Difference in Plaque Morphology and Stability in STEMI, NSTE-ACS and Stable CAD

Akiko Maehara, MD
Cardiovascular Research Foundation
Columbia University Medical Center

Cardiovascular Research Foundation

COLUMBIA UNIVERSITY MEDICAL CENTER
NewYork-Presbyterian

Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

Affiliation/Financial Relationship

- Grant/Research Support
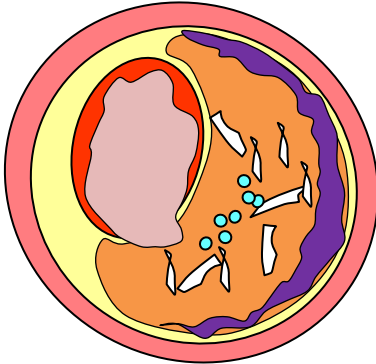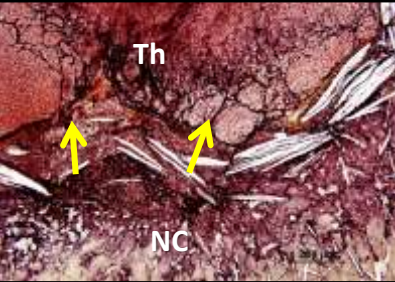- Consulting Fees/Honoraria

Company

- Boston Scientific, St Jude Medical
- Boston Scientific, OCT Medical Imaging Inc.
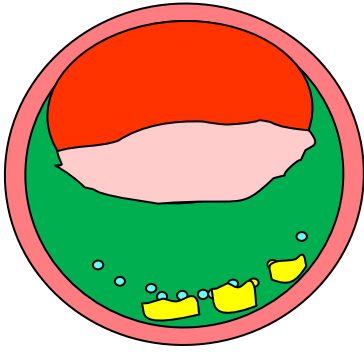
Causes of Coronary Thrombosis

Lesions with acute thrombi
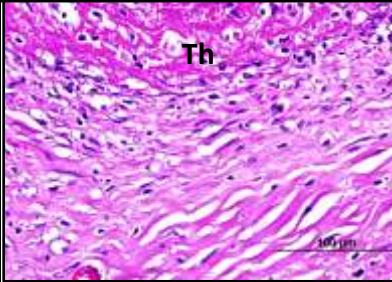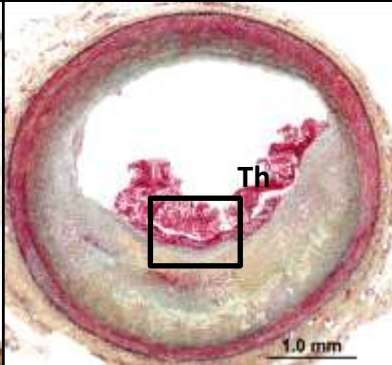
Joner M
CRT2015
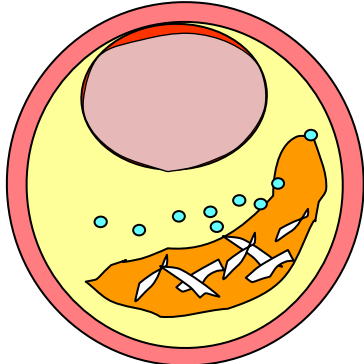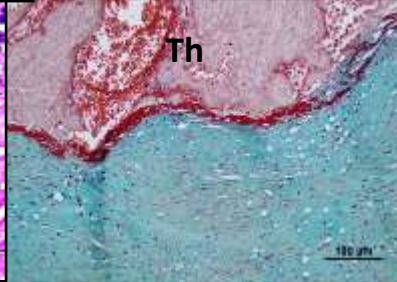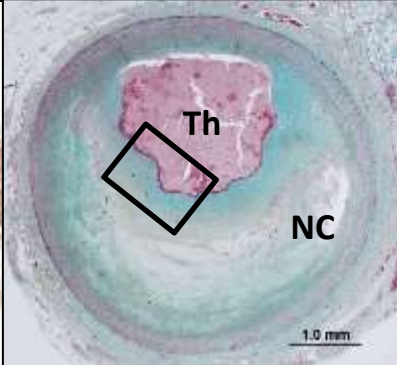
Rupture	Erosion		Calcified nodule	Plaque fissure
	Underlying PIT	*Underlying FA*		
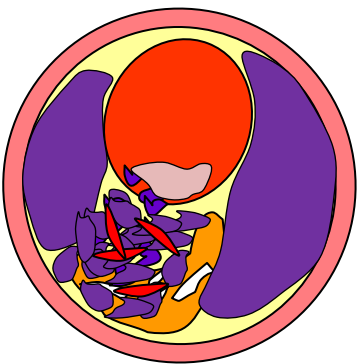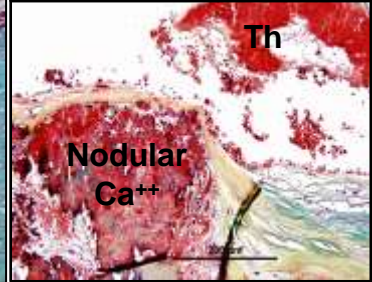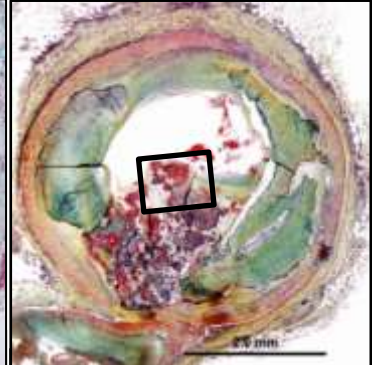
Subclinical episodes of plaque disruption followed by healing, leading to a chronic, high-grade coronary stenosis.

Number of prior ruptures and healed rupture site
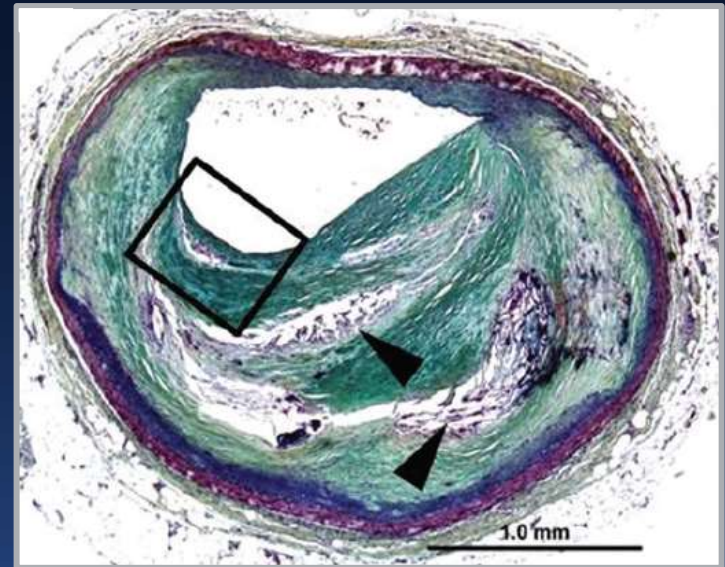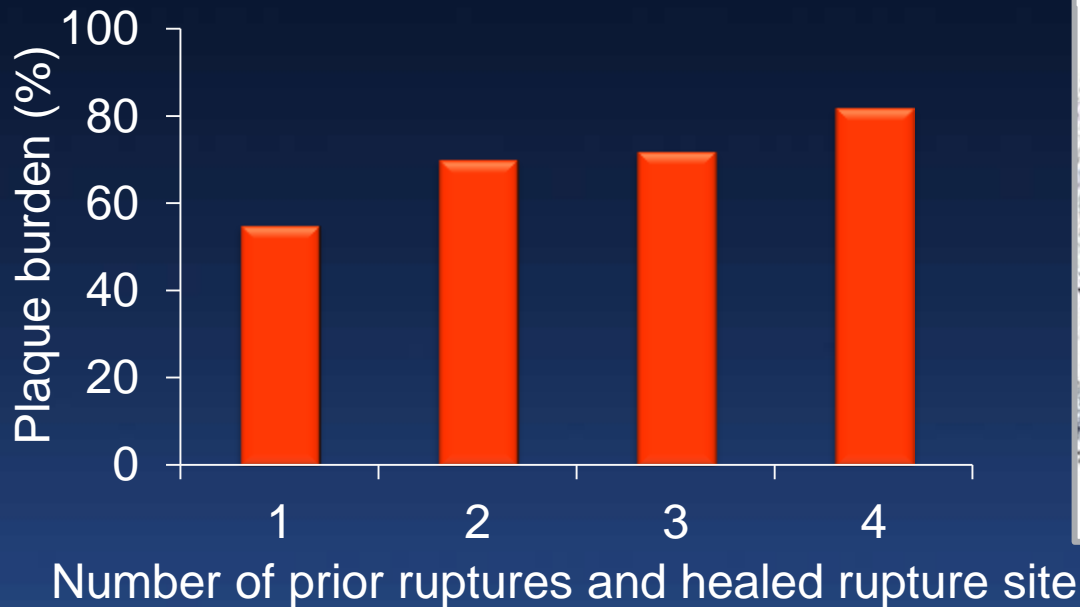
Burk AP et al. Circulation 2001;103:934-940.
Mann J et al. Heart 1999;82:265–268.

