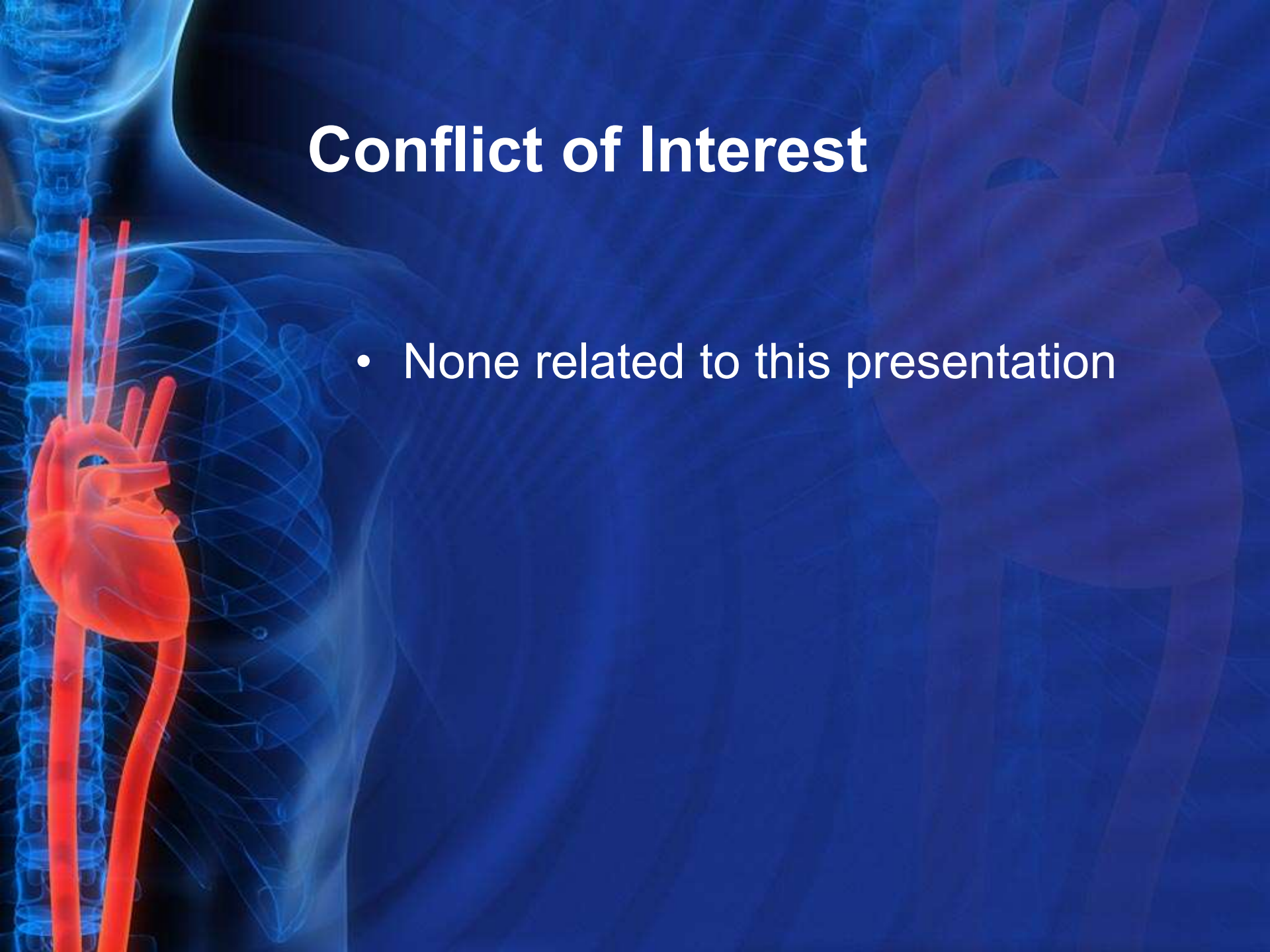
A medical illustration of a human torso. The heart is highlighted in a bright red, glowing 3D style, showing its major vessels. The rest of the body, including the ribcage, spine, and arms, is depicted in a translucent blue, wireframe-like style. The background is a solid dark blue.

Contemporary Clinical Utility of Intravascular Ultrasound in Coronary Artery Disease

Cesar E. Mendoza, MD
Cardiovascular Disease Division
Jackson Memorial Hospital

Conflict of Interest

- None related to this presentation

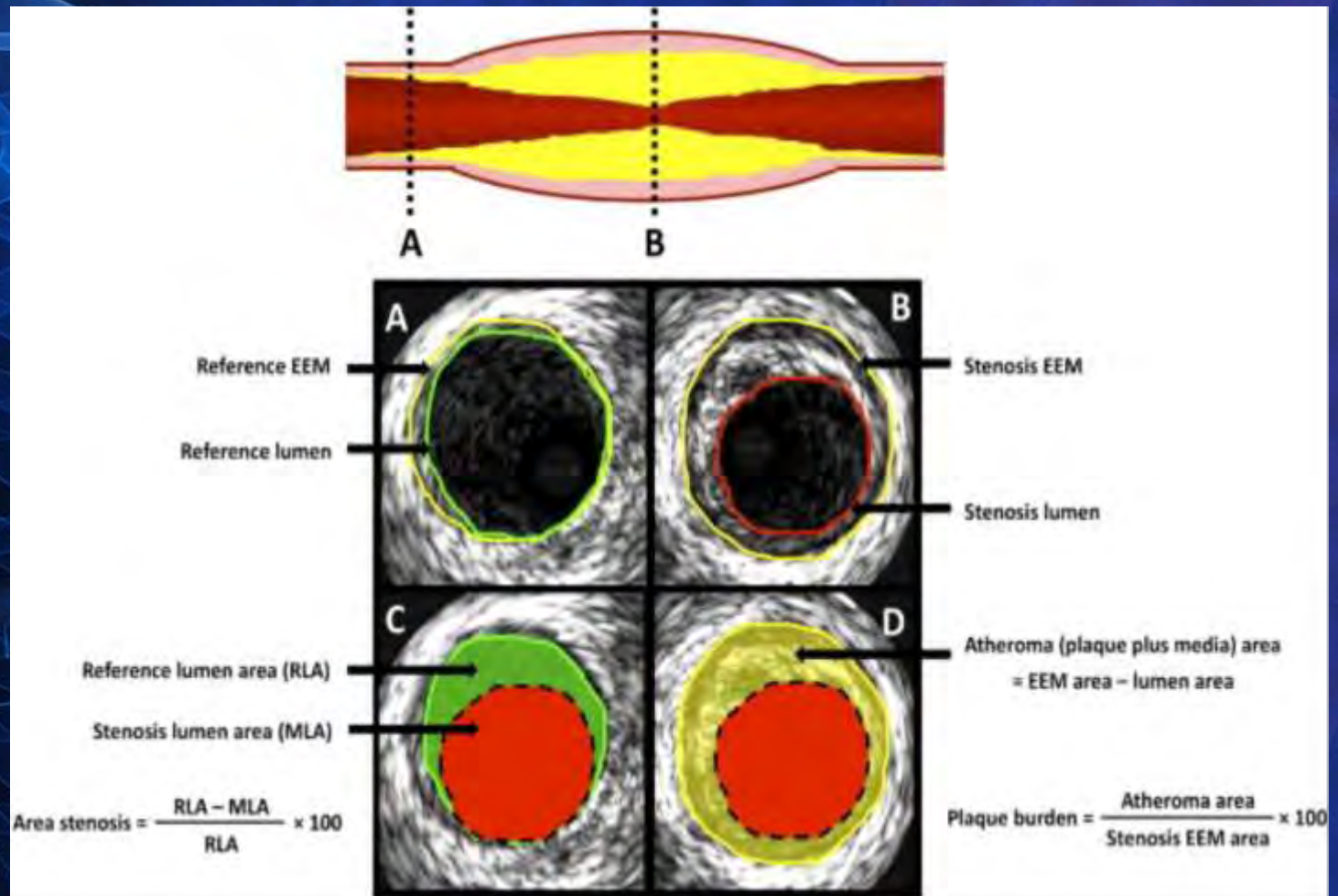




Recommended IVUS Use: Based on the Current Literature

- Pre-intervention assessment
 - Is this lesion significant?
 - Is this a vulnerable plaque?
 - What is the likelihood of distal embolization?
- PCI guidance
 - How do I optimize stent results?
- Follow up post PCI
 - Why did this stent thrombose or restenose?

Basic IVUS Measurements



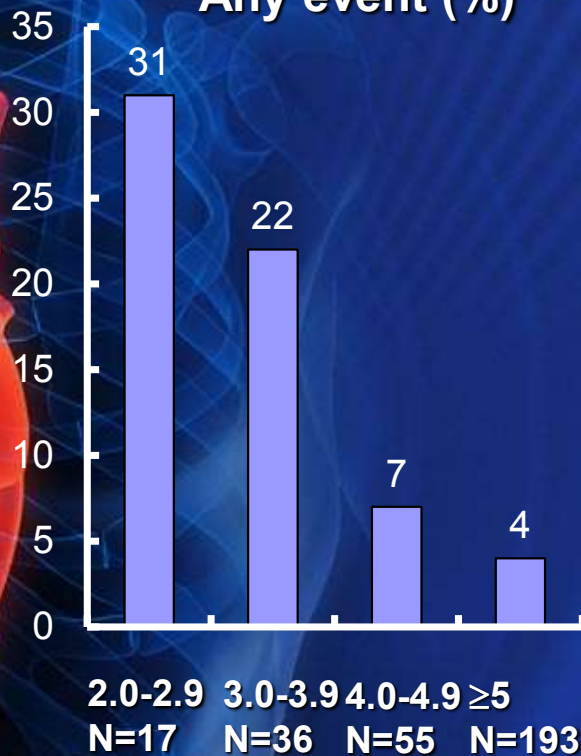
An anatomical illustration of a human torso. The skeletal structure, including the spine, ribs, and shoulder blades, is rendered in a translucent blue. The heart and major blood vessels are shown in a bright red color. The heart is positioned in the center-left of the chest, with the aorta extending downwards and the pulmonary artery and veins branching out. The lungs are visible in the background, also in a translucent blue. The overall image has a medical and scientific feel.

