

# SIGNS AND SYMPTOMS OF CARDIOVASCULAR SYSTEM DISEASES (syndrome of acute and chronic coronary insufficiency)

LECTURE IN INTERNAL MEDICINE PROPAEDEUTICS

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# Plan of the lecture



## Coronary insufficiency

- Definition
- Classification
- Causes
- Pathophysiology
- Risk factors
- Clinical picture
- Diagnosis

# Definition

Coronary insufficiency (CI) is the state in which an imbalance occurs between the oxygen supply and demand, which prevents adequate maintenance of the metabolic needs of the myocardium, resulting in ischemia of several degrees of intensity

# USMLE TEST

An autopsy is being performed on an elderly man who died from a myocardial infarction. Biopsy of the heart is likely to reveal necrosis most similar to necrosis seen in which of the following scenarios?

1. The central nervous system following a stroke
2. The lung following a tuberculosis infection
3. Acute pancreatitis resulting from release of enzymatically active enzymes into the pancreas
4. A region of kidney where blood flow is obstructed
5. An abscess

# USMLE TEST

The correct answer is 4

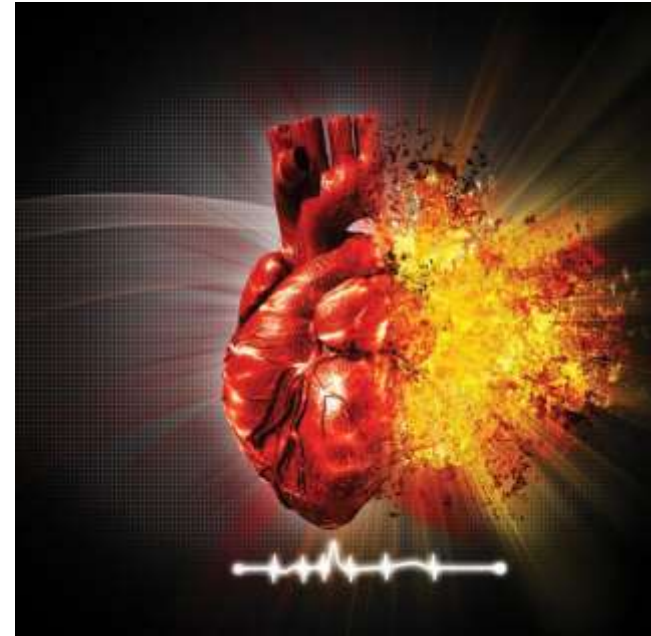
In a myocardial infarction (MI), the type of necrosis that presents is coagulative necrosis. Coagulative necrosis is also seen in kidney infarcts.

Incorrect answers:

1: Liquefactive necrosis is seen in the central nervous system due to hypoxia, 2: Caseous necrosis is the type of necrosis seen following a M. tuberculosis lung infection, 3: Acute pancreatitis due to release of enzymatically active enzymes into the pancreas results in fat necrosis., 4: Liquefactive necrosis is seen in abscesses (due to enzymes released from neutrophils).

# Classification 1

- acute (unstable angina, acute coronary syndromes)
- chronic (stable angina)



# Classification 2

- Acute coronary syndromes (ACS)) are named according to the appearance of the ECG
  - Non-ST segment elevation myocardial infarction (NSTEMI)
  - ST- segment elevation myocardial infarction (STEMI)

## Classification 3

- ACS should be distinguished from stable angina, which develops during exertion and resolves at rest
- ACS occur suddenly, often at rest or with minimal exertion, or at lesser degrees of exertion than the individual's previous angina ("crescendo angina")
- New onset angina is also considered unstable angina, since it suggests a new problem in a coronary artery

## Classification 4

- Chronic coronary insufficiency (stable angina (angina pectoris, angina)) is the sensation of chest pain, pressure, or squeezing, often due to ischemia of the heart muscle from obstruction or spasm of the coronary arteries
- The term derives from the Latin *angere* ("to strangle")
- There is a weak relationship between severity of pain and degree of oxygen deprivation in the heart muscle

## Classification 5

- Worsening ("crescendo") angina attacks, sudden-onset angina at rest, new onset effort angina and angina lasting more than 15 minutes are symptoms of unstable angina (sudden-onset angina at rest and angina lasting more than 15 minutes usually grouped with similar conditions as the acute coronary syndrome)



# USMLE TEST

A 64-year-old male with a past medical history of obesity, diabetes, hypertension, and hyperlipidemia presents with an acute onset of nausea, vomiting, diaphoresis, and crushing substernal chest pain. Vital signs are temperature 37° C, HR 110, BP 149/87, and RR of 22 with an oxygen saturation of 99% on room air. Physical exam reveals a fourth heart sound (S4), and labs are remarkable for an elevated troponin. EKG is shown below. The pathogenesis of the condition resulting in this patient's presentation involves:

1. Genetic inheritance of a mutation in  $\beta$ -myosin or troponin expressed in cardiac myocytes,
2. A fully obstructive thrombus at the site of a ruptured, ulcerated atherosclerotic plaque,
3. A partially occlusive thrombus at the site of a ruptured, ulcerated atherosclerotic plaque
4. Destruction of the vasa vasorum caused by vasculitic phenomena,
5. A stable atheromatous lesion without overlying thrombus

# USMLE TEST

The correct answer is 2

A fully obstructive thrombus at the site of a ruptured atherosclerotic plaque has caused an ST-elevation myocardial infarction (STEMI) in this patient.

Incorrect answers:

1: Autosomal dominant inheritance of mutations in sarcomeres (commonly the heavy chain of beta-myosin or troponin) are the underlying cause of hypertrophic cardiomyopathy, 3: A partially obstructive thrombus is the underlying cause of unstable angina, 4: Destruction of the vasa vasorum is the underlying mechanism of syphilitic heart disease, 5: A stable atheromatous lesion without overlying thrombus is the cause of stable angina.

# Canadian Cardiovascular Society Functional Classification of Angina Pectoris

Class	Definition	Specific Activity Scale
I	Ordinary physical activity (eg, walking and climbing stairs) does not cause angina; angina occurs with strenuous, rapid, or prolonged exertion at work or recreation.	Ability to ski, play basketball, jog at 5 mph, or shovel snow without angina
II	Slight limitation of ordinary activity. Angina occurs on walking or climbing stairs rapidly, walking uphill, walking or stair climbing after meals, in cold, in wind, or under emotional stress, or only during the few hours after awakening, when walking more than 2 blocks on level ground, or when climbing more than 1 flight of stairs at a normal pace and in normal conditions.	Ability to garden, rake, roller skate, walk at 4 mph on level ground, have sexual intercourse without stopping
III	Marked limitation of ordinary physical activity. Angina occurs on walking 1 to 2 blocks on level ground or climbing 1 flight of stairs at a normal pace in normal conditions.	Ability to shower or dress without stopping, walk 2.5 mph, bowl, make a bed, play golf
IV	Inability to perform any physical activity without discomfort.	Anginal symptoms may be present at rest. Inability to perform activities requiring 2 or fewer metabolic equivalents without angina

# Causes

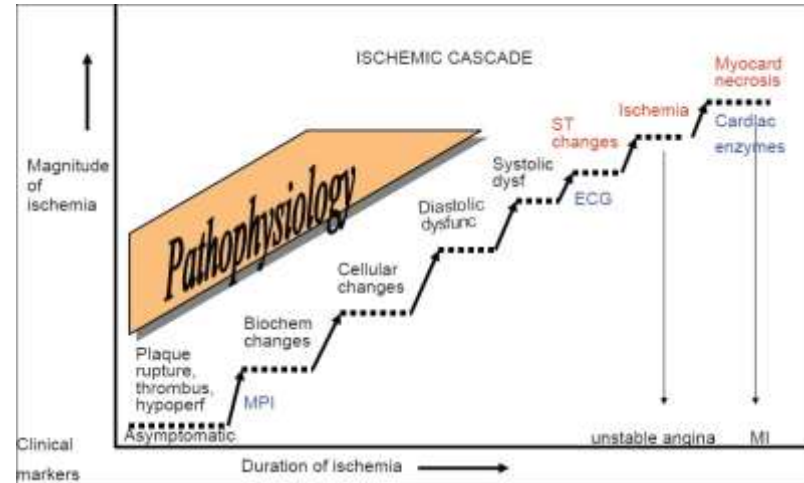
- Atherosclerotic obstructive coronary insufficiency (Coronary Artery Disease - CAD) –main cause
- Cardiac valvular diseases (aortic stenosis)
- Hypertrophic cardiomyopathy
- Microvasculature diseases (diabetes mellitus, syndrome X)
- Anomalous origin of coronary arteries, and coronary fistulas

# Pathophysiology

## Fundamental components

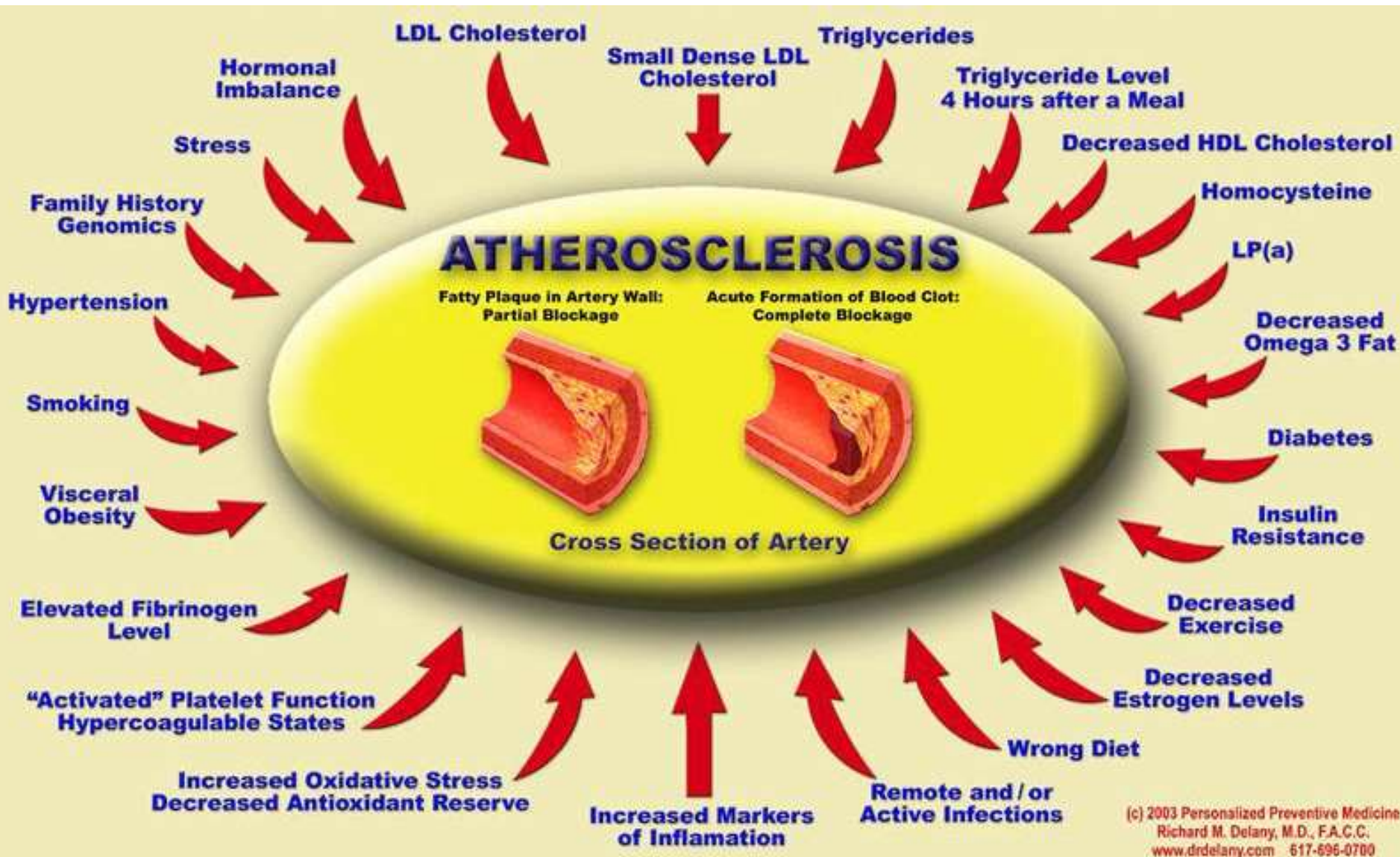
1. Endothelial dysfunction
2. Obstruction of the lumen of the vessel
3. Thrombosis at the location of the lesion

