MINOCA (Myocardial Infarction with Non-Obstructive Coronary Artery Disease)

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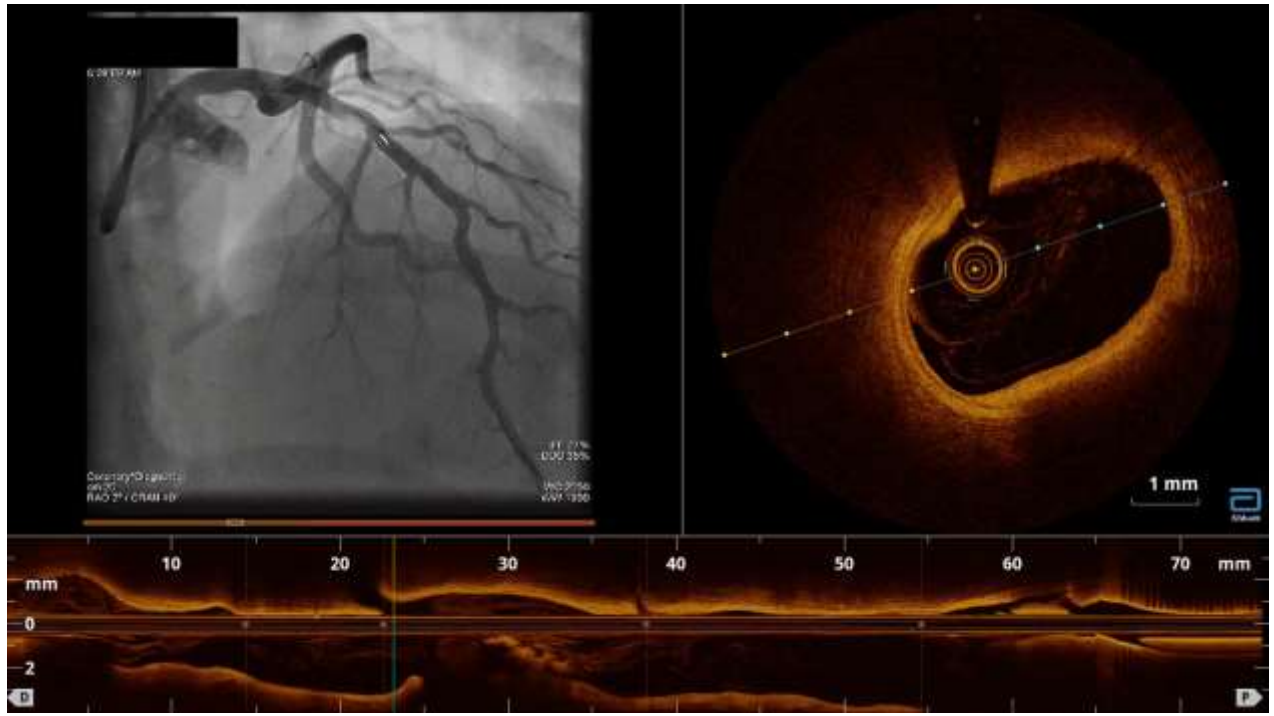
Case #1

27-year-old male with no past medical history presents with chest pain after lifting weights.

Blood Pressure: 120/80
HR: 78
PE: Unremarkable
Labs: Troponin T - .06 → 1.7 (NL < .01)
Echo: NL LVEF
CCTA shows evidence of obstruction in the LAD

Taken for Angiography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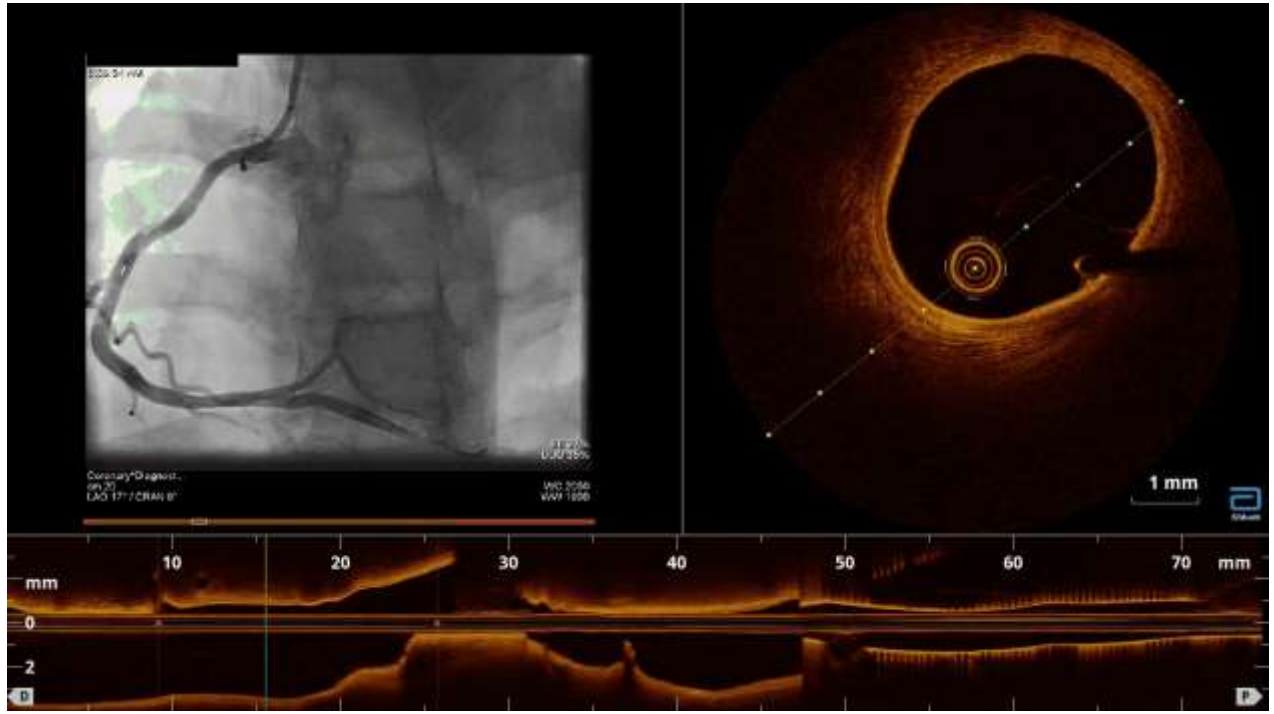
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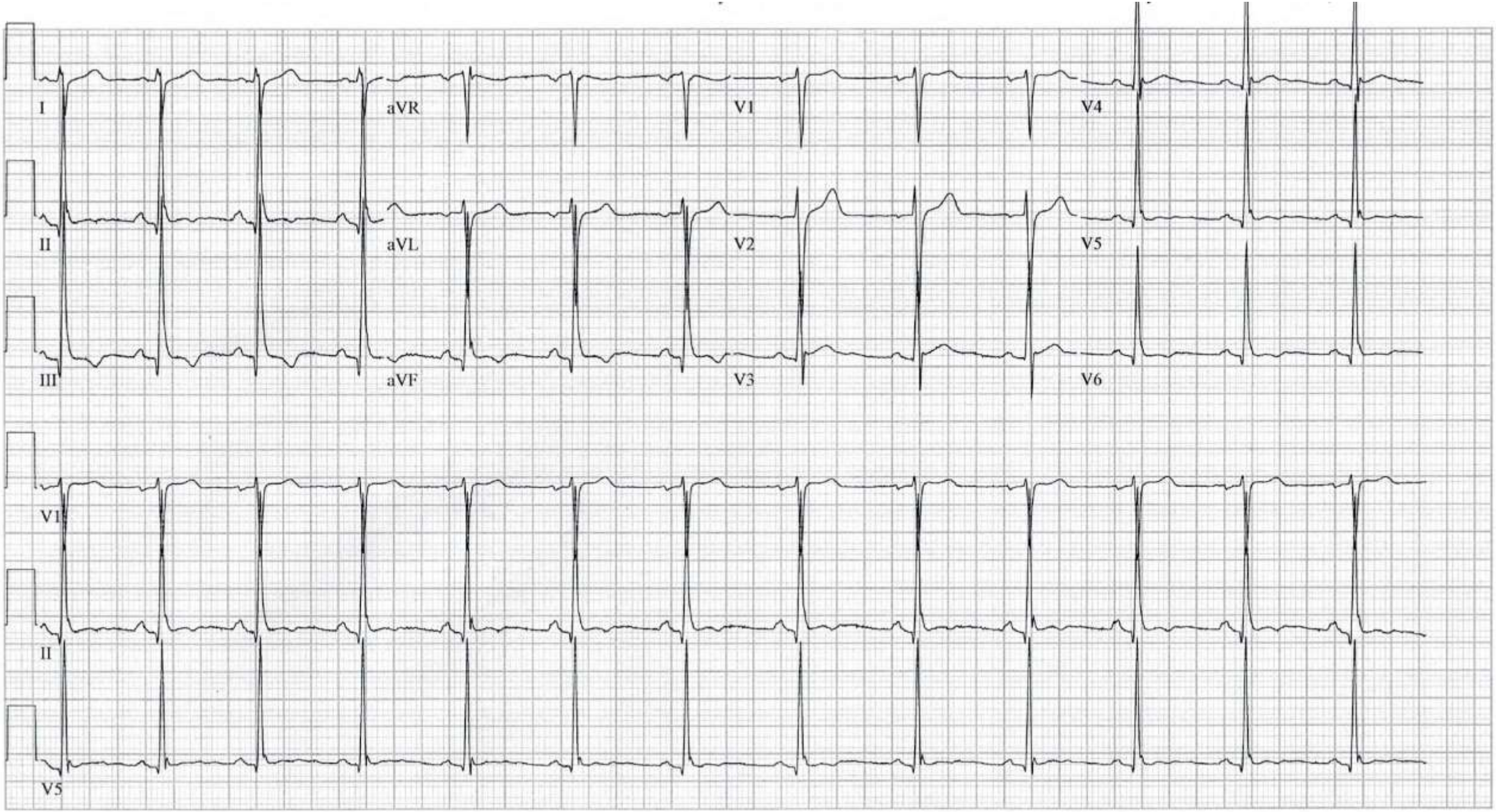
I
aVR
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V1
II
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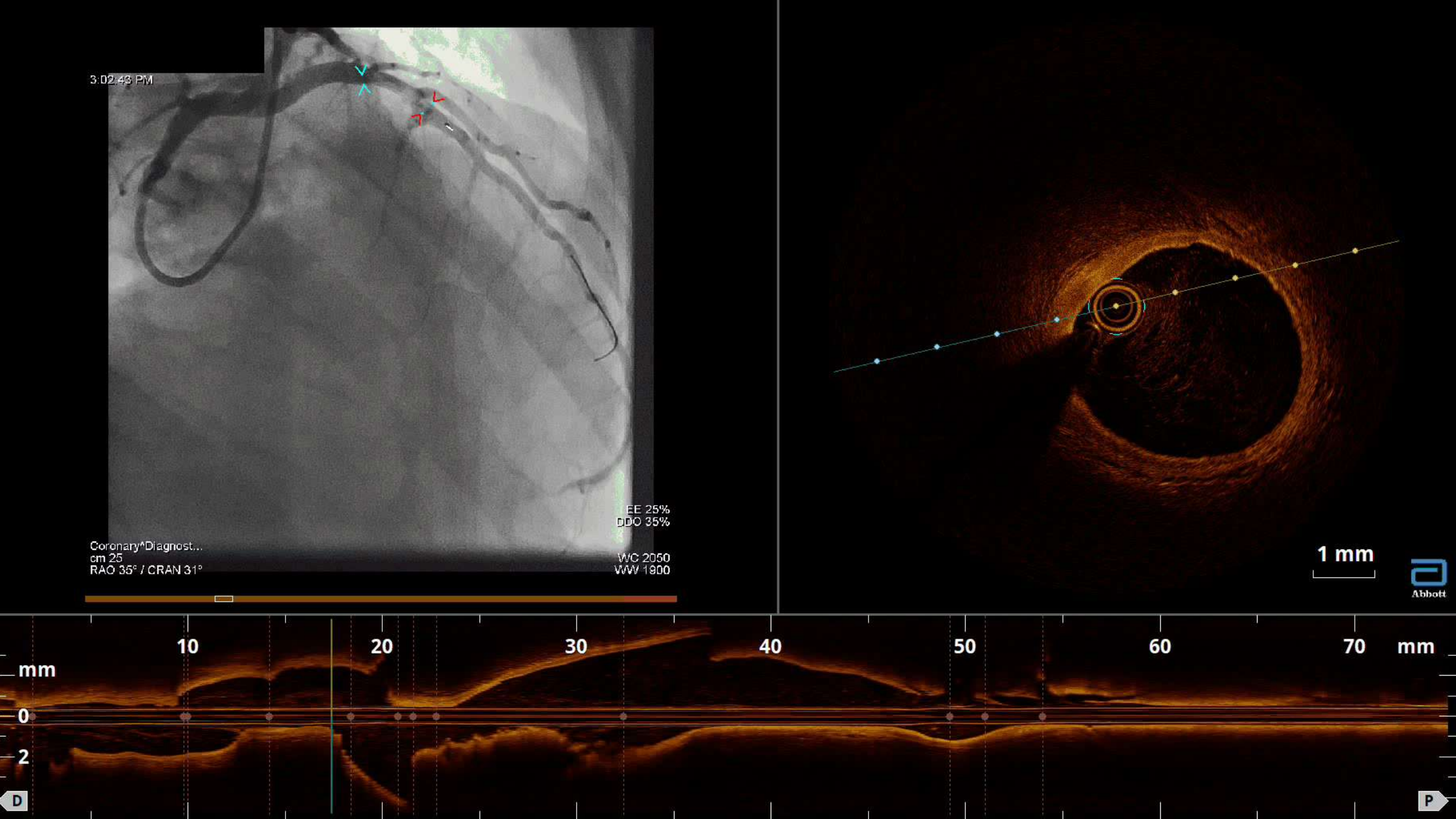
Case #2