Is this lesion significant?

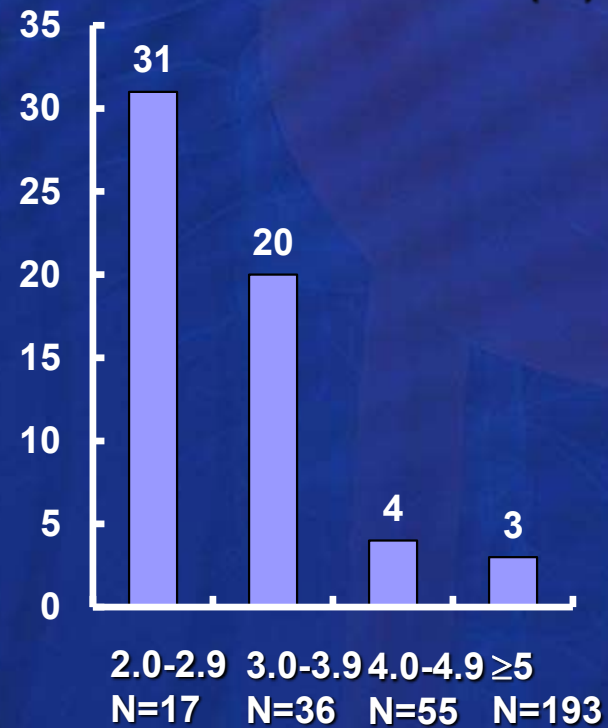
IVUS MLA < 4.0mm²

357 intermediate lesion in 300
pts

Clinical FU >1yr
Any event (%)



Revascularization (%)





Is this lesion significant?

- **Non-LM Coronary Arteries**
- Three randomized trials (DEFER, FAME, FAME II) established FFR as the gold standard.
- Cutoff thresholds range from 2.1-4.4 mm² (race dependent).
- Best cutoff: ≤ 3 mm². Correlates better with a significant FFR



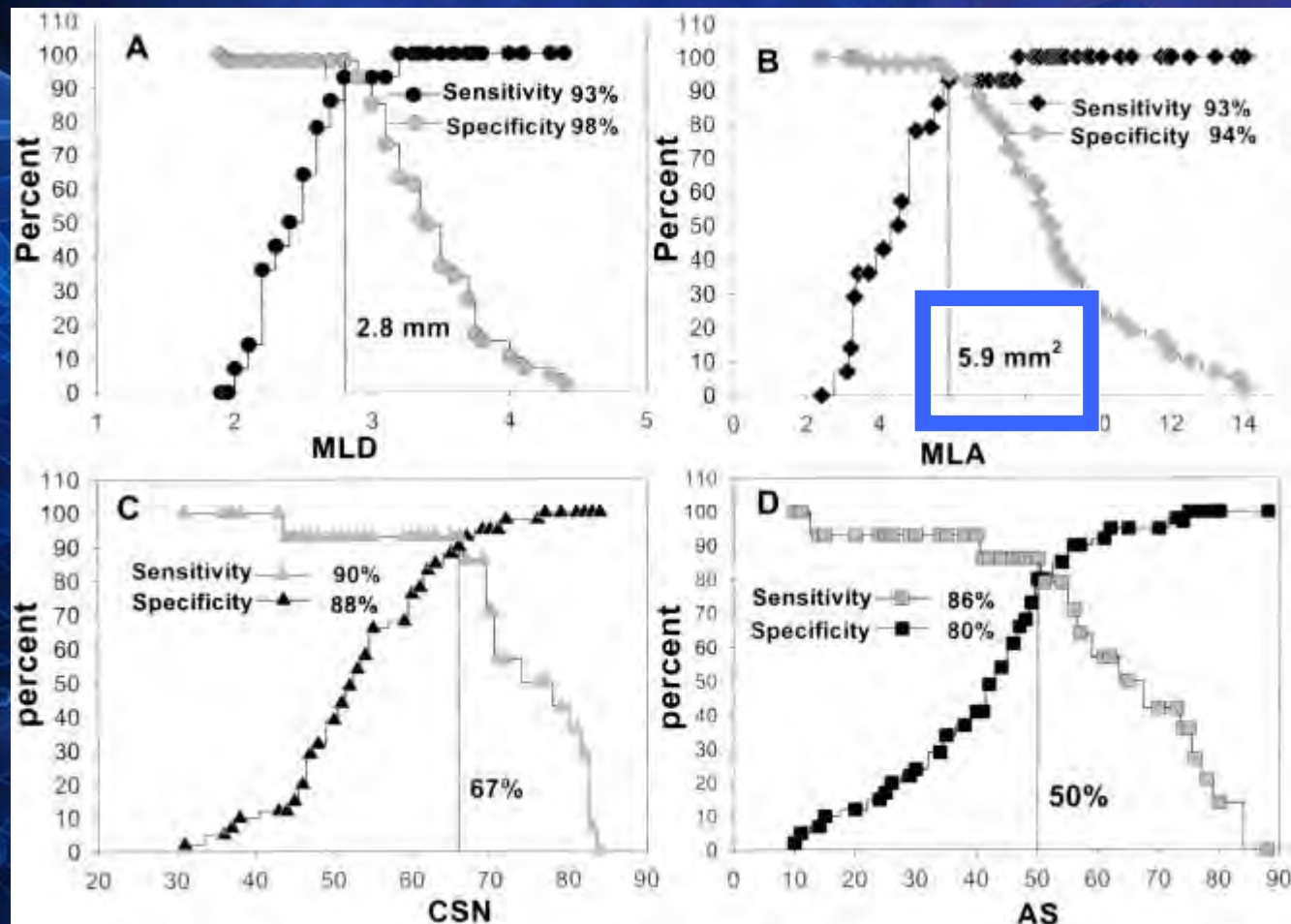
Is this lesion significant?

- **Non-LM Coronary Arteries**
- Using IVUS to justify the need for PCI is wrong 50% of the time

Therefore:

- IVUS is a suboptimal tool to assess lesion severity in non-LM coronary arteries.

LM: Is this lesion Significant?

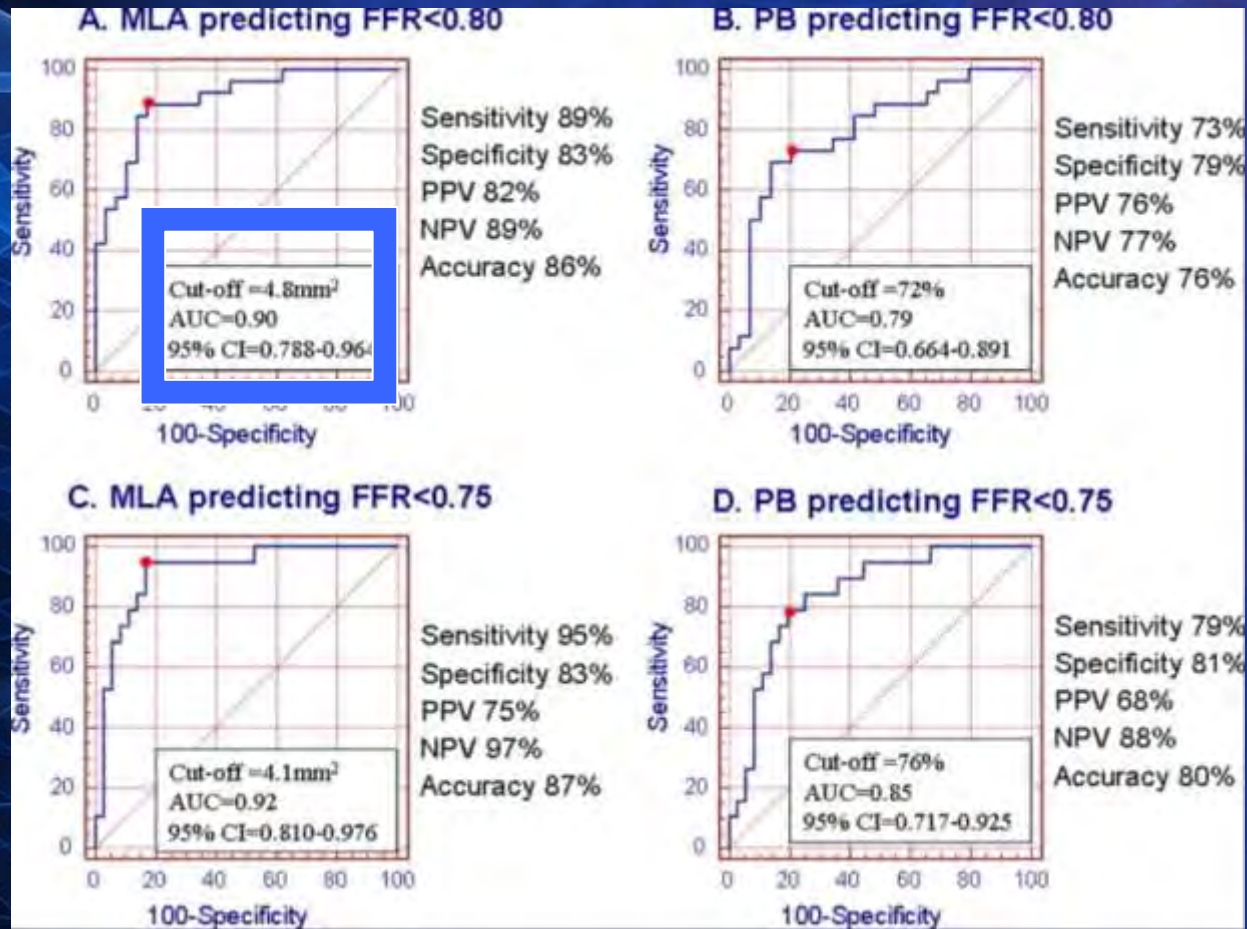




Left Main: Variability of Cutoff Values

- **LM diameter correlates linearly with body size**
- **LM diameter varies according to LAD or L Cx pullback**
- **Anatomic assessment of ostial and distal LM disease is more difficult.**

