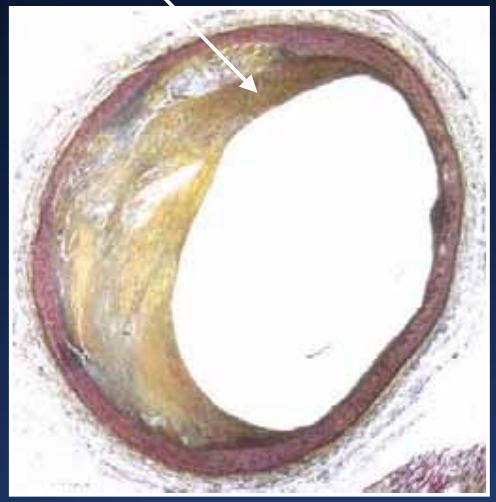
VH-IVUS
Native Plaque and Neointima

Jung-Min Ahn

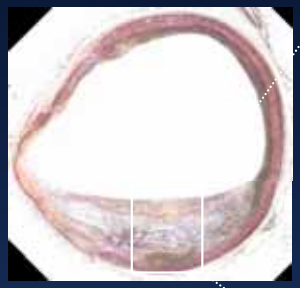
University of Ulsan College of Medicine
Asan Medical Center, Seoul, Korea

Fibrous Tissue



Densely packed collagen fibers with no evidence of lipid accumulation. No evidence of macrophage infiltration.

Necrotic Core

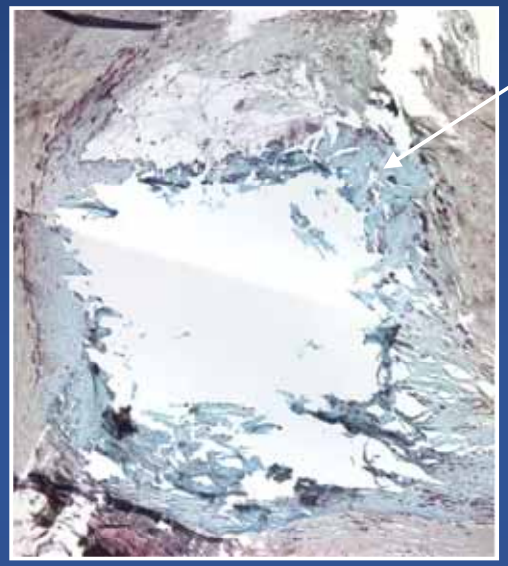


Highly lipidic necrotic region with remnants of foam cells and dead lymphocytes. No collagen fiber, Cholesterol clefts and micro calcifications

Fibro-Fatty

Loosely packed bundles of collagen fibers with regions of lipid deposition present. No cholesterol clefts or necrosis. Increase in extra-cellular matrix

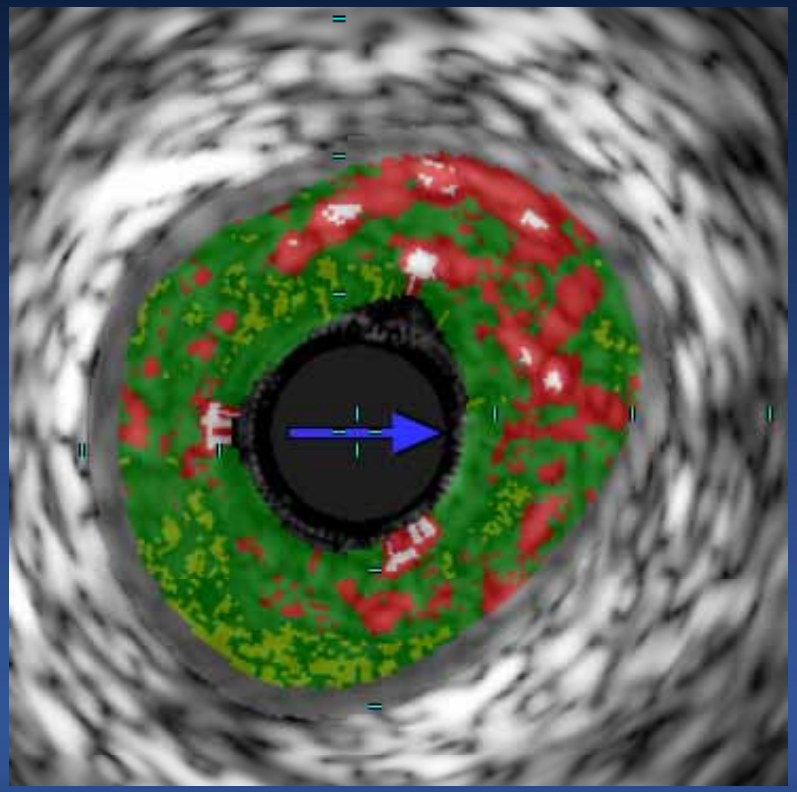
Dense Calcium



Focal dense calcium

Virtual Histology - IVUS

In-vivo characterization of plaque composition via advanced spectral analysis



- Fibrotic
- Fibro-Fatty
- Necrotic Core
- Dense Calcium

Validation of VH-IVUS with Histology

20MHz Electronic Array Transducer
in 51 post mortem LADs (115 sections, 407 ROIs)

	Sensitivity	Specificity	Accuracy
Fibrous tissue	84%	99%	93%
Fibrofatty	87%	95%	93%
Necrotic core	97%	94%	94%
Dense calcium	98%	99%	99%

Nair et al. Eurointervention 2007;3:113-20

Reproducibility of VH-IVUS

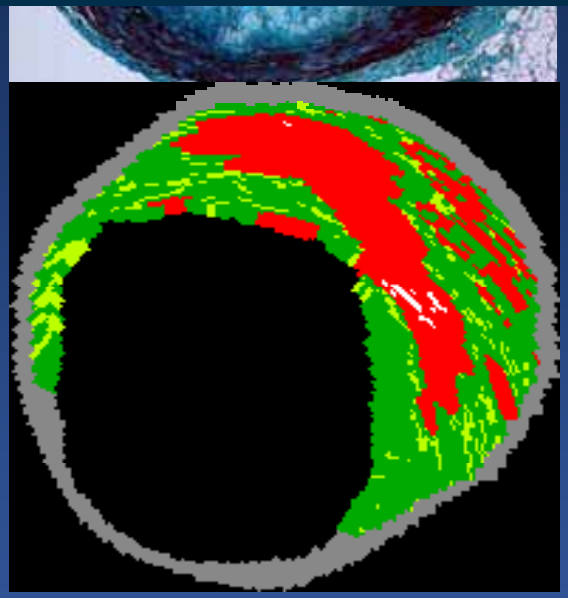
	Intra-observer		Inter-observer
	Same pullback	Repeated pullback	Same pullback
Fibrous tissue	0.45±2.1%	1.40±4.1%	-1.60±4.9%
Fibrofatty	-1.12±4.9%	1.26±6.7%	3.85±8.2%
Necrotic core	-0.22±1.8%	0.85±4.4%	-1.58±4.7%
Dense calcium	-0.84±2.1%	2.66±7.4%	1.66±7.5%

Hartmann et al. J Cardiovasc Imaging 200;25:13-23

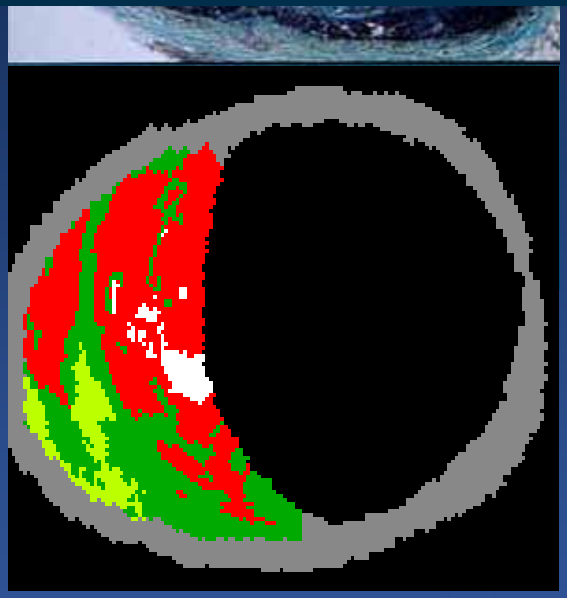
Criteria of TCFA

In at least 3 consecutive frames:

1) Necrotic core **≥ 10%**
2) without evident overlying fibrous tissue
3) Percent atheroma area **≥ 40%**



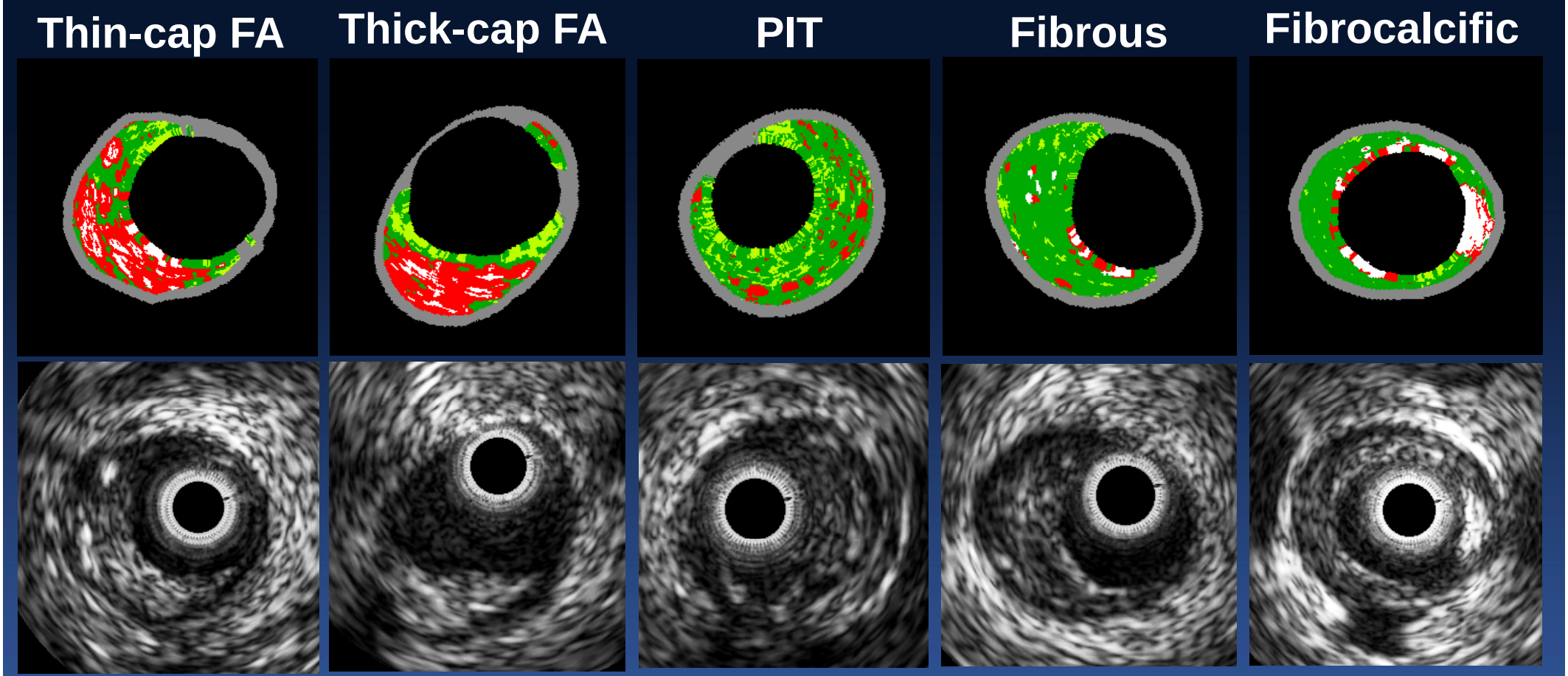
Thick fibrous cap
Low lipid conc
Low macrophage density