Cardiovascular Research Foundation

COLUMBIA UNIVERSITY MEDICAL CENTER
NewYork-Presbyterian

Rupture vs Erosion

Rupture: STEMI presentation in 70%, Erosion: NSTEMI presentation in 60%

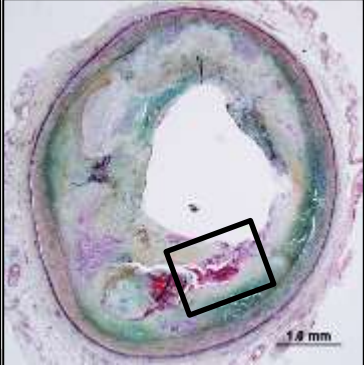|	Rupture (n=65)	Erosion (n=50)	P-Value
Pathophysiology	Disruption of fibrous cap	Deficiency of endothelium	
Age	52±10	43±9	<0.0001
Male	89%	74%	0.03
Plaque burden (%)	77±14	71±15	<0.0001
% Necrotic core	38±23	18±24	<0.0001
% Macrophage	3.4±2.8	2.5±2.7	<0.0001
Thrombus age			
Early <1 day	46%	12%	
Lytic 1-3 day	26%	14%	
Infiltrating 4-7 day	19%	28%	
Healing >7day	9%	46%	

Kramer M. et al. JACC 2010: 55; 122-32. Libby P. et al. Eur Heart J 2015: 36; 2984-7.

OCT Defined Underlying Plaque in ACS
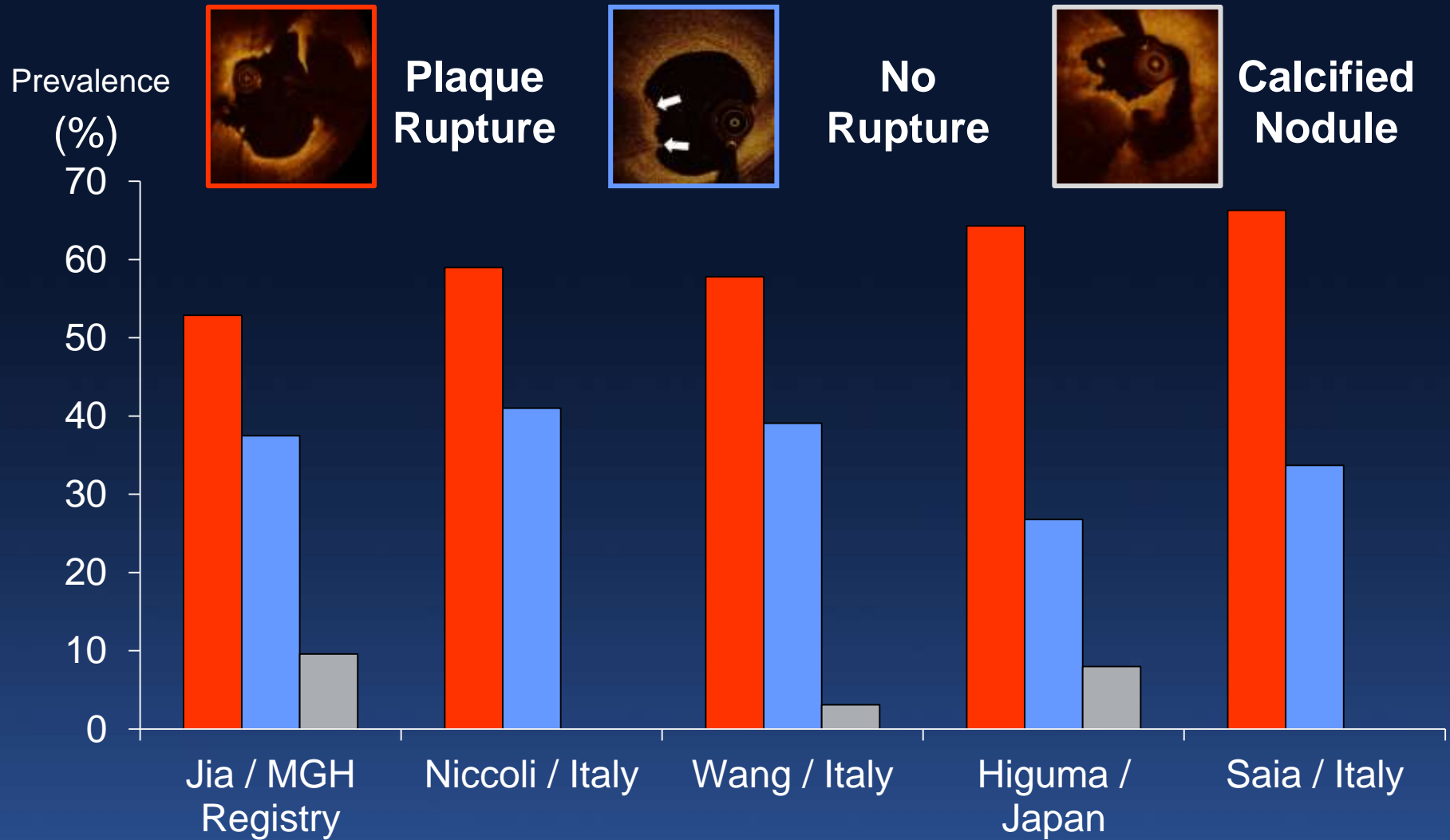
Plaque Rupture — **No Rupture** — **Calcified Nodule**

Prevalence (%)

Jia / MGH Registry — Niccoli / Italy — Wang / Italy — Higuma / Japan — Saia / Italy

Jia H, et al. JACC 2013;62:1748-58. Niccoli G et al. EHJ 2015; 36:1377-84.Wang L et al. EHJI 2015 doi:10.1093/ehjc.jev105 Higuma T et al. JACC Interv 2015;8:1166-76. Saia JACC Img 2015; 8: 566-75.

Cardiovascular Research Foundation

Columbia University Medical Center
NewYork-Presbyterian

Difference of Morphology

 Plaque Rupture   **No Rupture**

Prevalence (%)

TCFA

(Bar chart, Prevalence % on y-axis from 0 to 100)

- Jia / MGH Registry: Plaque Rupture ~67, No Rupture ~10
- Niccoli / Italy: Plaque Rupture ~52, No Rupture ~23
- Wang / Italy: Plaque Rupture ~60, No Rupture ~20
- Higuma / Japan: Plaque Rupture ~97, No Rupture ~3
- Saia / Italy: Plaque Rupture ~94, No Rupture ~47

Red Thrombus

(Bar chart, y-axis from 0 to 100)

- Jia / MGH Registry: Plaque Rupture ~70, No Rupture ~15
- Niccoli / Italy: Plaque Rupture ~70, No Rupture ~3
- Wang / Italy: Plaque Rupture ~49, No Rupture ~24
- Higuma / Japan: Not available
- Saia / Italy: Plaque Rupture ~57, No Rupture ~44