Left Main: MLA predicting $\text{FFR} < 0.80$





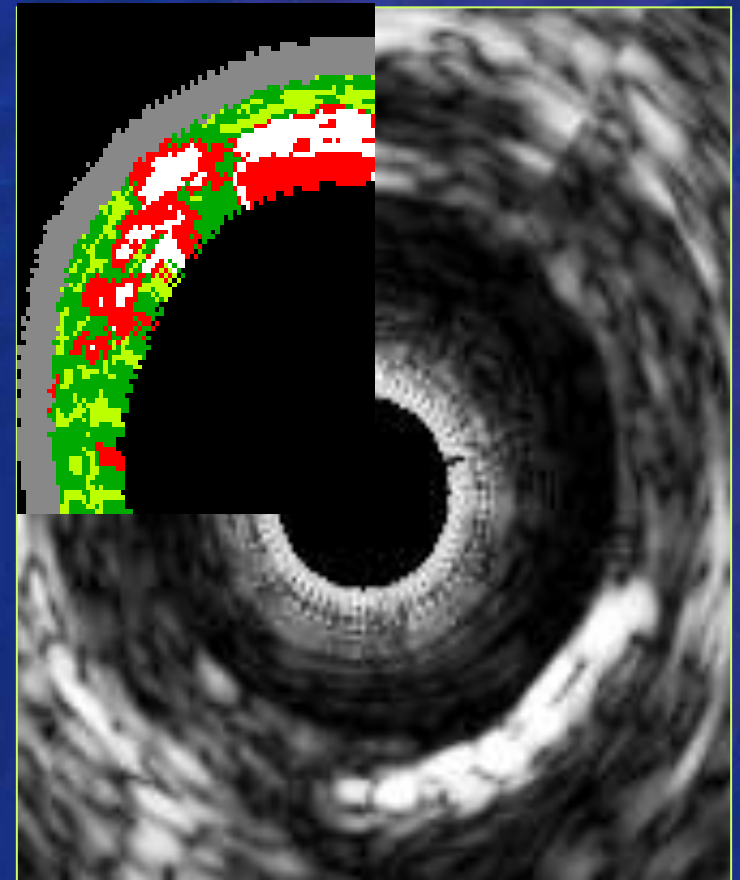
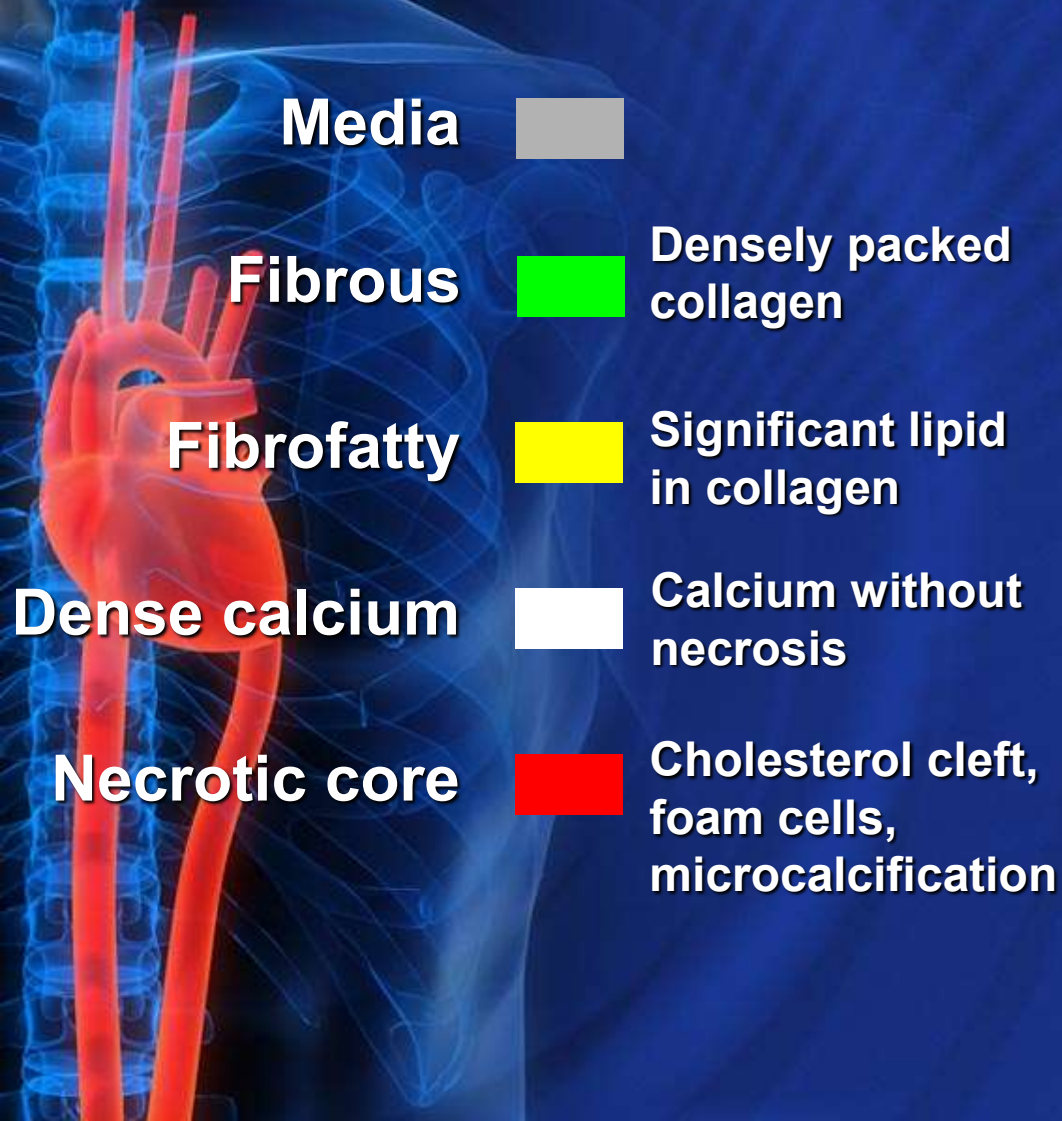
Left Main: Utility of Hybrid Assessment (IVUS and FFR)

- If $\text{FFR} < 0.80$, then revascularize
If $\text{FFR} > 0.85$, then treat medically
If $\text{FFR} 0.80-0.85$ and the patient is symptomatic and there is significant epicardial disease, then consider IVUS
- If $\text{MLA} > 6 \text{ mm}^2$, then defer revascularization.
- If $\text{MLA} < 6 \text{ mm}^2$, then consider revascularization

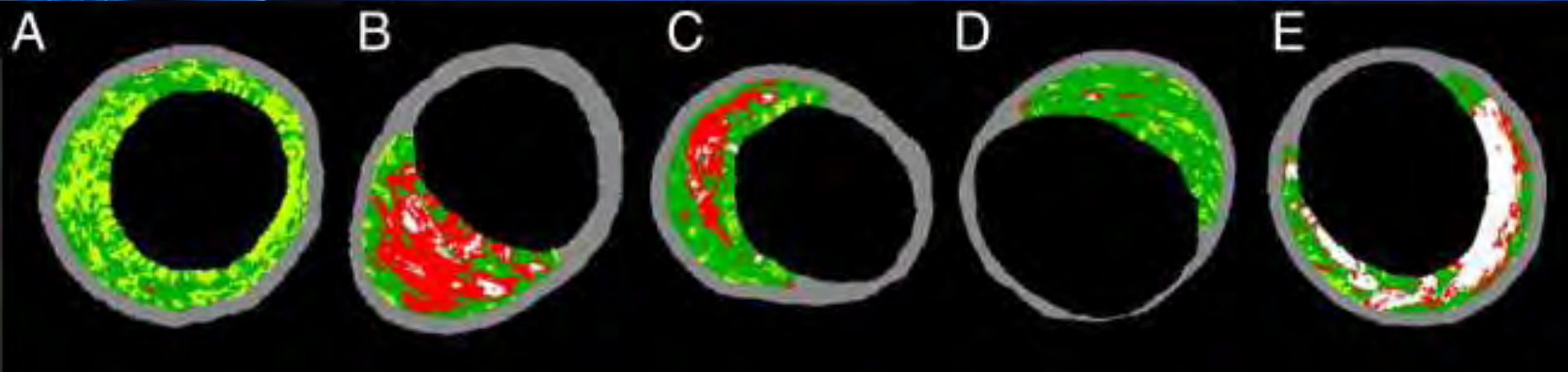


Is this a vulnerable plaque?

Tissue Characterization



Virtual Histology



(A) Pathological intimal thickening.

(B) Thin-capped fibroatheroma.

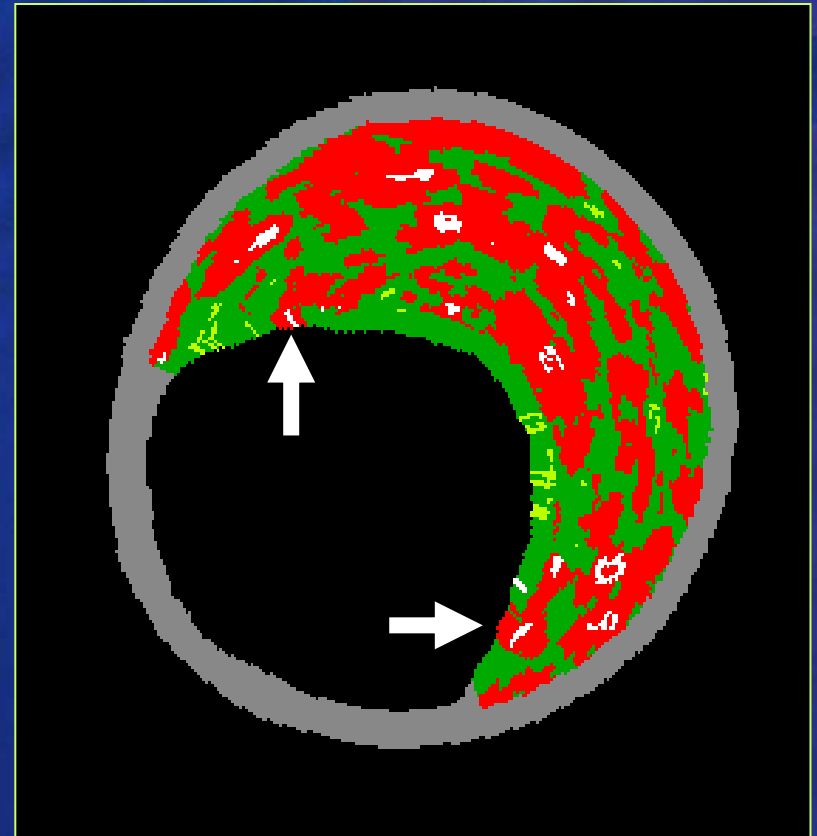
(C) Thick-capped fibroatheroma.

