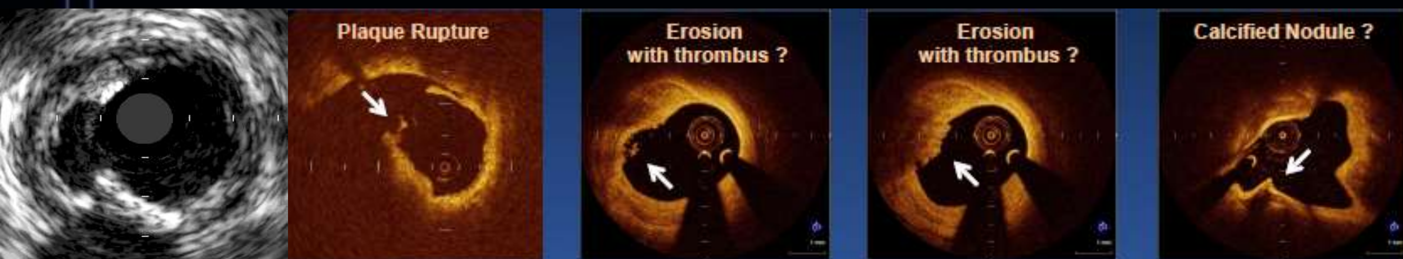
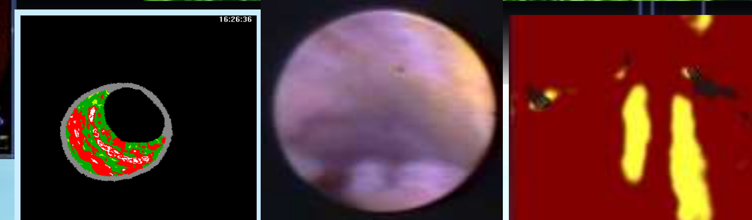
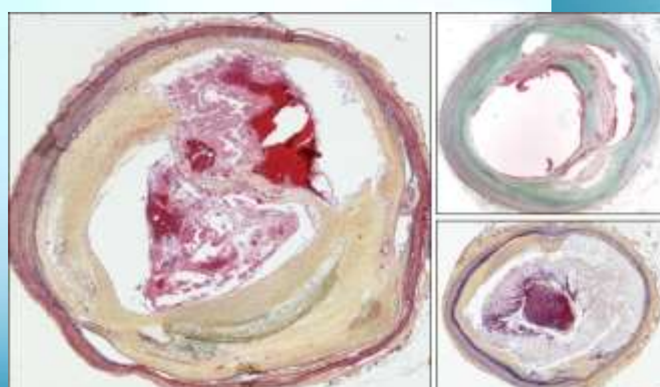
Pre- and Post-PCI IVUS Assessment in non-LM Lesion

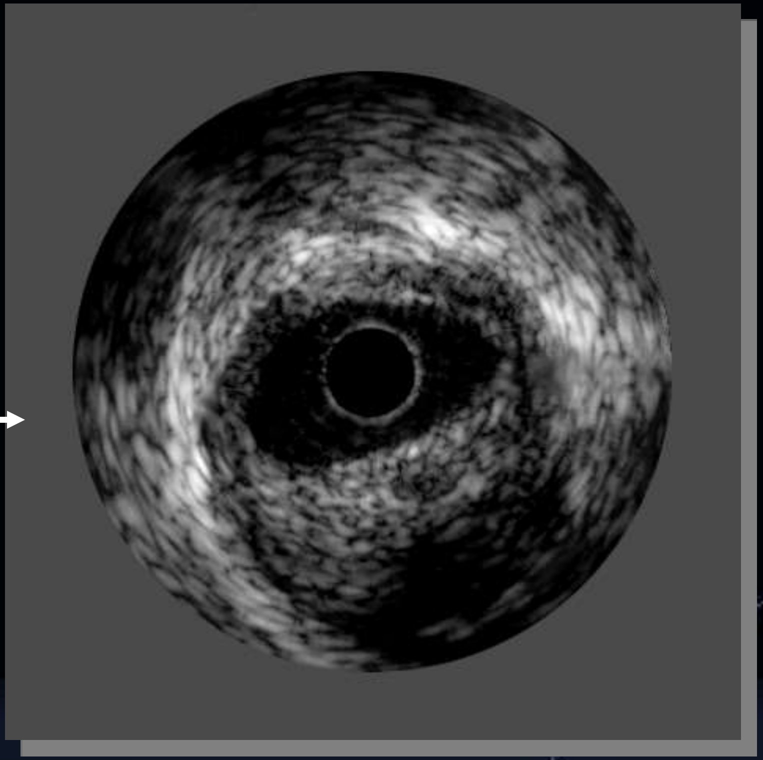
Young Joon Hong, Chonnam National University Hospital







Which is more Diagnostic?



Normal angiographic image of vessel

IVUS image of vessel with eccentric plaque

IVUS-Guided Intervention

Pre-interventional lesion assessment
Severity of coronary stenosis
Lesion characteristics
Anatomical relationship with other vessel

↓

Choice of devices
Determine device size and length
Making strategy of intervention

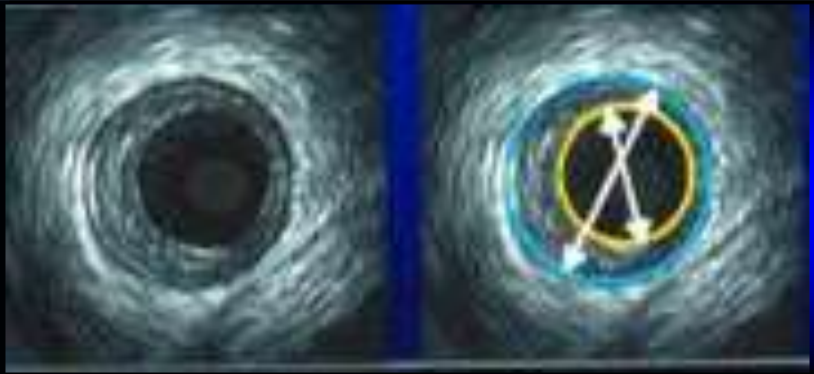
↓

Post-interventional assessment
Accuracy of intervention
Procedure-related complications

Roles of Pre-PCI IVUS

- Vessel, lumen, plaque size
- Plaque length
- Plaque morphology and calcium
- Remodeling
- Vulnerable plaque, Culprit lesion
- Dissection, Aneurysm
- Stent sizing