Jia H, et al. JACC 2013;62:1748-58. Niccoli G et al. EHJ 2015; 36:1377-84.Wang L et al. EHJI 2015 doi:10.1093/ehjc.jev105 Higuma T et al. JACC Interv 2015;8:1166-76. Saia JACC Img 2015; 8: 566-75.
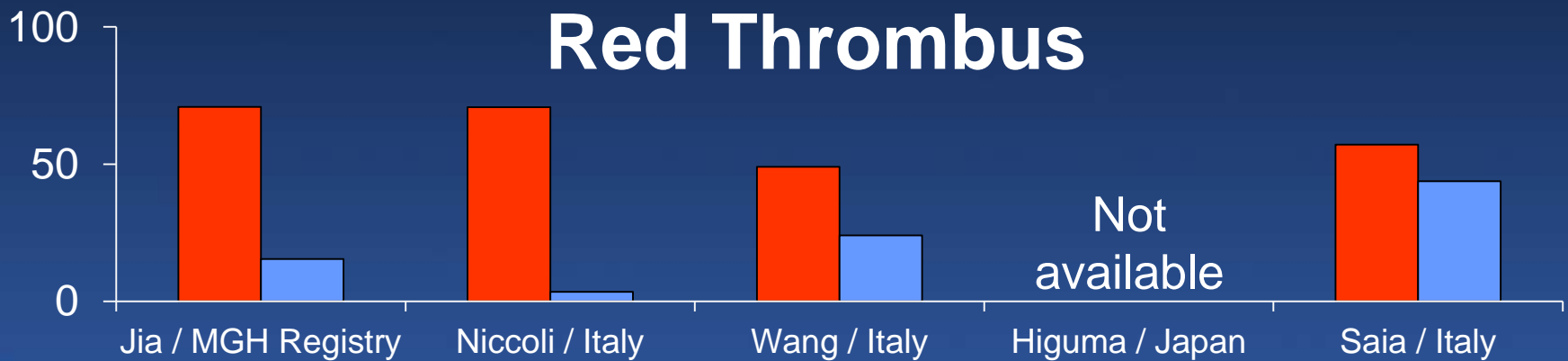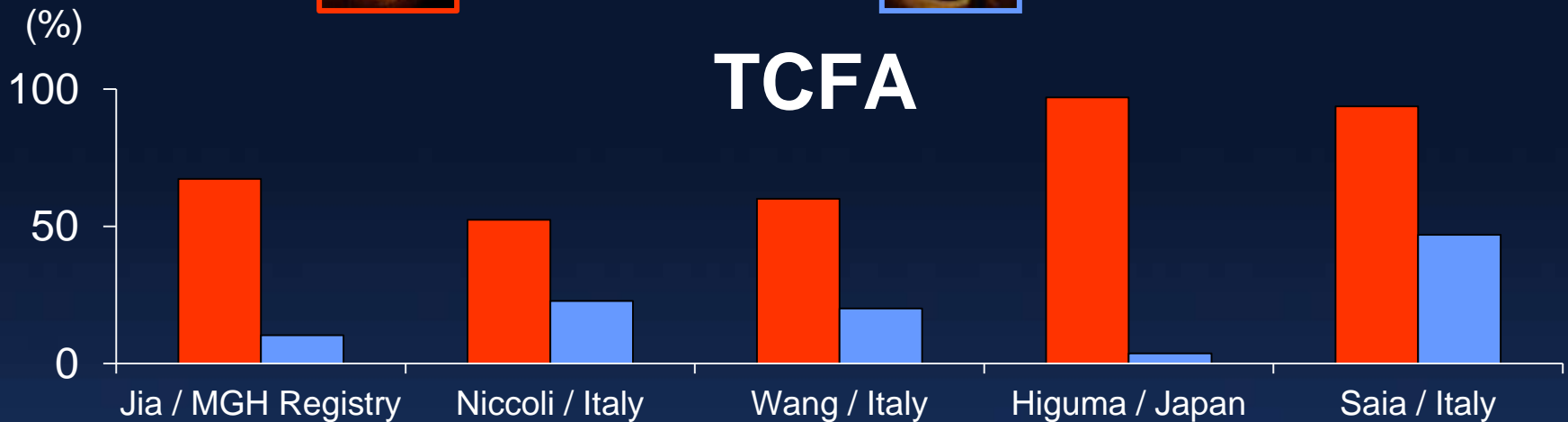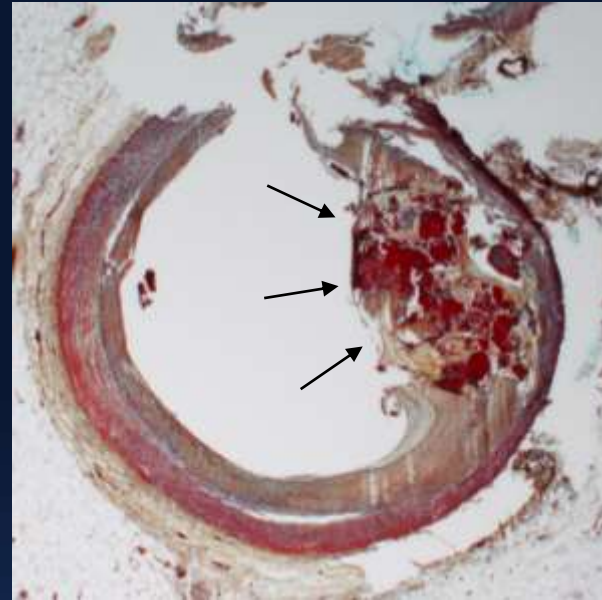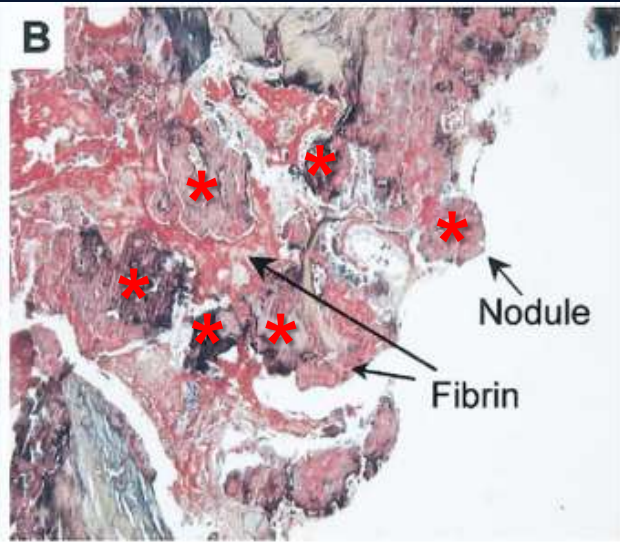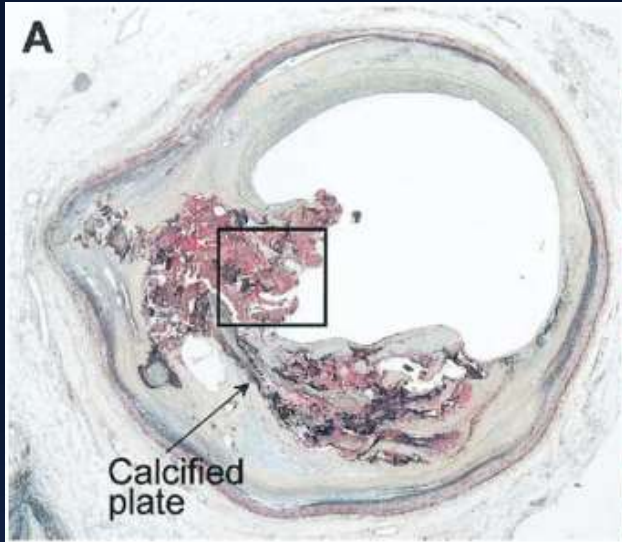
Cardiovascular Research Foundation

COLUMBIA UNIVERSITY MEDICAL CENTER
NewYork-Presbyterian

MGH Multicenter OCT Registry (n=126)

	Plaque Rupture (n=55)	OCT-Erosion (n=39)	OCT-Calcified Nodule (n=10)
Age	60.6	53.8	65.1
Male	80%	82%	80%
STEMI	71%	39%	0%
Lipidic plaque	100%	44%	0%
TCFA	67%	10%	0%
Fibrous cap thickness	60.4µm	169µm	NA

Jia H, et al. JACC 2013;62:1748-58.