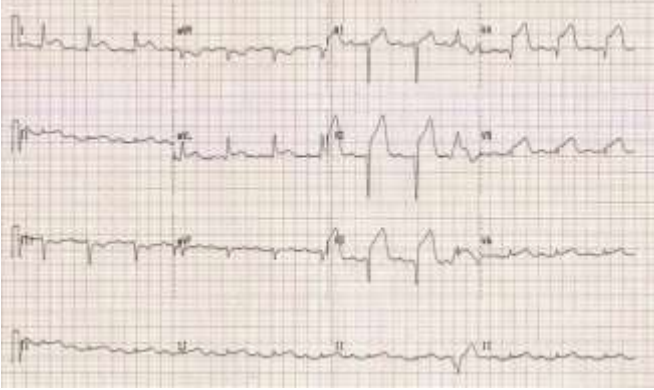
*The decline of coronary reserve starts when lesions occupy at least 70% of the vessel diameter*



**Depicts the myocardial ischemic cascade and stepwise changes, which occur at molecular and tissue level.**

# Risk factors





# USMLE TEST

A 60-year-old woman with history of type I diabetes currently on hormone replacement therapy is seen in your ED complaining of "bad indigestion", dizziness and nausea for the past several hours. Vitals are T98.9, HR 102, BP 130/100, RR 25 and she is mildly diaphoretic. An EKG is shown in Figure A. At what time point does the injury to her affected cells become irreversible?

1. 5 seconds
2. 60 seconds
3. 10 minutes
4. 30 minutes
5. 1 hour

# USMLE TEST

The correct answer is 4

The woman in question is having an ST-elevation myocardial infarction (STEMI) resulting from reduced blood flow to cardiomyocytes. After 30 minutes of ischemia, injury to cardiomyocytes is irreversible.

Incorrect answers:

1-3: Up until 30 minutes, ischemic effects on cardiomyocytes are reversible.

5: Damage to cardiomyocytes is irreversible after thirty minutes.

# Clinical picture

- Chest pain or discomfort
- Shortness of breath
- Heart failure
- Irregular heartbeat
- Nausea
- Sweating
- Decreased exercise tolerance
- Etc.



# Clinical picture from William Heberden 1

But there is a disorder of the breast marked with strong and peculiar symptoms, considerable for the kind of danger belonging to it, and not extremely rare, which deserves to be mentioned more at length.



WILLIAM HEBERDEN, 1772

# Clinical picture from William Heberden 2

The seat of it and the sense of strangling and anxiety with which it is attended, may make it not improperly be called angina pectoris.



**WILLIAM HEBERDEN, 1772**

## Clinical picture from William Heberden 3

Those who are afflicted with it, are seized while they are walking (more especially if it be uphill, and soon after eating) with a painful and most disagreeable sensation in the breast, which seems as if it would extinguish life if it were to increase or to continue; but the moment they stand still, all this uneasiness vanishes.



WILLIAM HEBERDEN, 1772

## Clinical picture from William Heberden 4

In all other respects, the patients are, at the beginning of this disorder, perfectly well, and in particular have no shortness of breath, from which it is totally different. The pain is sometimes situated in the upper part, sometimes in the middle, sometimes in the bottom of the os. sterni, and often more inclined to the left than to the right side. It likewise very frequently extends from the breast to the middle of the left arm.



WILLIAM HEBERDEN, 1772

# Clinical picture from Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Blood Vessels, 1953 1

In this syndrome the major symptom is thoracic pain, which is precipitated usually by effort but sometimes by excitement, a heavy meal or exposure to cold.

The pain is usually substernal or just to the left of the sternum.

Occasionally the pain is epigastric and in rare instances it may be localized in the neck or the left arm or shoulder.

# Clinical picture from Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Blood Vessels, 1953 2

There is a tendency for the pain to radiate, most frequently to the left shoulder and arm and occasionally to the fingers. Less frequently it may radiate to the neck, jaw and teeth, to the back, upper abdomen, or to the right shoulder and arm.

At times the pain will start at one of these points before focusing on the anterior surface of the chest. The intensity varies from a slight sense of heaviness to a severe crushing pain.

# Clinical picture from Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Blood Vessels, 1953 3

Since the precipitating cause is commonly physical exertion, rest usually causes the pain to subside.

The length of the episode, therefore, is relatively short.

Occasionally an attack may come on while the patient is at rest or even when asleep.

The pain is often accompanied by a sense of choking or inability to breathe which is also relieved by rest.

The patient will often complain of flatulence as well.

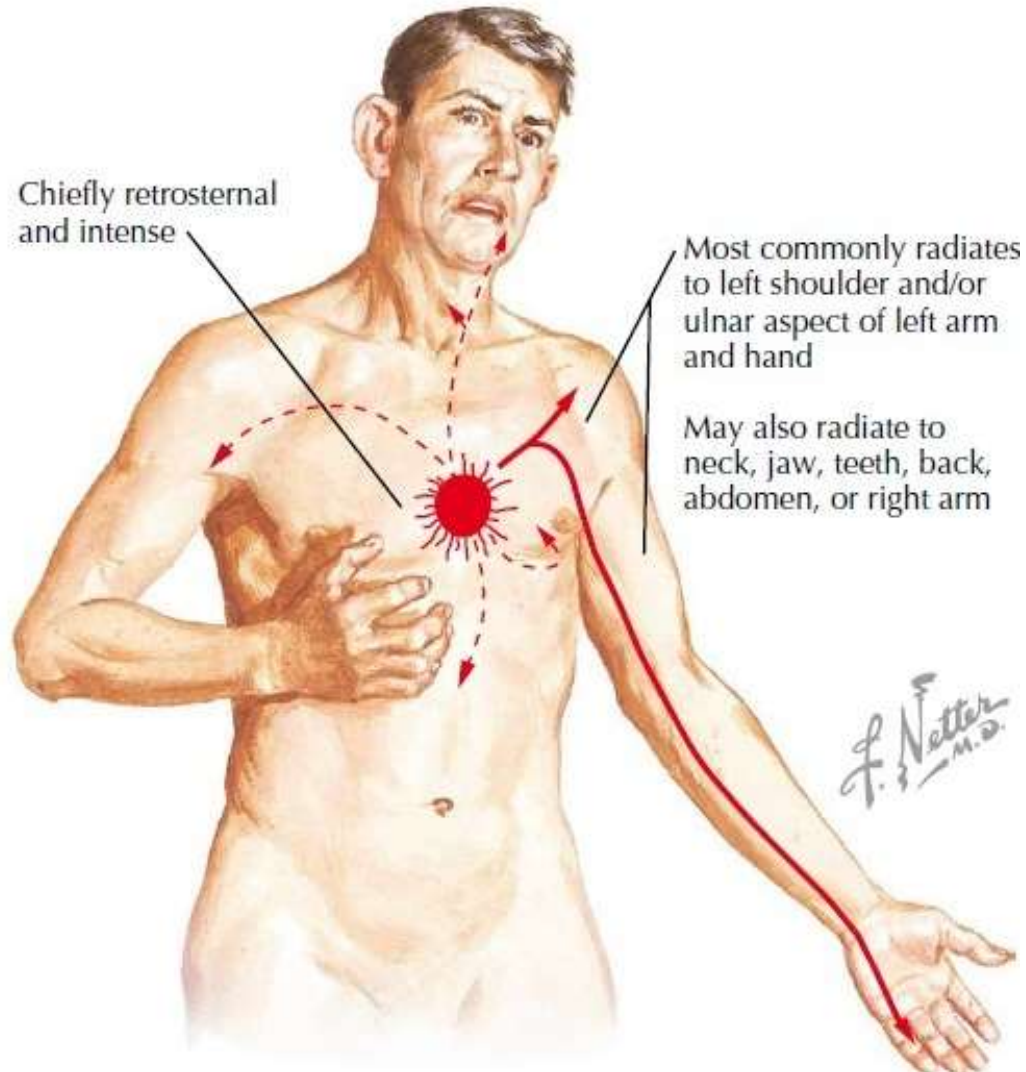
# Clinical picture from Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Blood Vessels, 1953 4

If the attack is not relieved by rest or a nitrite and lasts for an hour or more, and especially if it is accompanied by circulatory collapse, myocardial infarction should be strongly suspected.

Occasionally the pain of myocardial infarction may be identical with the pain of the anginal syndrome.

The associated symptomatology and the subsequent course will determine the diagnosis.

