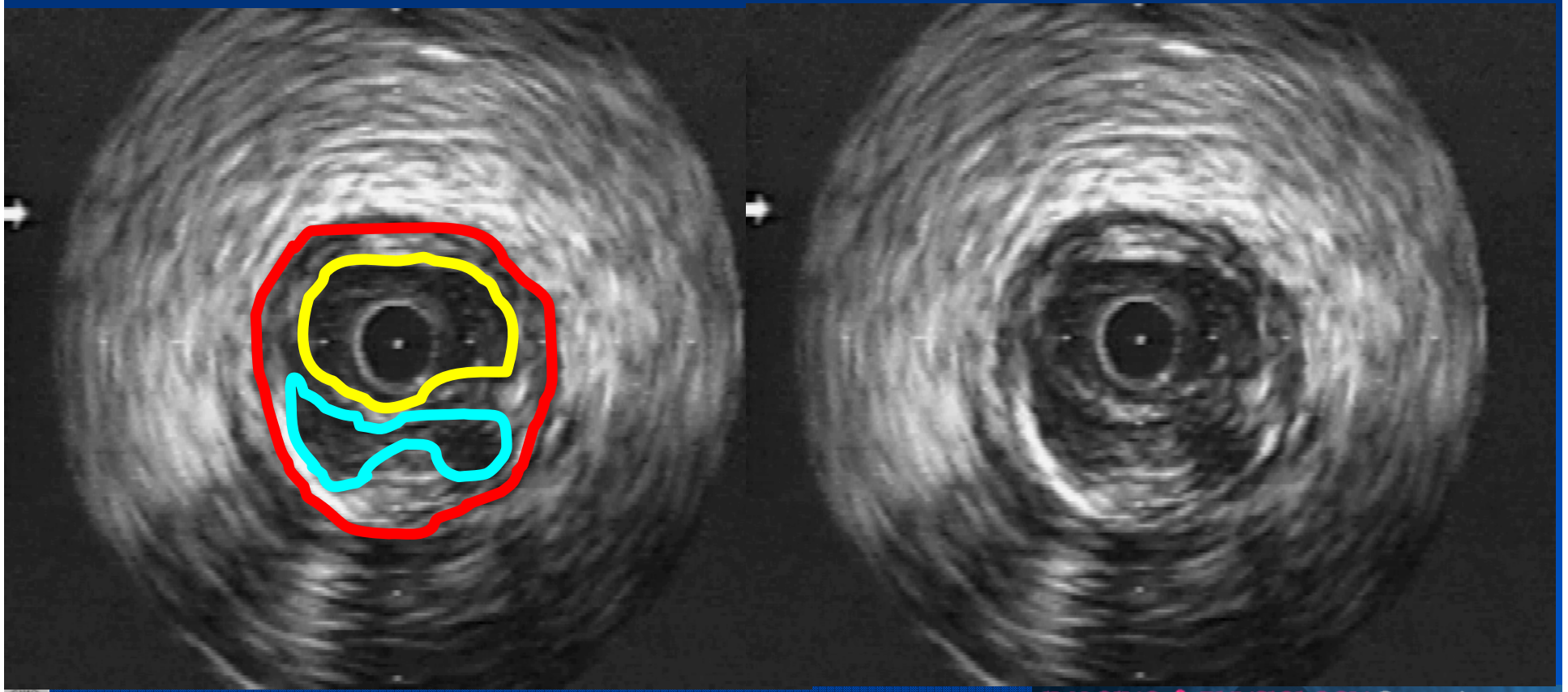
Atheroma Morphology

rupture



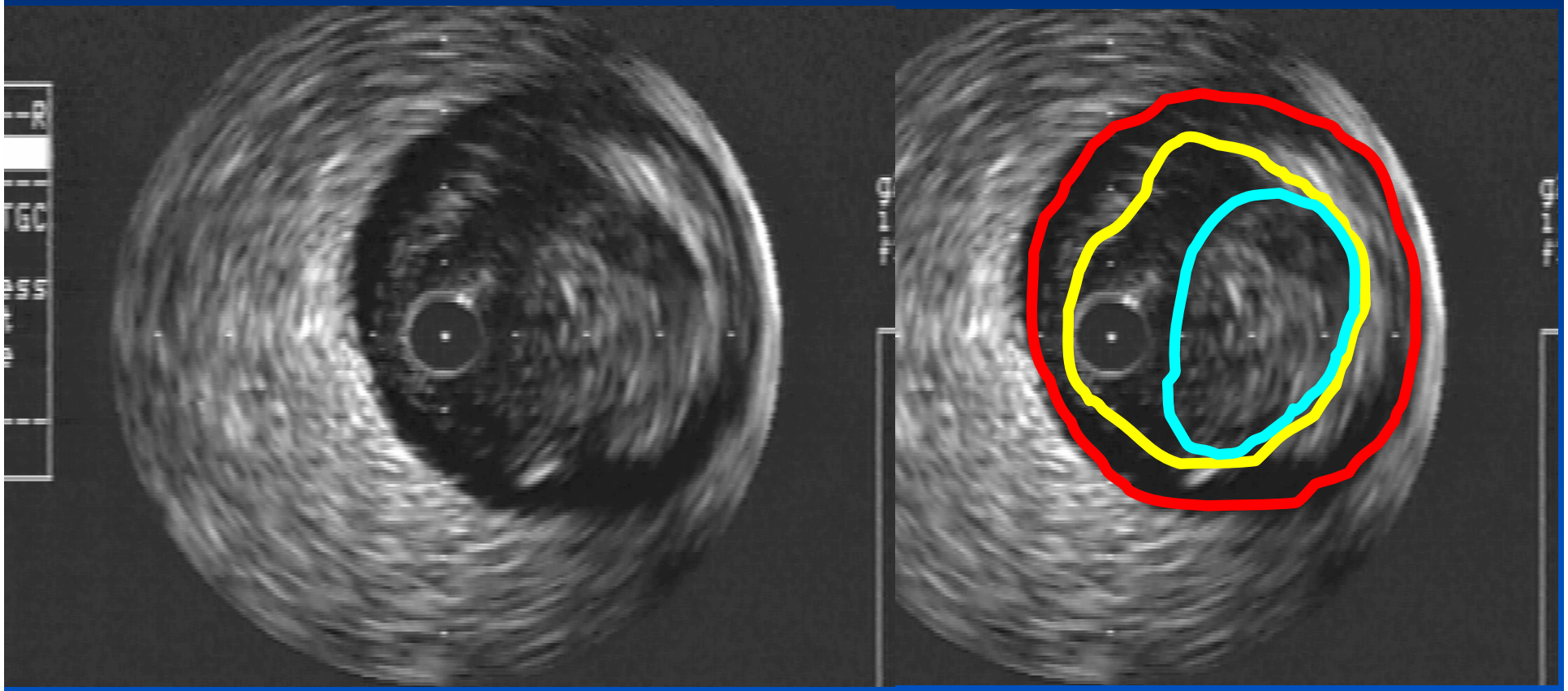
Atheroma Morphology

lipid core



Atheroma Morphology

thrombus



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Reporting of IVUS results

- ✓ Appropriate patient demographic information and date
- ✓ Indication and brief description of procedure
- ✓ Basic findings : MLD, minimum stent area, or plaque burden…
- ✓ Plaque features : dissection, calcium, or thrombus…
- ✓ Changes of therapy by IVUS
- ✓ IVUS-related complications and any consequent therapy.

ACC Clinical Expert Consensus. *J Am Coll Cardiol*. *2001*

In my opinion ….

When you meet the complex cases, IVUS will help you at any time and answer you clearly about difficult questions

Image quality

- Contrast resolution
  - the distribution of the gray scale of the reflected signal and is often referred to as dynamic range