Vulnerable Plaque Detection by VH-IVUS

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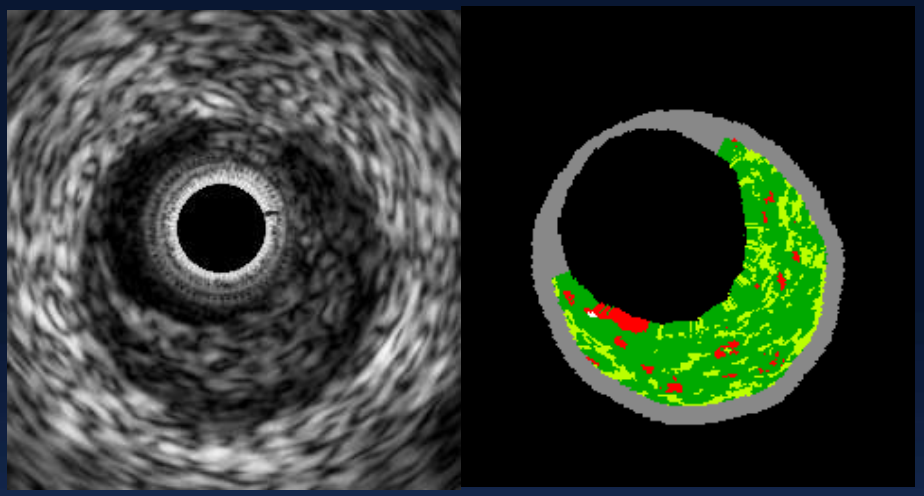
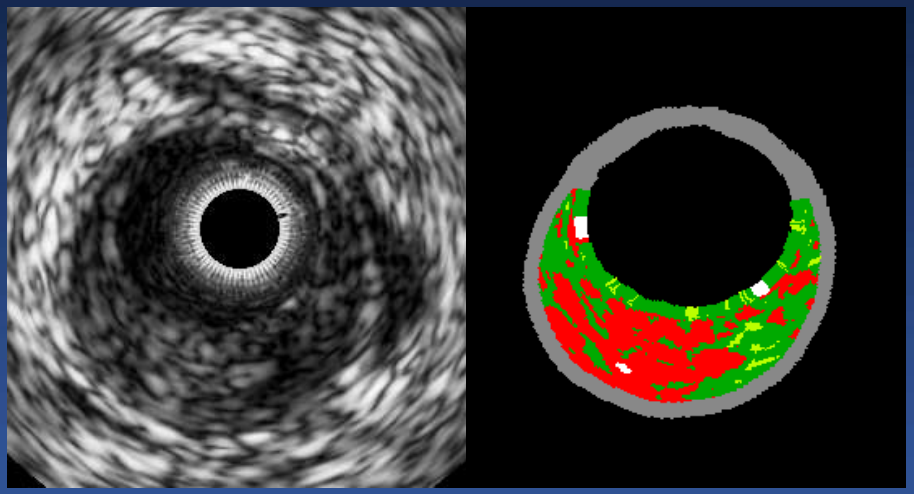
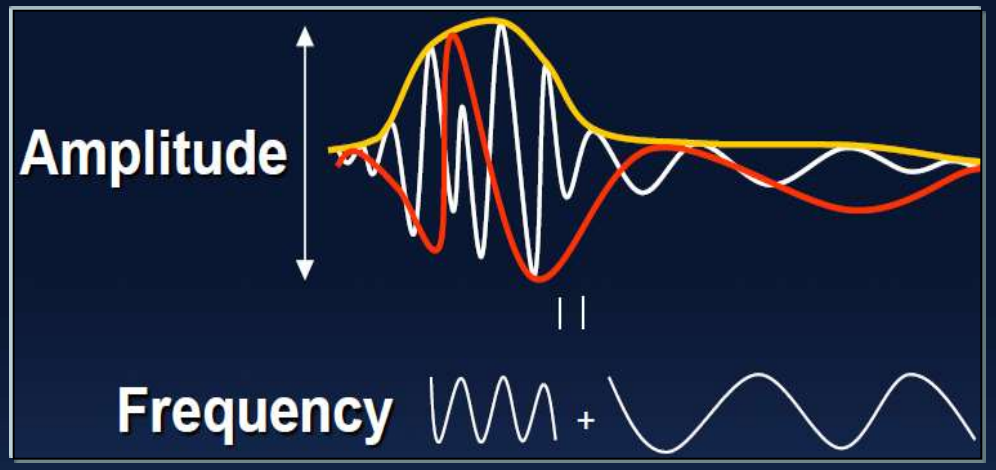
Disclosure Statement of Financial Interest

I, Soo-Jin Kang DO NOT have a financial interest /arrangement or affiliation with organizations that could be perceived as a conflict of interest in the context of the subject of this presentation

Grayscale vs. VH IVUS







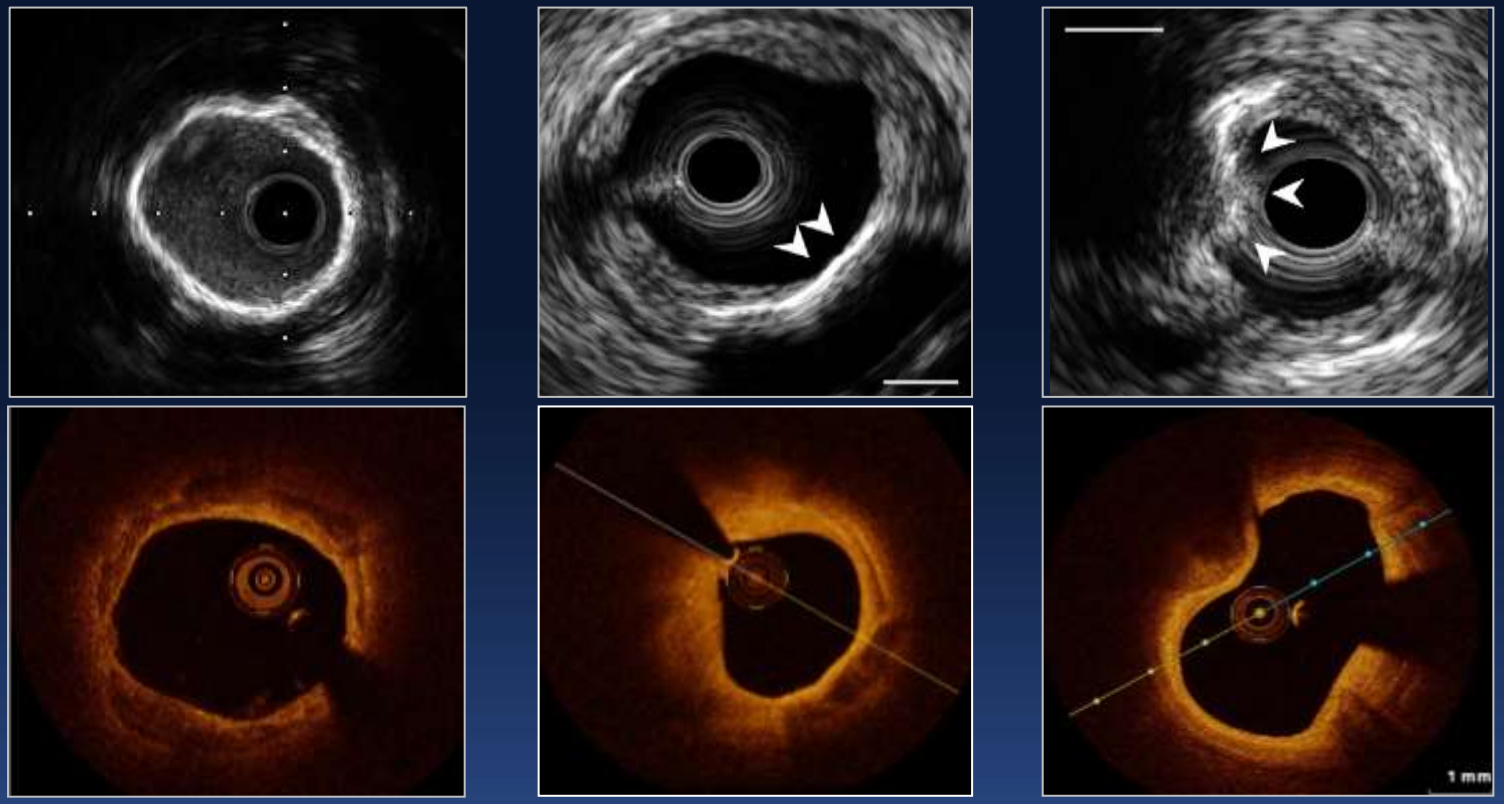
- Fibrous
- Fibrofatty
- Necrotic core
- Dense calcium

Validation of VH-IVUS

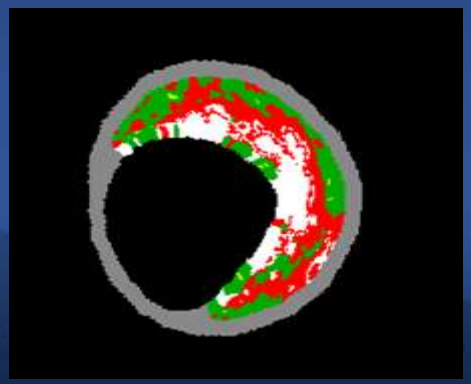
		Fibrous	Fibrofatty	NC	DC
Ex vivo (Nair et al.)	Sensitivity Specificity Accuracy	96% 91% 94%	72% 98% 94%	92% 97% 96%	87% 99% 97%
In vivo (Nasu et al.)	Sensitivity Specificity Accuracy	87%	87%	67% 93% 88%	97%
Ex vivo (porcine)	Accuracy	58%	38%	38%	

Nair et al. Eurointervention 2007;3:113-20
Nasu et al. J Am Coll Cardiol 2006;47:2405–12
Granada et al. Arterioscler Thromb Vasc Biol 27:387–93