(D) Fibrotic plaque.

(E) Fibrocalcific plaque.

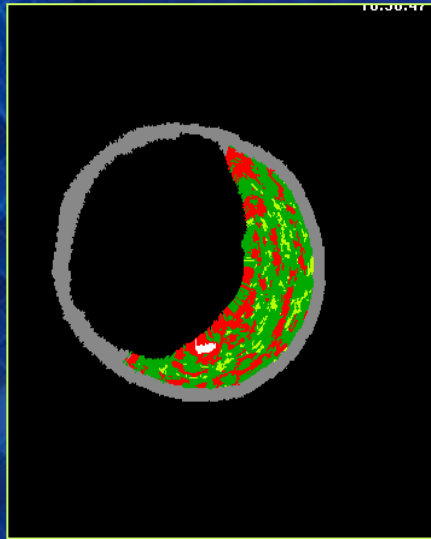
TCFA by IVUS-VH

- In at least three consecutive frames;
- 1) necrotic core $\geq 10\%$ without evident overlying fibrous tissue and
- 2) percent atheroma area $\geq 40\%$



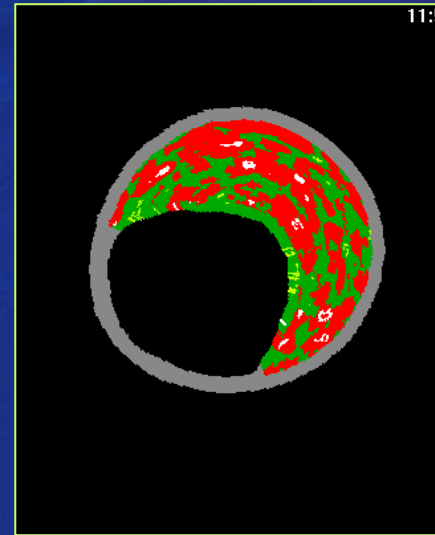
Vulnerable Plaque: Thin Cap Fibroatheroma (TCFA) Classification

Less vulnerable



NC < 20%
< 50% Plaque burden

Highest vulnerable



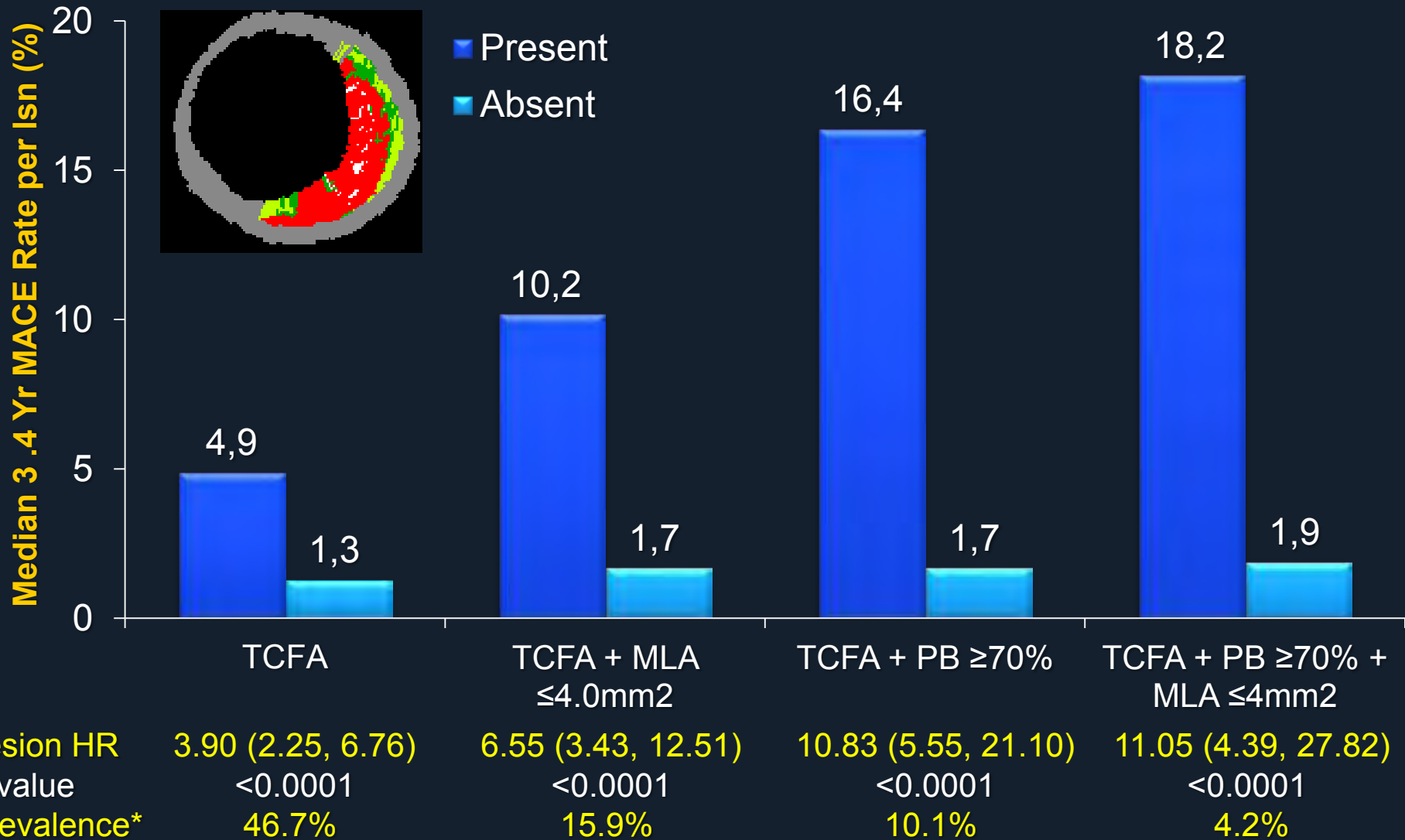
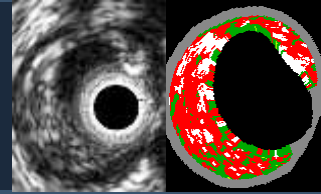
NC > 20%
> 50% Plaque burden



Prospect. MACE in Non Culprit Lesions

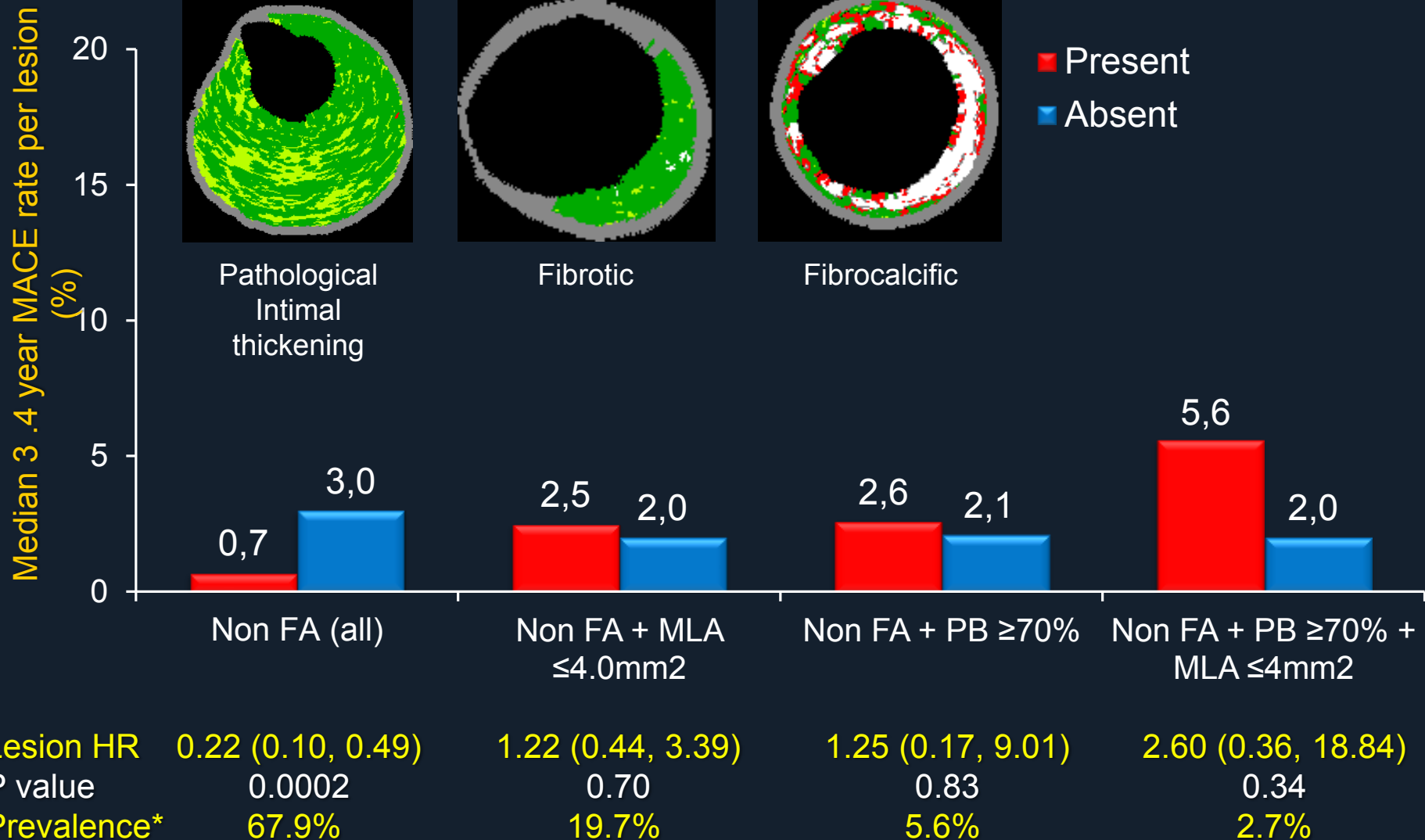
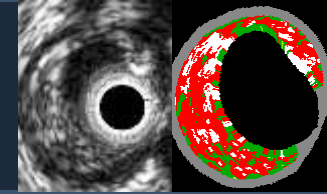
<u>Variable</u>	<u>OR [95% CI]</u>	<u>P value</u>
PB _{MLA} $\geq 70\%$	4.99 [2.54, 9.79]	<0.0001
VH-TCFA	3.00 [1.68, 5.37]	0.0002
MLA $\leq 4.0 \text{ mm}^2$	2.77 [1.32, 5.81]	0.007
Lesion length $\geq 11.6 \text{ mm}$	1.97 [0.94, 4.16]	0.07
EEM _{MLA} $< 14.3 \text{ mm}^2$	1.30 [0.62, 2.75]	0.49

