

Understanding MINOCA: Lessons and Case Examples from the HARP Registry

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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

- Consultant

Company

- Boston Scientific, SpectraWave, Shockwave

Standardized AHA Diagnostic Criteria for MINOCA

The diagnosis of MINOCA is made in patients with acute myocardial infarction that fulfill the following criteria:

(1) Acute Myocardial Infarction (Modified from the 4th Universal Definition of Myocardial Infarction Criteria)

(a) Detection of a rise and/or fall of cTn with at least one value above the 99th percentile upper reference limit.
and

(b) Corroborative clinical evidence of infarction evidenced by at least one of the following:

- (i) Symptoms of myocardial ischemia
- (ii) New ischemic ECG changes
- (iii) Development of pathological Q waves
- (iv) Imaging evidence of new loss of viable myocardium or new regional ischemic etiology
- (v) Identification of a coronary thrombus by angiography or autopsy.

(2) Non-obstructive coronary arteries on angiography:

- Defined as the absence of obstructive disease on angiography (i.e. no coronary vessel**).
- This includes patients with:
 - Normal coronary arteries (no angiographic stenosis)
 - Mild luminal irregularities (angiographic stenosis <30% stenoses)
 - Moderate coronary atherosclerotic lesions (stenoses >30% but <50%)

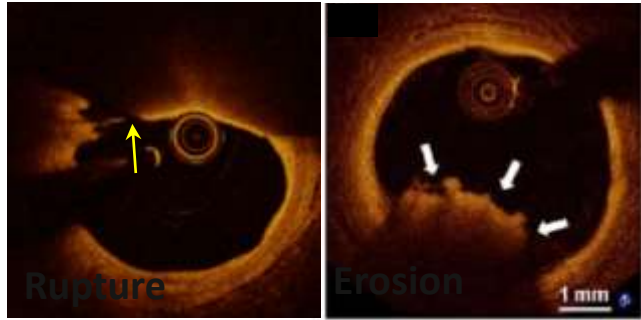
(3) No Specific Alternate Diagnosis for the Clinical Presentation:

- Alternate diagnoses include, but are not limited to, non-ischemic causes such as sepsis, pulmonary embolism, myocarditis, etc.

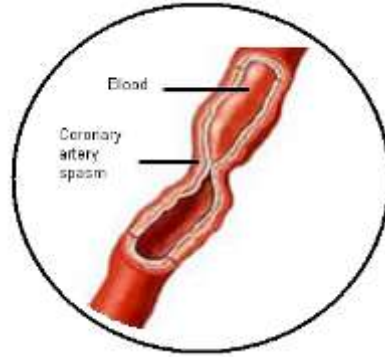
- 6-15% of MI
- More common among women, younger patients, people of color
- 24% 4-year MACE rate

MINOCA is MI.

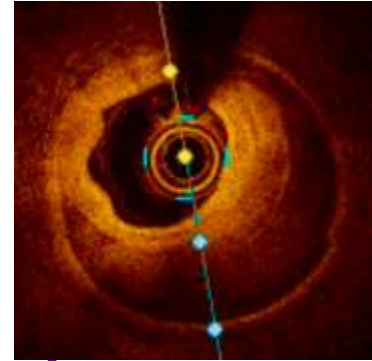
Plaque Rupture / Erosion



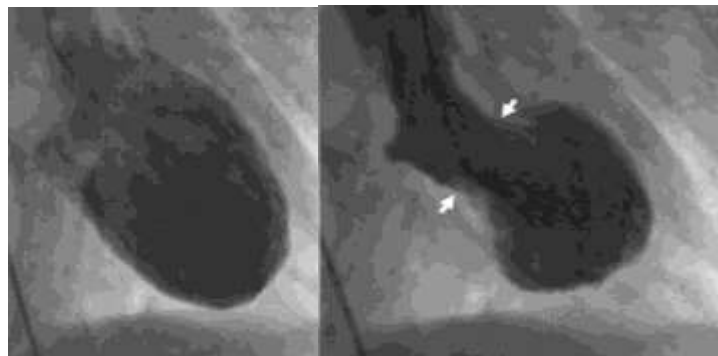
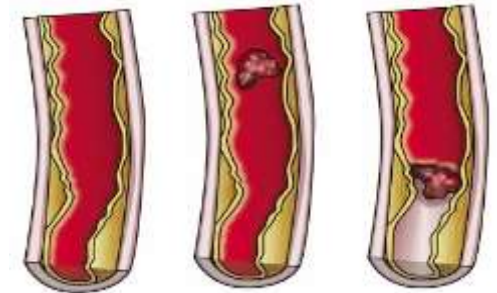
Coronary Spasm



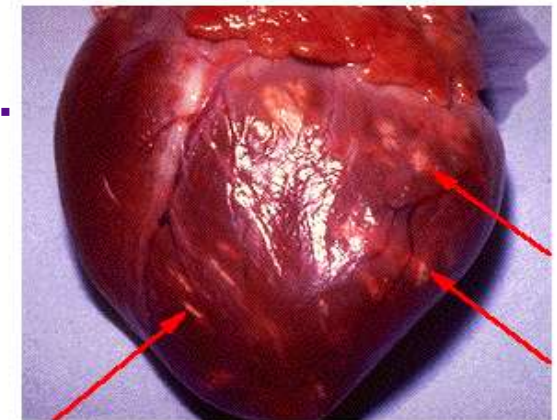
Dissection



Thrombosis/
Thromboembolism



Takotsubo Syndrome



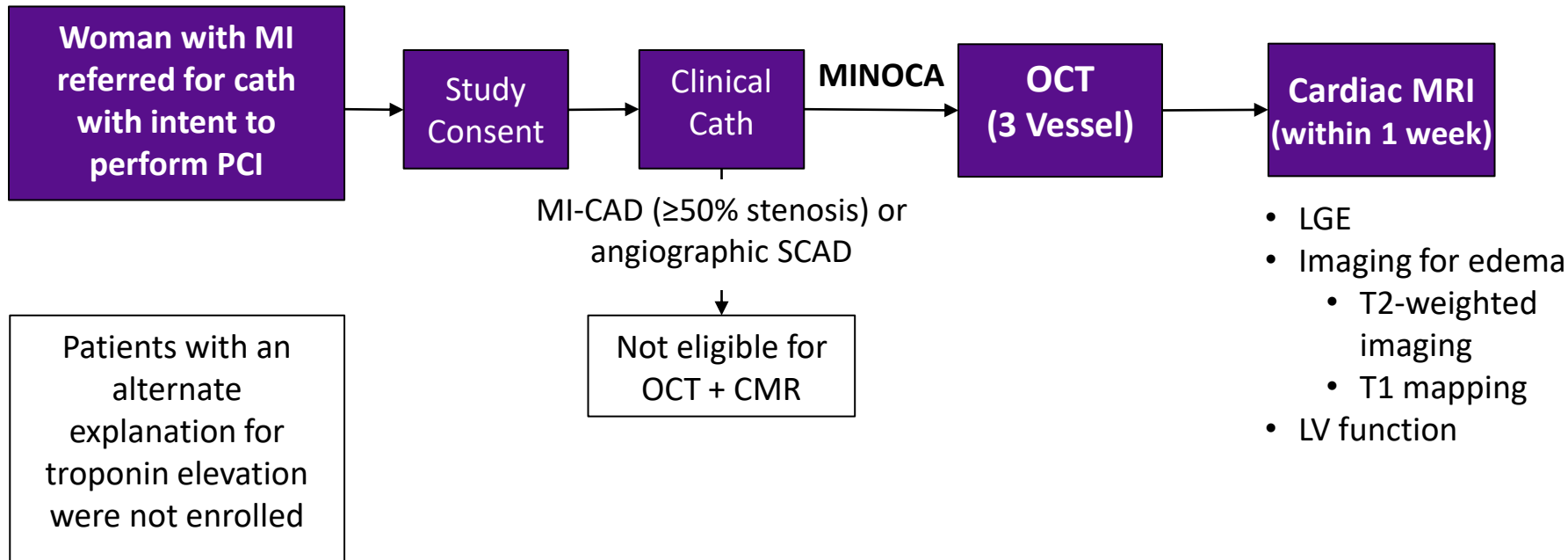
Myocarditis

Women's Heart Attack Research Program (HARP)

Objectives - to determine frequency of:

- Vascular causes of MINOCA on optical coherence tomography (OCT)
- Myocardial abnormalities on cardiac MRI (CMR) - ischemic or non-ischemic
- Various underlying etiologies identified based on OCT + CMR

**Core laboratories
blinded to detailed
clinical information,
results of other
imaging tests**



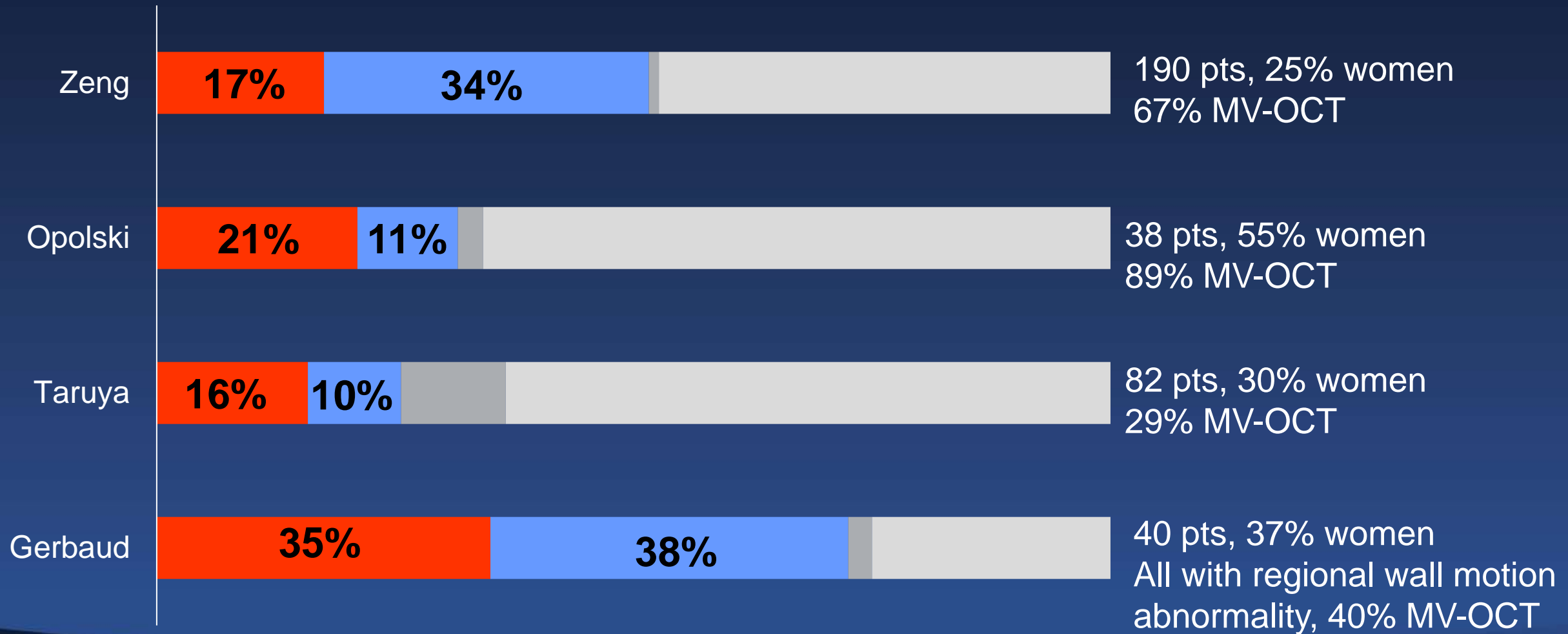
OCT Core Lab
Dr. Akiko Maehara,
Cardiovascular
Research Foundation

CMR Core Lab
Dr. Raymond Kwong,
Brigham and Women's
Hospital

Angiography Core Lab
Dr. Ziad Ali,
Cardiovascular
Research Foundation

Multivessel OCT in MINOCA

■ Plaque Rupture ■ Plaque Erosion ■ Calcified Nodule ■ Others

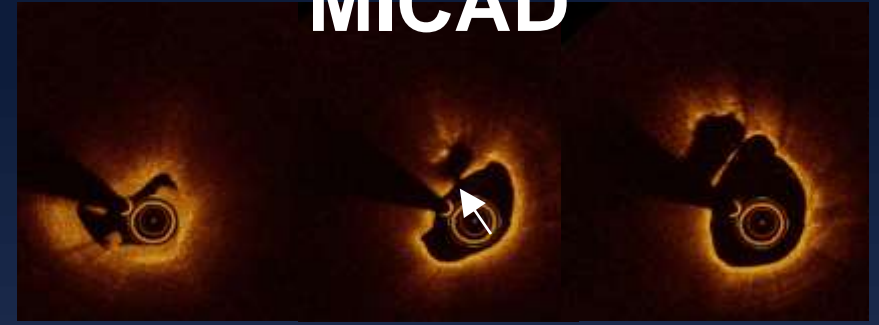


Zeng M, JACC img 2023; 16: 521-32, Opolski MP, JACC Img 2019; 12:2210-2221, Taruya A, EHJ 2020; 21:202-209, Gerbaud E, JACC img, 2020; 13:2619-2631.