Detection of Calcium

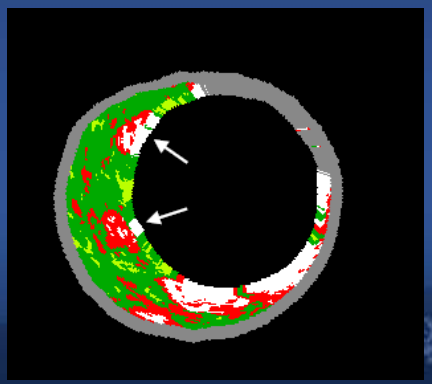


Superficial calcium

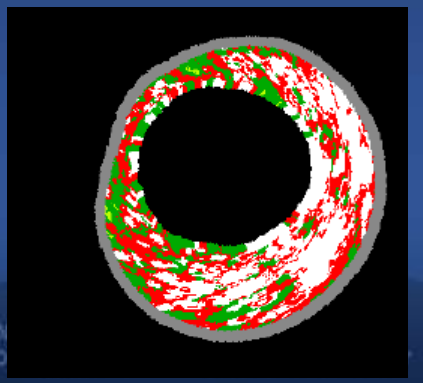


One pixel white border

Stent struts

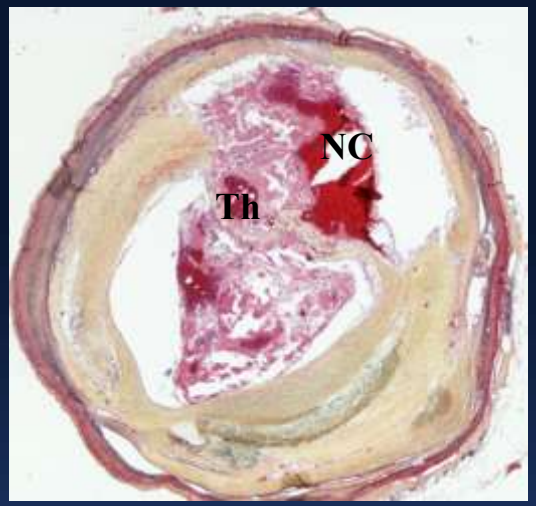


Strong power

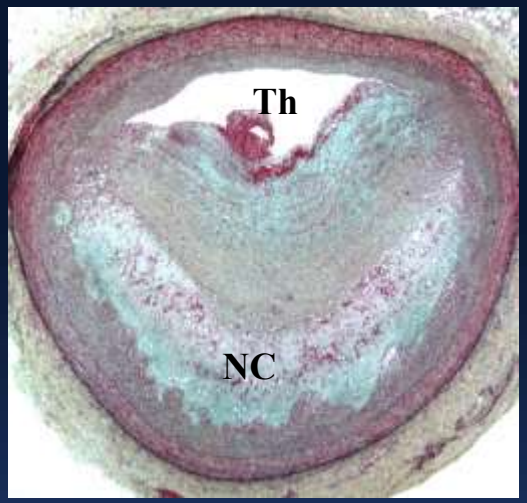


Causes of Coronary Thrombosis

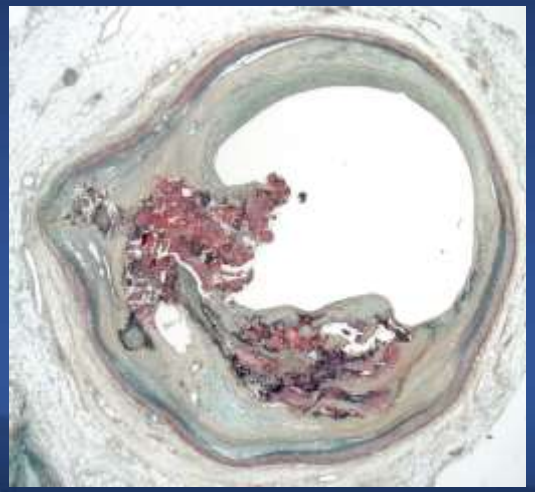
Rupture 60-75%



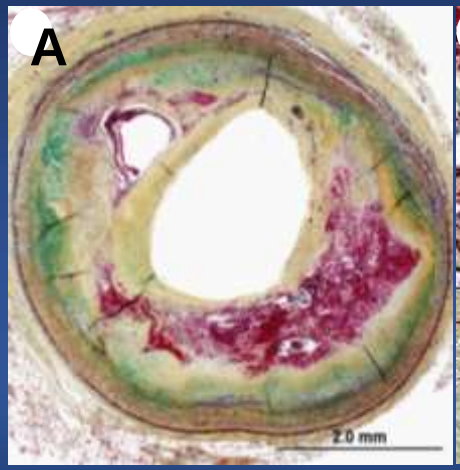
Erosion 30-35%

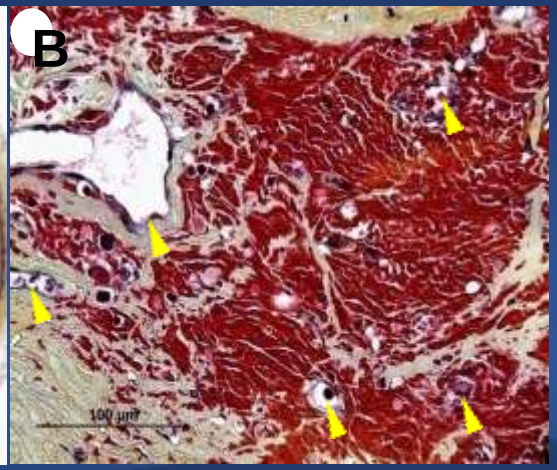


Calcified nodule (2-7%)



Intra-plaque hemorrhage





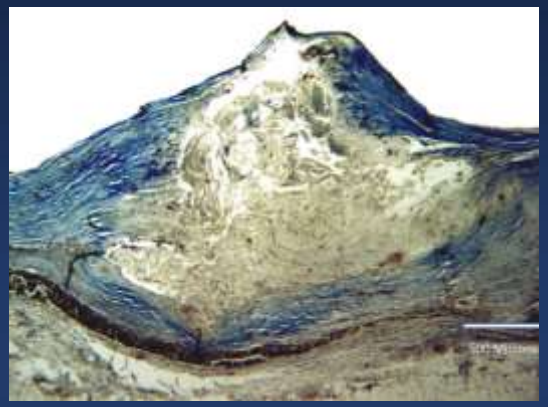
Virmani R et al. Arterioscler Thromb Vasc Biol 2000;20:1262

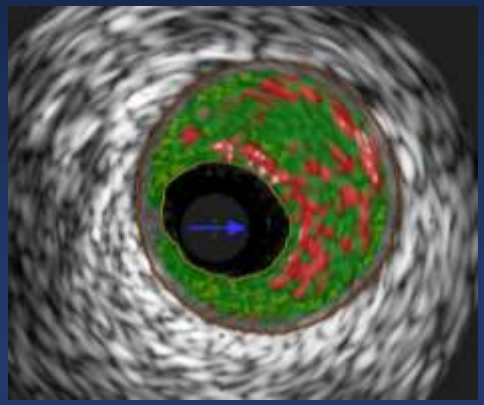
Morphological Predictors of Plaque Rupture			
	p	Odds Ratio	95% CI
%Necrotic core	0.02	2.0	1.1 – 3.7
Cap thickness (<65 μm)	0.005	0.35	0.2 – 0.7
%Macrophage	0.052	1.8	1.0 – 3.2

Thin-cap Fibroatheroma (TCFA)

a Precursor of Plaque Rupture

a Prototype of Vulnerable Plaque





Rodriguez-Granillo et al. JACC 2005;46:2038-42

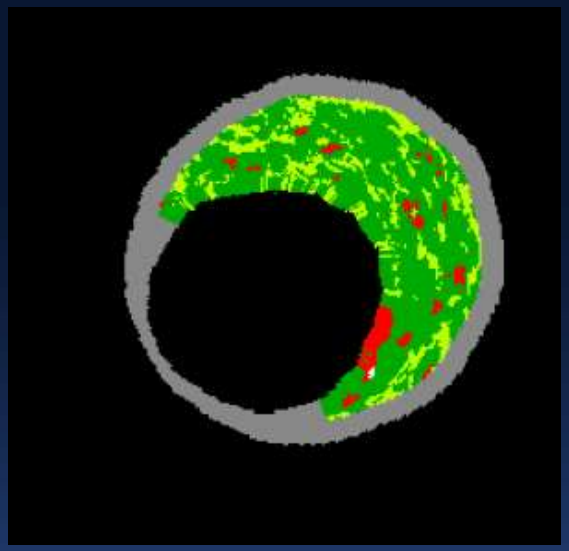
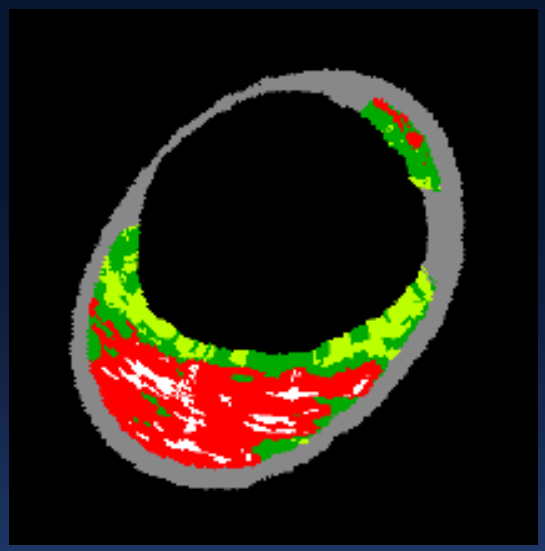
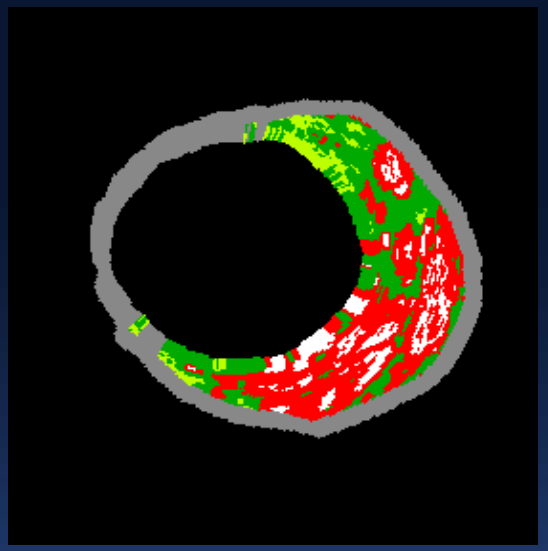
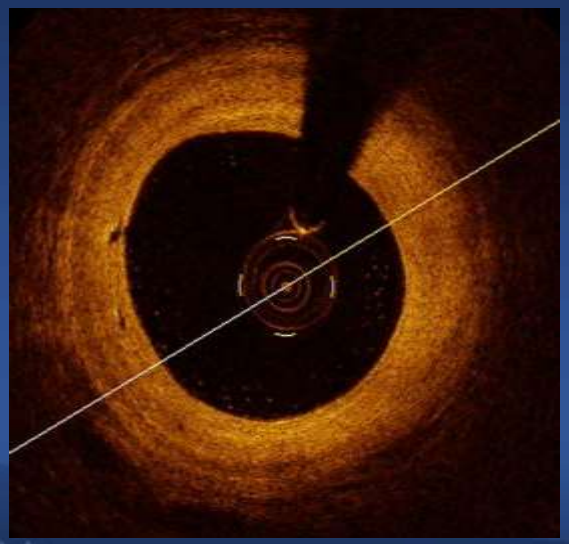
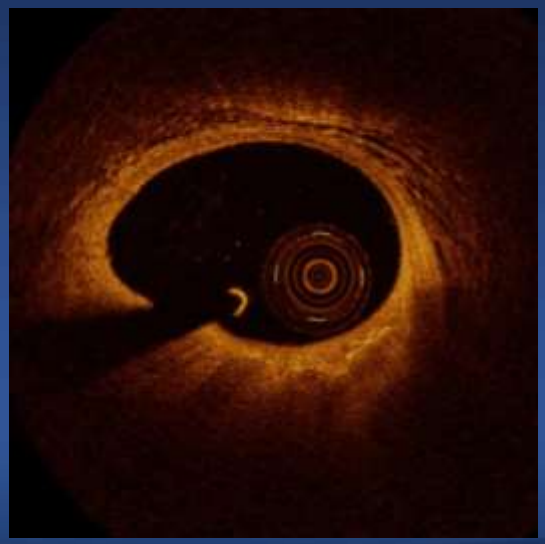
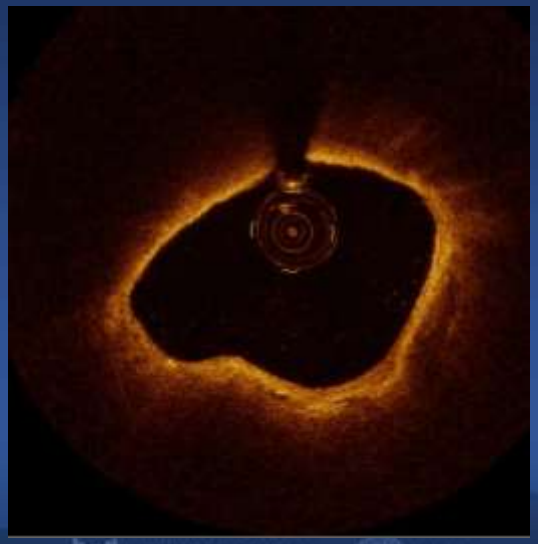
Naghavi et al. Circulation 2003;108:1664-72