45-year-old man with no past medical history presents with chest pain. Notes occasional palpitation.

BP: 136/80
HR: 78
PE: Unremarkable
Labs: Troponin T – 0.0 → .63 (NL < .01)
Echo: NL LVEF

Taken for Angiography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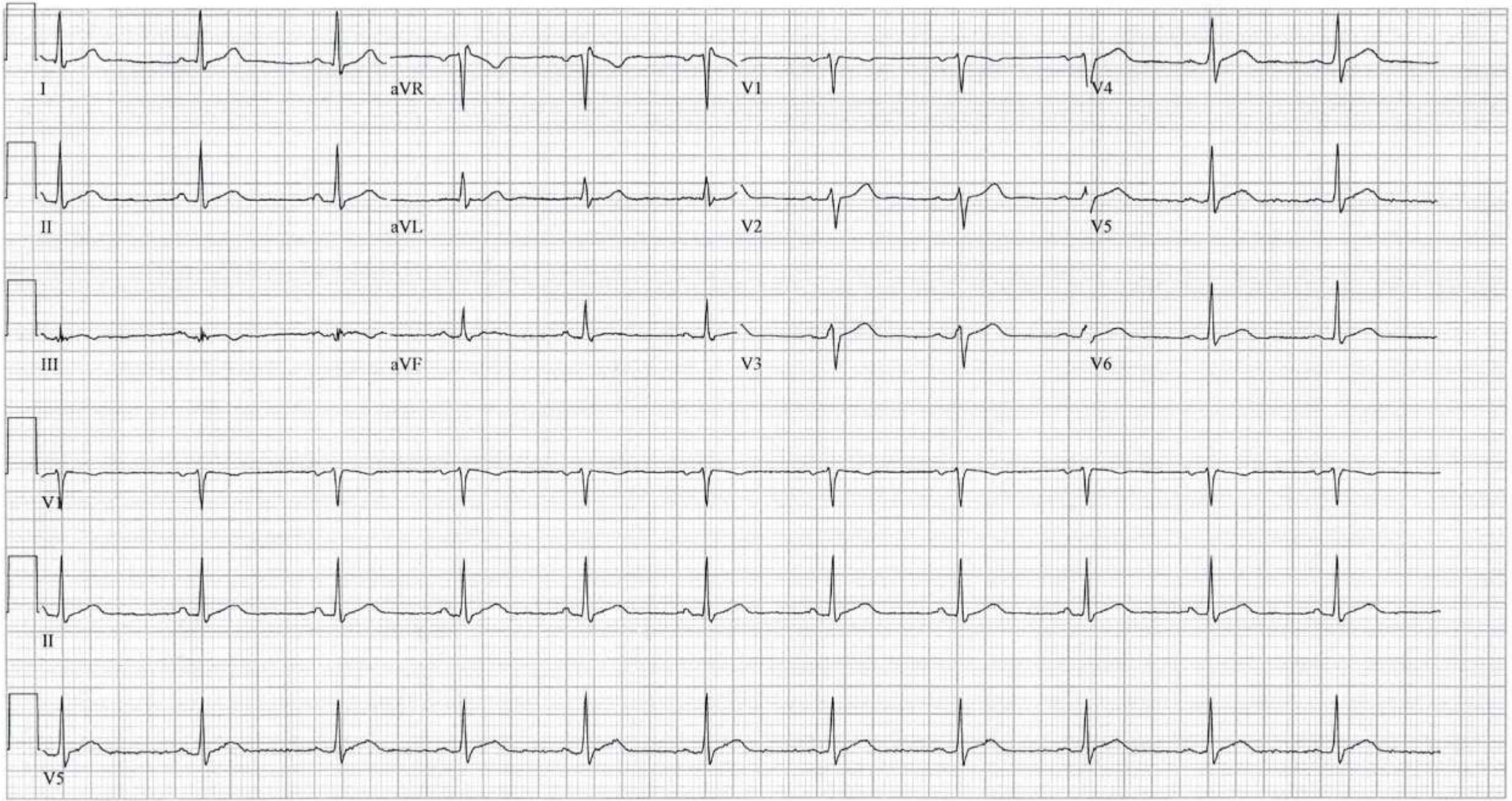
I
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III
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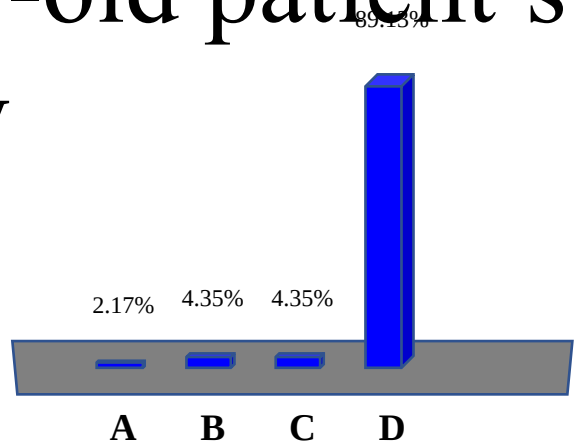
II
V5

Questions

A. Stent the 27-year-old patients's RCA
B. Stent the 27-year-old patient's LAD
C. Stent the 45-year-old patient's LAD
D. Medical Therapy



Definition of myocardial infarction

Criteria for acute myocardial infarction

The term acute myocardial infarction (MI) should be used when there is evidence of myocardial necrosis in a clinical setting consistent with acute myocardial ischaemia. Under these conditions any one of the following criteria meets the diagnosis for MI:

- Detection of a rise and/or fall of cardiac biomarker values [preferably cardiac troponin (cTn)] with at least one value above the 99th percentile upper reference limit (URL) and with at least one of the following:
  - Symptoms of ischaemia.
  - New or presumed new significant ST-segment–T wave (ST–T) changes or new left bundle branch block (LBBB).
  - Development of pathological Q waves in the ECG.
  - Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality.
  - Identification of an intracoronary thrombus by angiography or autopsy.

Am Coll Cardiol. 2012 Oct 16;60(16):1581-98.

MINOCA (Myocardial Infarction with Non-Obstructive Coronary Artery Disease

The diagnosis of MINOCA is made immediately upon coronary angiography in a patient presenting with features consistent with an acute myocardial infarct, as detailed by the following criteria:

(1) AMI criteria.[1]

(a) Positive cardiac biomarker (preferably cardiac troponin) defined as a rise and/or fall in serial levels, 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 ischaemia
(ii) New or presumed new significant ST-T changes or new LBBB
(iii) Development of pathological Q waves
(iv) Imaging evidence of new loss of viable myocardium or new RWMA
(v) Intracoronary thrombus evident on angiography or at autopsy

(2) Non-obstructive coronary arteries on angiography:

- Defined as the absence of obstructive CAD on angiography, (i.e. no coronary artery stenosis $\geq$50%), in any potential infarct-related artery.
- This includes both patients with:
  - normal coronary arteries (no stenosis $>$30%)
  - mild coronary atheromatosis (stenosis $>$30% but $<$50%).

(3) No clinically overt specific cause for the acute presentation:

- At the time of angiography, the cause and thus a specific diagnosis for the clinical presentation is not apparent.
- Accordingly, there is a necessity to further evaluate the patient for the underlying cause of the MINOCA presentation.

Eur Heart J. 2017 Jan 14;38(3):143-153.

ESC working group position paper on myocardial infarction with non-obstructive coronary arteries

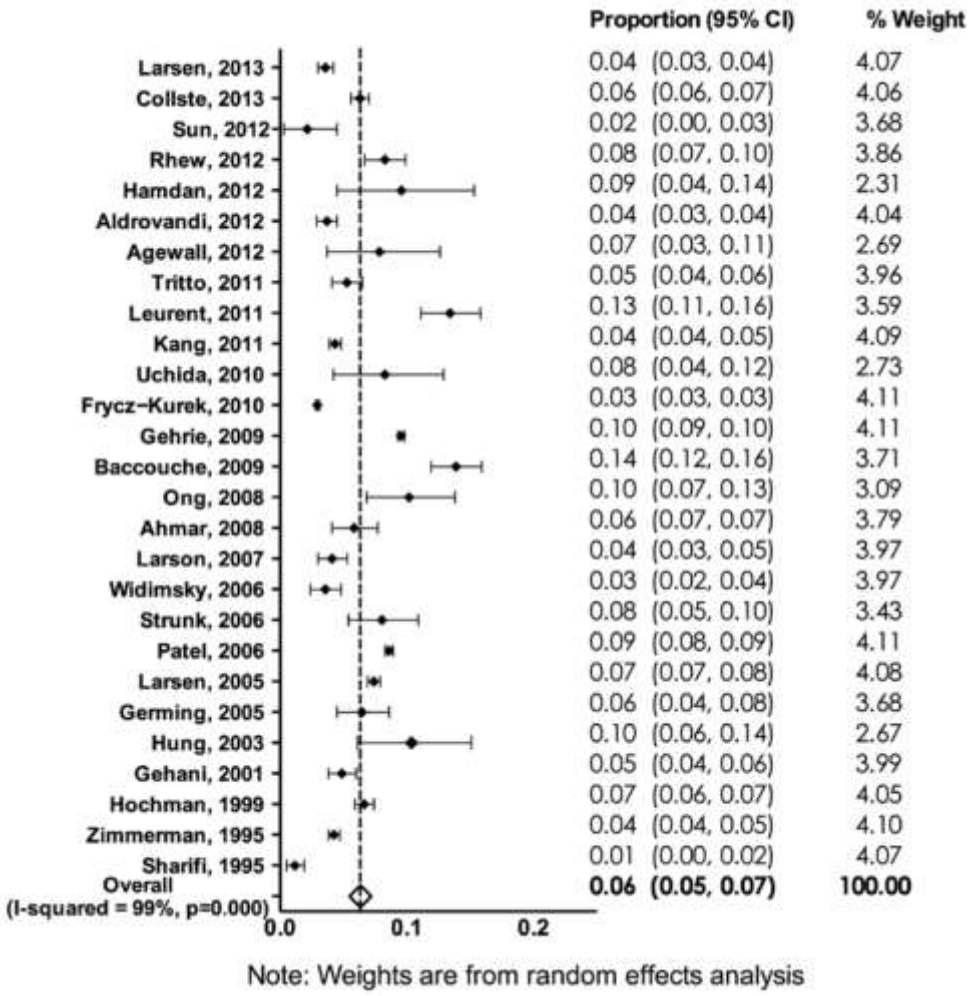
The diagnosis of MINOCA is made immediately upon coronary angiography in a patient presenting with features consistent with an AMI, as detailed by the following criteria:
(1) Universal AMI criteria[8]
(2) Non-obstructive coronary arteries on angiography, defined as no coronary artery stenosis ≥50% in any potential IRA
(3) No clinically overt specific cause for the acute presentation