IVUS : Practical Uses in the Cath Lab

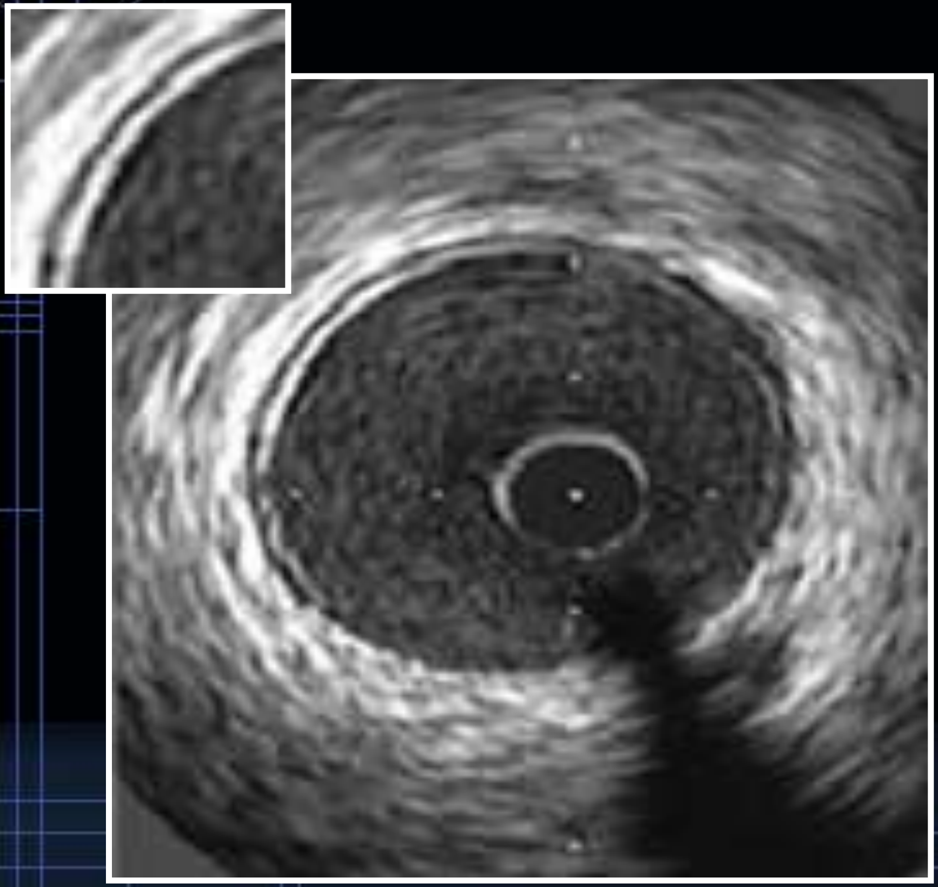


Size

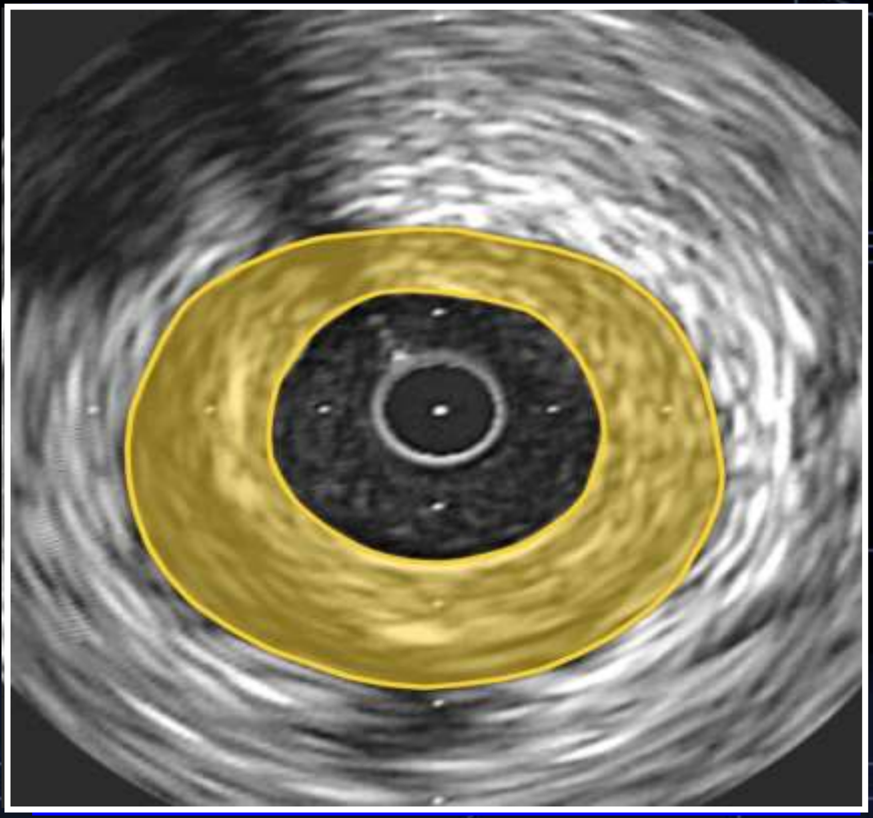
Plaque Length

Plaque Type

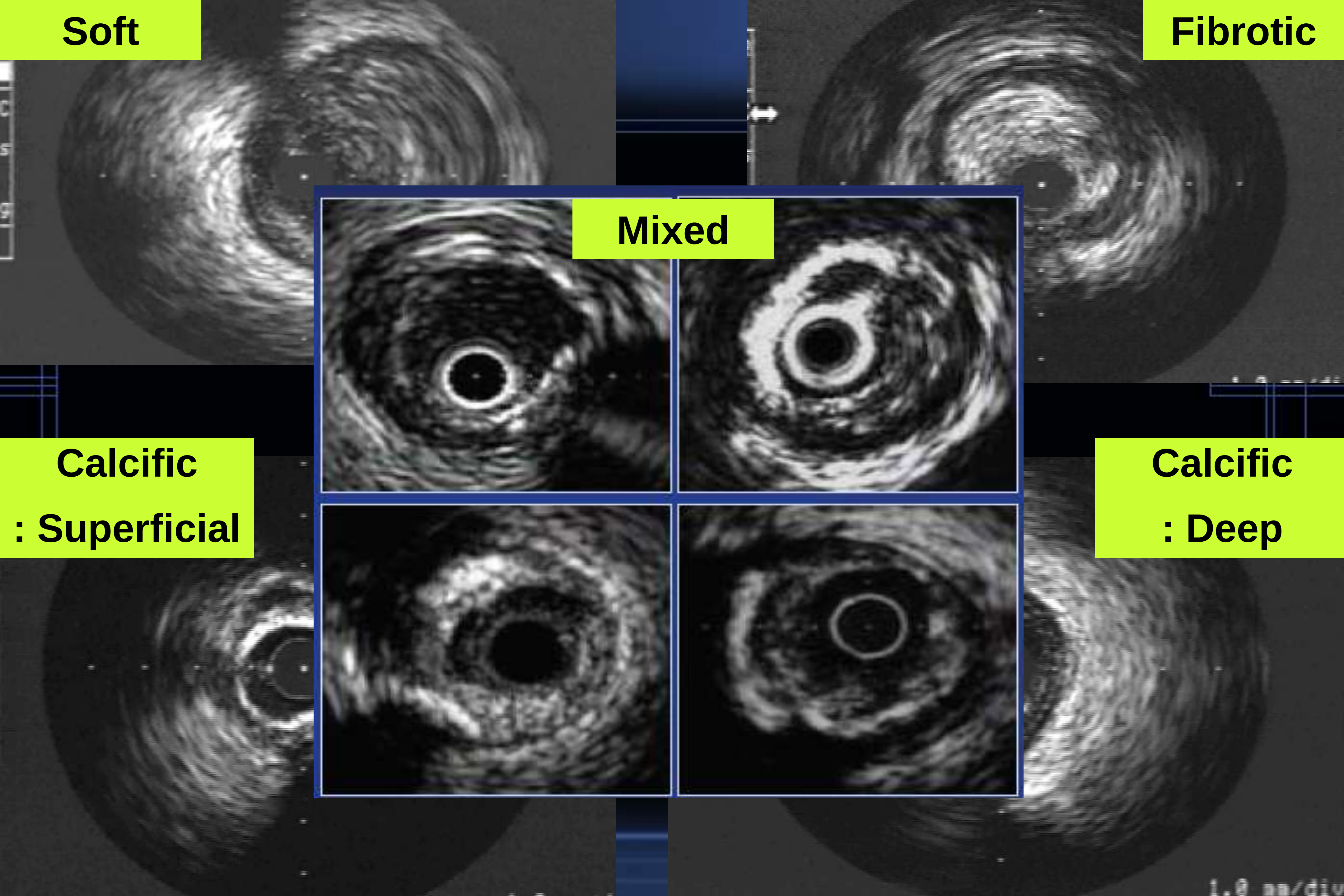
IVUS: Normal and diseased anatomy



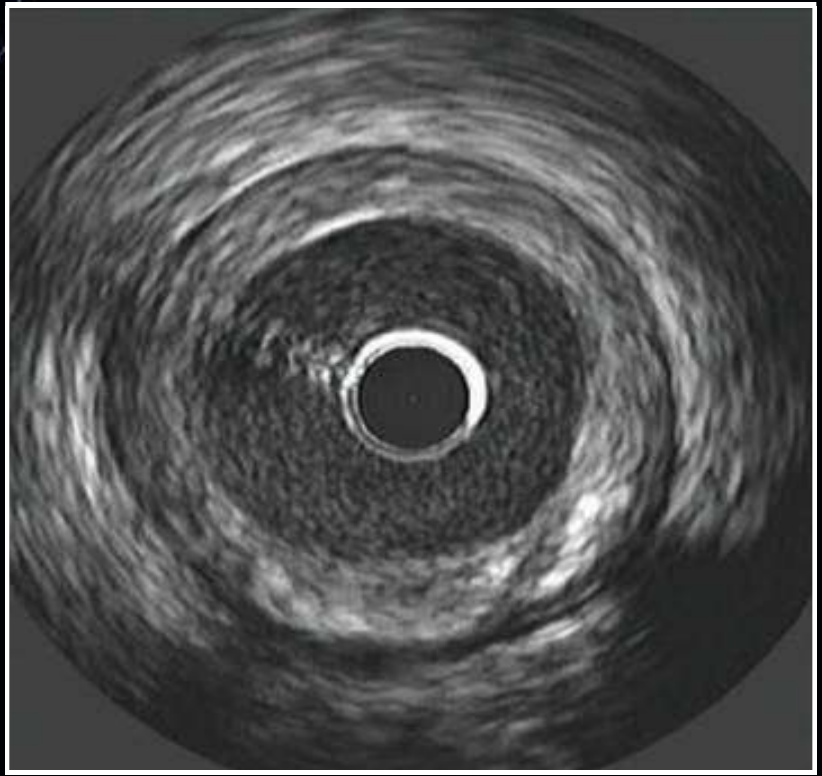
Normal Anatomy

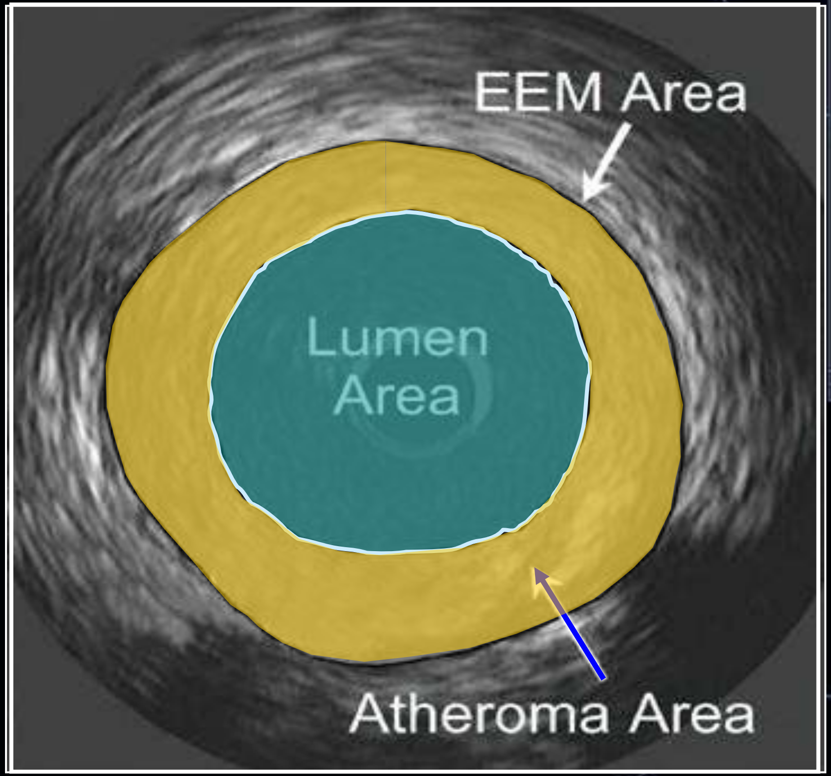


Concentric Disease


Soft
Fibrotic
Mixed
Calcific
: Superficial
Calcific
: Deep

Analysis of atheroma area

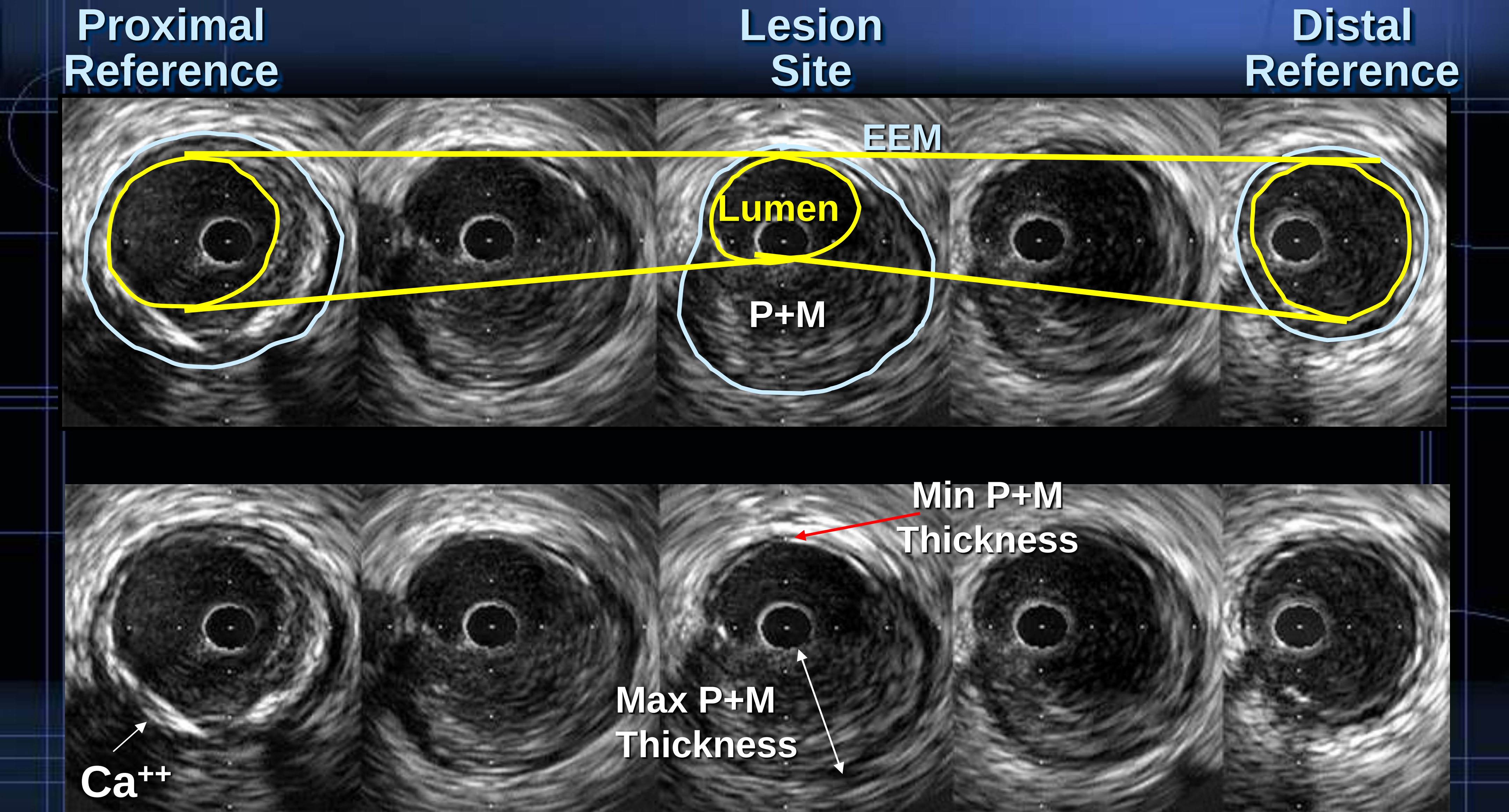




Atheroma area = (EEM area) – (Lumen area)

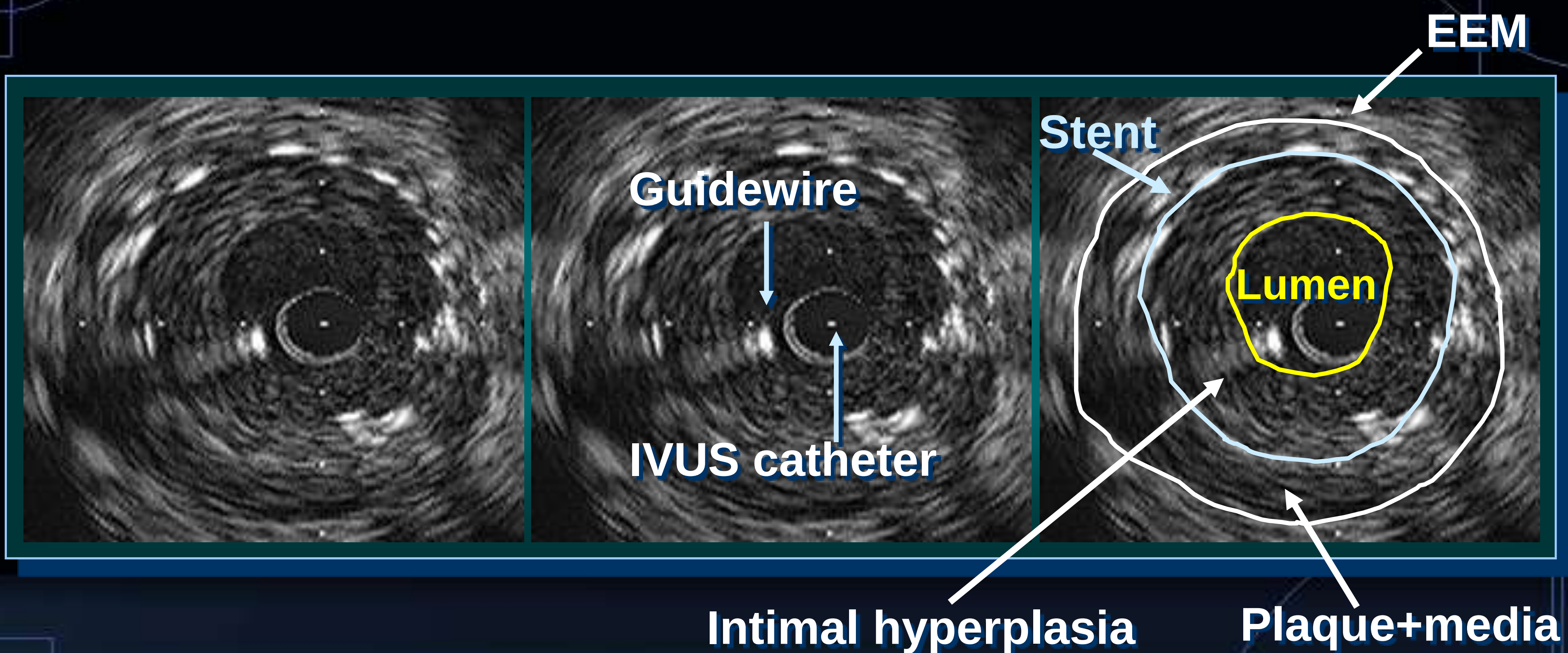
Plaque burden = 100*(Atheroma area / EEM area)

Area stenosis?



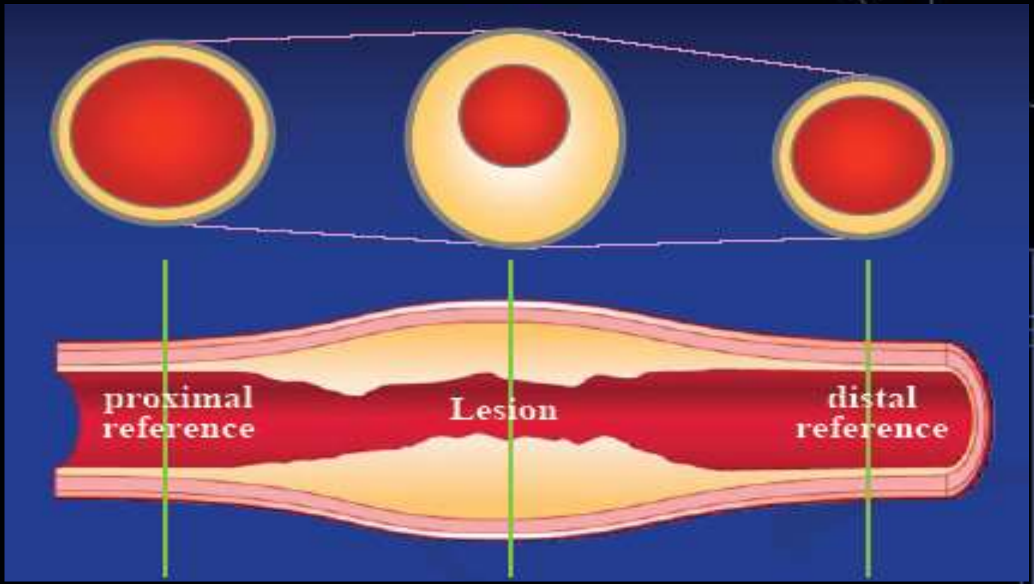
Area stenosis=100*(Lesion site lumen/Reference lumen)