Cardiovascular Research Foundation

COLUMBIA UNIVERSITY MEDICAL CENTER

NewYork-Presbyterian

Calcified Nodule

Virmani R et al. J Am Coll Cardiol 18;47:C13-8.
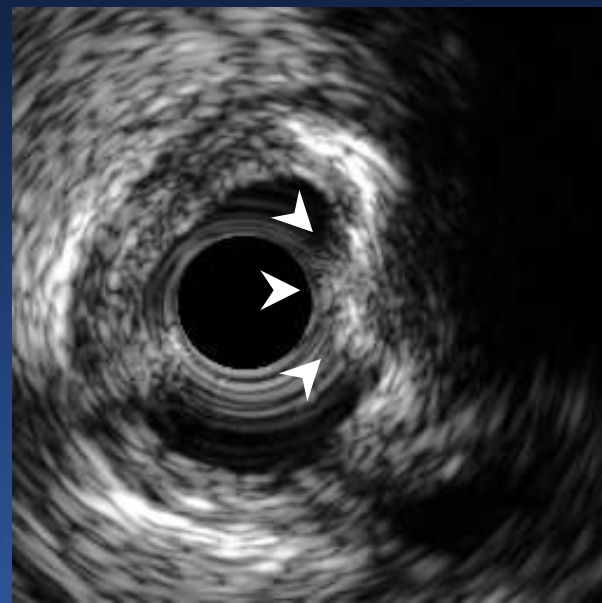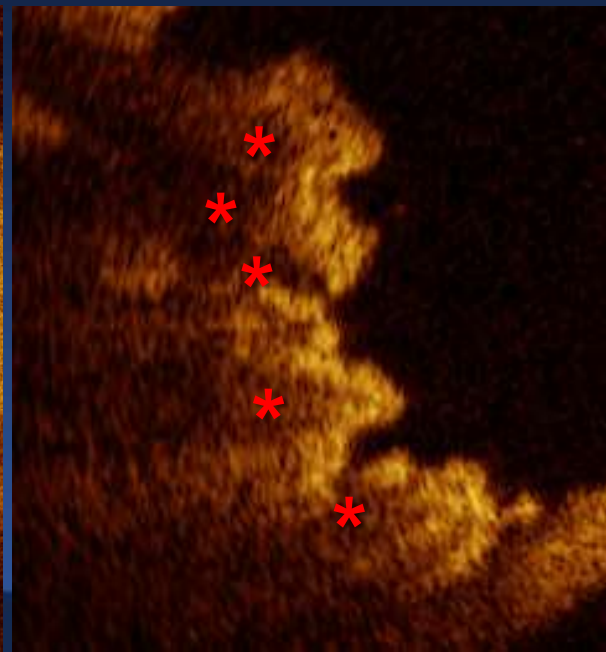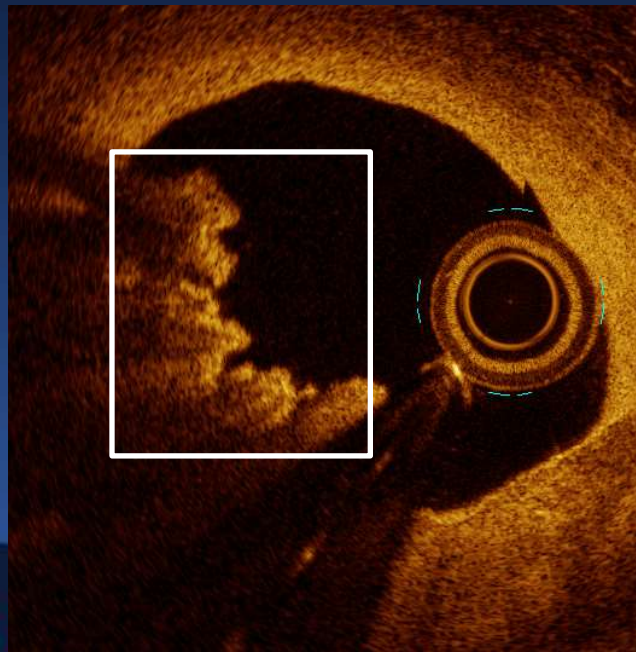
Prevalence of calcified nodule in all lesions

- ■ All lesions (n = 889)
- ■ Lesions with calcified nodule (n = 37)

(N)

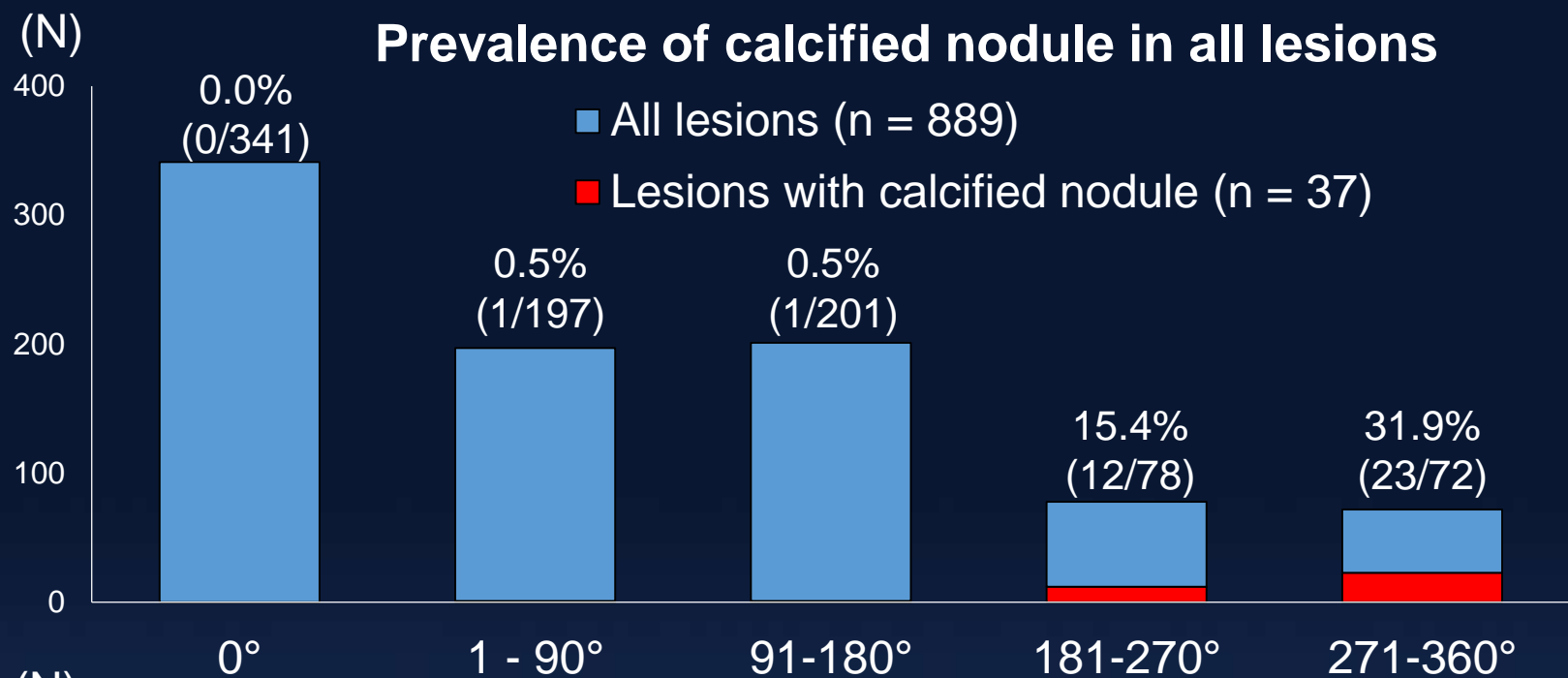| Angle	Prevalence
0°	0.0% (0/341)
1 - 90°	0.5% (1/197)
91-180°	0.5% (1/201)
181-270°	15.4% (12/78)
271-360°	31.9% (23/72)

Prevalence of calcified nodule in ACS lesions

- ■ All ACS lesions (n = 428)
- ■ Calcified nodule lesions in ACS (n = 17)
- STEMI: 24%

(N)

Angle	Prevalence
0°	0.0% (0/195)
1 - 90°	0.0% (0/99)
91-180°	0.0% (0/77)
181-270°	22.2% (8/36)
271-360°	42.9% (9/21)