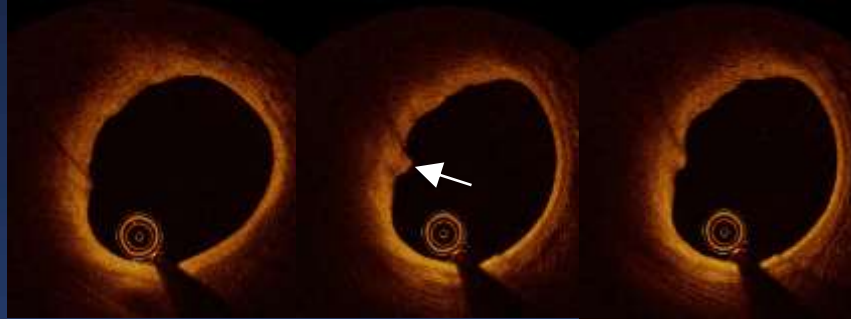
MINOCA

MICAD

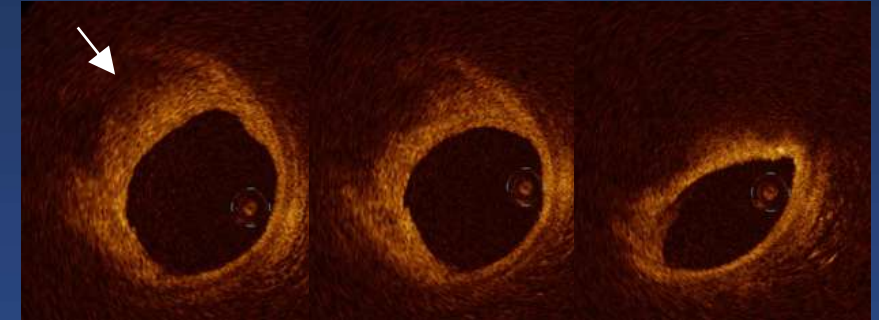
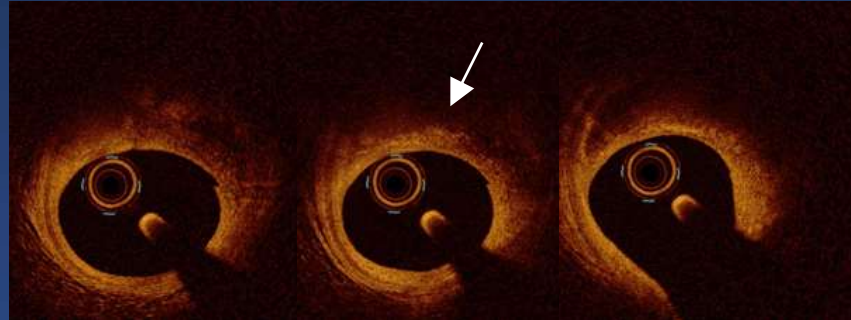
Plaque Rupture



Plaque Erosion



Intraplaque Hemorrhage



Layered Plaque



OCT Findings in Women with MINOCA: HARP

301 women with clinical diagnosis of MI, 16 sites



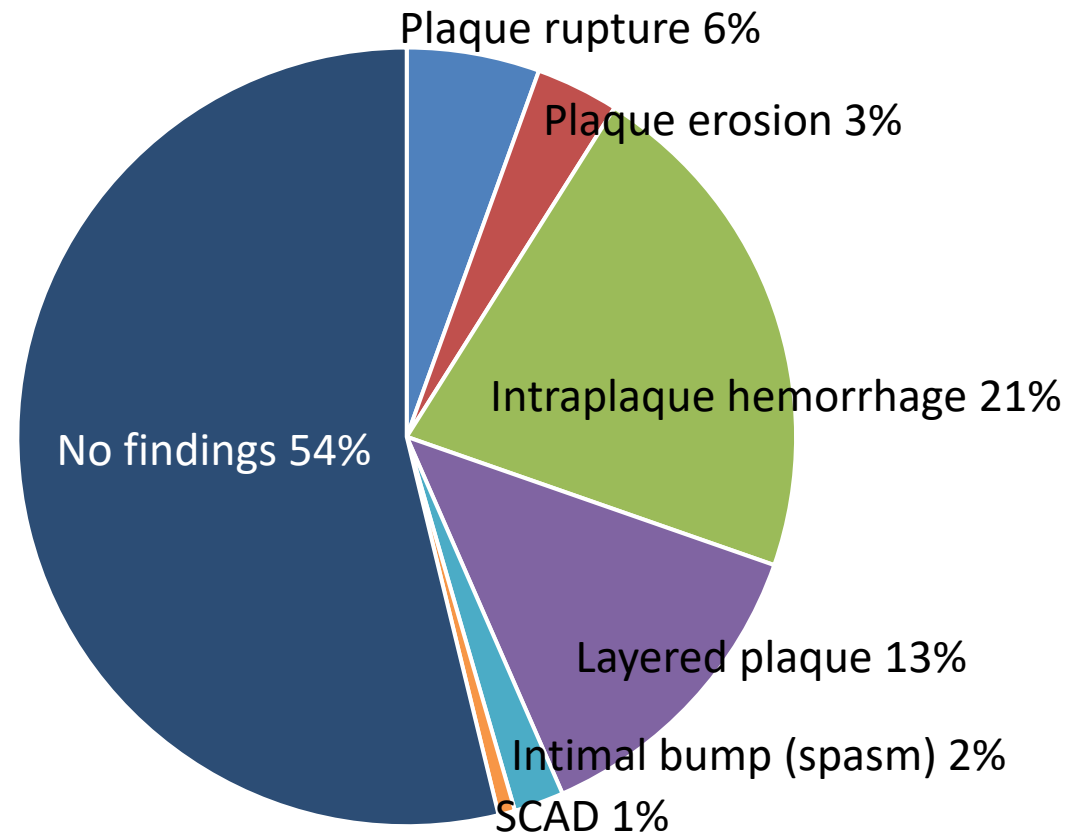
145 MINOCA with OCT, 116 CMR

Median peak troponin 0.94 ng/mL

53% "normal" angiography

By OCT Culprit Lesion Identified 46% (67/145)

No major complications of OCT; transient spasm in 46



Clinical Correlates of OCT Culprit Lesion

	Odds Ratio (95% CI)	P value
Diabetes vs. No Diabetes	5.41 (1.77, 19.2)	0.005
Abnormal vs. Normal Angiography	5.43 (2.50, 12.4)	<0.001
Age, per year	1.05 (1.02, 1.09)	0.004

but not peak troponin or vessel-level angiographic stenosis severity per core laboratory

0-10% stenosis	11-30% stenosis	31-49% stenosis	P value
12/82 (14.6%)	44/227 (19.4%)	14/55 (25.9%)	0.263

- Angiography was normal in 34% with an OCT culprit lesion (per sites) vs. 69% in women without a culprit lesion, $p < 0.001$
- Women with more vessels imaged were more likely to have a culprit lesion

CMR Findings (N=116)

Infarction n=38 (33%)

Regional Injury n=24 (21%)

Non-Ischemic n=24 (21%)

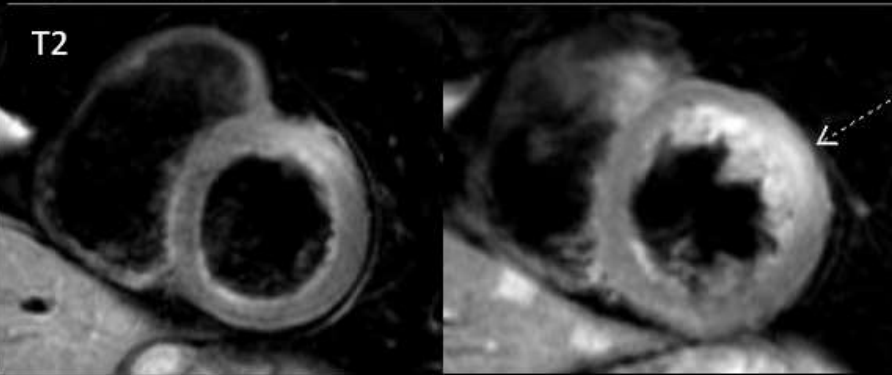
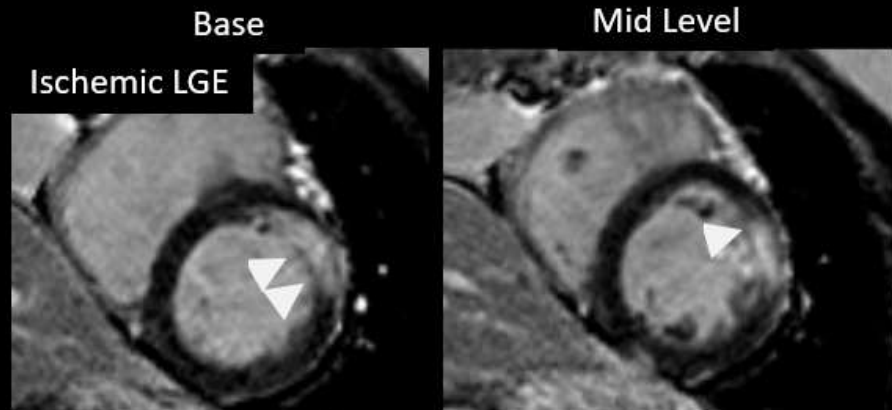
Myocarditis n=17 (15%)

Takotsubo Syndrome n=4 (3%)

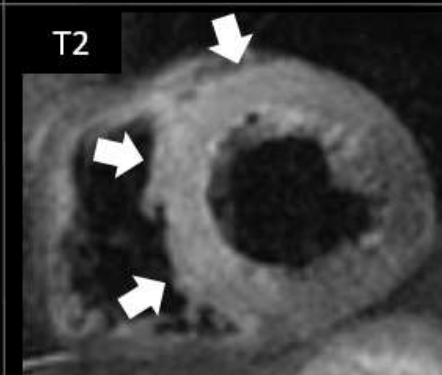
Other Cardiomyopathy n=3 (3%)

Normal
n=30 (26%)