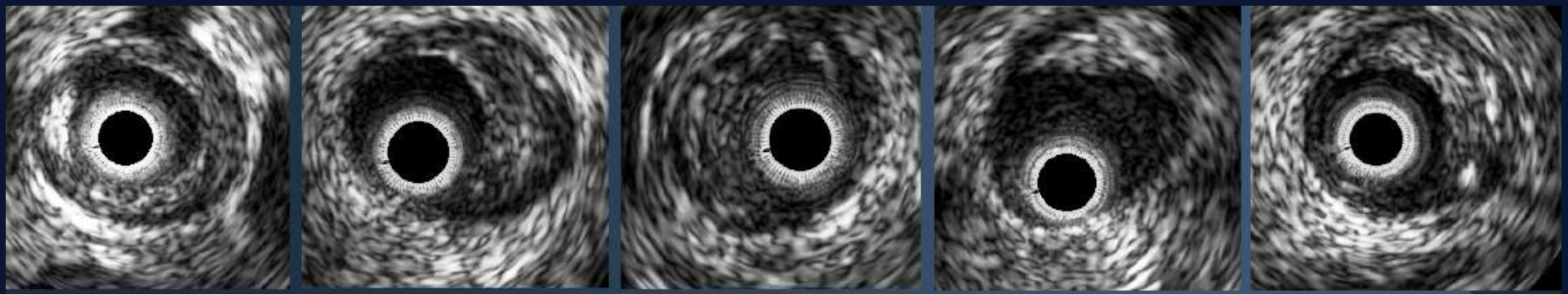
Pathologic intimal thickening

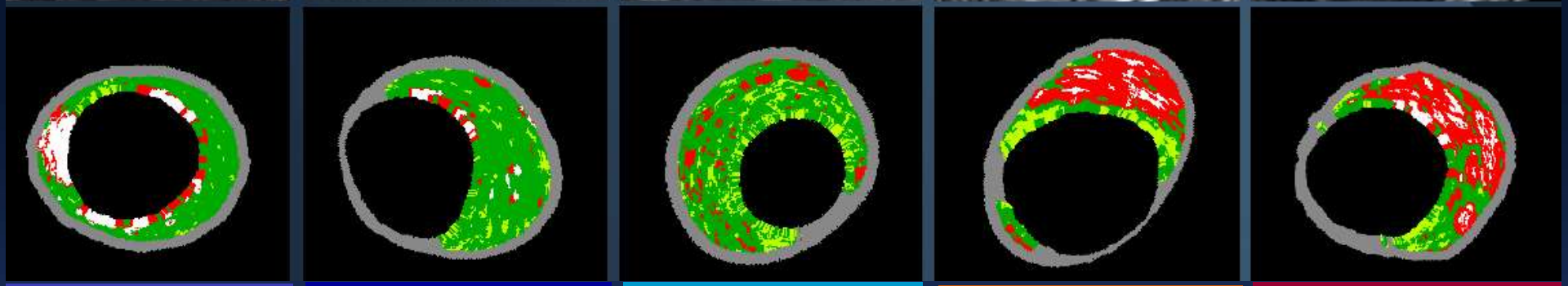
Fibroatheroma (FA)

Thick-cap FA

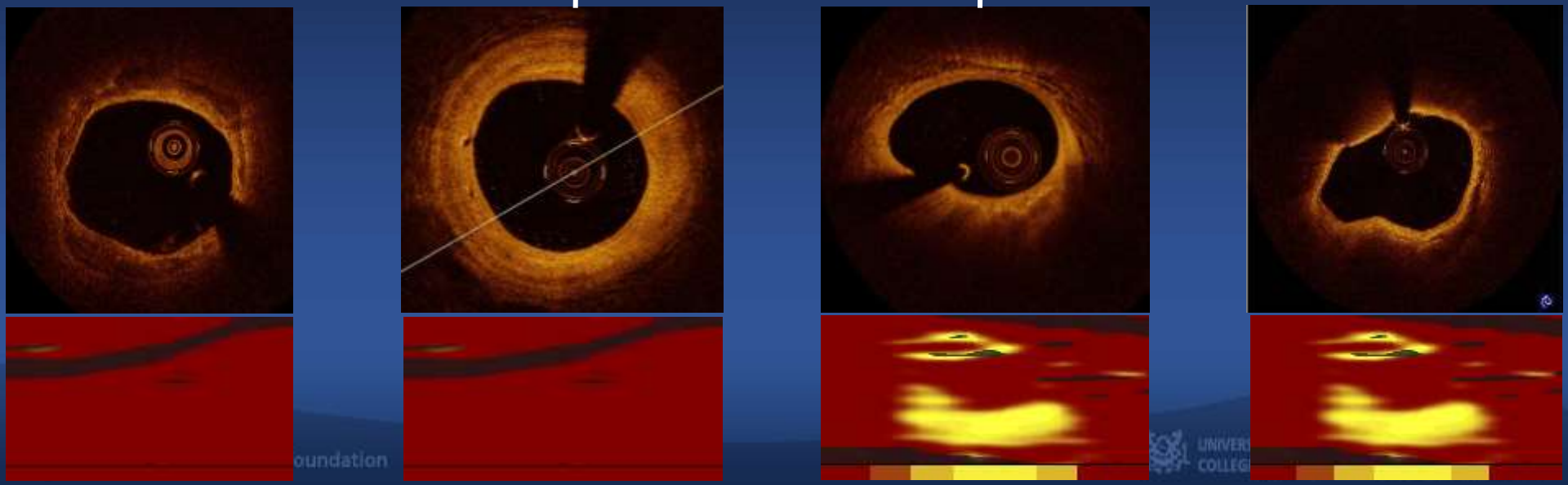
Thin-cap FA (TCFA)



