

VH-IVUS

Native Plaque and Neointima

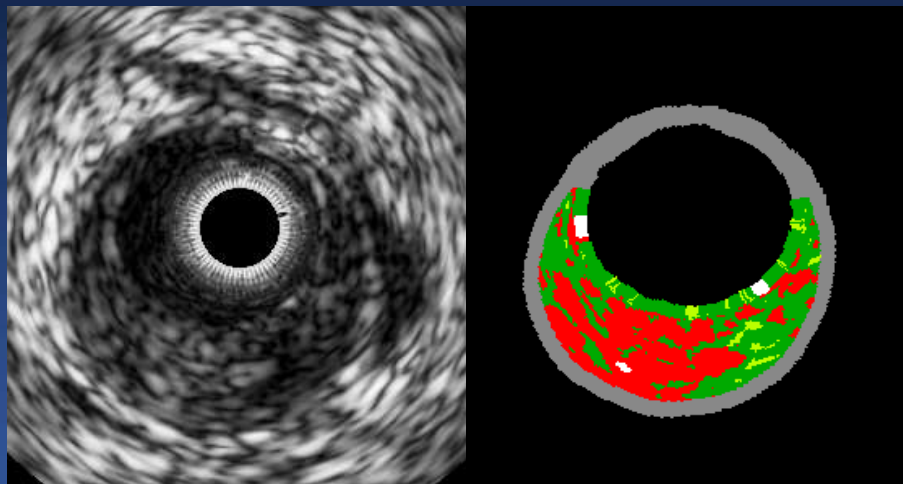
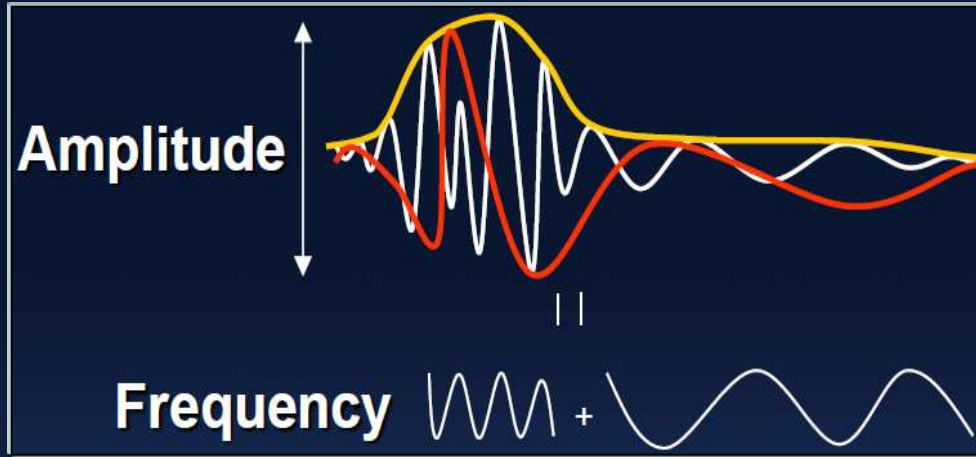
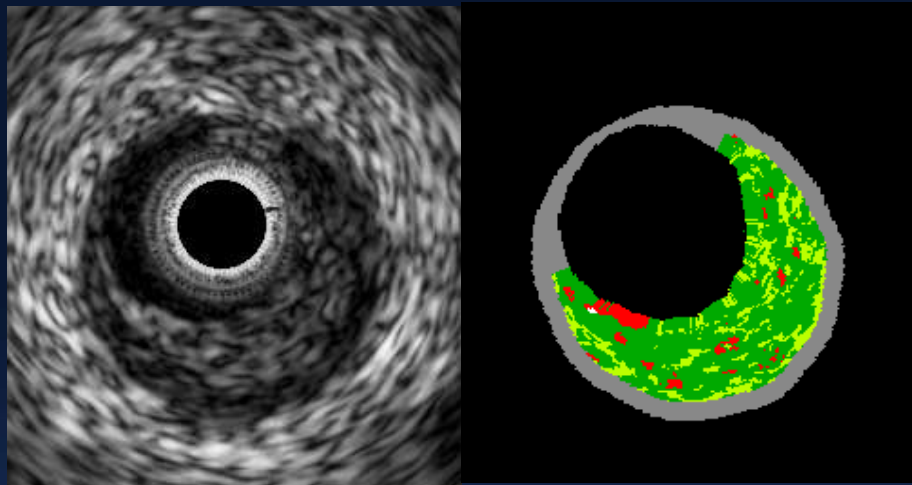
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Disclosure Statement of Financial Interest

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

Grayscale vs. VH IVUS



-  **Fibrous**
-  **Fibrofatty**
-  **Necrotic core**
-  **Dense calcium**

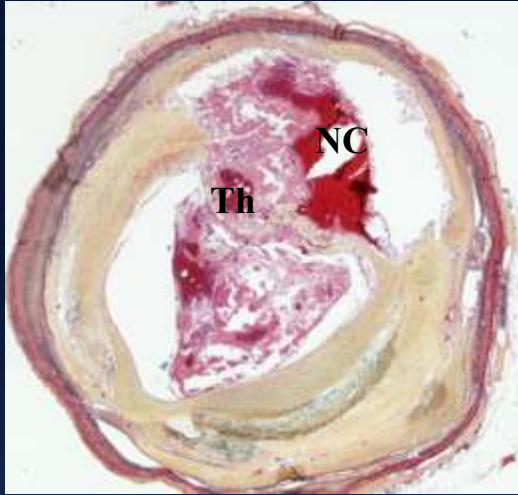
Validation of VH-IVUS with Histology

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

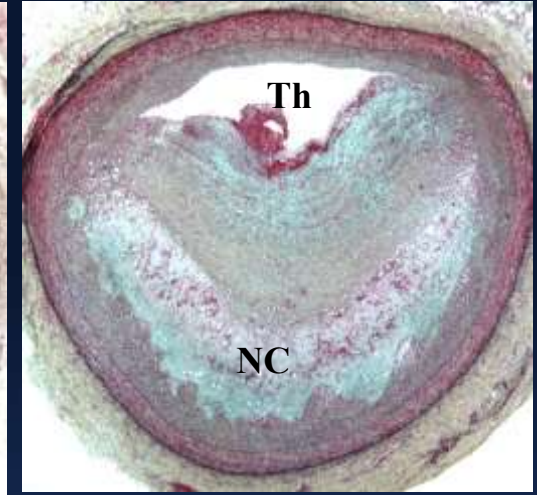
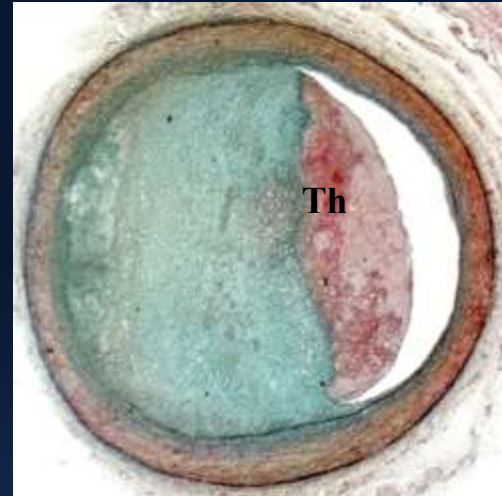
Nair et al. Eurointervention 2007;3:113-20

Causes of Coronary Thrombosis

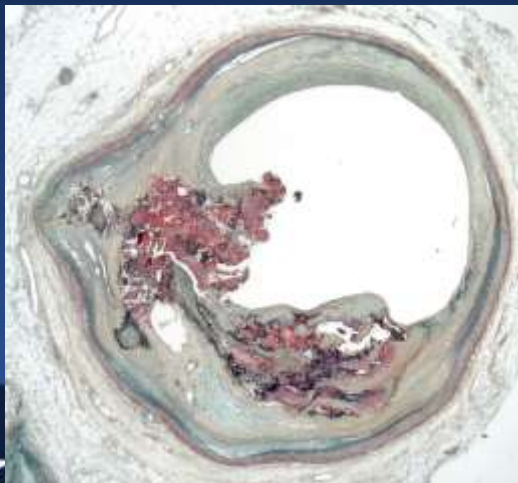
Rupture 60-75%



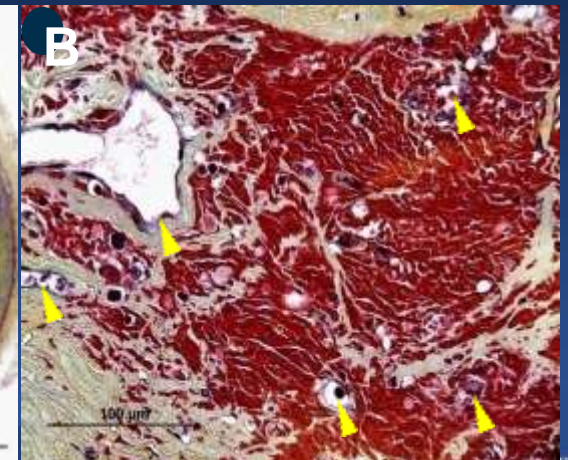
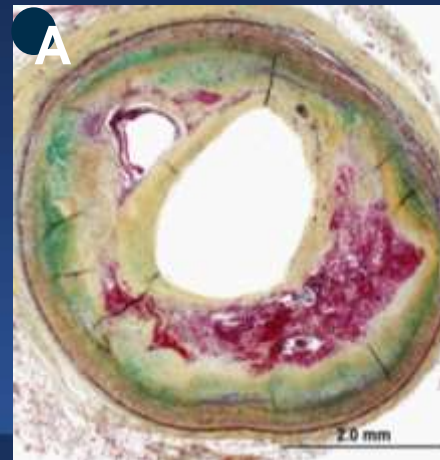
Erosion 30-35%



Calcified nodule (2-7%)



Intra-plaque hemorrhage



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)