Lee T, et al. JACC img in press

Cardiovascular Research Foundation
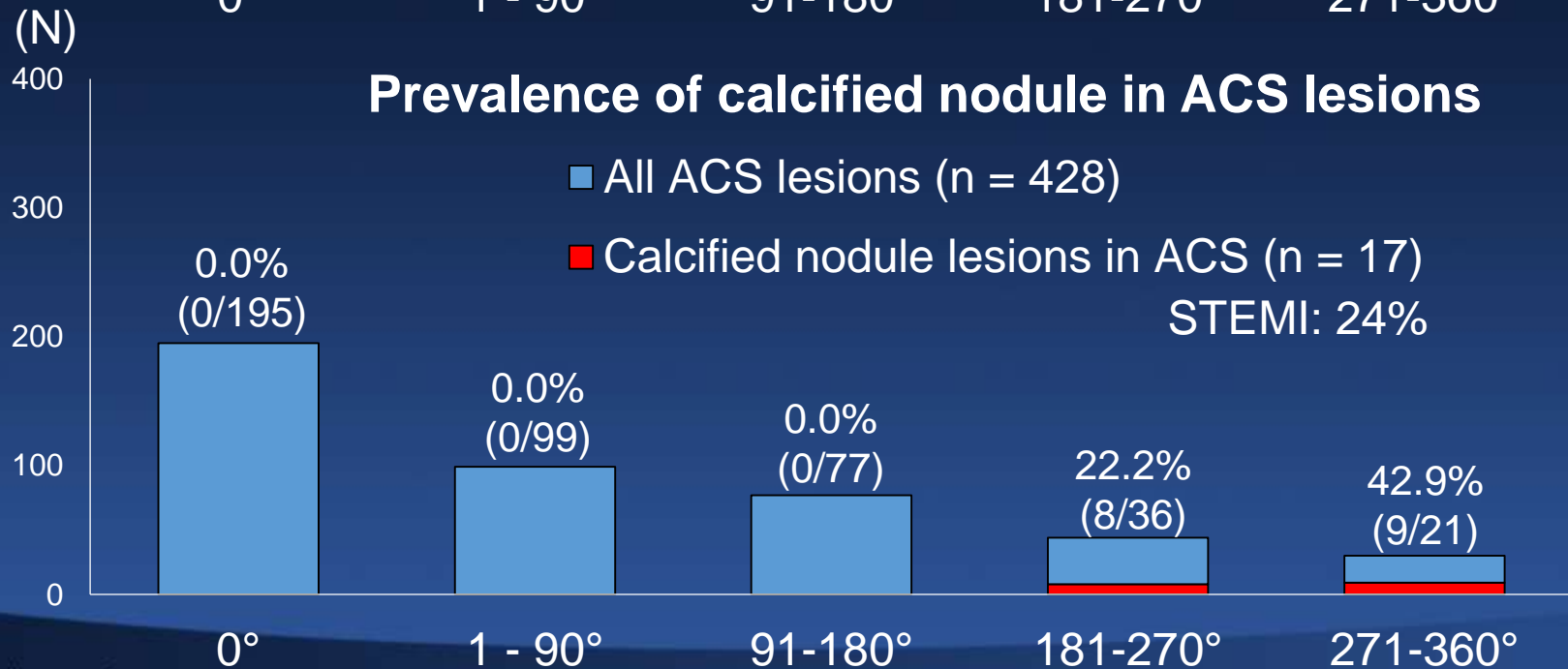
ADAPT-DES VH-IVUS Comparison

	STEMI (n=167)	NSTEMI /UAP (n=217)	Stable CAD (n=292)	P-Value
Plaque Rupture	56%	36%	24%	<0.0001
VH-TCFA	65%	53%	44%	<0.0001
Ca-ThCFA	10%	19%	26%	<0.0001
Minimum lumen area (mm^2)	2.5±0.7	2.8±1.0	3.0±1.1	<0.0001
Plaque Burden at MLA (%)	80.3±12.3	76.5±10.1	74.0±10.5	<0.0001
Remodeling index	1.11±0.47	1.02±0.36	0.99±0.41	0.0002

Cardiovascular Research Foundation

COLUMBIA UNIVERSITY MEDICAL CENTER

NewYork-Presbyterian
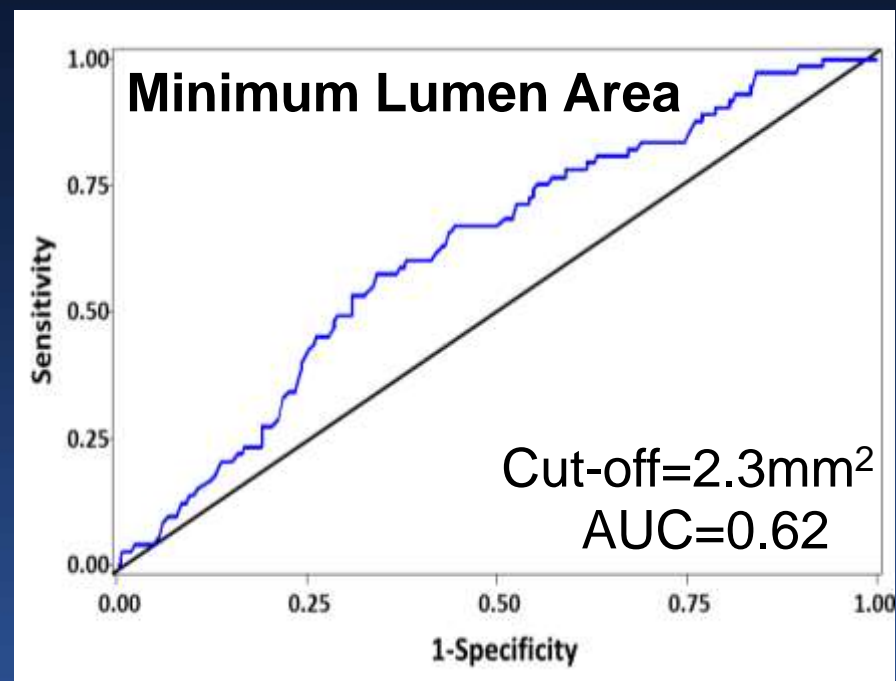
Plaque morphology associated to STEMI