# Clinical picture



# Clinical picture

## Pain (Chest)

		Cardiac	Pleuritic	Traumatic
<b>D</b>	<b>Description:</b> <ul style="list-style-type: none"> <li>• Can you describe the pain to me? (You need to determine it's nature.)</li> <li>• Is it there all the time ? Does it come and go?</li> <li>• Have you ever had this pain before?</li> <li>• What was it that time?</li> </ul>	<ul style="list-style-type: none"> <li>• Heavy</li> <li>• Tight</li> <li>• Squeezing</li> <li>• Dull</li> </ul>	<ul style="list-style-type: none"> <li>• Sharp</li> <li>• Catching</li> <li>• Stabbing</li> </ul>	<ul style="list-style-type: none"> <li>• Sharp</li> <li>• Catching</li> <li>• Stabbing</li> </ul>
<b>O</b>	<b>Onset:</b> <ul style="list-style-type: none"> <li>• When did it start?</li> <li>• What were you doing at the time?</li> <li>• Did it come only suddenly or slowly?</li> </ul>	<ul style="list-style-type: none"> <li>• Gradual (Angina)</li> <li>• Sudden (UA/Infarct)</li> <li>• With Exercise (Angina)</li> <li>• At Rest (UA/Infarct)</li> </ul>	<ul style="list-style-type: none"> <li>• Gradual (Infection)</li> <li>• Sudden (Pneumothorax)</li> </ul>	<ul style="list-style-type: none"> <li>• Gradual (post trauma)</li> <li>• Sudden (post trauma)</li> </ul>
<b>L</b>	<b>Location:</b> <ul style="list-style-type: none"> <li>• "Take one finger and point to the pain?"</li> <li>• "Does it extend anywhere else?"</li> <li>• If well localised palpate and visualise</li> </ul>	<ul style="list-style-type: none"> <li>• Poorly localised</li> <li>• Chest to back to jaw</li> <li>• Rarely changes with palpation</li> </ul>	<ul style="list-style-type: none"> <li>• Well localised</li> <li>• Usually chest wall</li> <li>• Usually changes with palpation / ventilation</li> </ul>	<ul style="list-style-type: none"> <li>• Well defined</li> <li>• Usually chest wall</li> <li>• Changes with palpation / ventilation</li> </ul>
<b>O</b>	<b>Other Signs and Symptoms:</b> <ul style="list-style-type: none"> <li>• "Do you feel nauseous? (If yes) "Have you vomited"</li> <li>• "Do you feel SOB?"</li> <li>• "Have you noticed palpitations?"</li> <li>• "What came first, the discomfort or the (OSS)?"</li> </ul>	<ul style="list-style-type: none"> <li>• SOB %</li> <li>• Diaphoresis %</li> <li>• Palpitations %</li> </ul>	<ul style="list-style-type: none"> <li>• SOB (on exertion)</li> <li>• Chest infection (prodromal)</li> </ul>	<ul style="list-style-type: none"> <li>• SOB (on exertion)</li> </ul>
<b>R</b>	<b>Relief:</b> <ul style="list-style-type: none"> <li>• "Have you taken anything for the discomfort? (If yes) "Has it helped?"</li> <li>• "Does it usually?"</li> <li>• "Does taking a deep breath make the pain better, worse or no different?"</li> <li>• "Does moving make the pain better, worse or no different?"</li> </ul>	<ul style="list-style-type: none"> <li>• Relieved with Nitrates (Angina)</li> <li>• Unrelieved with Nitrates (UA/Infarct)</li> <li>• Poor relief with NSAIDS</li> <li>• Poor relief with position</li> </ul>	<ul style="list-style-type: none"> <li>• Unrelieved with Nitrates</li> <li>• Mild relief with NSAIDS</li> <li>• Some relief with position</li> </ul>	<ul style="list-style-type: none"> <li>• Unrelieved with Nitrates</li> <li>• Mild relief with NSAIDS</li> <li>• Some relief with position</li> </ul>

# Clinical picture



A man experiences shortness of breath.

# Clinical picture

Courtesy of Jason E. Roediger, CCT, CRAT



Ventricular fibrillation.

# Clinical picture



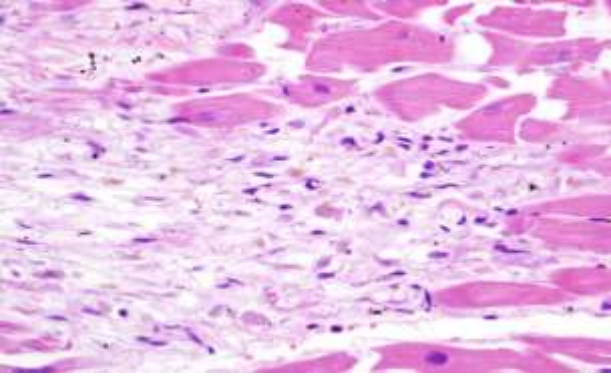
**Nausea.**

<http://cdn1.medicalnewstoday.com/content/images/articles/290/290196/woman-curved-up-with-nausea.jpg>

# Clinical picture



Sweating.



# USMLE TEST

A 62-year-old male collapses while mowing the lawn, and it is determined that he experienced sudden cardiac death. The patient's medical history is significant for a preceding myocardial infarction that was managed conservatively. Posthumous histologic evaluation of the patient's heart reveals extensive granulation tissue replacing dead myocardium as well as early evidence of neovascularization, which is shown in Figure A. How long prior to death did this patient most likely experience his myocardial infarction?

1. 16 hours,
2. 3 days,
3. 8 days,
4. 2 weeks,
5. 2 months

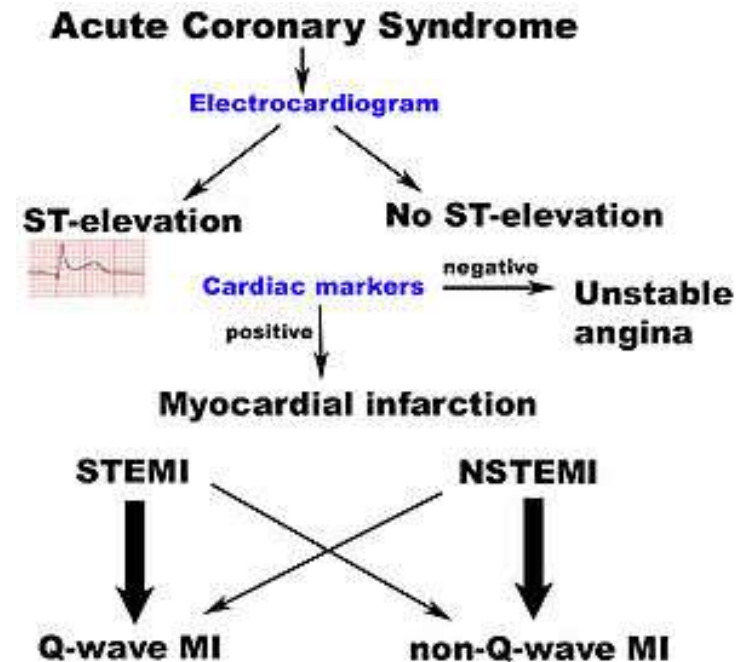
# USMLE TEST

The correct answer is 4: Extensive granulation tissue replacing dead myocardium and early neovascularization are histologic changes expected 10-14 days after a myocardial infarction (MI).

Incorrect answers: 1: Hypereosinophilia, contraction bands, and early coagulative necrosis would be expected 12-24 hours post-MI; neutrophil emigration typically begins after 24 hours, 2: 2-4 days post-MI is associated with extensive coagulation necrosis and neutrophilic infiltrate, 3: Macrophage emigration and infiltration as well as early granulation tissue are expected 5-10 days post-MI, 5: 2 weeks to 3 months post-MI is characterized by collagen deposition by fibroblasts and dense scar formation.

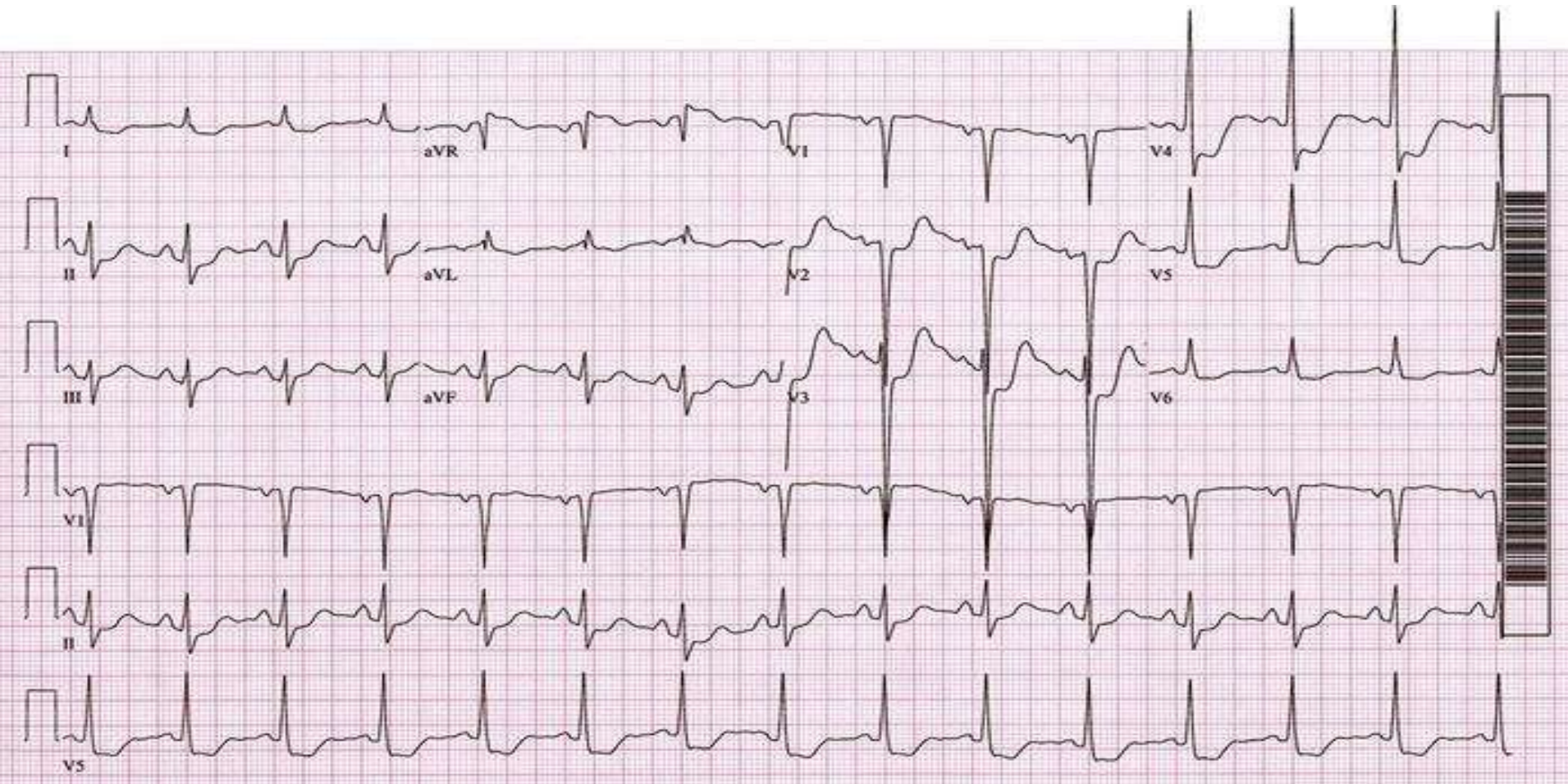
# Diagnosis

- Electrocardiography
- Stress test
- Echocardiography (including stress echocardiography and intravascular ultrasound)
- Coronary angiography
- Radioisotopes
- Visualization
- Blood Test