MINOCA is a “Working Diagnosis”

European Heart Journal (2017) 38, 143-153

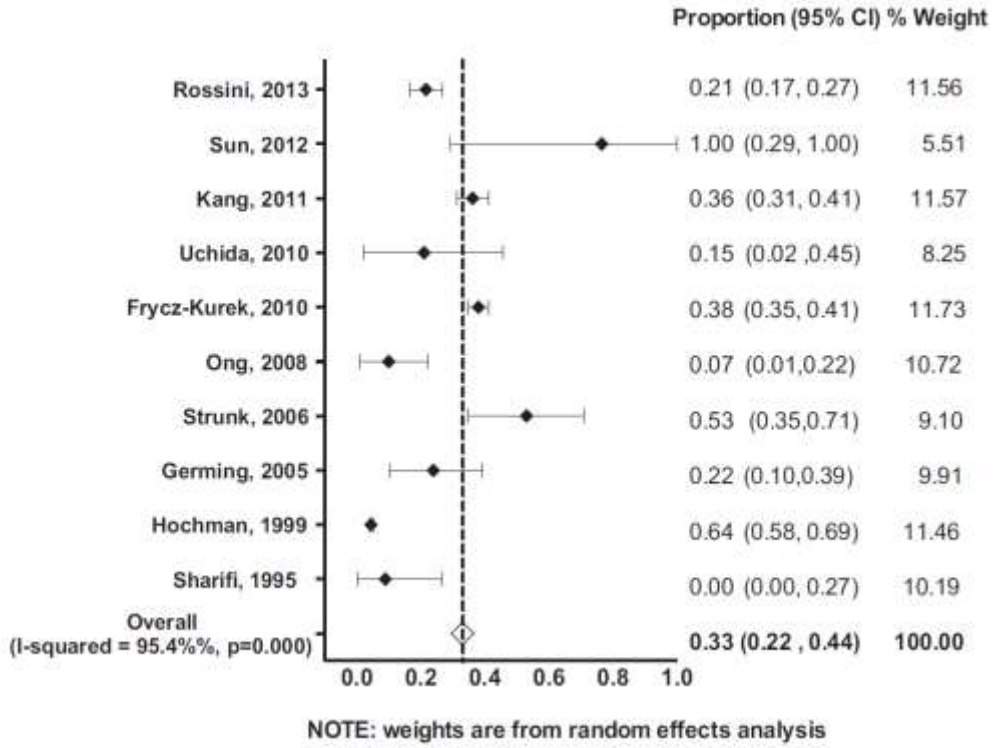
Prevalence

Overall: 6%



Note: Weights are from random effects analysis

STEMI: 33%



NOTE: weights are from random effects analysis

Circulation. 2015;131:861-870.

MINOCA Prevalence in United States

- **Estimated 54,000-187,000 cases/year in United States**

- **ACTION Registry-GWTG (2007-2014, N=322,523 with MI)**
- 5.9% of patients undergoing angiography had MINOCA (10.5% of women, 3.4% of men)
- MINOCA compared to MI-CAD:
  - more common among **women**, younger individuals, black patients
  - **fewer traditional risk factors** for coronary heart disease
  - more likely to have ESRD requiring hemodialysis, prior CHF, atrial fibrillation/flutter, chronic lung disease
  - higher heart rates at presentation, **less STEMI**, lower troponin levels
  - received less guideline-directed medical therapy

Pasupathy S et al. Circulation. 2015;131:861-870.
Smilowitz NR, et al. Circ Cardiovasc Qual Outcomes. 2017;10(12):e003443.

MINOCA Causes Significant Mortality

All-Cause Mortality	Comparative Studies			All MINOCA Studies
	MI-CAD % (95% CI)	MINOCA % (95% CI)	OR (95% CI) *P* Value	
In-hospital	3.2% (1.8%, 4.6%)	1.1% (-0.1%, 2.2%)	0.37 (0.2–0.67) *P*=0.001	0.9% (0.5%, 1.3%)
12-month	6.7% (4.3%, 9.0%)	3.5% (2.2%, 4.7%)	0.59 (0.41–0.83) *P*=0.003	4.7% (2.6%, 6.9%)

Circulation 2015;131:861-870

MINOCA in the South East Asian Cohort (Singapore)

3.9% MINOCA

	MINOCA (n=159)	MICAD (n=3,965)
Age (years), mean (SD)	59 (13.5)	60 (11.3)
Men	**26%**	**34%**
Ethnicity		
Chinese 74.3%	**65%**	2,467 (62.2)
Malay 13.5%	**16%**	762 (19.2)
Indian 9%%	**13%**	533 (13.4)
		203 (5.1)
Medical History		
Hypertension, n (%)	94 (59.1)	2,332 (59.0)
Dyslipidaemia, n (%)	90 (56.6)	2,171 (54.9)
Diabetes	**26%**	**34%**
Heart Failure	**6%**	**3%**
History of ischaemic stroke, n (%)	0 (0)	140 (3.5)
Peripheral artery disease, n (%)	1 (0.6)	50 (1.3)
Smoking	**51%**	**44%**
Creatinine, mmol/l (SD)	94 (132)	109 (117)
LVEF, % (SD)	62 (11.0)	54 (14.3)
Presentation		
STEMI	**17%**	**54%**
		1,956 (47.4)

Comparative Studies

Risk Factors	MI-CAD % (95% CI)	MINOCA % (95% CI)	Mean difference/OR (95% CI) & *P* Value
Age	61.3 (52.2, 70.4)	58.8 (51.6, 66.1)	4.1 (2.9,5.4) *P*<0.001
Women	24% (19%, 30%)	43% (35%, 51%)	2.1 (1.7, 2.7) *P*<0.001
Hyperlipidemia	32% (15%, 48%)	21% (6%, 35%)	0.6 (0.5, 0.7) *P*<0.001
Hypertension	45% (30%, 59%)	52% (41%, 62%)	1.3 (0.9, 1.9) *P*=0.183
Diabetes mellitus	22% (14%, 29%)	15% (9%, 20%)	0.8 (0.5, 1.3) *P*=0.333
Smoking	39% (26%, 52%)	42% (33%, 51%)	1.1 (0.7, 1.5) *P*=0.785
Family history	27% (10%, 43%)	21% (5%, 38%)	1.0 (0.7, 1.3) *P*=0.794

https://www.singstat.gov.sg

Journal of Asian Pacific Society of Cardiology 2022;1:e04.

MINOCA in the South East Asian Cohort

Outcome at 4.5 Years

	MINOCA (n=159), % (n)	MICAD (n=3,965), % (n)	Unadjusted		Multivariable-adjusted	
			HR [95% CI]	p-value	HR [95% CI]	p-value
All-cause mortality	10.1 (16)	16.5 (656)	0.58 [0.35–0.95]	0.030	0.42 [0.21–0.82]	0.011
MACE	20.8 (33)	35.5 (1,409)	0.51 [0.36–0.72]	<0.0001	0.42 [0.26–0.69]	0.001
Recurrent MI	6.9 (11)	17.0 (673)	0.36 [0.20–0.65]	0.001	0.35 [0.15–0.85]	0.021
Hospitalisation for heart failure	3.8 (6)	10.1 (401)	0.34 [0.15–0.77]	0.010	0.51 [0.19–1.40]	0.19
Ischaemic stroke	3.1 (5)	3.0 (118)	1.0 [0.41–2.44]	0.91	–	–

MACE:

All Cause Mortality
Recurrent MI,
Heart failure hospitalization
Stroke

Journal of Asian Pacific Society of Cardiology 2022;1:e04

MINOCA in the South East Asian Cohort (Singapore)

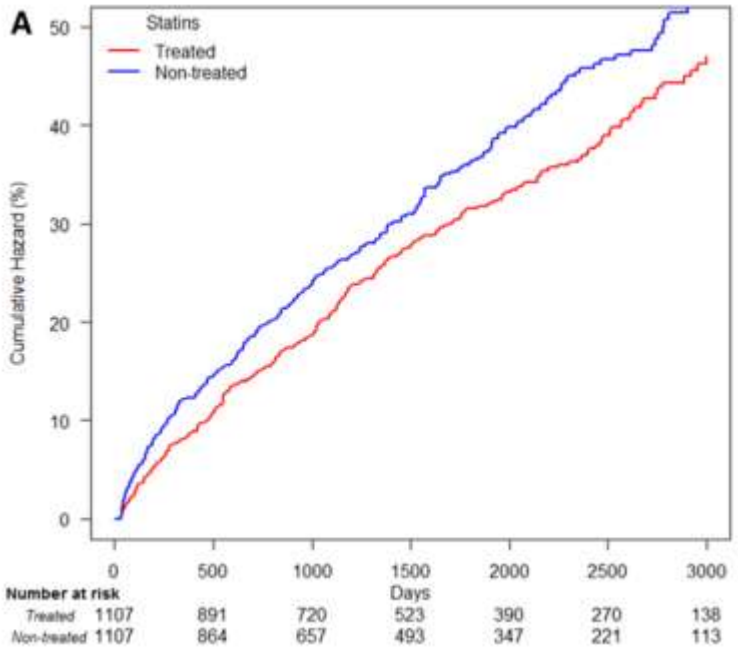
	MINOCA (n=159)	MICAD (n=3,965)	Overall Population (n=4,124)	p-value
Medications at Discharge				
ACE-I/ARBs, n (%)	78 (49.1)	2,690 (67.8)	2,768 (67.1)	<0.0001
β-blockers, n (%)	85 (53.5)	3,258 (82.2)	3,343 (81.1)	<0.0001
Statins, n (%)	137 (86.2)	3,584 (90.4)	3,721 (90.2)	0.078
Aspirin, n (%)	122 (76.7)	3,501 (88.3)	3,623 (87.9)	<0.0001
$P2Y_{12}$ inhibitor, n (%)	105 (66.0)	3,461 (87.3)	3,566 (86.5)	<0.0001
Any antiplatelet use, n (%)	135 (84.9)	3,645 (91.9)	3,780 (91.7)	0.002

ACE-I = angiotensin converting enzyme inhibitor; ARB = angiotensin receptor blocker; LVEF = left ventricular ejection fraction; MICAD = MI with obstructive coronary artery disease; MINOCA = MI with non-obstructive coronary arteries; NSTEMI = non-ST-elevation MI; PCI = percutaneous coronary intervention; STEMI = ST-elevation MI.