Thin fibrous cap
High lipid conc
High macrophage density

Rodriguez-Granillo et al. J Am Coll Cardiol 2005;46:2038–42

VH-IVUS Classification



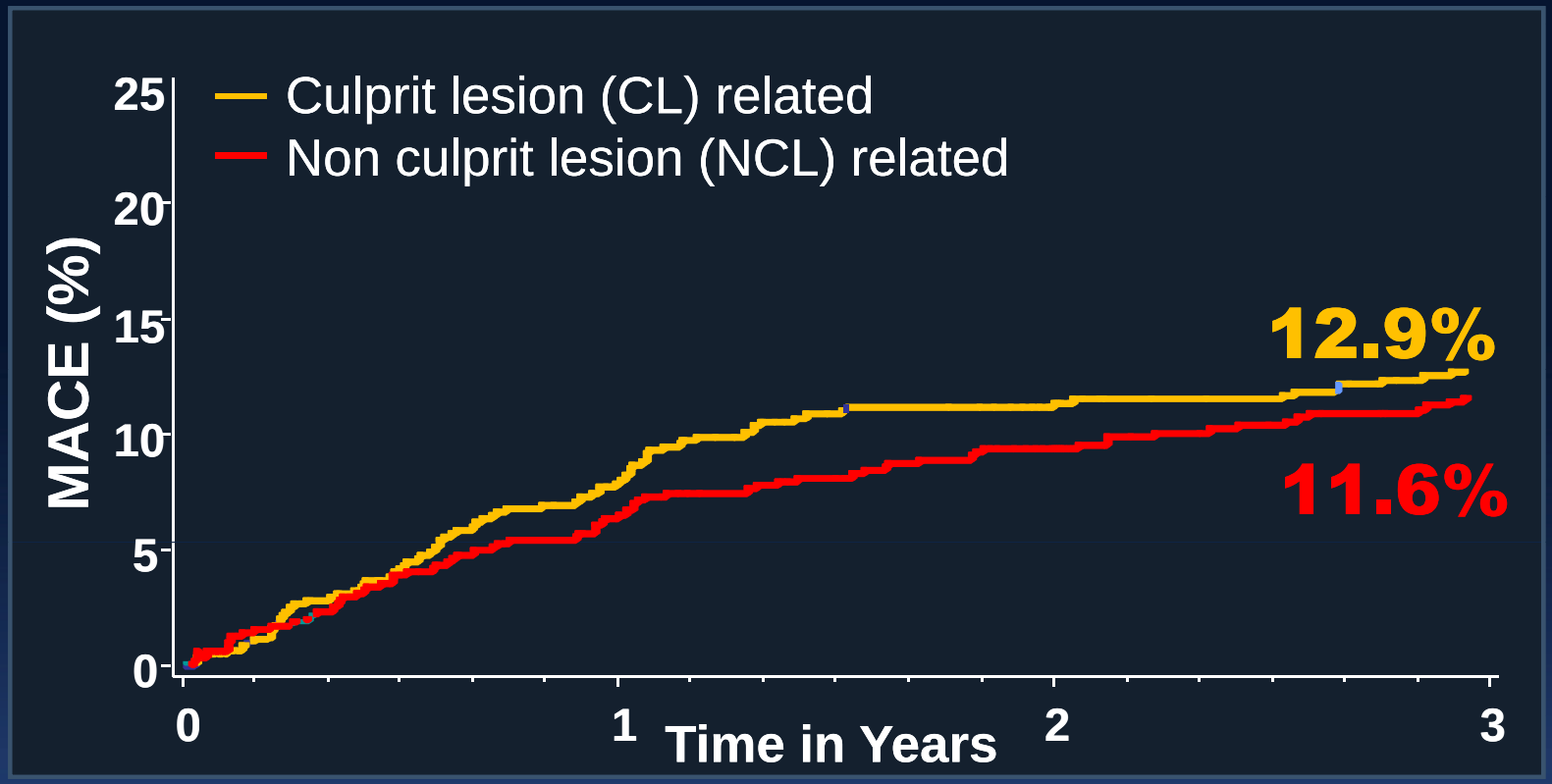
More than 10%
Confluent
Necrotic Core

More than 15%
Fibrofatty

NO more than 10%
Confluent Necrotic
Core

More than 10%
confluent
calcium

PROSPECT 3-year MACE (N=697 ACS pts.)

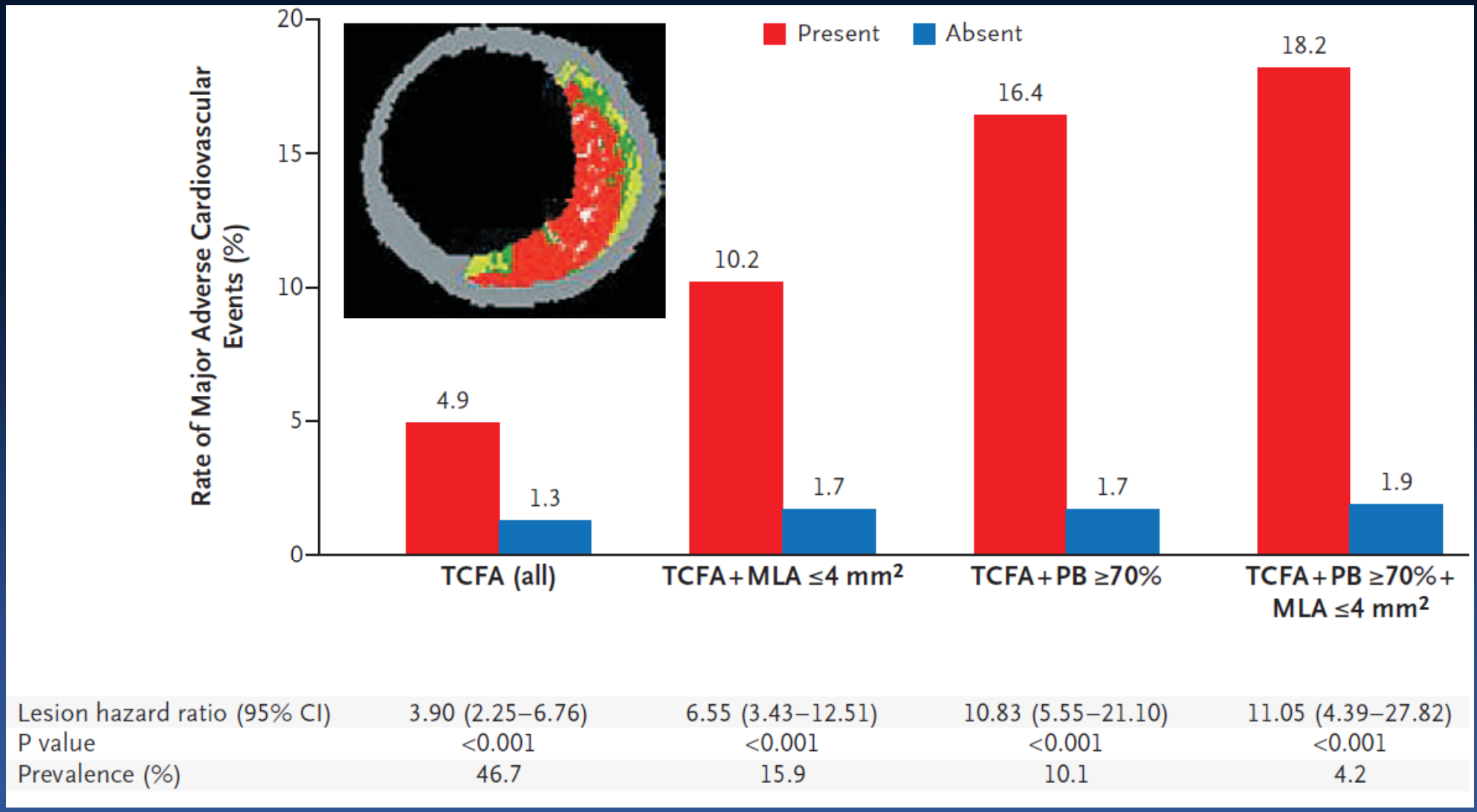


*MACE = cardiac death, arrest, MI, rehospitalization for unstable/ progressive angina

	HR [95% CI]	p value
PB_{MLA} ≥70%	5.03 [2.51-10.11]	<0.001
VH-TCFA	3.35 [1.77-6.36]	<0.001
MLA ≤4.0 mm^2	3.21 [1.61-6.42]	0.001

Stone G et al. N Engl J med 2011;364:226-35

VH-TCFA and Non-culprit Events

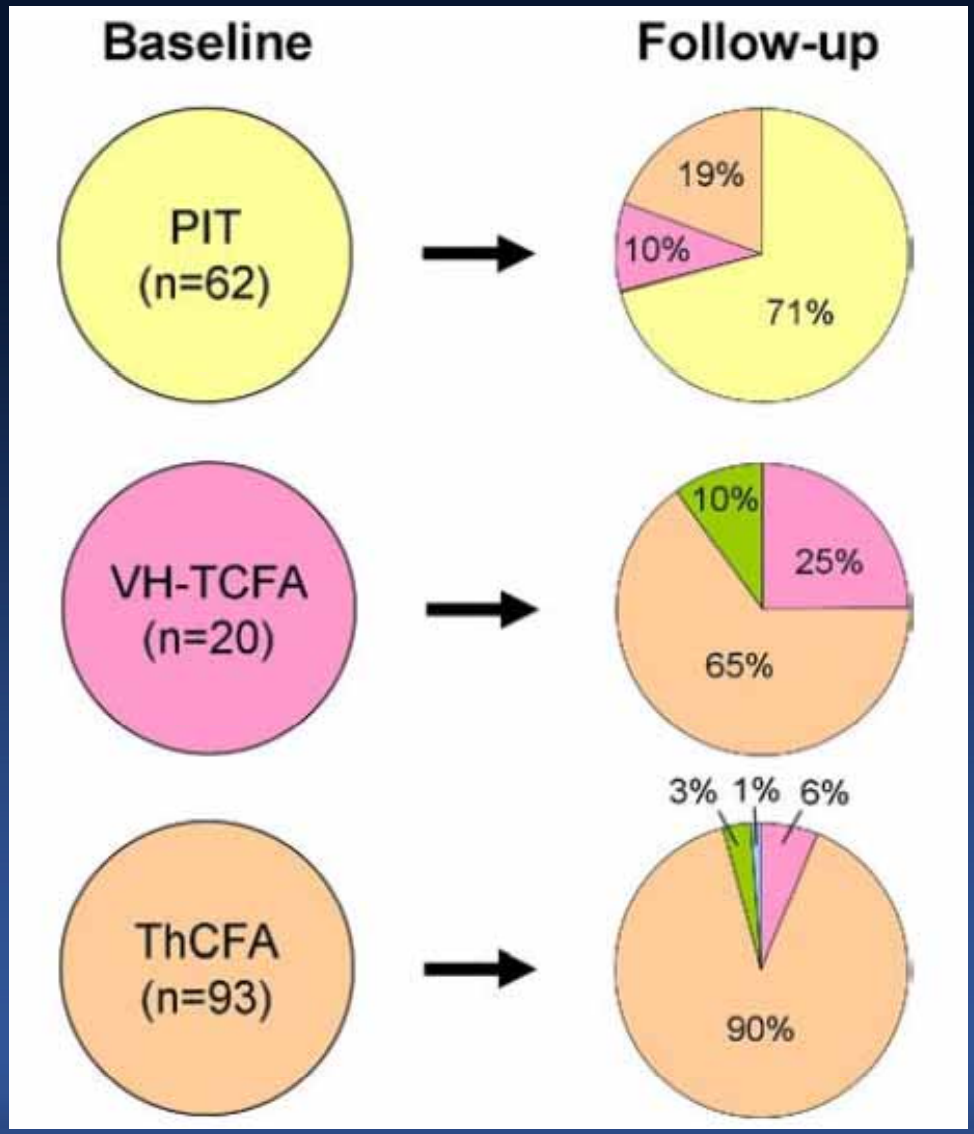


Lesion hazard ratio (95% CI)	3.90 (2.25–6.76)	6.55 (3.43–12.51)	10.83 (5.55–21.10)	11.05 (4.39–27.82)
P value	<0.001	<0.001	<0.001	<0.001
Prevalence (%)	46.7	15.9	10.1	4.2