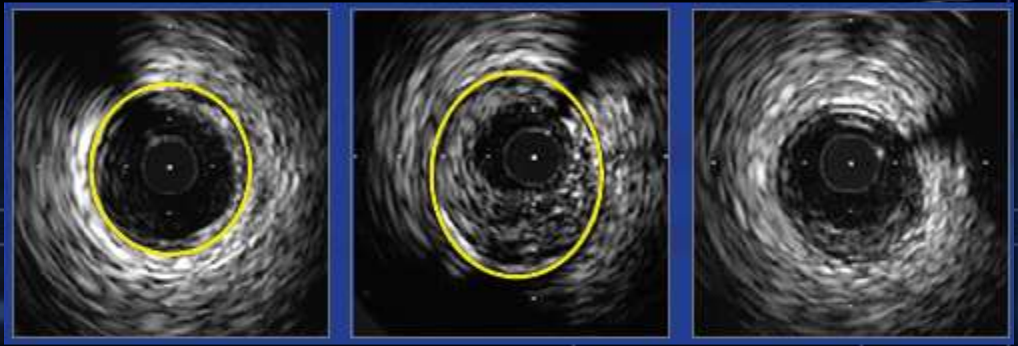
Stented Artery



Positive Remodeling

The remodeling index (RI)=
Lesion EEM CSA /
mean reference EEM CSA

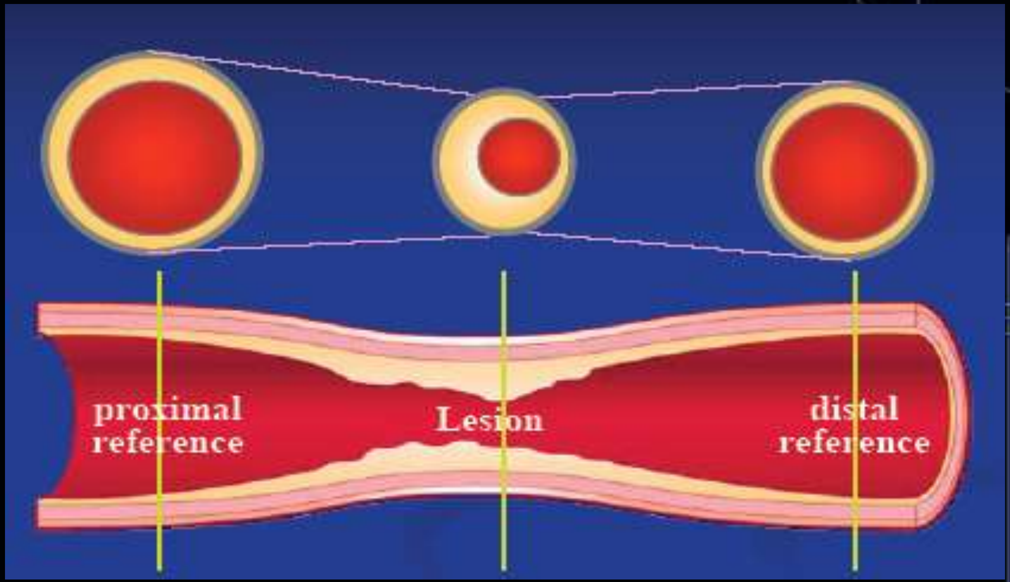




Positive remodeling, RI >1.05

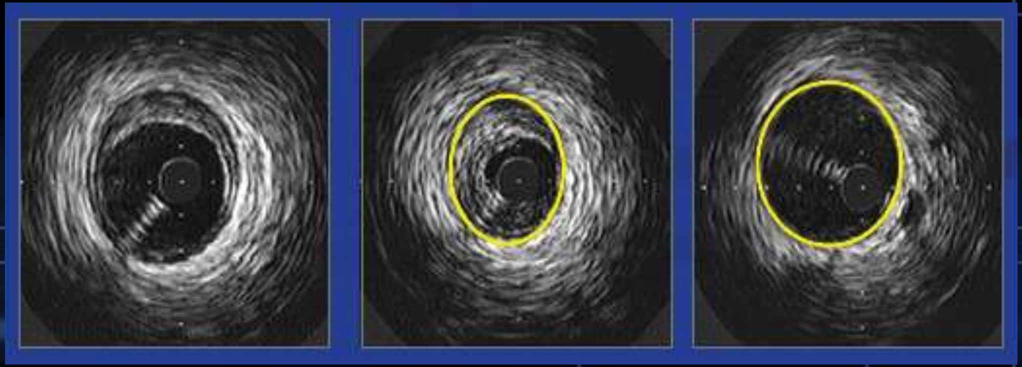
Negative Remodeling

The remodeling index (RI)=
Lesion EEM CSA /
mean reference EEM CSA

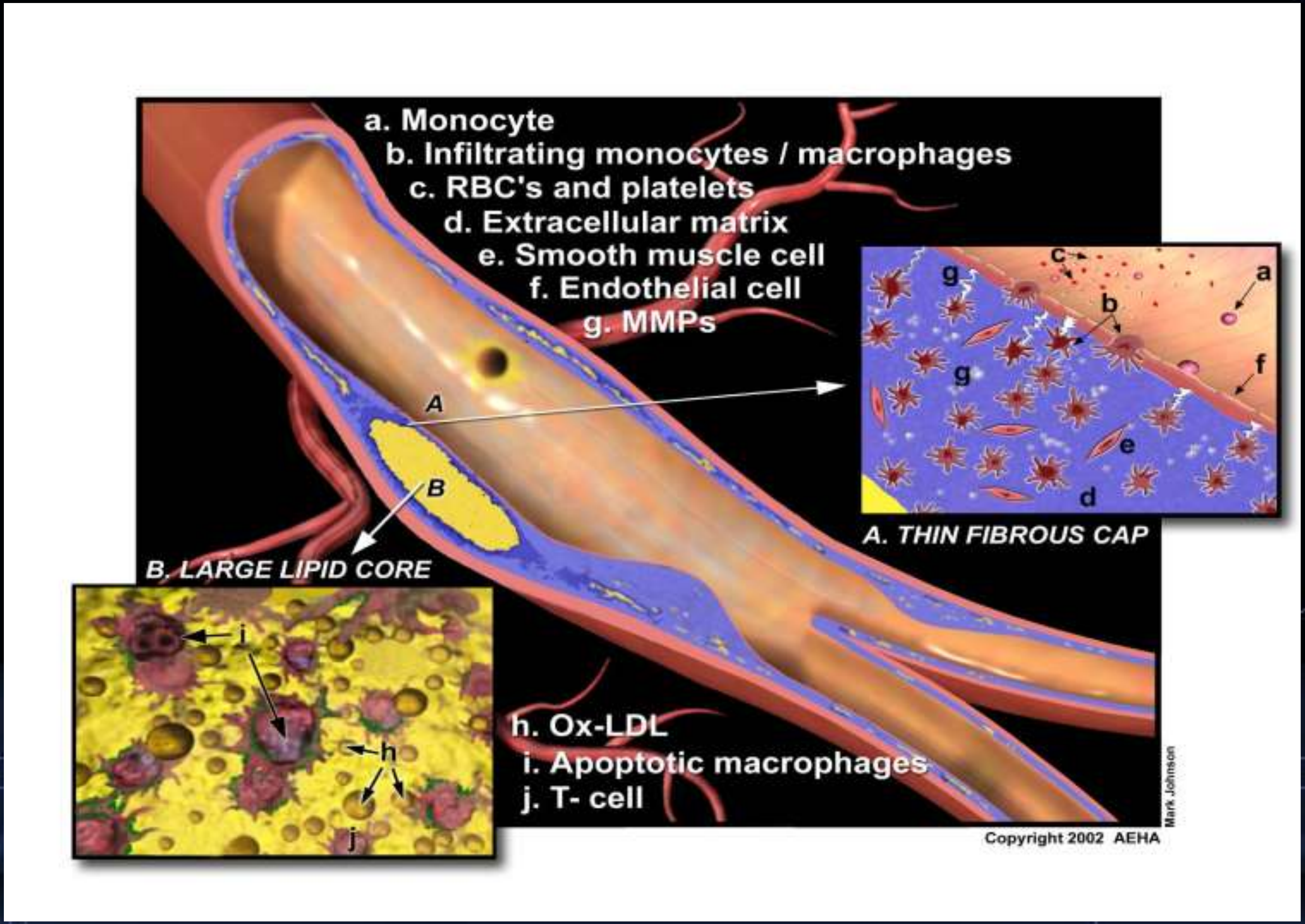


Negative remodeling, RI<0.95

Intermediate remodeling,
RI between 0.95 and 1.05

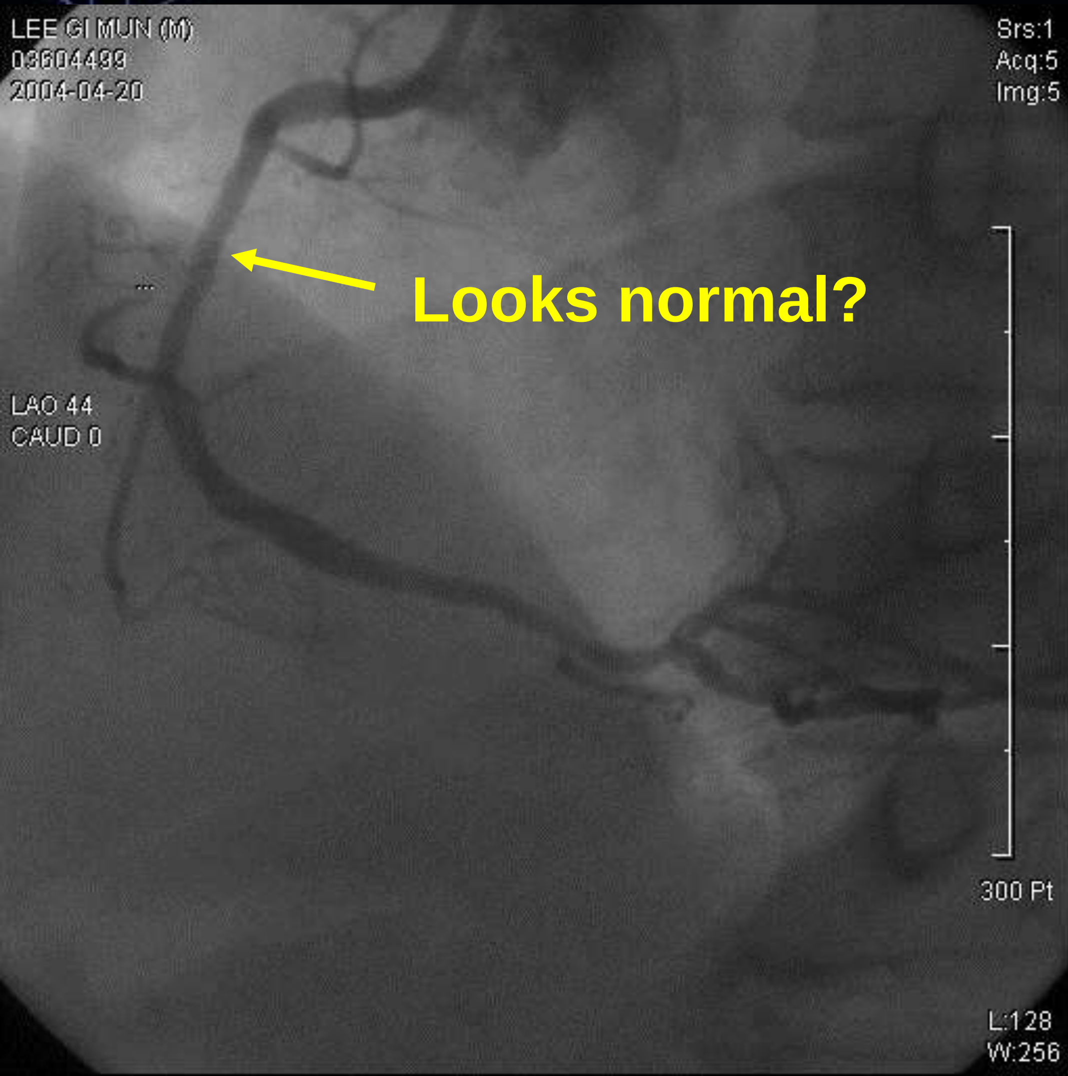


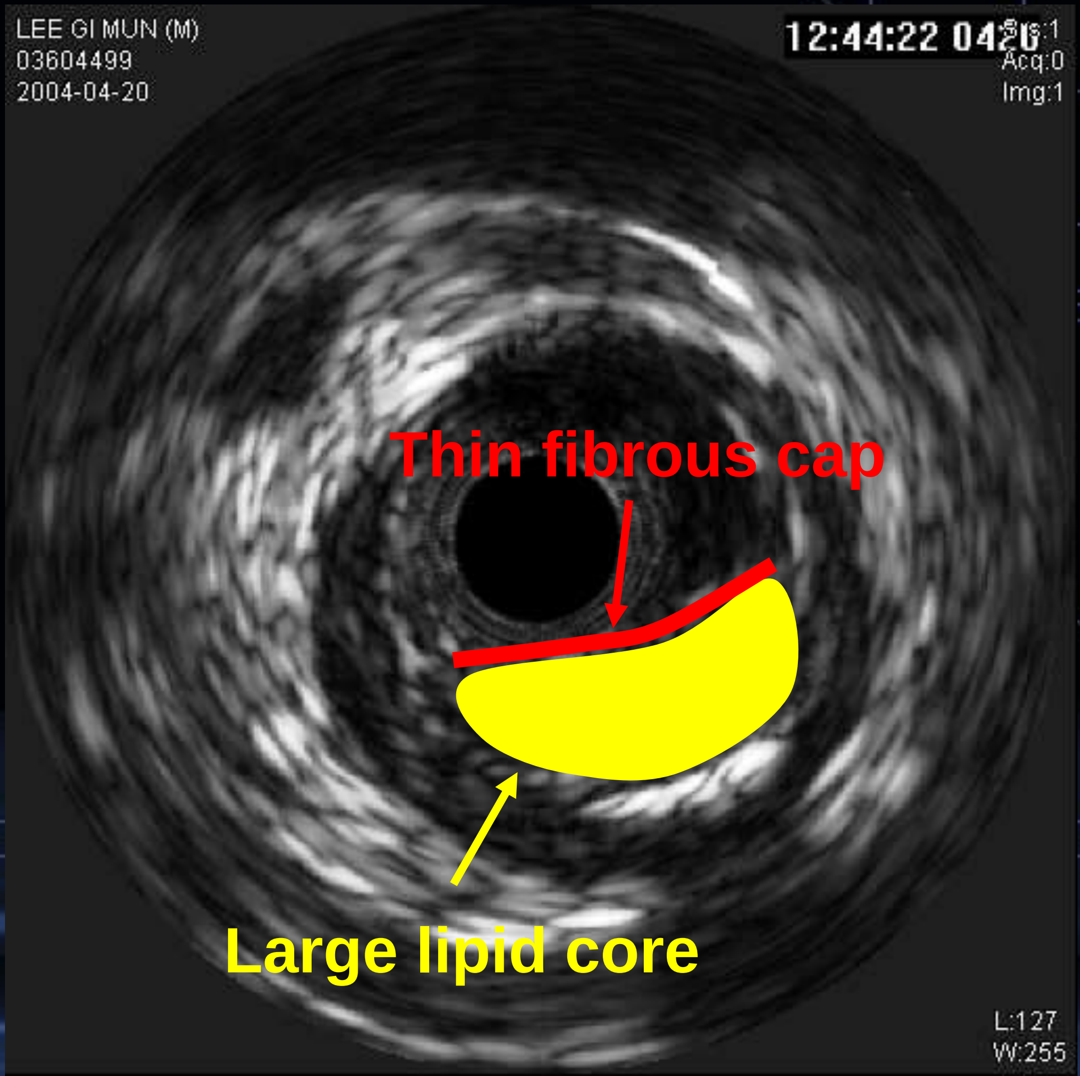
The Most Common Type of Vulnerable Plaque



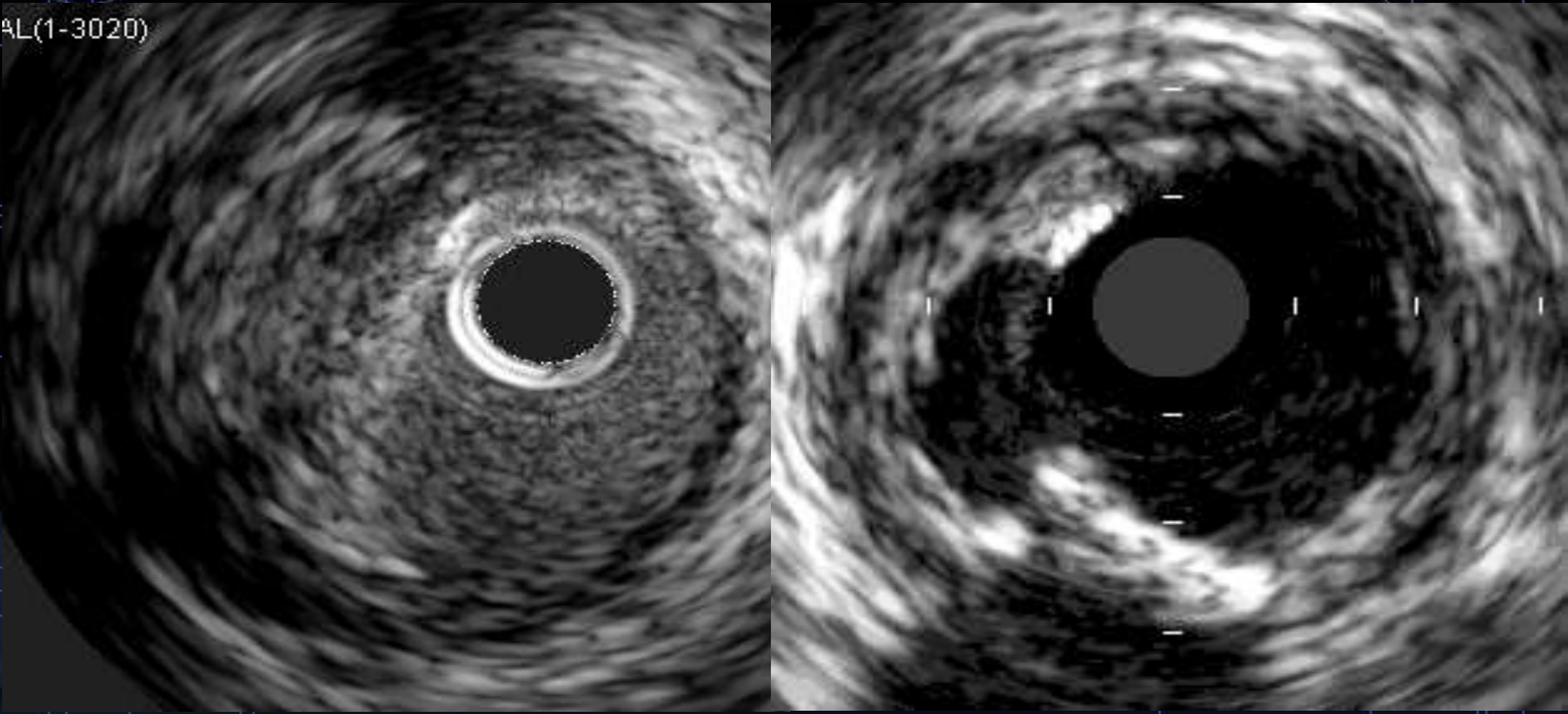
Circulation. 2003;108:1664

57Y/M Diabetic Patient





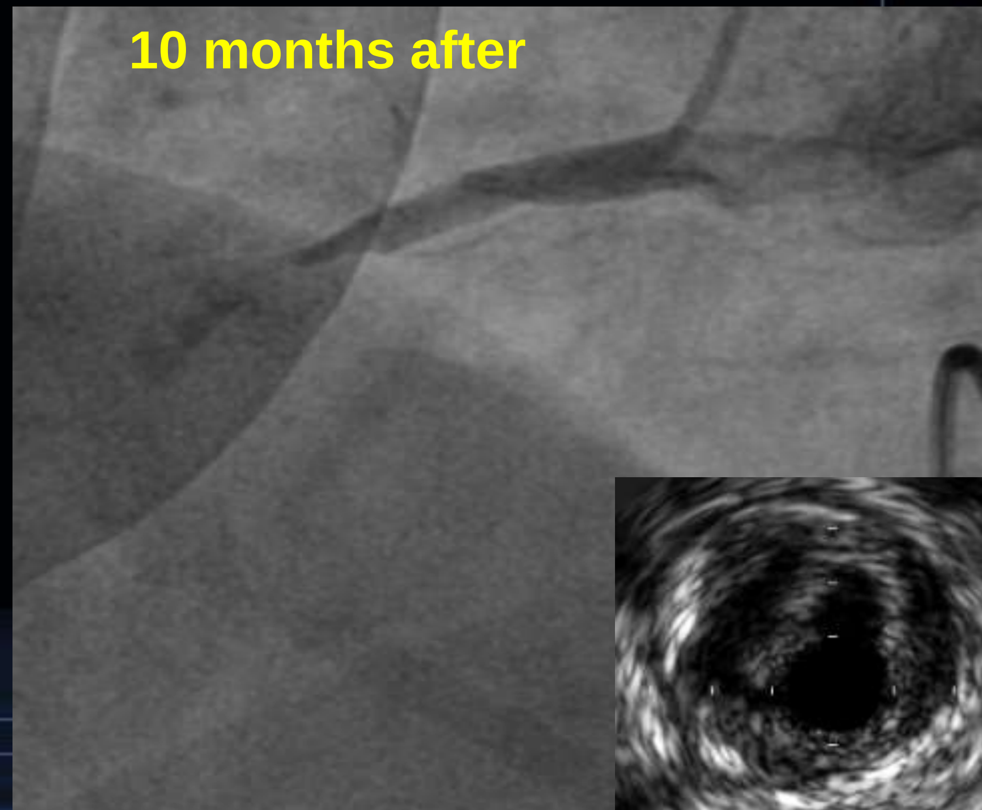
Vulnerable plaque ? → Ruptured plaque ?