With Plaque Rupture

Plaque Burden per 10%
Odds Ratio: 2.8 [1.6, 4.8]
p=0.0001
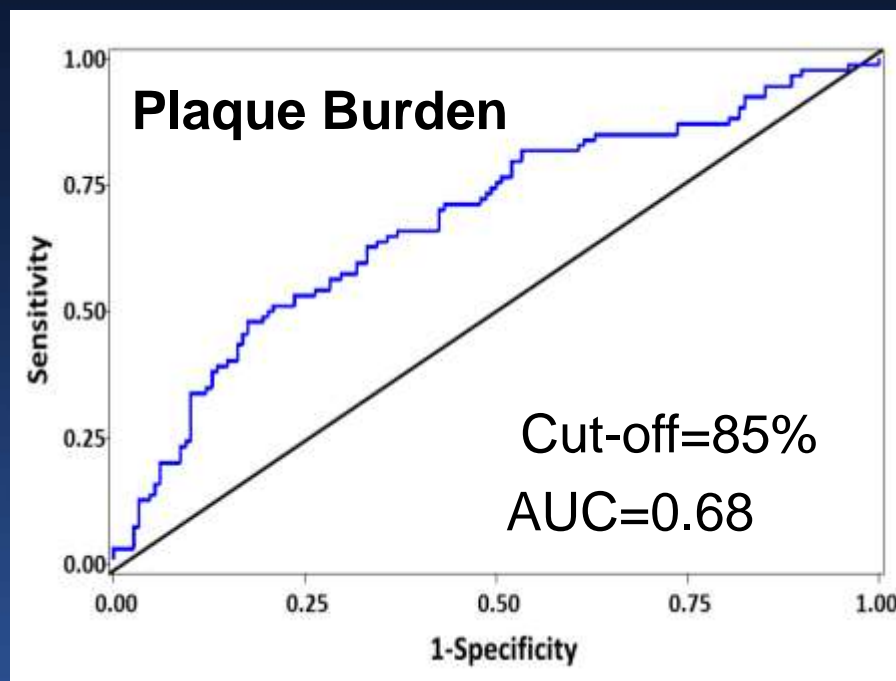
Without Plaque Rupture
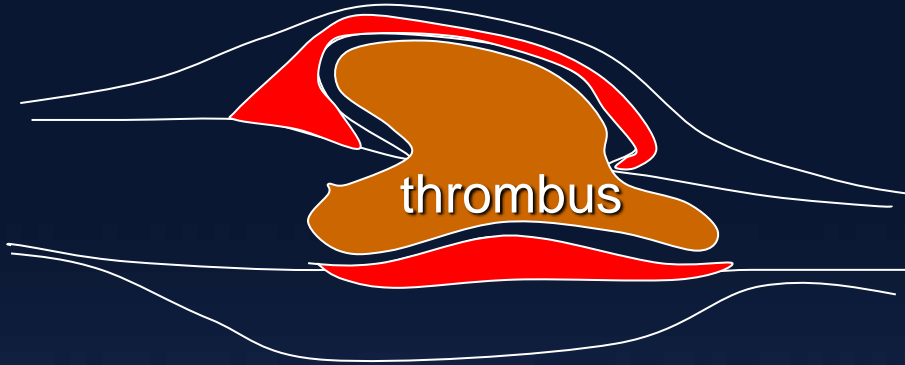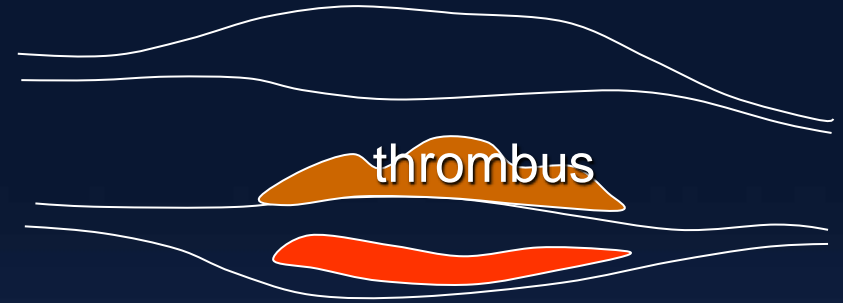
MLA per 1.0 mm^2
Odds Ratio: 0.64 [0.44, 0.94]
p=0.022
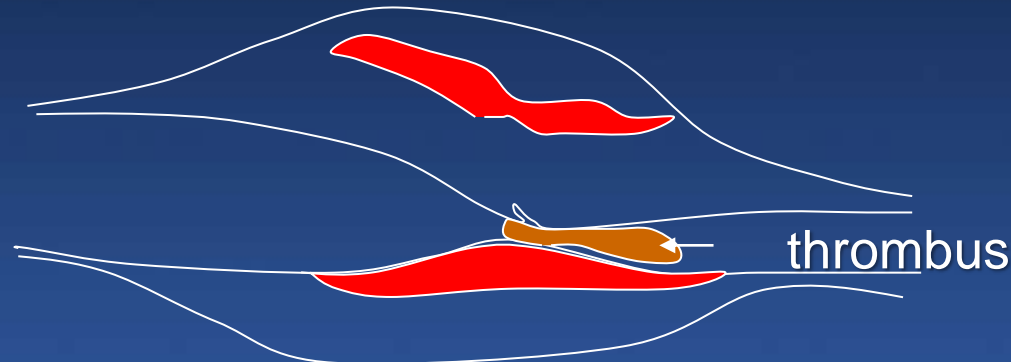

Plaque Burden

Cut-off=85%
AUC=0.68

Minimum Lumen Area

Cut-off=2.3mm^2
AUC=0.62

Dong L, Am J Cardiol, 2015; 115: 860-6.

Cardiovascular Research Foundation

COLUMBIA UNIVERSITY MEDICAL CENTER
NewYork-Presbyterian

Large rupture with large thrombus
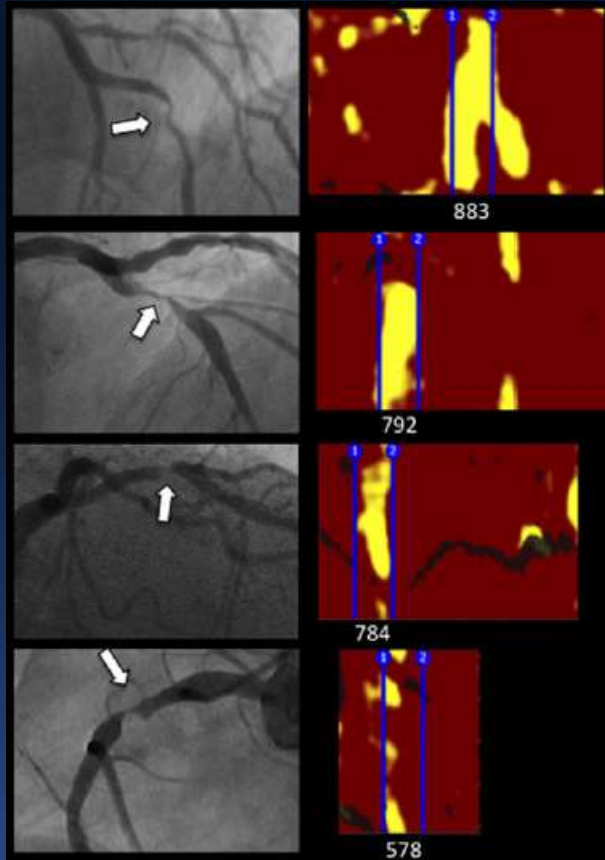
Erosion with small thrombus

thrombus

thrombus

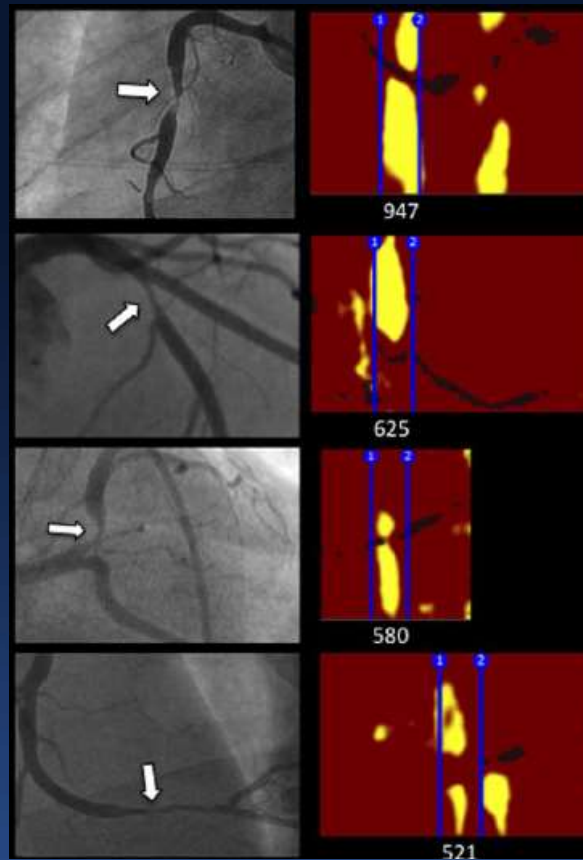# Severe stenosis with small thrombus with rupture or erosion