*as a Precursor of Plaque Rupture
as a Prototype of Vulnerable Plaque*



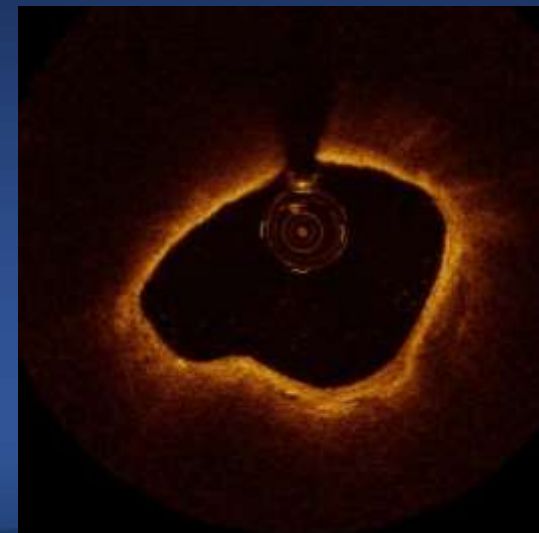
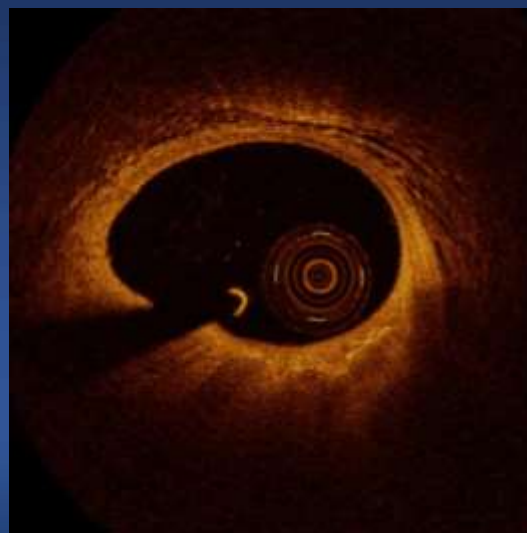
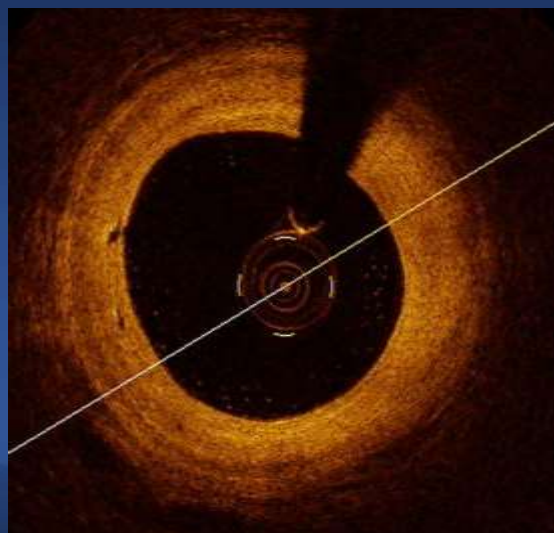
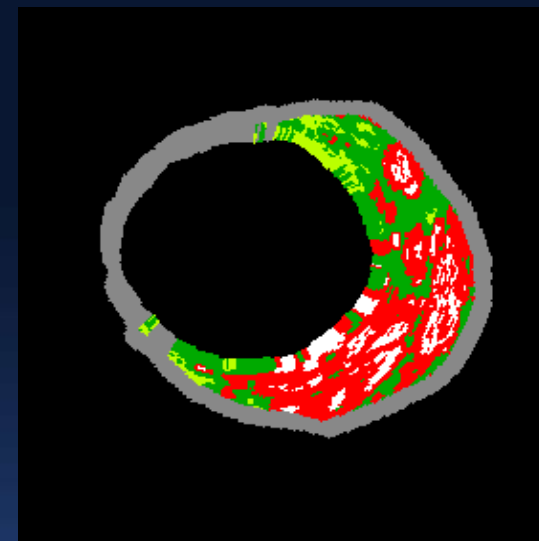
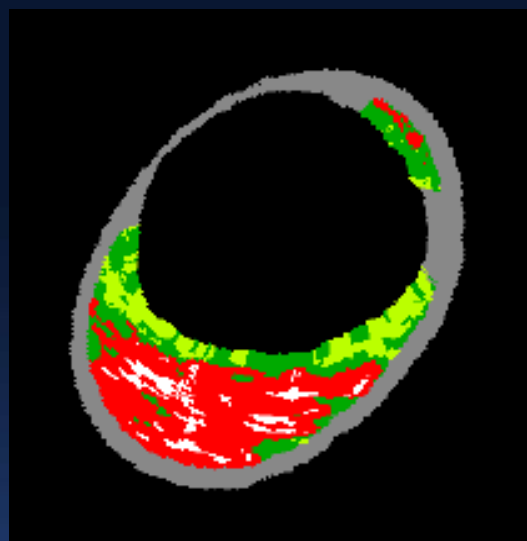
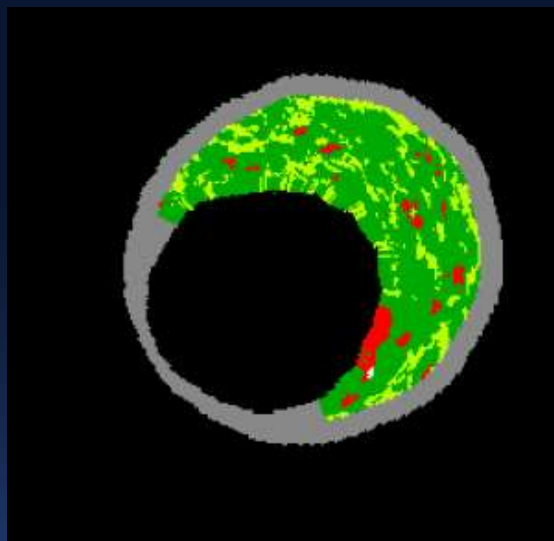
*Rodriguez-Granillo et al. JACC 2005;46:2038-42
Naghavi et al. Circulation 2003;108:1664-72*

Pathologic intimal thickening

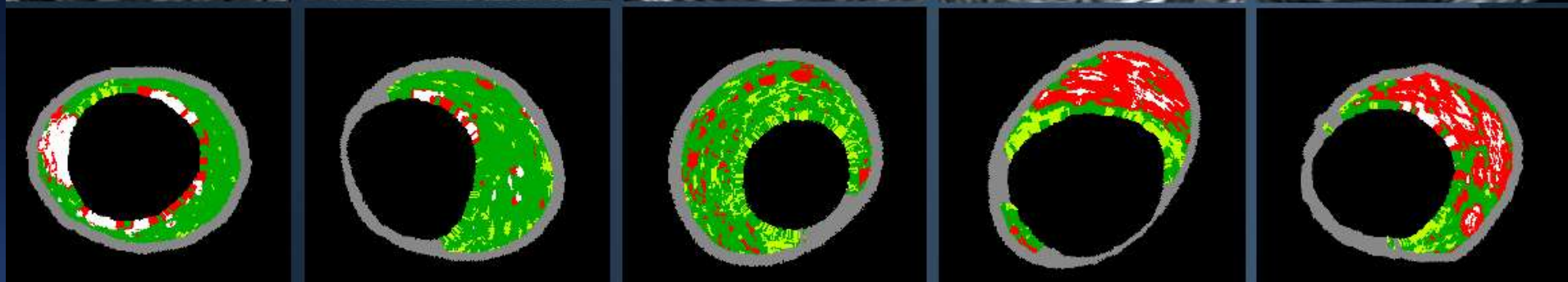
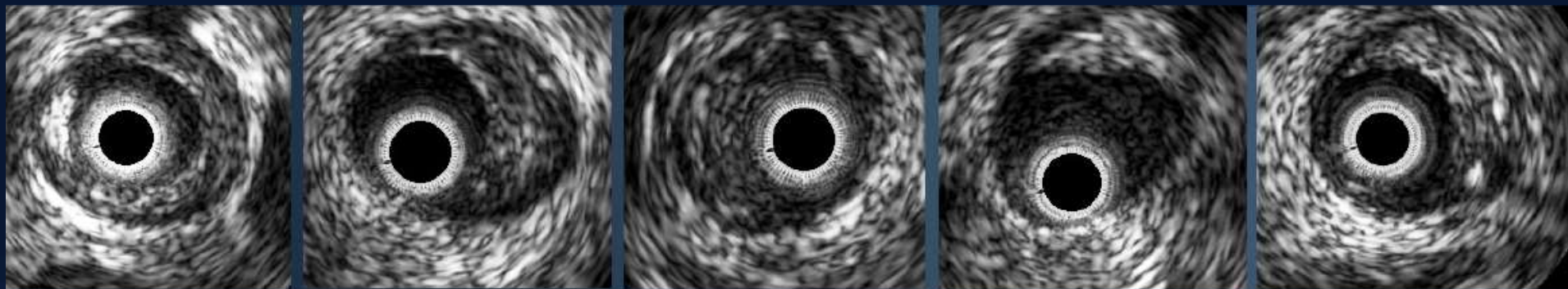
Fibroatheroma (FA)

Thick-cap FA

Thin-cap FA (TCFA)