62 Years Old Gentleman

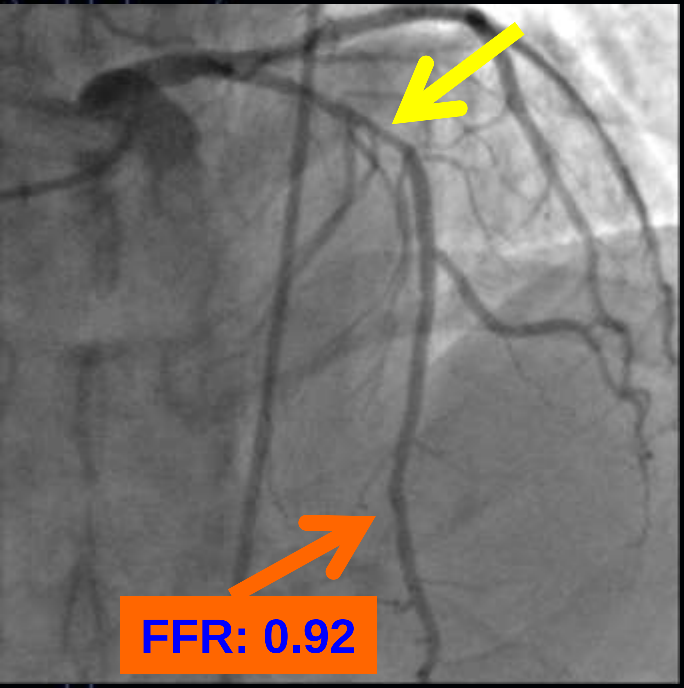
SAP

STEMI

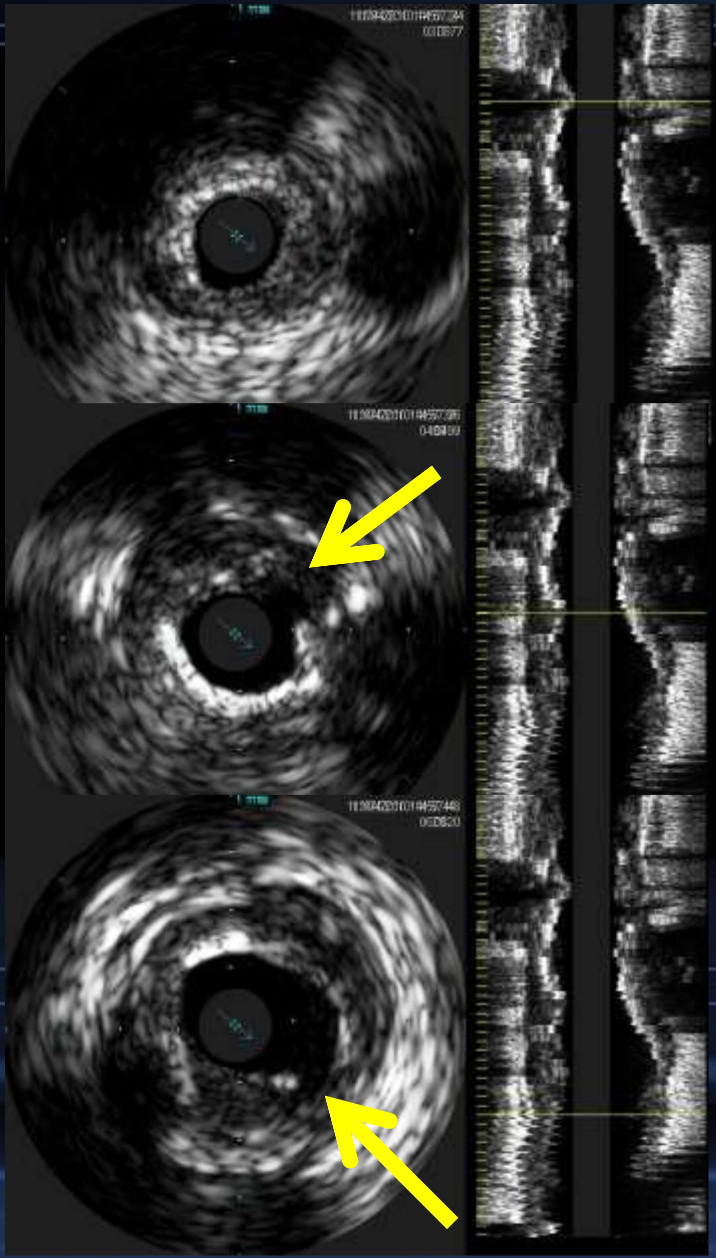


Courtesy of Bae JH

64Y/Male Unstable angina, DM, HT



NSTEMI

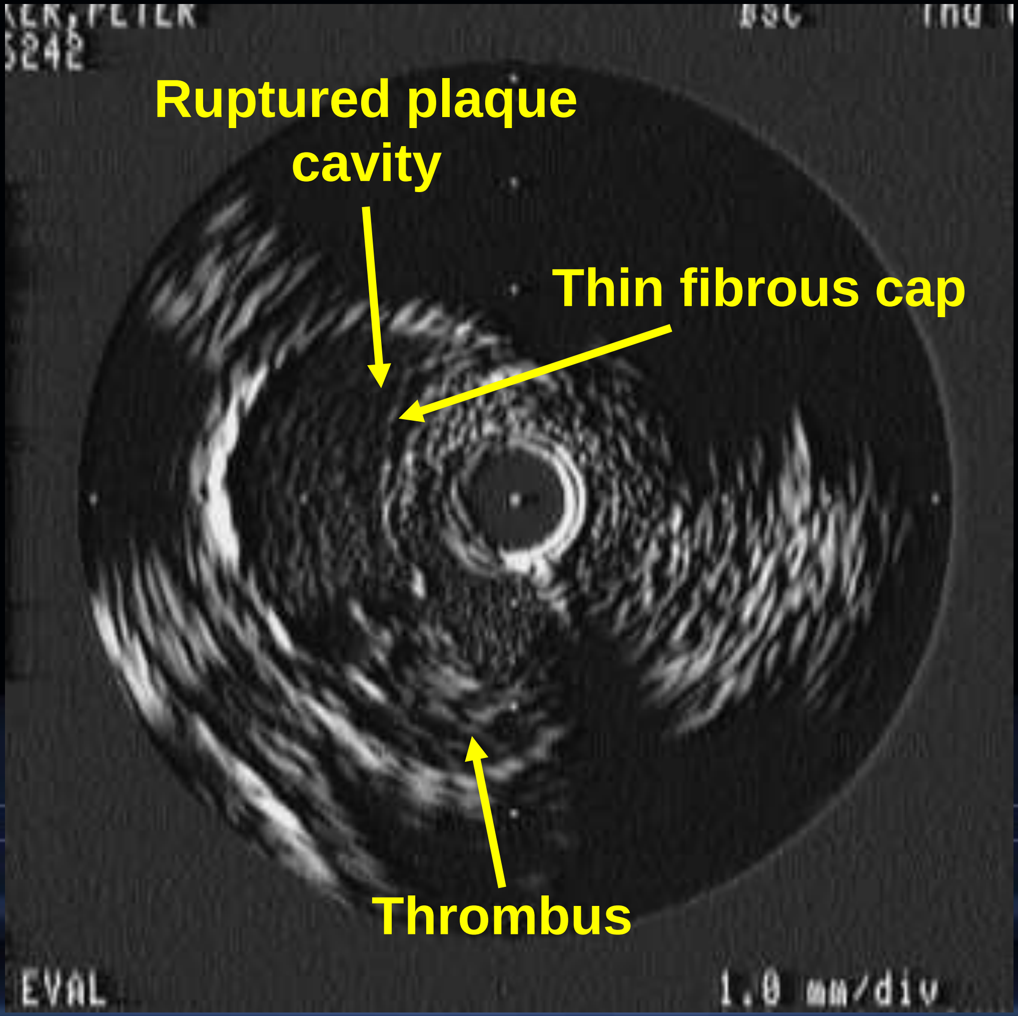


MLA 2.04 mm^2

Heavily calcified lesion with multiple plaque rupture

Courtesy of Kim SW

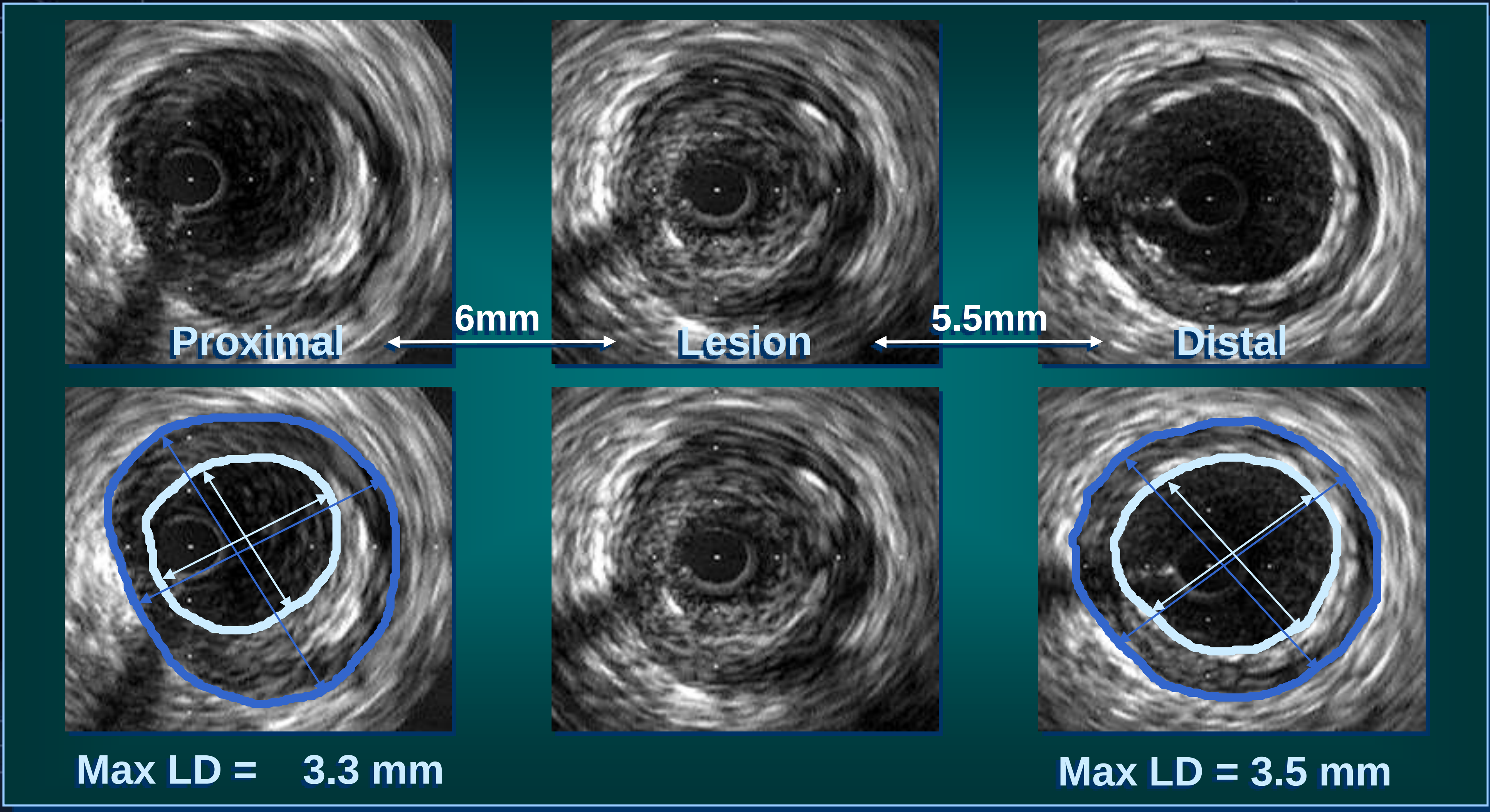
Example of Plaque Rupture with Thrombus



Stent Sizing

- To stent from "most normal proximal - to - most normal distal" reference
  - Using pre-intervention IVUS, identify most normal-looking proximal and distal reference sites within the same lesion segment (largest lumens with least plaque in the same coronary segment).
  - Measure proximal and distal reference maximum lumen diameter - select stent size based on larger of these measurements
  - Measure distance between proximal and distal reference sites to select stent length (must use motorized pullback device to do this).

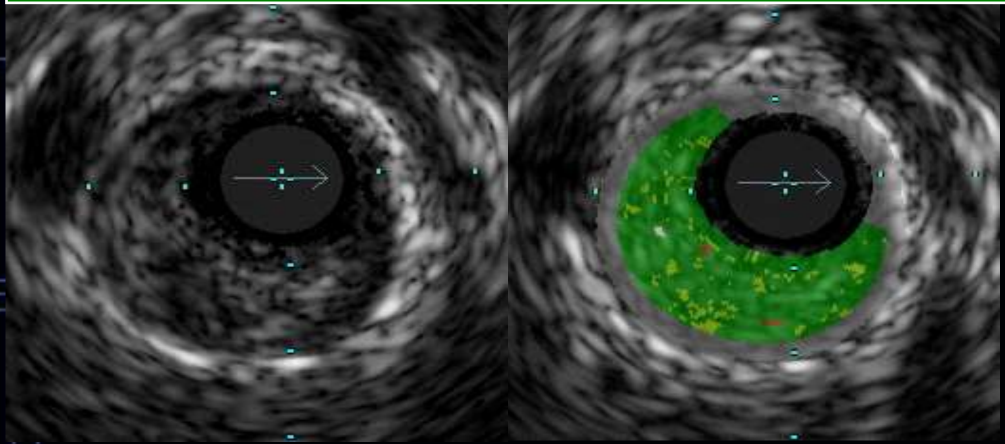
Sizing a Stent using IVUS



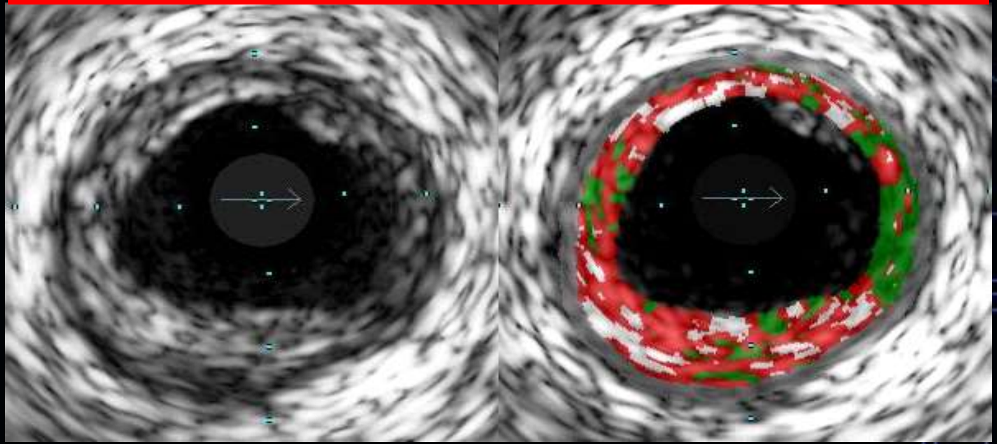
Therefore, initial stent size would be 3.5 mm

Plaque classification: Gray scale IVUS vs VH-IVUS

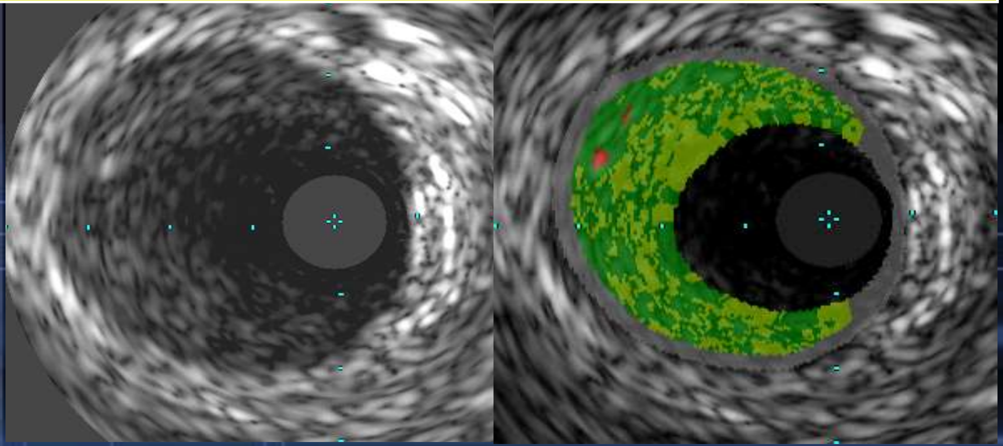
Fibrous Tissue



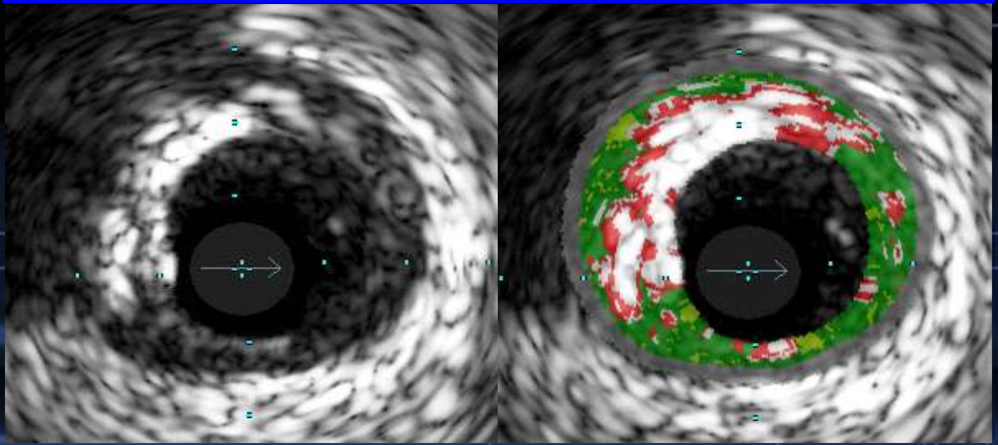
Necrotic Core



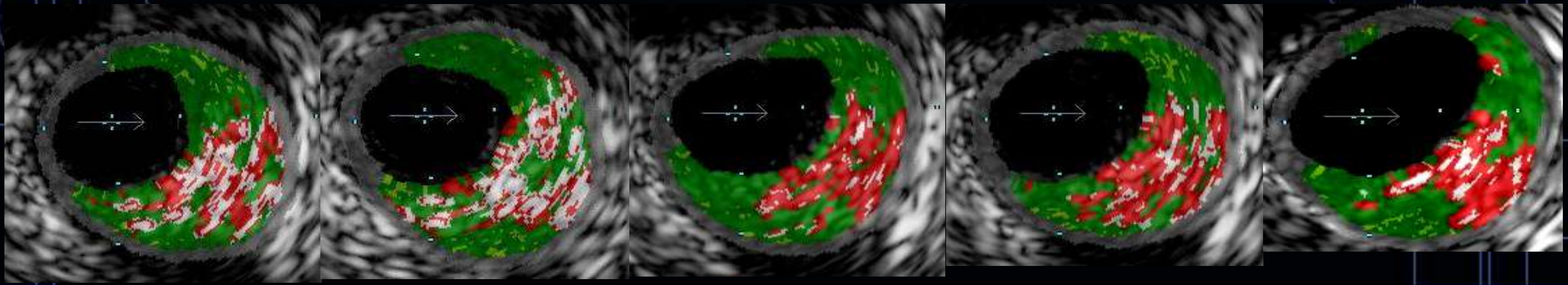
Fibro-Fatty



Dense Calcium



Thin-Cap Fibroatheroma



Histopathologic Criteria

- Necrotic core
- Thin fibrous cap < 65 um
- Cap infiltrated by macrophages and lymphocytes
- Cap composition – type 1 collagen and few smooth muscle cells

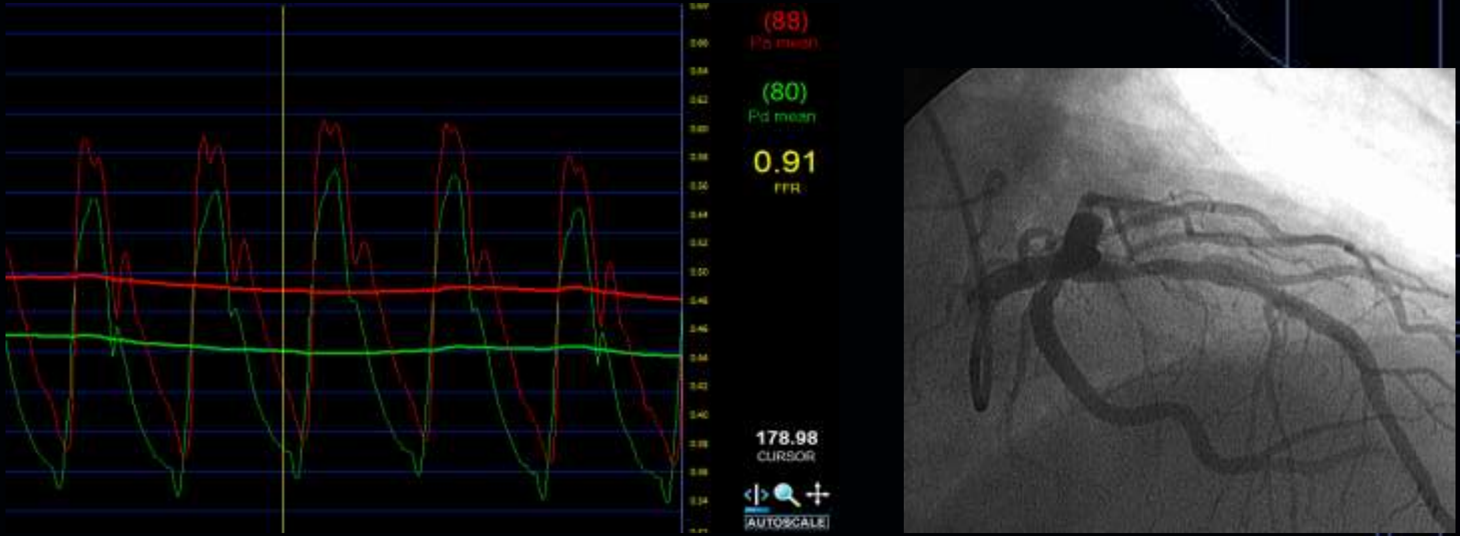
VH-IVUS Criteria

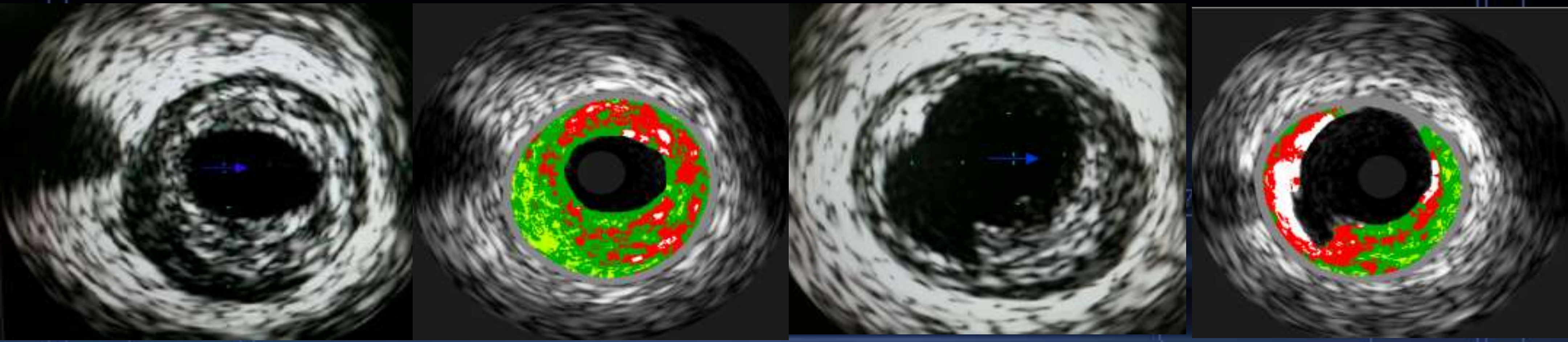
- Plaque burden > 40%
- Thin cap not measurable
- Necrotic core >10% of plaque area
- Necrotic core contact lumen at least 3 image slices

Kolodgie et al. Current Opinion in Cardiology 2001;16:285

Rodriguez-Granillo, et al JACC 2005;45:2038-42

62Y/M, Acute Resting Chest Pain, NSTEMI, Insignificant FFR, VH-TCFA



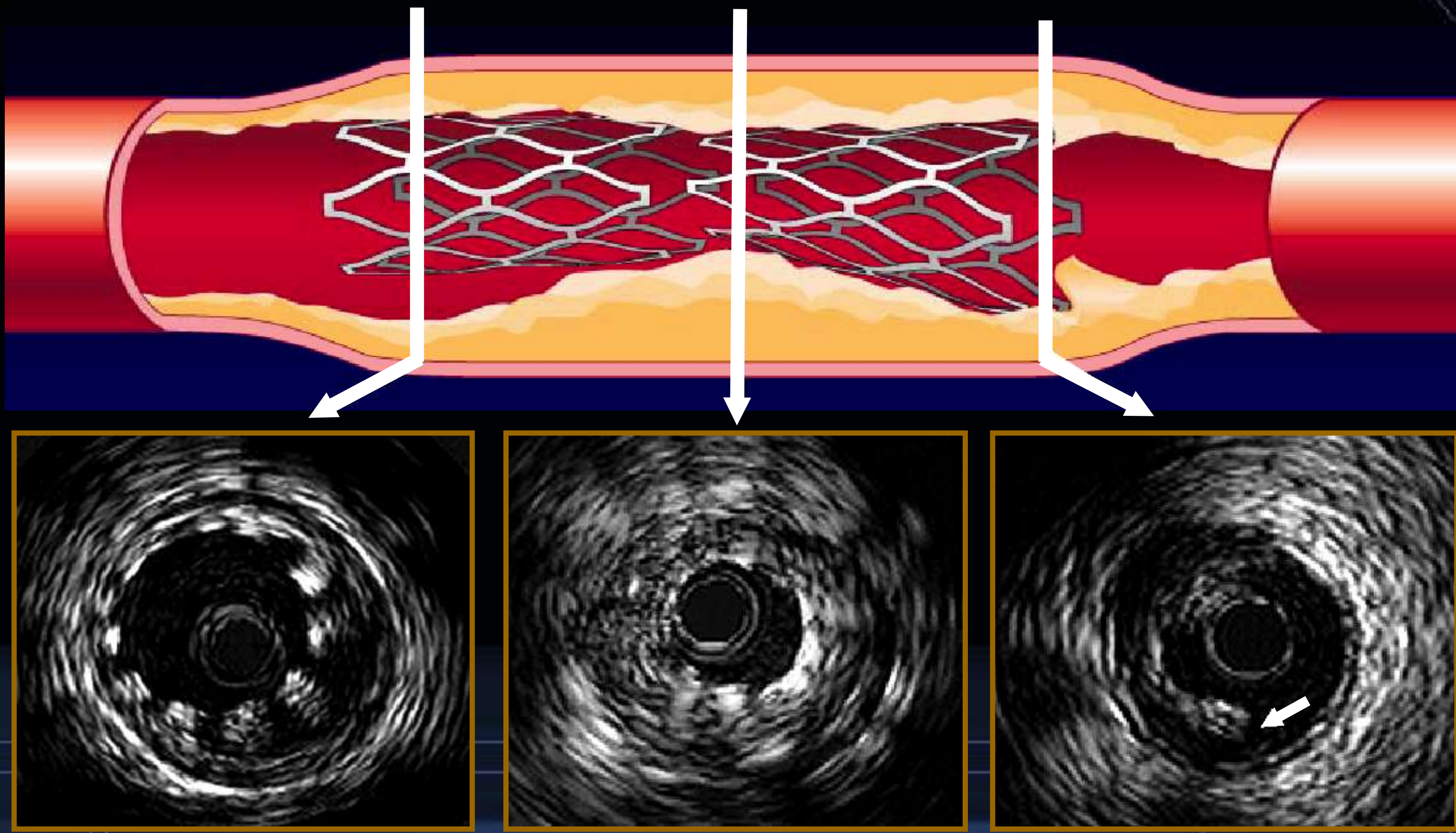


Courtesy of Doh JH

Roles of Post-PCI IVUS

- Verify stent expansion
- Verify stent apposition
- Post-PCI complications

Problems after Stenting



Incomplete Apposition

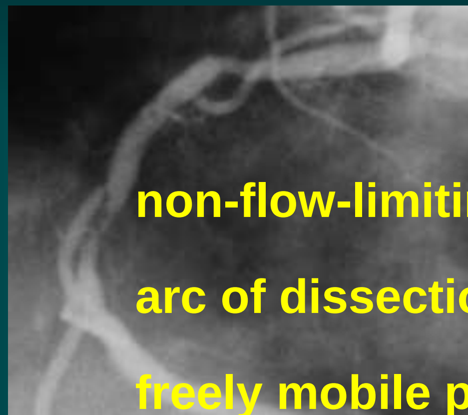
Stent Underexpansion

Edge Dissection

Post-stenting Complications

- Dissection
- Intramural/Extramural hematomas
- Stent thrombosis/No-reflow
- Stent dislodgement
- Perforation