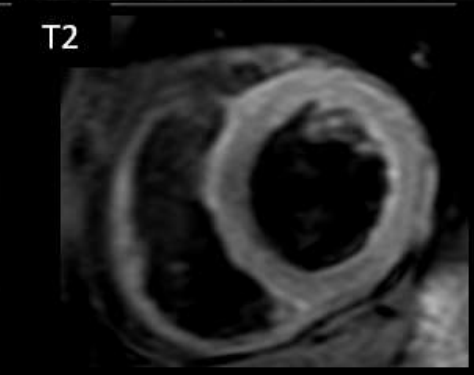
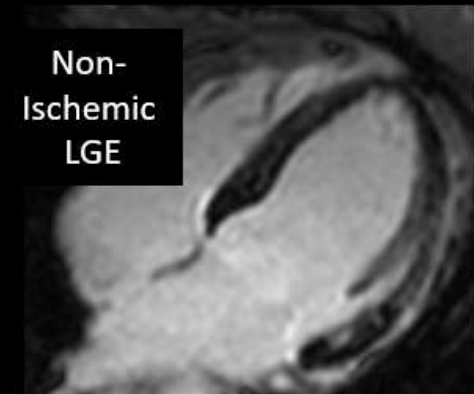
Myocardial Infarction



Regional Injury (Ischemic)



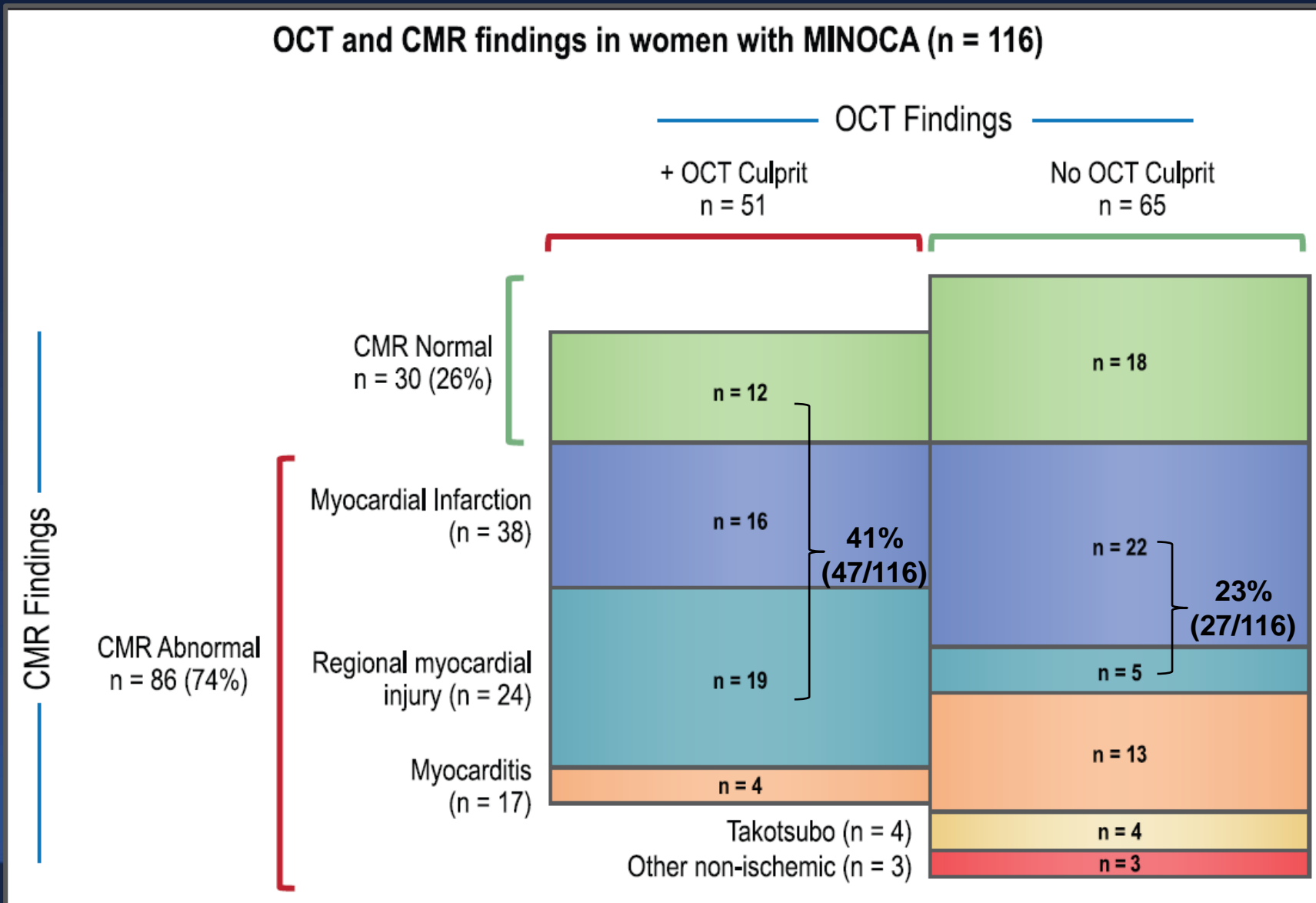
Myocarditis



170 MINOCA women → 116 both OCT & CMR → Cause identified (85%) → MI (64%)

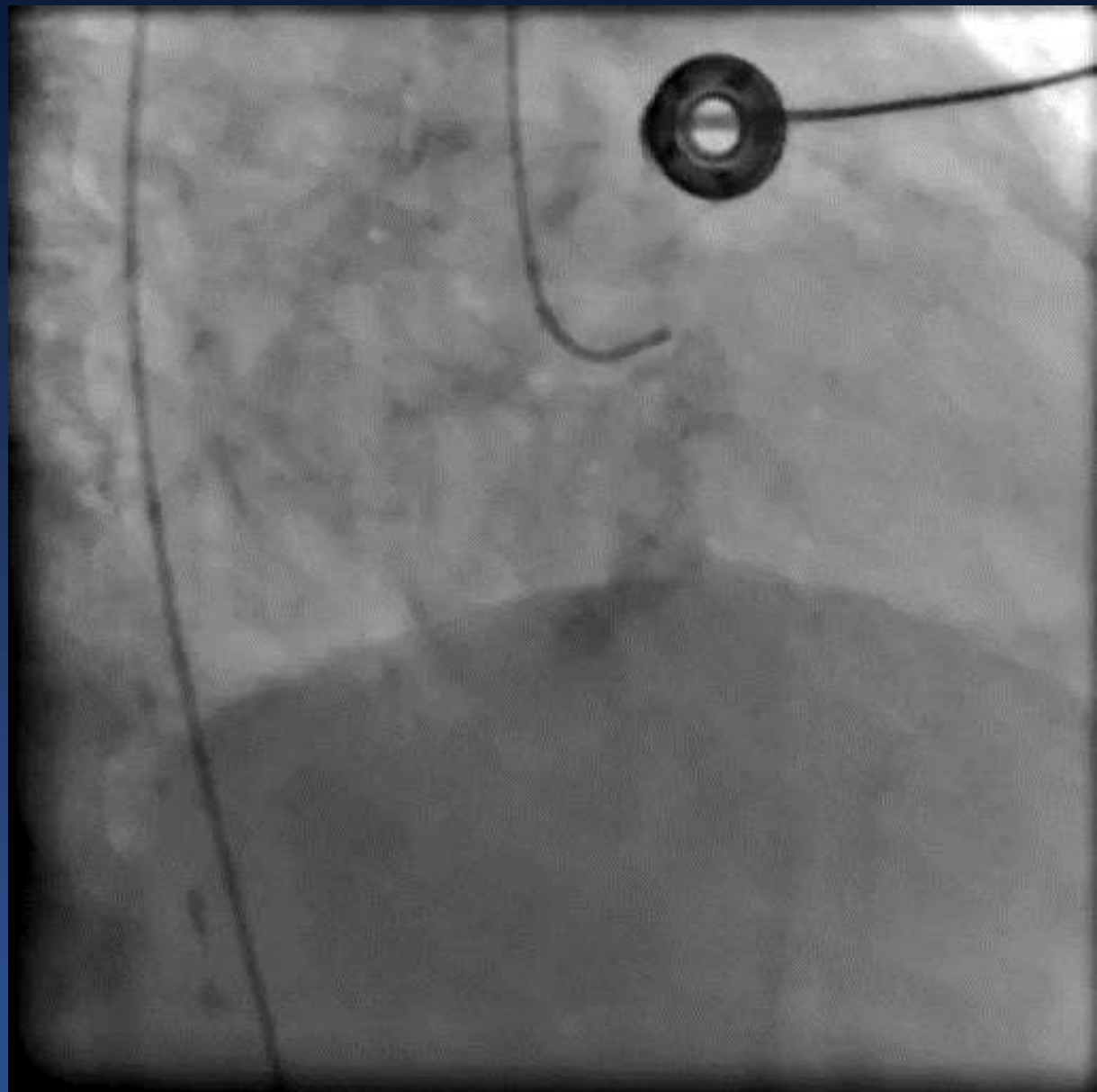
Women's Heart Attack Program

3-vessel OCT in 59%, 2-vessel in 32%, 1-vessel in 8%

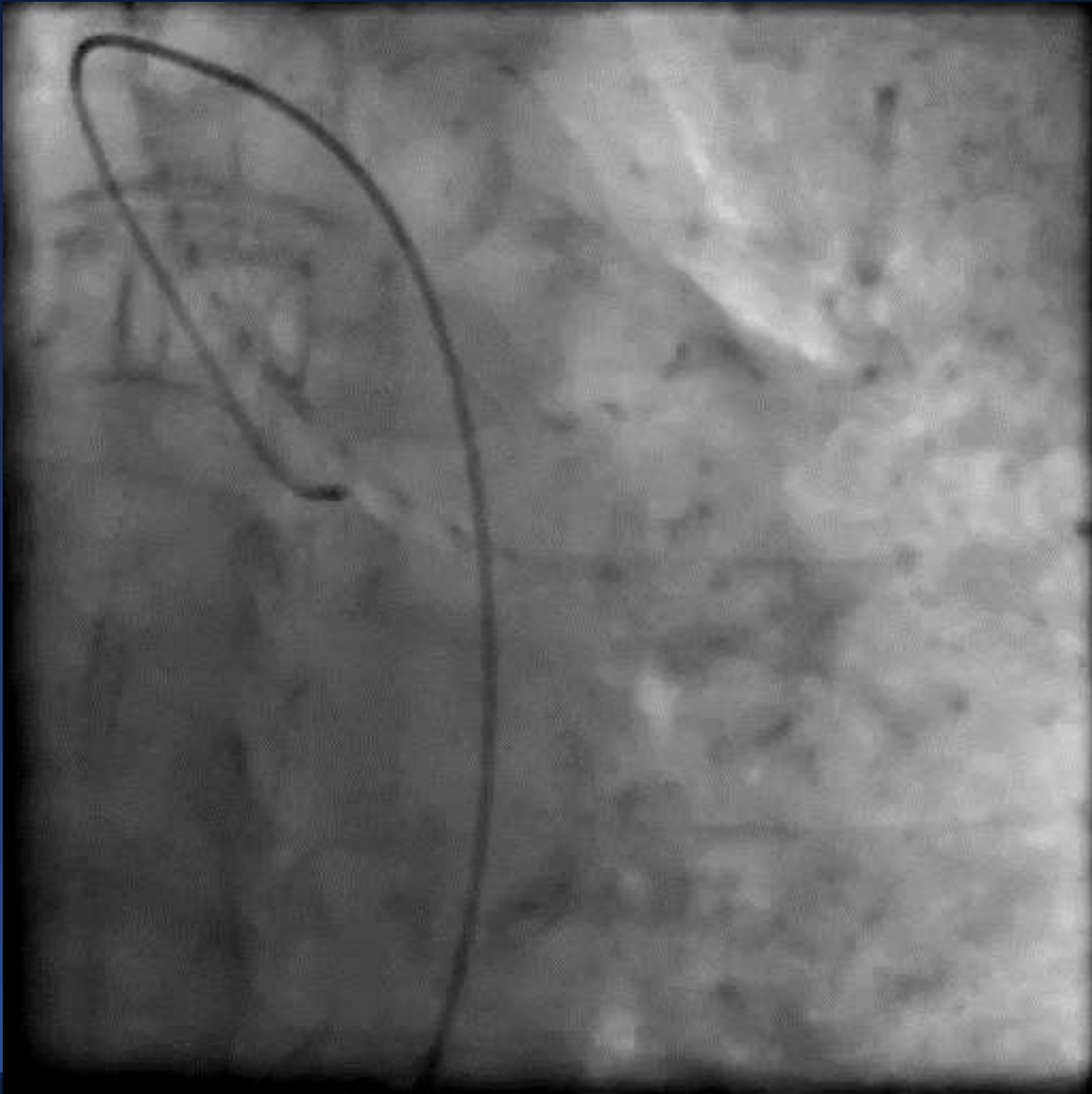


82 year old woman with hypertension, dyslipidemia

- Retrosternal chest pain for 6 hours, onset at rest
- Troponin I 1.65 ng/mL, downtrended after admission; D-dimer normal
- CT negative for pulmonary embolism
- ECG: new IVCD, no ST segment shift
- Normal LV function on echocardiography