VH-IVUS Plaque Types



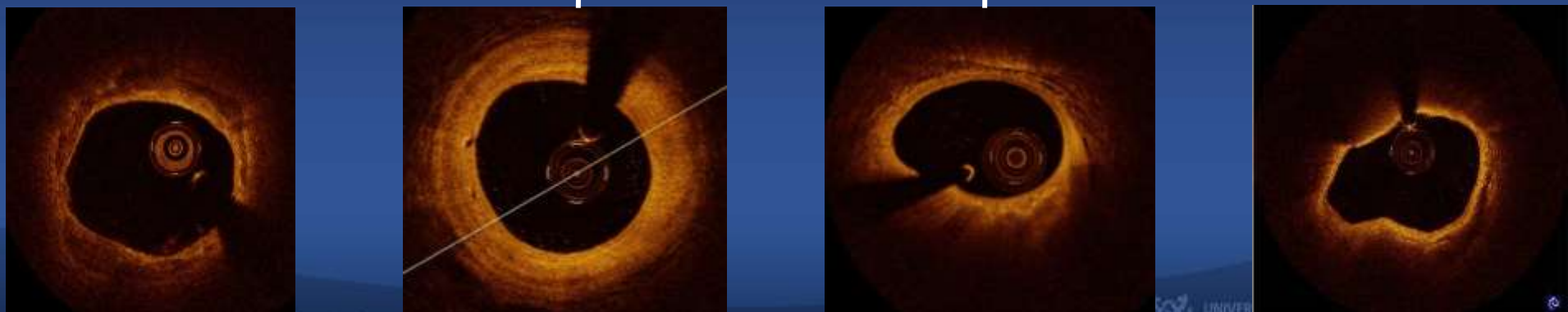
Fibrocalcific

Fibrous

PIT

Thick-cap FA

TCFA



	PROSPECT¹	ATHEROREMO²	VIVA³
Population	697 ACS patients	581 patients (318 ACS, 263 SA)	170 patients (70 ACS, 100 SA)
Imaging	3 vessel VH-IVUS	1 vessel VH-IVUS	3 vessel VH-IVUS
Median f/u	3.4 years	1 year	1.7 years
NCL-TCFA	22% (>30° of NC abutted the lumen)	37%	60%
Death/ MI	NCL-related 1%	NCL-related 3.8%	Total 2.4%
MACE Def.	CV death, MI, hospitalization from progressive angina	Death, ACS, unplanned revasc	Death, MI, unplanned revasc
MACE	NCL-related 11.6%	NCL-related 7.7%	Total 9.4%

Prospective natural history studies of non-culprit lesions

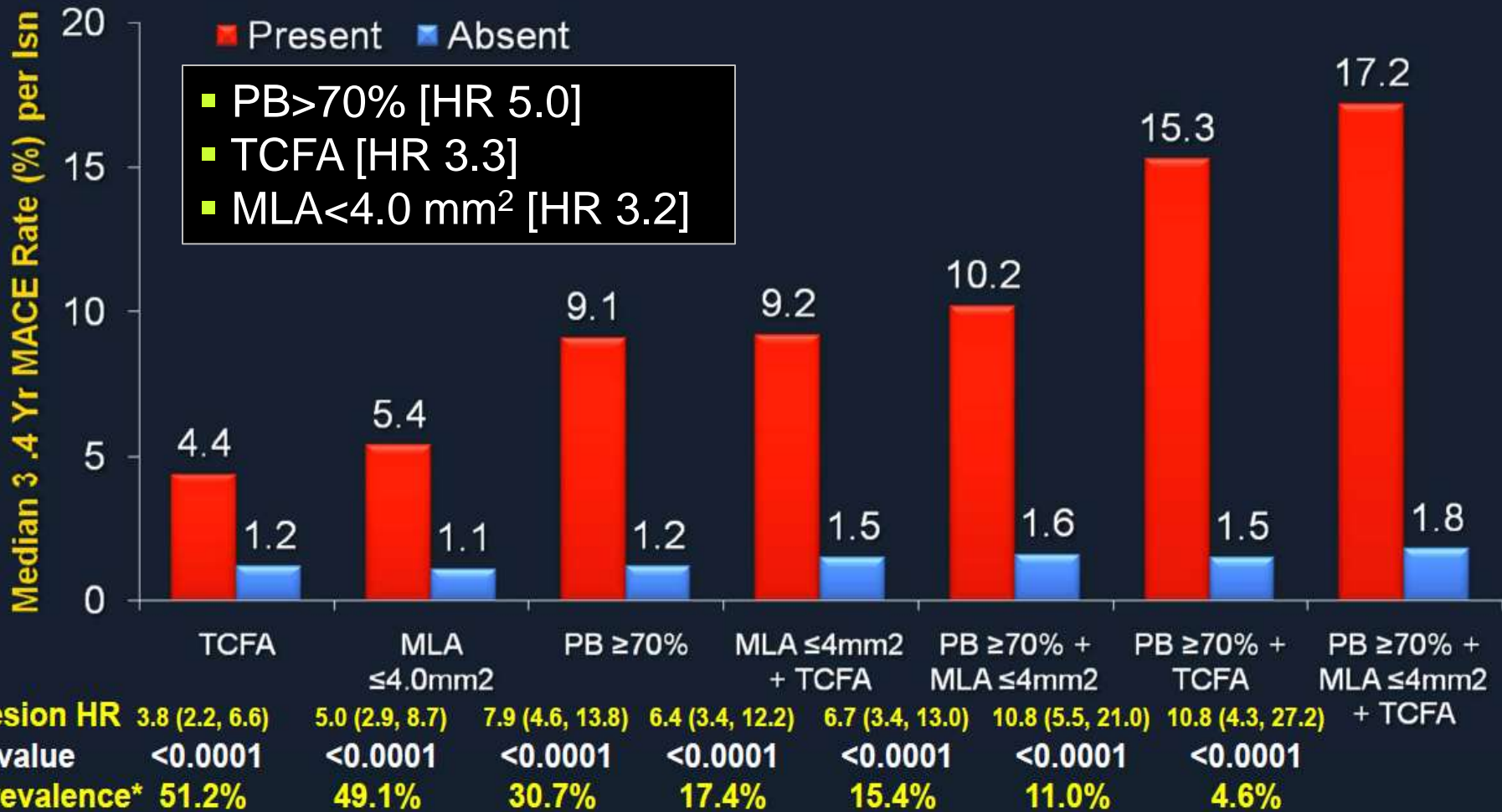
1. Stone G et al. *NEJM* 2011;364:226-35

2. Calvert et al. *JACC* 2011;4:894-901

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

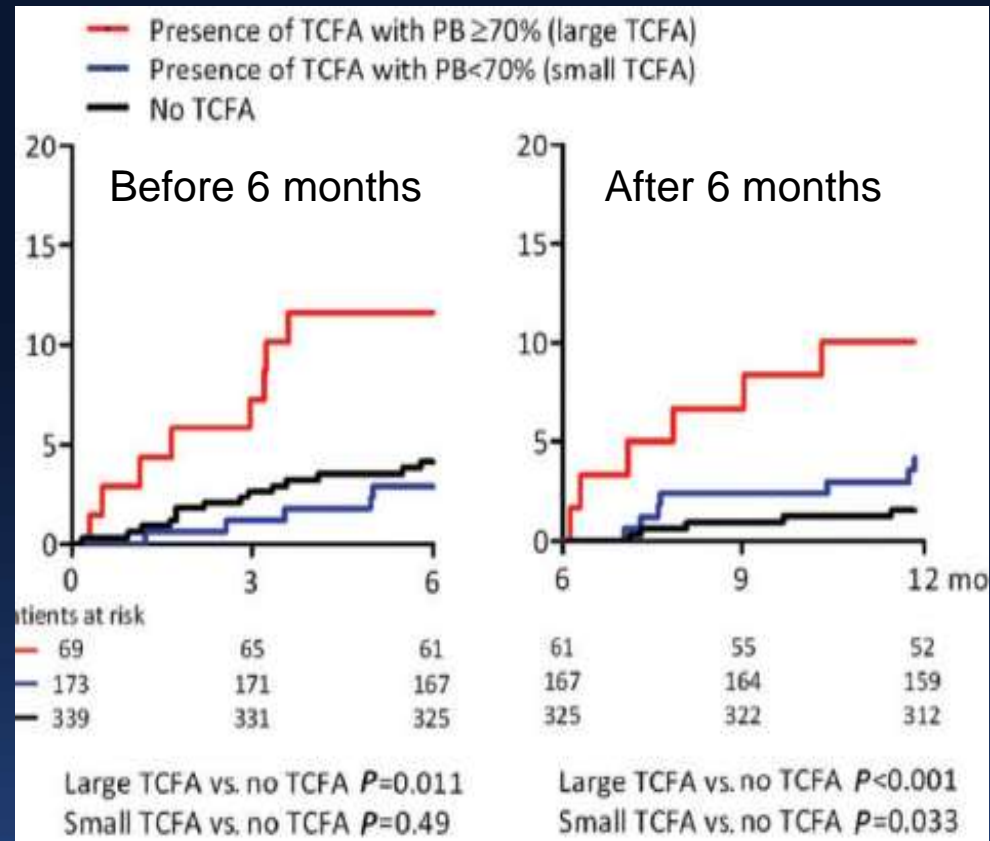
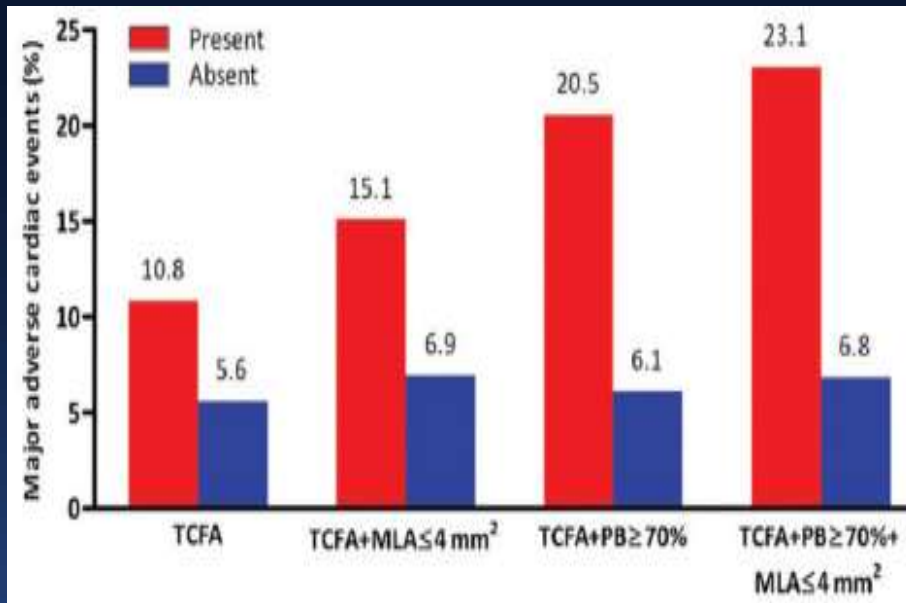
Predictors of Non-Culprit MACE