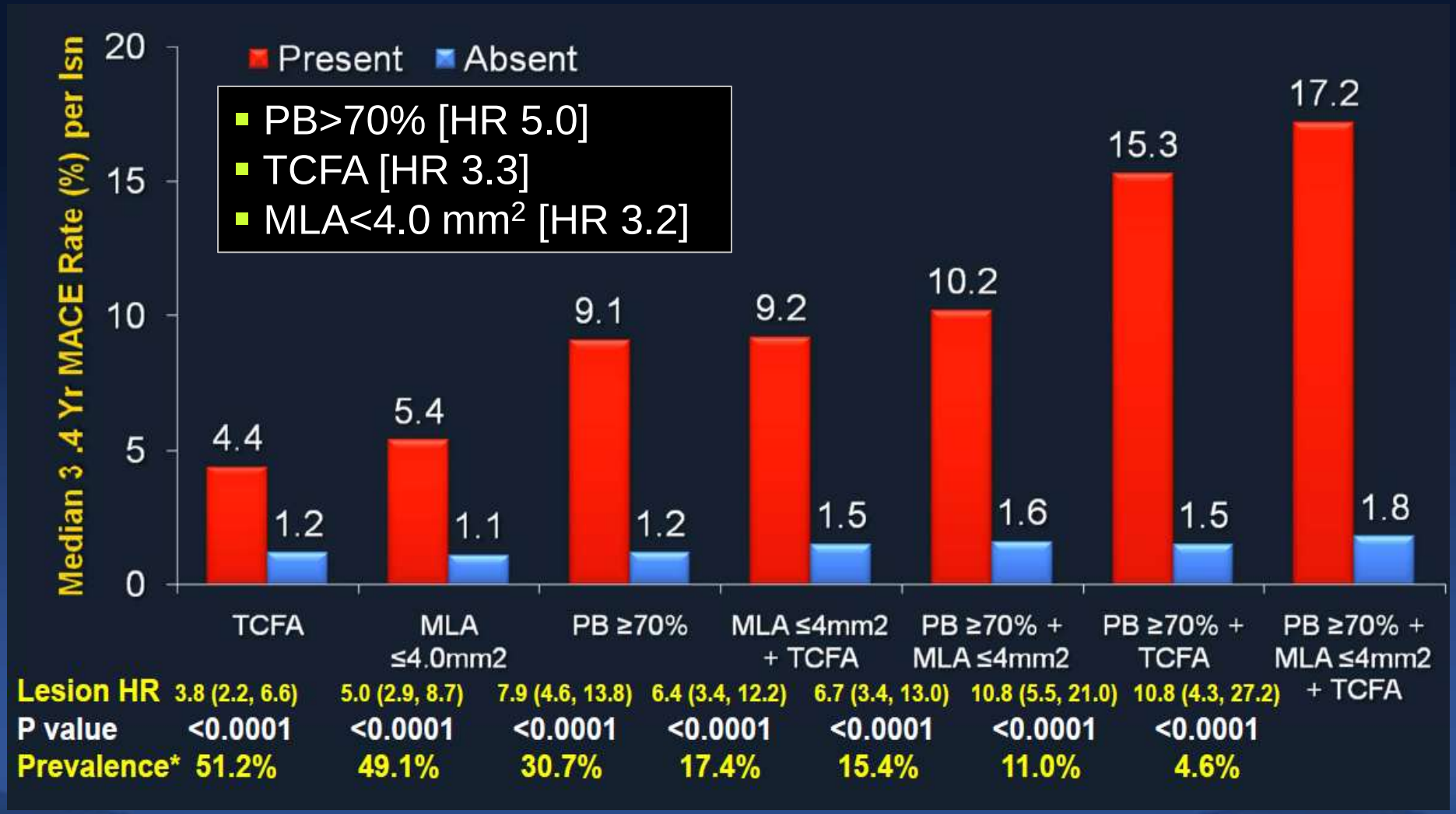


Fibrocalcific | Fibrous | PIT | Thick-cap FA | TCFA



Predictors of Non-Culprit MACE

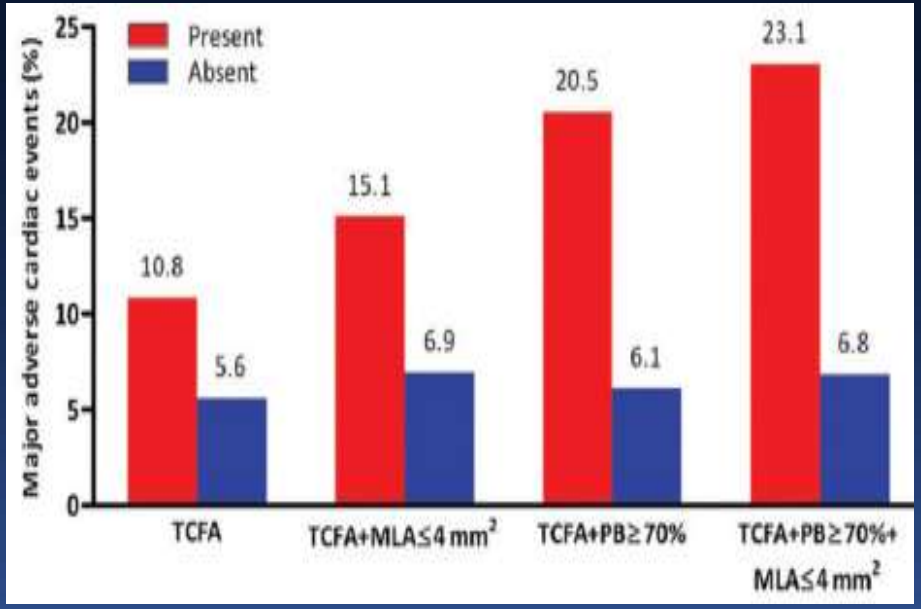
PROSPECT

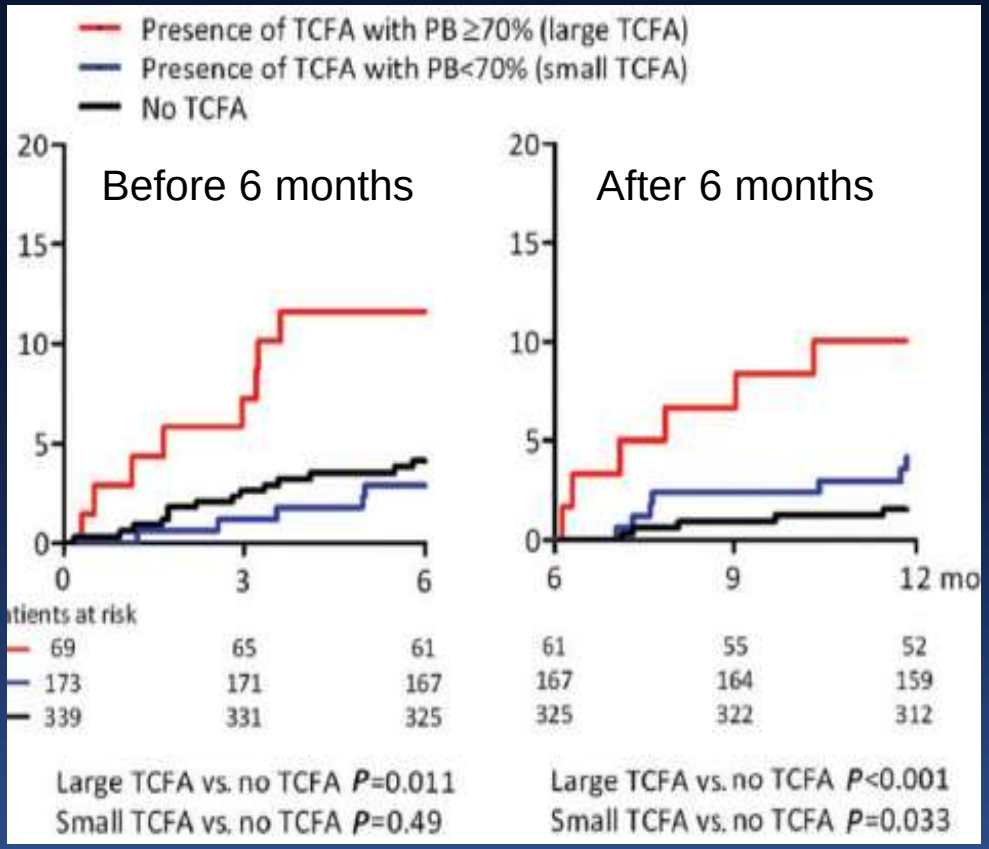


Stone G et al. NEJM 2011;364:226-35

Predictors of Non-Culprit MACE

ATHEROREMO





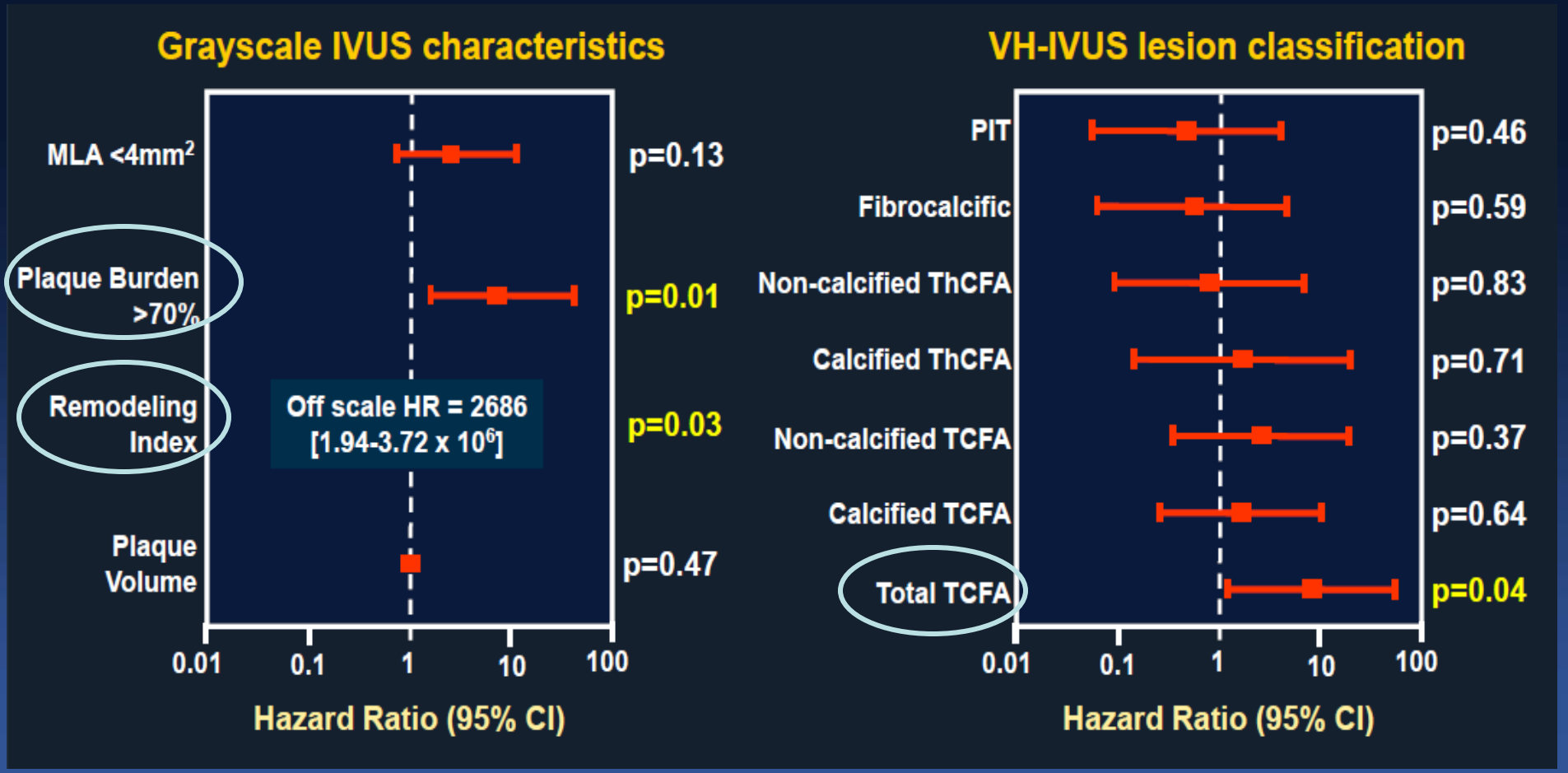
- PB>70% [HR 2.9]
- TCFA [HR 1.9]

Cheng et al. EHJ 2014;35:639-47

Predictors of Non-Culprit MACE

VIVA

Univariable analysis



Calvert et al. JACC Cardiovasc Imaging 2011;4:894–901

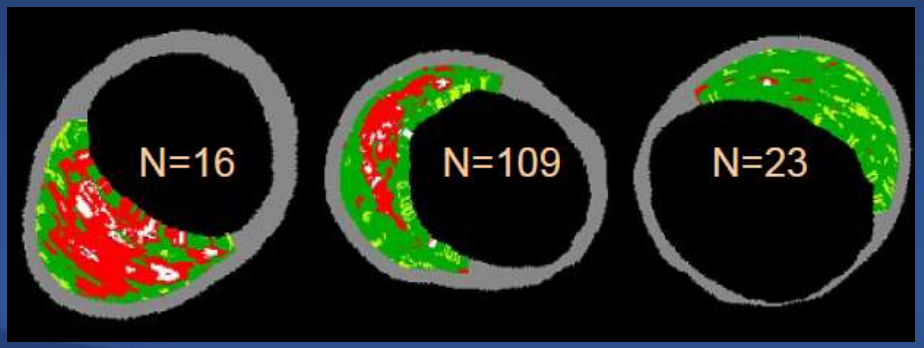
Dynamic Change in TCFA

PROSPECT

25%

65%

10%



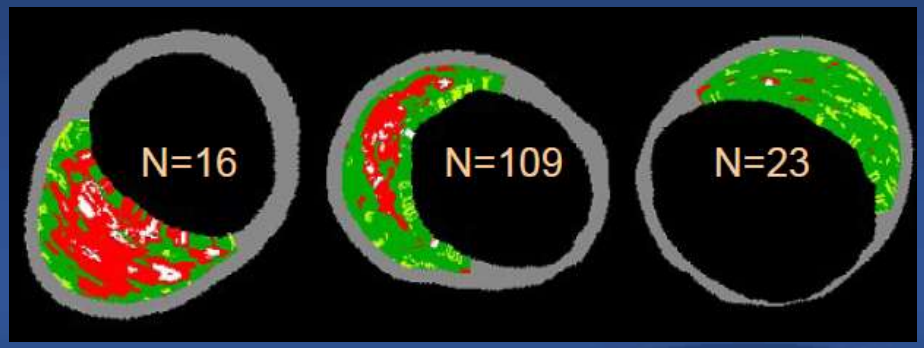
Kubo et al. J Am Coll Cardiol 2010;55:1590-7