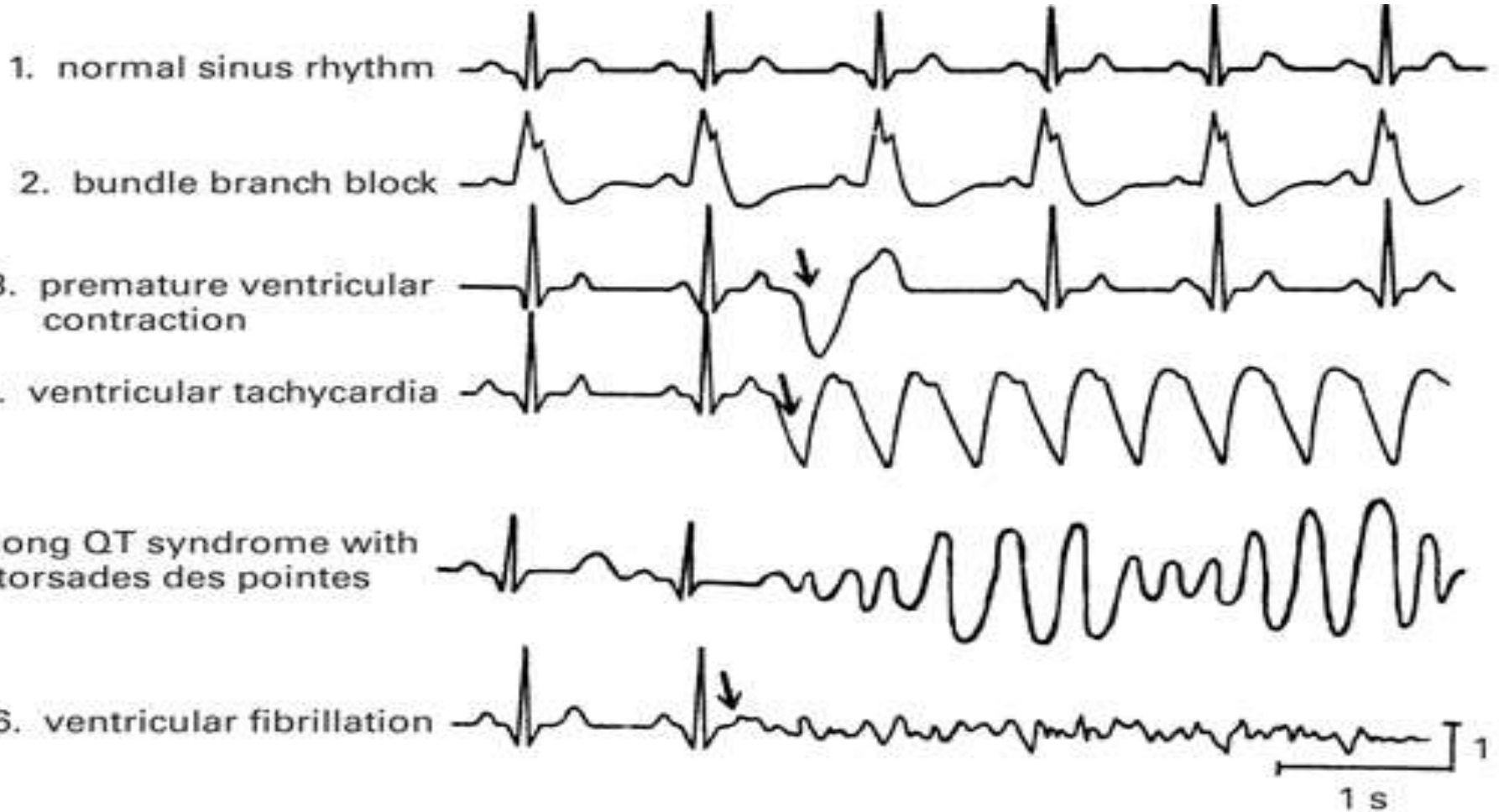
Diagnostics algorithm:  
STEMI ST-elevation Myocardial Infarction,  
NSTEMI – No ST-elevation Myocardial  
Infarction

# Diagnosis: electrocardiography 1



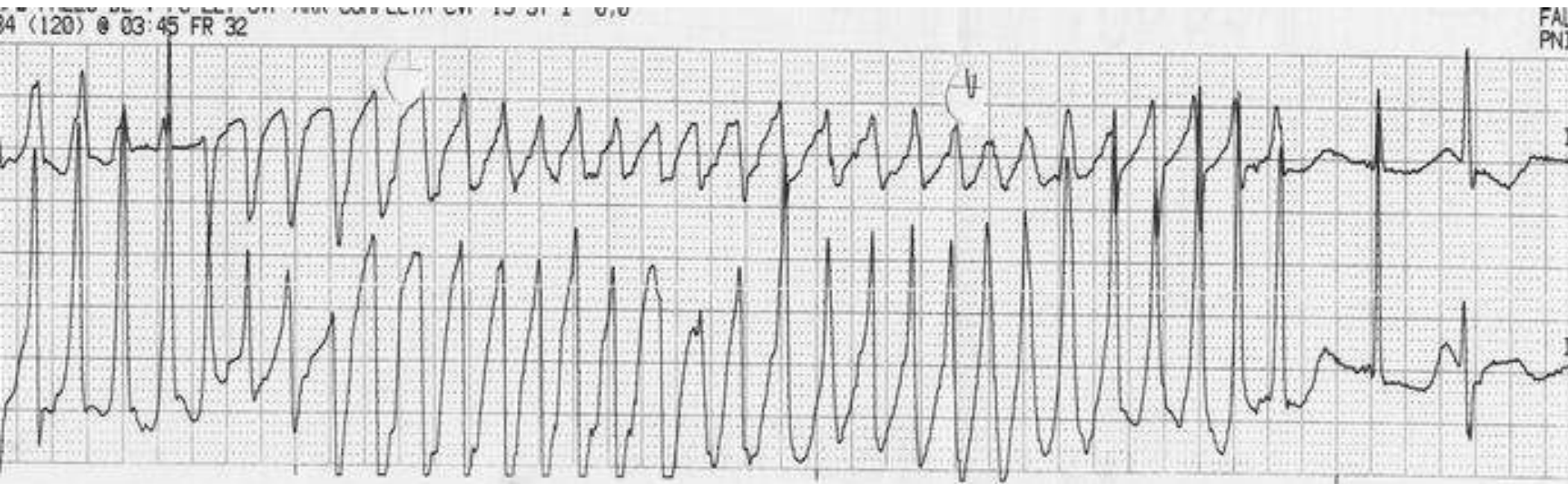
A 12-lead ECG of ischemic anterolateral ST-segment depression in a patient with coronary artery disease.

# Diagnosis: electrocardiography 2



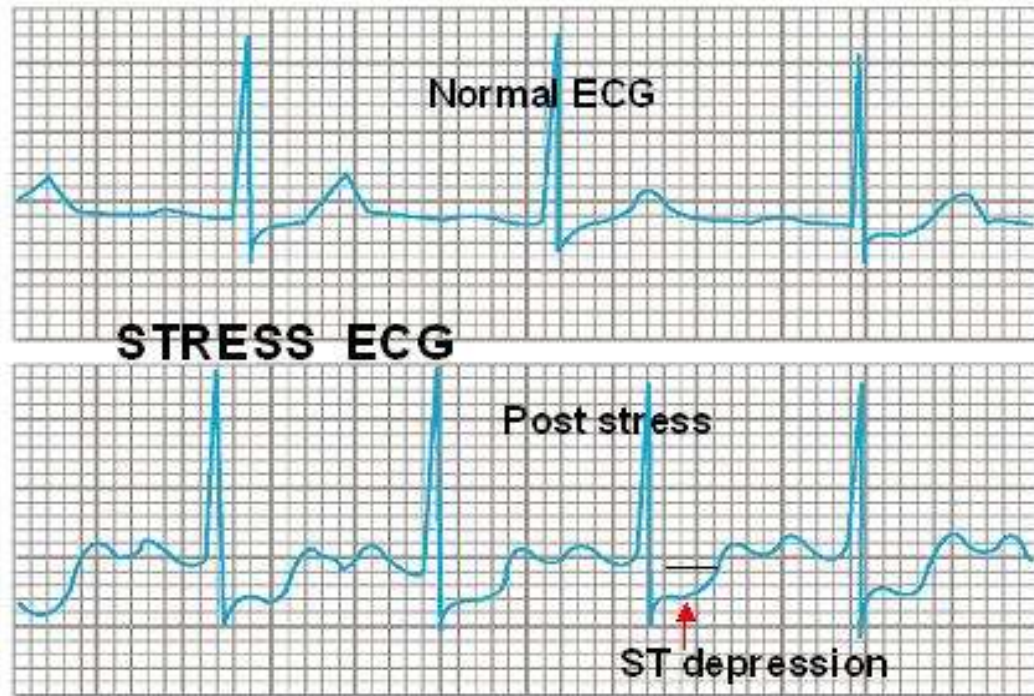
Ventricular arrhythmias.

# Diagnosis: electrocardiography 3



Polymorphic ventricular tachycardia  
in torsade de pointes.