PROSPECT



Predictors of Non-Culprit MACE

ATHEROREMO



Cheng et al. *EJH* 2014;35:639-47

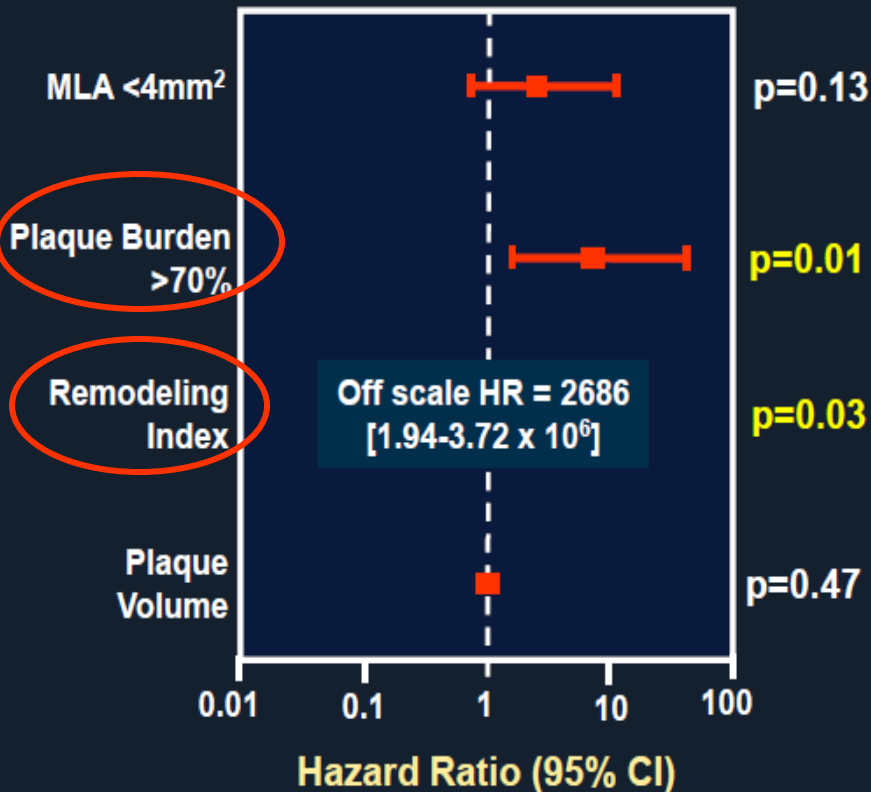
- PB > 70% [HR 2.9]
- TCFA [HR 1.9]