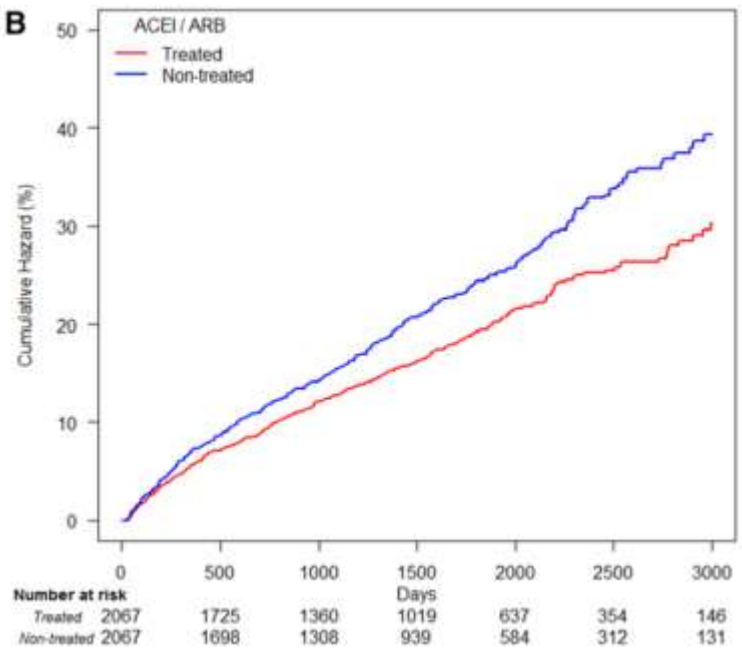
MINOCA is medically undertreated in the South East Asian Population

Journal of Asian Pacific Society of Cardiology 2022;1:e04

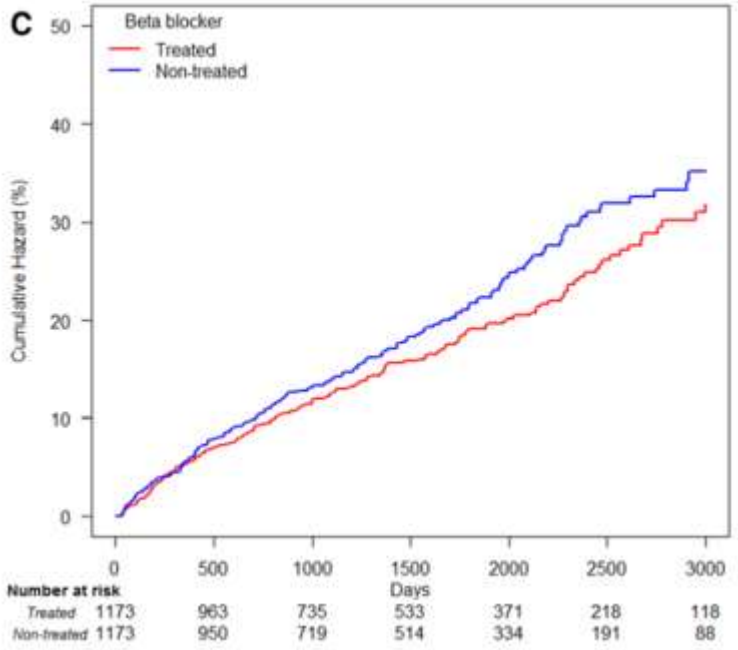
Statins
HR 0.77 (0.68-0.87)



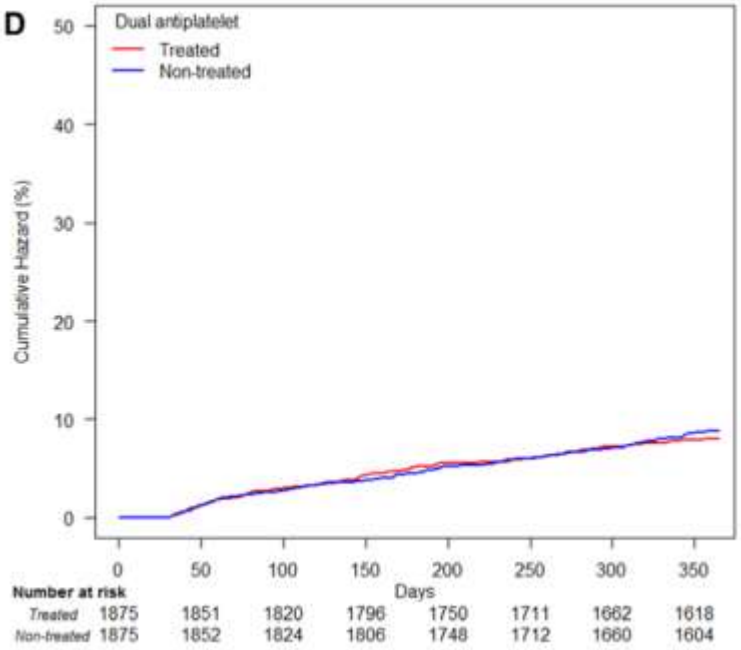
ACE-I/ARB
HR 0.82 (0.73-0.93)



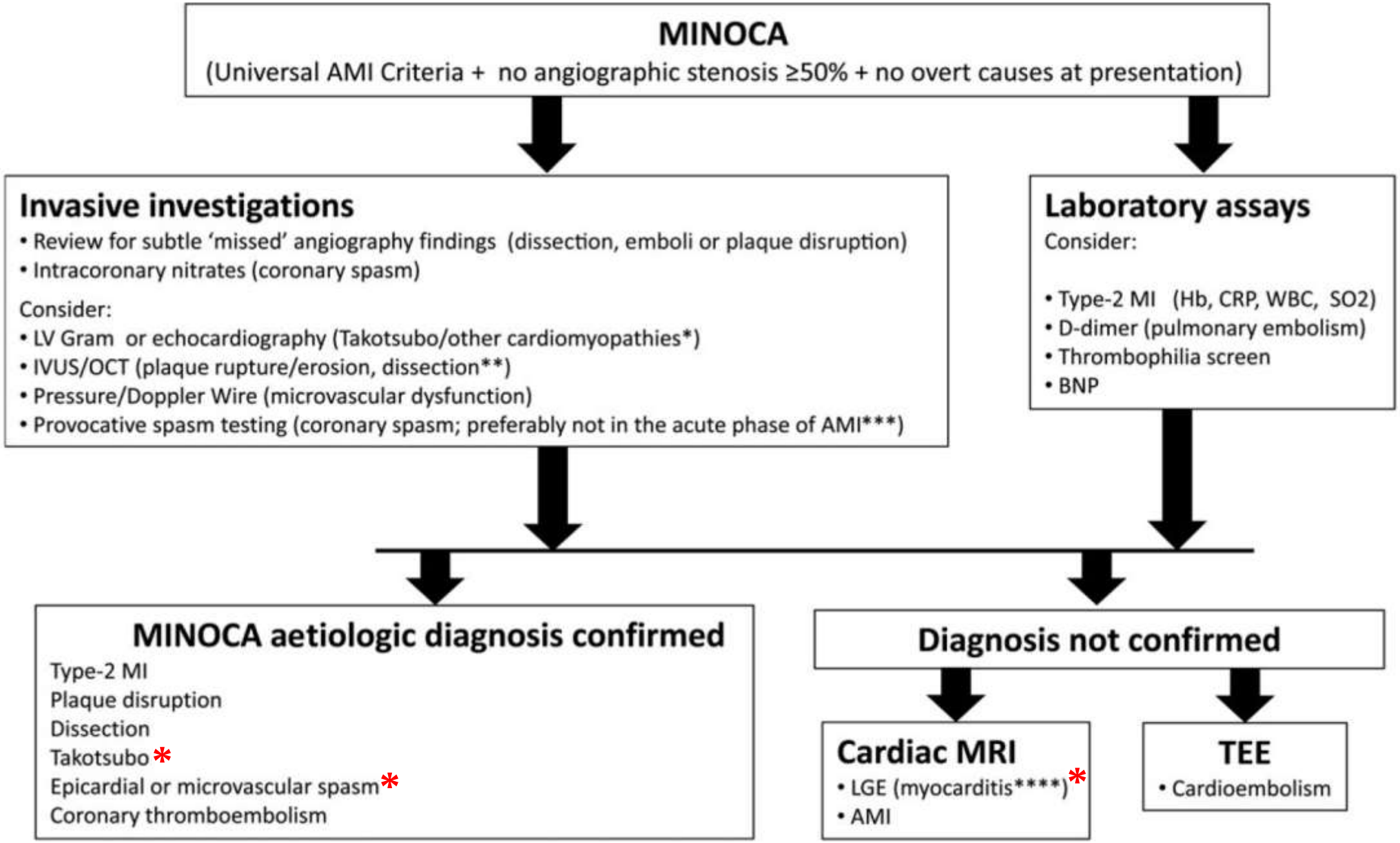
Beta-blocker
HR 0.86 (0.74-1.01)



DAPT
HR 0.90 (0.74-1.08)

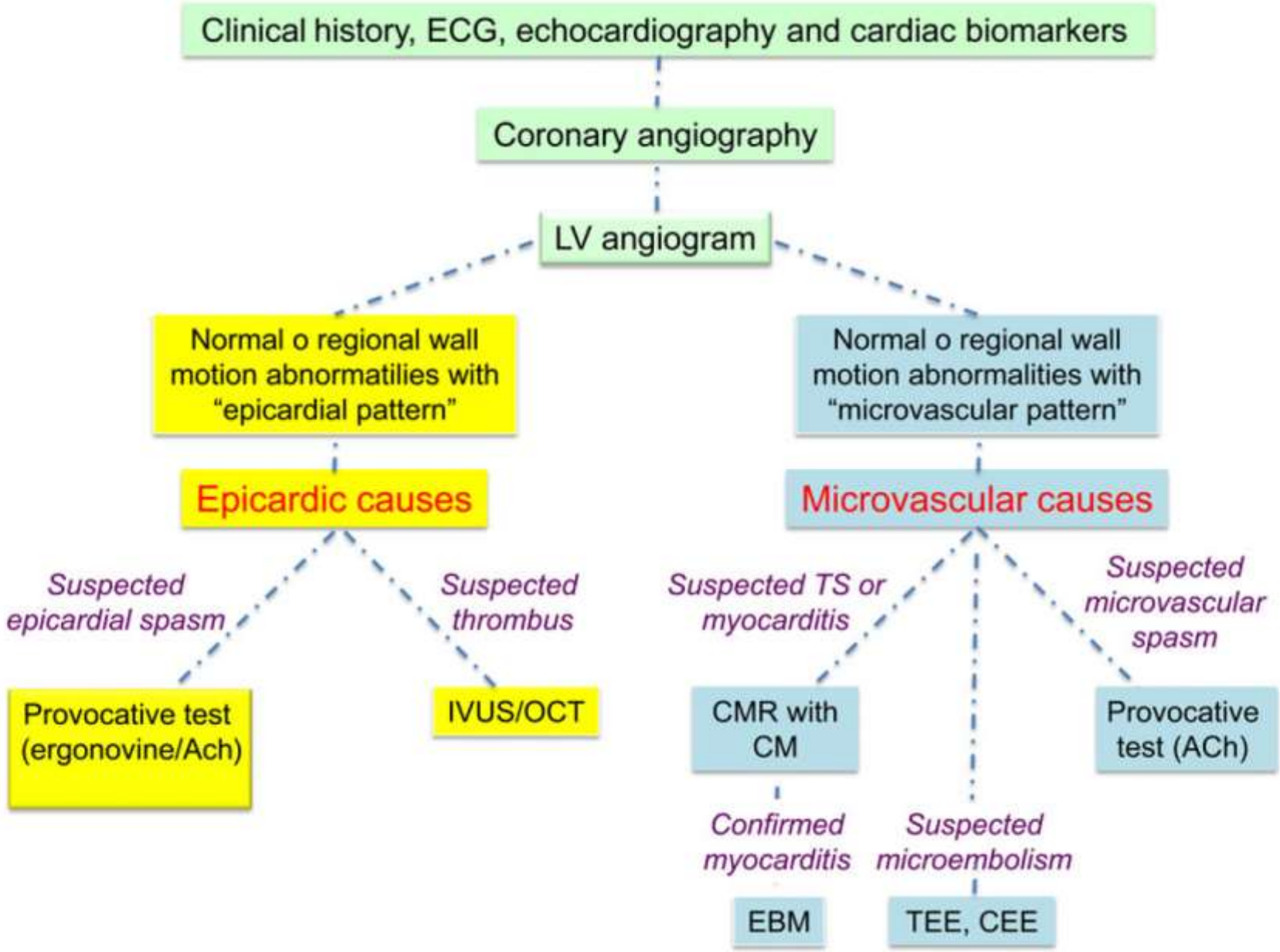


Lindahl B, et al. Circulation 2017;135:1481-89.