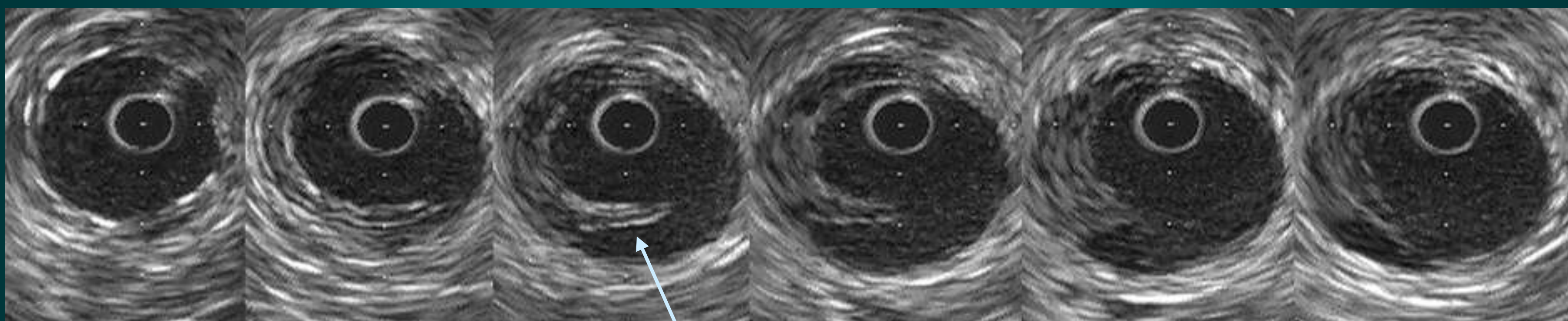
Minor Stent Edge Dissection



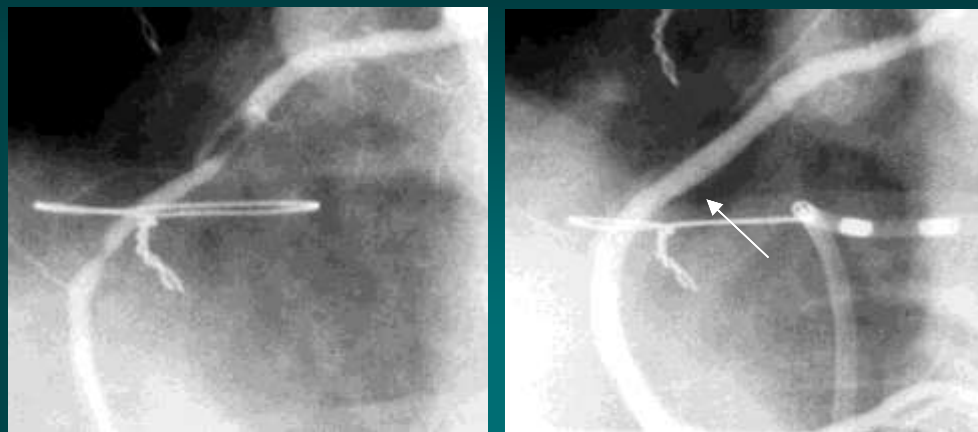
non-flow-limiting or no lumen compromise

arc of dissection <90 degrees

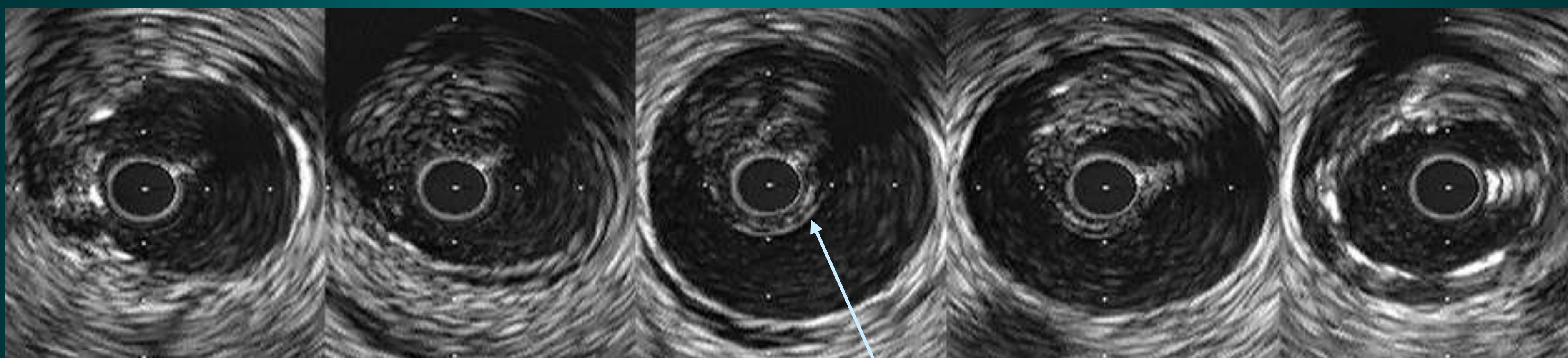
freely mobile plaque protruding into the lumen,
but not directed toward the center of the lumen



Major Stent Edge Dissection

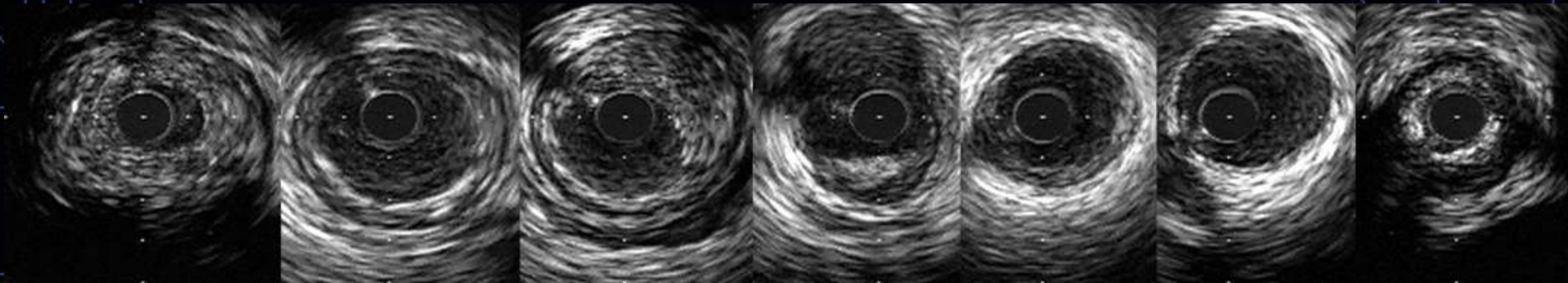


- a mobile flap
- arc of dissection > 90 degrees
- flow-limiting or lumen compromise

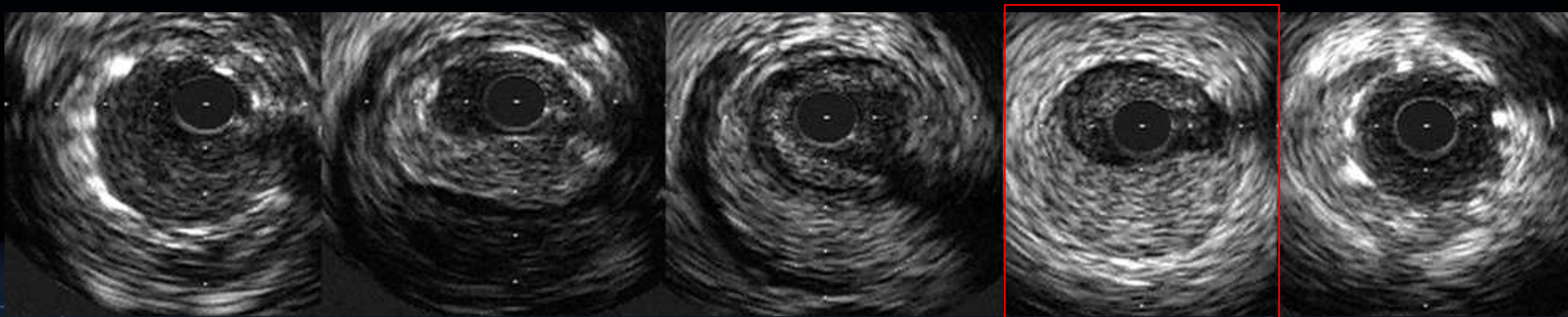


Dissection

Intramural Hematoma



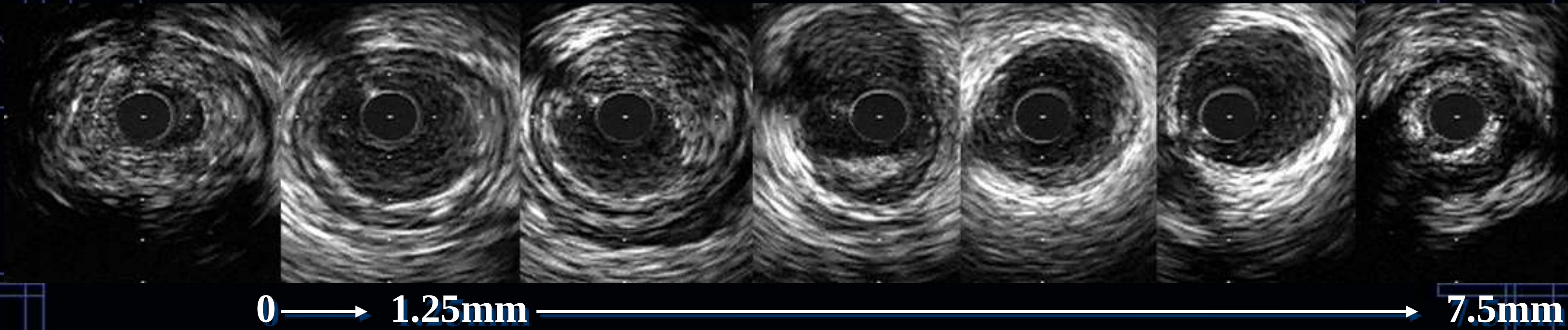
0 → 1.25mm → 7.5mm

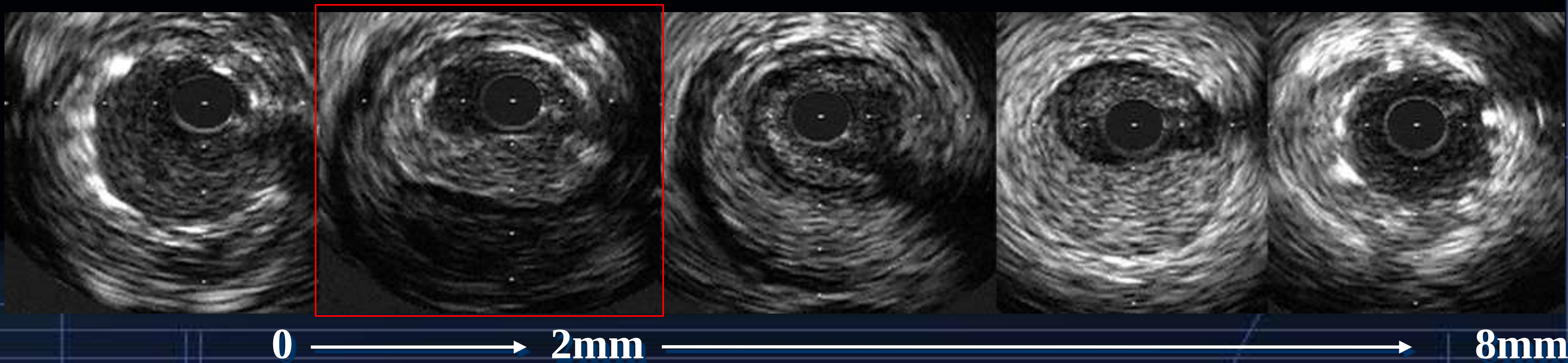


0 → 2mm → 8mm

The EEM expands outward and the internal elastic membrane or intima is pushed inward and straightened to cause lumen compromise.
Blood accumulates in the space caused by the split in the media.

Extramural Hematoma

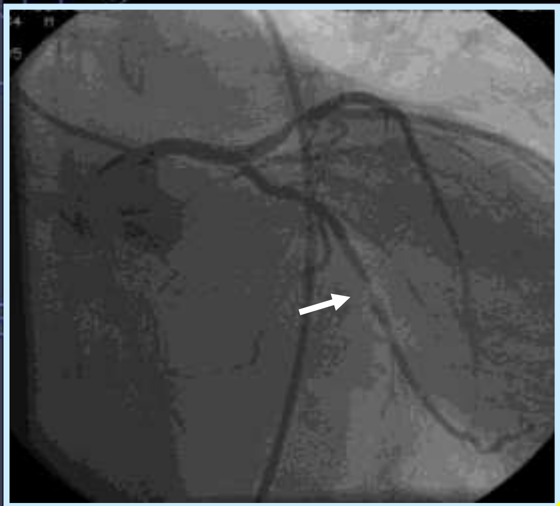




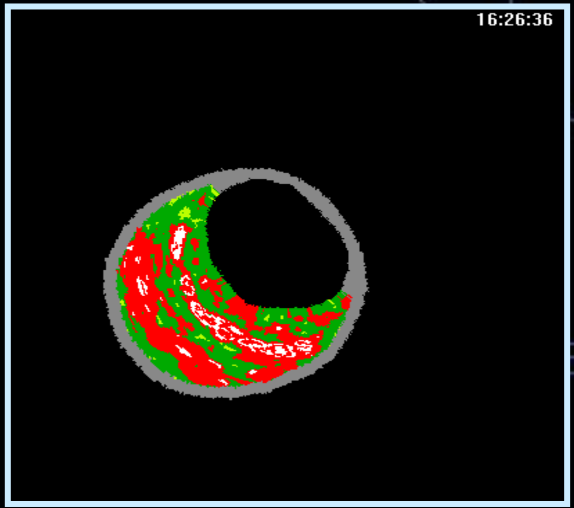
Extramural hematoma displaced the media and EEM inward.
a new, peri-adventitial echolucent interface.

71/M Unstable Angina

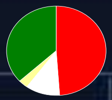
Pre-PCI (cTnI=0ng/ml)



Cypher (cTnI=3.24ng/ml)