Predictors of Non-Culprit MACE

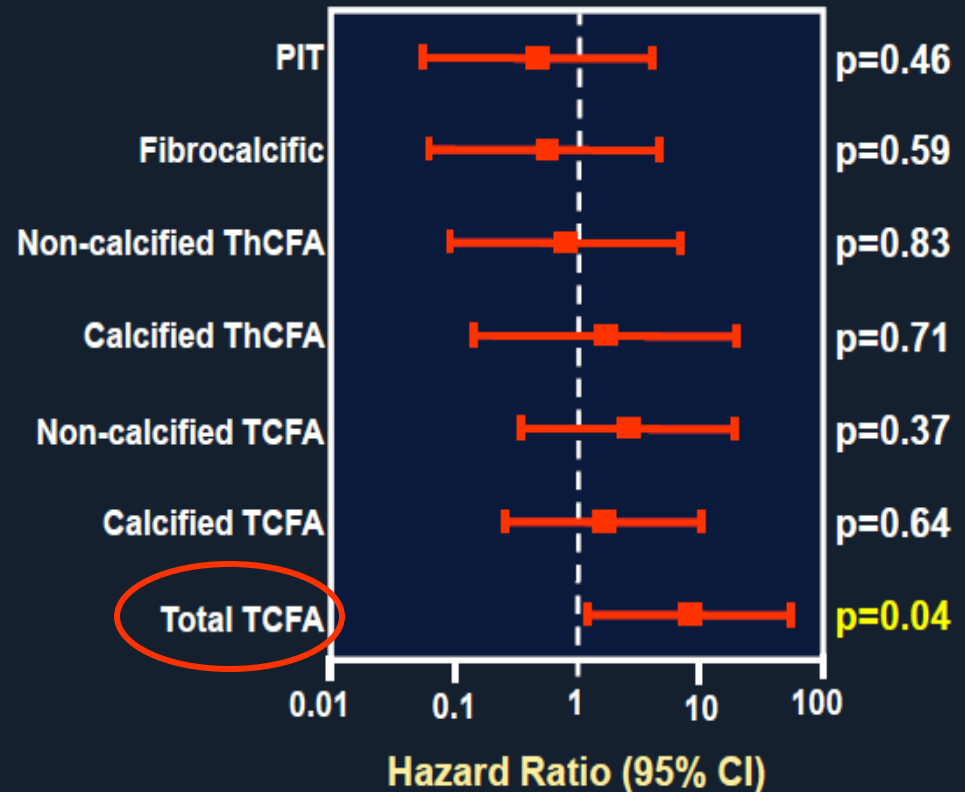
VIVA

Univariable analysis

Grayscale IVUS characteristics

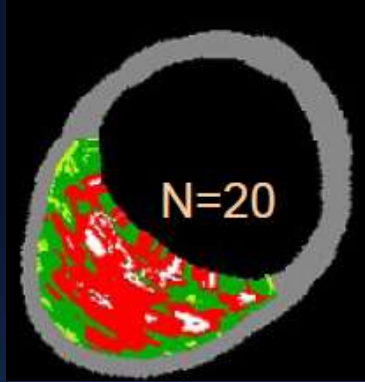


VH-IVUS lesion classification



Dynamic Change in TCFA

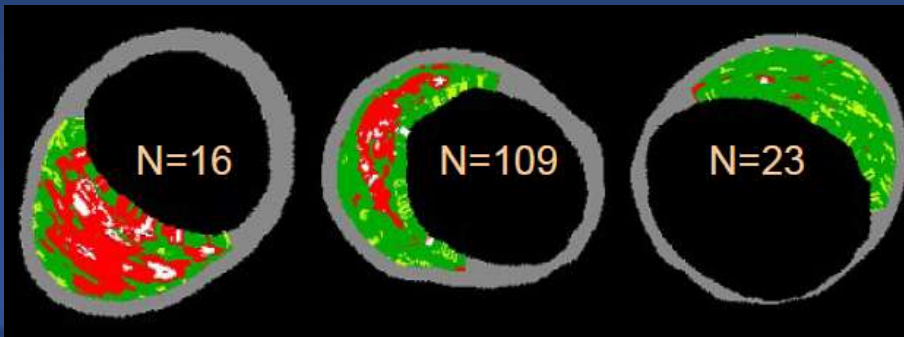
PROSPECT



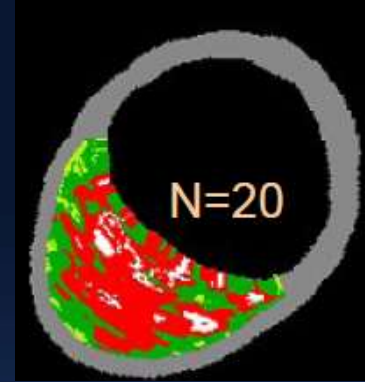
25%

65%

10%



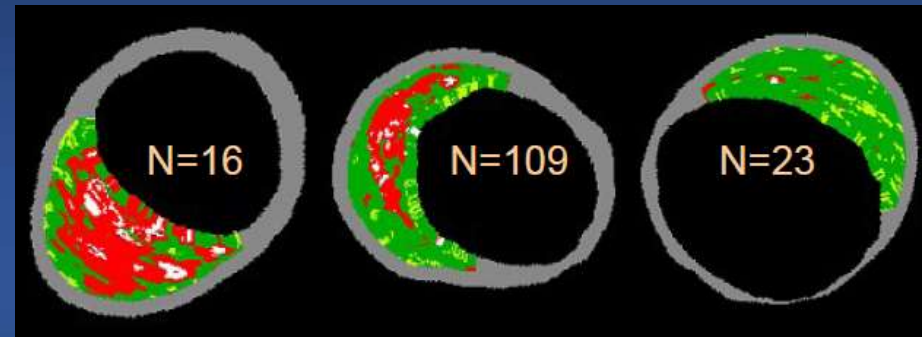
HORIZON-AMI



76%

14%

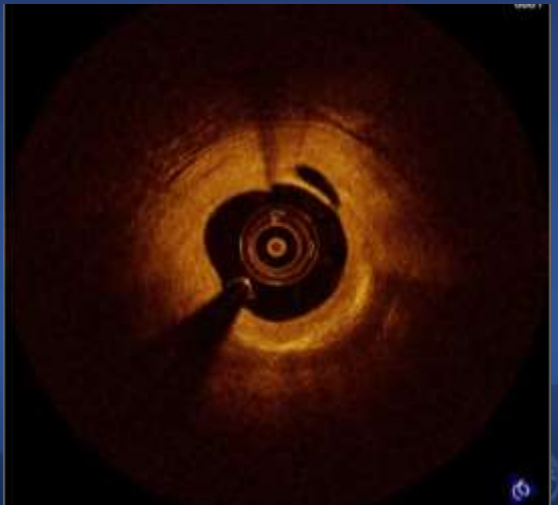
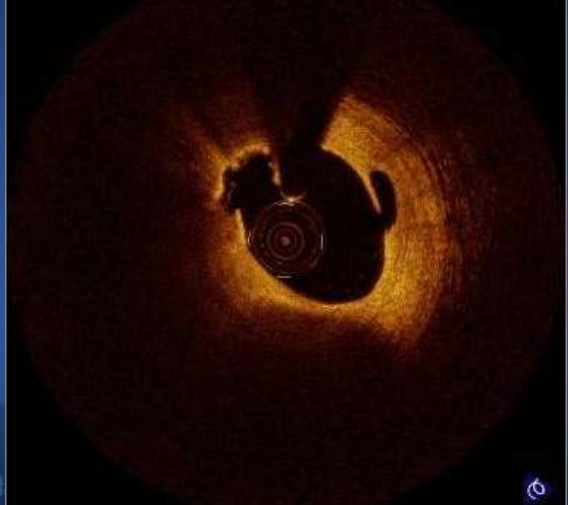
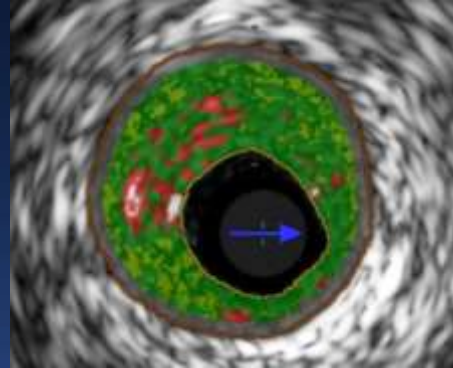
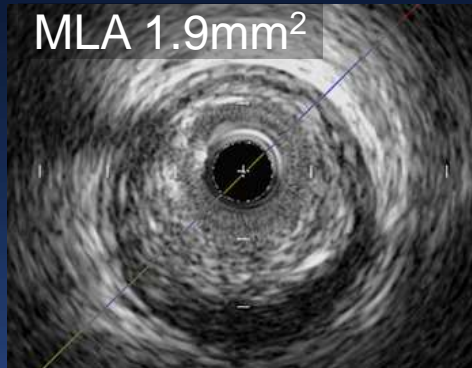
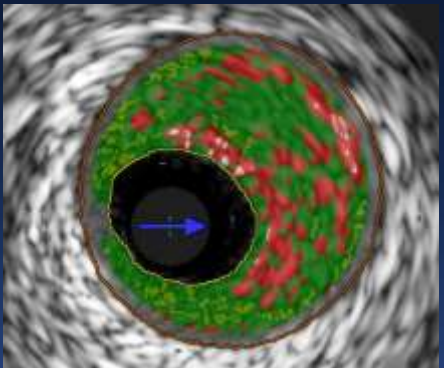
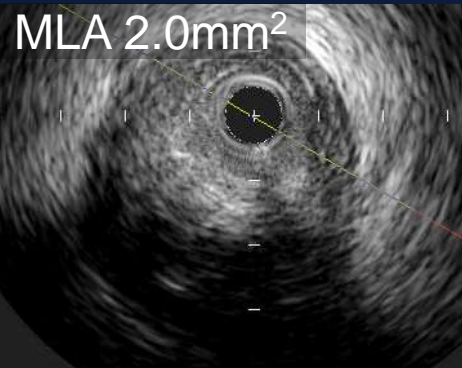
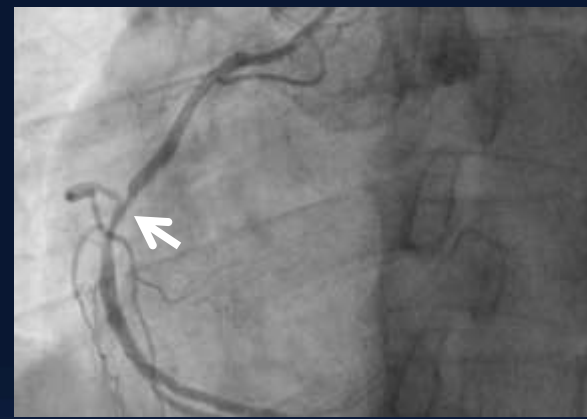
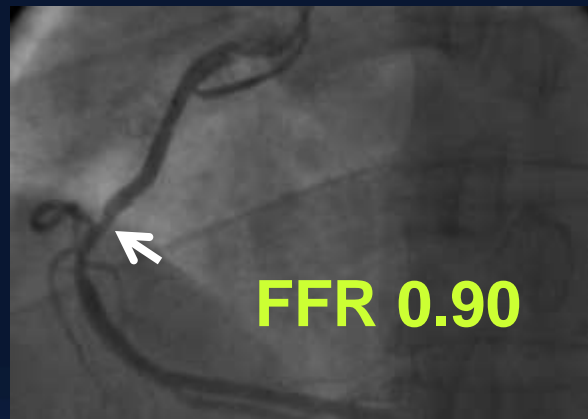
5%