European Heart Journal (2017) 38, 143–153

Evaluation for Coronary Vascular Causes

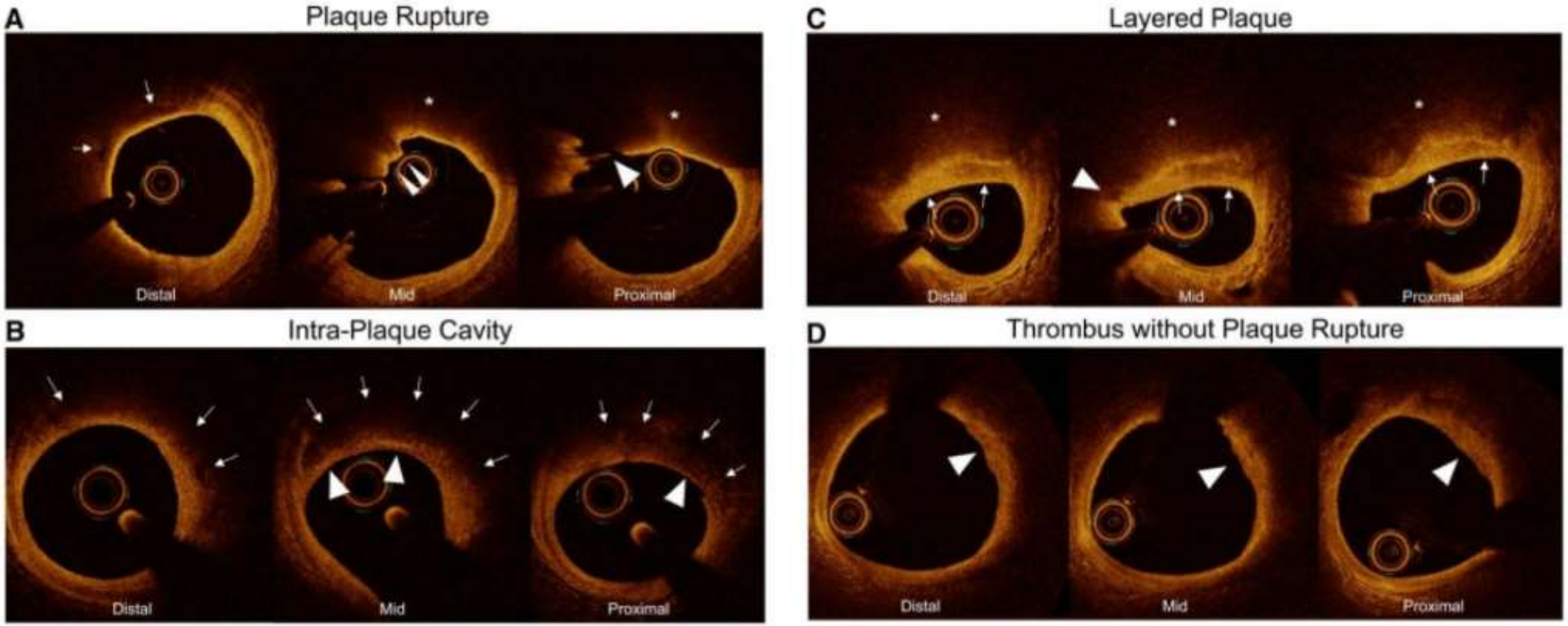


Niccoli G et al. **European Heart Journal (2015) 36, 475–481**

OCT N=145

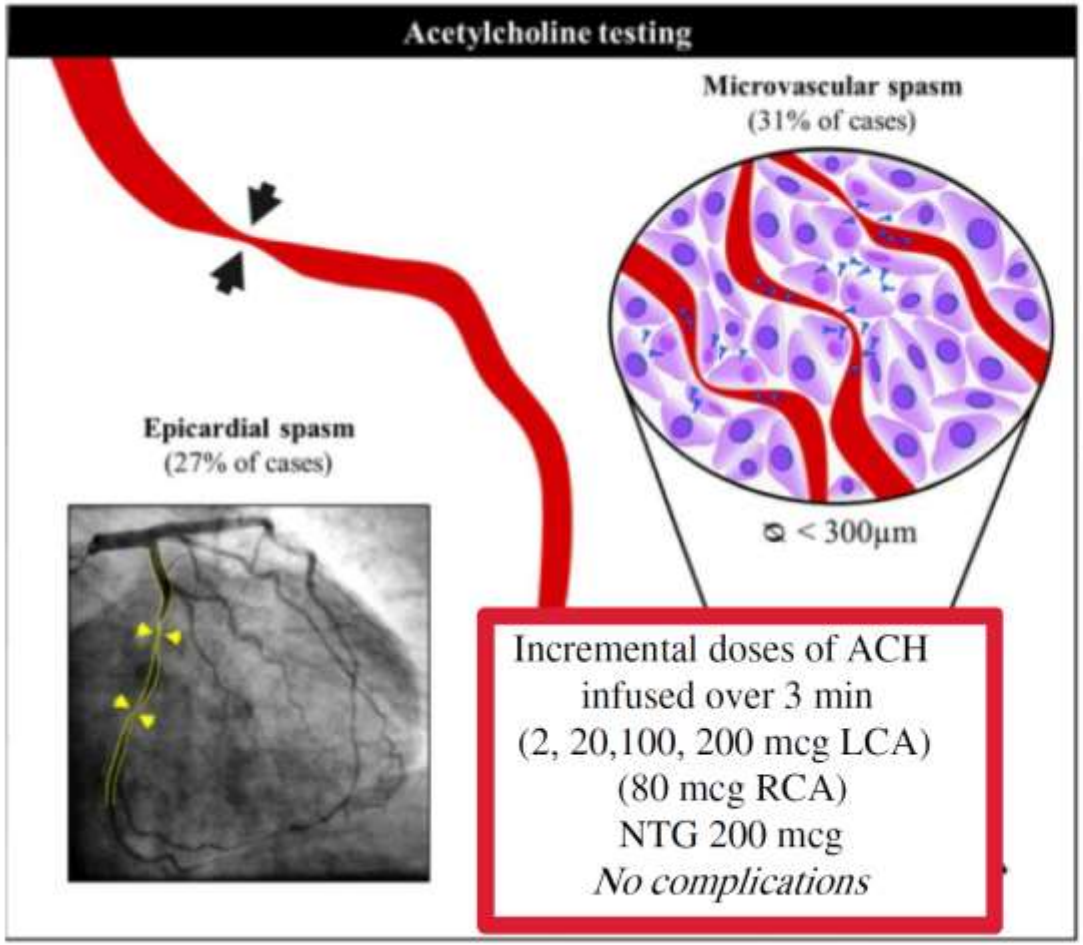
Culprit Lesion n=67 (46.2%)

Plaque Rupture	n=8 (5.5%)
Thrombus without plaque rupture	n=5 (3.1%)
Intra-Plaque Cavity	n=31 (21.4%)
Layered Plaque	n=19 (13.1%)
Intimal Bump (Spasm)	n=3 (2.1%)
SCAD	n=1 (0.7%)

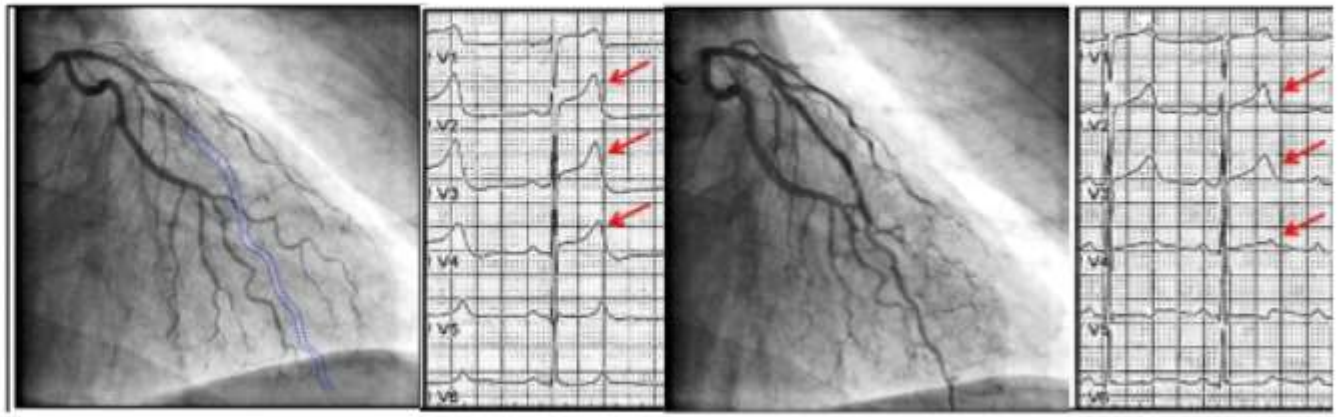


Reynolds HR et al. Circulation. 2021;143(7):624-640

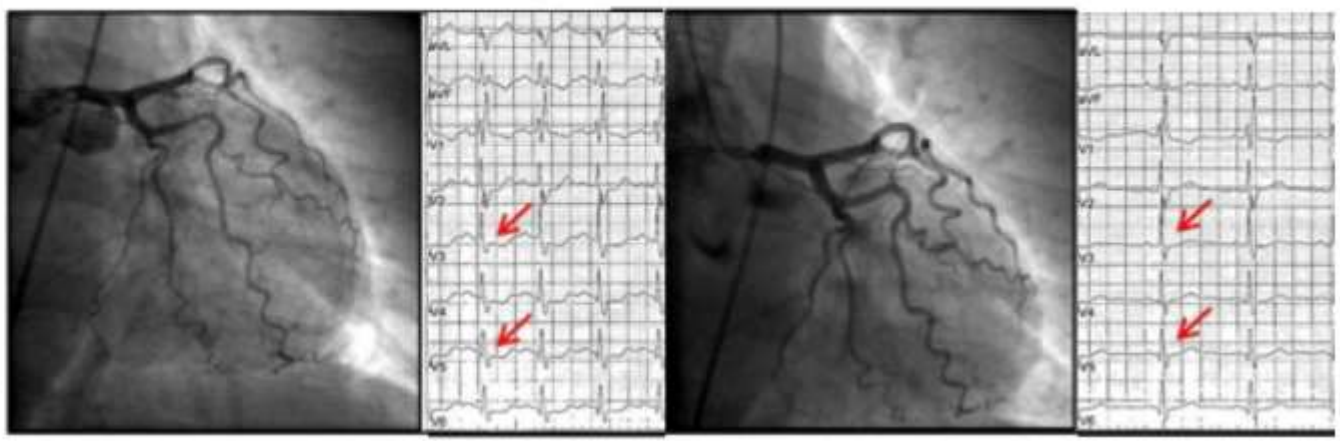
N=96 patients with NSTEMI and no obstructive CAD