Courtesy of Harmony Reynolds MD



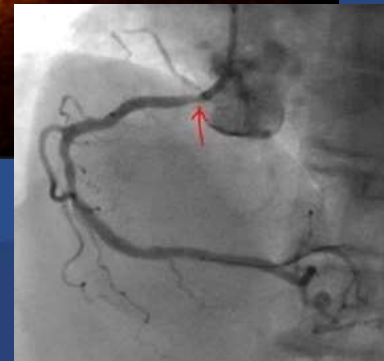
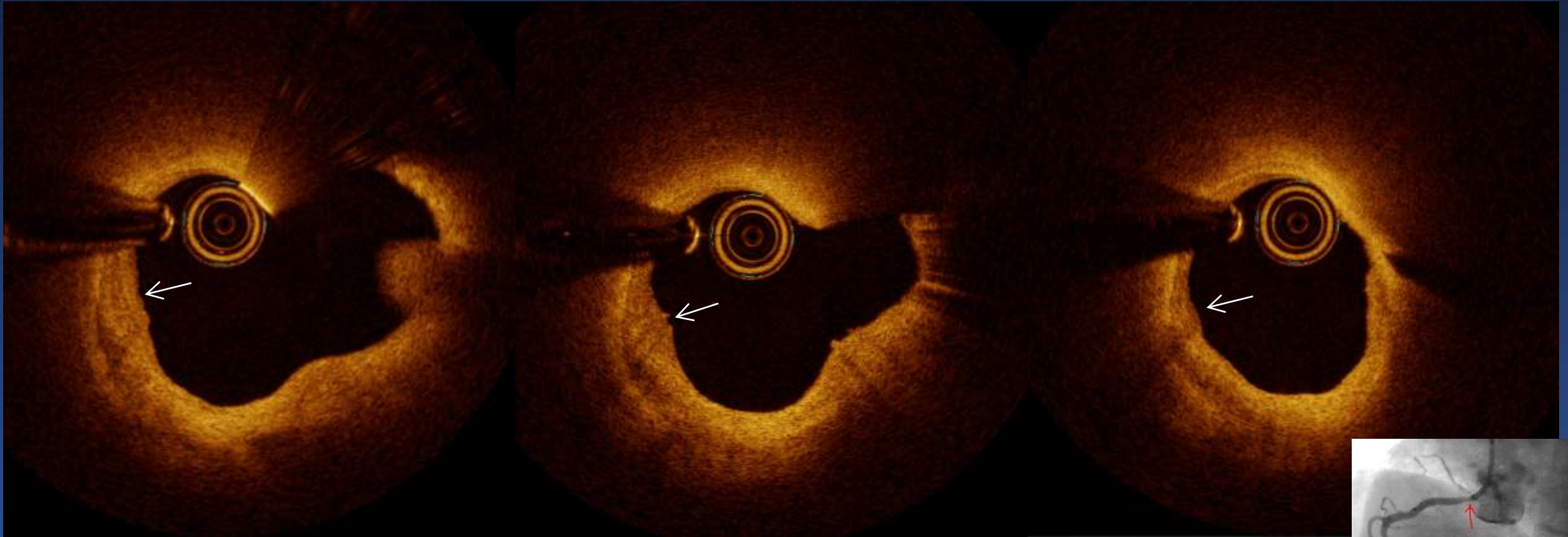
Courtesy of Harmony Reynolds MD

OCT: Ostial RCA

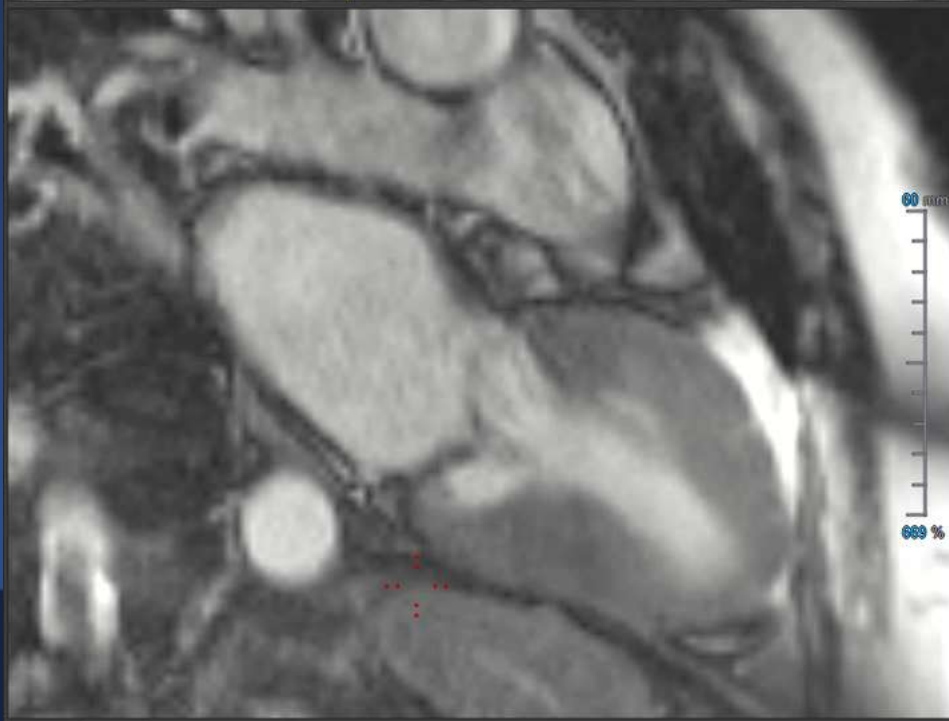
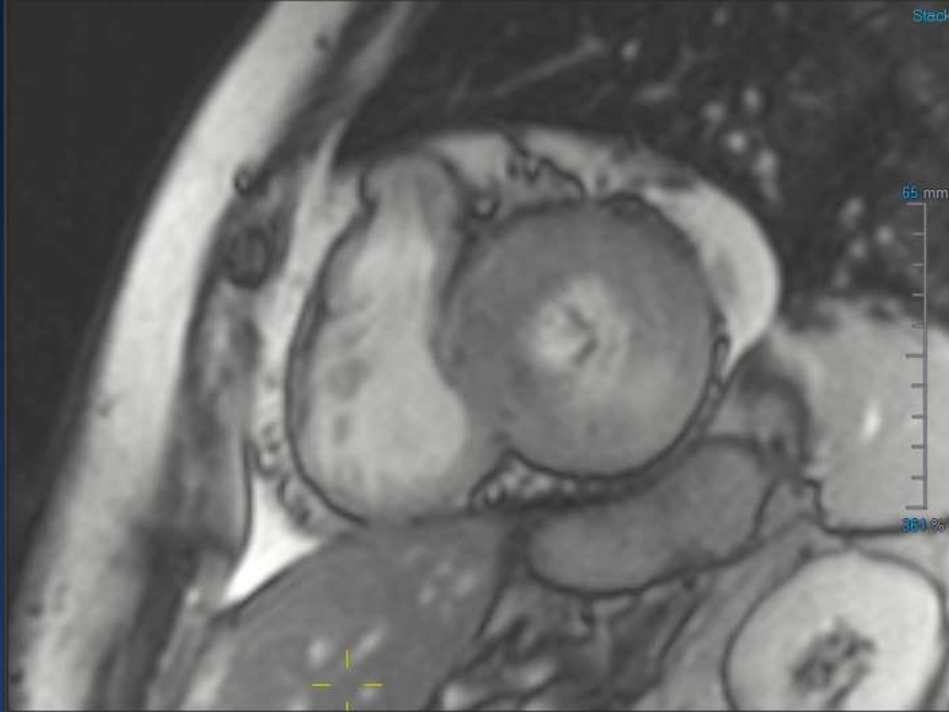
Plaque Rupture with Mural White Thrombus