thrombus

Culprit/Non-culprit Lesion Characteristics

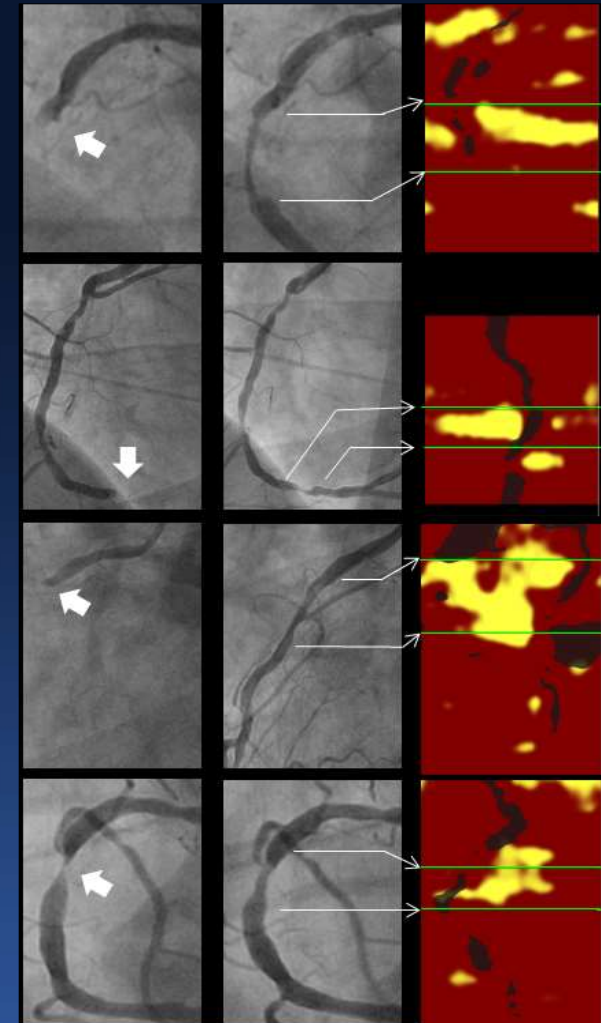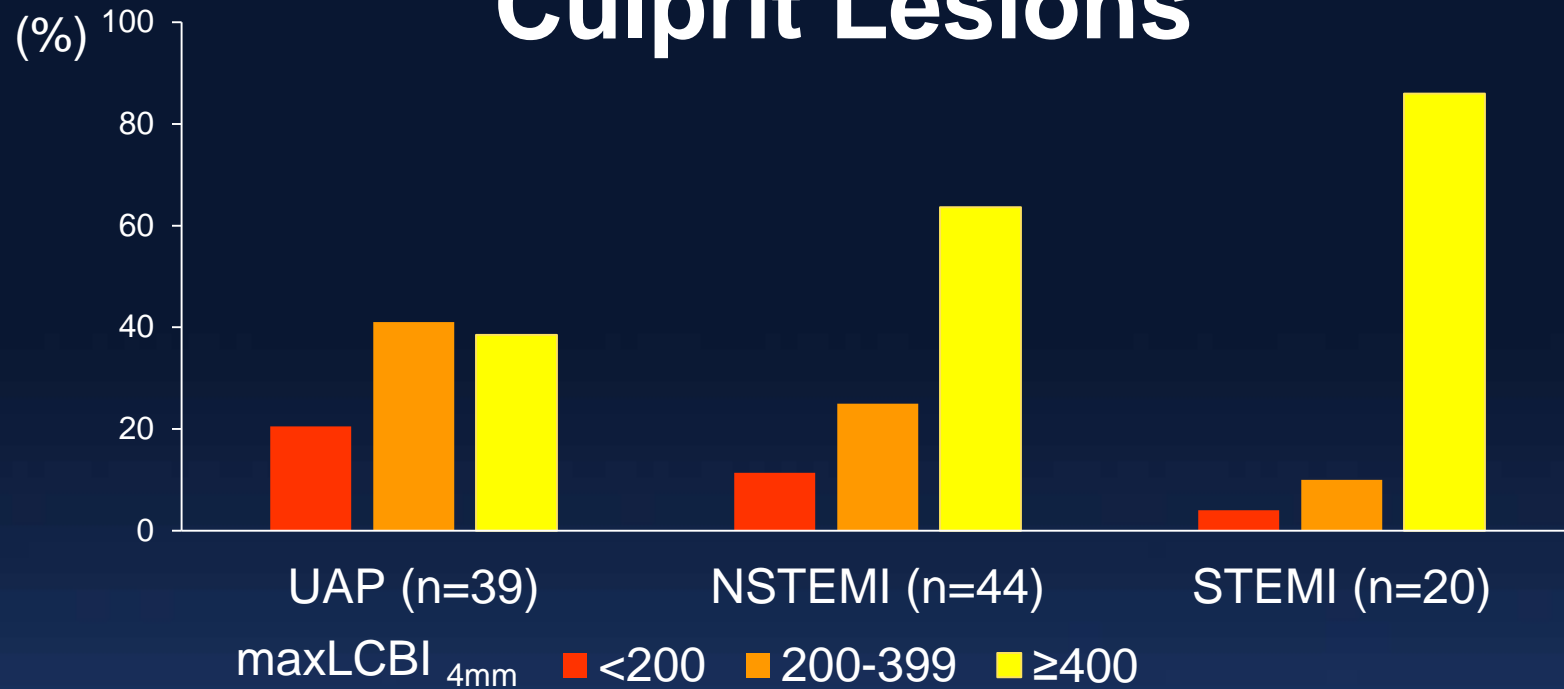## UAP NSTEMI STEMI

Prevalence of Lipid Rich Plaque in Culprit Lesions

maxLCBI $_{4mm}$	UAP	NSTEMI	STEMI
Culprit lesion	381 ± 239	448 ± 229	
Non-culprit lesion	146 ± 175	132 ± 154	
Cut off of Culprit lesion	208	317	400
AUC for cut off	0.87 (0.80-0.94)	0.79 (0.70-0.87)	0.93

Madder RD, Erlige, JACC Interv 2013, Cather Cardiovasc Interv 2015, Euro Atheroscl Soc 2013
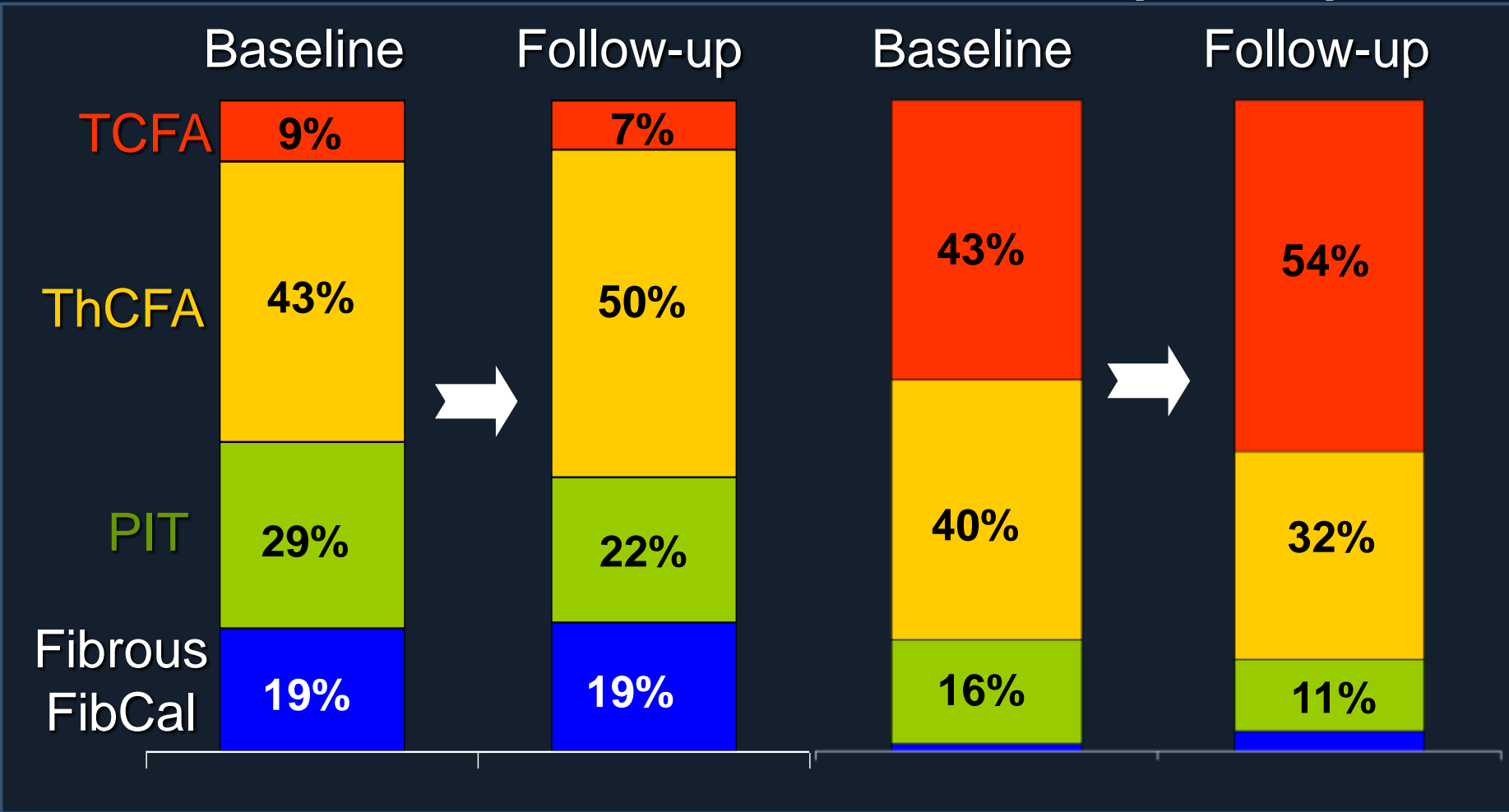
Relationship between the extent of lipid-rich plaque and clinical presentation in COLOR registry (n=800)