HORIZON-AMI

76%

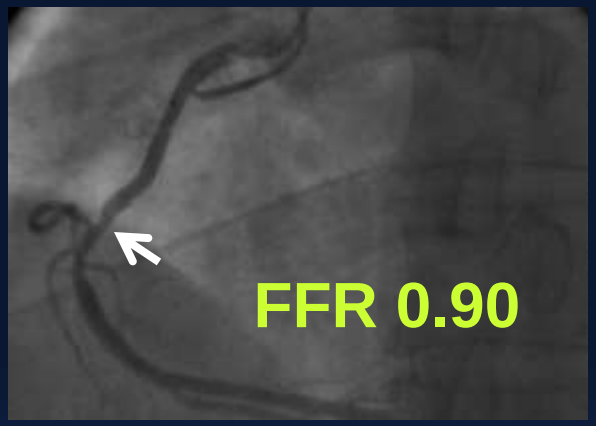
14%

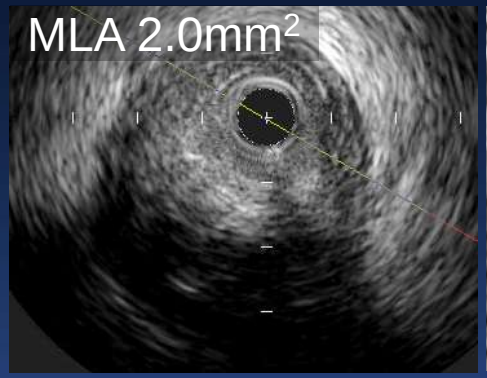
5%

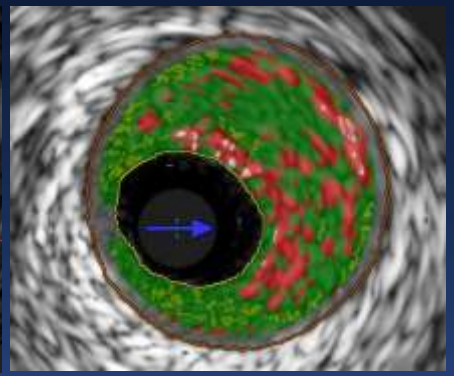


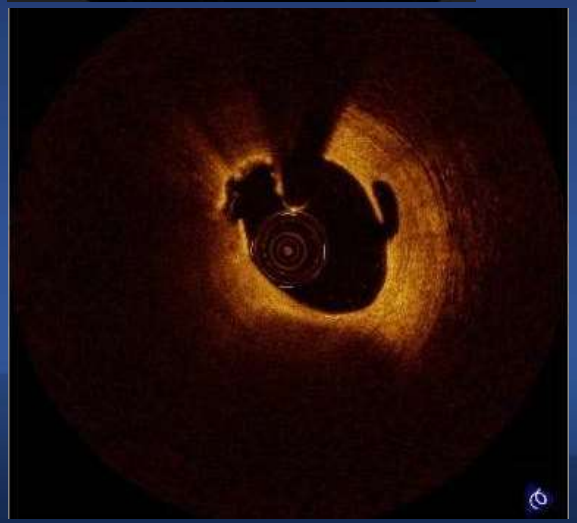
Zhao et al. JACC Imaging in press

Baseline

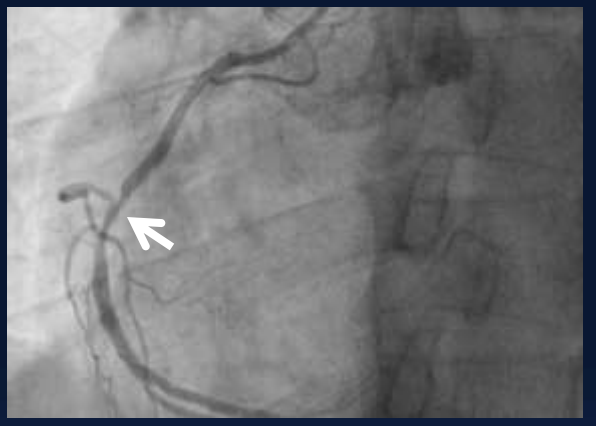


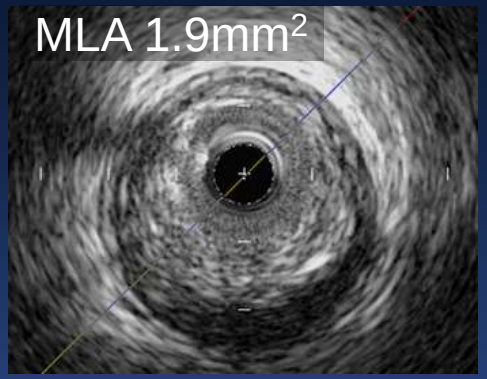


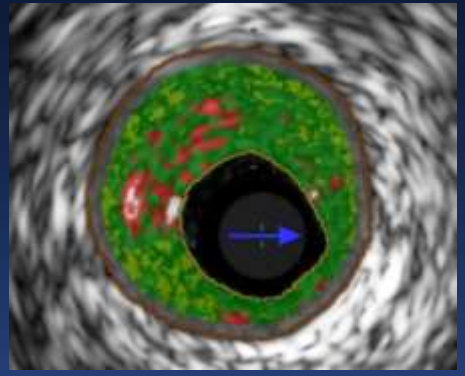


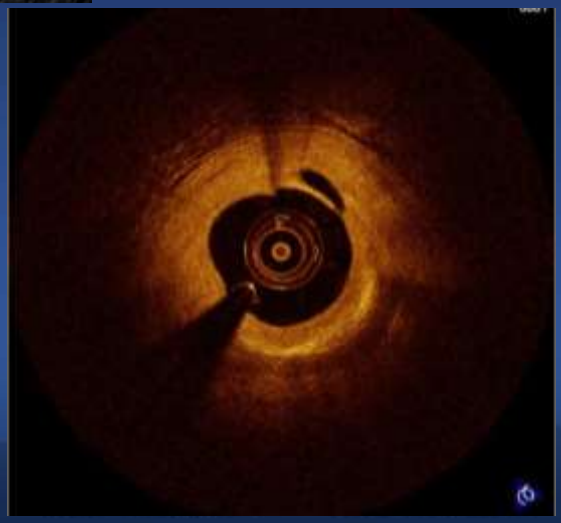


1-year F/U





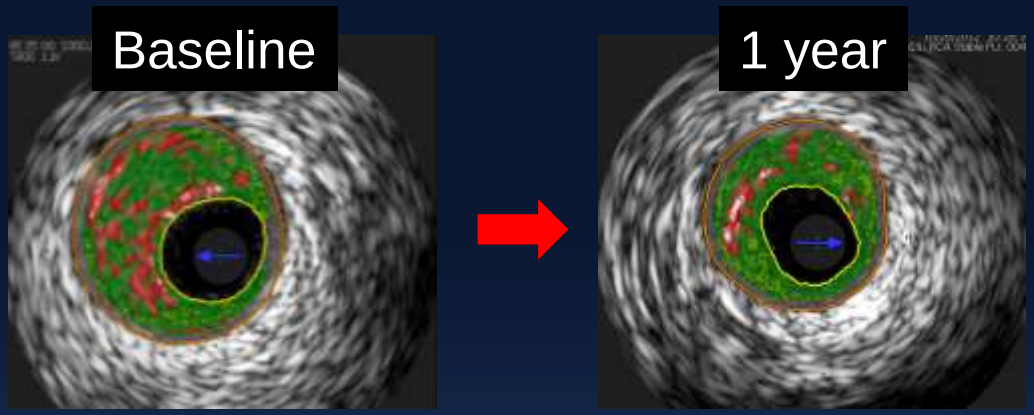


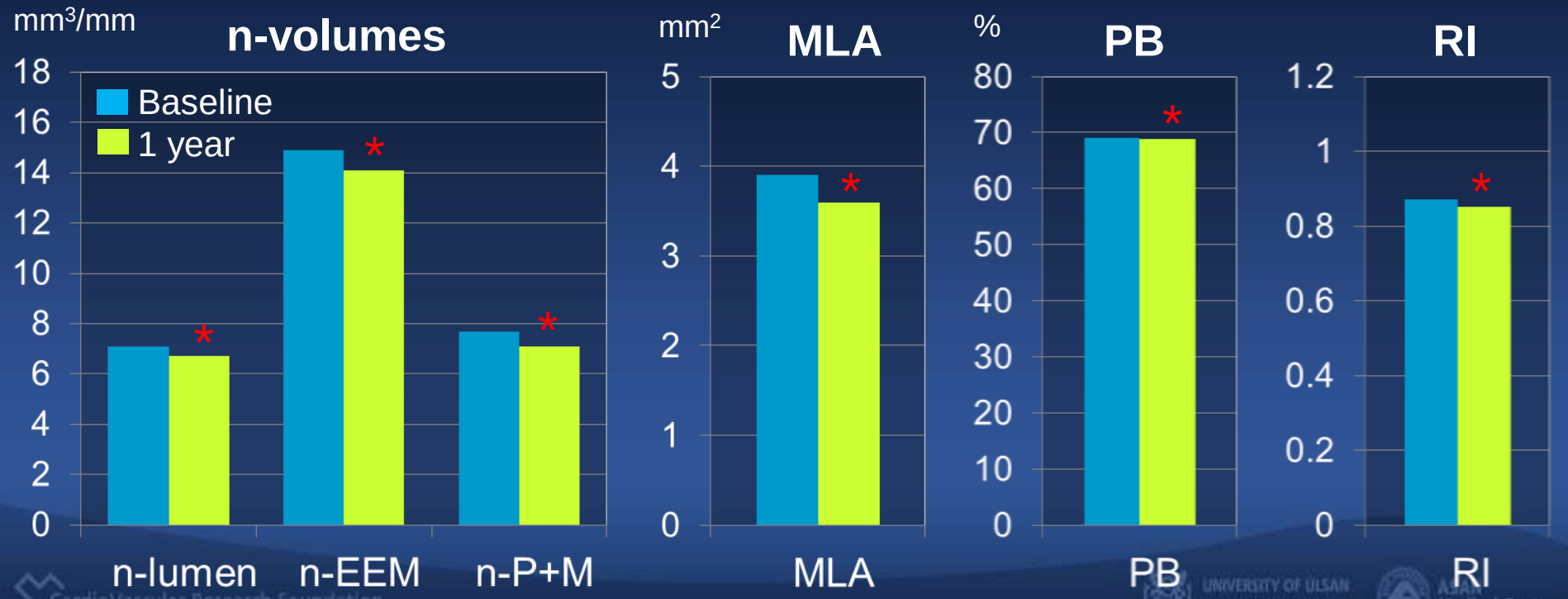


Plaque burden ↓
IVUS-attenuation ↓
Necrotic core ↓
Constrictive remodeling
Disappeared TCFA

STABLE Vascular Change after 1-year Statin

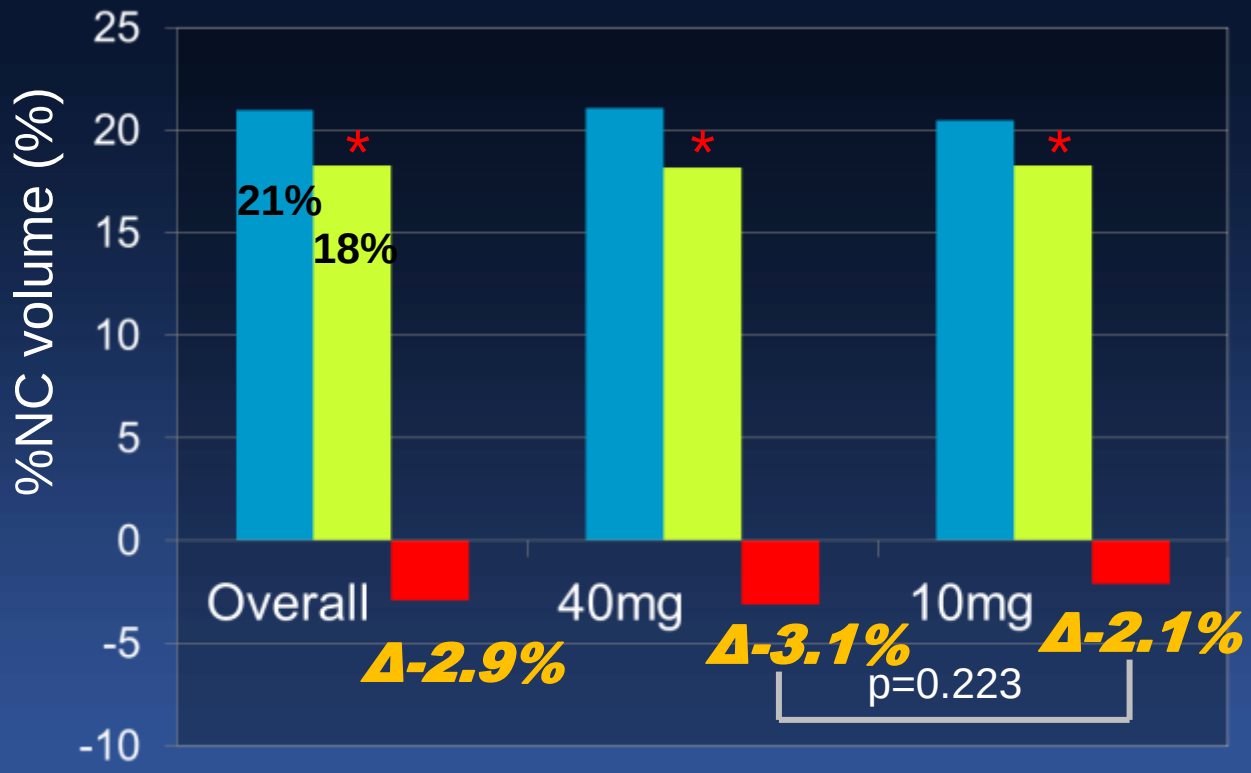
Fibroatheroma-containing non-culprit lesions

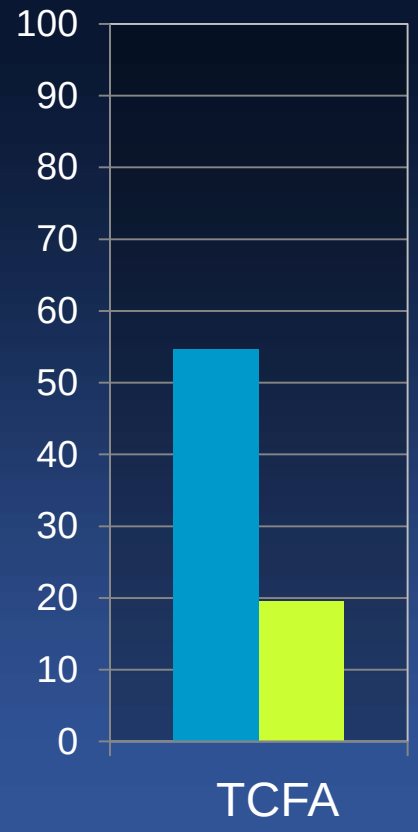




STABLE: Endpoints

Primary: change in %NC volume within target segment
Secondary: change in %NC volume in rosuvastatin 40 vs. 10mg