42/M

Baseline

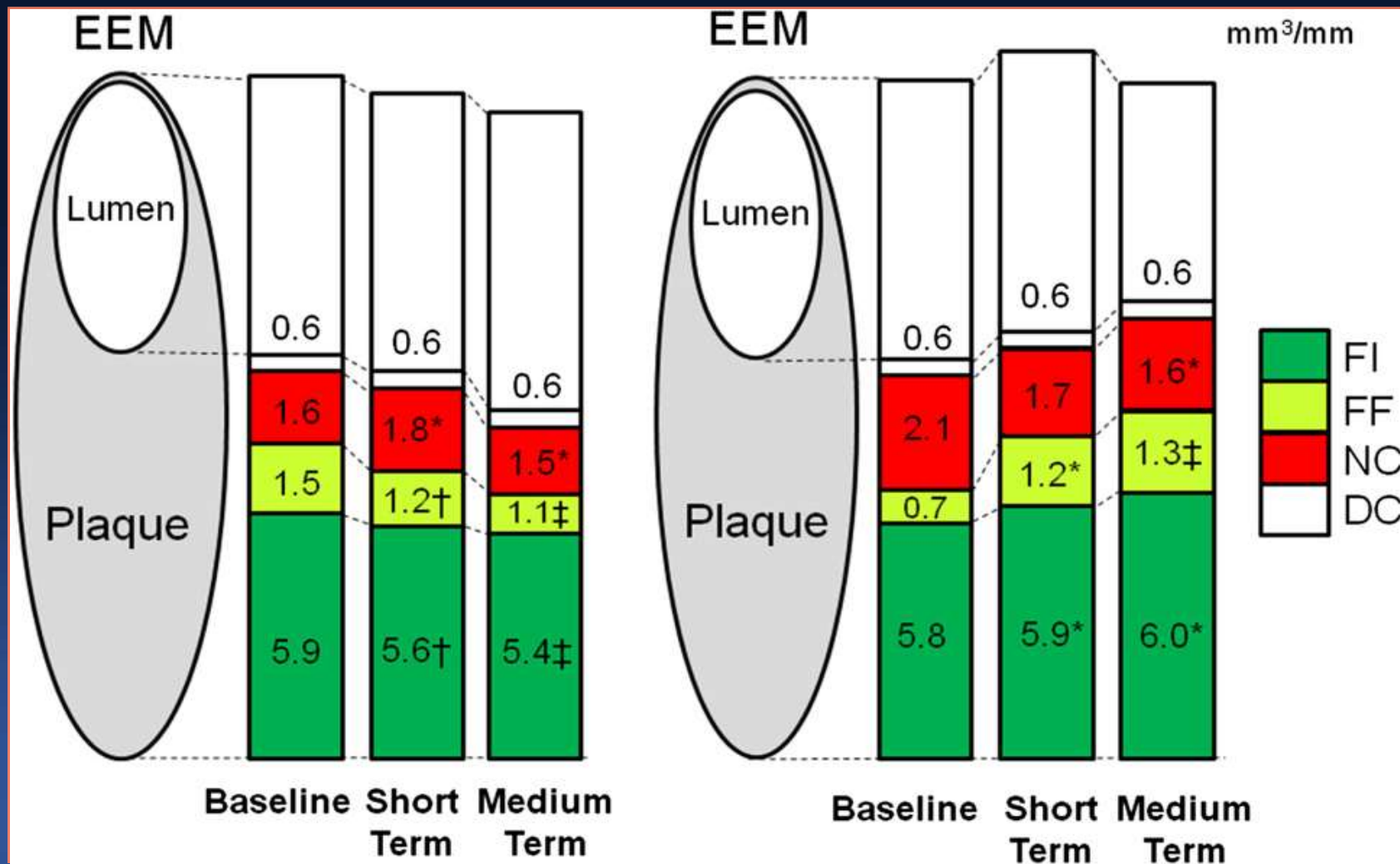
1-year F/U



Serial Change During Statin Treatment

Plaque Regression Group

Plaque Progression Group



Taguchi et al. Am J Cardiol 2013;111:1246-52

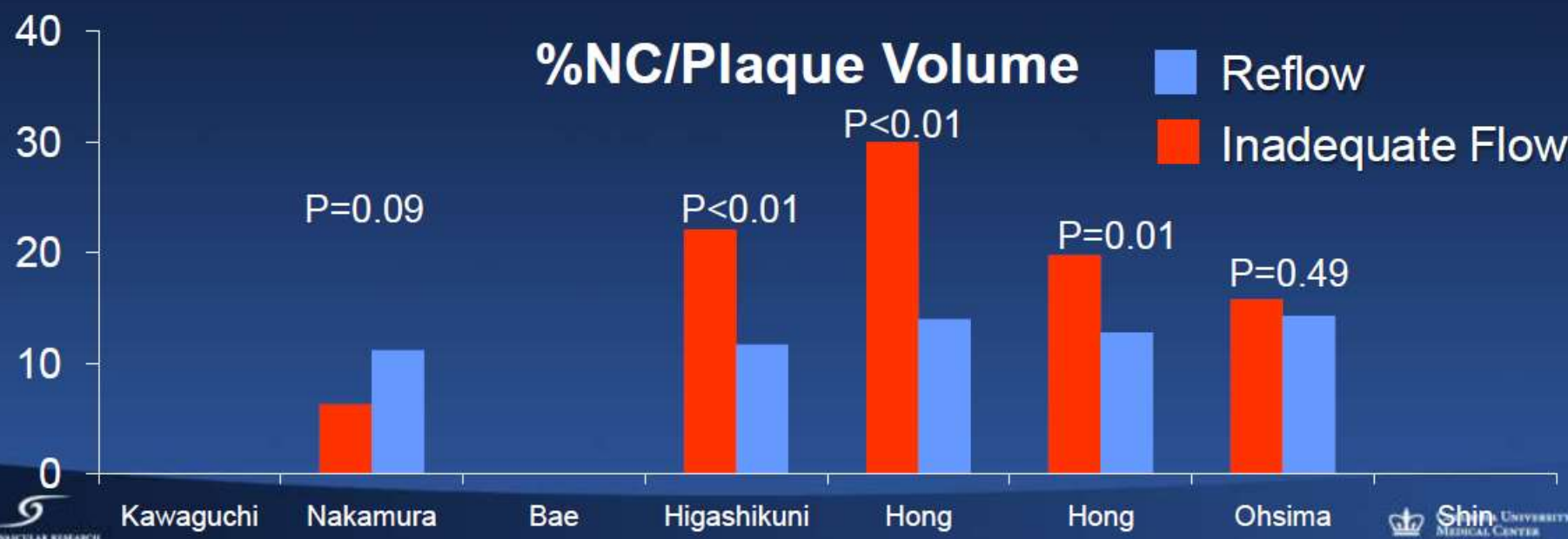
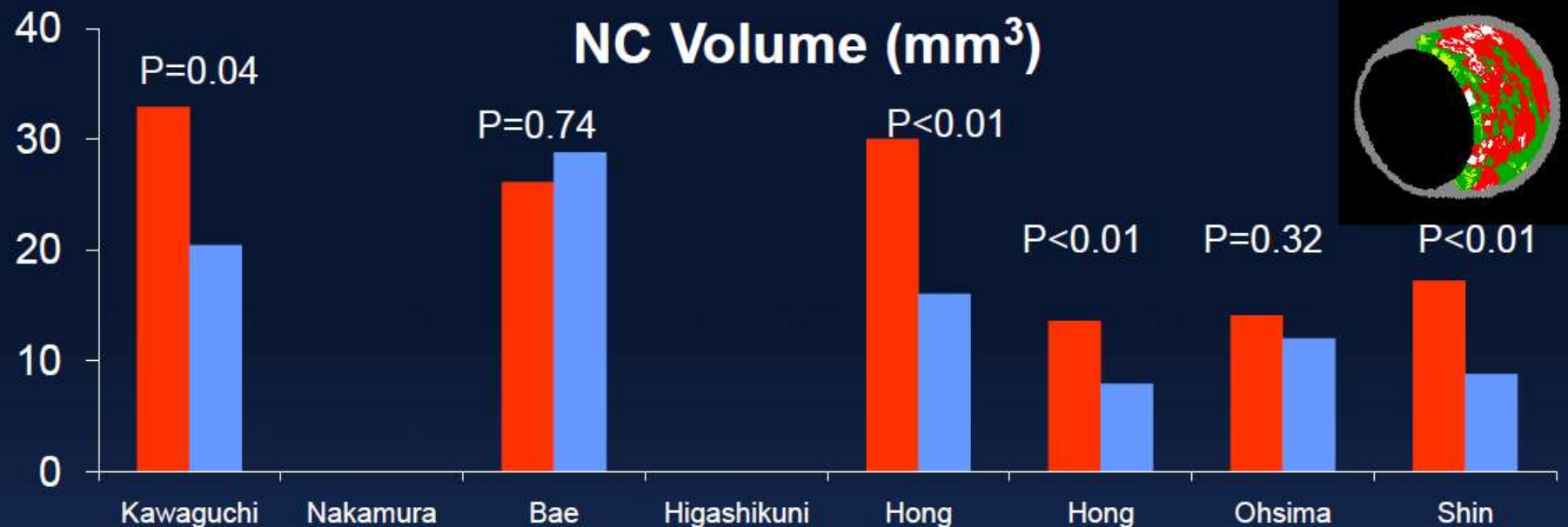
VH Plaque Characteristics to Predict Distal Embolization

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

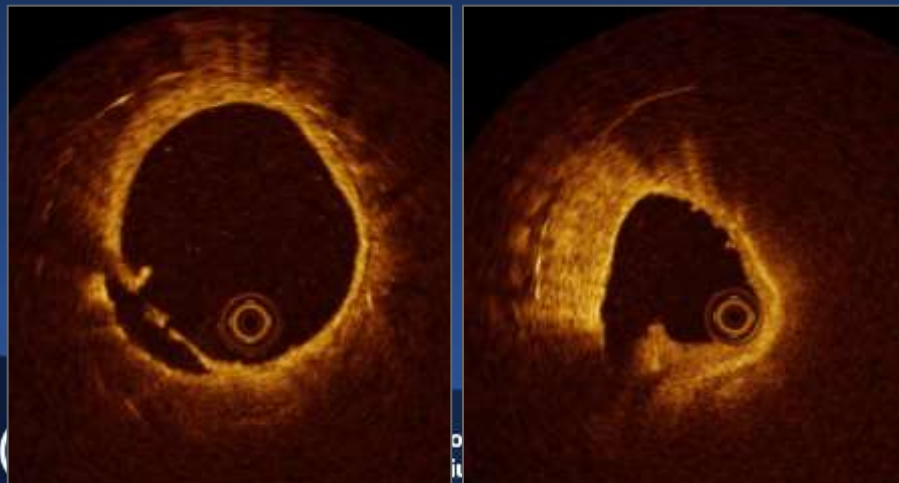
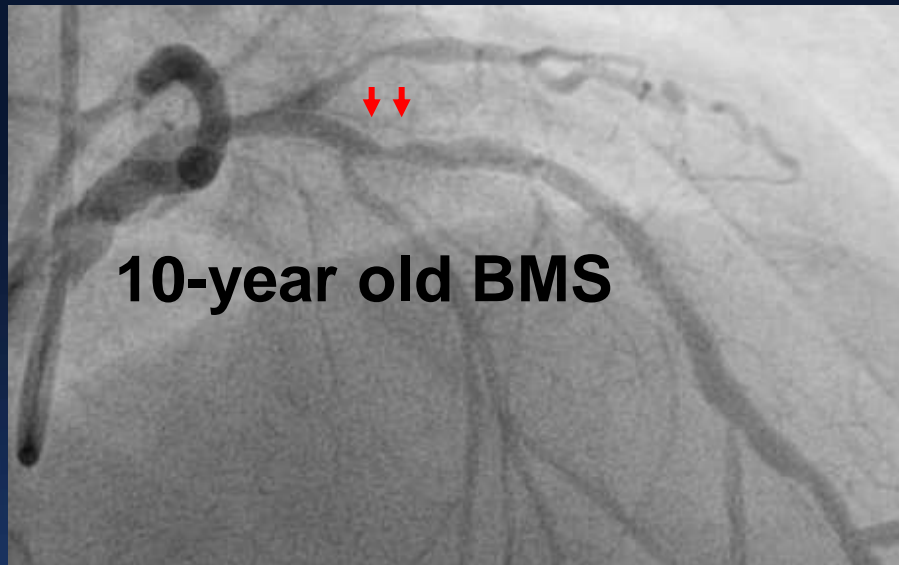
Claessen et al. JACC Cardiovasc Imaging 2012;5:S111-8