Proximal

Distal



Cardiac MRI: Inferolateral LGE consistent with MI

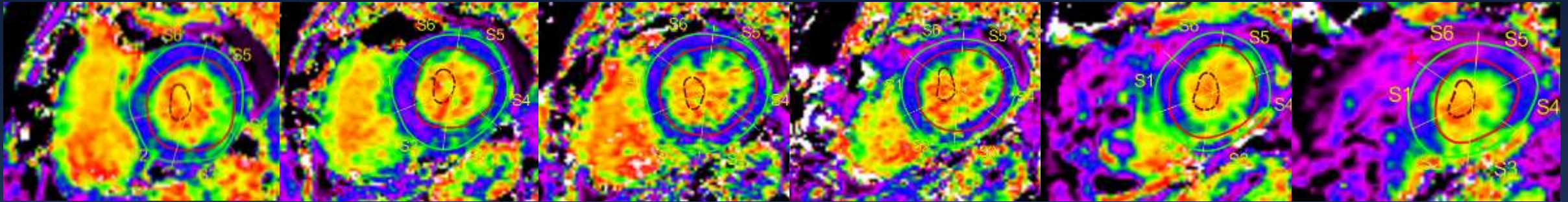


Images courtesy of
Raymond Kwong MD, HARP
CMR Core Lab Director

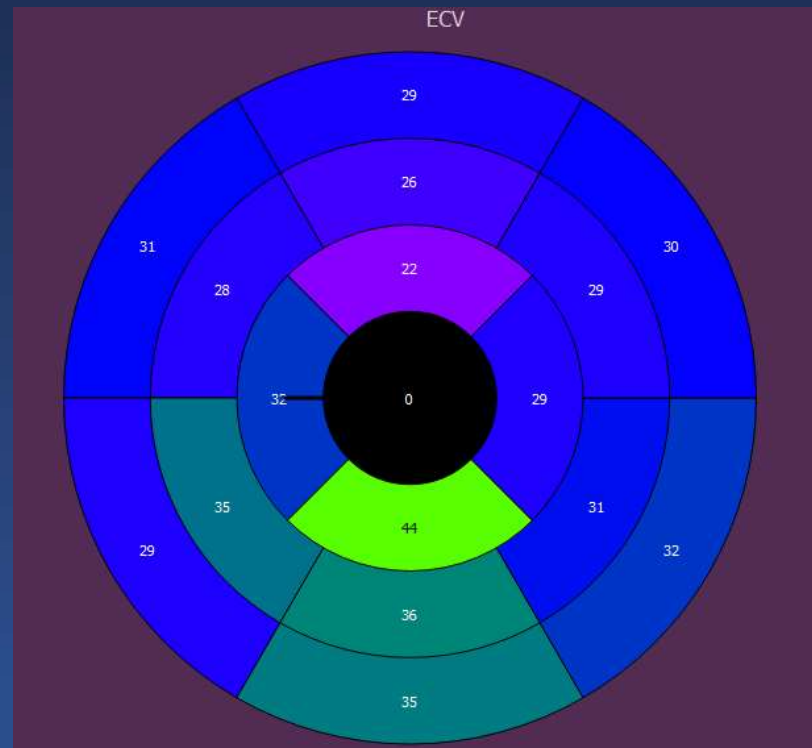
T1 Mapping on Cardiac MRI

Base

→ Apex



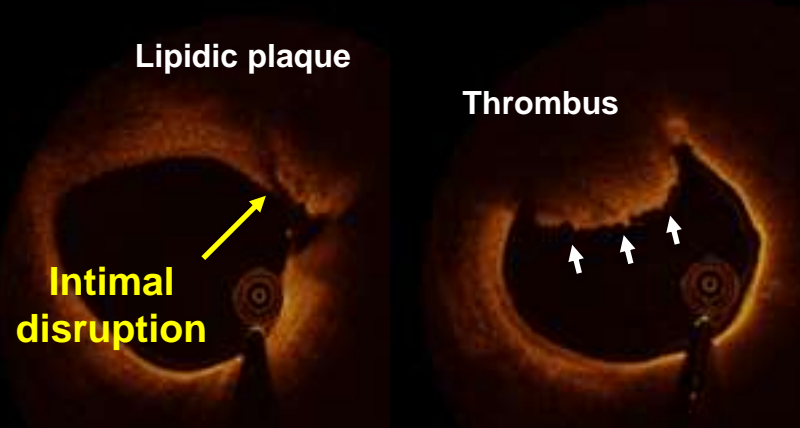
Diagnosis
“Inferior Myocardial Edema”



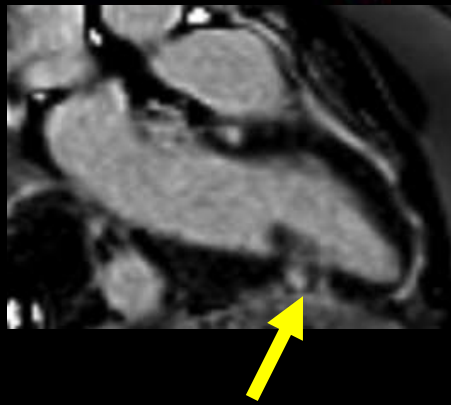
Final Diagnosis: RCA Plaque Rupture causing MINOCA with MI on CMR

- Aspirin added, statin intensified
- 3-year follow up: no further events

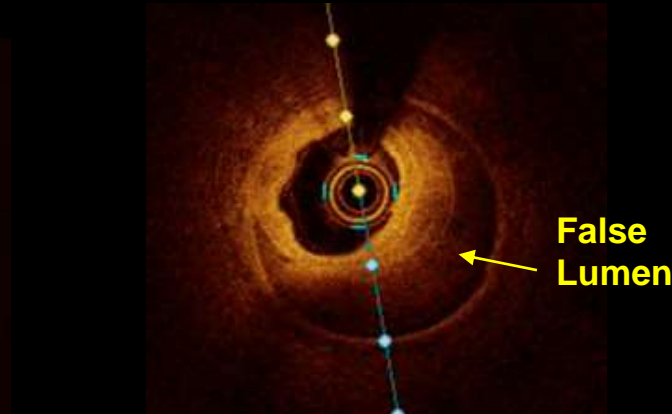
44 yo woman, CP,
anemia/menorrhagia, small inferior
STE, troponin 3.3 →
mild LAD stenosis (wraparound)



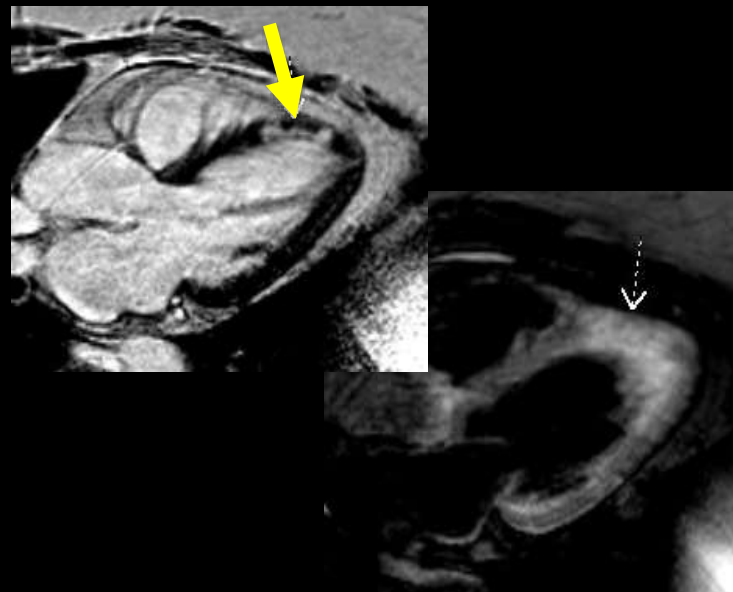
**Plaque Rupture
Causing Embolic Infarct**



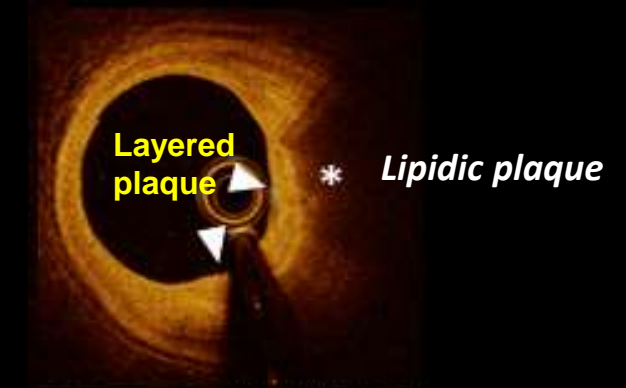
50 yo woman, CP, anemia,
1mm STE V2, troponin 2.4 →
mild LAD stenosis



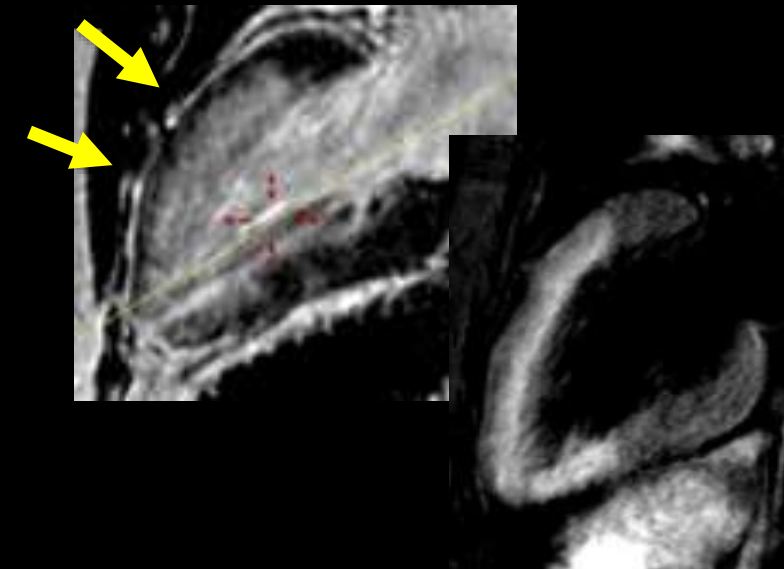
Coronary Dissection Causing MI



72 yo woman, CP, HTN, BP
200/126, STE V1-4, trop.
5.1 →
mild LAD stenosis (after NTG)