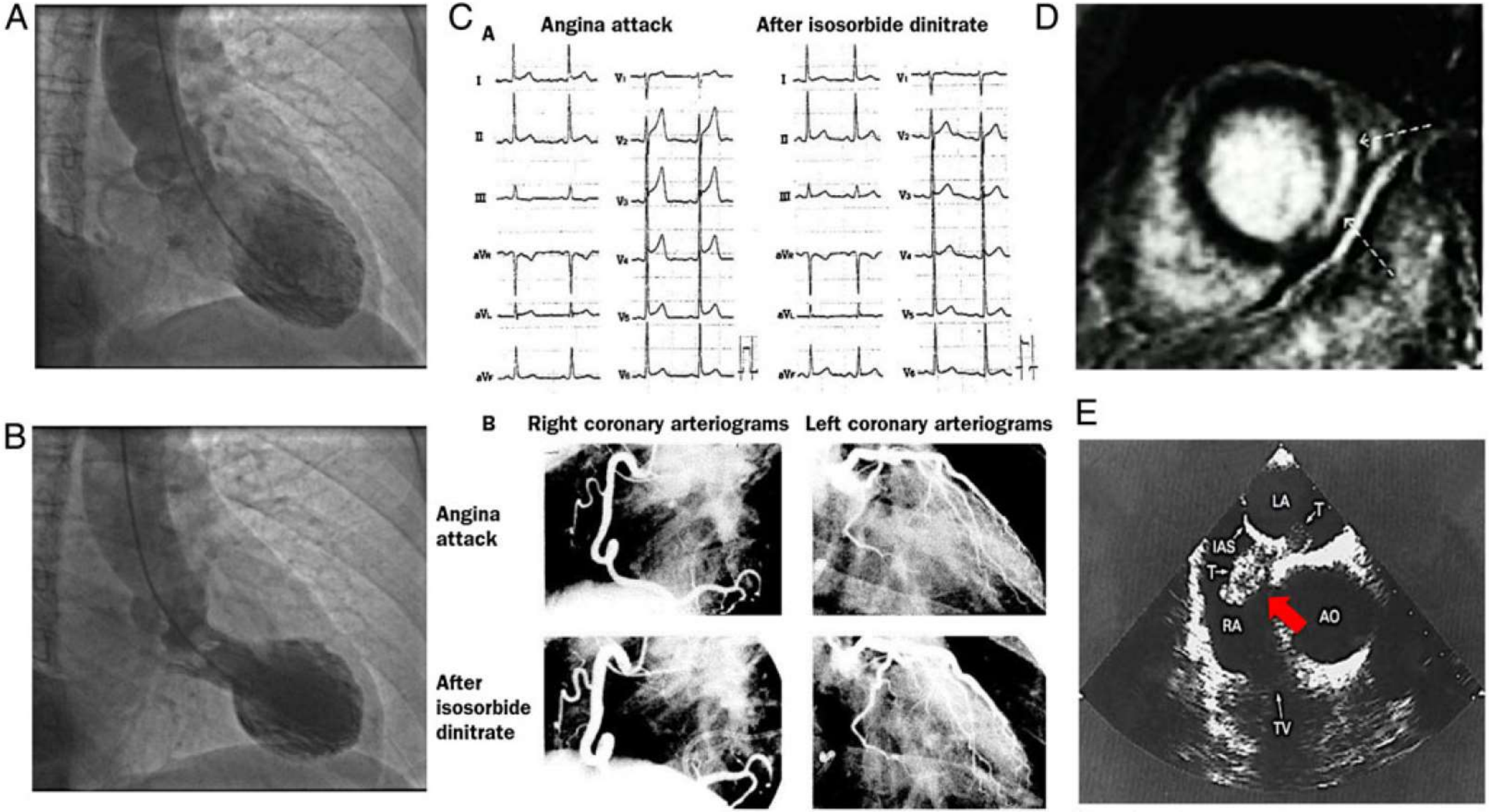
Epicardial Vasospasm



Microvascular Vasospasm



Pirozzolo G et al. Clinical Research in Cardiology. 2020;109:246-254



European Heart Journal (2015) 36, 475–481

IMMEDIATE THERAPEUTIC CONSIDERATIONS FOR MINOCA

ON-GOING MYOCARDIAL ISCHEMIA

INVASIVE THERAPY

- MCS to Reduce Demand
- Stent
- CABG

NO ON-GOING MYOCARDIAL ISCHEMIA

INTRAVASCULAR IMAGING

HIGH LIKLIHOOD OF ACUTE CLOSURE *

INVASIVE THERAPY

- Stent?
- CABG?

LOW LIKLIHOOD OF ACUTE CLOSURE *

PHARMACOLOGIC THERAPY

- Anti-thrombotics
- Anti-platelets

* Will Require Research

EROSION STUDY

Patients presenting with ACS (492)
Enrolled Patients (60)
96% Presented with STEMI

Inclusion Critera

1. Erosion Diagnosed by OCT
2. <70% Diameter Stenosis by OCT
3. TIMI 3 Flow
4. Symptom Free

Eur Heart J. 2017 Mar 14;38(11):792-800

EROSION STUDY

Importance of Lesion Characterization

Treatment

Anti-coagulation for 3 days
DAPT – Aspirin and Ticagrelor
No patients stented during hospitalization

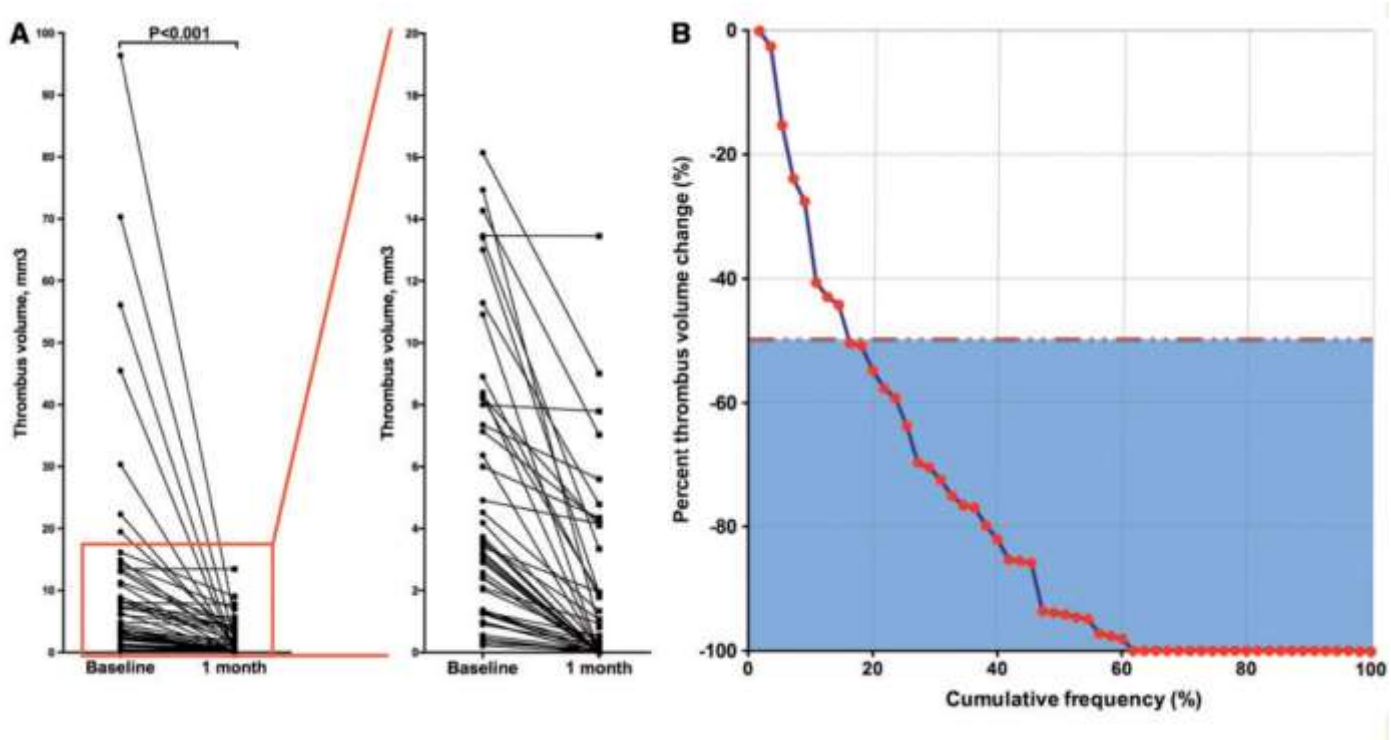
Outcome

55 Patients Completed Follow Up

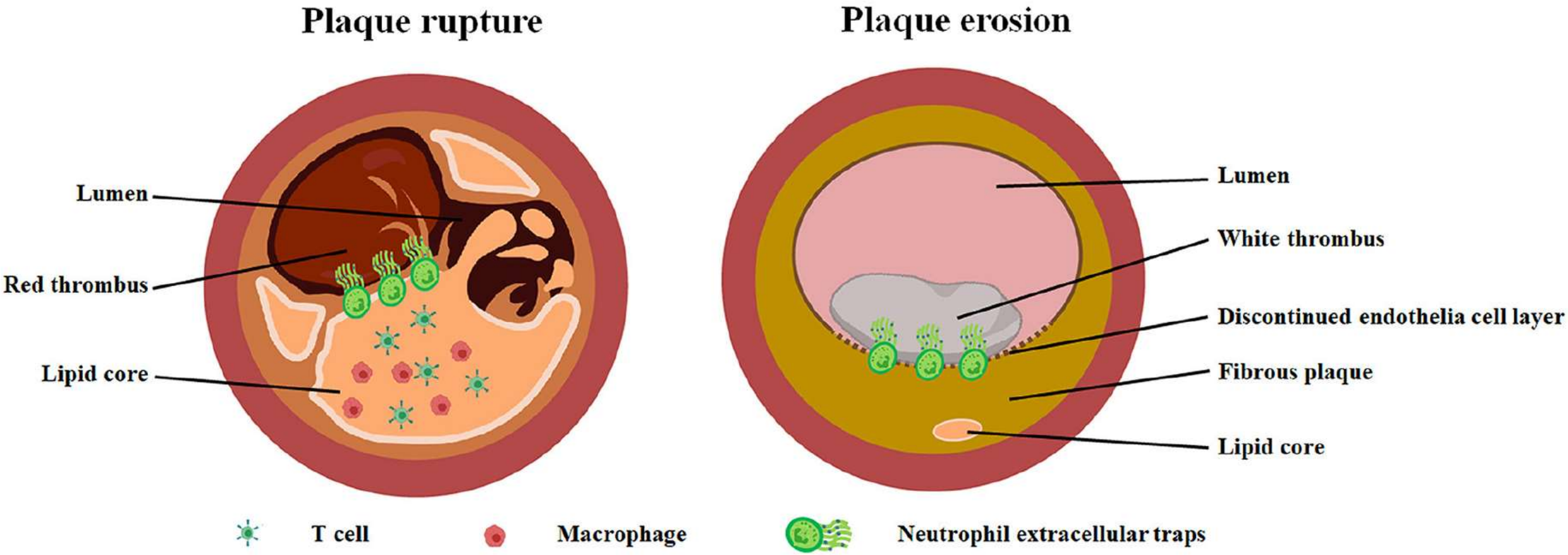
1/55 died of GI Bleeding

1/55 required revascularization (PCI)