Stone G et al. N Engl J med 2011;364:226-35

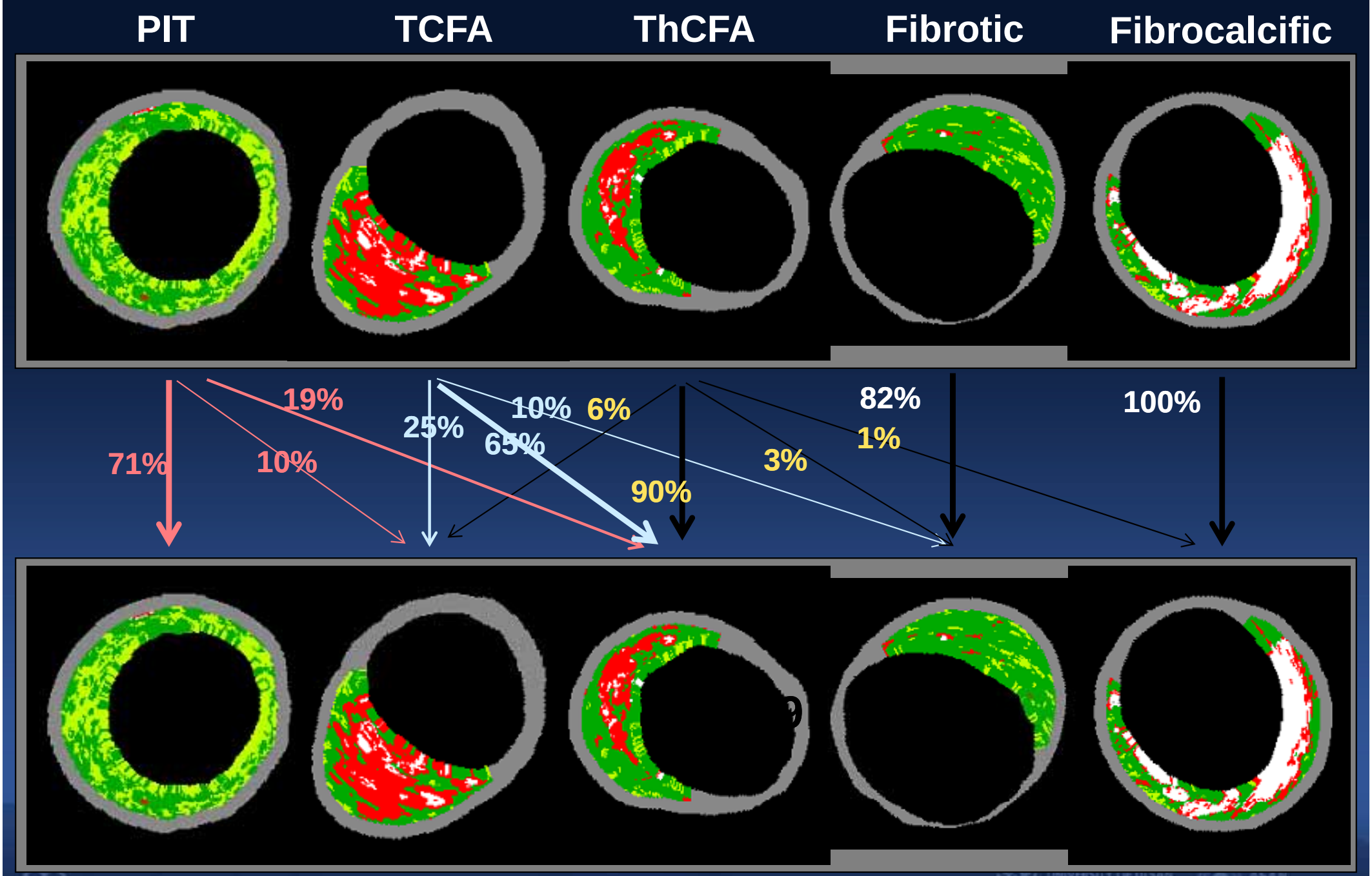
Dynamic Natural History of TCFA

(Global VH-IVUS Registry of CRF, NY)

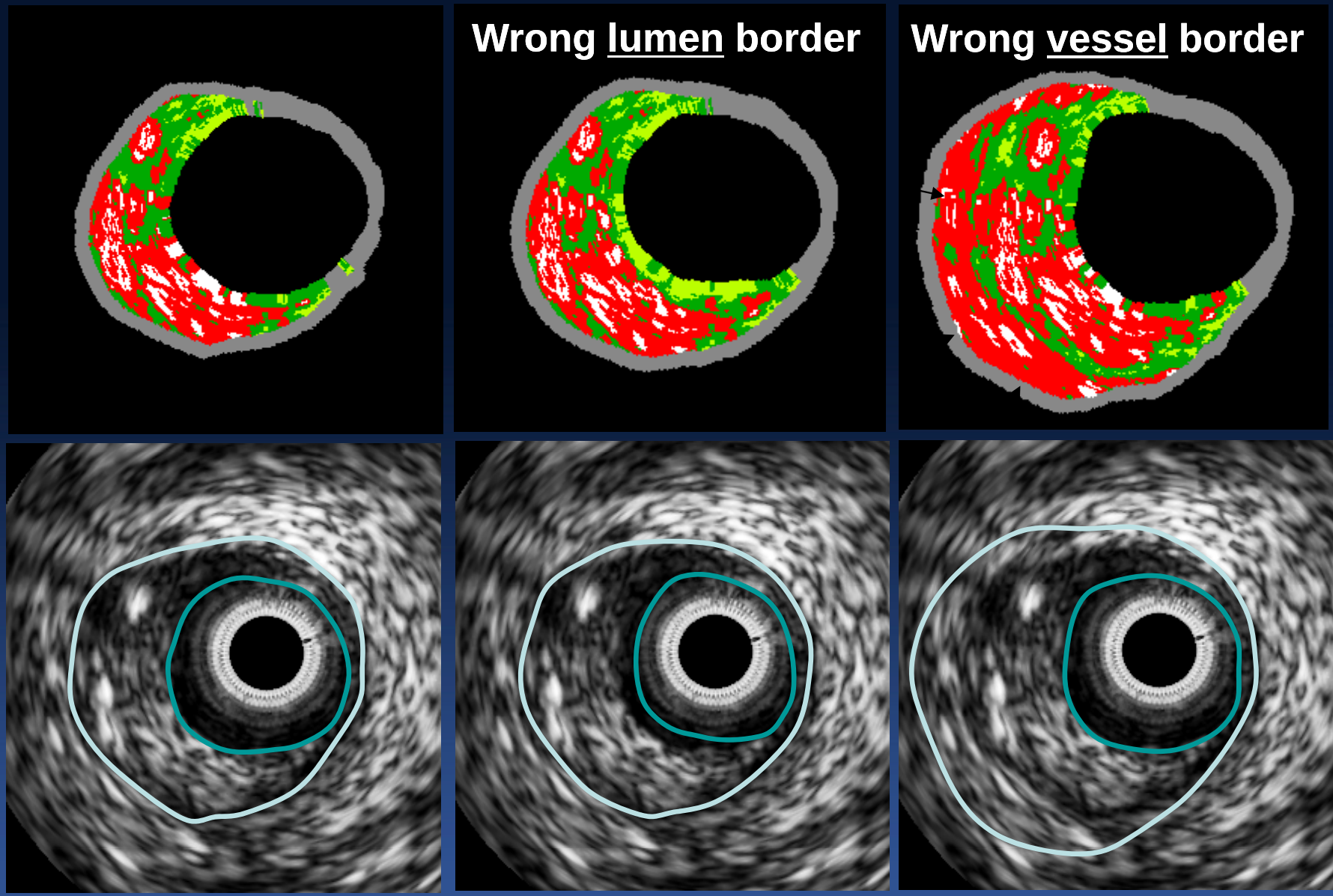


Kubo et al. J Am Coll Cardiol 2010;55:1590-7

Change of Plaque Type

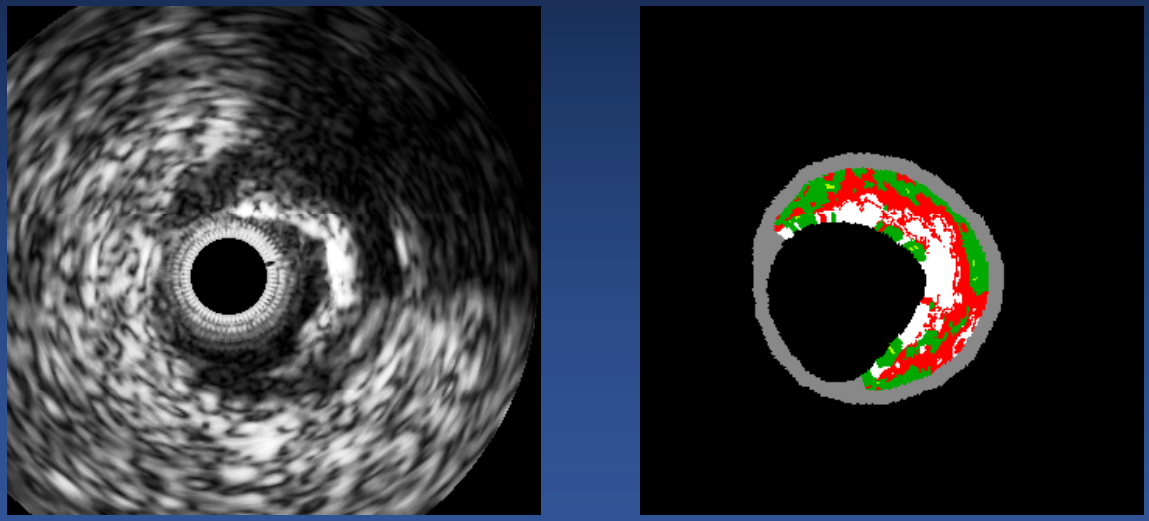


Kubo T, JACC 2010;55:1590


Wrong lumen border
Wrong vessel border

Plaque Behind Calcium

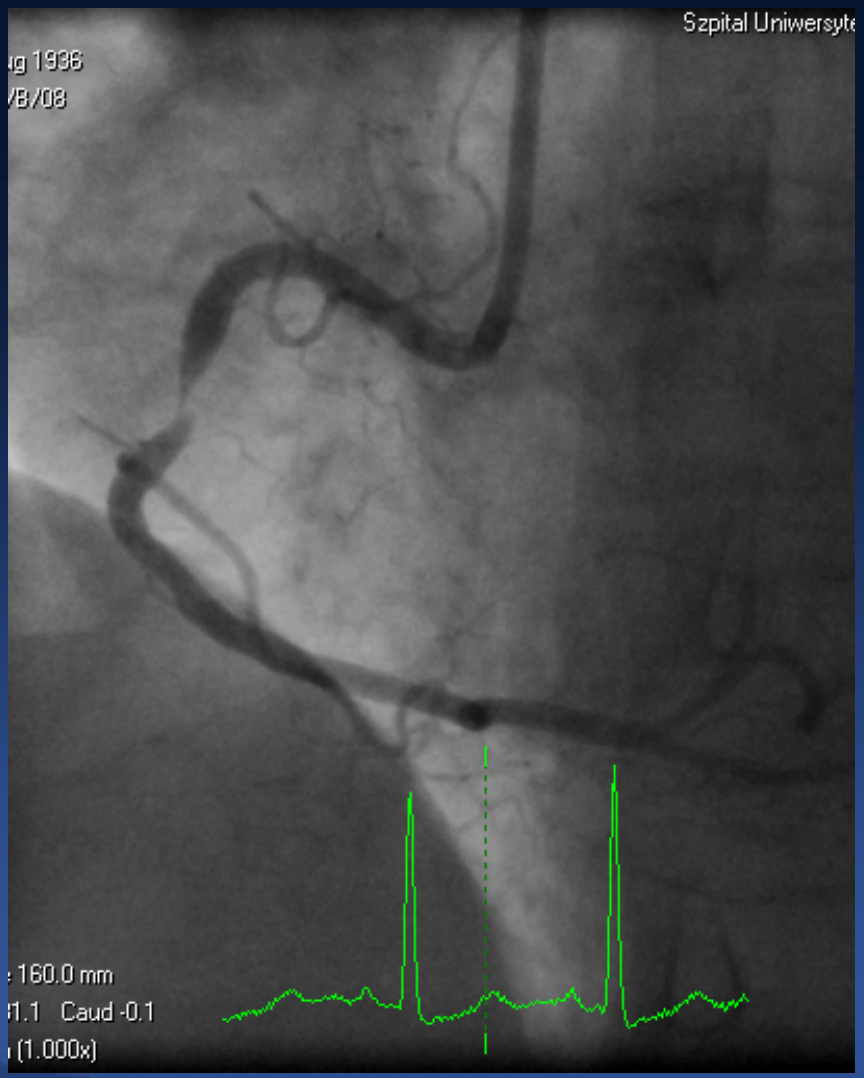
- Using 20MHz transducer, 80% of ROI behind calcium contained both reflected ultrasound signal and noise, while 20% of ROIs behind calcium had only noise
- When inaccurate, tissue is classified as NC (65% of the time), as FT (18%of the time) and As FF (14% of the time)
- When the calcium>90 ° NC rarely correlated with LCBI