PROSPECT: VH-TCFA and Non-Culprit Lesion Related Events



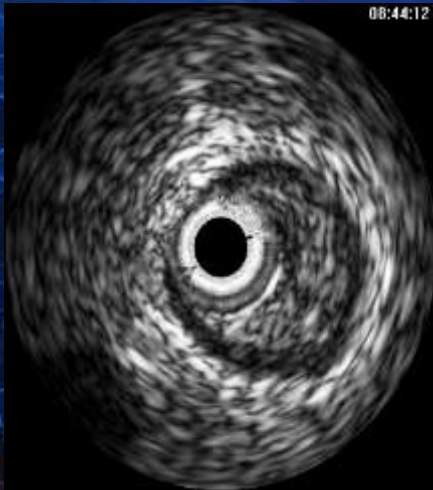
*Likelihood of one or more such lesions being present per patient. PB = plaque burden at the MLA

PROSPECT: Non Fibroatheromas and Non-Culprit Lesion Events

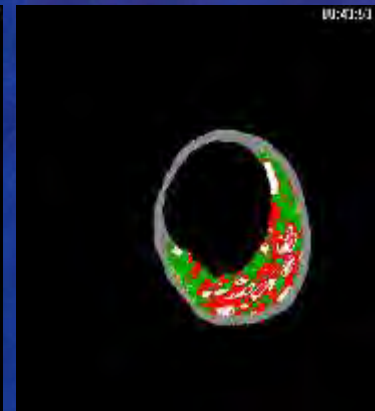
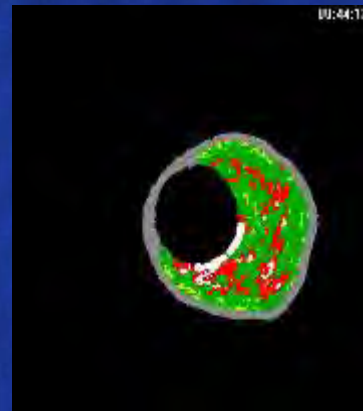


*Likelihood of one or more such lesions being present per patient. PB = plaque burden at the MLA

Treatment in this patients ?



EEM CSA = 17.6
Lumen CSA = 4.1 ~ 4.3
P+M CSA = 13.1
Max Lumen dia = 2.5
MLD = 2.3
Plaque burden = 74%



Fibrous Volume 68.2 mm³ 59%
Fibro-Fatty volume 6.2 mm³ 5%
Dense Calcium Volume 11.7 mm³ 10%
Necrotic Core Volume 28.9 mm³ 25%

TCFA

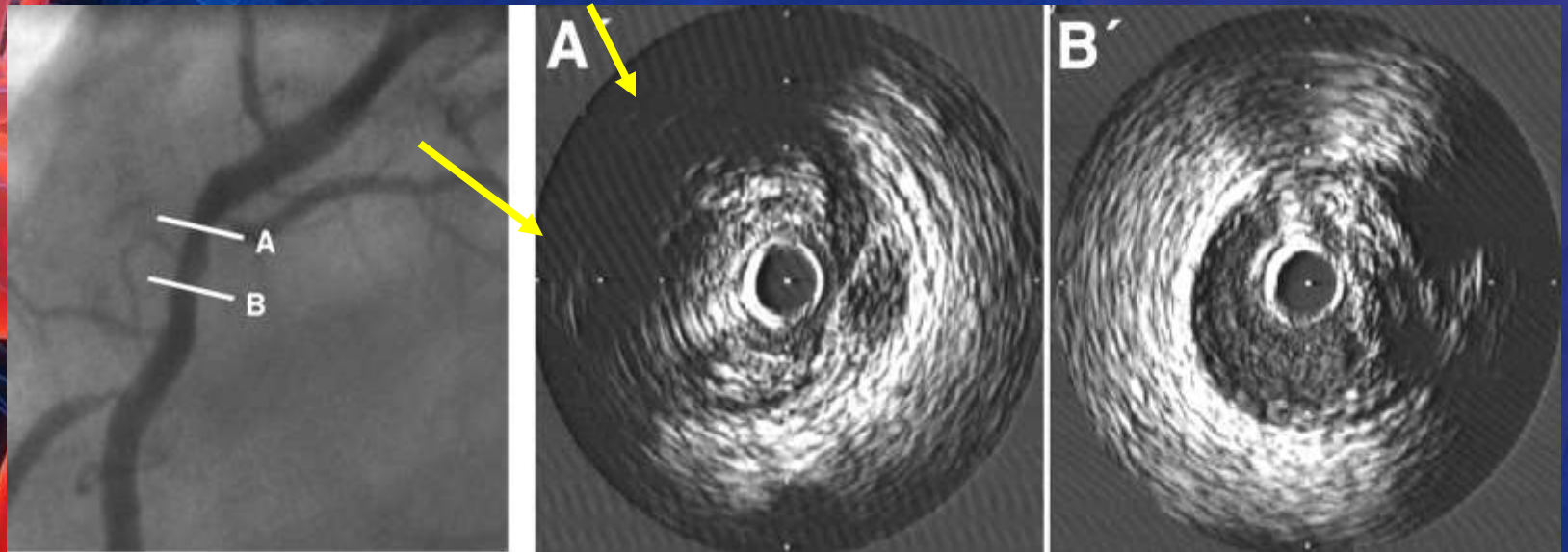
An anatomical illustration of the human circulatory system. The heart is shown in a bright red color, positioned in the center-left of the image. It is connected to a network of blue blood vessels that branch out across the body. The background is a dark blue, semi-transparent human silhouette, showing the skeletal structure and internal organs. The overall style is medical and scientific.

What is the likelihood of distal embolization?

Attenuated Plaque (Black Holes, Echo Signal Attenuation)

WHC: SY Lee, Mintz et al. JACC Interv 2009;2:65-72

Shadowing in spite of no visible calcium



Two attenuated plaques 6.4 mm apart were seen in this RCA.



Attenuated Plaque in ACS.

WHC: SY Lee, Mintz et al. JACC Interv
2009;2:65-72

293 ACS patients: 26% with attenuated plaque (40% STEMI, 18% NSTEMI)

Attenuated plaque in ACS patients was associated with:

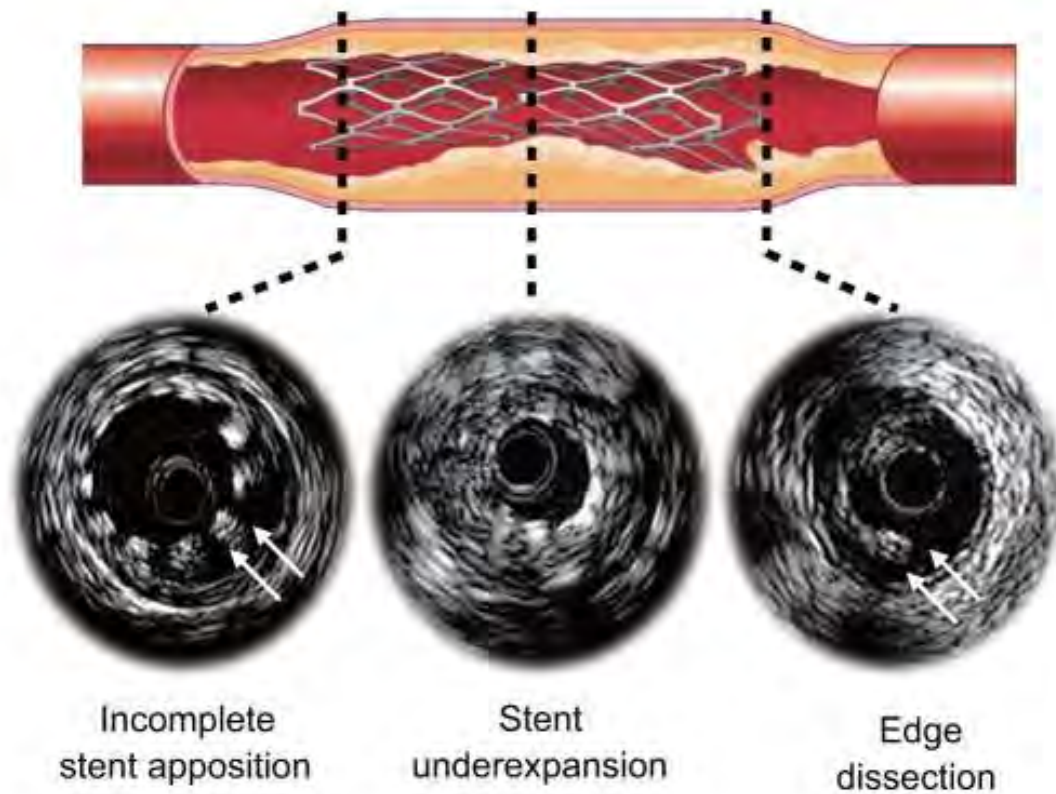
- positive remodeling and higher CRP,
- more thrombus and complex lesion morphology,
- more plaque burden and plaque rupture,
- **frequent no-reflow after PCI.**