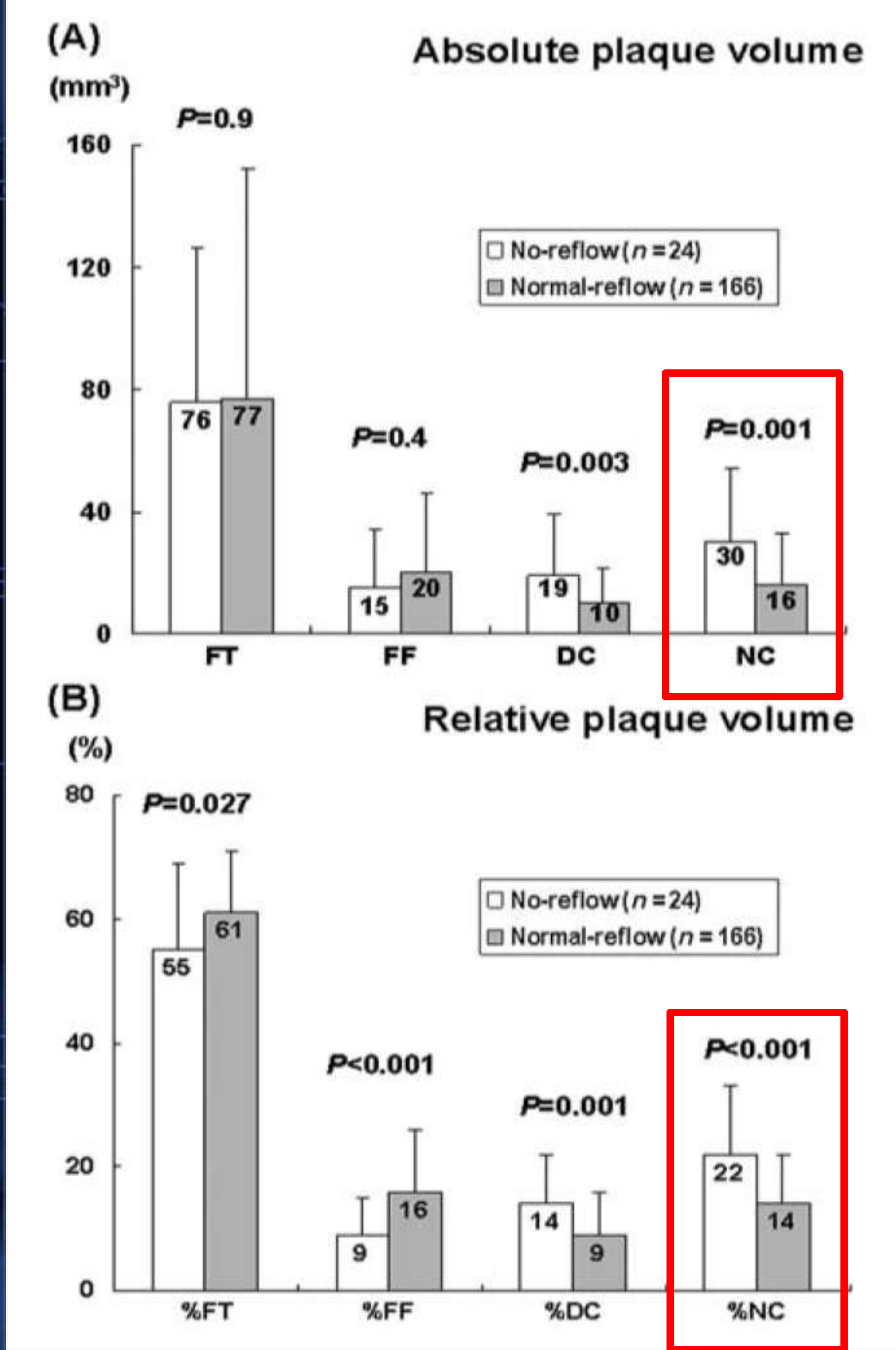


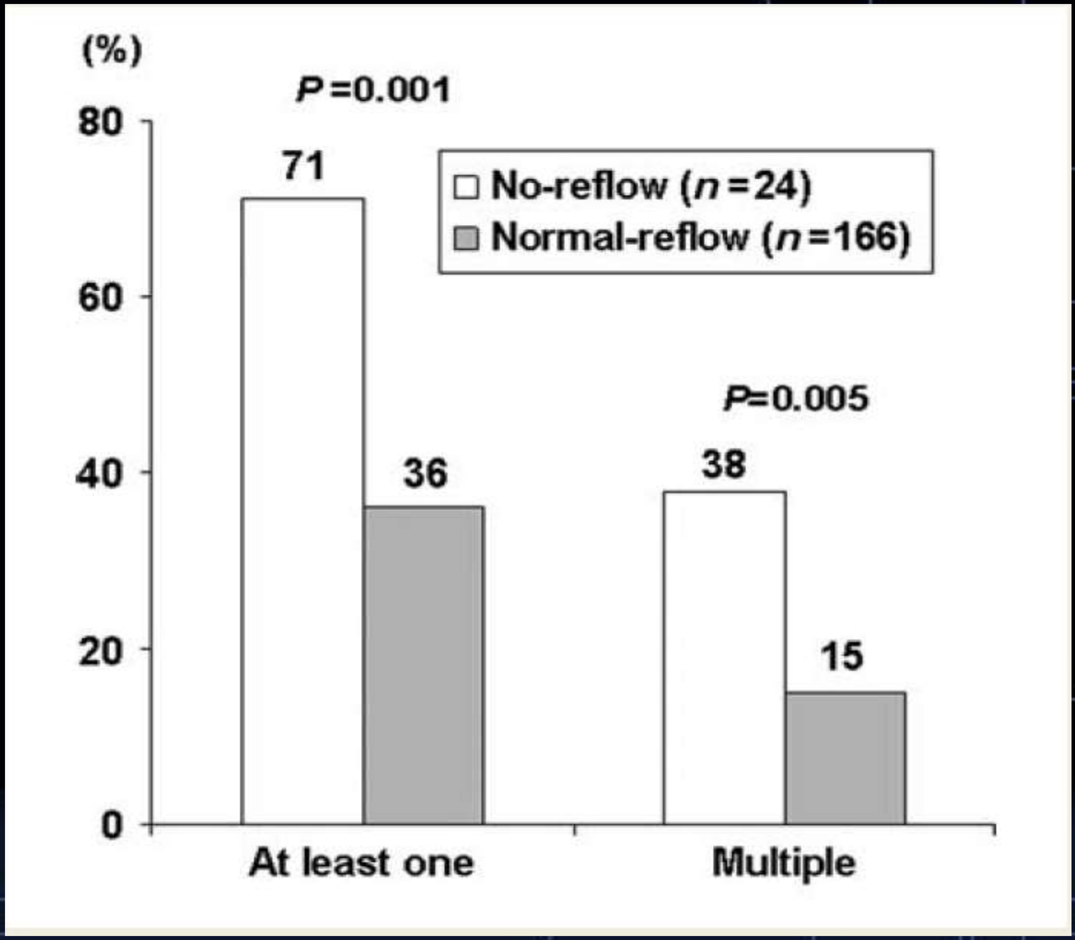
Lumen Area	3.8 mm^2	
EEL Area	16.0 mm^2	
Plaque Area	12.2 mm^2	
% Plaque Burden	76%	
Fibrous Area	3.7 mm^2	37%
Fibro-Fatty Area	0.3 mm^2	3%
Dense Calcium Area	1.1 mm^2	11%
Necrotic Core Area	5.0 mm^2	49%



Hong YJ et al. JACC Cardiovasc Imaging 2009;2:458-68

Thin-Cap Fibroatheroma



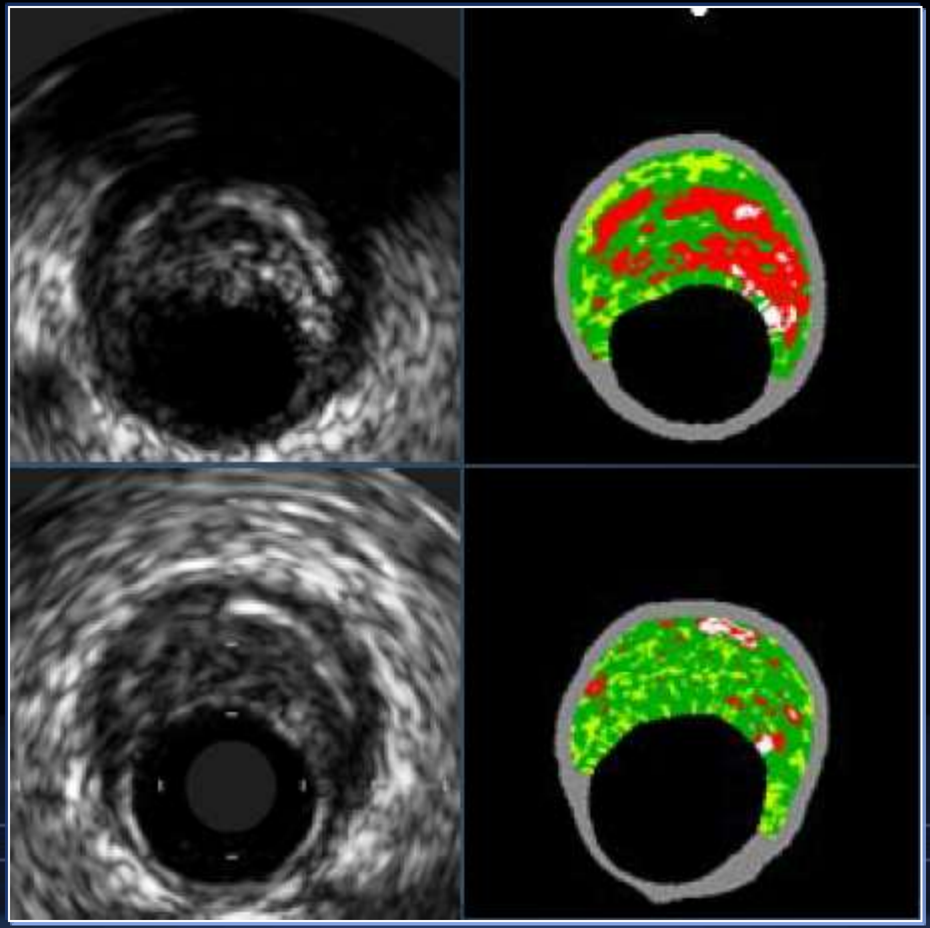


Hong YJ et al., Eur Heart J 2011:32;2059-2066

Attenuated Plaque: VH-IVUS Finding

Attenuated plaque

P&M : 9.44 mm2
PB: 67.3%



NC area: 1.96 mm2
NC%: 20.8%

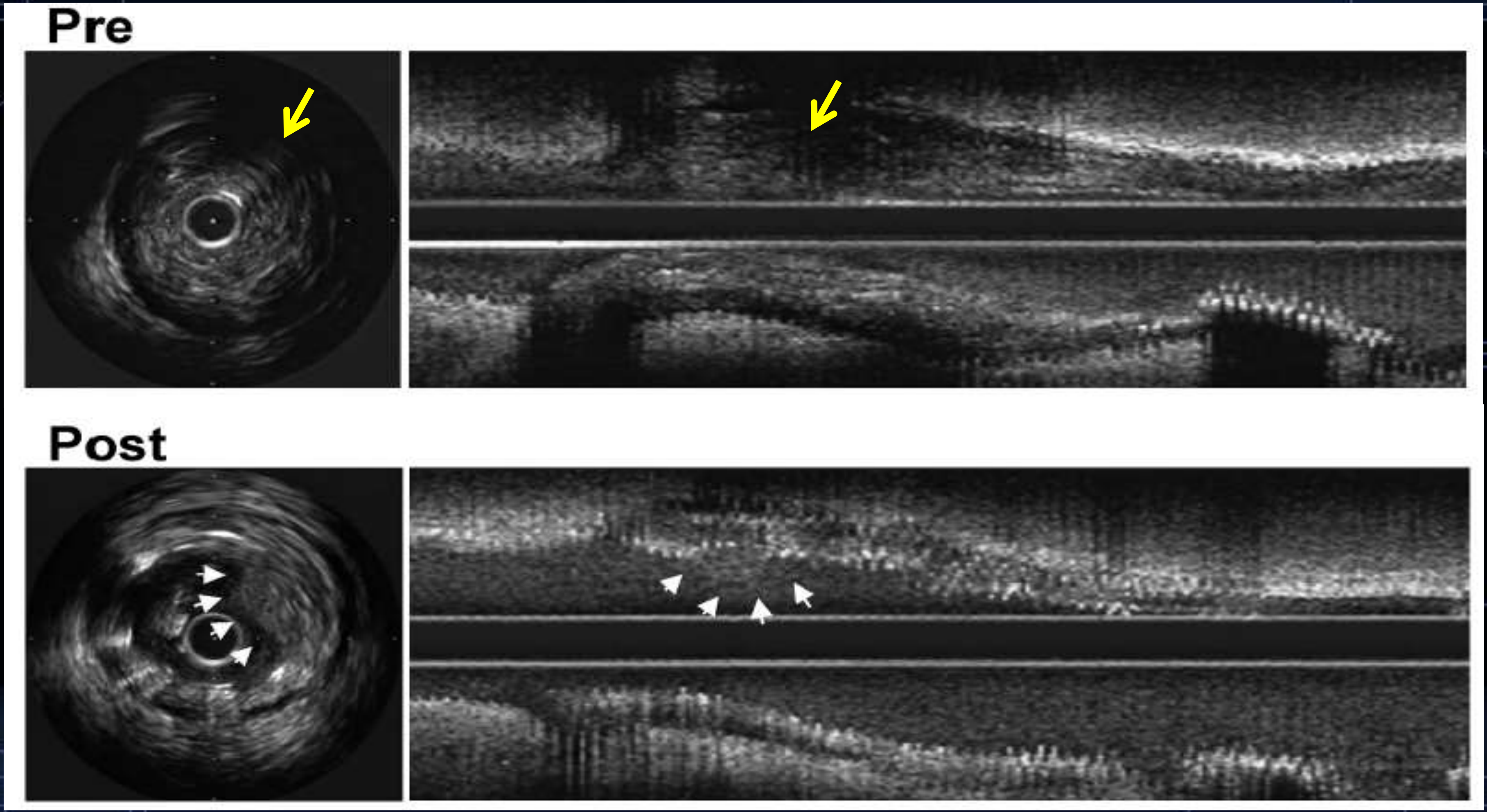
Non attenuated plaque

P&M : 8.8 mm2
PB: 61.7%

NC area: 0.54 mm2
NC%: 6.1%

Wu X, Maehara A, Mintz GS. Am J Cardiol 2010;105:48-53

Large Amount of Plaque with Attenuation



Plaque/thrombus protrusion through the stent struts

Okura H et al. Circ J 2007;71:648-653

Plaque Prolapse After Stent Implantation in Patients With Acute Myocardial Infarction

An Intravascular Ultrasound Analysis

Young Joon Hong, MD, PhD, Myung Ho Jeong, MD, PhD, FACC, Youngkeun Ahn, MD, PhD, FACC, Doo Sun Sim, MD, Jong Won Chung, MD, Jung Sun Cho, MD, Nam Sik Yoon, MD, Hyun Ju Yoon, MD, Jae Youn Moon, MD, Kye Hun Kim, MD, PhD, Hyung Wook Park, MD, PhD, Ju Han Kim, MD, PhD, Jeong Gwan Cho, MD, PhD, FACC, Jong Chun Park, MD, PhD, Jung Chaee Kang, MD, PhD

Gwangju, Korea

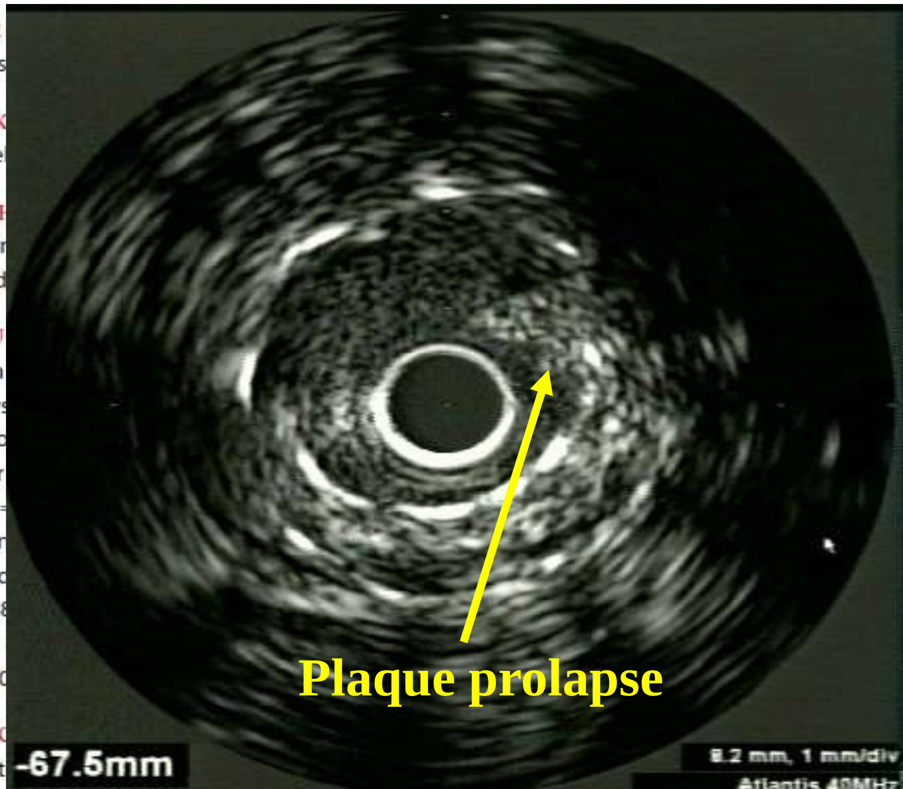
OBJE ... me of plaque
prolaps

BACK ... nfarction are
not wel

METH ... immediately
followi ... hic and IVUS
derived

RESU ... longer (31 ±
13 mm ... aque rupture
(51% vs ... common in
PP lesio ... significantly
greater ... −4.9 ± 46.1
U/l, p = ... significantly
differen ... riate analysis
showed ... nd thrombus
(OR: 1.8 ... n, and stent
length ... ng (OR: 1.72,
p = 0.0

CONC ... ation. Lesion
charact ... t predict PP.
Although long-term follow-up is pending, PP is associated with more myonecrosis after stenting in patients with acute myocardial infarction. (J Am Coll Cardiol Img 2008;1:489–97) © 2008 by the American College of Cardiology Foundation



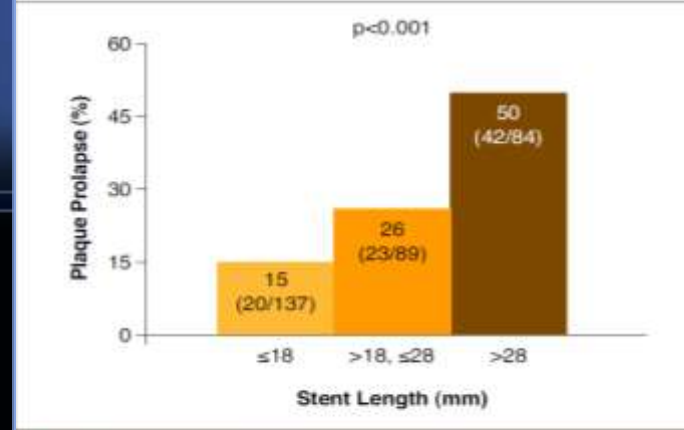


Figure 1. Incidence of PP in Relation to the Stent Length

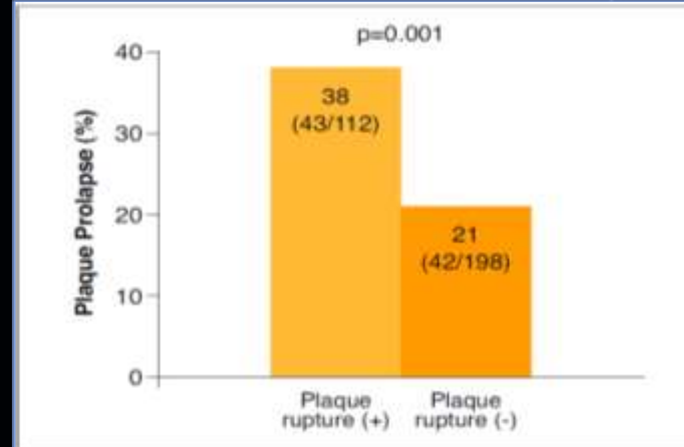


Figure 2. Incidence of PP in Relation to the Presence or Absence of the Plaque Rupture