VH Necrotic Core and Inadequate Flow



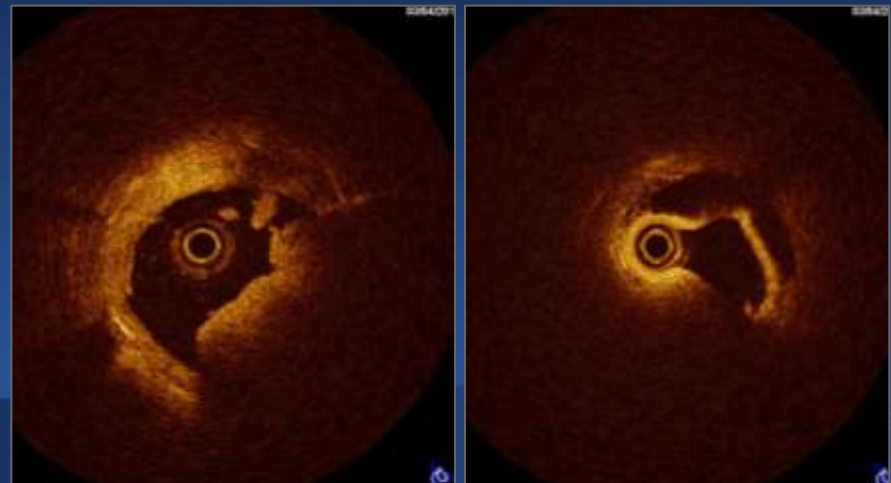
Late ISR

63-year old male
Stable angina



VLST

60-year old male
AMI with VLST



Neoatherosclerosis is a Mechanism of Stent Failure

Stent failure OCT data from AMC

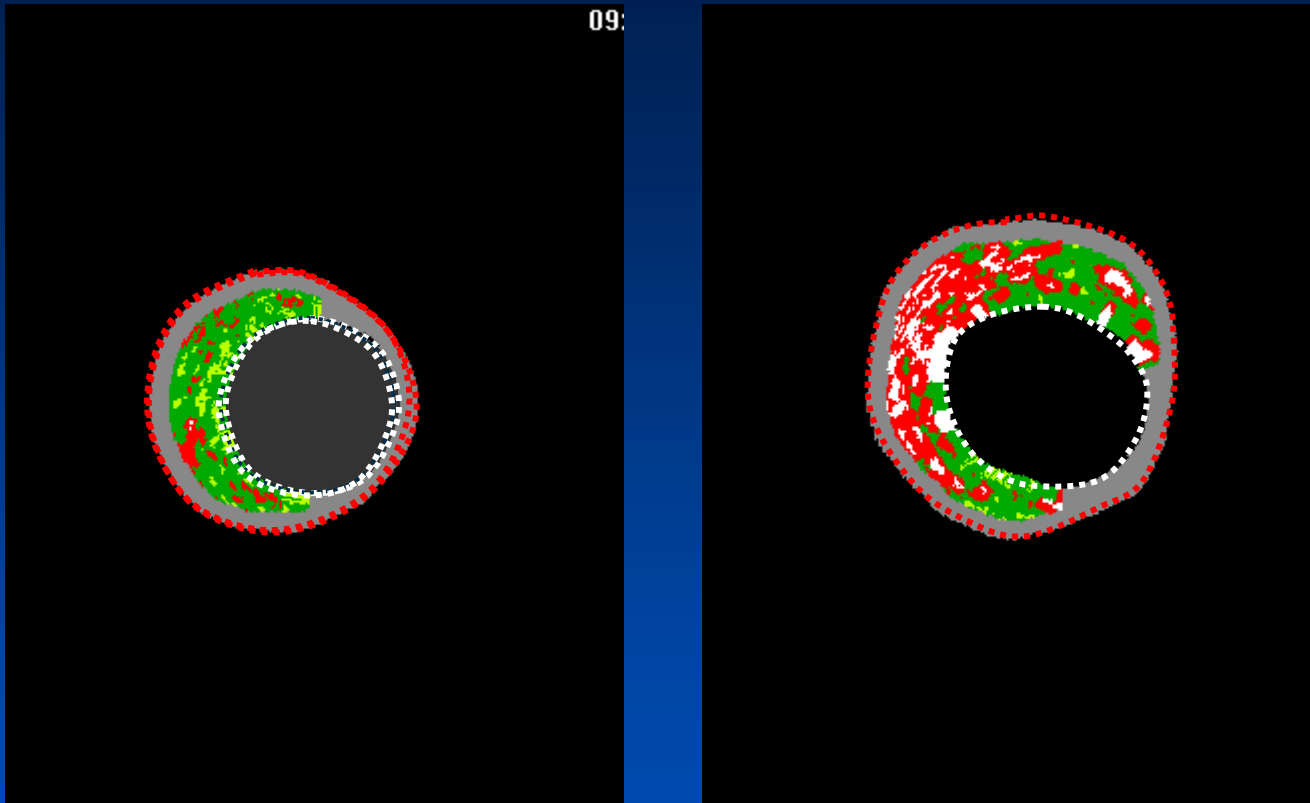
	DES-ISR ¹	BMS-ISR ²	VLST ³	
Lesion	50 DES	51 BMS	6 BMS	27 DES
Median F/U	32 Mo	132 Mo	109 Mo	62 Mo
Lipid or NC	90%	100%	100%	100%
OCT-TCFA	52%	68%	100%	56%
OCT-rupture	58%	59%	100%	63%
TLR	98%	all	all	all

1. Kang et al. *Circulation* 2011;123:2954-63

2. Kang et al. *JACC Cardiovasc Imaging* 2012;5:1267-8

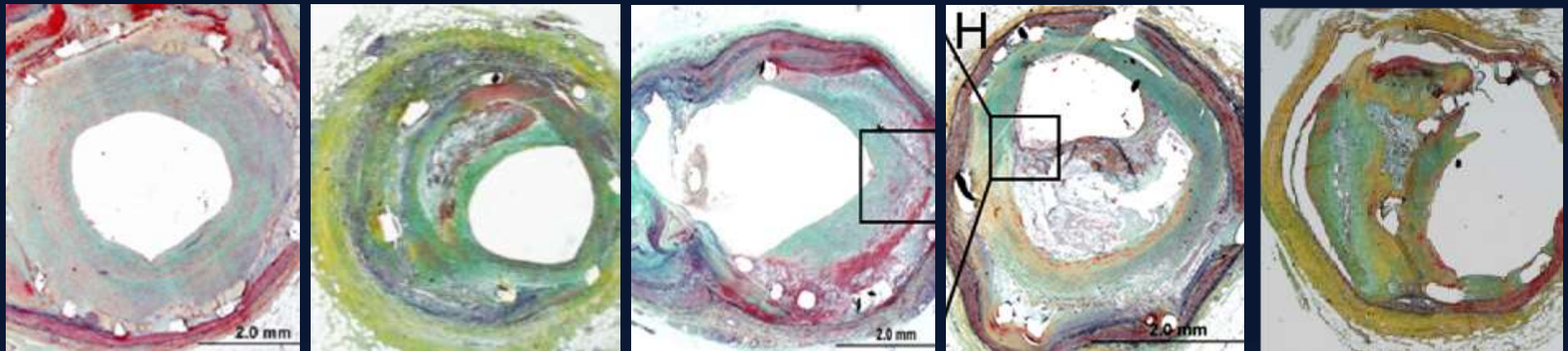
3. Kang et al. *JACC Cardiovasc Imaging* 2013;6:695-703

Tissue Characterization of Neointima

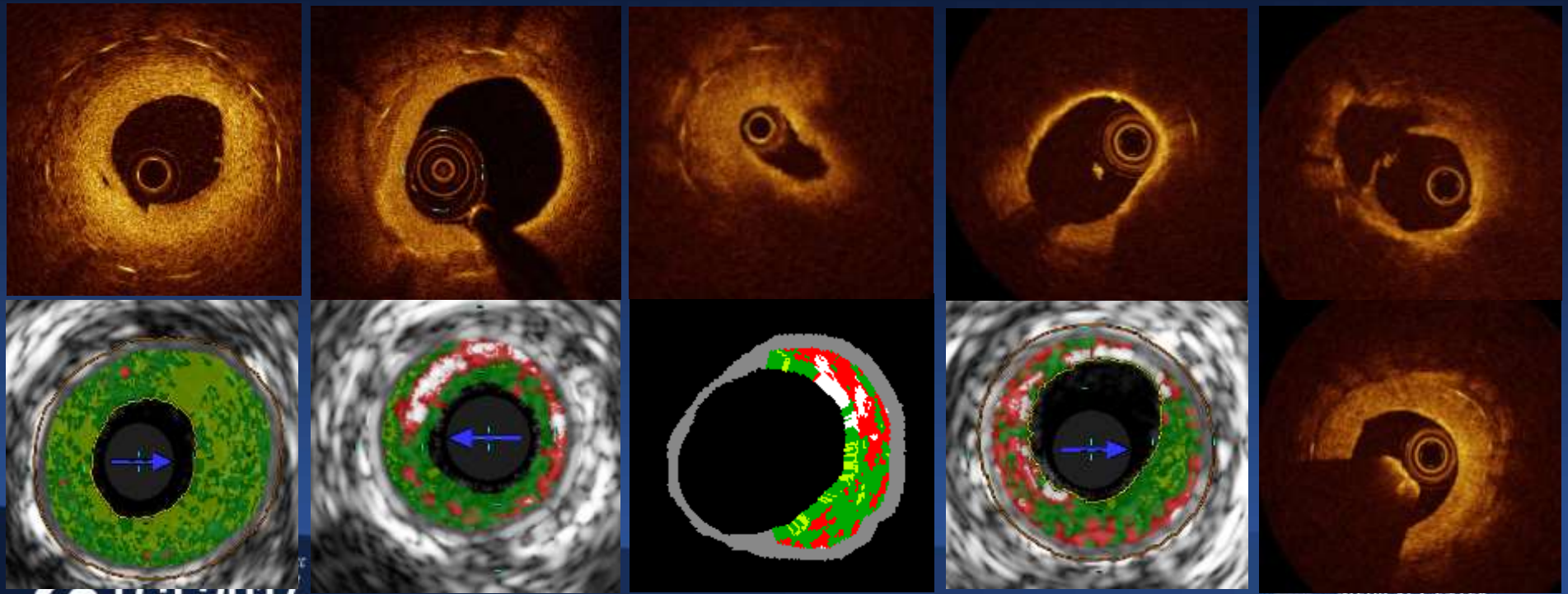


- luminal border (exclude the catheter and its artifacts)
- inner border of stent struts (exclude the struts)

Early neointima Fibrocalcific ThCFA TCFA Intimal rupture



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



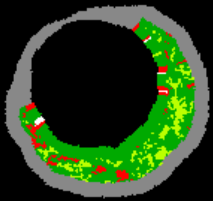
Tissue Characterization of In-Stent Neointima Using Intravascular Ultrasound Radiofrequency Data Analysis

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

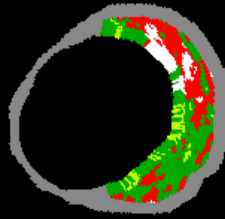
6-mo Taxus

%NC 8%
%DC 2%



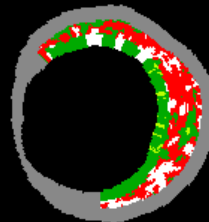
9-mo Taxus

%NC 28%
%DC 8%



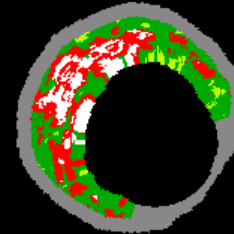
22-mo Taxus

%NC 39%
%DC 20%



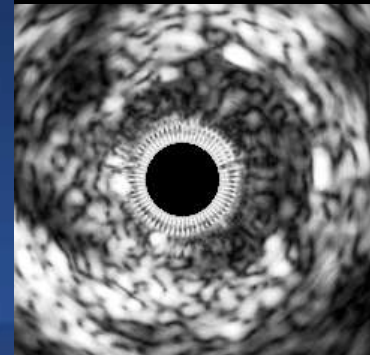
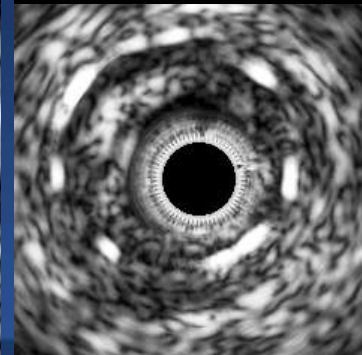
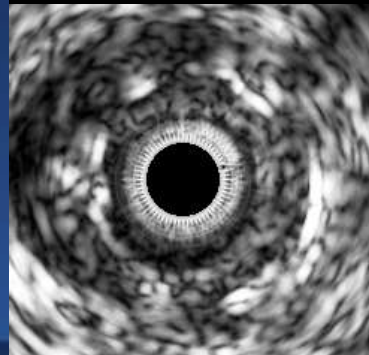
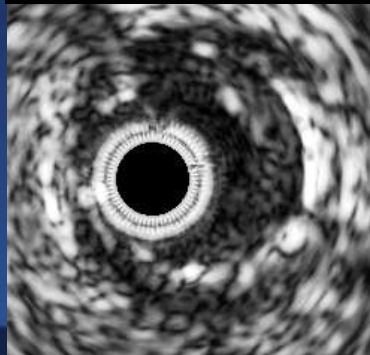
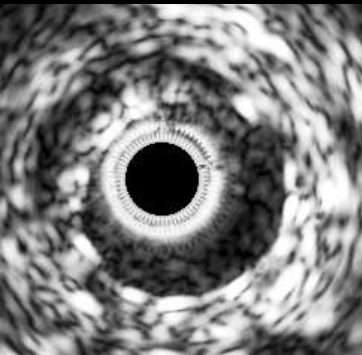
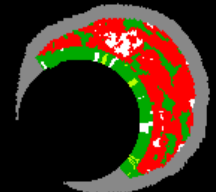
48-mo BMS