Plaque Volume

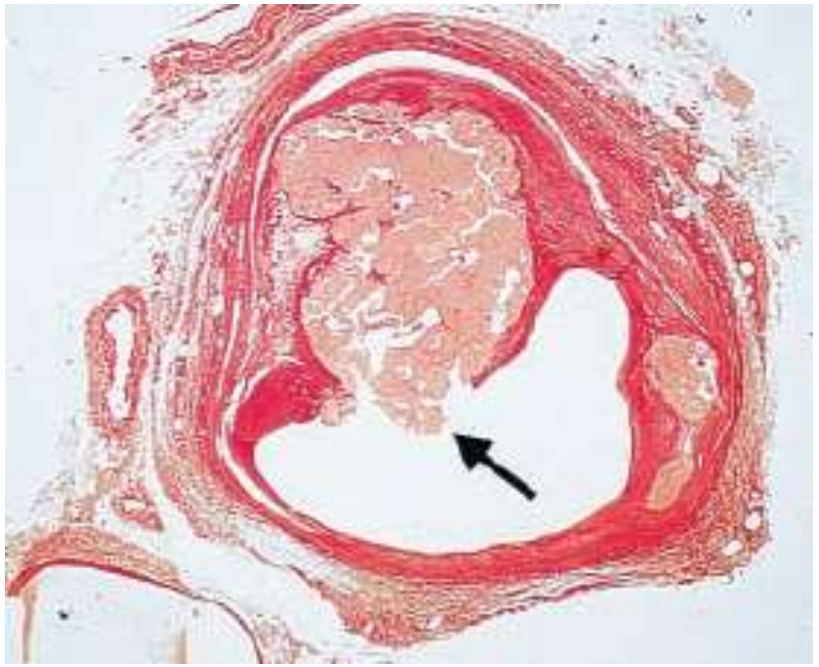


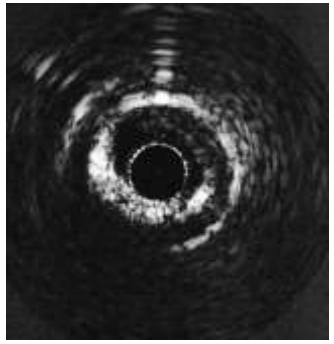
Eur Heart J. 2017 Mar 14;38(11):792-800

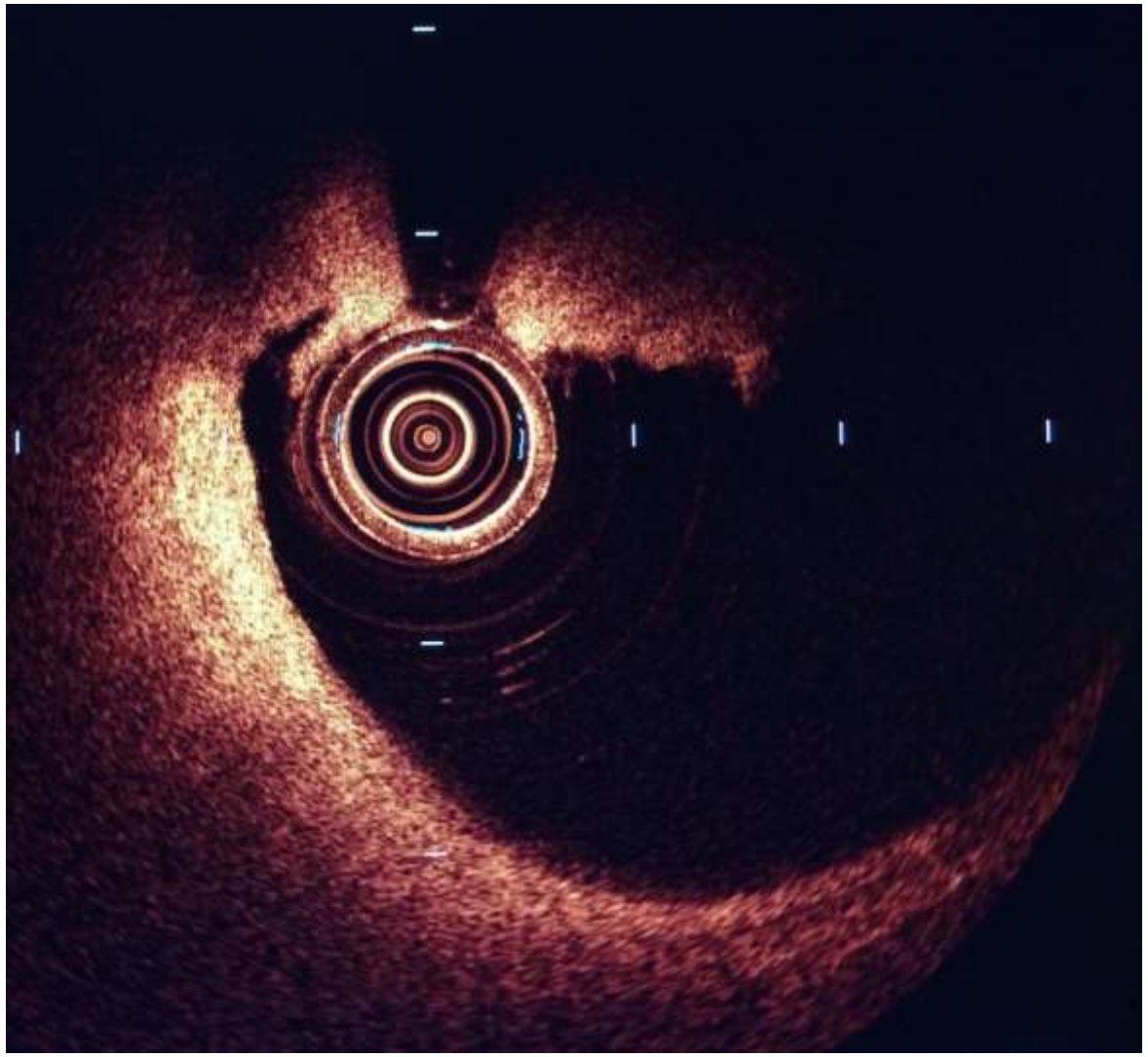


Front Cardiovasc Med. 2021 Sep 28;8:711453.

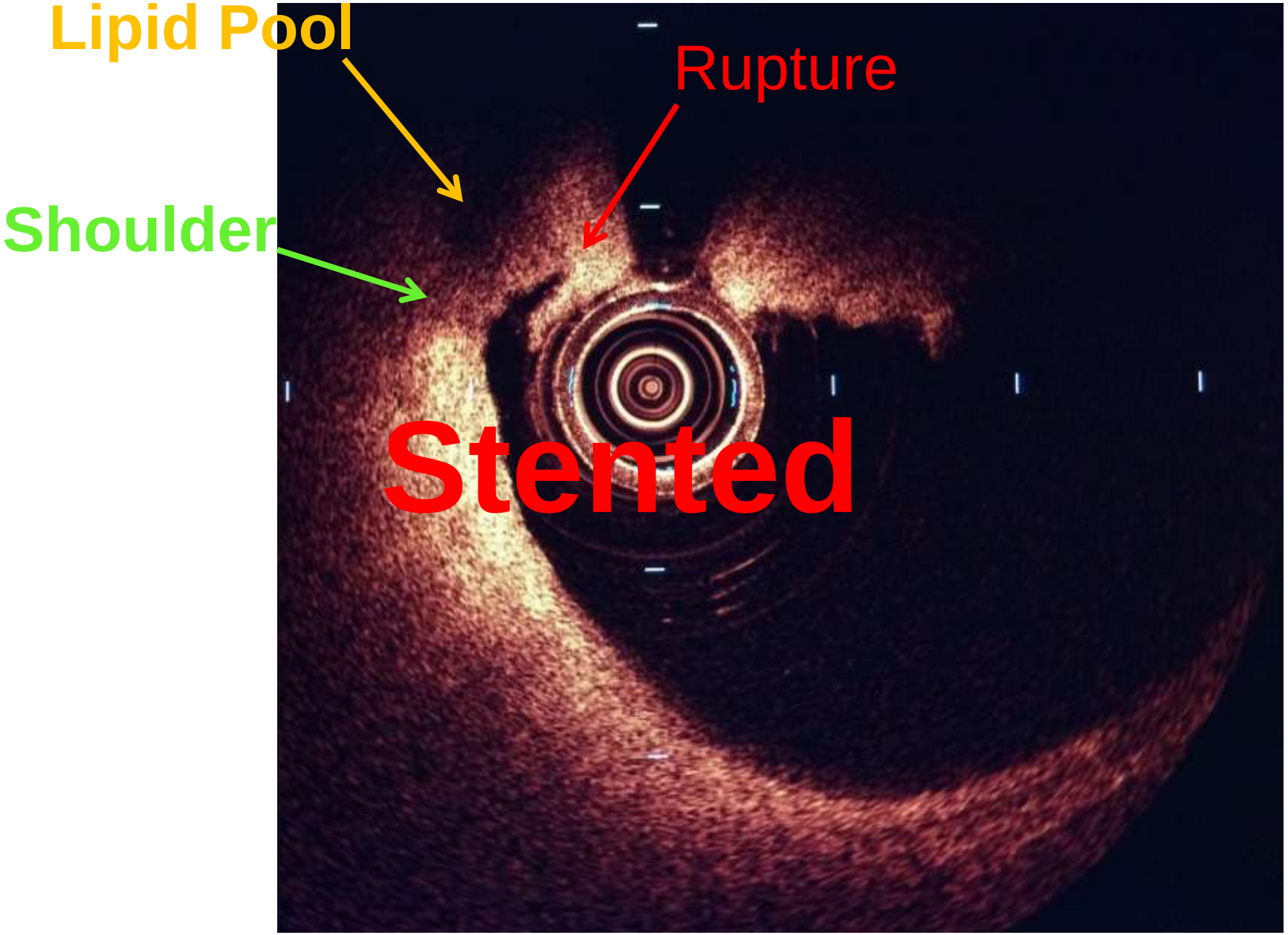
Techniques Characterizing the Coronary Atherosclerotic Plaque: Influence on Clinical Decision Making?







JACC Vol. 36, No. 1, July 2000:13–21

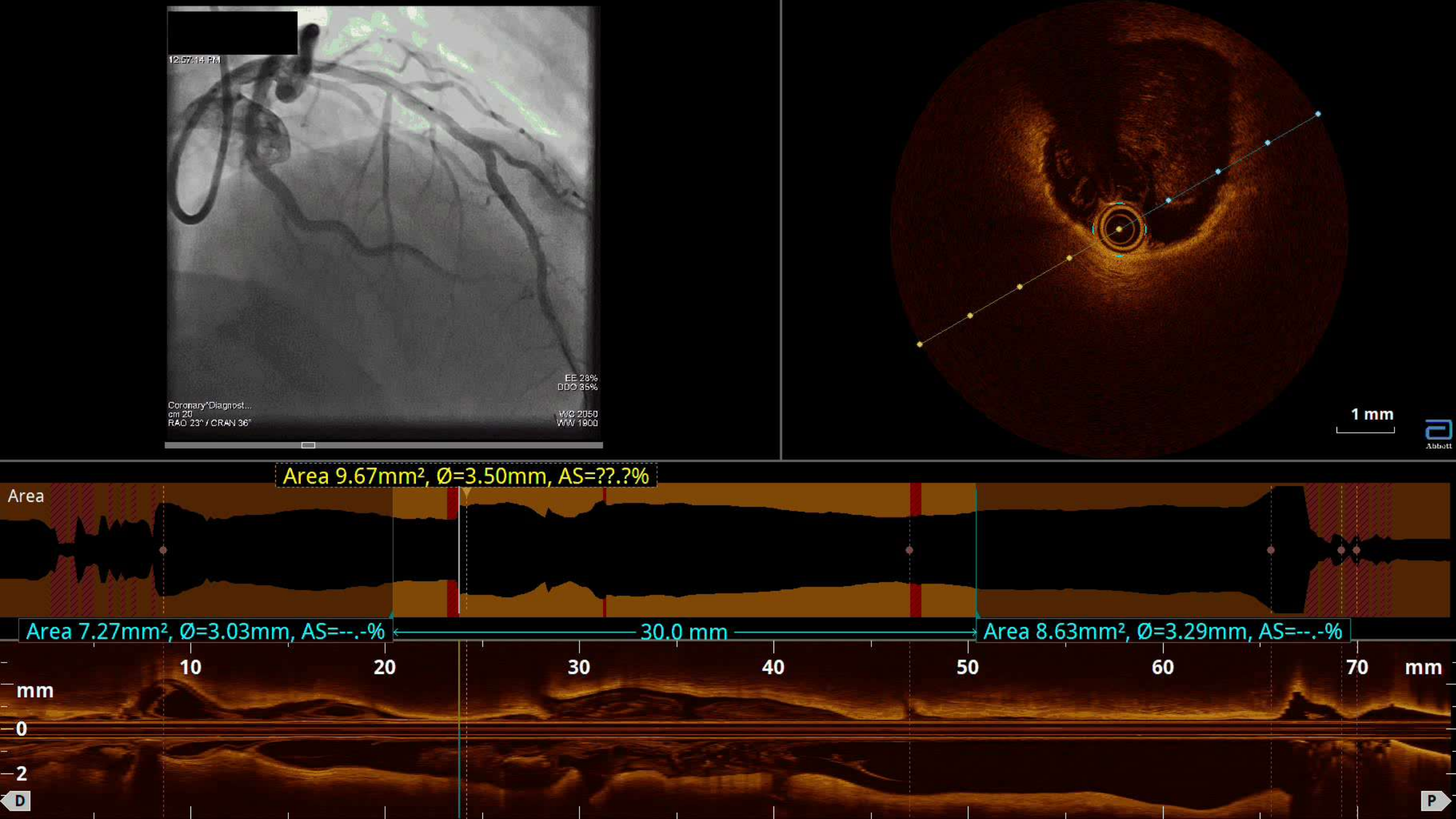

Lipid Pool
Rupture
Shoulder
Stented

Questions

A. Stent the 27-year-old patients's RCA
B. Stent the 27-year-old patient's LAD
C. Stent the 45-year-old patient's LAD
D. Medical Therapy