	MI (N=130)	Unstable AP (N=339)	Stable CAD (N=331)	P-value
Age, years	60 (54, 67)	65 (58, 73)	65(59, 71)	< 0.001
Male	78.9%	73.9%	82.2%	0.046
Hypertension	81.5%	91.0%	91.6%	0.01
Diabetes	30.6%	37.0%	39.3%	0.28
Dyslipidemia	80.2%	92.9%	94.3%	< 0.001
Prior PCI	33.9%	55.0%	43.0%	< 0.001
Lesion length, mm	24 (18, 30)	24 (18, 31)	24 (18, 34)	0.66
Plaque burden at MLA site, %	78.9 (72.5, 84.2)	75.4 (68.7, 82.0)	75.3 (67.0, 81.8)	0.18
LRP burden at MLA, %	35.0 (14.7, 49.1)	18.1 (0.0, 38.5)	26.0 (0.0, 47.9)	0.06
LCBI in lesion	141 (65, 247)	93 (29, 171)	98 (41, 185)	< 0.001
MaxLCBI$_{4mm}$	392 (205, 661)	288 (96, 478)	305 (138, 495)	0.001

Lee C. ACC 2016

Differences in Temporal Changes of Non-Culprit Lesions

Stable Angina

Baseline → Follow-up

	Baseline	Follow-up
TCFA	9%	7%
ThCFA	43%	50%
PIT	29%	22%
Fibrous FibCal	19%	19%

STEMI (100%)

Baseline → Follow-up

	Baseline	Follow-up
	43%	54%
	40%	32%
	16%	11%

Zhao Z et al. JACC Img 2013;6:86-95.
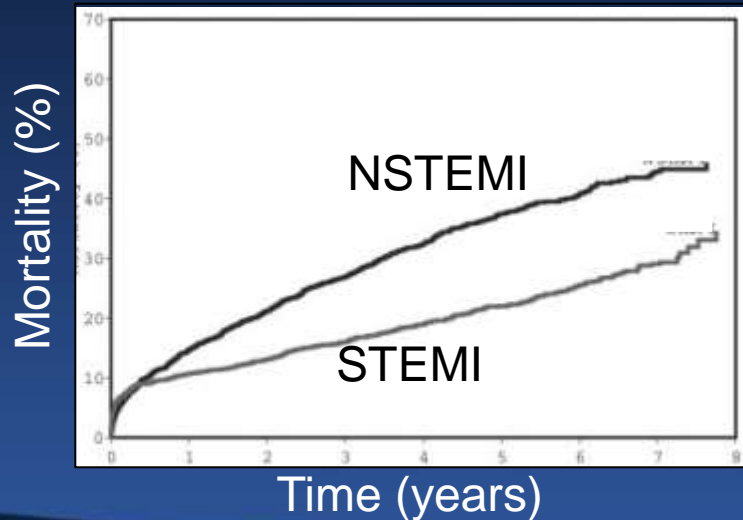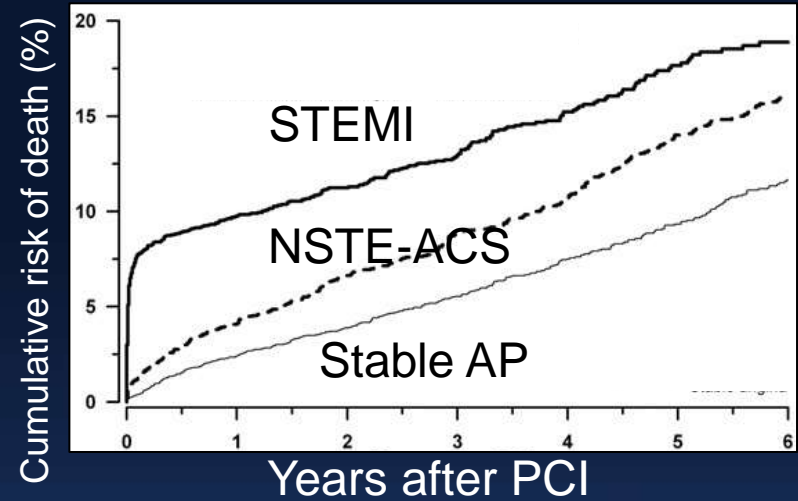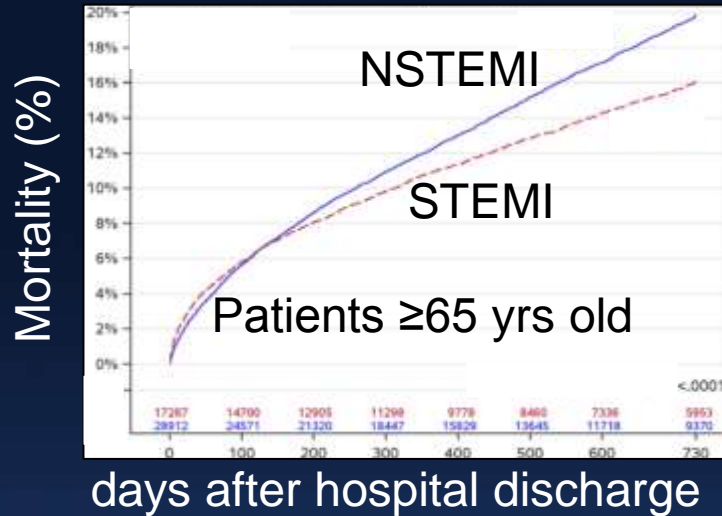
Unadjusted Long-term Outcome

Patient with NSTE-ACS are older, more female, more risk factors, prior MI, and diffuse coronary artery disease compared to those with STEMI.
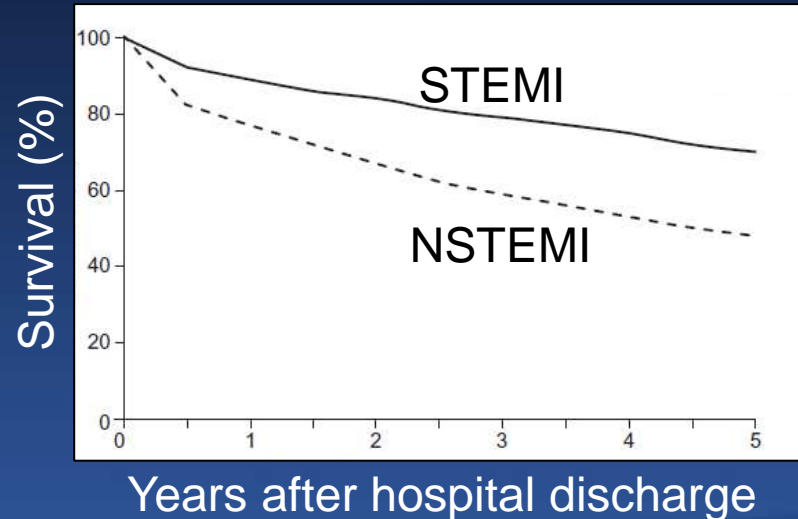
Hirsh A, et al. Am J Cardiol. 2009 104: 333-7. Chan MY, et al. Circulation. 2009 119:3110-7. Darling CE, et al. Clinical Epidemiology 2013 5: 229-36. Vora AN, et al. Circ Cardiovasc QO 2016; 9:513-22

Summary

1. **STEMI culprit lesions have more plaque rupture with more necrotic core (plaque burden), and smaller lumen area compared to those in NSTE-ACS or stable culprit lesions.**

2. **Non-rupture culprit lesions (erosion, calcified nodule) are more prevalent in NSTE-ACS or stable angina patients compared to STEMI pts.**

3. **ACS non-culprit lesions have more unstable than non-culprit lesions in stable patients and some lesions remain unstable.**

4. **In overall cohort (unadjusted cohort), NSTE-ACS patients showed worse outcome after discharge due to more risk factors and diffuse disease.**