%NC 40%
%DC 25%



57-mo BMS

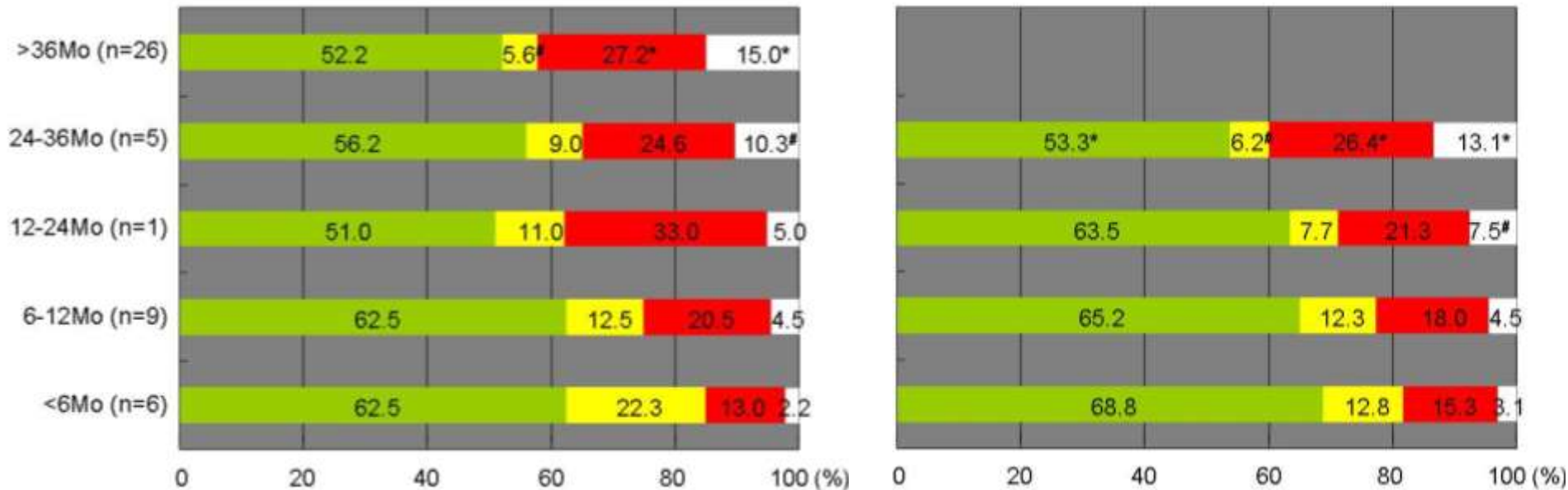
%NC 57%
%DC 15%



Neointimal VH Composition

47 BMS-ISR

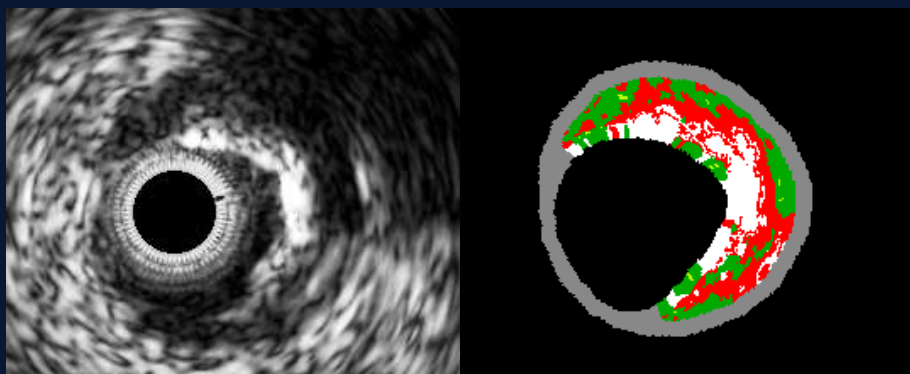
70 DES-ISR



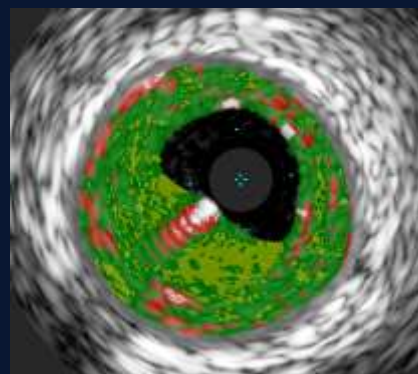
* $p < 0.01$ and # $p < 0.05$, vs. lesions at follow-up time <6 months

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

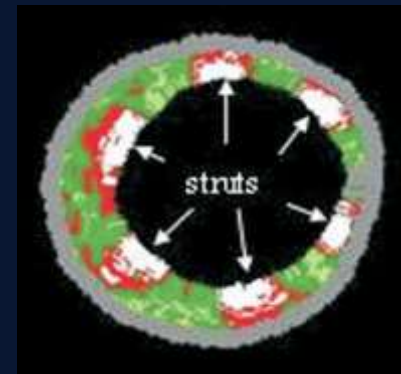
Plaque behind calcium



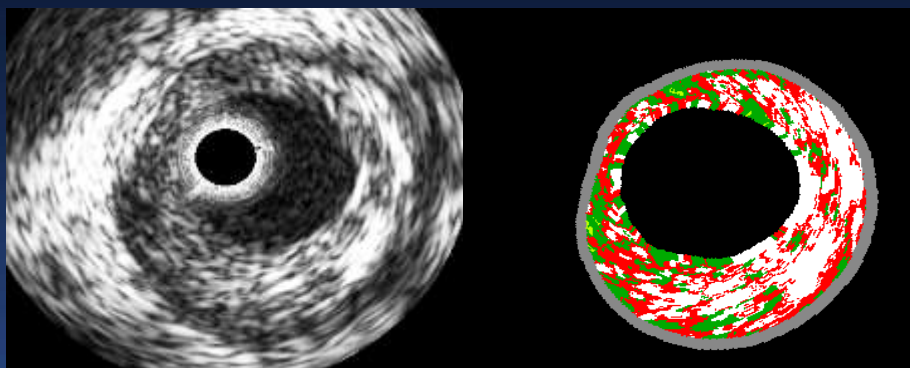
Guidewire



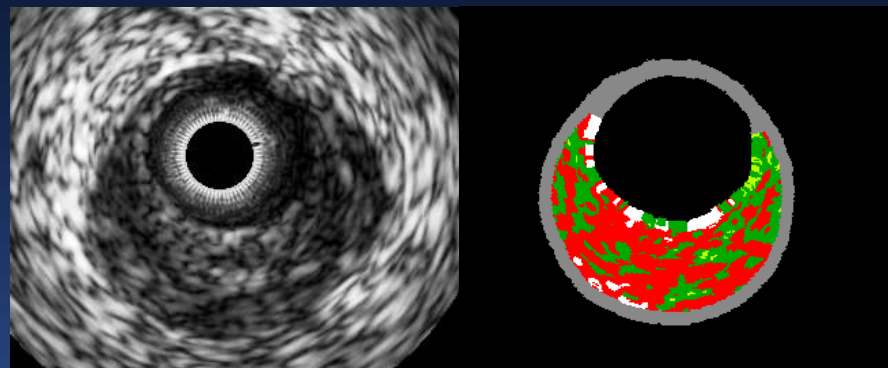
Peri-stent halo



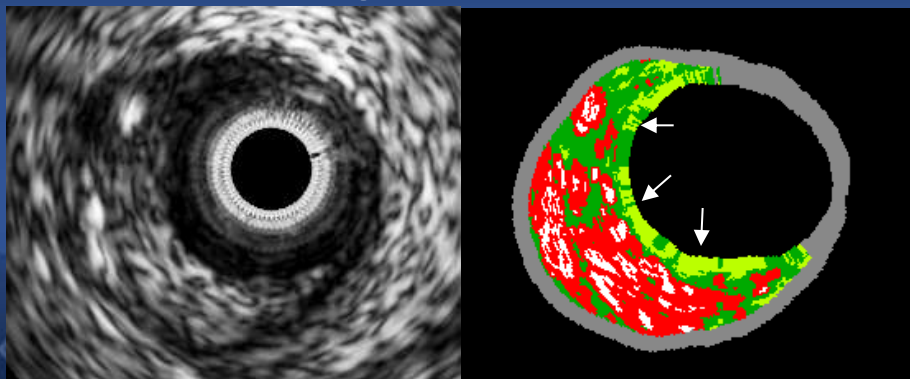
Strong power



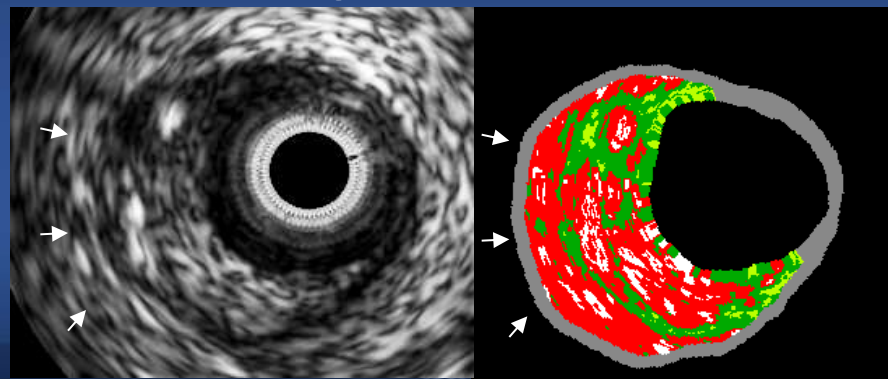
Isolated white pixel



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 periprocedural MI
- VH-IVUS is useful in neointimal characterization and provides a surrogate of neoatherosclerosis