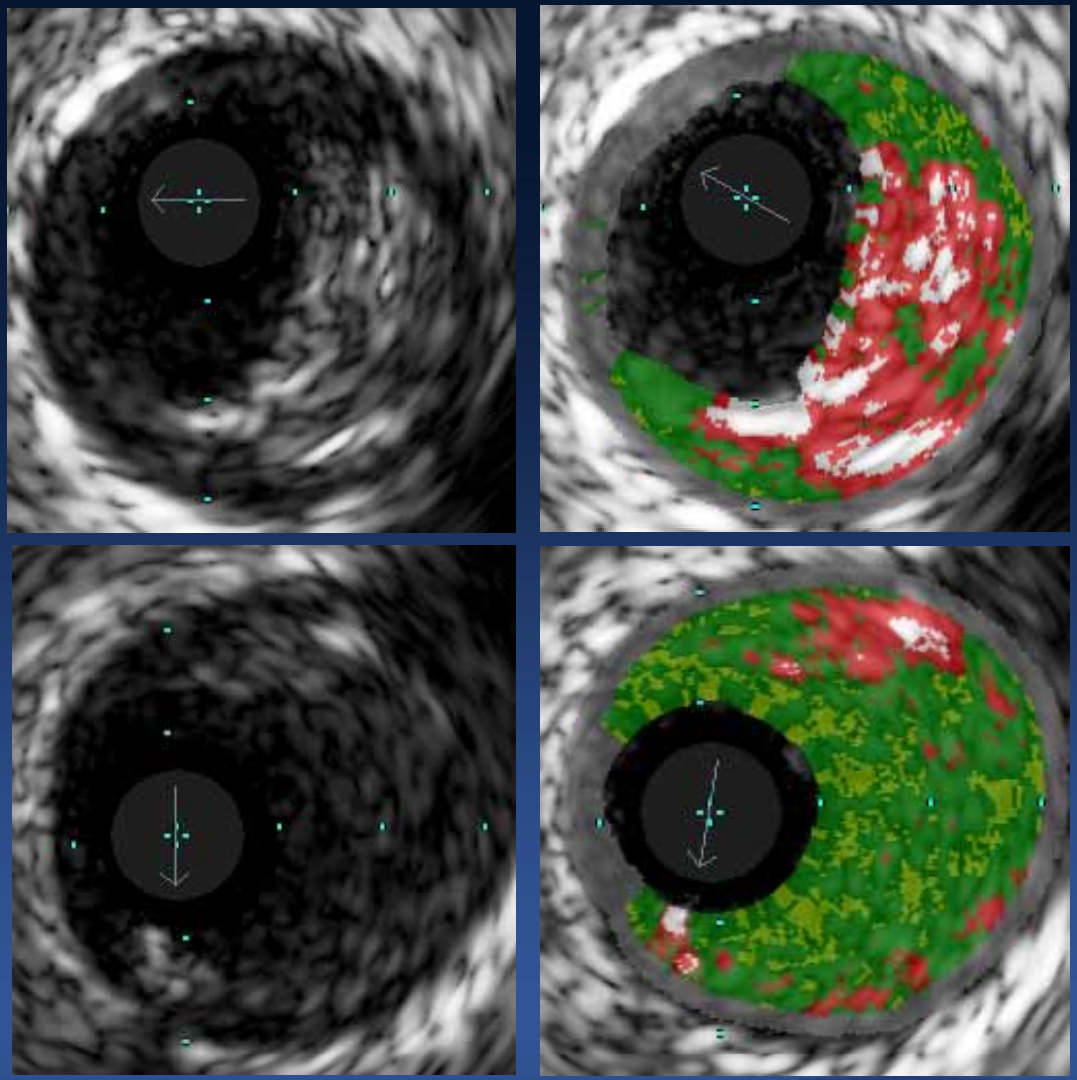


Tanaka et al. J Am Coll Cardiol 2007;49:29B

Thrombi-containing Lesion

- Thrombus-containing lesion is classified as PIT or fibrotic
- Superficial thrombus cause a TCFA to be misclassified as a ThFCA

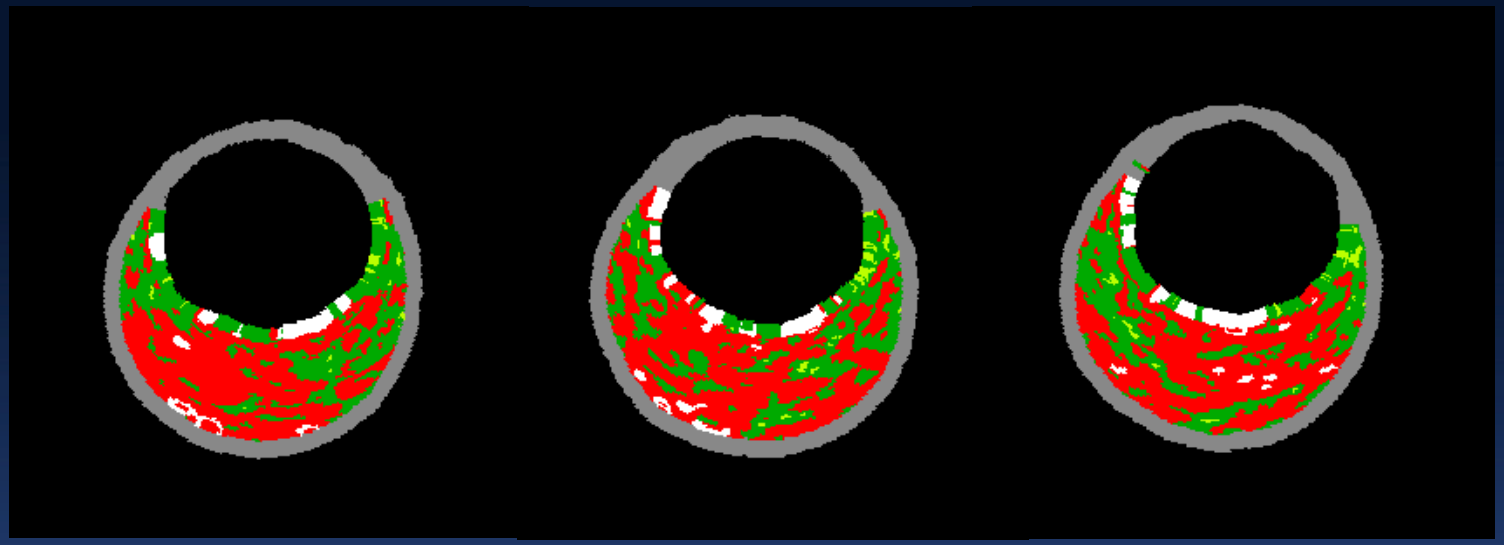


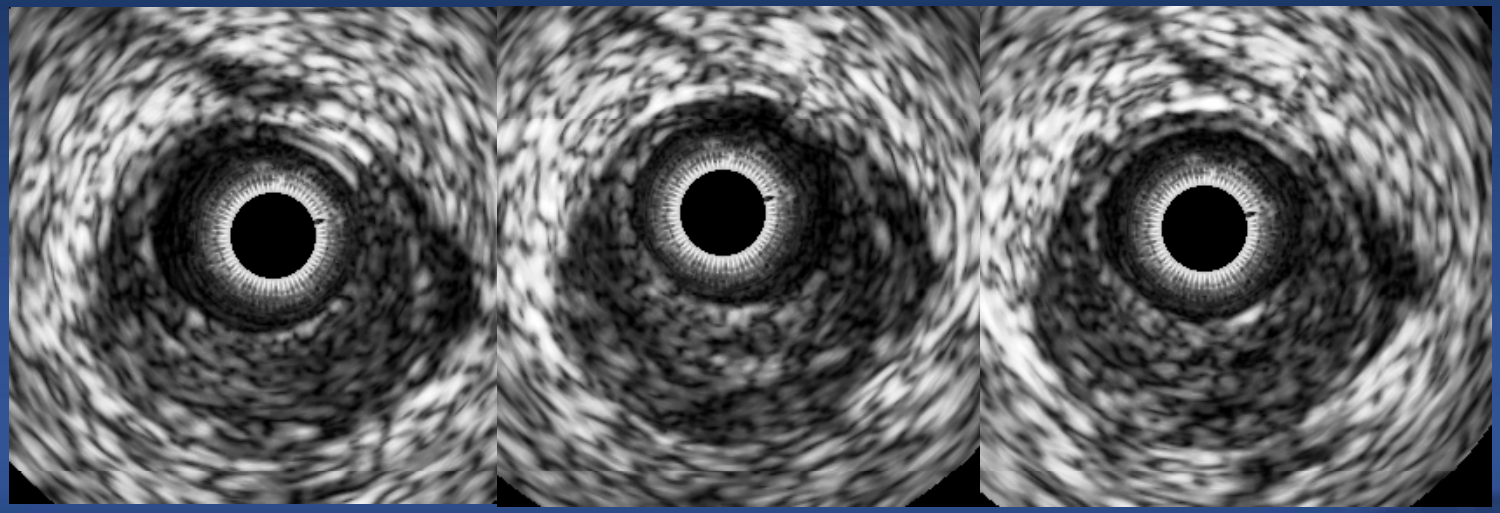


Nasu et al Am J Cardiol 2008;101:1079-83

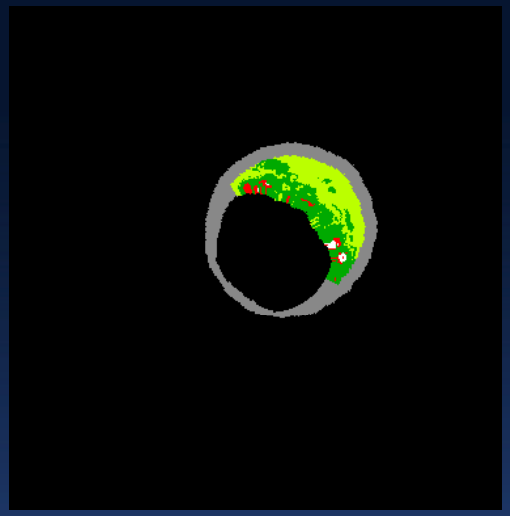
Artifacts

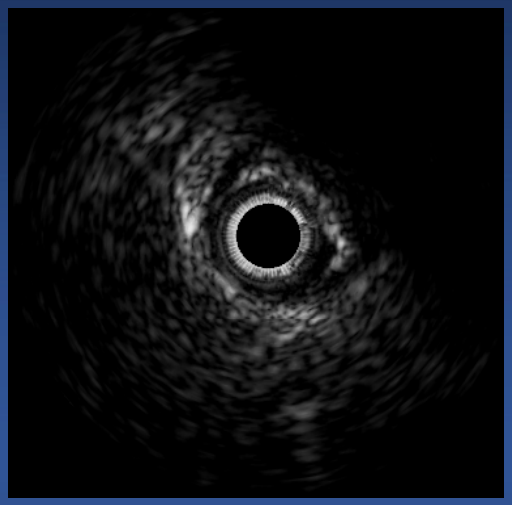
Isolated white pixels on the lumen interface further confound the diagnosis of a VH-TCFA