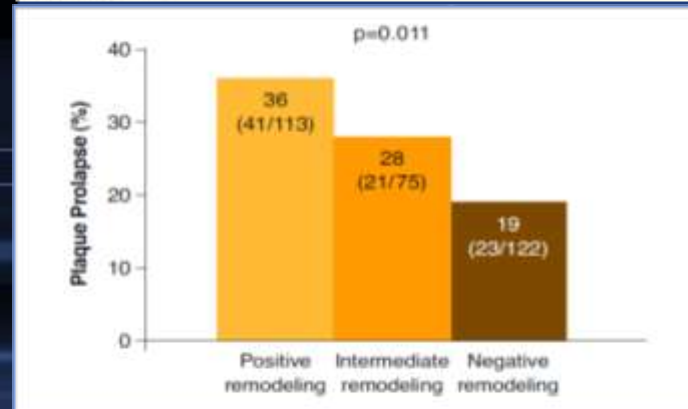
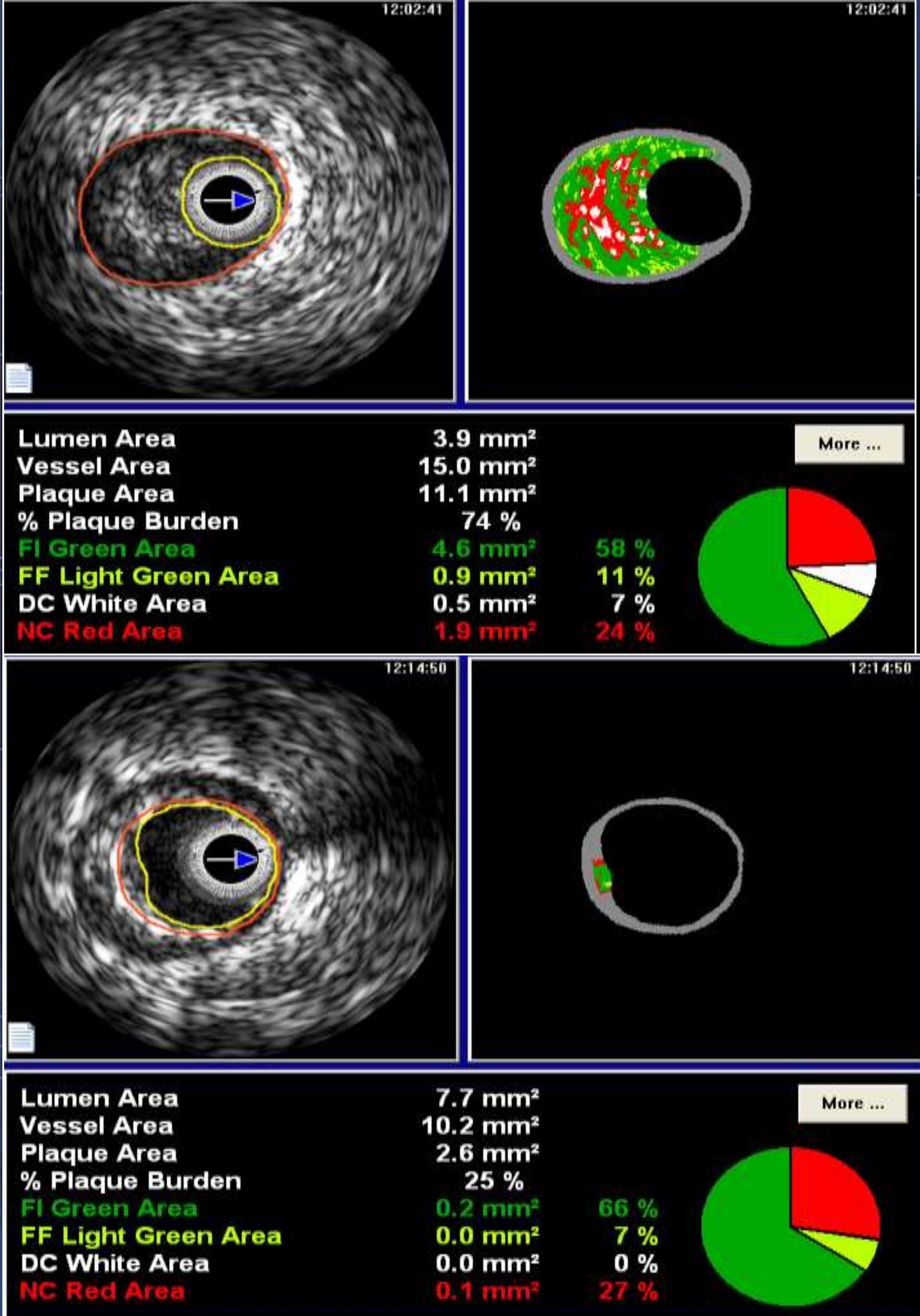
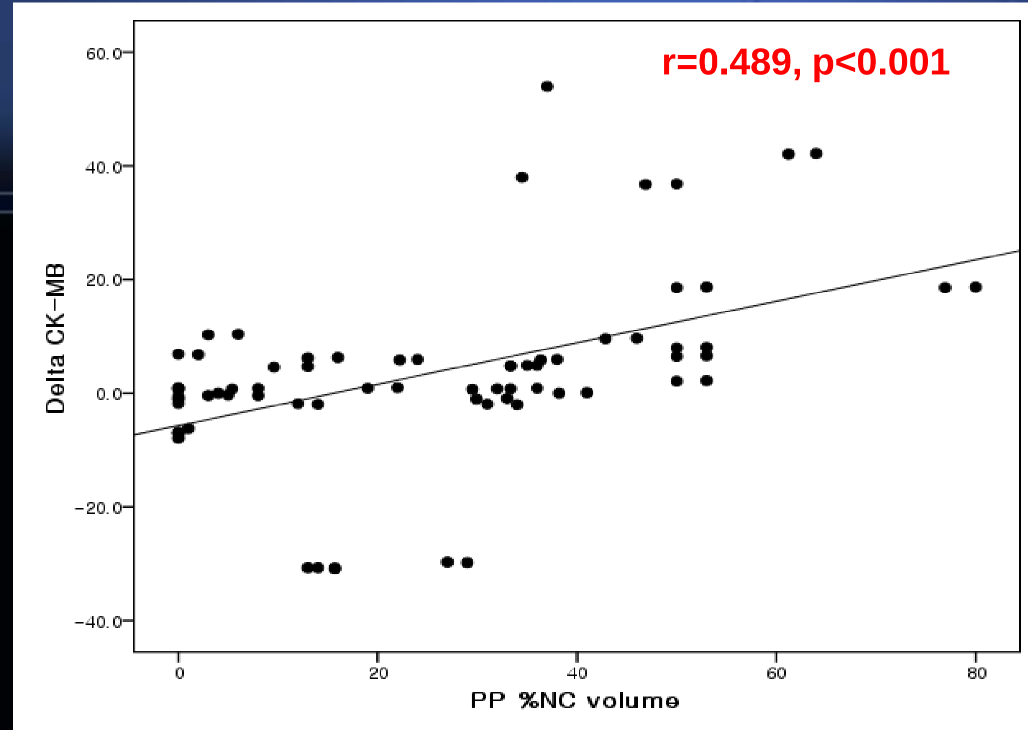


Figure 3. Incidence of PP in Relation to the Remodeling Pattern





Plaque Component (Necrotic core)

Tissue Prolapse

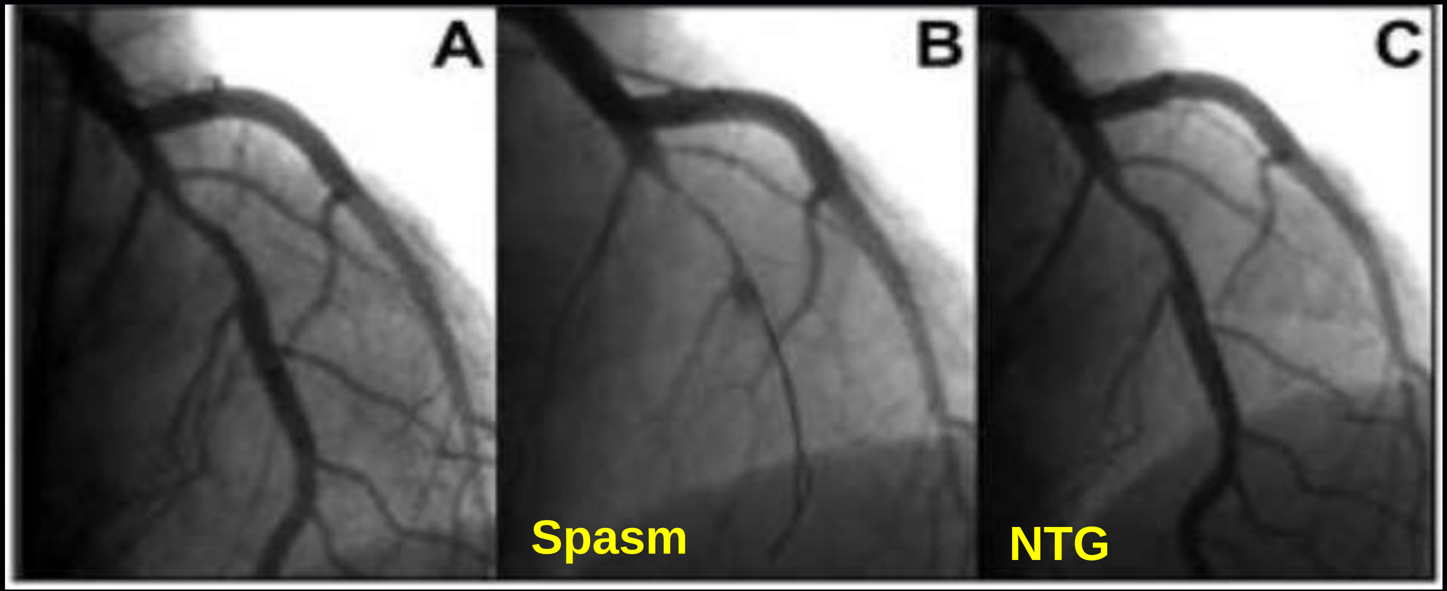
Post-PCI CK-MB Elevation

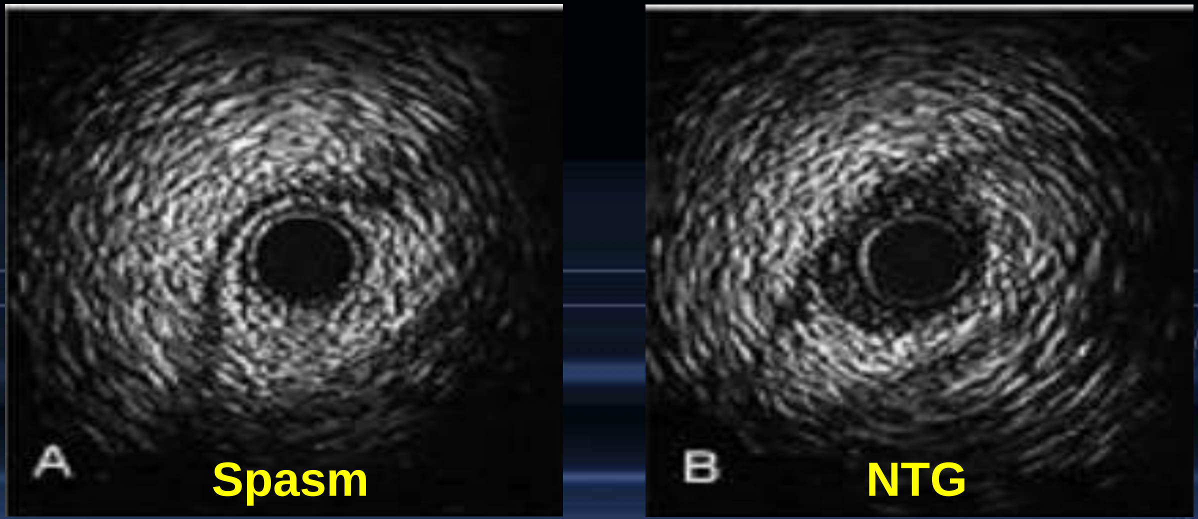
Hong YJ et al., Circ J 2010;74:1142-1151

IVUS-Related Troubles

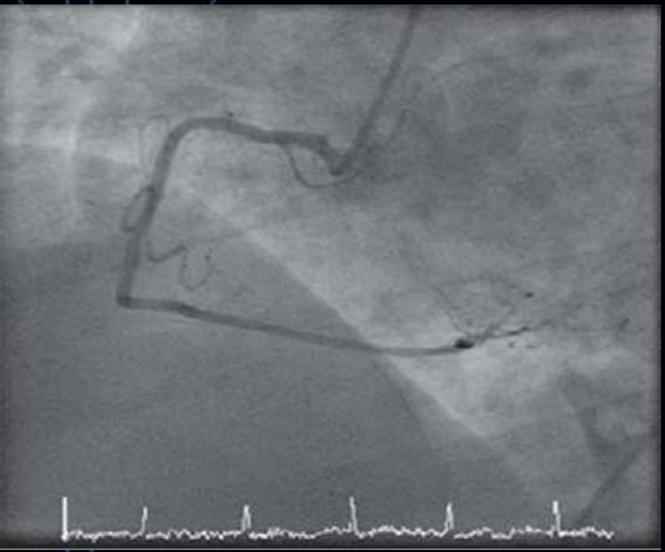
- Transient coronary spasm
- Dissection
- Air embolization
- Slow flow
- Thrombotic occlusion / MI
- IVUS catheter fracture
- Stent distortion