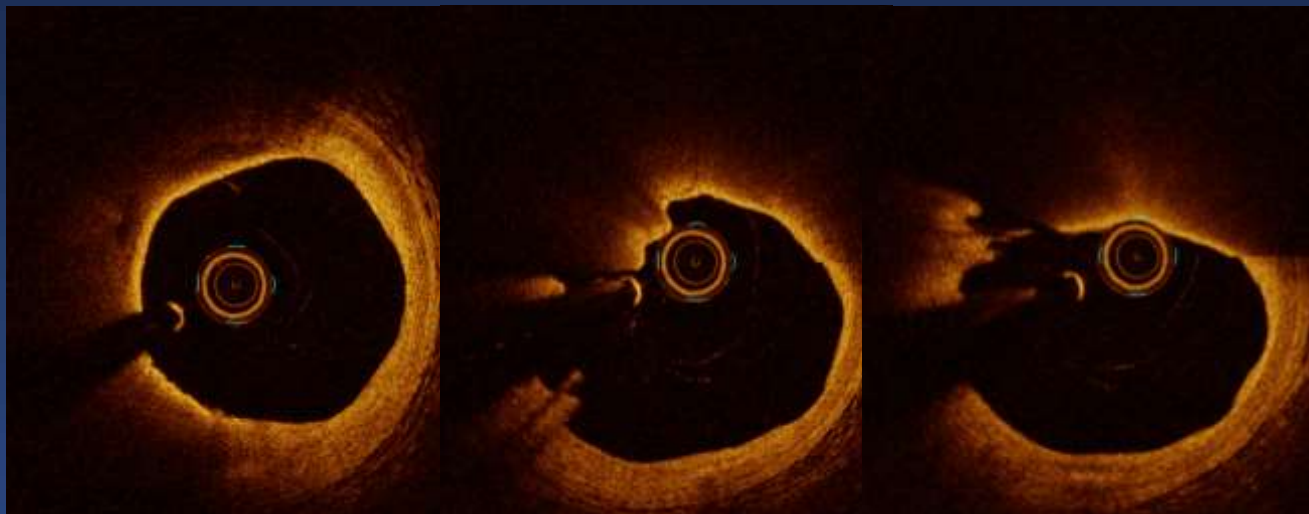


**Layered Plaque at Spasm Site
Causing Large MI**

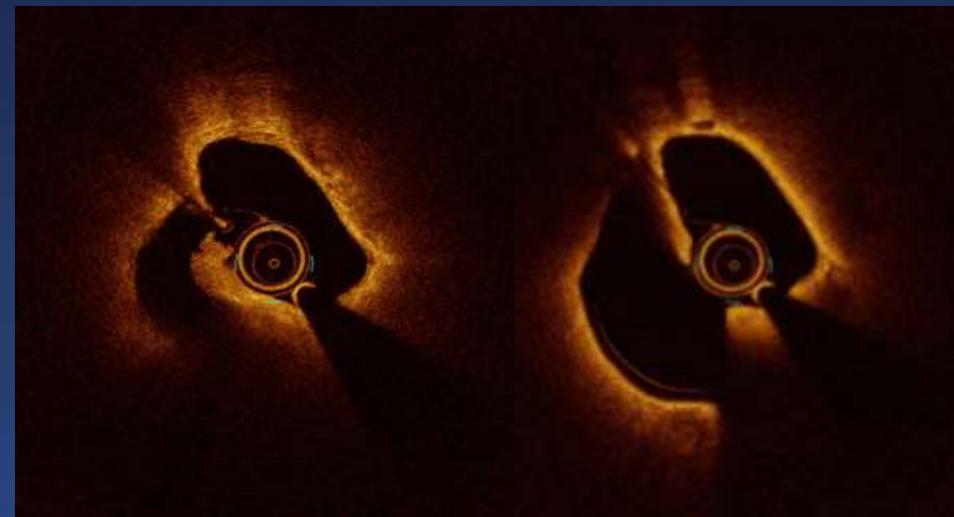


Plaque Rupture in MINOCA and MI-CAD

MINOCA Case

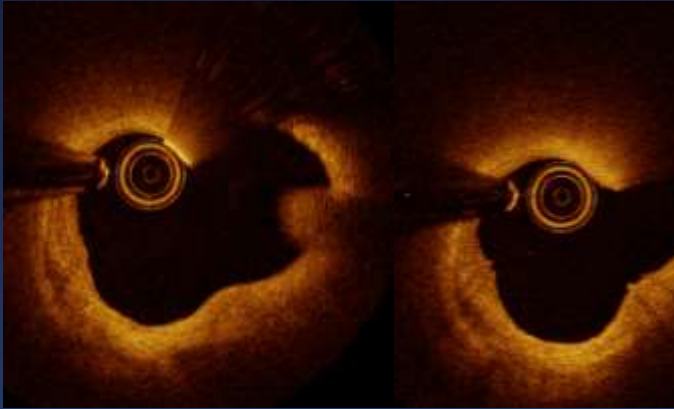


MI-CAD Case

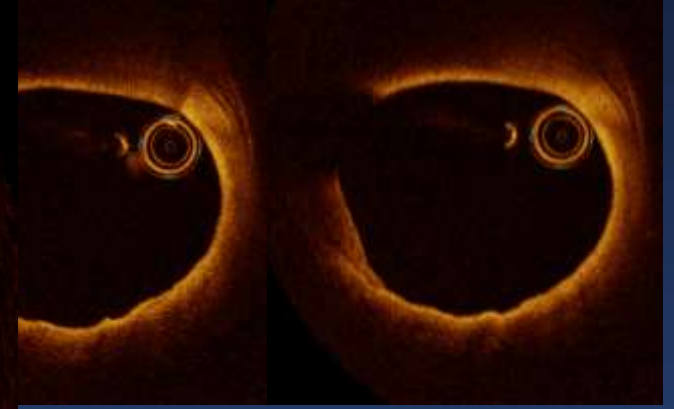


Trivial Findings in MINOCA

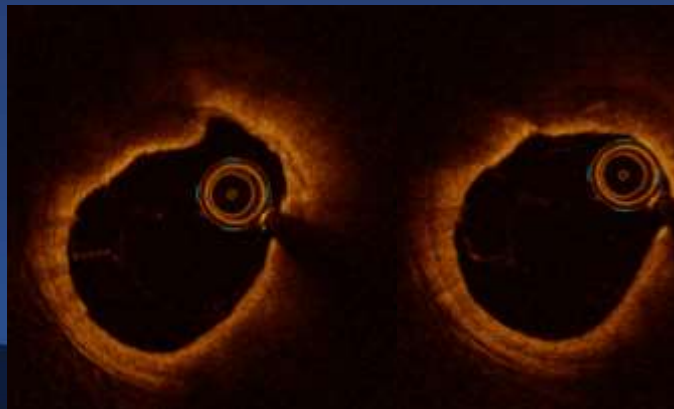
Case 1



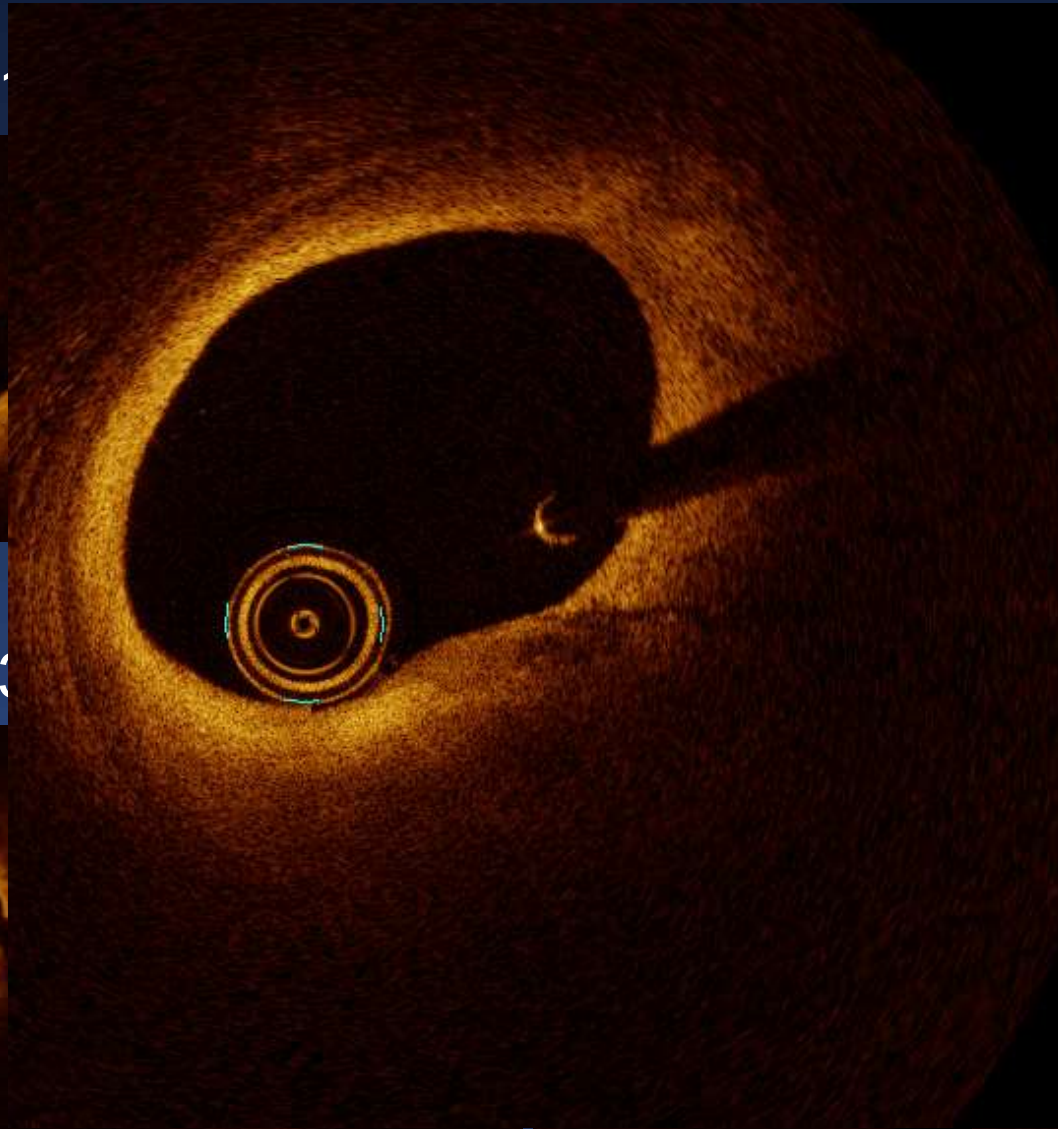
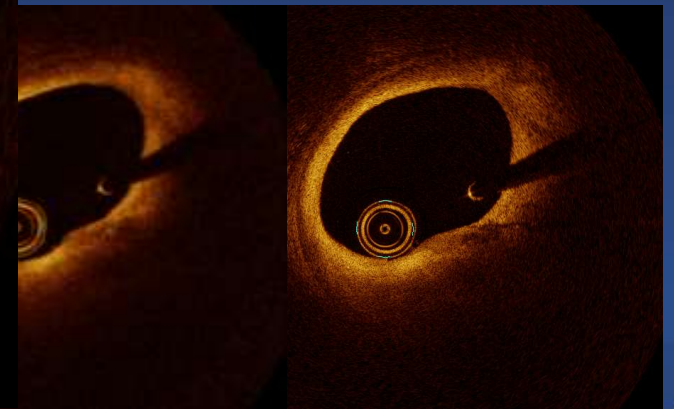
Case 2



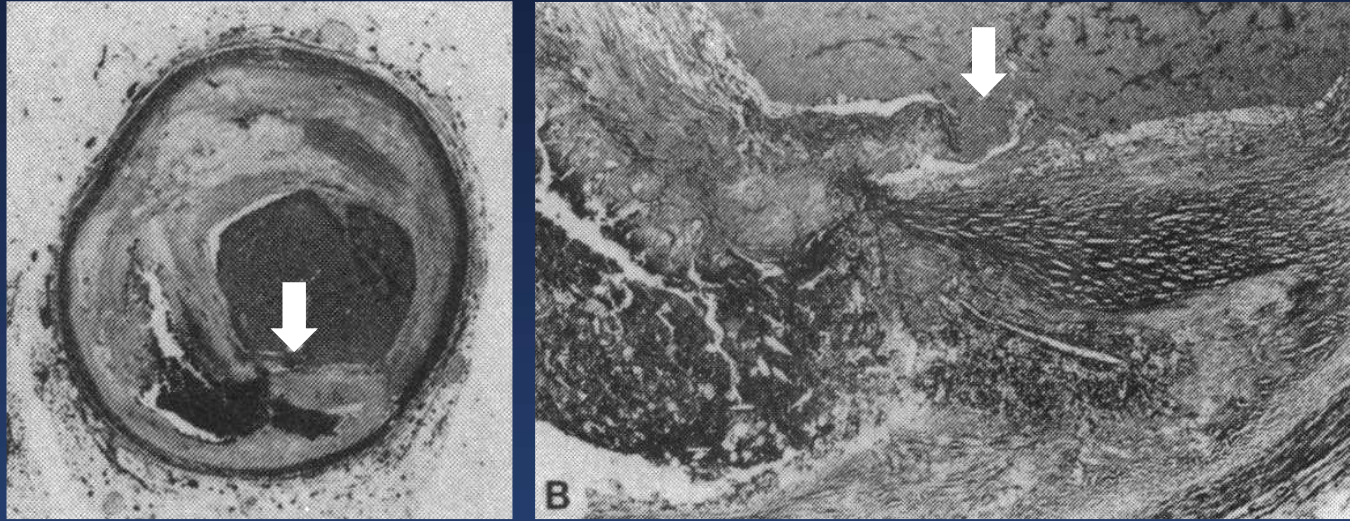
Case 3



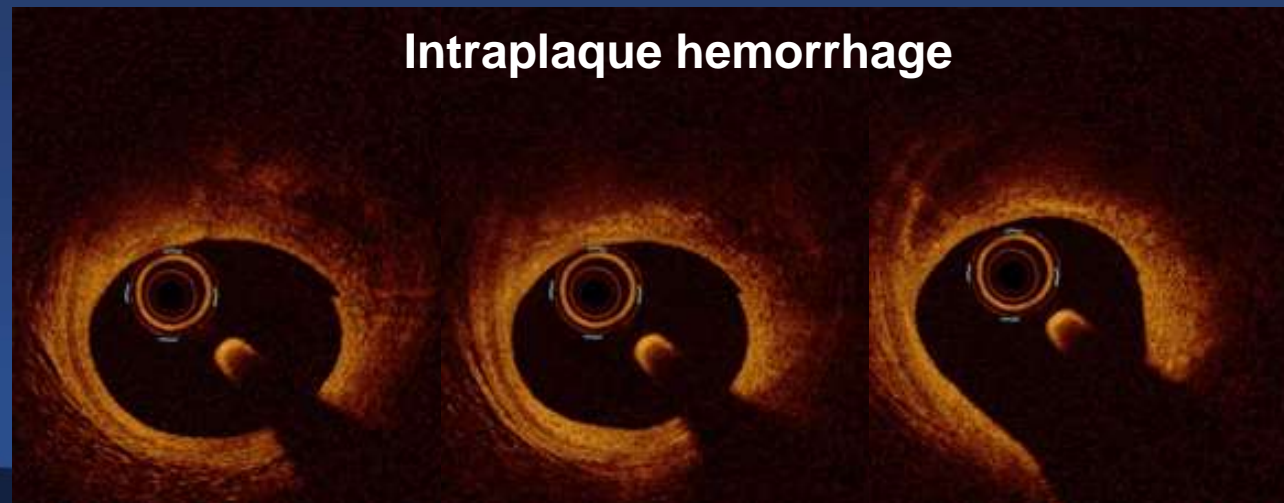
Case 4



103 Plaque rupture (40 with lumina thrombus, 63 Intraplaque hemorrhage without luminal thrombus or tiny mural thrombosis sealing the rupture site which could just be seen under the microscope)