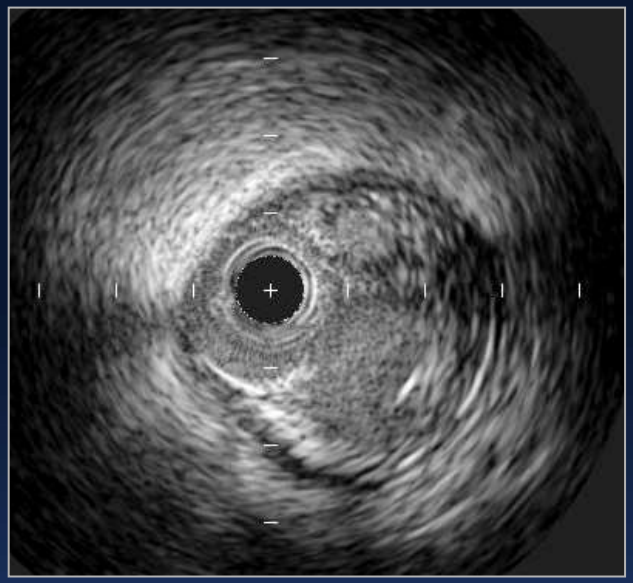


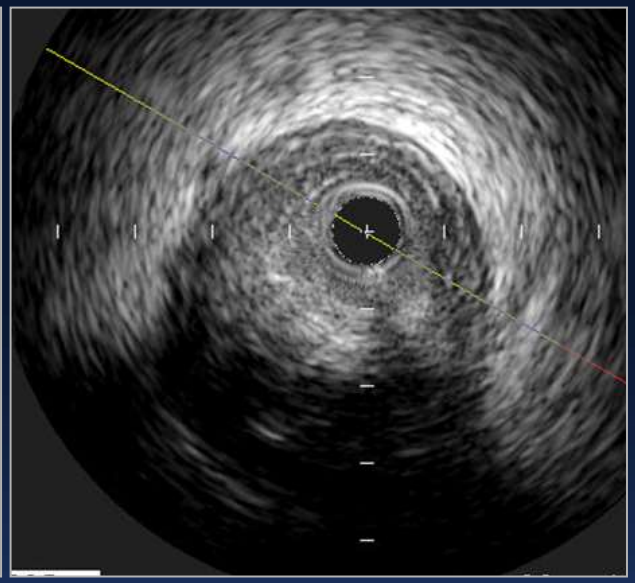


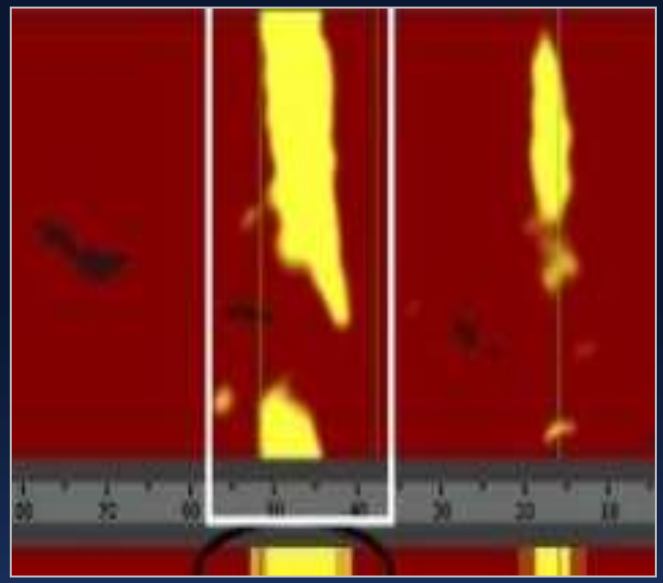
Baseline
12 months

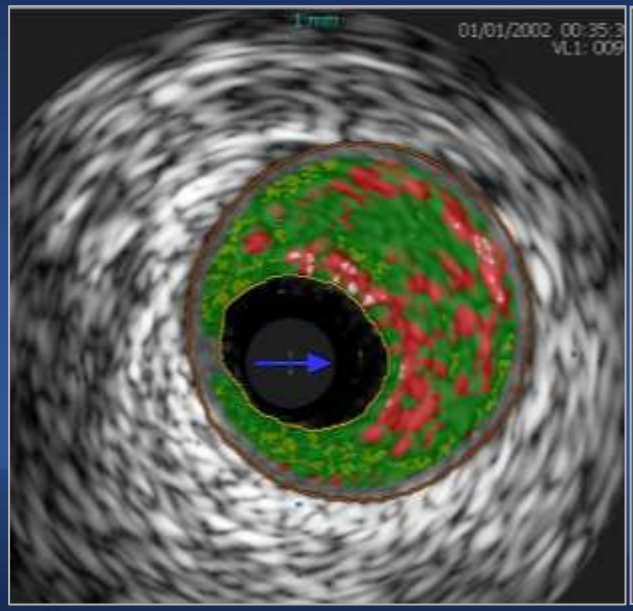
* *p value <0.05*

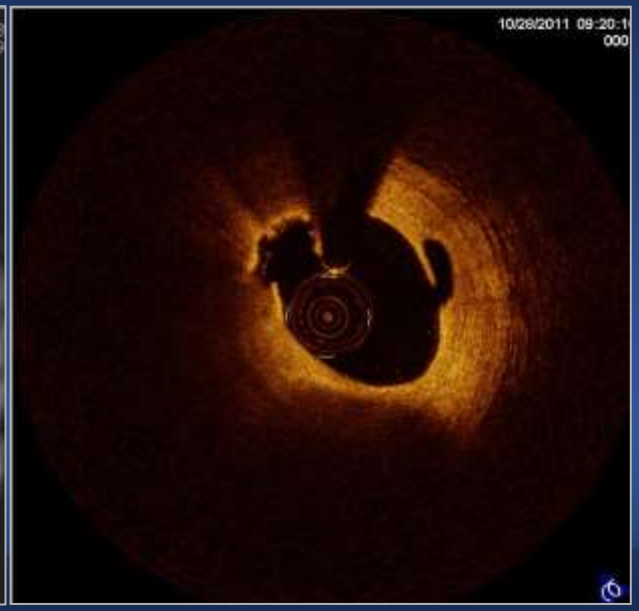
Predictor for Distal Embolization

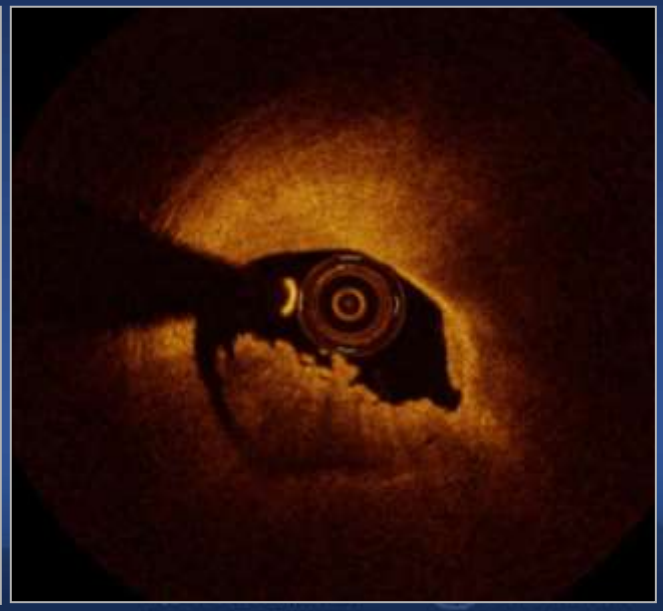












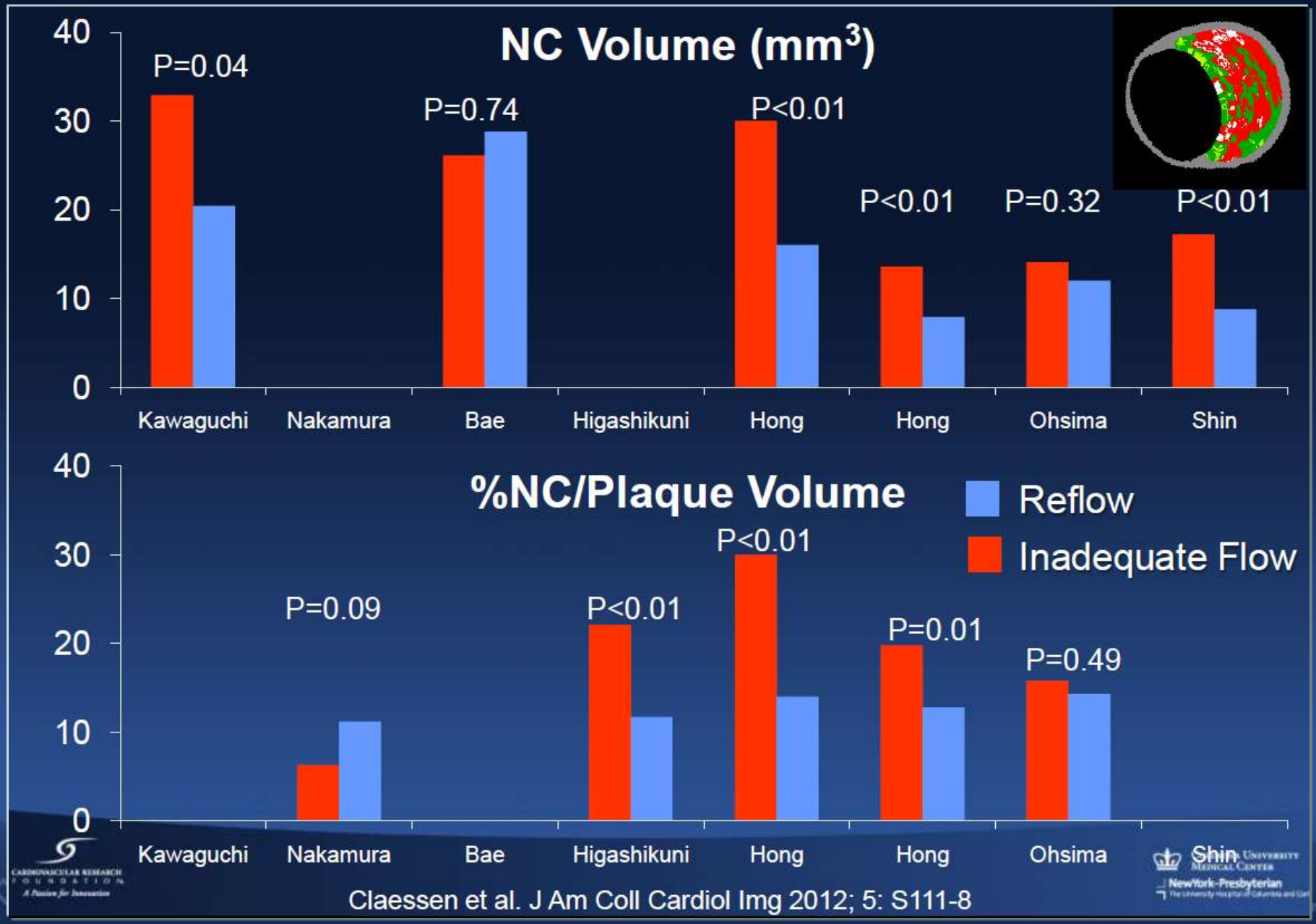
VH Plaque Characteristics to Predict Distal Embolization

from 11 published articles

First Author (Ref. #)	Year	N	Elective/ACS/ STEMI	NC Associated With Distal Embolization				
				NC Volume	% NC Volume	NC Area	% NC Area	VH-TCFA
Kawaguchi et al. (8)	2007	71	STEMI	+	n/a	n/a	n/a	n/a
Kawamoto et al. (9)	2007	44	Elective	n/a	n/a	+	n/a	n/a
Nakamura et al. (15)	2007	50	STEMI	n/a	–	n/a	n/a	n/a
Bae et al. (10)	2008	57	ACS	–	n/a	n/a	–	n/a
Higashikuni et al. (12)	2008	49	ACS	n/a	+	n/a	+	n/a
Bose et al. (11)	2008	55	Elective	+	+	n/a	n/a	n/a
Hong et al. (13)	2011	190	ACS	+	+	+	+	+
Hong et al. (14)	2009	80	Elective and ACS	+	+	+	+	n/a
Ohshima et al. (16)	2009	44	STEMI	–*	–*	n/a	n/a	+
Yamada et al. (18)	2010	29	Elective	n/a	n/a	n/a	n/a	+
Shin et al. (17)	2011	112	Unstable angina	+	n/a	+	+	n/a