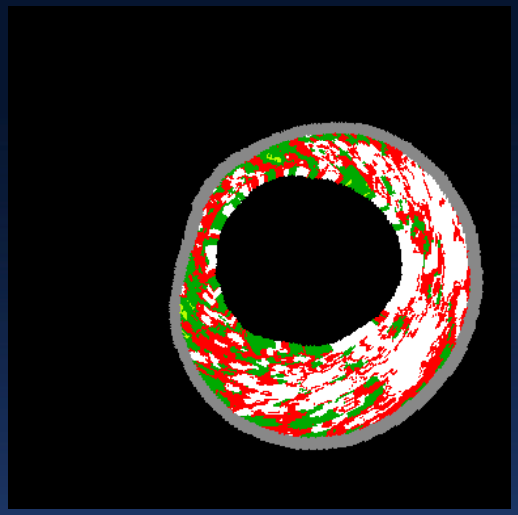


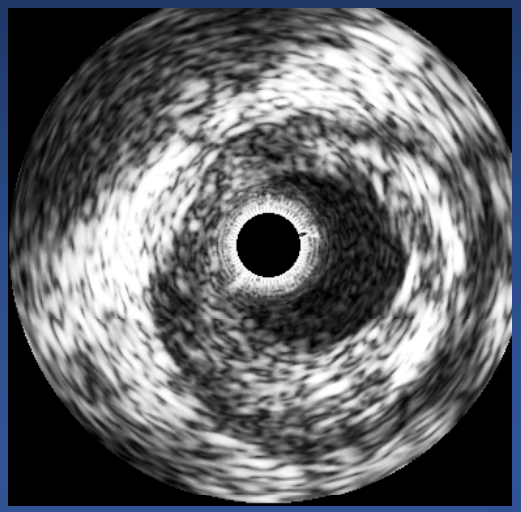
Weak Transducer Power





Strong Transducer Power

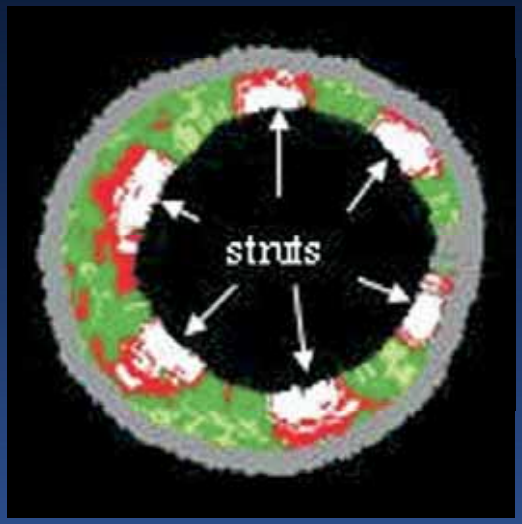




VH-IVUS Findings in Stented Lesions

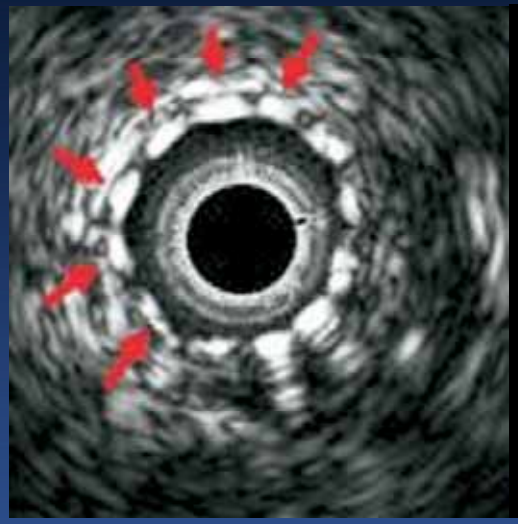
Stent metal appears white (reported by the algorithm as calcium) with or without surrounding 'peri-stent red halo'

White surrounded by 'Red' (80%)



White without 'Red' (2%)

Not detectable struts (17%)

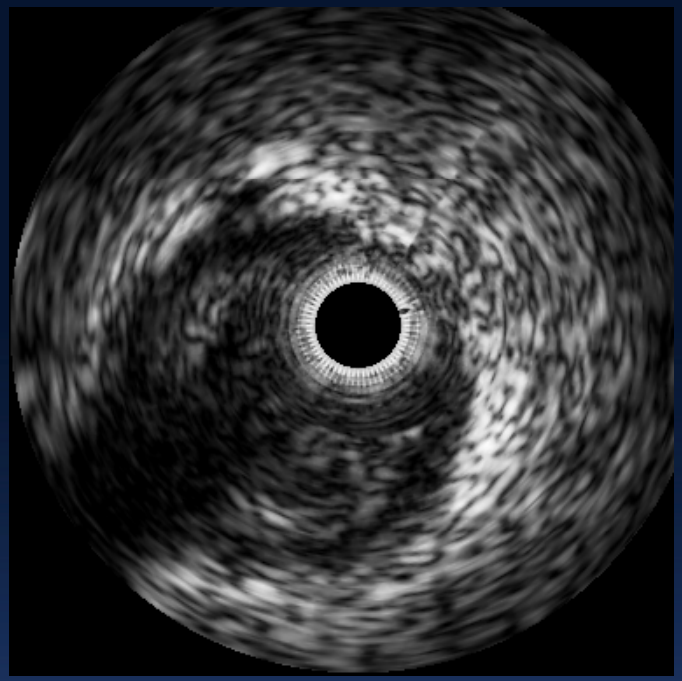


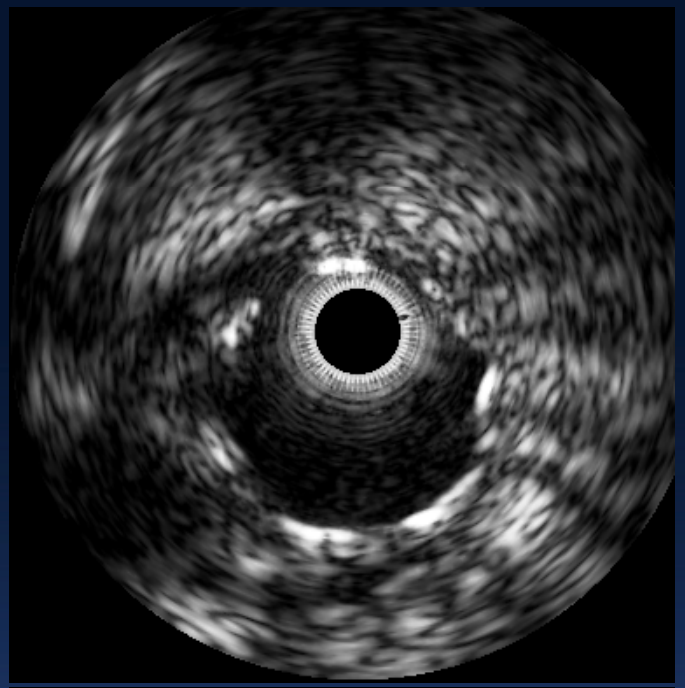
Kim et al. Am J Cardiol 2008;102:1182-6

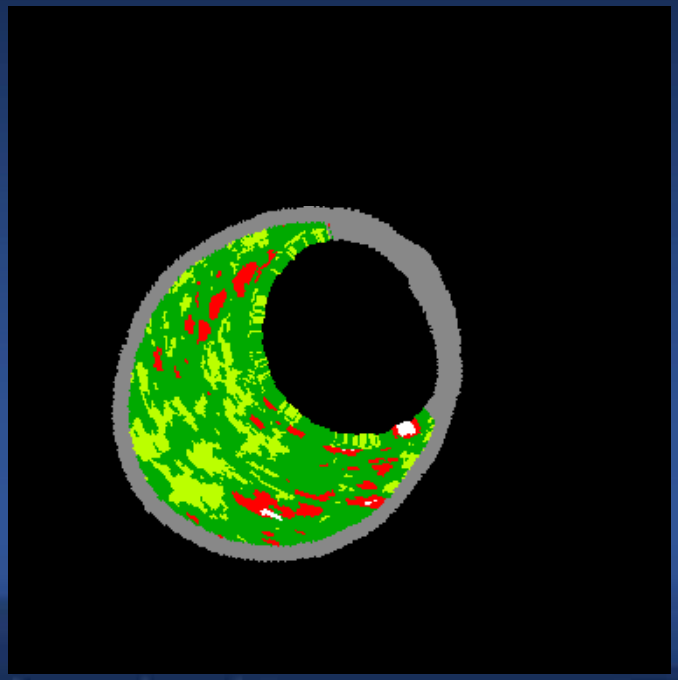
Compared with grayscale IVUS, struts were obscured by artificially imposed gray medial stripe