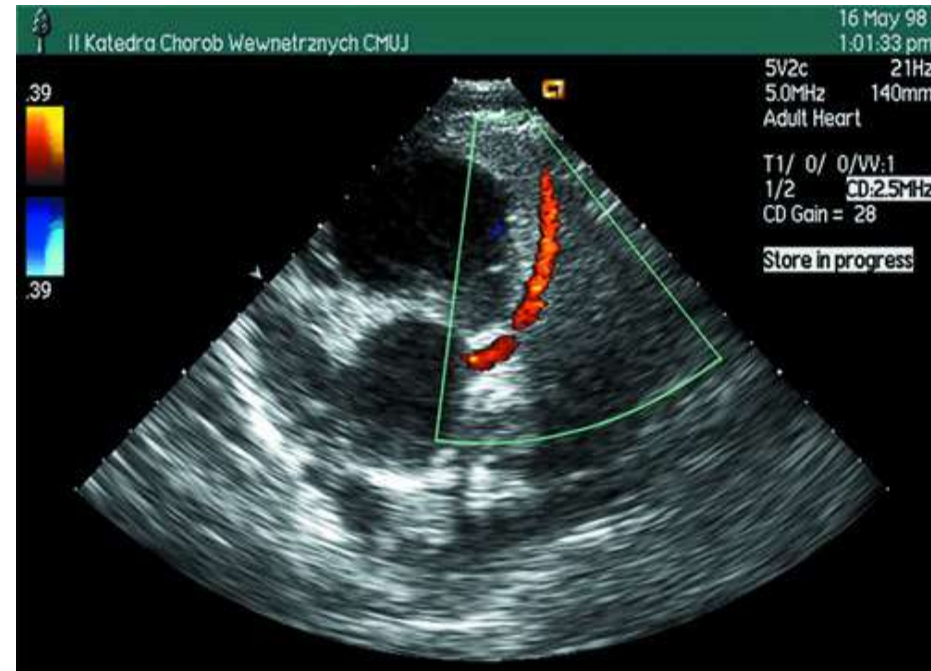
# Diagnosis: stress test



ST-segment depression confirms ischemia  
and positive stress test

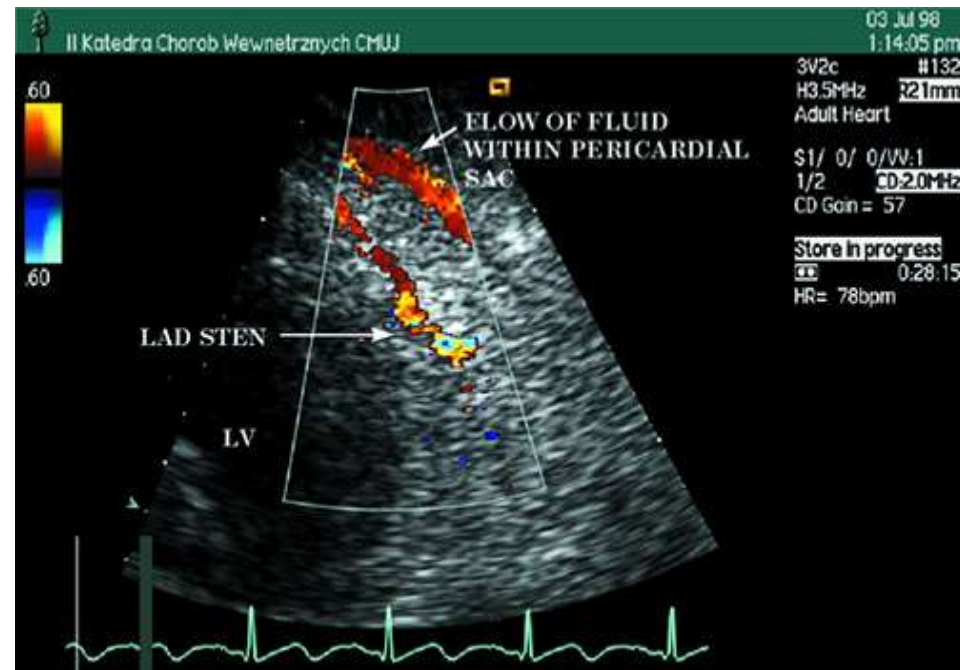
# Diagnosis: echocardiography 1

Left main stem coronary artery and proximal segment of left anterior descending coronary artery (LAD) in color-coded transthoracic Doppler echocardiography



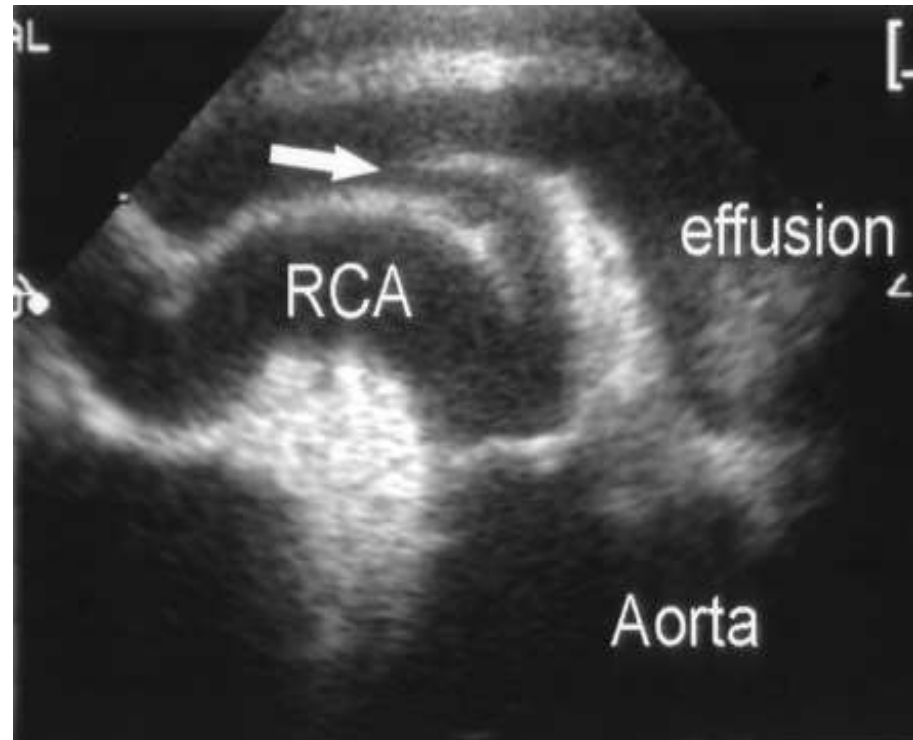
# Diagnosis: echocardiography 2

- Direct visualization of coronary artery stenosis
- The portion of mid segment of left anterior descending coronary artery (LAD) with color mosaic (a sign of high-velocity, turbulent flow) at stenotic site



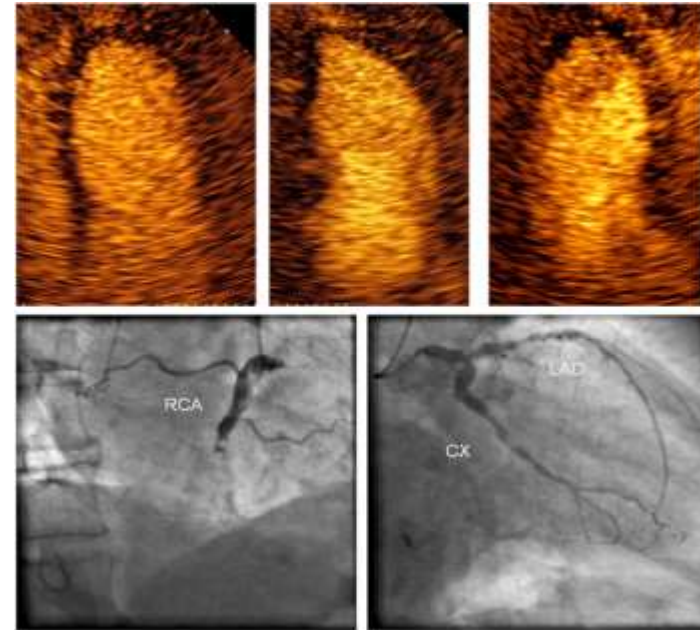
## Diagnosis: echocardiography 3

- Echocardiography, parasternal short-axis view
- In presence of pericardial effusion, proximal part of right coronary artery (RCA) is suspicious for dissection (arrow).  
Imaging plane is off axis of nondilated RCA ostium



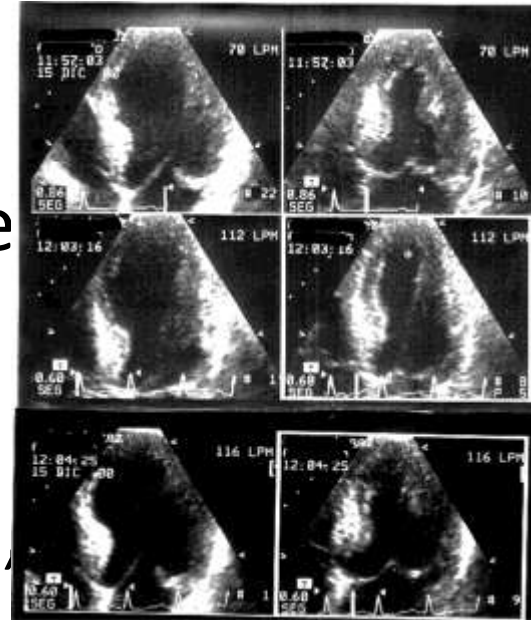
# Diagnosis: echocardiography 4

Contrast echocardiography in apical 4-chamber, 2-chamber and 3-chamber views (upper panels) demonstrating the extensive reduction of myocardial perfusion in a non ST-elevation myocardial infarction (NSTEMI) patient with angiographic trippel-vessel disease including acute occlusion of the right coronary artery and left main stem stenosis (lower

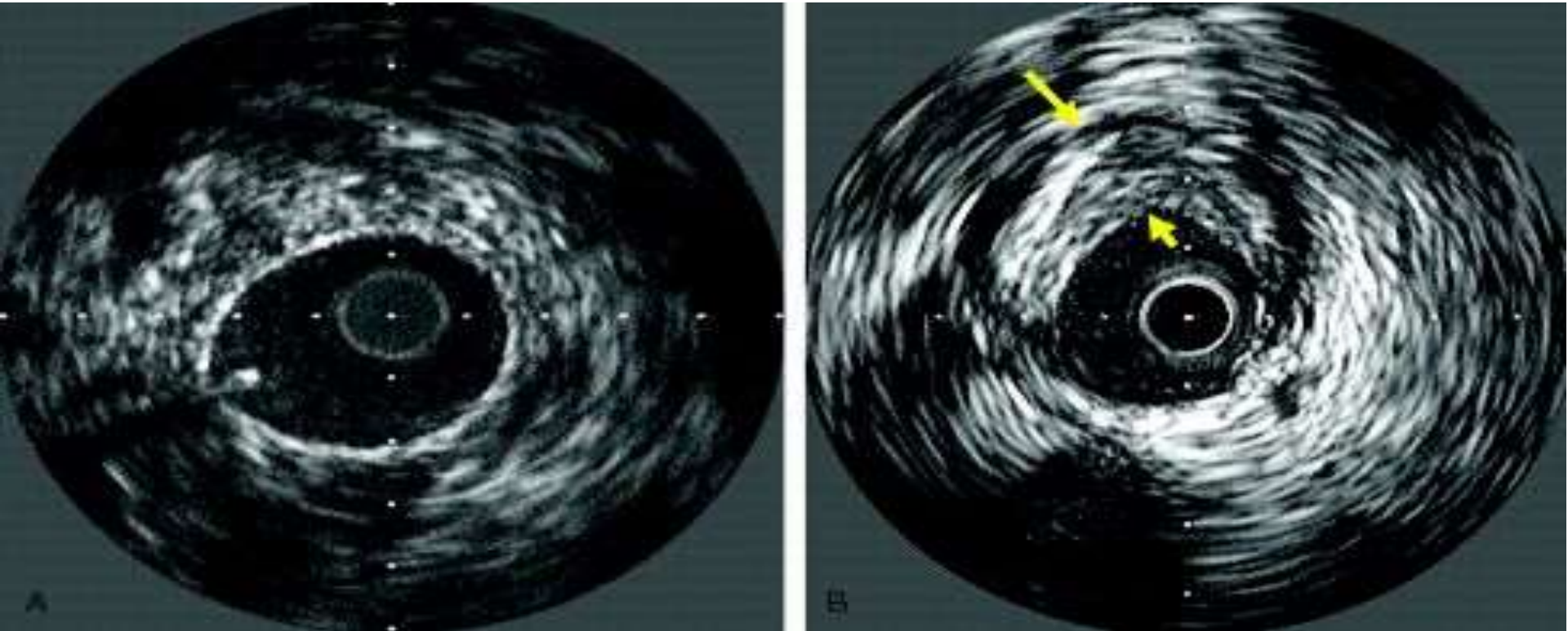


## Diagnosis: echocardiography 5

- Four-chamber diastolic (left) and systolic (right) apical frames at rest (top), peak (middle) and post-exercise (bottom) imaging in a patient with a previous inferior infarction
- Rest regional wall motion was normal, whereas apical hypokinesia developed at peak exercise (asterisk) and had been resolved by the time post-exercise imaging was performed