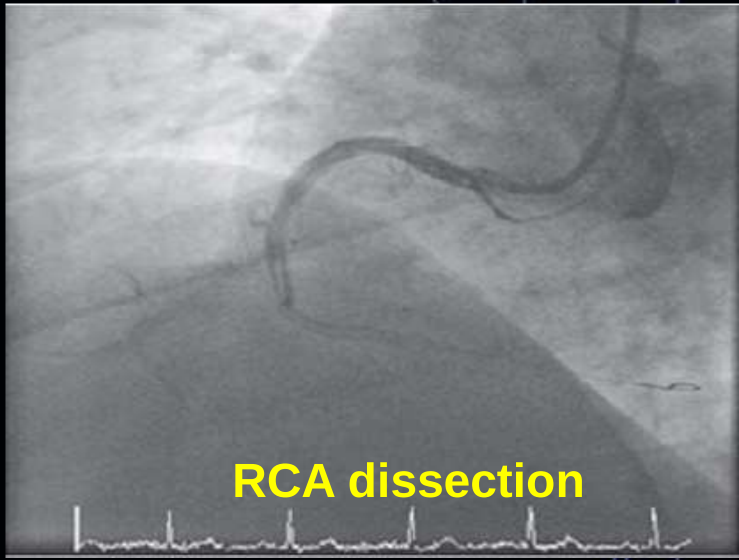
IVUS-Related Spasm

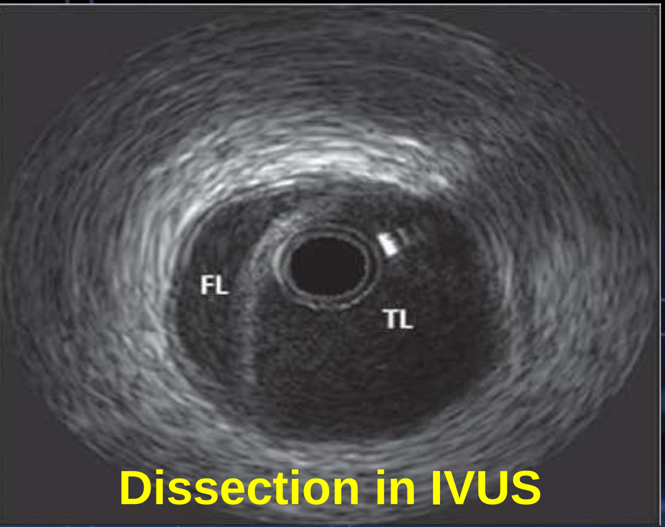


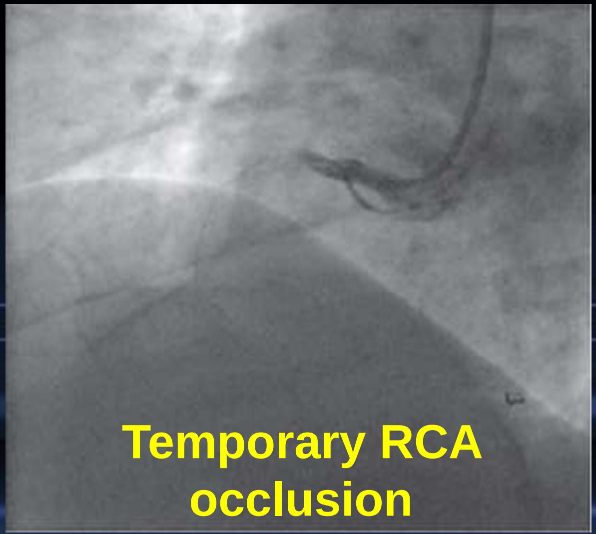


IVUS-Related RCA Dissection



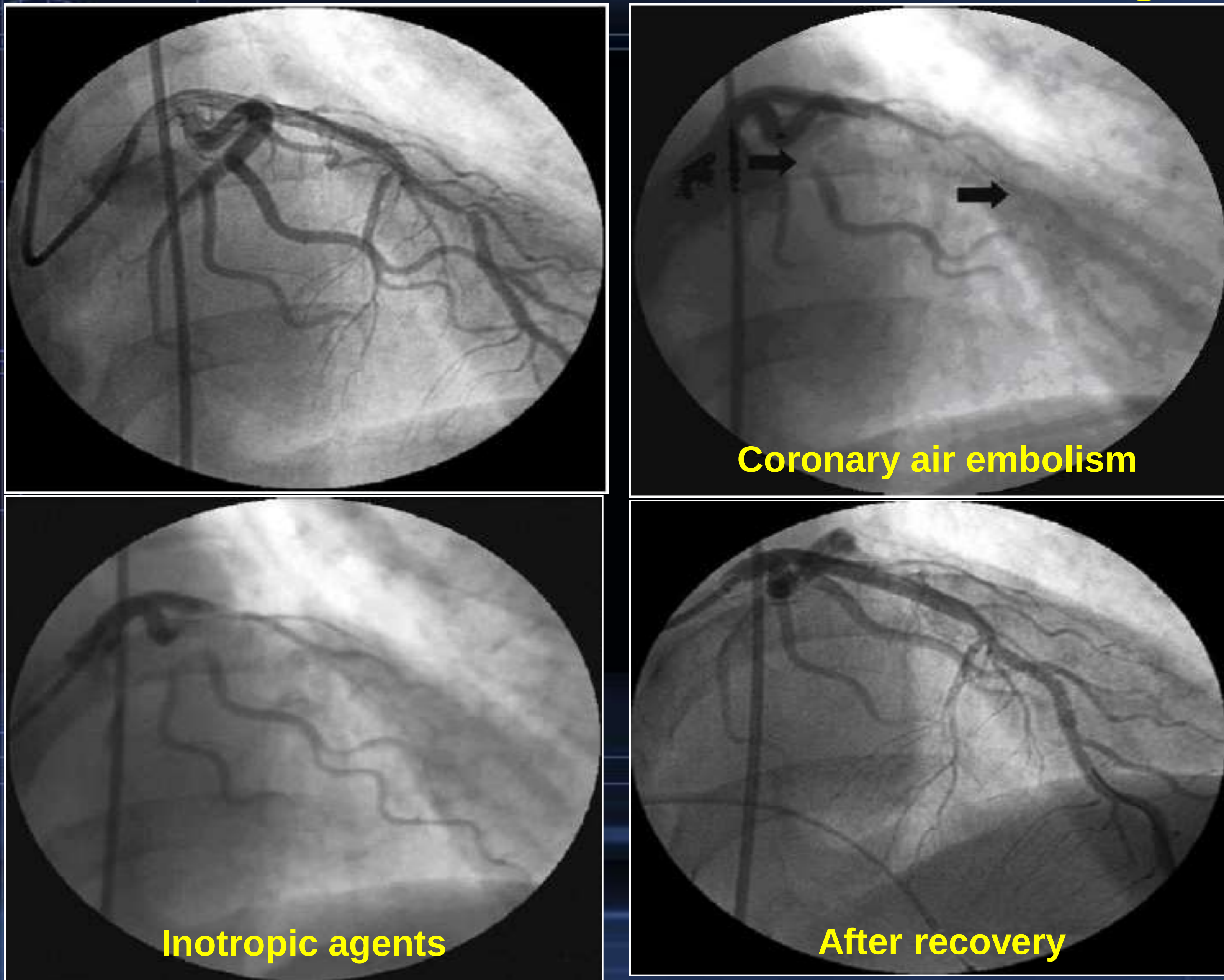






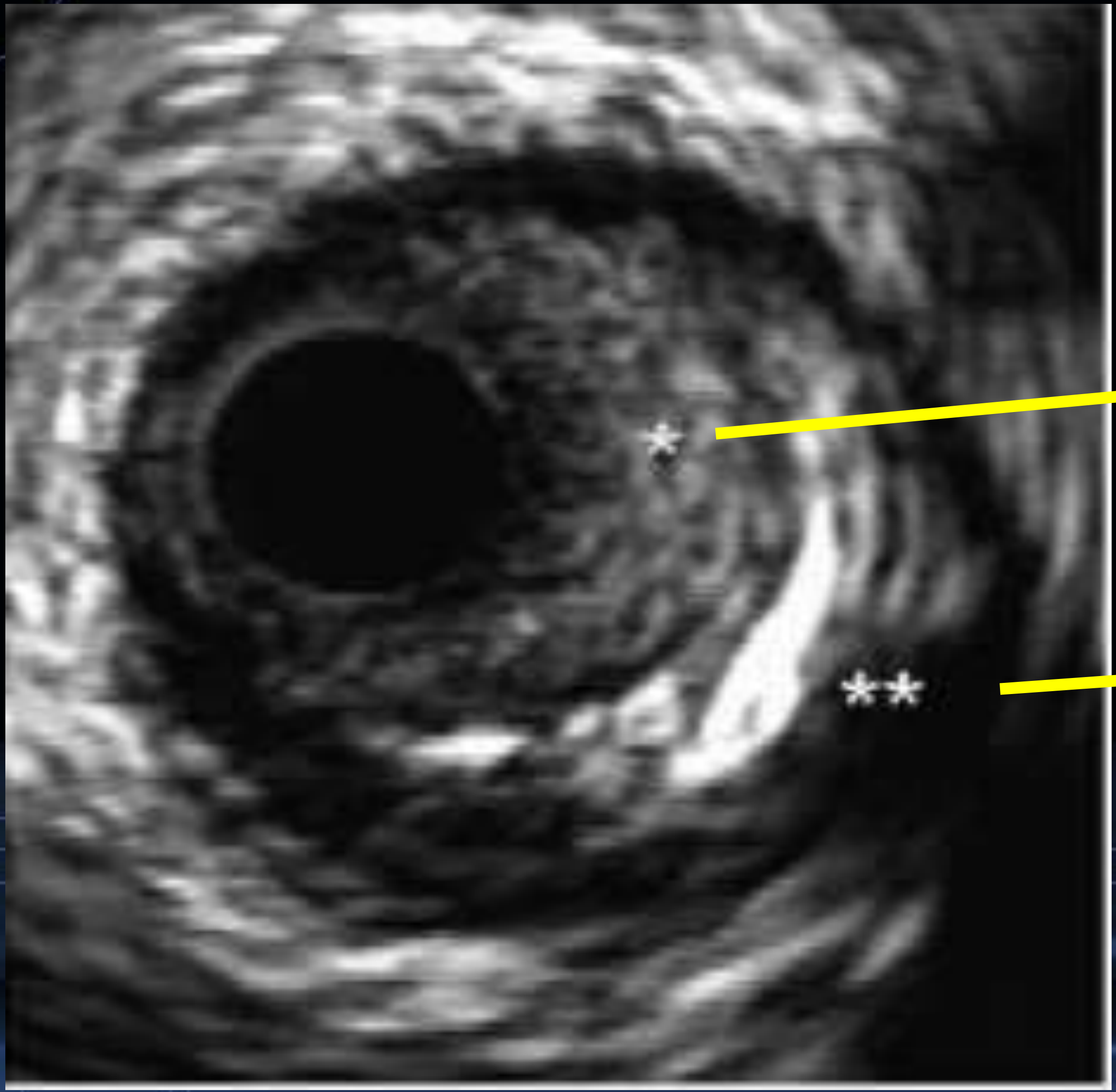
Herz 2007

Air Embolization During IVUS



Korean Circulation J 2007

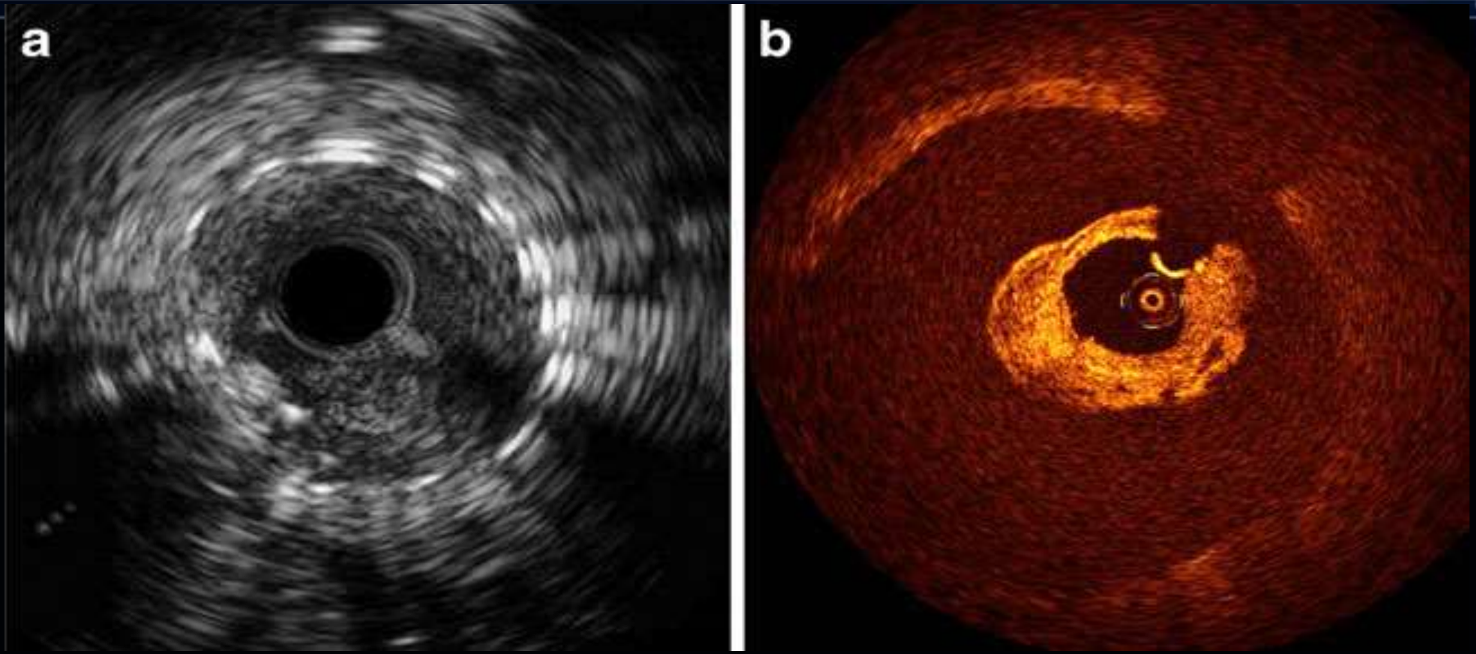
Slow Flow During IVUS Pullback

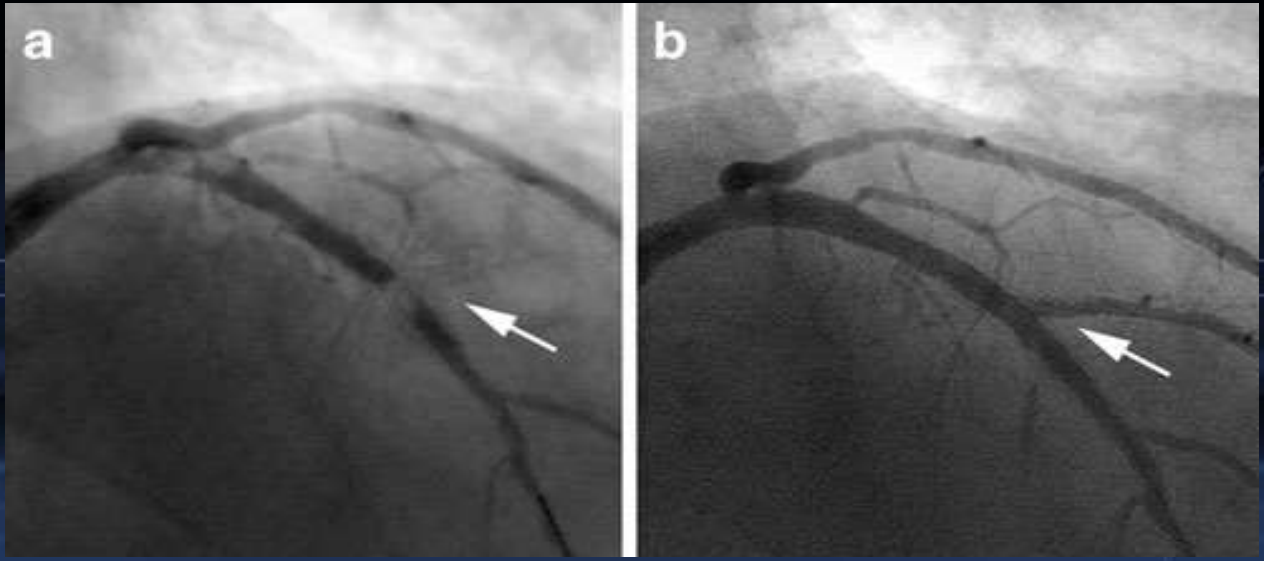


Slow flow pattern

Plaque

Thrombotic Complication During IVUS



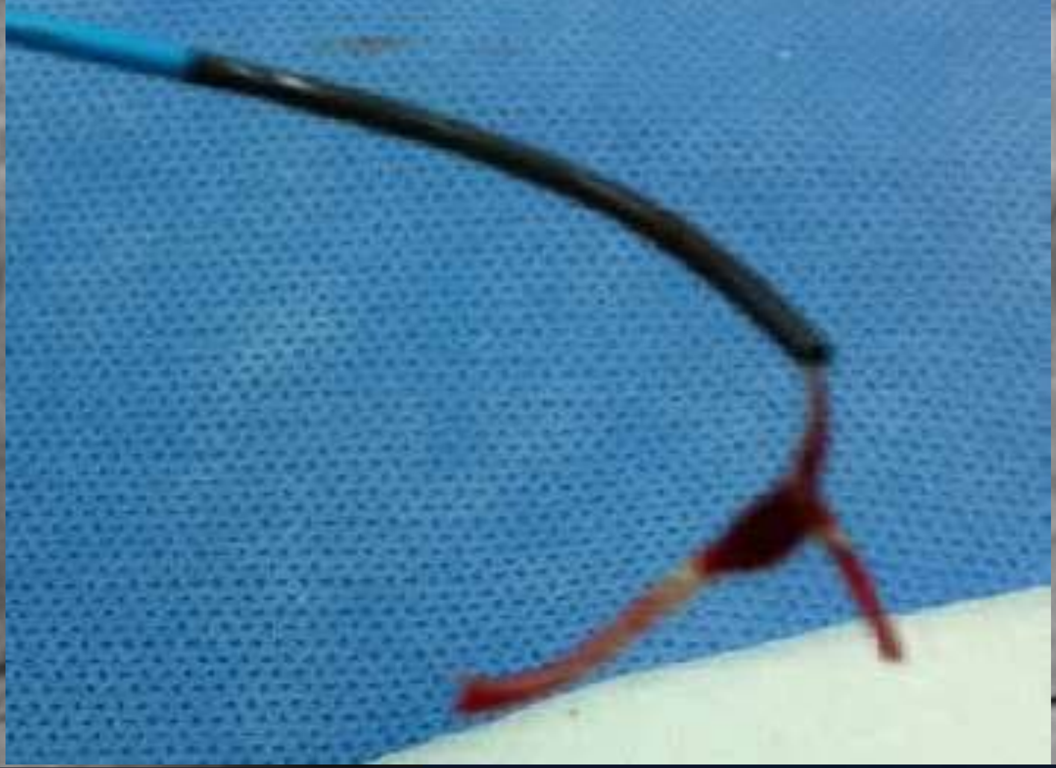


Thrombus aspiration, balloon dilatation, administration of GP IIb/IIIa blockers

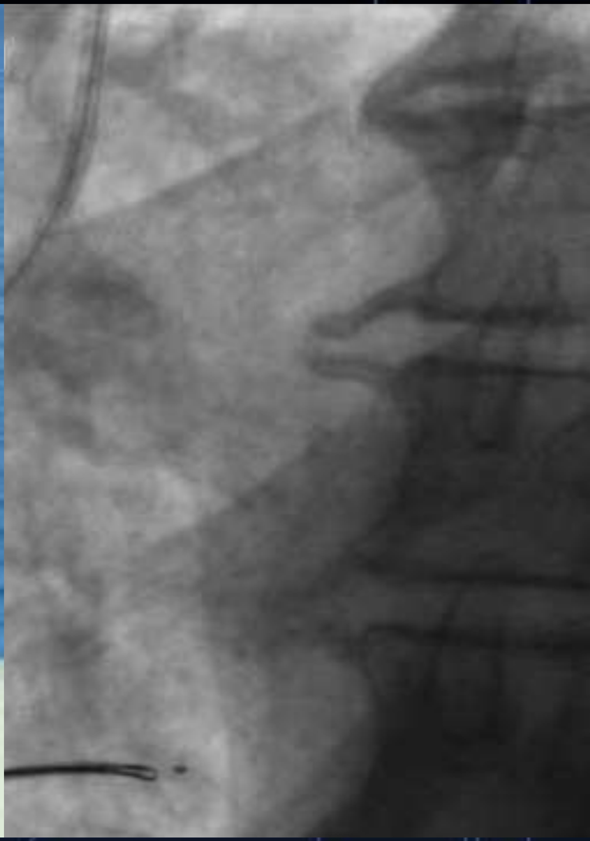
Neth Heart J 2012

Fracture of the IVUS Catheter

Distal marker of IVUS catheter

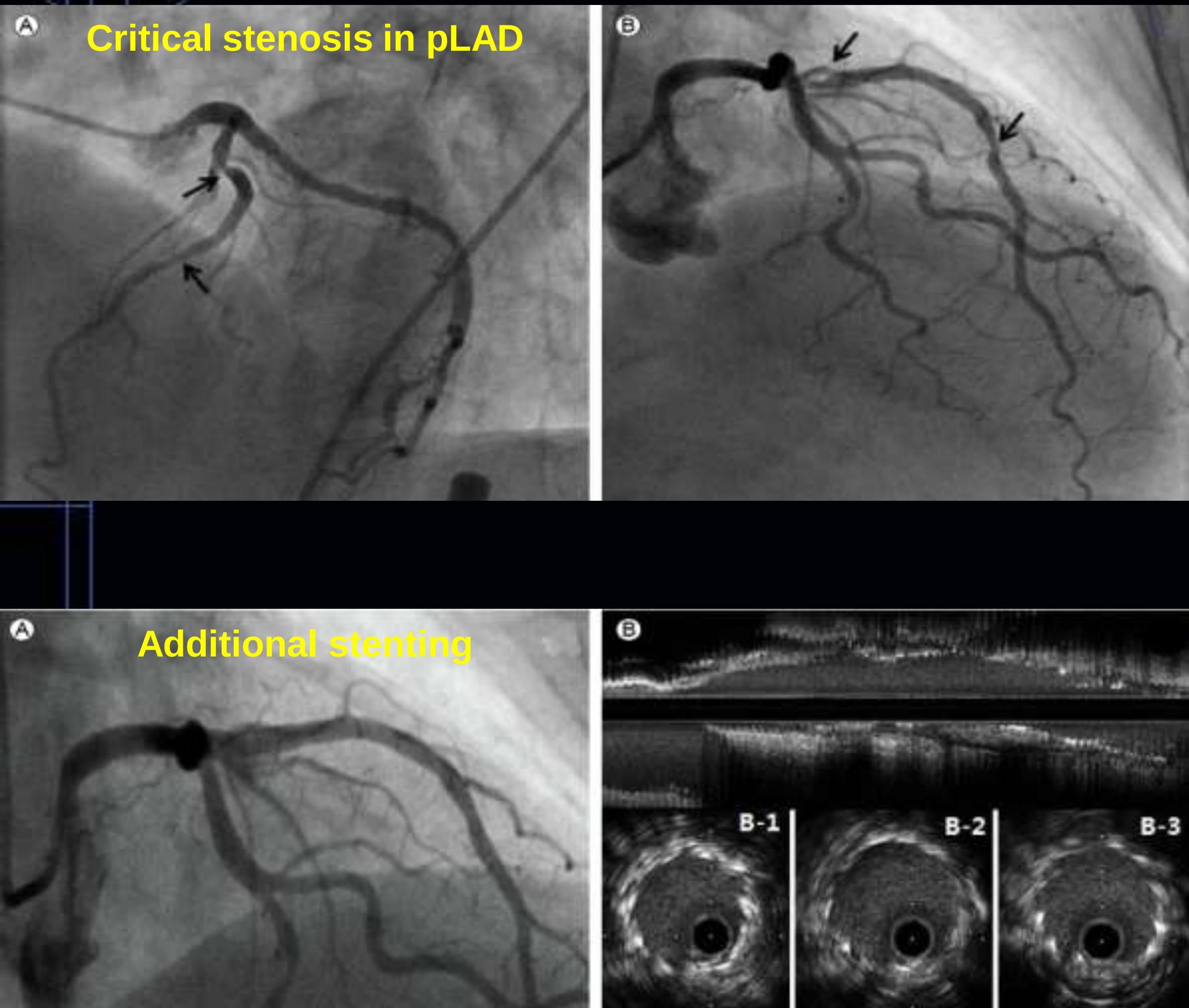


Retrieved IVUS catheter tip

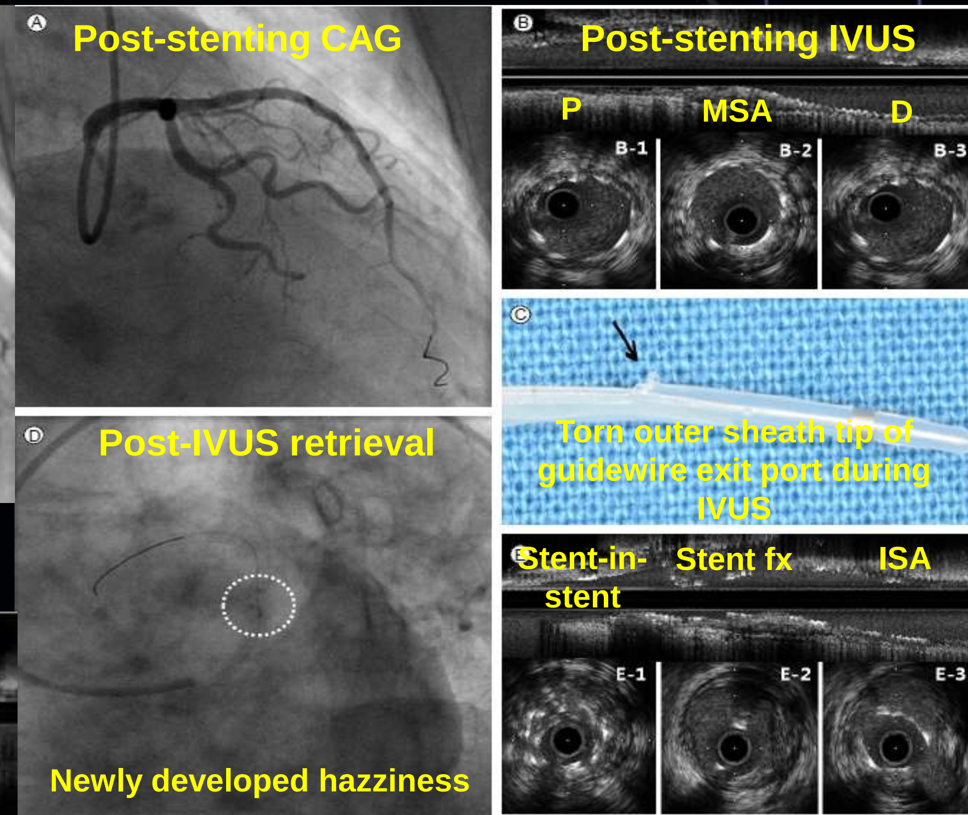


Loop snare catheter inserted through a 4F transport catheter

Stent Distortion Complicated by IVUS Catheter Entrapment During Pullback Interrogation



Stent-in-stent | Stent fx | ISA



Forceful removal of the IVUS catheter

Korean J Med 2013

IVUS-Related Complications

	Certain/uncertain complications		
	Hausmann et al (n=2207)	Batkoff et al (n=718)	Lopez-Palop et al (n=209)
Spasm	63 (2.9%) / 0	4 (0.6%) / 0	1 (0.5%) / 0
Acute procedural complications			
Occlusion	3/5	0/0	0/4
Dissection	1/3	2/0	1/1
Thrombus	1/0	0/0	0/0
Embolism	1/0	0/0	0/0
Arrhythmia	0/1	0/0	1/0
Total	6 (0.3%) / 9 (0.4%)	2 (0.3%) / 0	2 (1.0%) / 5 (2.4%)
Major complications			
MI	3/2	0/0	0/0
CABG	0/3	0/0	0/0
Death	0/0	0/0	0/0
Total	3 (0.1%) / 5 (0.2%)	0/0	0/0

Overall, IVUS appears to be a relatively safe procedure.

Conclusions:
IVUS guided PCI

- Detecting vulnerable plaque
- Sizing a Stent
- Achieving stent optimization and detecting post-stenting complications

Use IVUS



Thank You For Your Attention