Claessen et al. JACC Cardiovasc Imaging 2012;5:S111-8

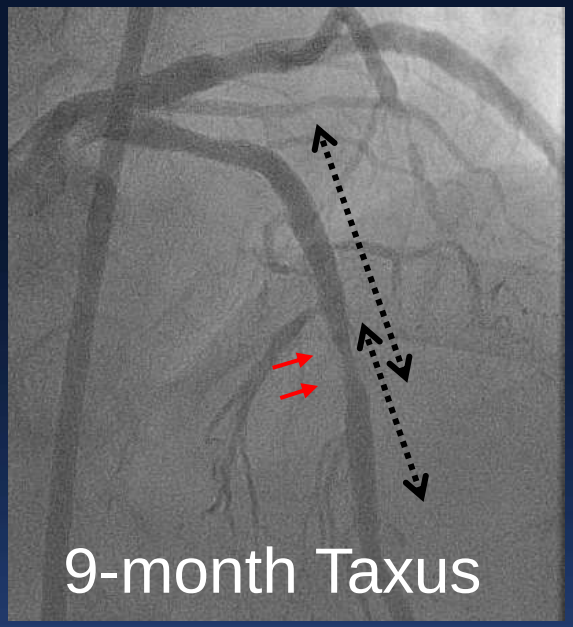
VH Necrotic Core and Inadequate Flow



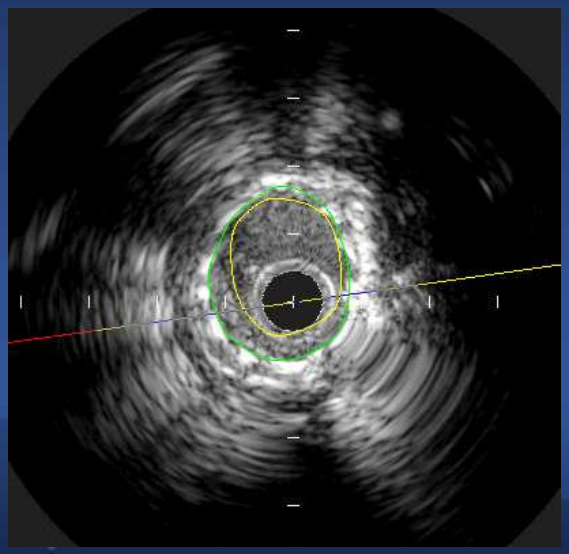
Claessen et al. J Am Coll Cardiol Img 2012; 5: S111-8