27-year-old man

Medical Therapy for one Month:
Eliquis
Ticagrelor 90mg bid
Aspirin 81mg daily
Atorvastatin
Toprol XL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EE 28%
DDO 35%
Coronary^Diagnost...
cm 20
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W/C 2050
WW 1900
1 mm
Abbott
Area 9.67mm², Ø=3.50mm, AS=??.?%
Area
Area 7.27mm², Ø=3.03mm, AS=--.-%
30.0 mm
Area 8.63mm², Ø=3.29mm, AS=--.-%
10
20
30
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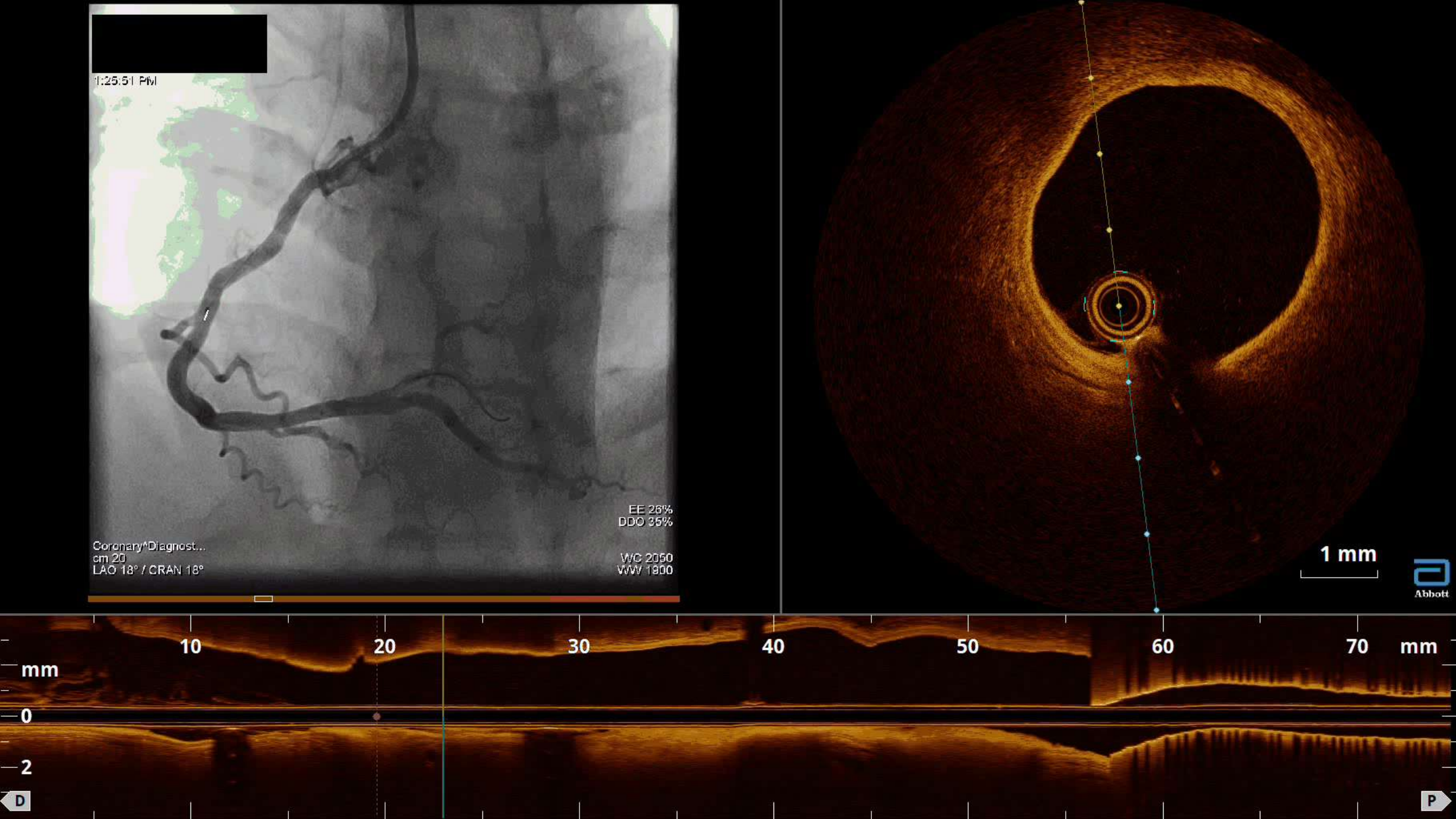
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EE 26%
DDO 35%
Coronary^Diagnost...
cm 20
LAO 18° / CRAN 18°
WC 2050
WW 1900
1 mm
Abbott
10
20
30
40
50
60
70
mm
mm
0
2
D
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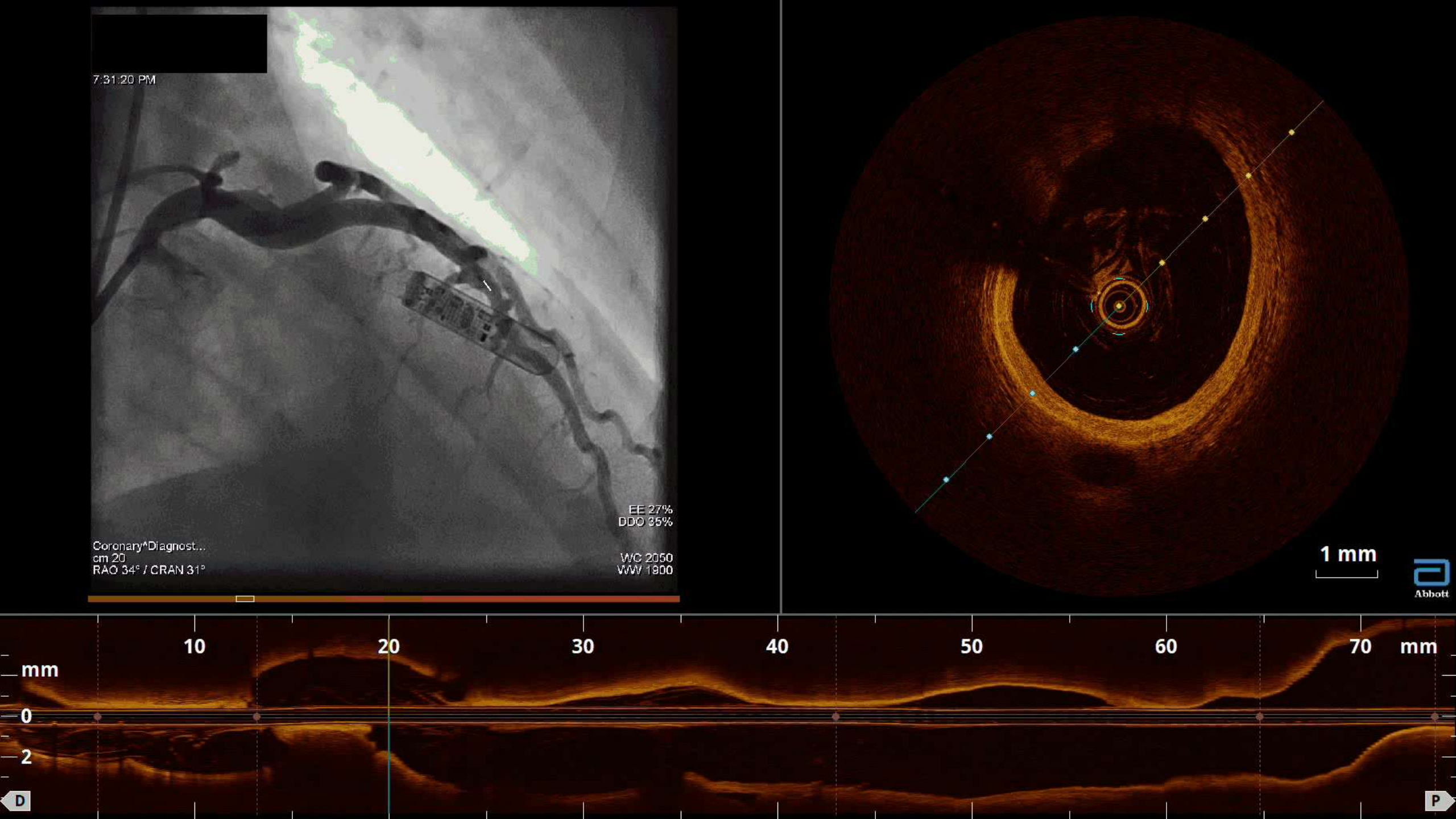
45-year-old man

Medical Therapy for one Month:
Eliquis
Ticagrelor 90mg bid
Aspirin 81mg daily
Atorvastatin
Toprol XL
Monitoring for Arrhythmia


7:31:20 PM
EE 27%
DDO 35%
Coronary^Diagnost...
cm 20
RAO 34° / CRAN 31°
WC 2050
WW 1900
1 mm
Abbott
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Conclusions

MINOCA is found in about 4-6% of patients undergoing angiography at presentation of MI

The Pathophysiology is Heterogeneous

Medications for more “typical” MI (caused by obstructive lesions) do not seem to be as effective

Invasive therapy using stents may **not be needed** in some cases

Careful evaluation using intra-vascular imaging; CMR; provocative pharmacologic testing are needed

Research to fully evaluate the prevalence and impact in specific patient populations

Large outcome trials needed to evaluate optimal therapy

- **Medical Therapy - Beta Blockers; ACE/ARB; Statins; ?Antiplatelet; ?AC**
- Invasive Therapy – Decision for immediate stenting*

Questions

Which of the following is true regarding medical treatment for MINOCA

A. Physicians are more likely to treat MINOCA with medical therapy than traditional MI because PCI is not done

B. Dual anti-platelet therapy has been shown to reduce outcomes

C. ACE-I has not been shown to improve outcomes

D. Treatment with beta blockers after MI is universally supported

E. Statins improve outcomes

Which of the following is true about MINOCA

A. More common is patients who smoke and thus explains the vasomotor dysfunction in these patients

B. Overall prevalence is low and is about 3%

C. MINOCA is a “working diagnosis”

D. It has a worse prognosis than patient who present with MI and obstructive CAD

E. Culprit lesions associated with MINOCA should always be stented