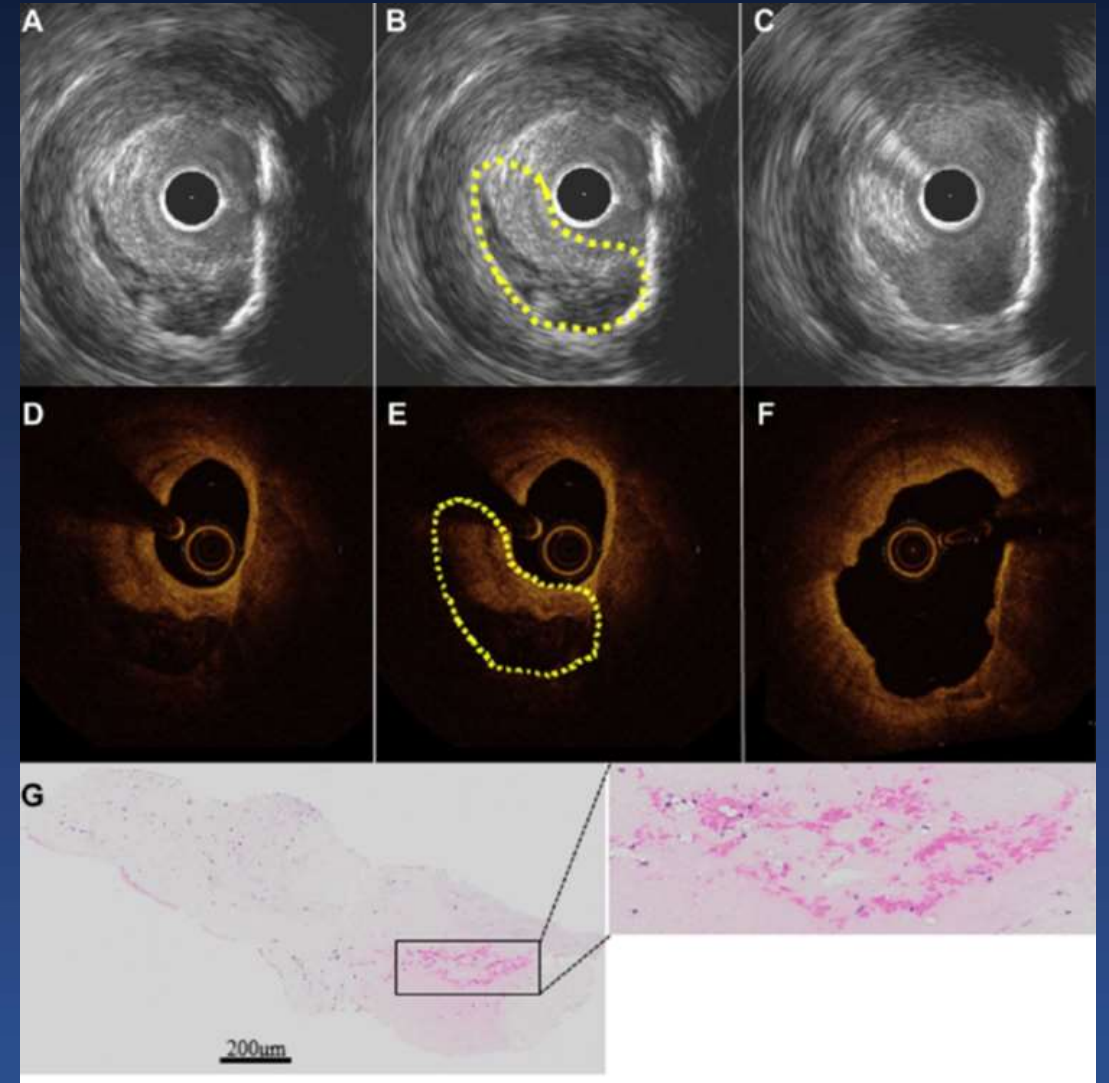
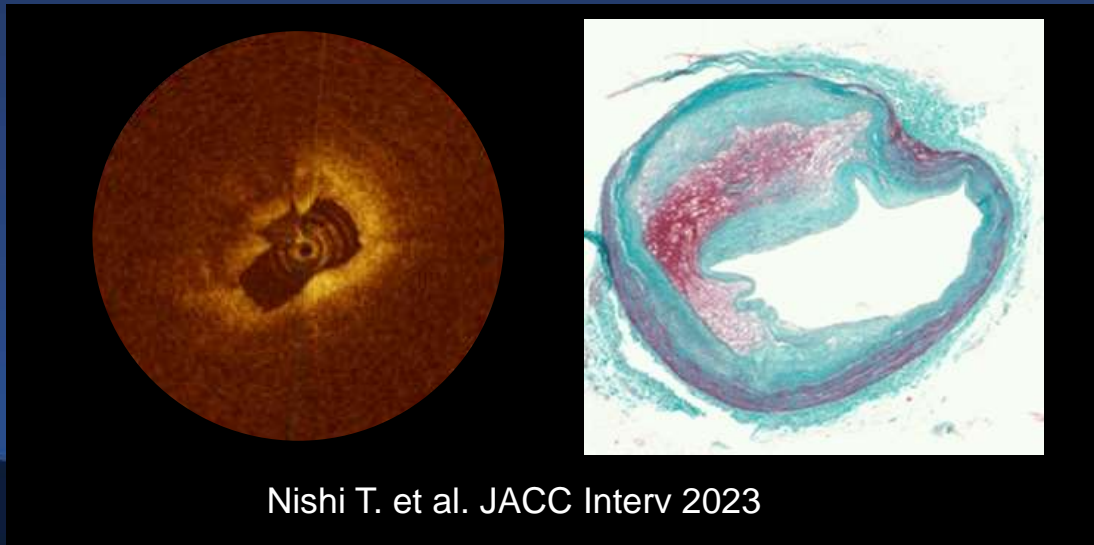
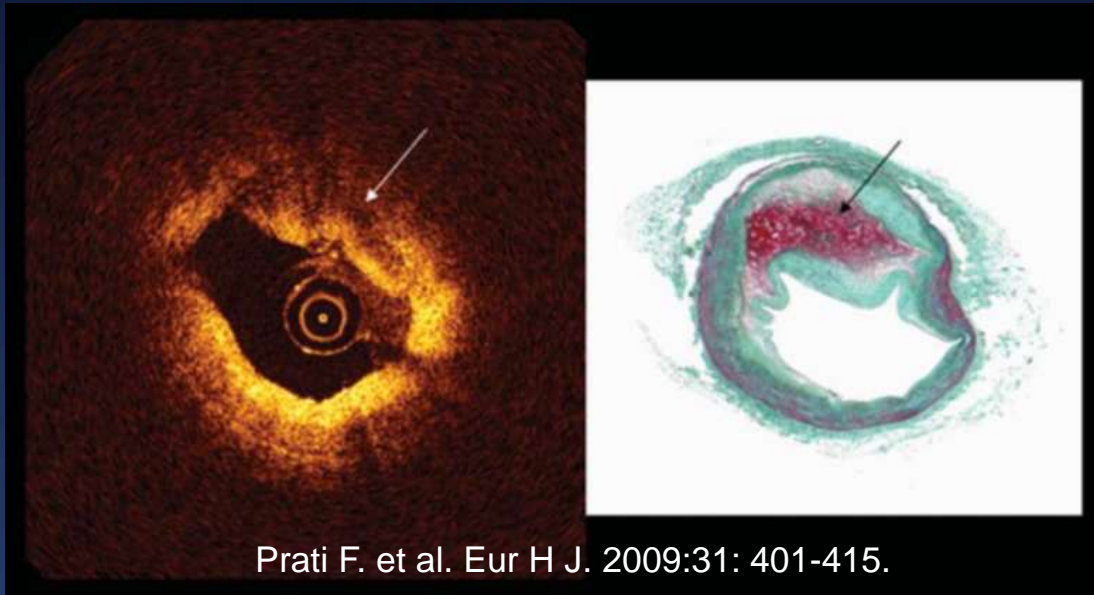


49 pts with fatal IHD
76% men, age 42-87 yo

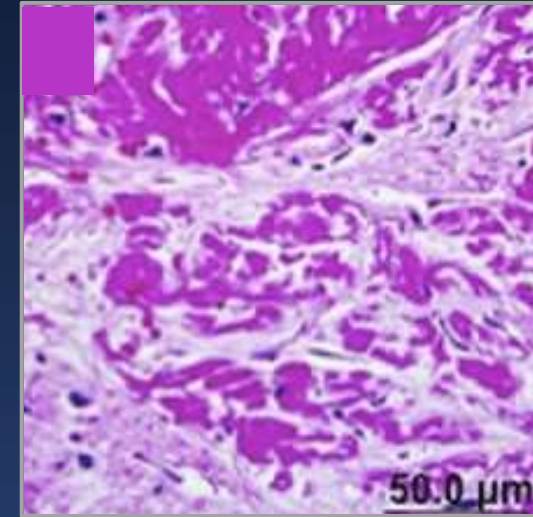
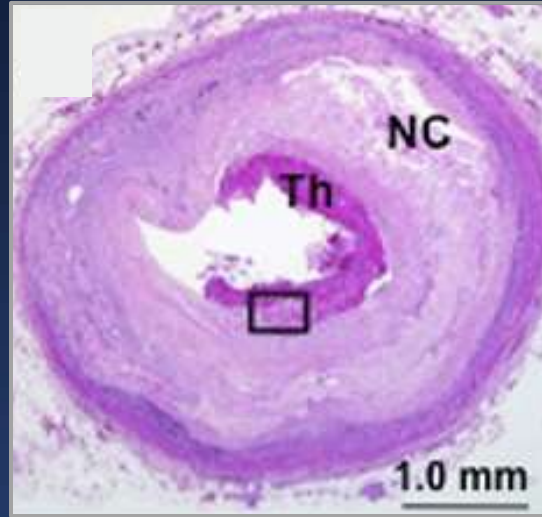
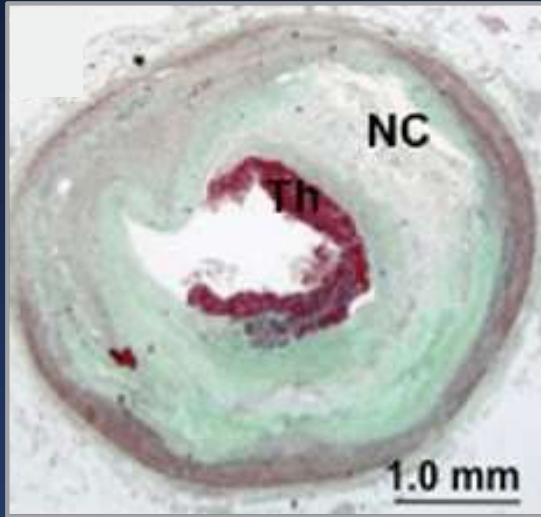


Fark E. Br Heart J 1983; 50:127-134.