Mechanism of In-stent Restenosis

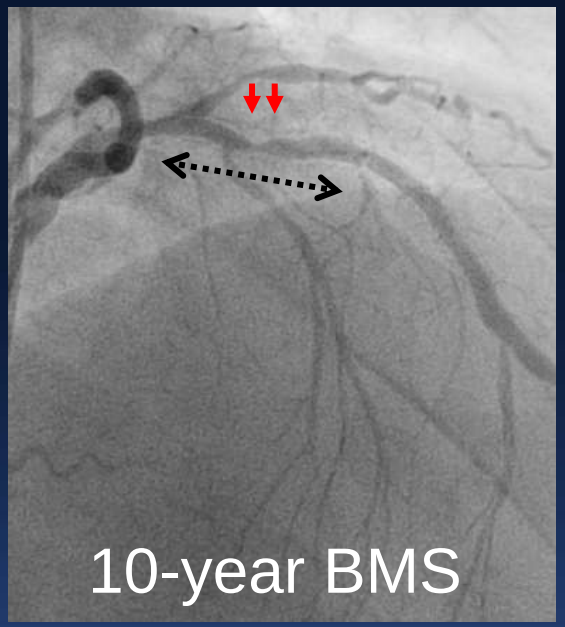
Underexpansion



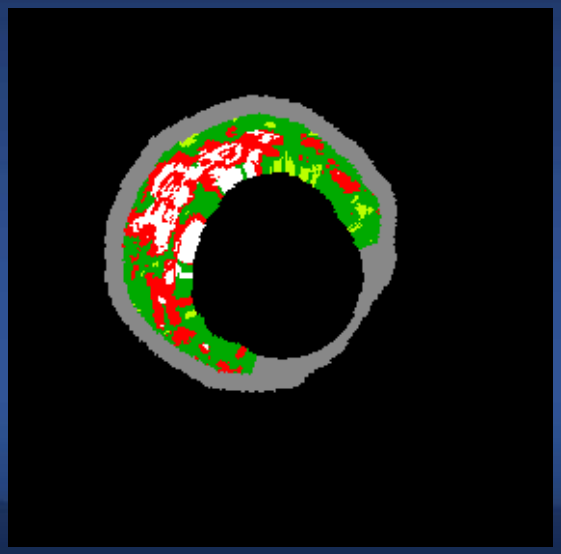
9-month Taxus



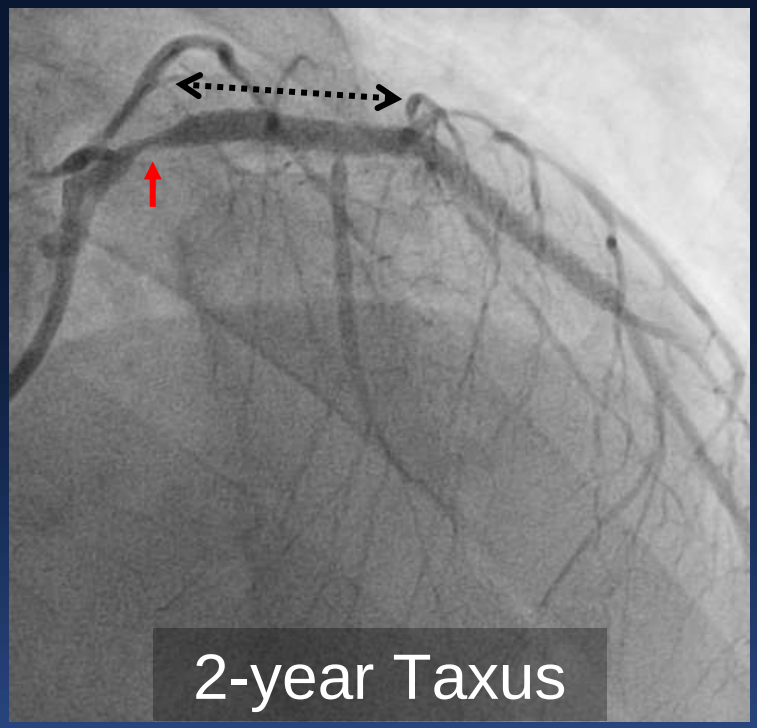
Intimal HP



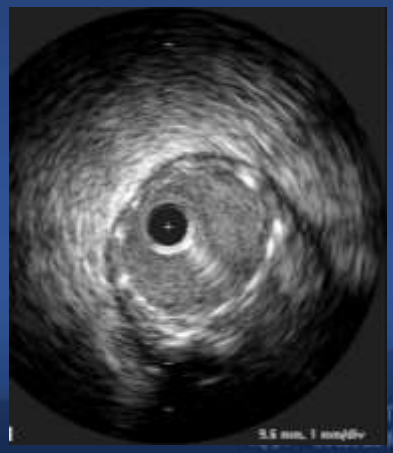
10-year BMS

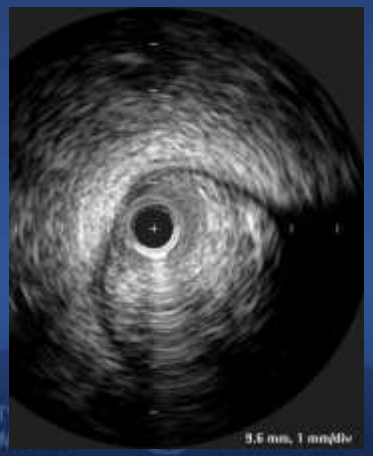


Edge Restenosis

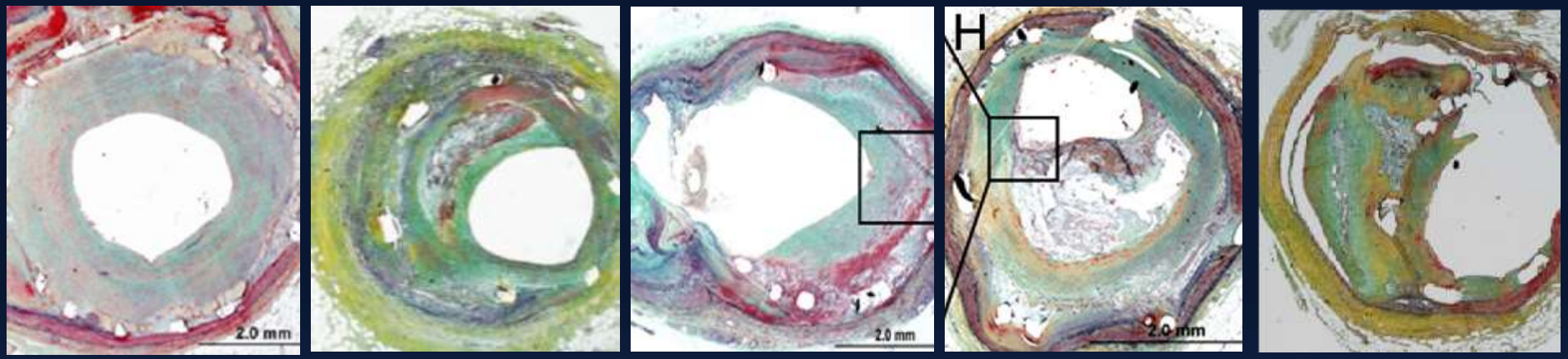


2-year Taxus

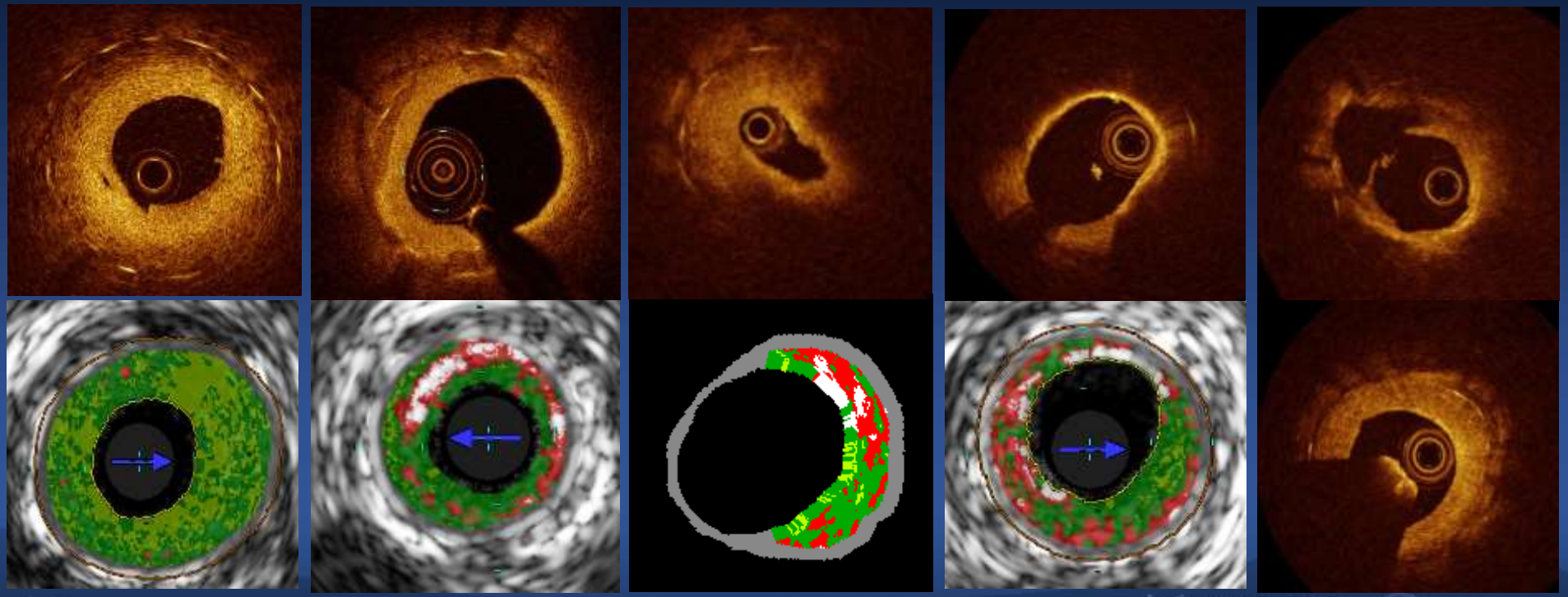




Early neointima | Fibrocalcific | ThCFA | TCFA | Intimal rupture



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

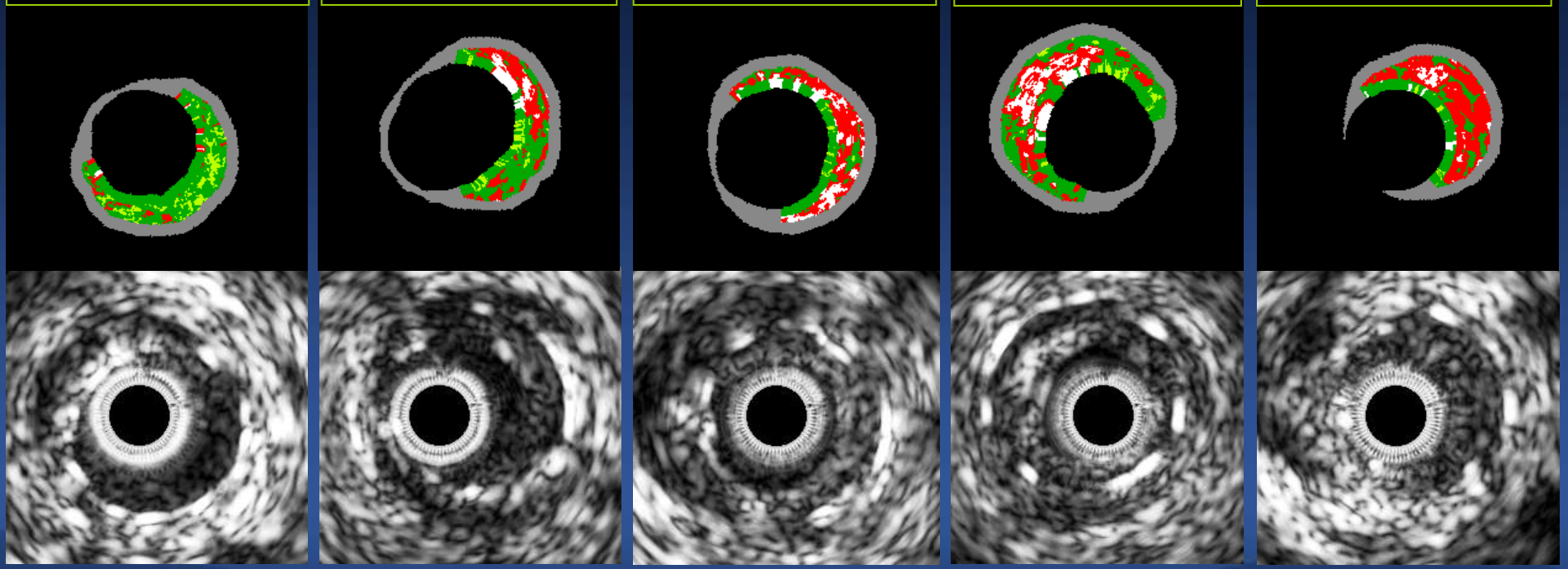


Tissue Characterization of In-Stent Neointima Using Intravascular Ultrasound Radiofrequency Data Analysis

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,*]

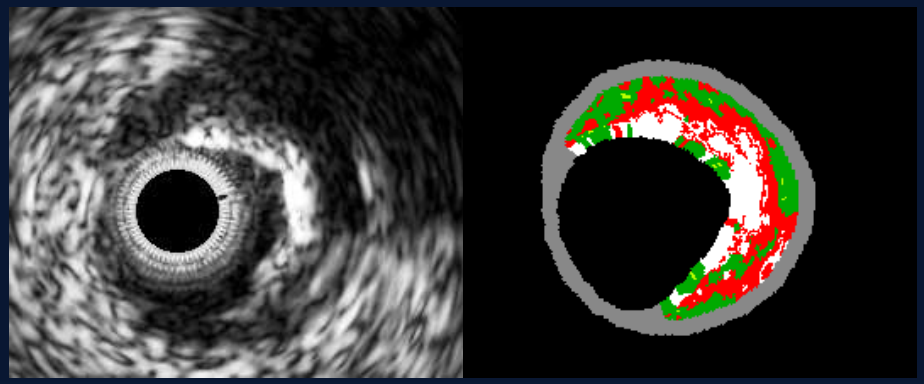
The longer f/u duration, the greater atherosclerotic change

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%

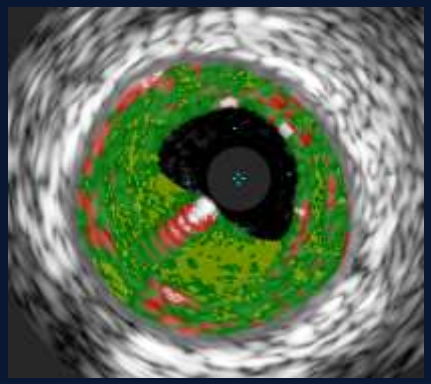


Kang SJ et al. AJC 2010 ;106:1561-5

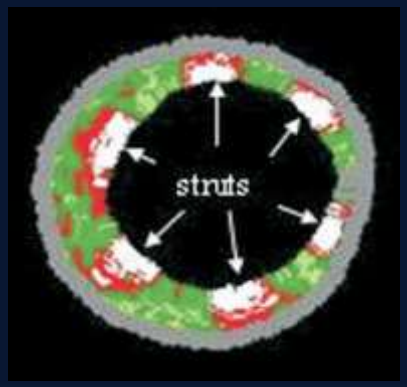
Plaque behind calcium



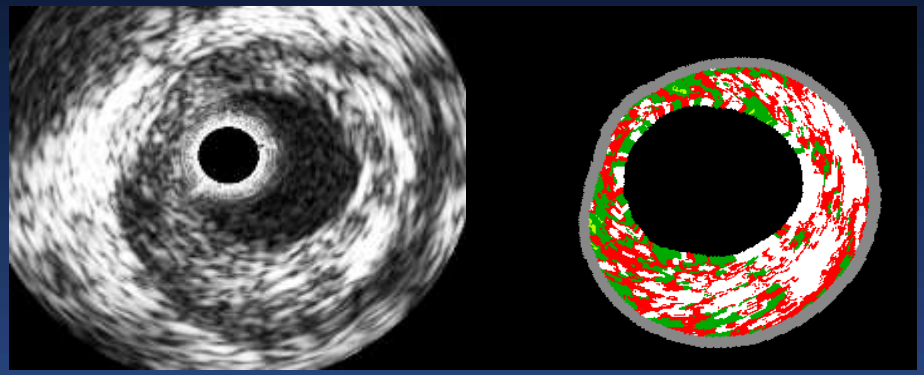
Guidewire



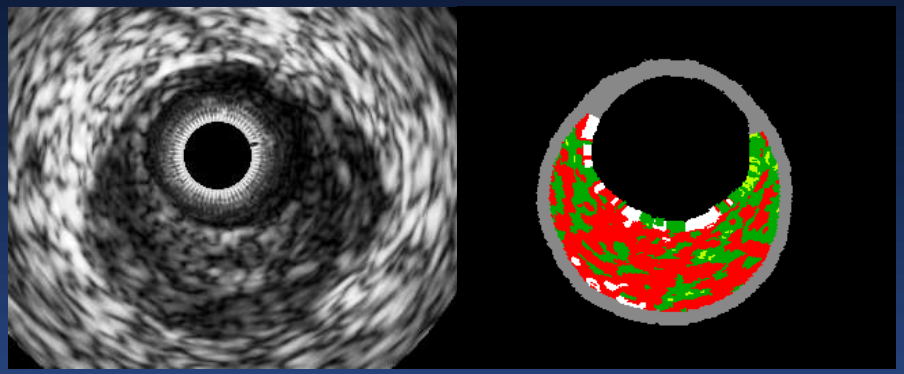
Peri-stent halo



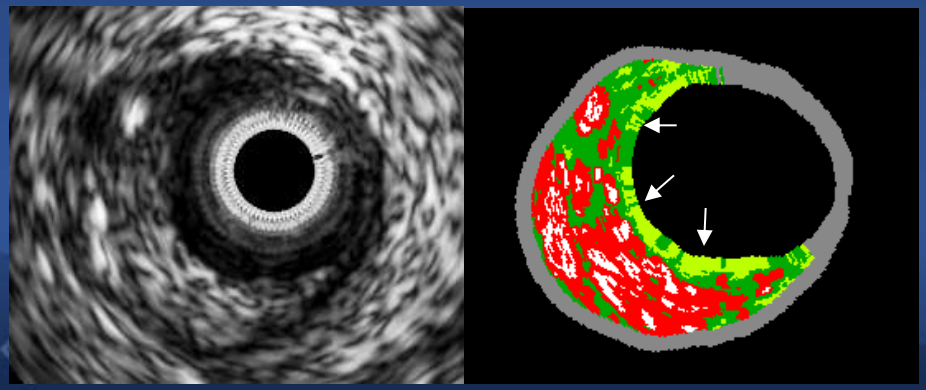
Strong power



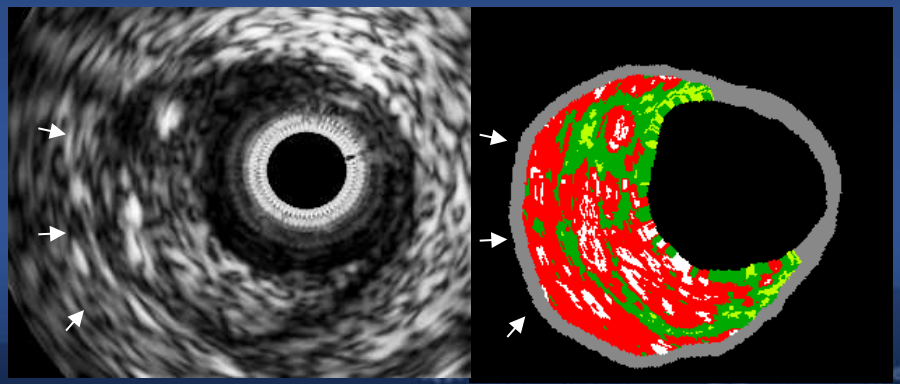
Isolated white pixel



Wrong lumen border



Wrong EEM border



Summary

- VH-TCFA is a predictor of NC-MACE, which has been validated by prospective trials
- VH-TCFA and a large necrotic core predict peri-procedural MI
- VH-IVUS is useful in neointimal characterization and provides a surrogate of neoatherosclerosis
- Despite pitfalls and methodological limitations, VH-IVUS is helpful to identify high-risk coronary lesion and to assess the effect of local or systemic treatment