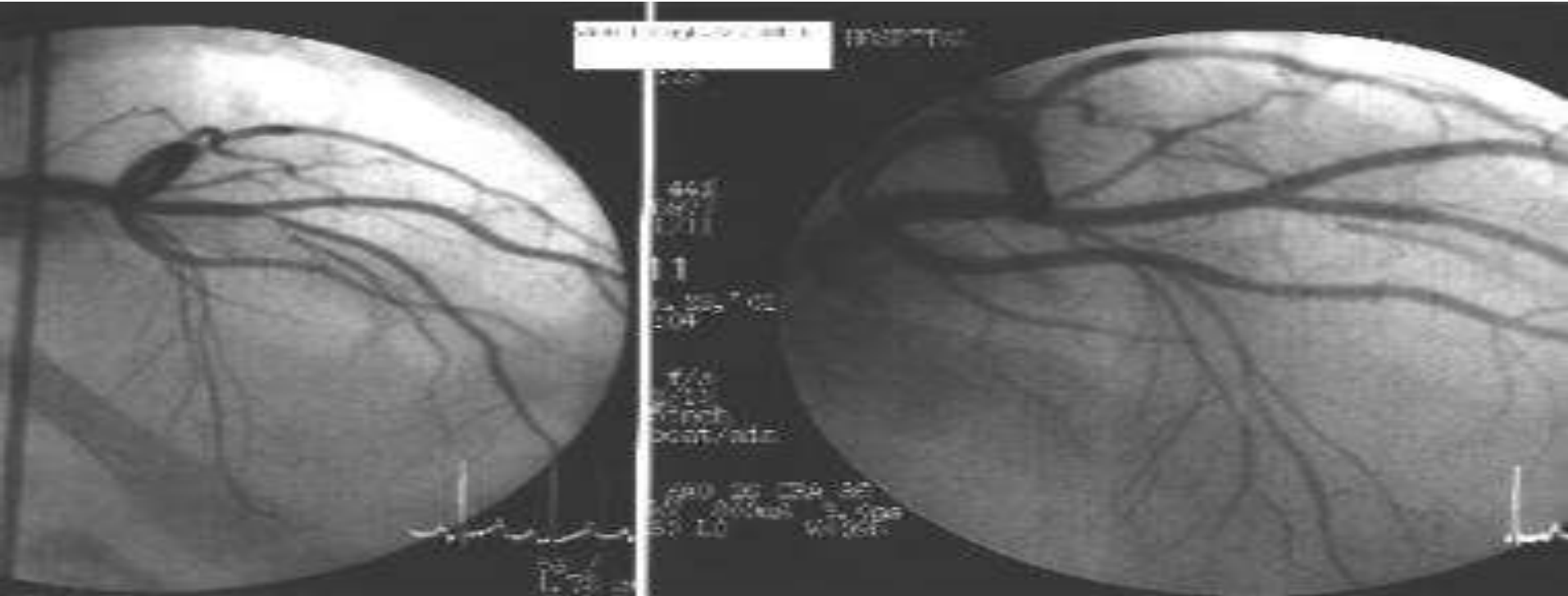


# Diagnosis: intravascular echocardiography



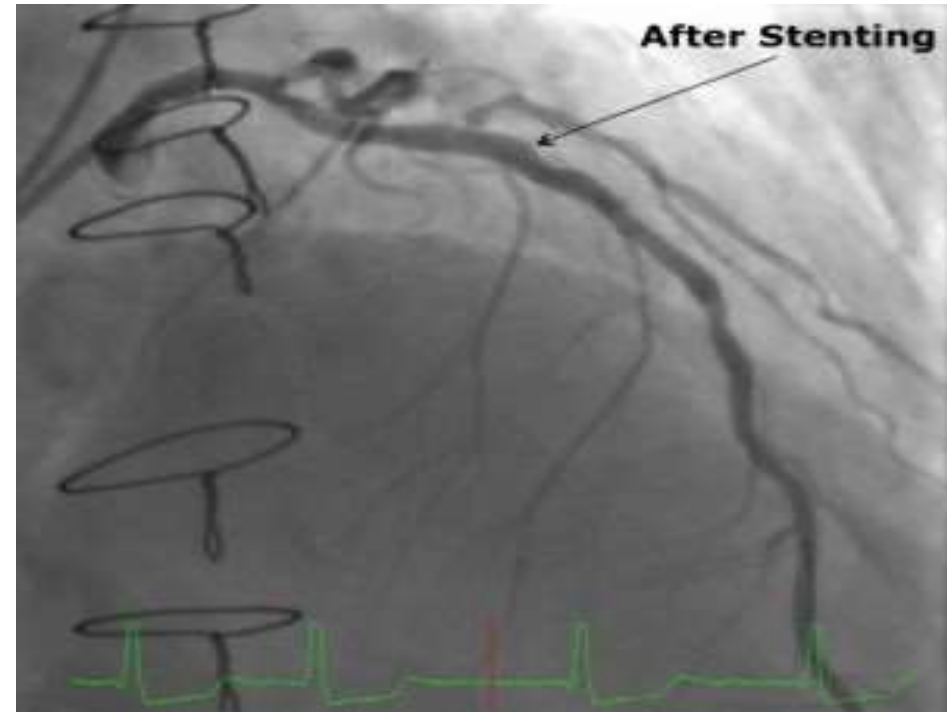
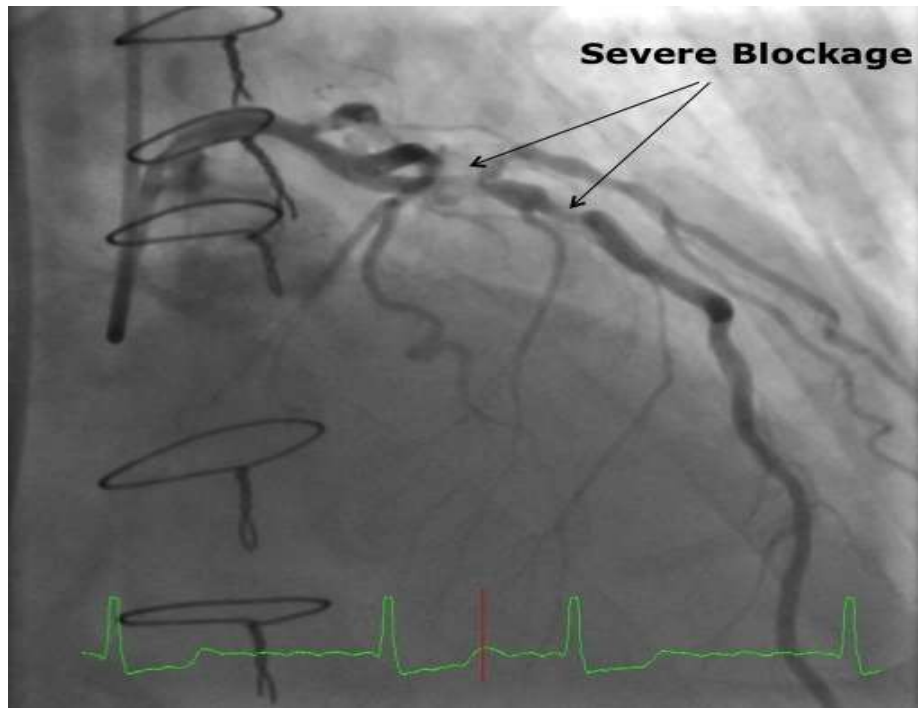
- Left - normal coronaries
- Right - increased coronary intimal thickness (1.2 mm; arrows), suggesting severe vasculopathy

# Diagnosis: coronary angiography 1



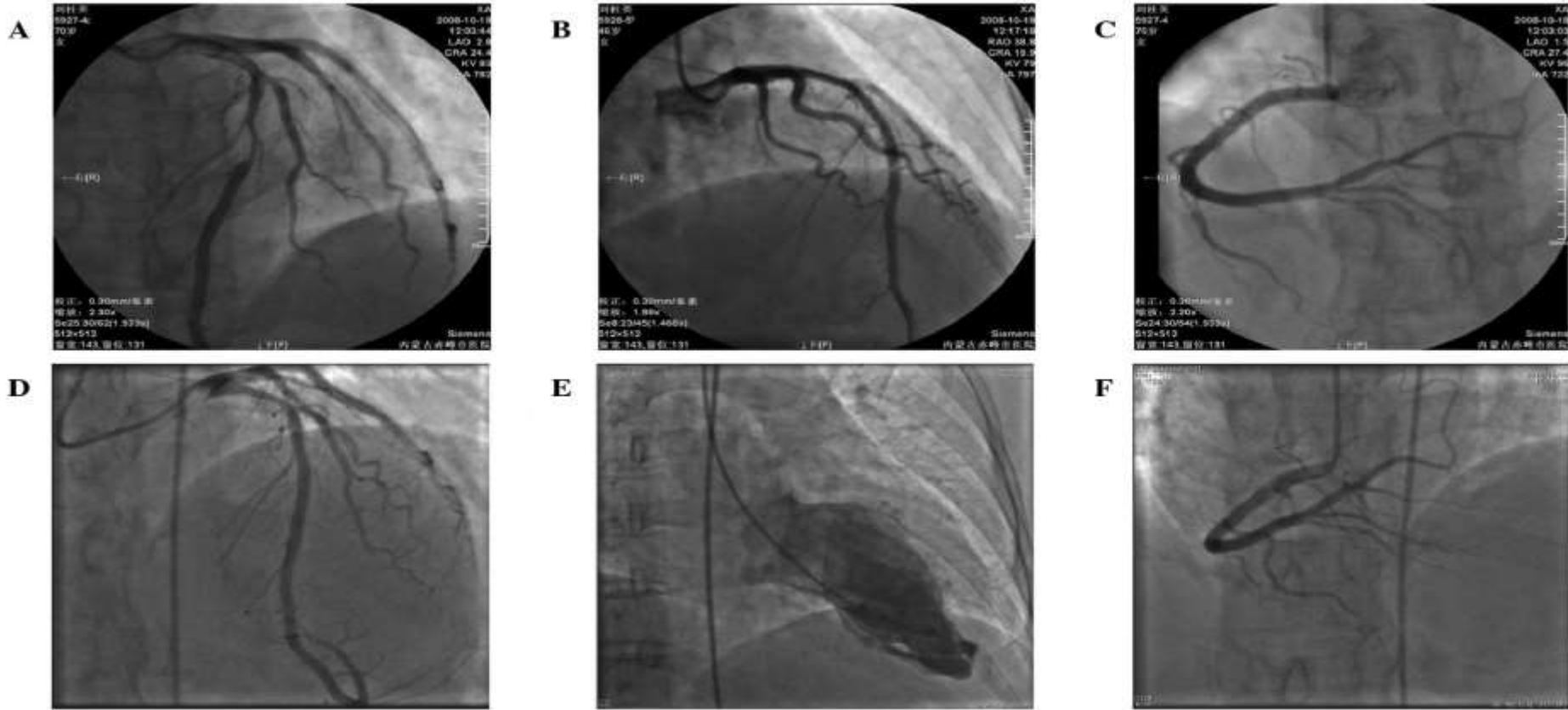
Cardiac catheterization and coronary angiography shows severe left anterior descending coronary artery stenosis (left panel) with stent placement in the left anterior descending coronary artery (right panel).