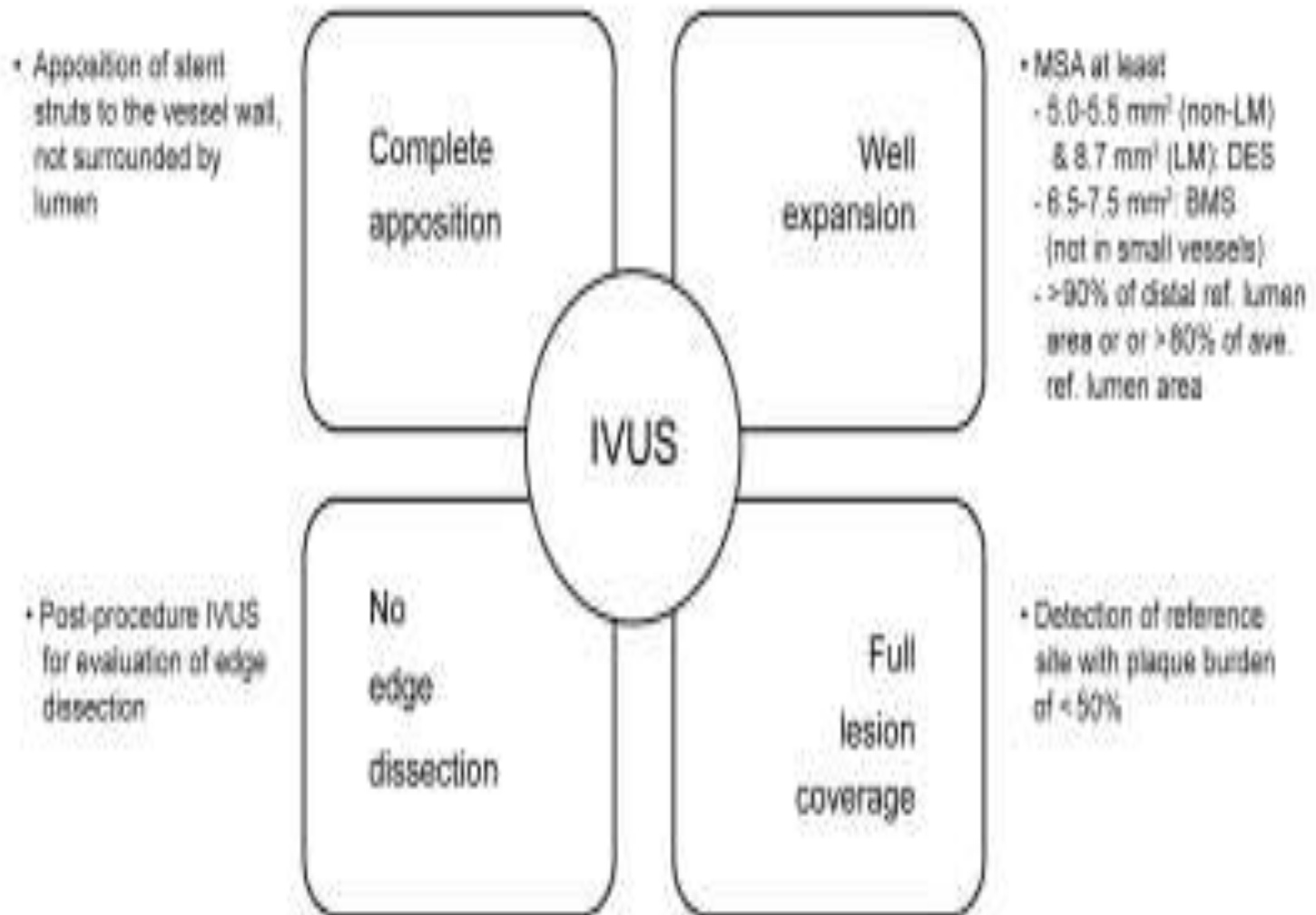
PCI Guidance: How do I optimize stent results?

- **Determine reference vessel diameter**
- **Determine the need for additional lesion preparation (rotablation, orbital atherectomy, etc)**
- **Choose stent size**

PCI Guidance: How do I optimize stent results?

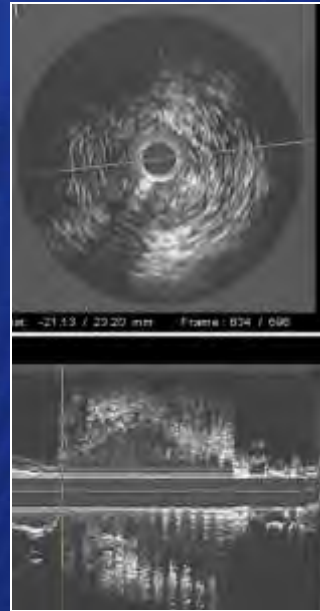


Criteria of Optimal Stent Placement

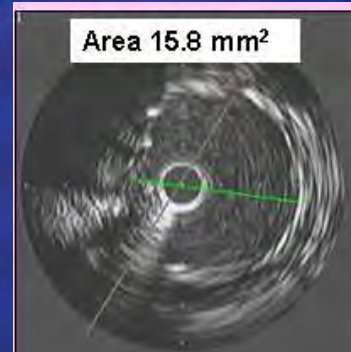
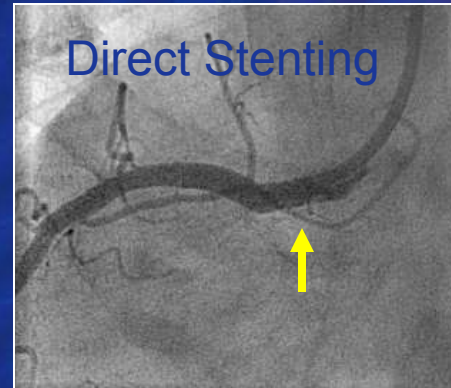


Different Strategies based on IVUS findings

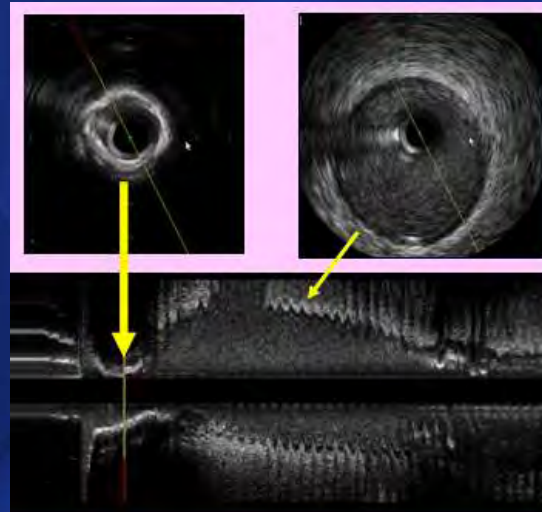
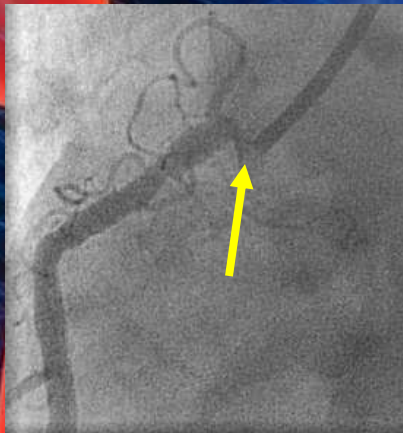
A



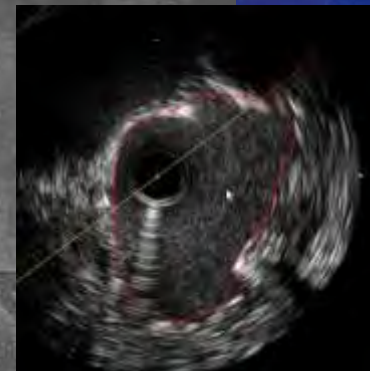
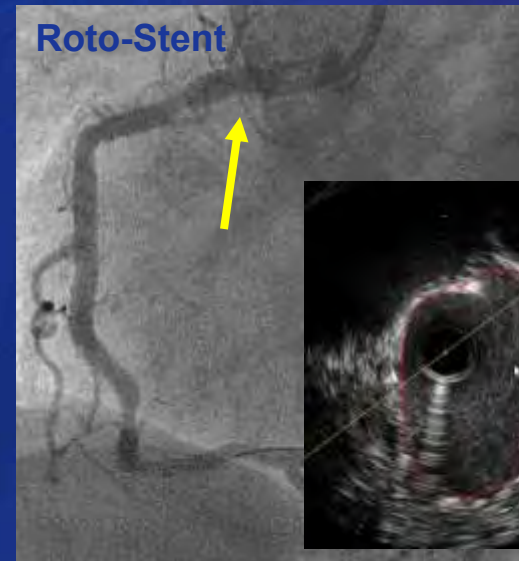
Direct Stenting