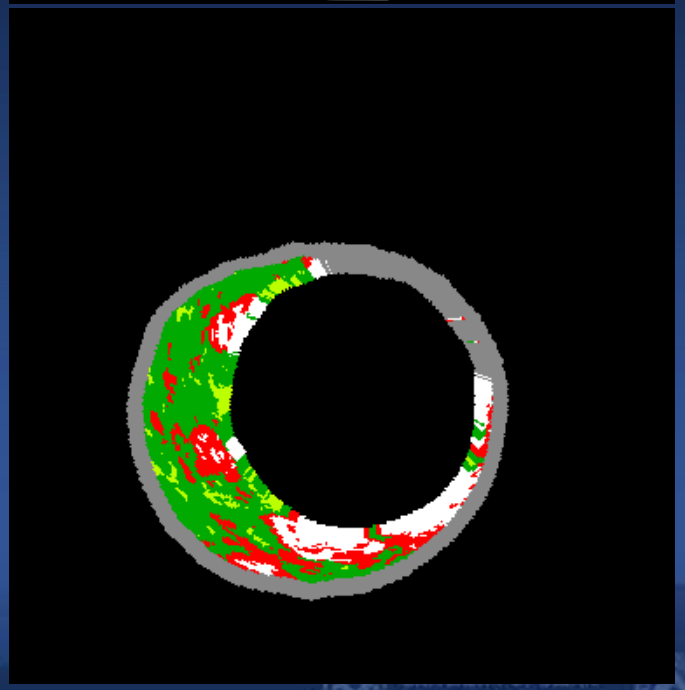
Before-Stent

Post-Stent

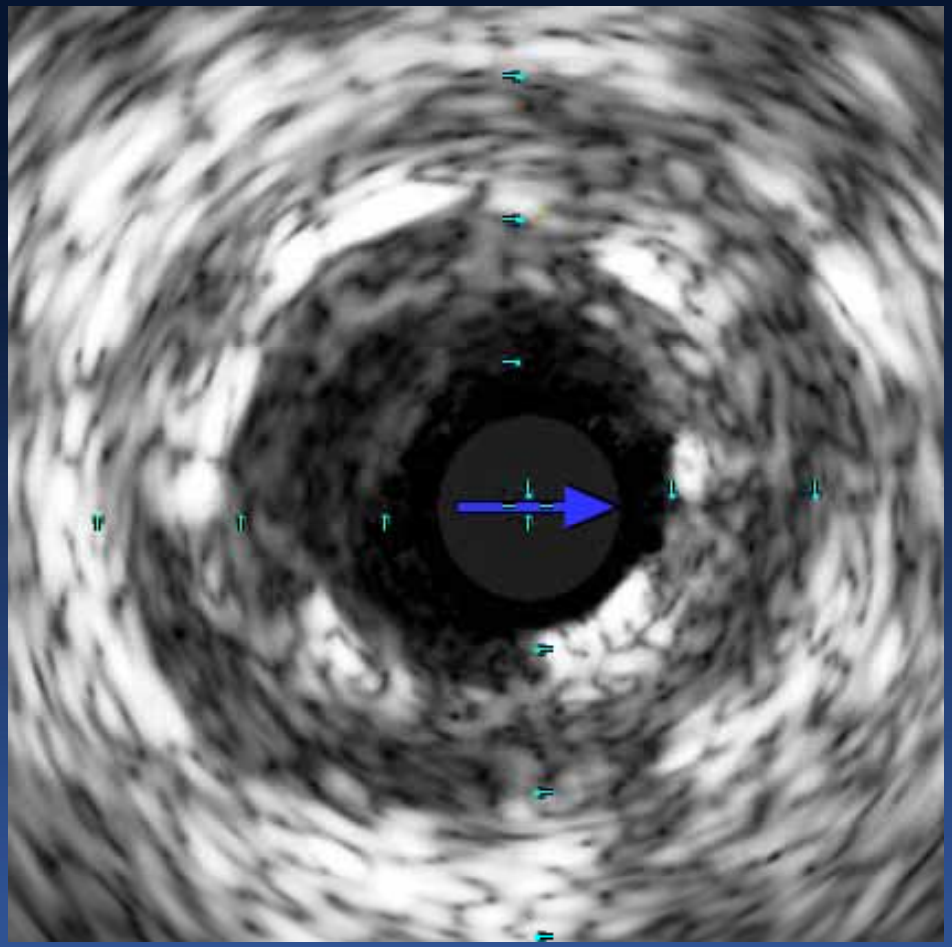


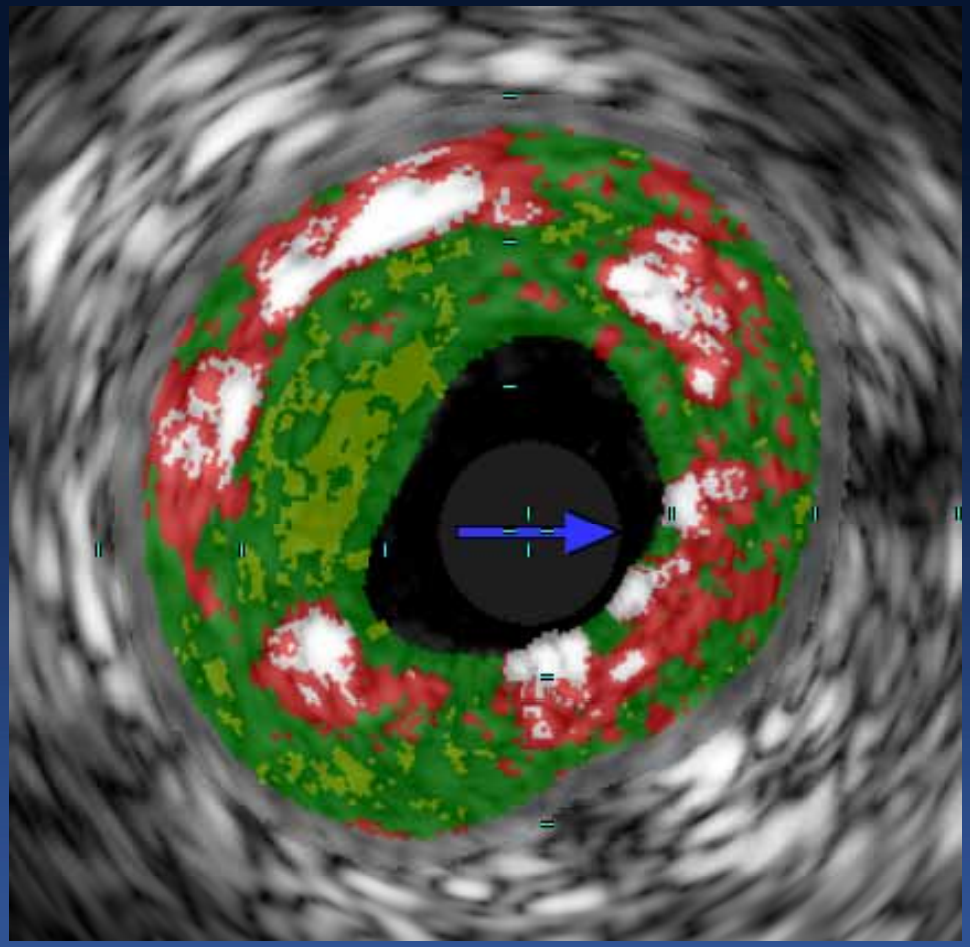




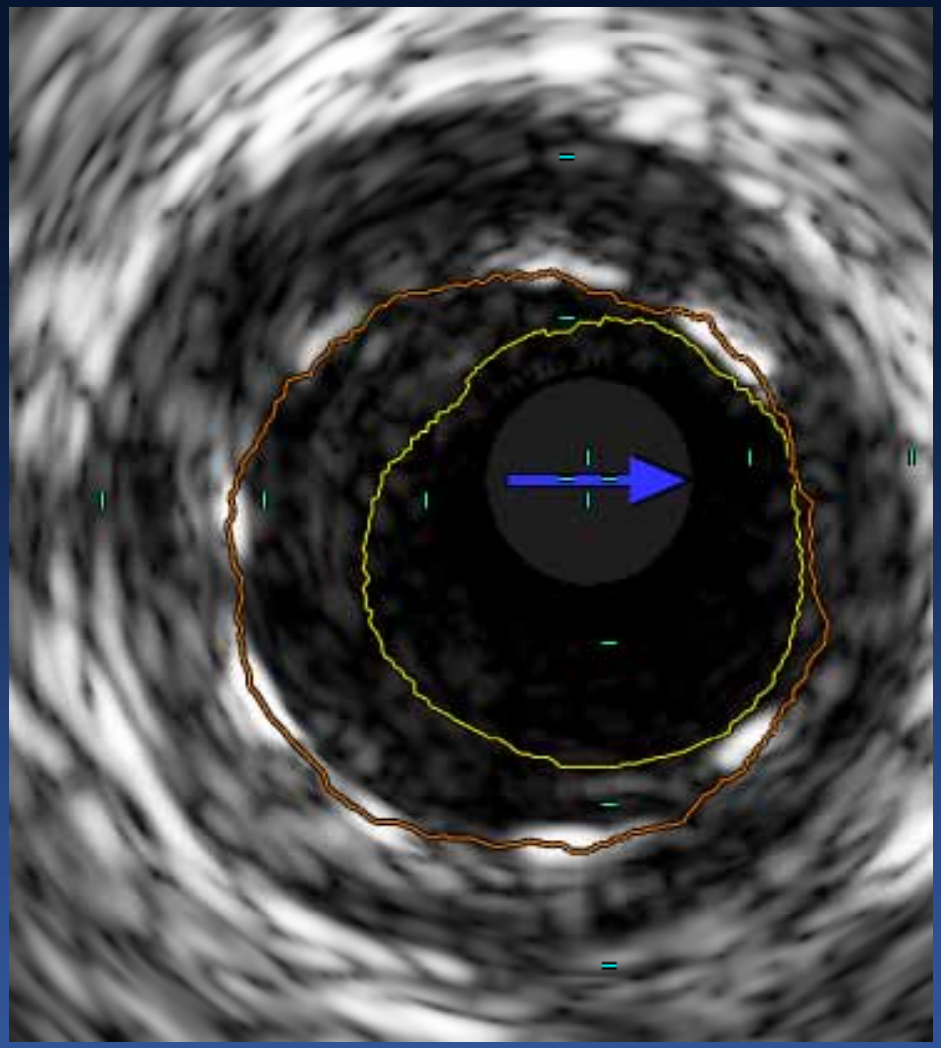


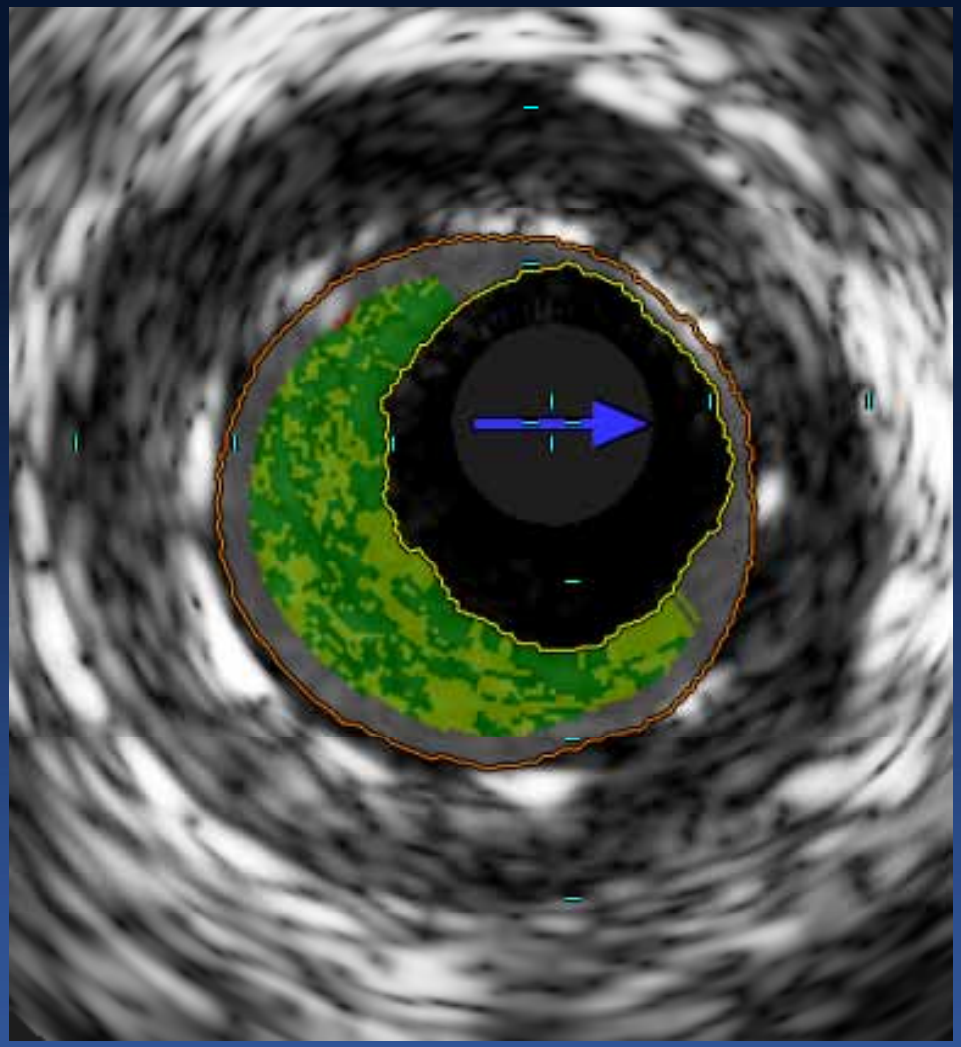
Stent Strut & Peri-Stent Tissue





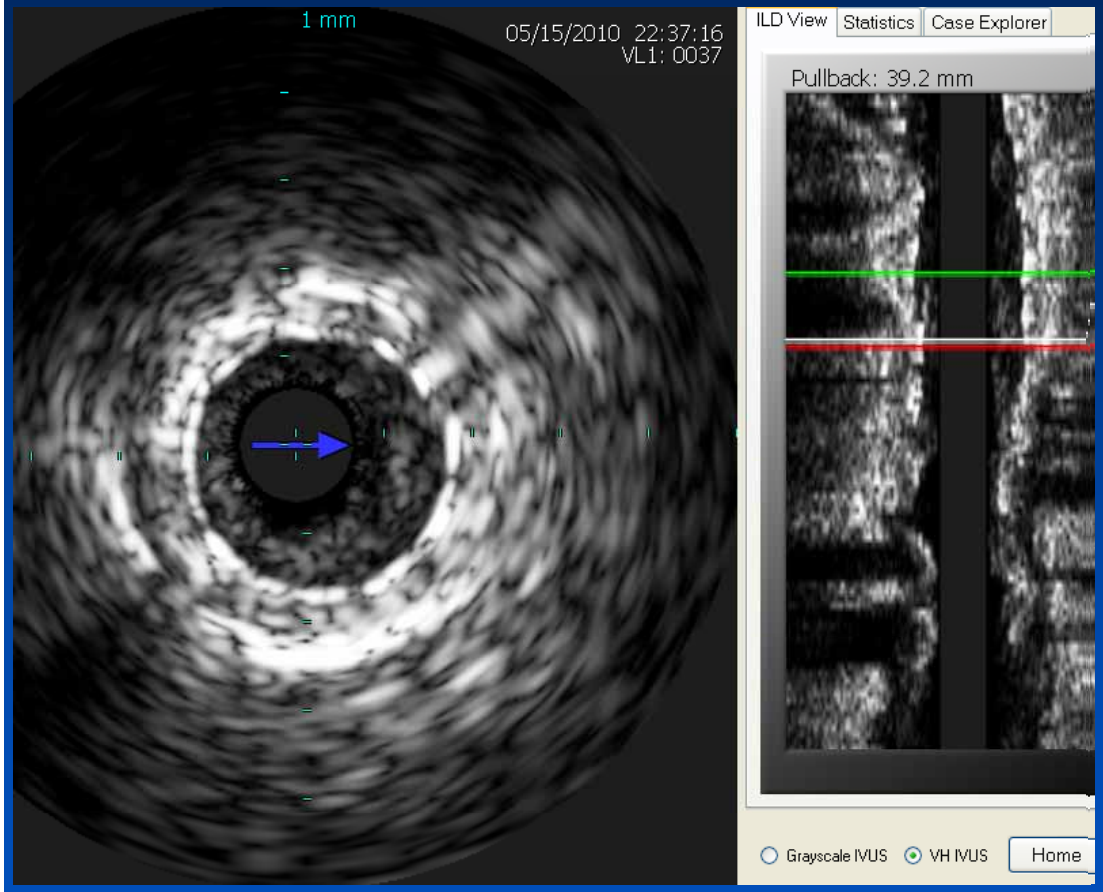
VH imaging of Neointima

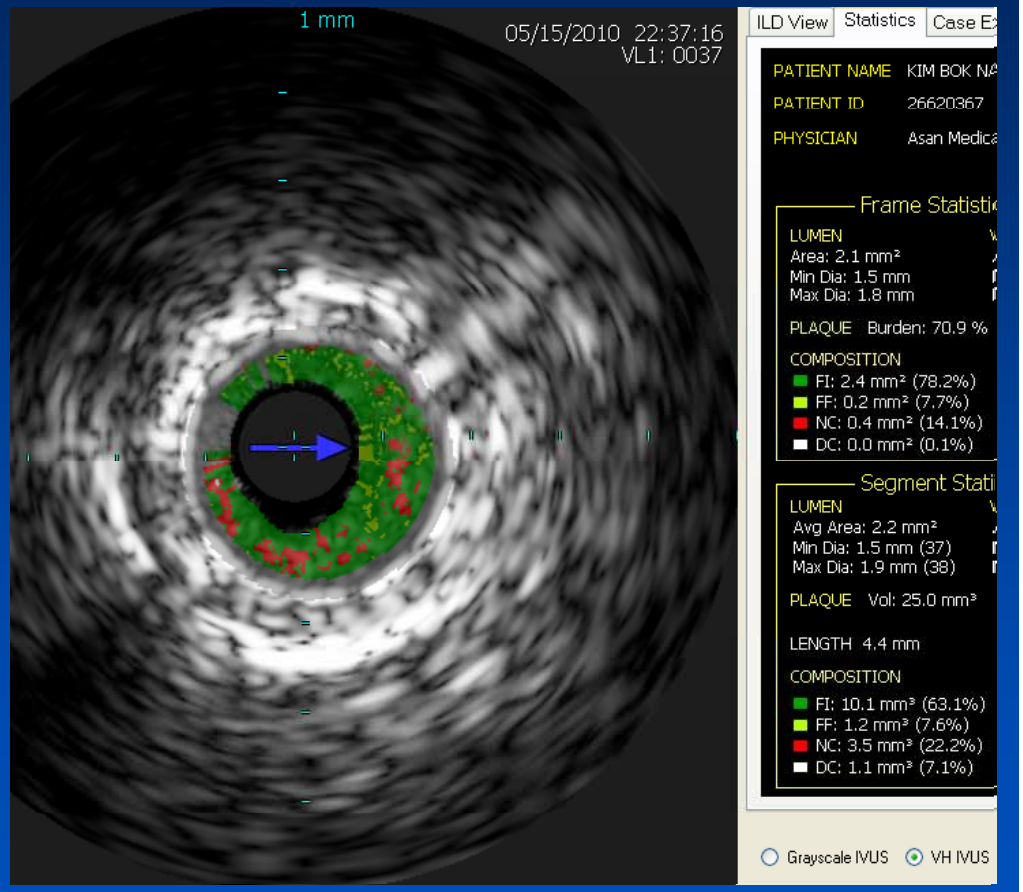




71 Year-Old Female

- Unstable angina
- 8 YA s/p BMS at pRCA and mLAD





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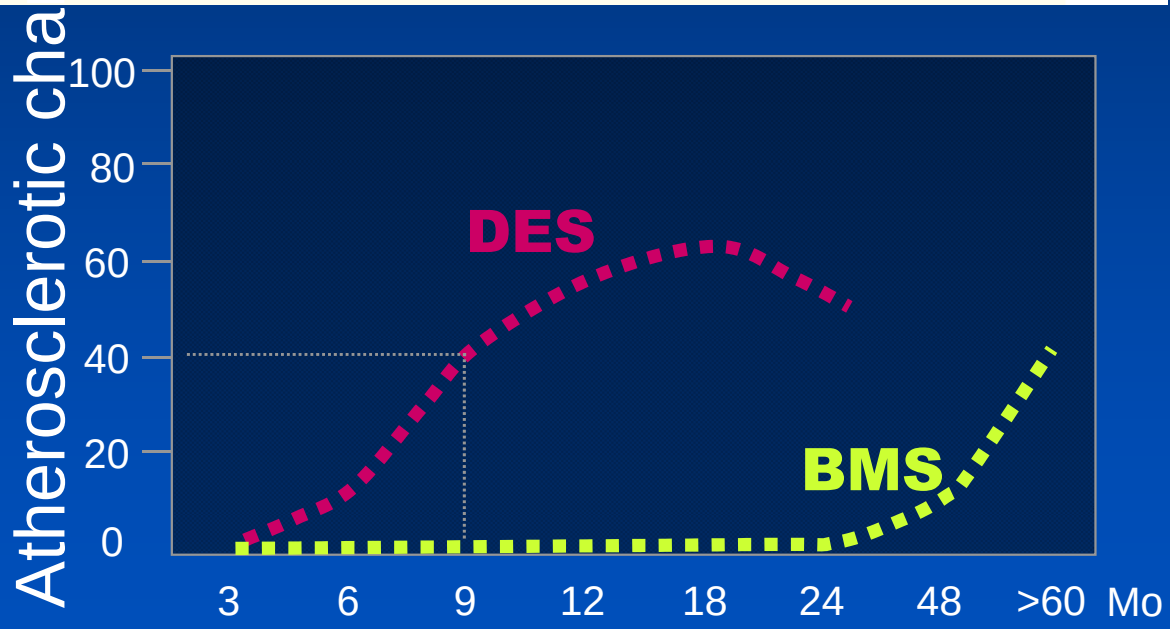