# Diagnosis: coronary angiography 2



Single-vessel coronary artery disease

# Diagnosis: coronary angiography 3



Coronary angiography of a case with acute myocardial infarction in the (A–C) first and (D–F) second time admissions.

# USMLE TEST

A 62-year-old Caucasian male presents to the emergency room with severe substernal chest pain, diaphoresis, and nausea. Imaging reveals transmural myocardial infarction in the posterior 1/3 of the ventricular septum. Which of this patient's coronary arteries is most likely occluded?

1. Left circumflex
2. Left anterior descending
3. Diagonal perforators
4. Septal perforators
5. Right main

# USMLE TEST

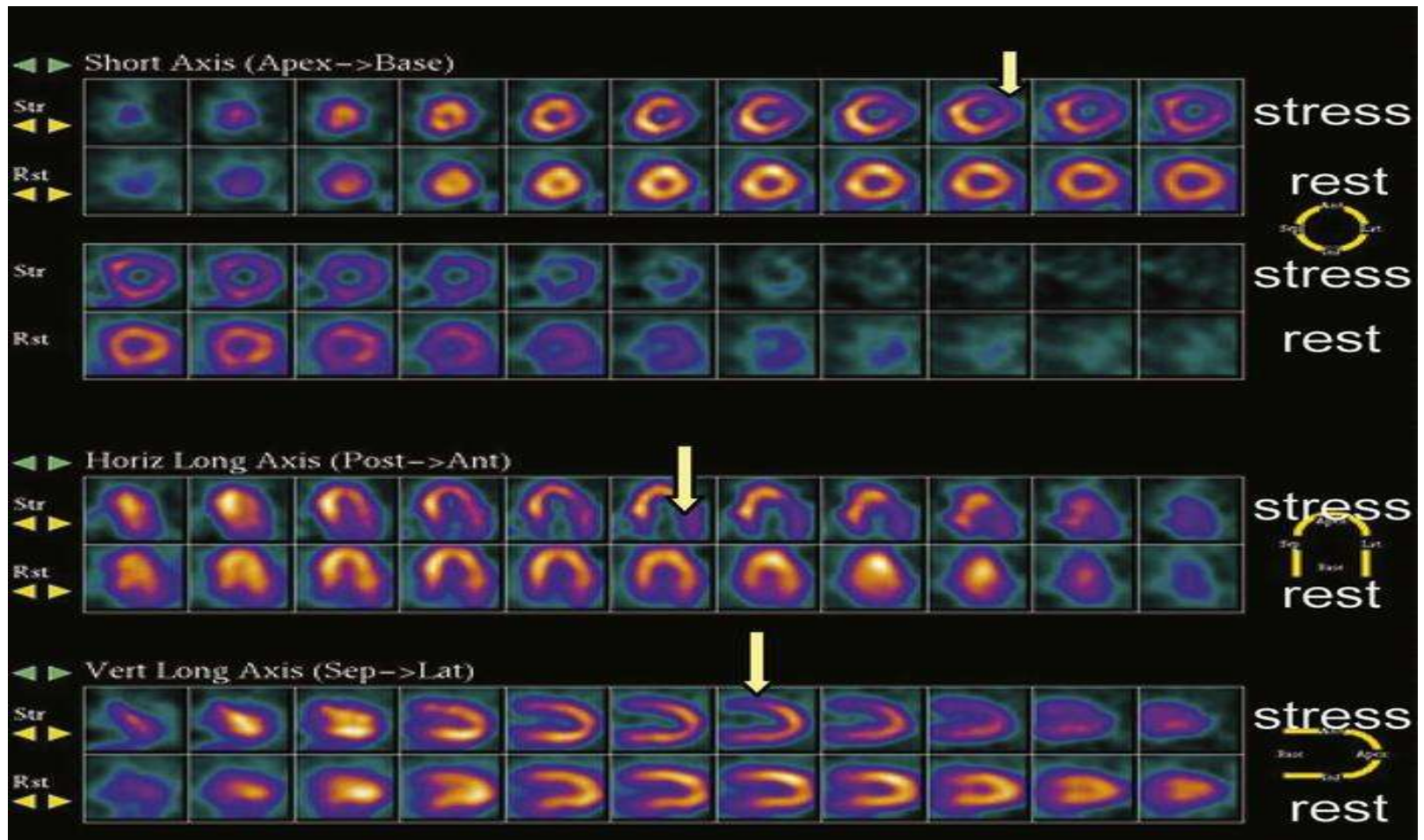
The correct answer is 5:

The artery supplying the posterior 1/3 of the ventricular septum is referred to as the "dominant" artery. In approximately 80% of people, the right main coronary artery (RCA) is dominant.

Incorrect answers:

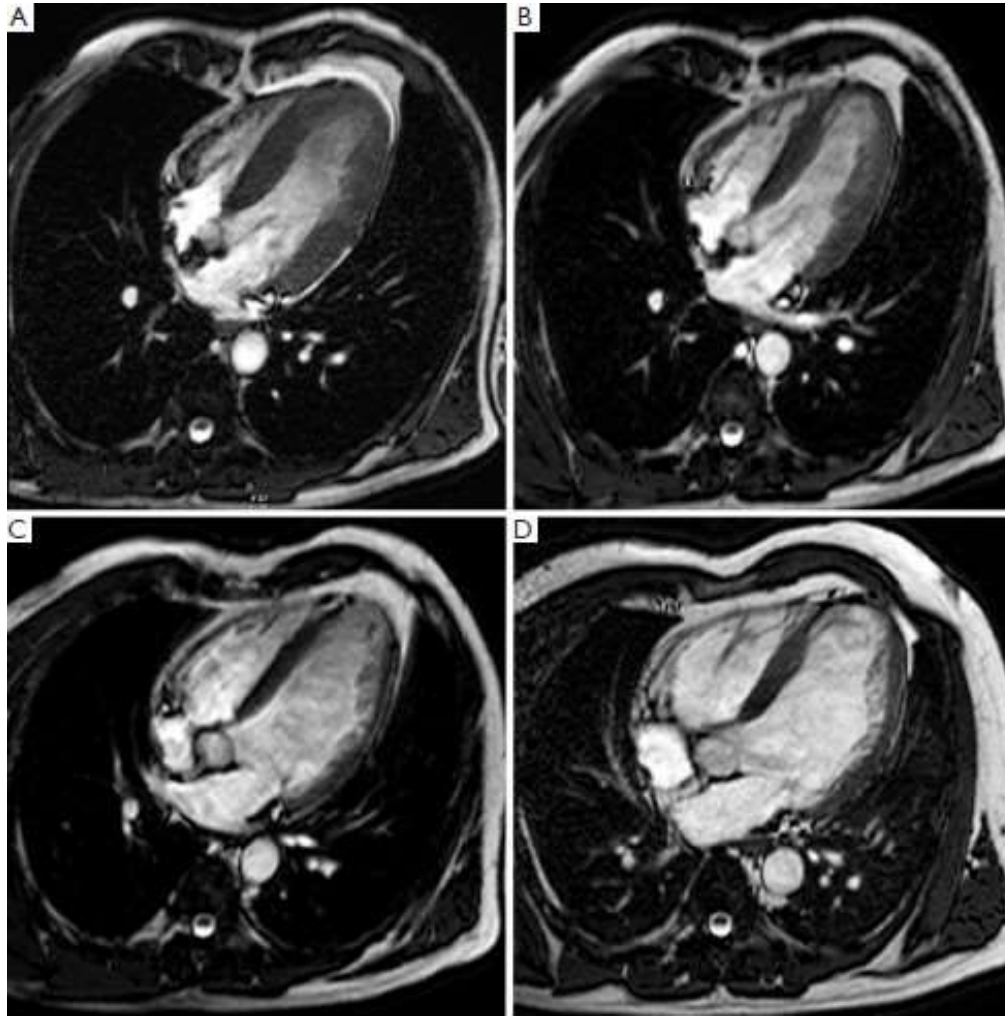
1-4: Occlusion of any of these vessels would be unlikely to produce a posterior MI.