B



Roto-Stent



IVUS-guided PCI for CTO

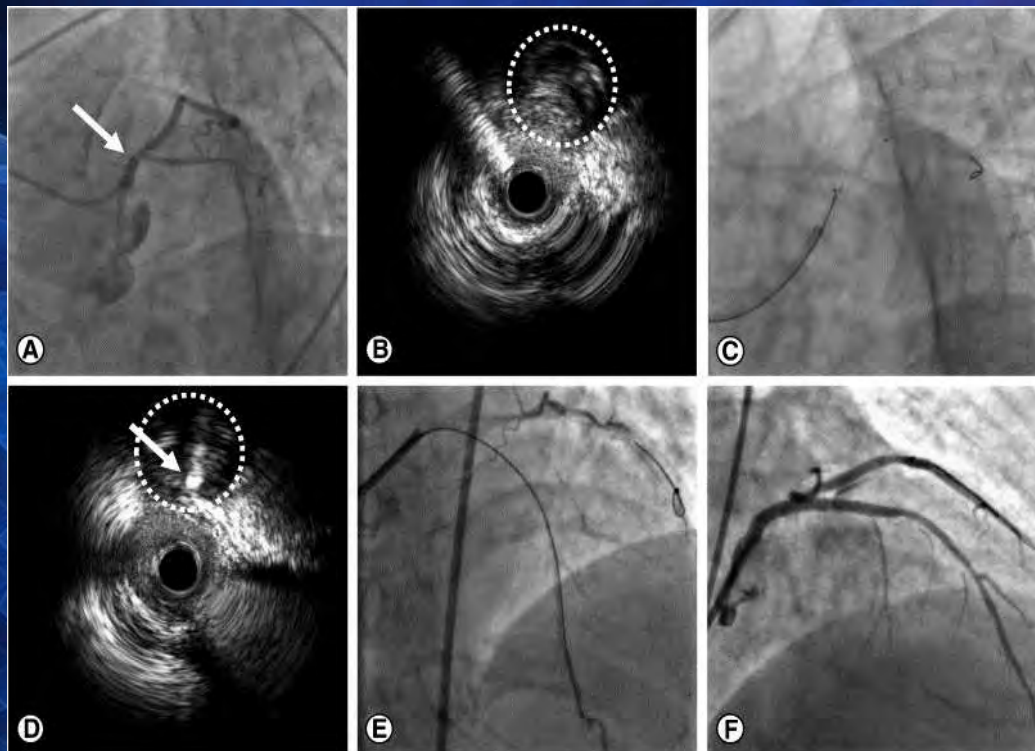


Fig. 2 Steps of intravascular ultrasound-guided wiring technique. A: Chronically occluded left anterior descending artery and a blunt stump with a side branch. B: A soft-tip guidewire (Runthrough®, Terumo, Aichi, Japan) was placed in the adjacent side bran...

Yongwhi Park , Hun Sik Park , Gui-Lyen Jang , Dong-Yeub Lee , Hyunsang Lee , Ju Hwan Lee , Hyun Jae Kang , Dong H...

Intravascular ultrasound guided recanalization of stumpless chronic total occlusion

International Journal of Cardiology, Volume 148, Issue 2, 2011, 174 - 178

<http://dx.doi.org/10.1016/j.ijcard.2009.10.052>

IVUS-guided PCI for CTO

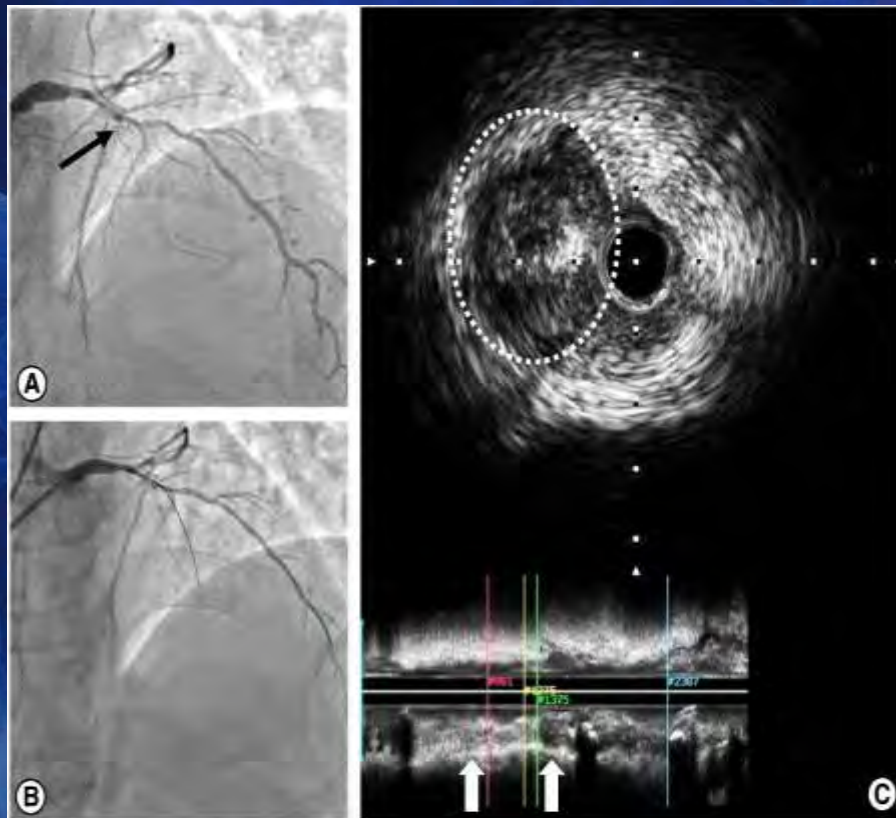


Fig. 3 Intravascular ultrasound images of sub-intimal passage. A. A left anterior descending artery was totally occluded just distal to the diagonal branch and the stump was hardly recognizable (black arrow). B. A guidewire seemed to cross the lesion. Howe...
Yongwhi Park , Hun Sik Park , Gui-Lyen Jang , Dong-Yeub Lee , Hyunsang Lee , Ju Hwan Lee , Hyun Jae Kang , Dong H...

Intravascular ultrasound guided recanalization of stumpless chronic total occlusion

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<http://dx.doi.org/10.1016/j.ijcard.2009.10.052>

IVUS-guided PCI for saphenous vein graft lesions

SVGs are often larger, making angiographic size assessment more difficult.....

Oversized stents (stent to reference ratio 1.0) result in greater rates of periprocedural myocardial necrosis and distal embolization without reducing 9-month revascularization rates .

In addition, stent oversizing may result in graft perforation.

So it is reasonable to use IVUS to select appropriately sized stents for SVG PCI.



Outcomes of IVUS-guided PCI

- **BMS**

Metanalysis showed reduced restenosis and repeat revascularization but no death or MI

- **DES**

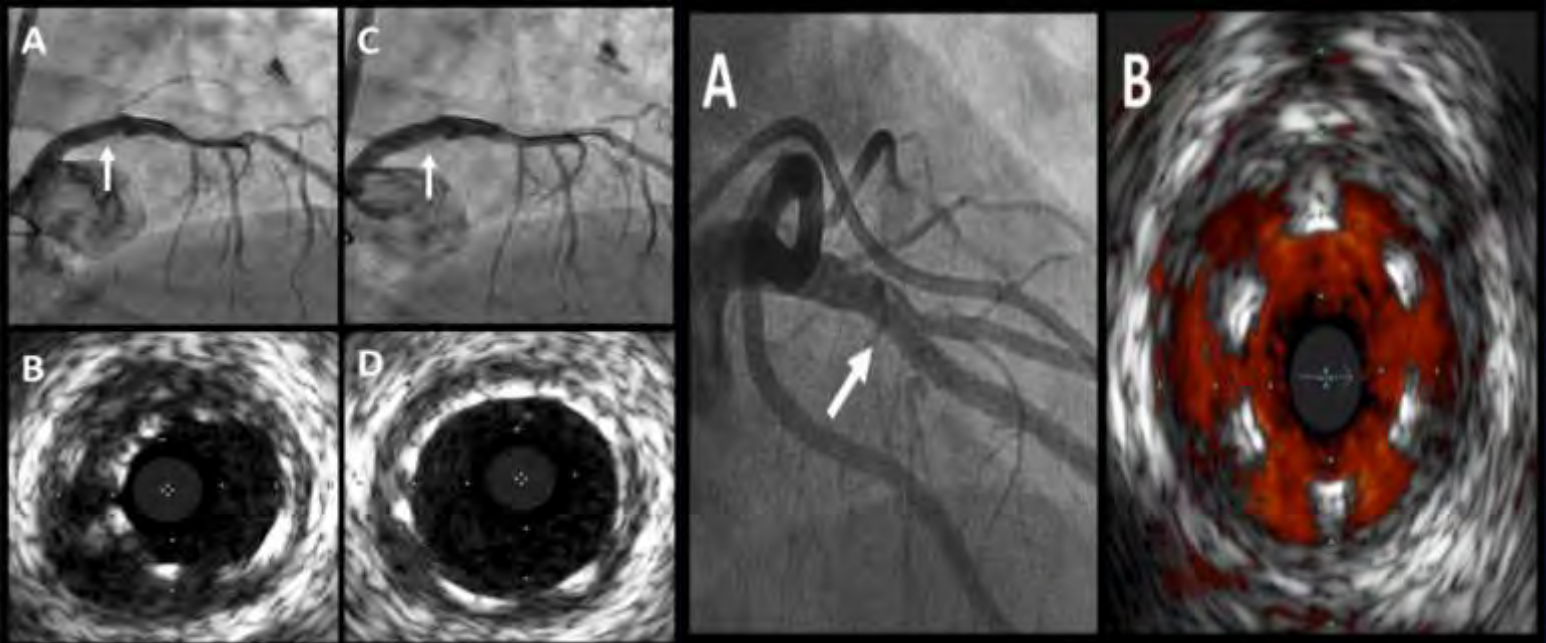
Metanalysis showed reduced stent thrombosis, repeat revascularization, MI and death

American Journal of Cardiology 2014; 113: 1338–1347

Why did thrombosis or restenosis occur in this stent?