EXPEDITED PUBLICATIONS

The Pathology of Neoatherosclerosis in Human Coronary Implants

Bare-Metal and Drug-Eluting Stents

Gaku Nakazawa, MD,* Fumiyuki Otsuka, MD,* Masataka Nakano, MD,* Marc Vorpahl, MD,* Saami K. Yazdani, PHD,* Elena Ladich, MD,* Frank D. Kolodgie, PHD,* Aloke V. Finn, MD,† Renu Virmani, MD*

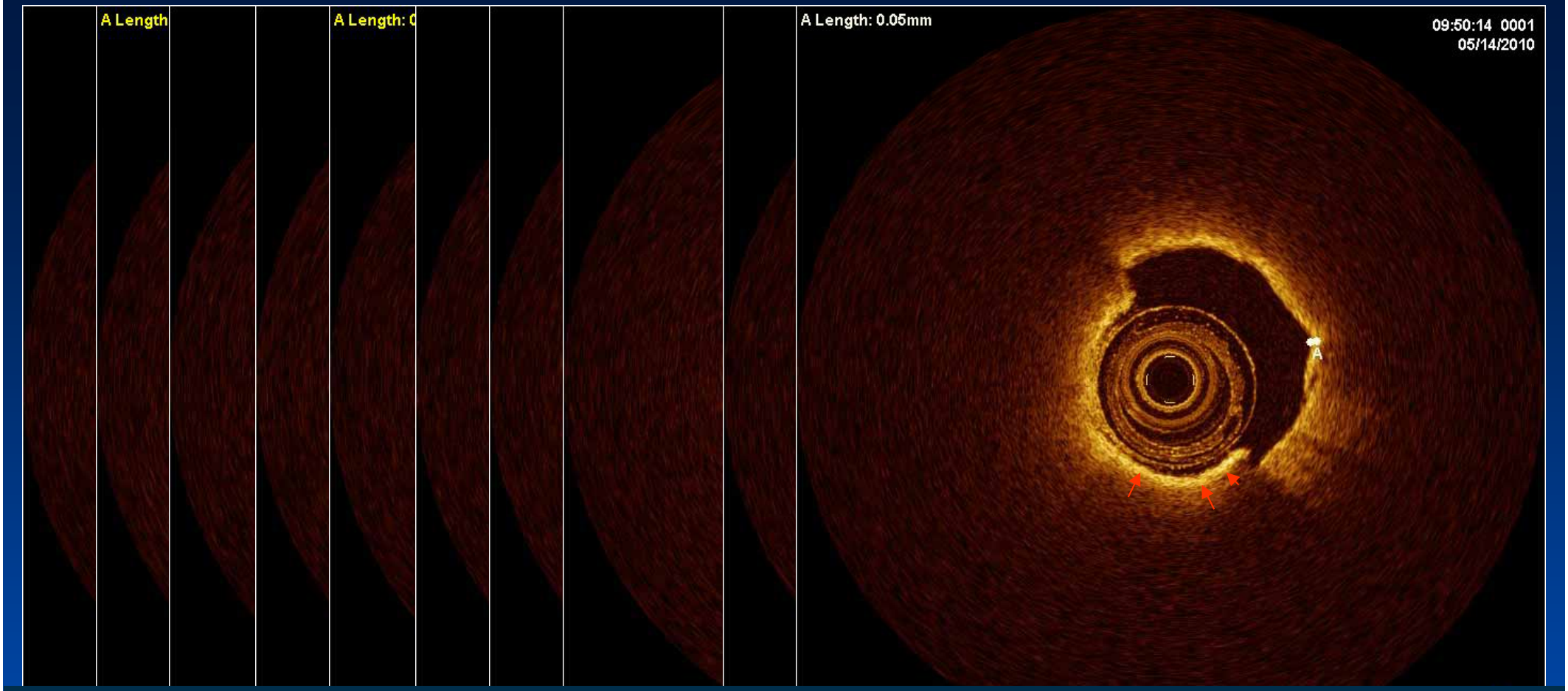
	DES	BMS
Incidence	31%	16%
Median F/U	14mo	72mo



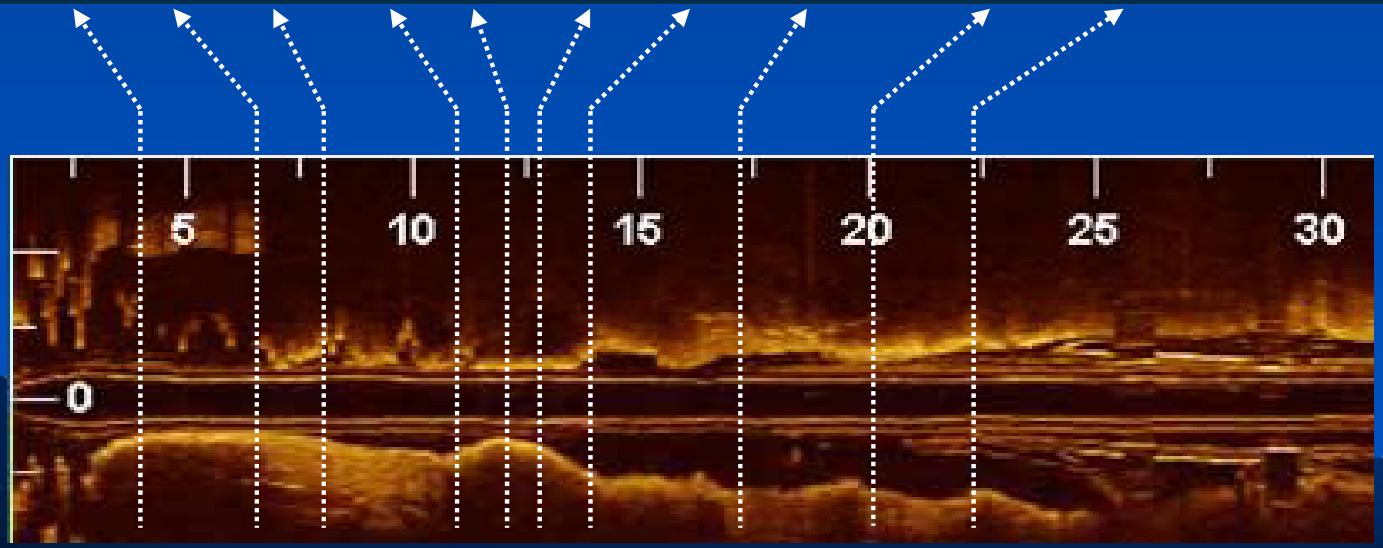
f/u duration, stent type, target to identify