# Diagnosis: radioisotopes



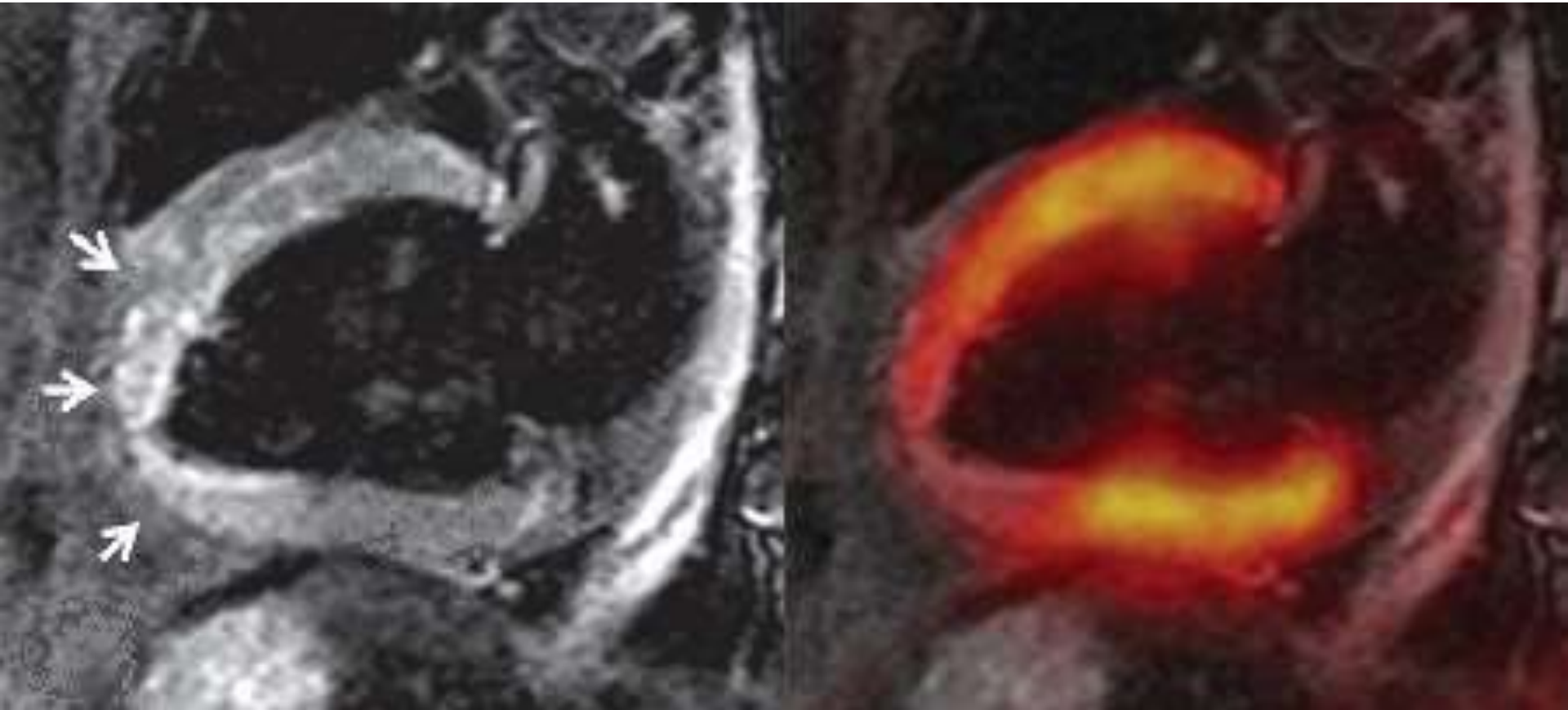
Stress images (arrows) demonstrate inferolateral and anterolateral (left circumflex) ischemia.

# Diagnosis: magnetic resonance imaging



Ventricular remodeling post myocardial infarction.

# Diagnosis: positron emission tomography



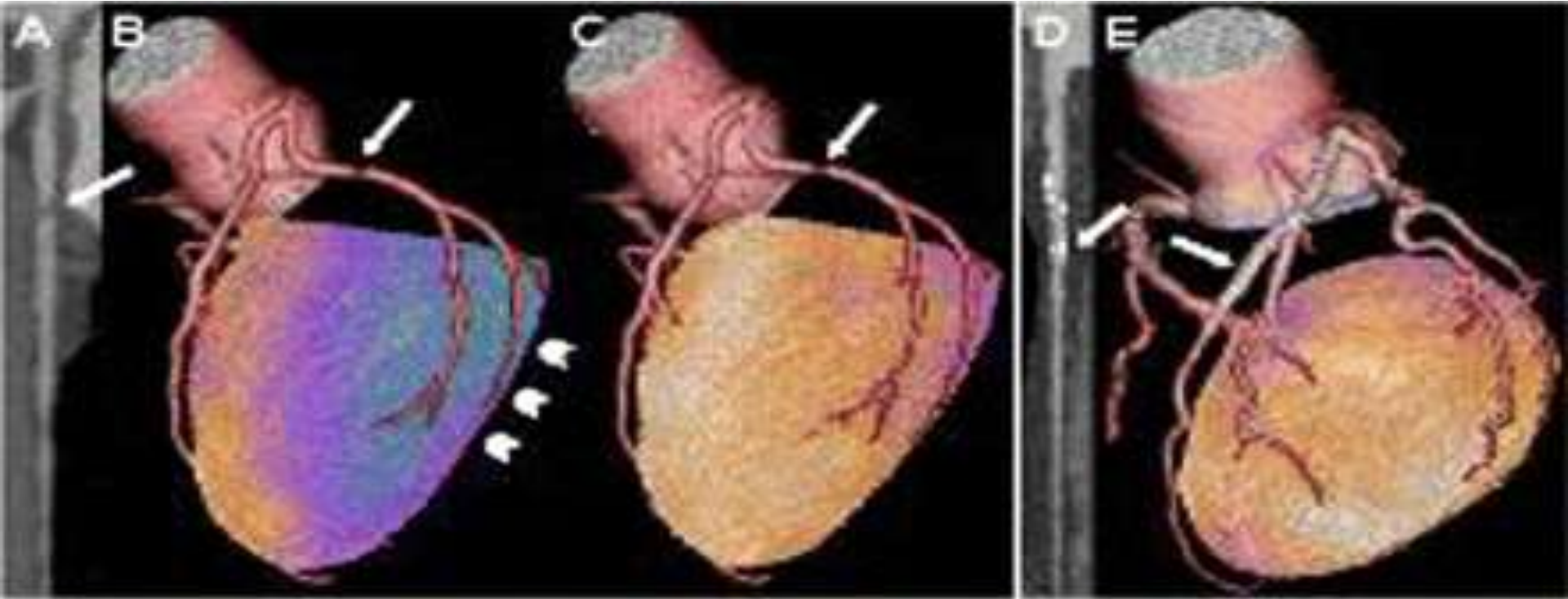
The infarct zone of the entire left ventricular myocardium.

## Diagnosis: computed tomography

1. Mild proximal stenosis with expansive remodelling and predominantly nonexpansive plaque
2. Partially calcified advanced mid to distal stenosis



# Diagnosis: hybrid imaging



Patient with silent ischemia. Cardiac hybrid imaging integrating single-photon emission computed tomography with computed tomography coronary angiography.

# USMLE TEST

In the coronary steal phenomenon, vessel dilation is paradoxically harmful because blood is diverted from ischemic areas of the myocardium. Which of the following is responsible for the coronary steal phenomenon?

1. Venodilation
2. Microvessel dilation
3. Dilation of the large coronary arteries
4. Arterial dilation
5. Volume loss of fluid in the periphery

# USMLE TEST

The correct answer is 2:

Microvessel dilation is responsible for the coronary steal phenomenon in the acute setting.

Incorrect answers:

1, 3, 4, 5: These vessels are not responsible for the coronary steal phenomenon.

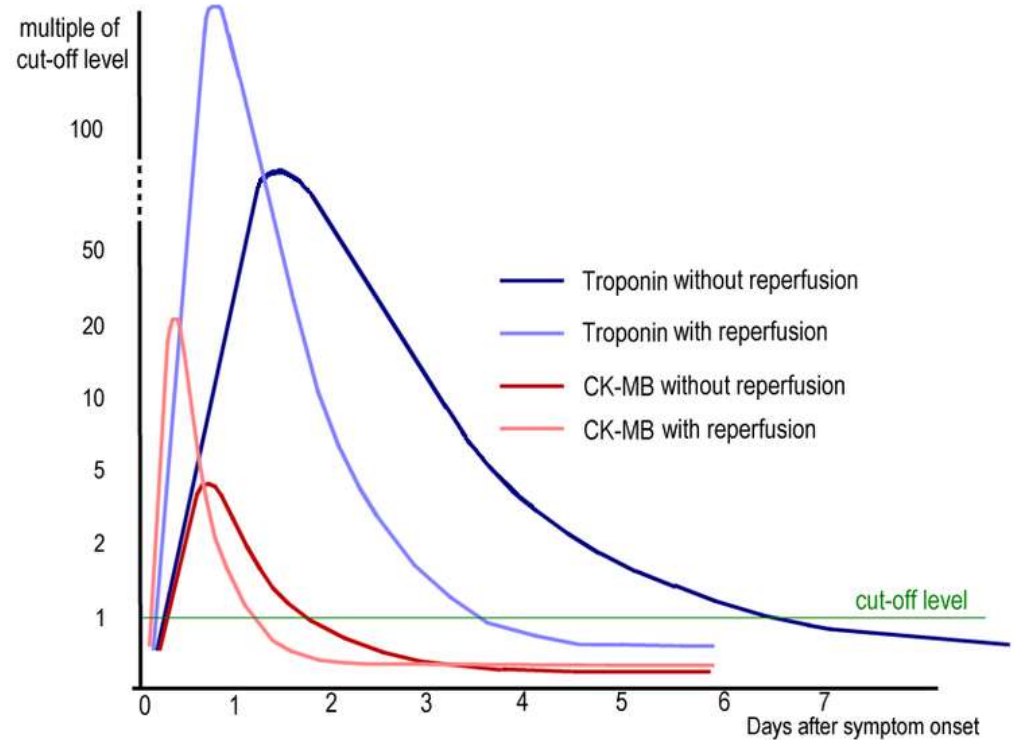
## Diagnosis: blood test 1

- Lipid profile (LDL-C, HDL-C, cholesterol, triglycerides)
- CRP—C-reactive protein, a marker of inflammation that is associated with atherosclerosis, among other conditions
- Lp(a)—an additional lipid test that may be used to identify an elevated level of lipoprotein (a), a modification to LDL-C that increases risk of atherosclerosis; the test may be used in conjunction with a routine lipid profile to provide additional information

# Diagnosis: blood test 2

## Heart attacks tests:

- Troponin
- Myoglobin
- CK-MB
- Etc.



# USMLE TEST

A 55-year-old man with a past medical history of hypertension, hyperlipidemia, and insulin dependent diabetes mellitus presents to the ED with a sudden onset of substernal chest pain and pressure that radiated into his neck and down his left arm. The pain started a few hours ago while he was watching television. It was not relieved by rest. He has not had any similar episodes previously. His family history is significant an uncle who had a heart attack at age 45. He drinks one drink every other day and has a 25-pack-year smoking history. T=37.2°C, BP=150/90 mmHg, HR=63/minute, RR=22/minute, and point-of-care glucose level is 110 mg/dl. Troponin level is elevated. EKG is shown in image A. What is the most likely etiology of this patient's presentation?

1. Left main coronary artery occlusion,
2. Right main coronary artery occlusion,
3. Left circumflex artery occlusion,
4. Left anterior descending artery occlusion,
5. Coronary vasospasm

# USMLE TEST

The correct answer is 2: The most likely diagnosis is an inferoposterior wall ST elevated myocardial infarction (STEMI) which is most likely caused by a right coronary artery occlusion.

Incorrect answers: 1: Occlusion of the left main coronary artery - EKG would show ST elevations in leads 1, 2, aVL, and V1 – V6, 3: Occlusion of the left circumflex artery - EKG would show ST elevations in leads 1, aVL, and V5 – V6, 4: Occlusion of the left anterior descending artery would - EKG would show ST elevations in leads V1 – V4, 5: Coronary vasospasm (vasospastic angina/ Prinzmetal angina) can present similarly to STEMIs as the myocardium becomes ischemic during episodes.