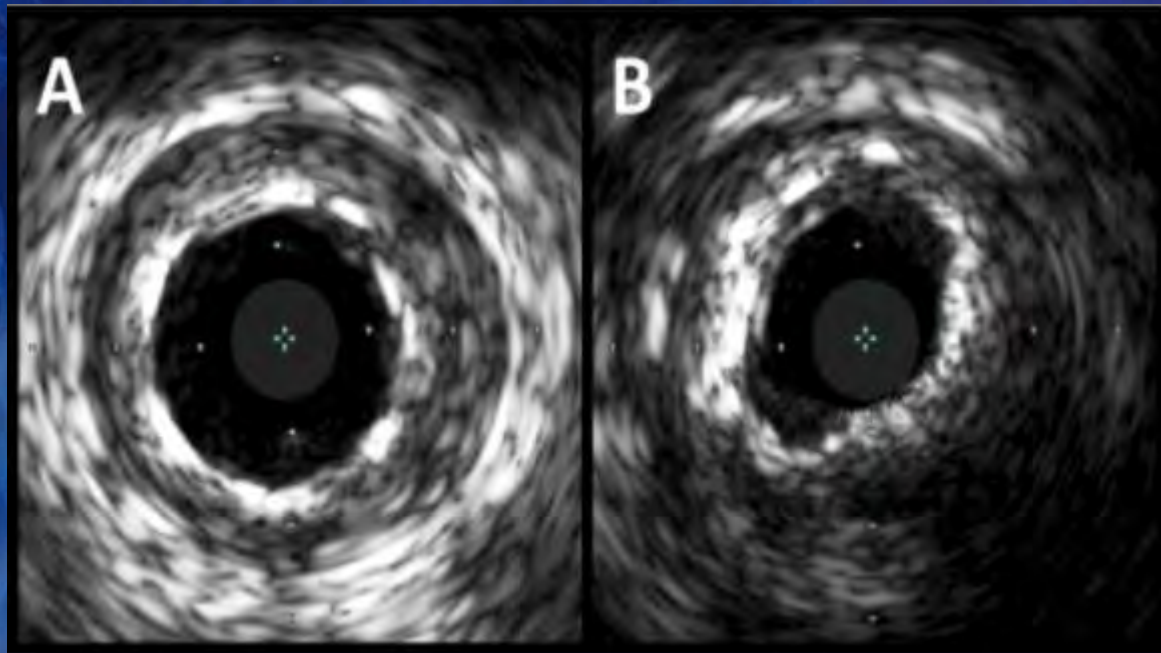
Acute Stent Incomplete Apposition

Late Stent Incomplete Apposition

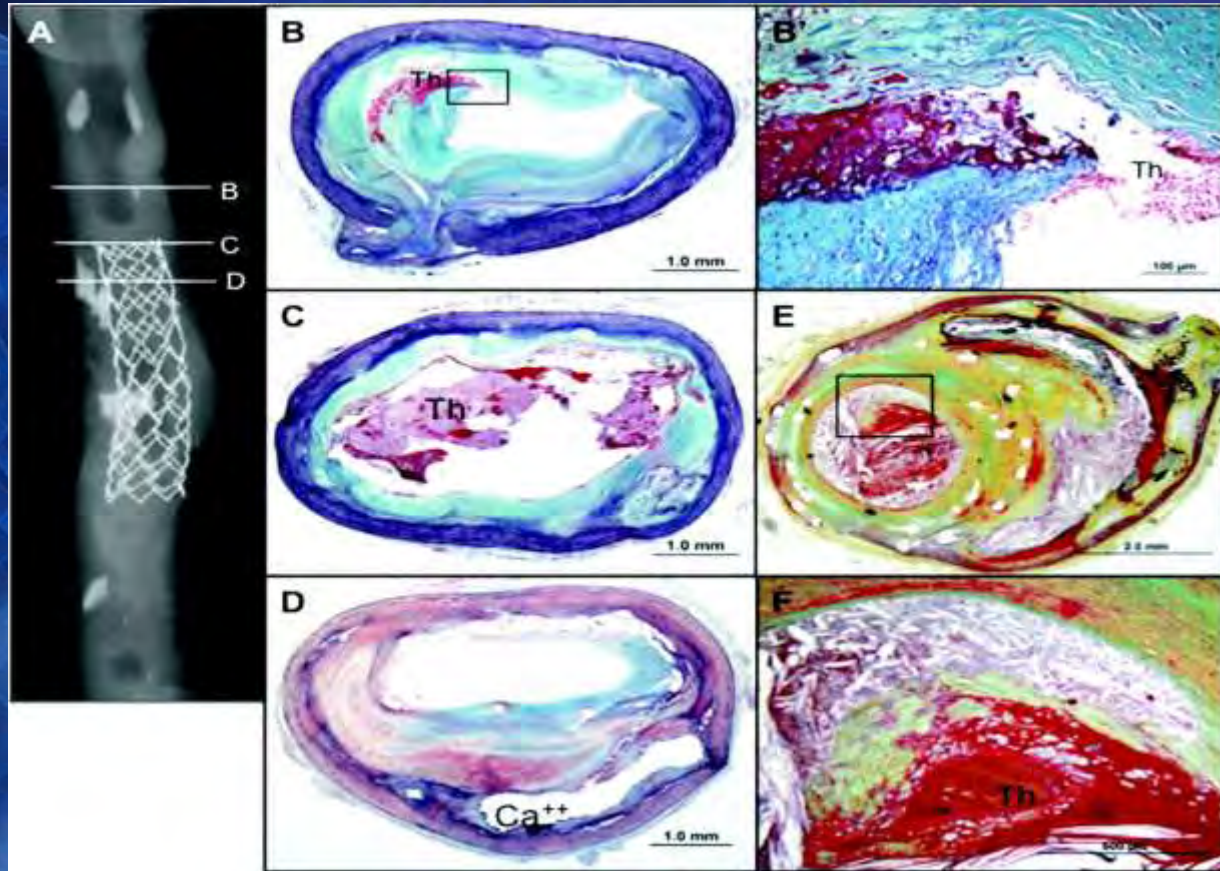


Why did thrombosis or restenosis occur in this stent?

Stent Underexpansion

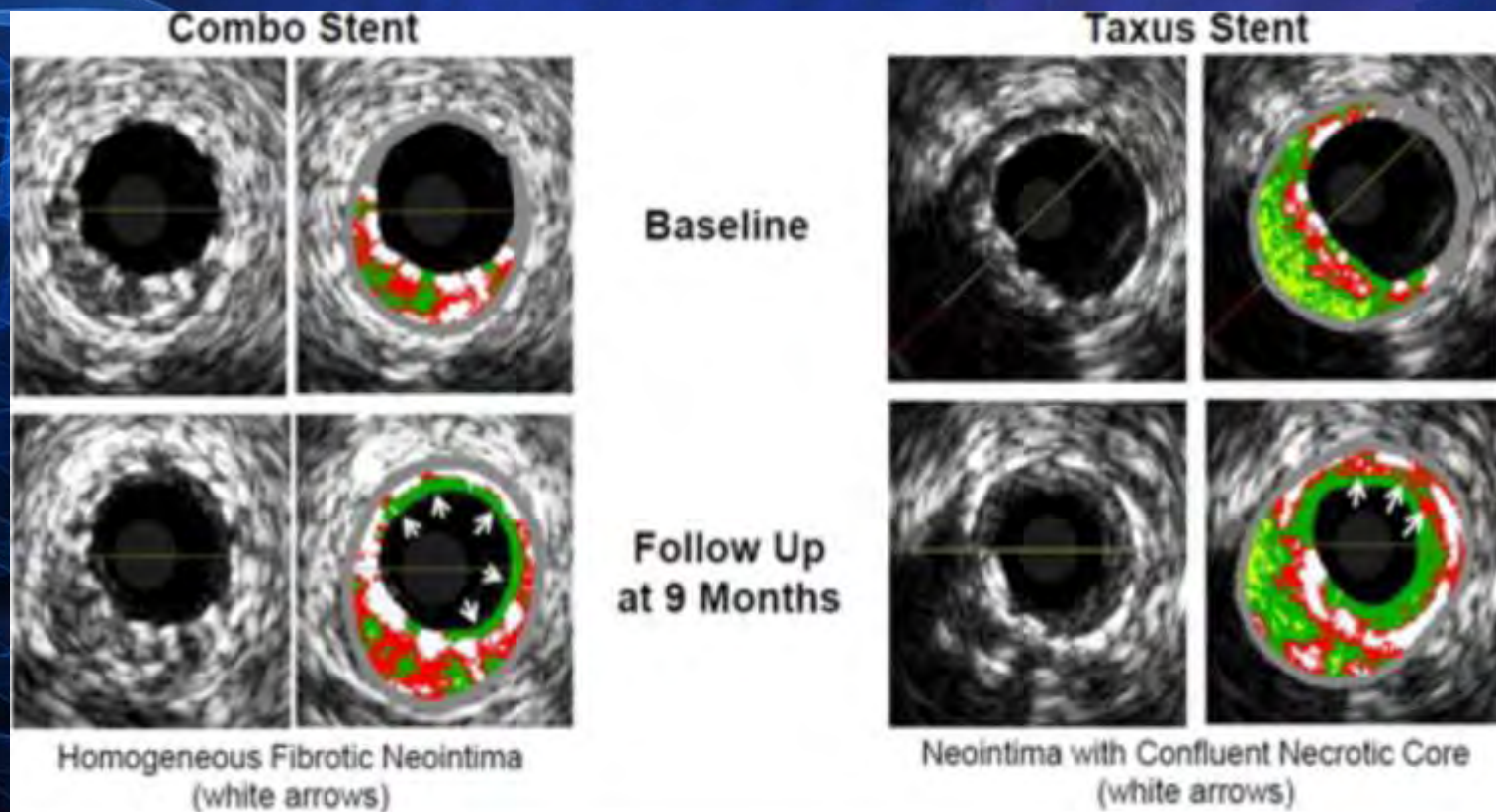


Neoatherosclerosis



Finn A V , and Otsuka F Circ Cardiovasc Interv. 2012;5:6-9

Neoatherosclerosis



J Am Coll Cardiol Interv. 2013;6(4):334-343
doi:10.1016/j.jcin.2012.10.018



Conclusions

- Lesion characterization by IVUS allows for:
- Better PCI planning and execution.
- Better PCI outcome.
- Better prediction of near and long term outcome.
- Better delineation of need for optimal medical therapy for that lesion.
- Better understanding of Coronary Atherosclerosis.



Thank You