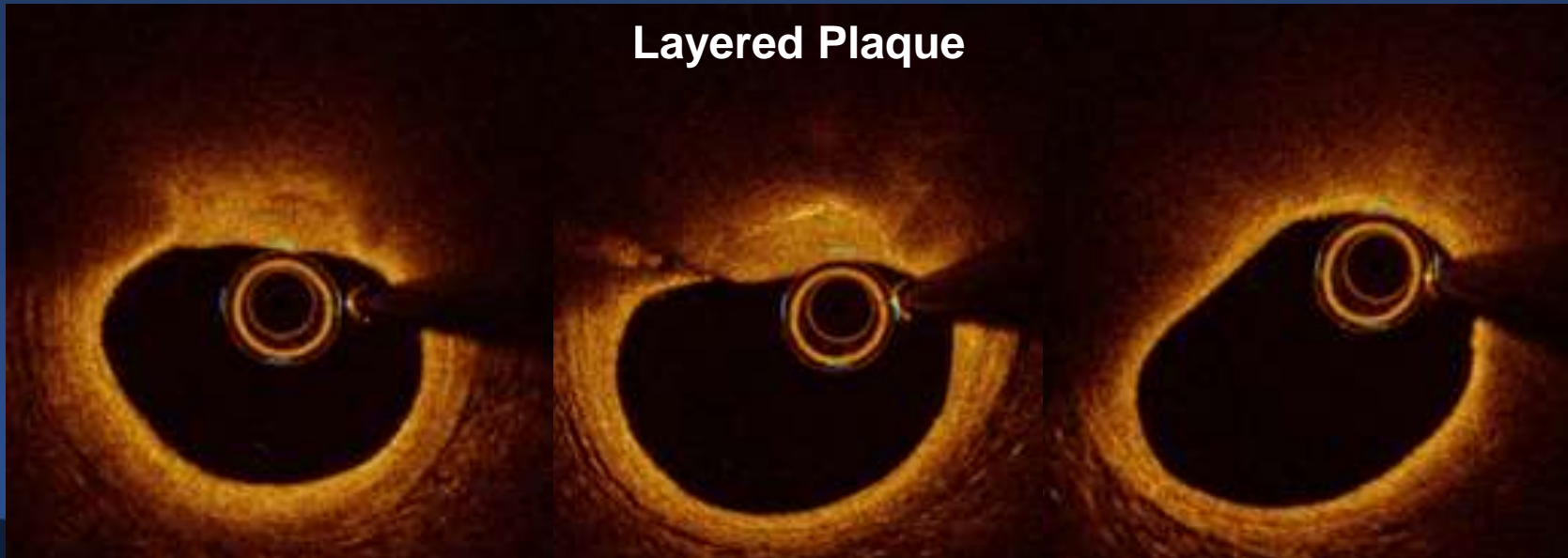
Intraplaque Hemorrhage



Thrombus were healing stage in 9% and infiltrating stage (4-7 days) in 19% in 65 SCD
Organized thrombus in 9% of thrombectomy specimen



Layered Plaque

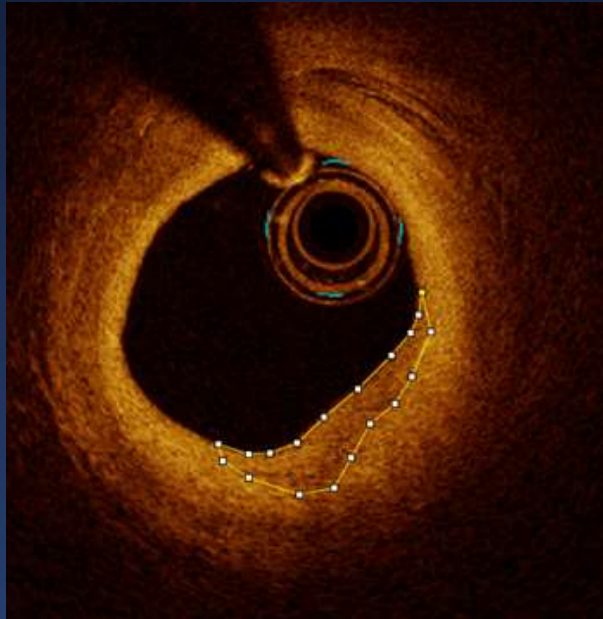


Evidence by CMR

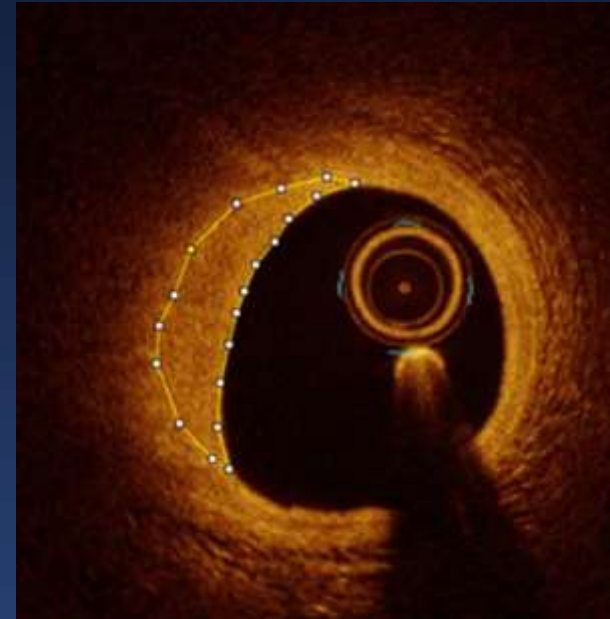
	Plaque Rupture	Plaque Erosion	Intraplaque Hemorrhage	Layered Plaque
# of pts with CT and MRI	7	4	18	14
Matched territory	2 (29%)	4 (100%)	13 (72%)	6 (43%)
Unmatched territory	0	0	3 (17%)	3 (21%)
Normal CMR	5 (71%)	0	2 (11%)	5 (36%)

Difference of Tissue Characterization of Layered Plaque

Current MI Cohort

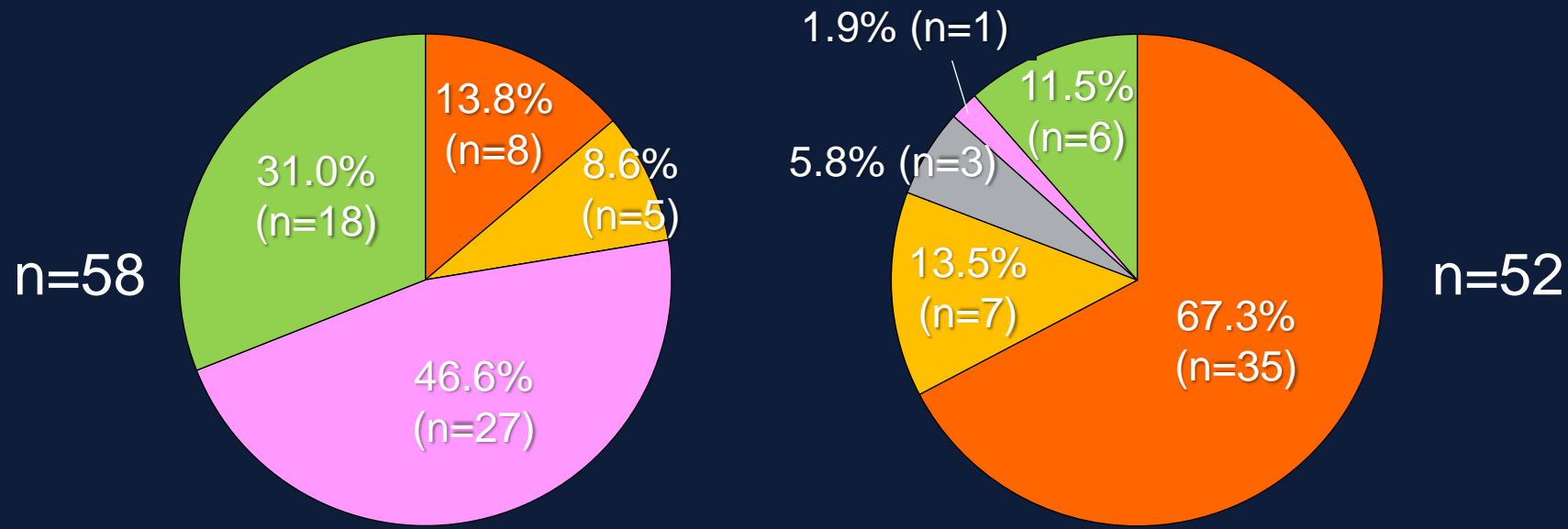


Stable Angina Cohort

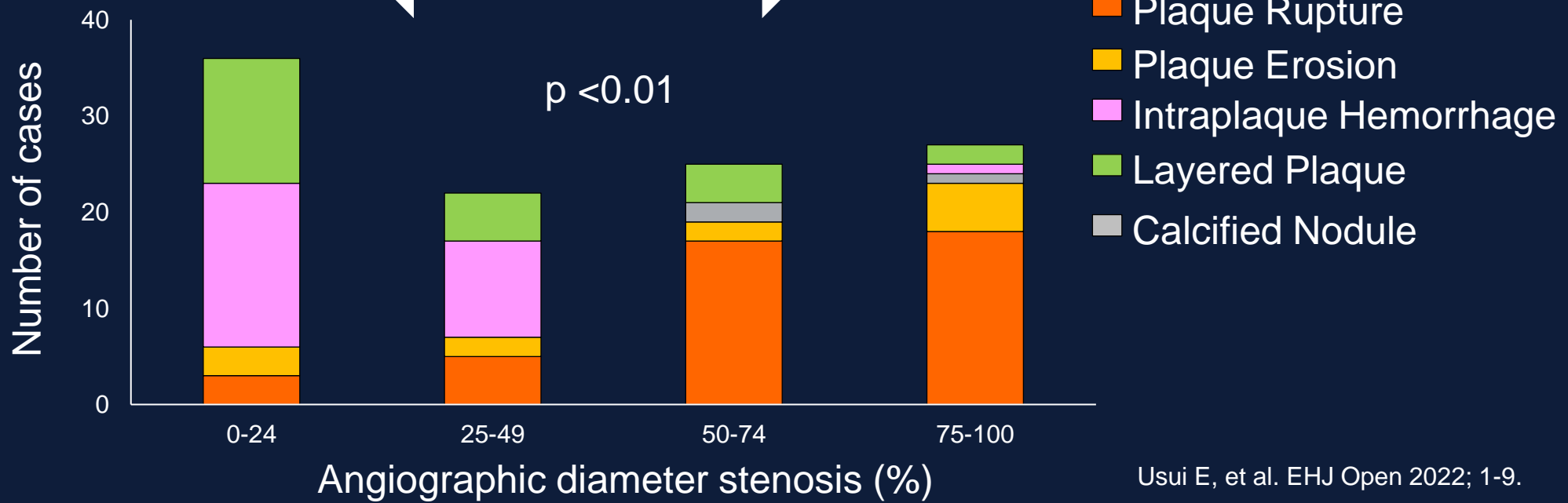


	MI Cohort (n=19)	Stable CAD (n=38)	P-value
Mean signal intensity	78.9 (67.0, 88.2)	91.4 (85.0, 104.3)	<0.01
Standard deviation / Mean	0.20 (0.17, 0.25)	0.16 (0.14, 0.19)	0.02
Area	0.48 ± 0.19	0.66 ± 0.24	<0.01

Differences between MINOCA and MI-CAD



MINOCA ← → MICAD



- Plaque Rupture
- Plaque Erosion
- Intraplaque Hemorrhage
- Layered Plaque
- Calcified Nodule

Summary

- In multicenter HARP registry including women with angiographic DS<50%, using both MV-OCT and CMR, the cause was identified in 85% of cases and 64% were MI.
- In women, OCT features of typical thrombotic morphology (plaque rupture, erosion) were less common in MINOCA than MI-CAD. Intraplaque hemorrhage and layered plaque were more common in MINOCA than MI-CAD.