Nakazawa et al. JACC 2011;57:1314–22

Nakazawa et al. JACC Imaging 2009;2:625-8



In-Stent Neo-atherosclerosis with Vulnerable Intima



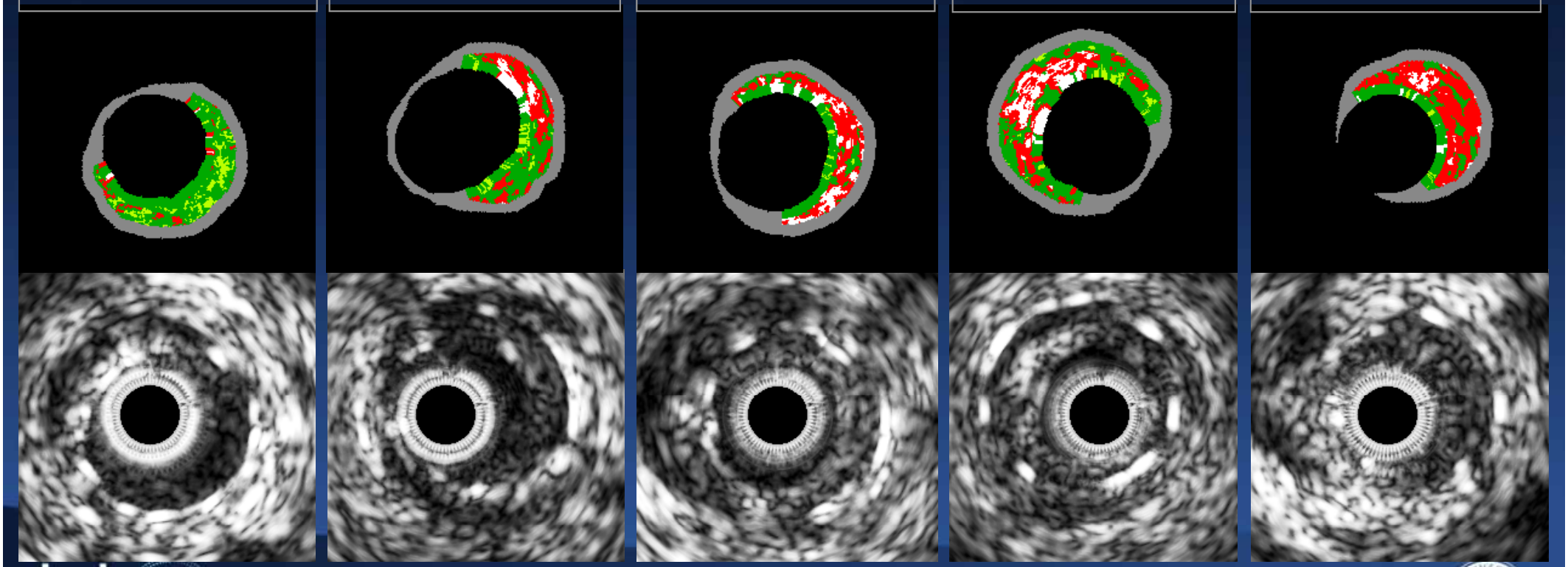
UNIVERSITY OF ULSAN COLLEGE MEDICINE
ASAN Medical Center

Tissue Characterization of In-Stent Neointima Using Intravascular Ultrasound Radiofrequency Data Analysis

Soo-Jin Kang, MD[a], Gary S. Mintz, MD[b], Duk-Woo Park, MD[a], Seung-Whan Lee, MD[a], Young-Hak Kim, MD[a], Cheol Whan Lee, MD[a], Ki-Hoon Han, MD[a], Jae-Joong Kim, MD[a], Seong-Wook Park, MD[a], and Seung-Jung Park, MD[a,*]

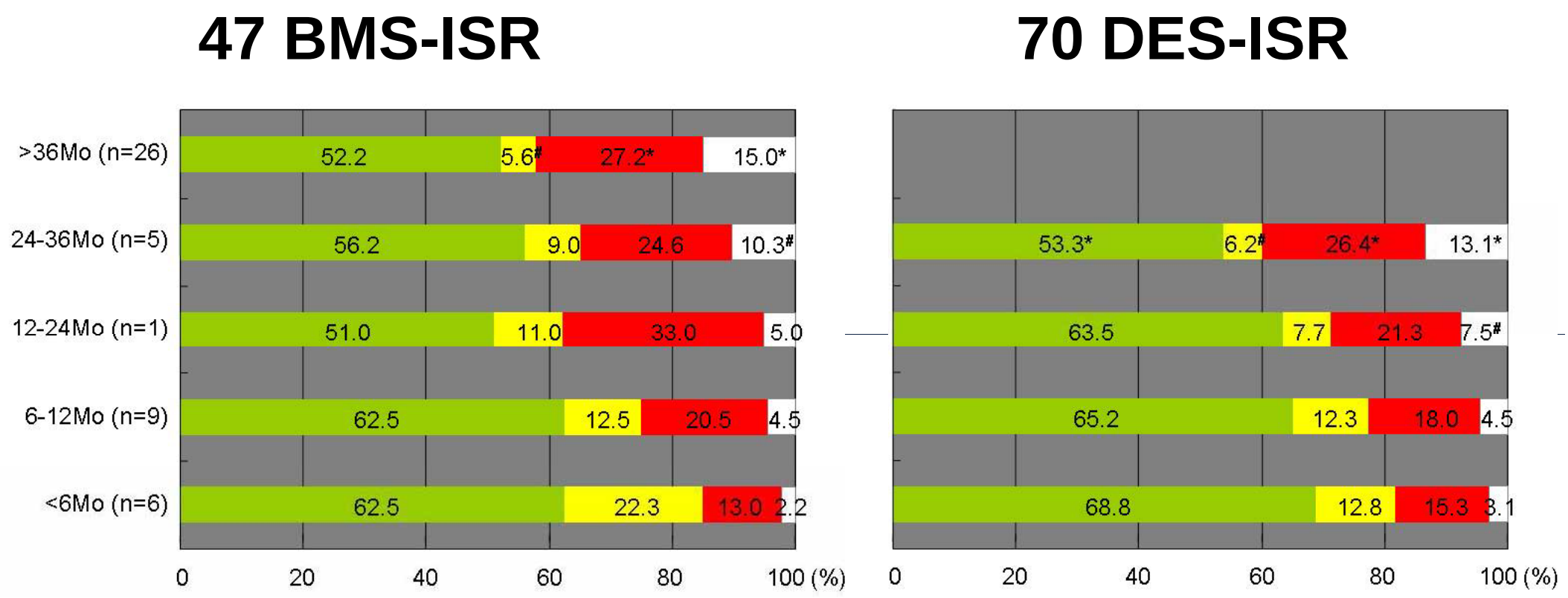
The longer f/u duration, the greater atherosclerotic change

6-mo Taxus	9-mo Taxus	22-mo Taxus	48-mo BMS	57-mo BMS
%NC 8%	%NC 28%	%NC 39%	%NC 40%	%NC 57%
%DC 2%	%DC 8%	%DC 20%	%DC 25%	%DC 15%



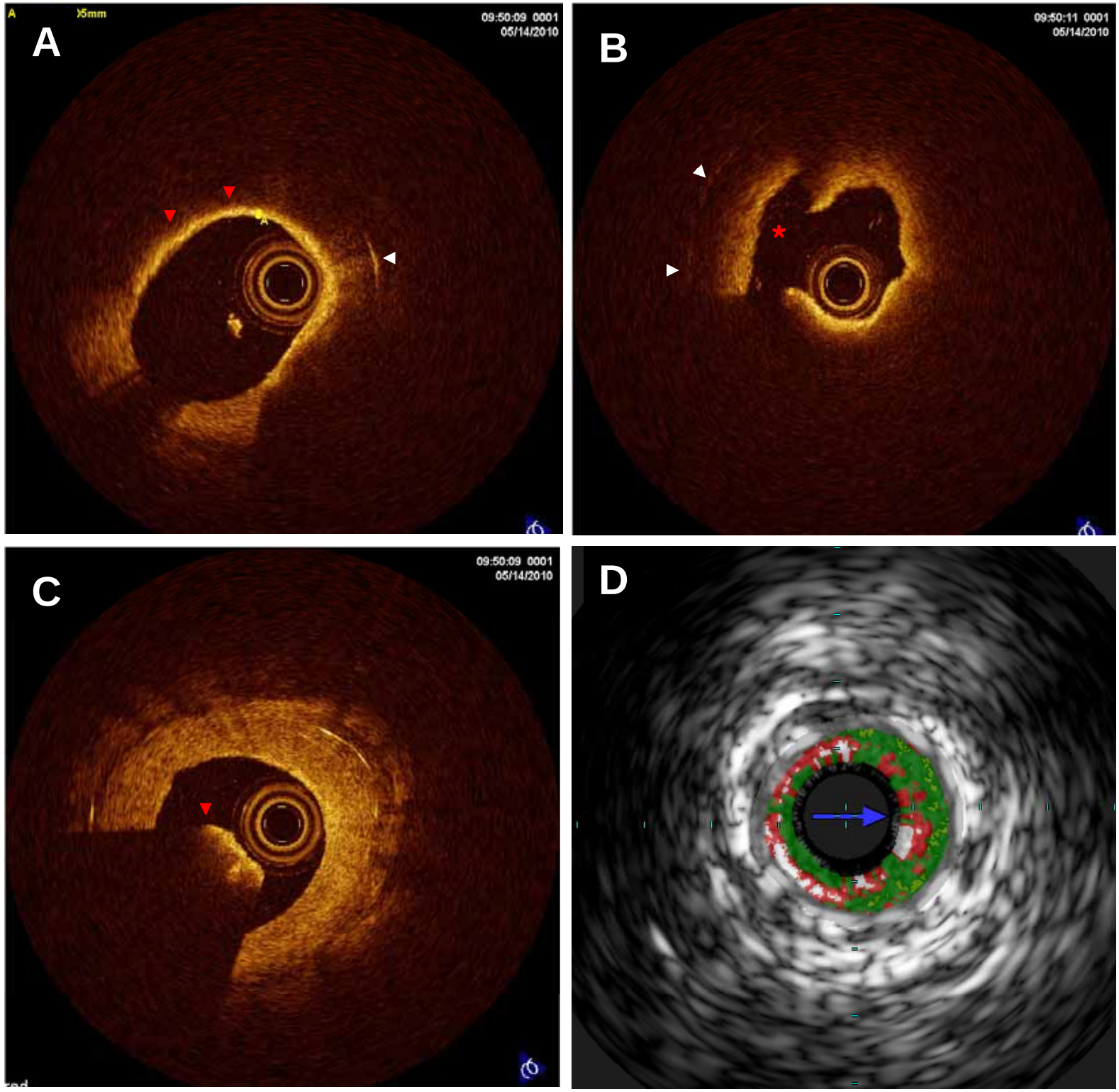
Kang SJ et al. AJC 2010 ;106:1561-5

Neointimal VH Composition



*p<0.01 and #p<0.05, vs. lesions at follow-up time <6 months

Kang SJ et al. AJC 2010 ;106:1561-5


A
09:50:09 0001
05/14/2010
B
09:50:11 0001
05/14/2010
C
09:50:09 0001
05/14/2010
D