Ischaemic heart disease

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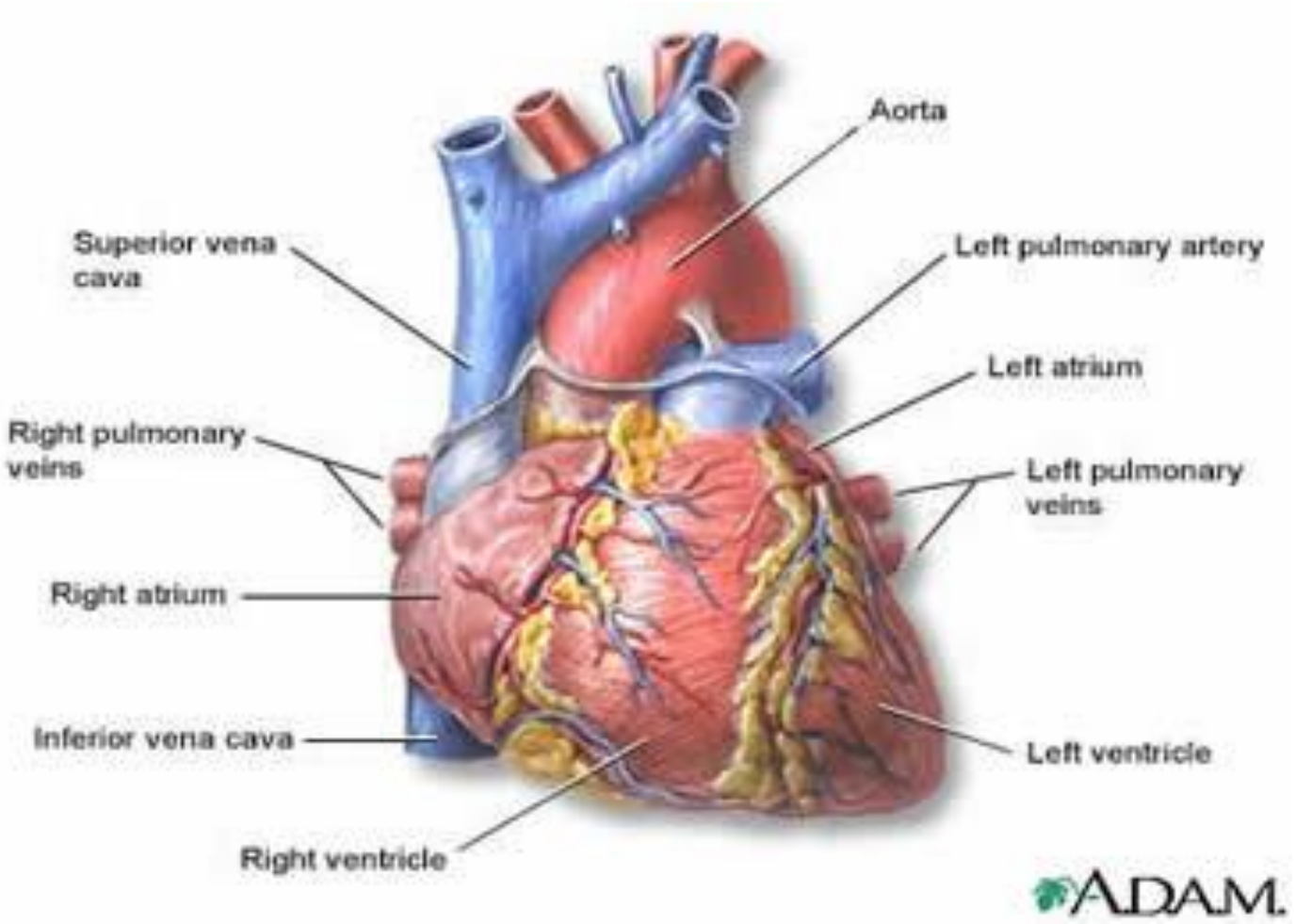
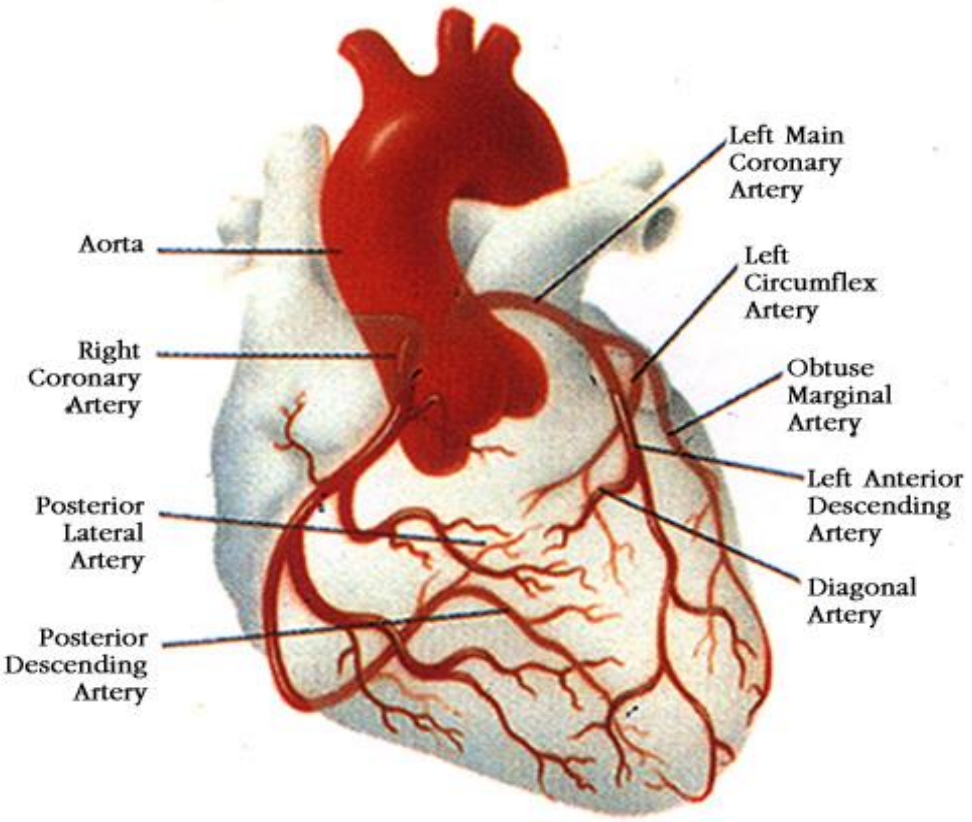
Ischaemic heart disease

- Definition
  - An imbalance between the supply of oxygen and other myocardial nutrients, and the myocardial demand.

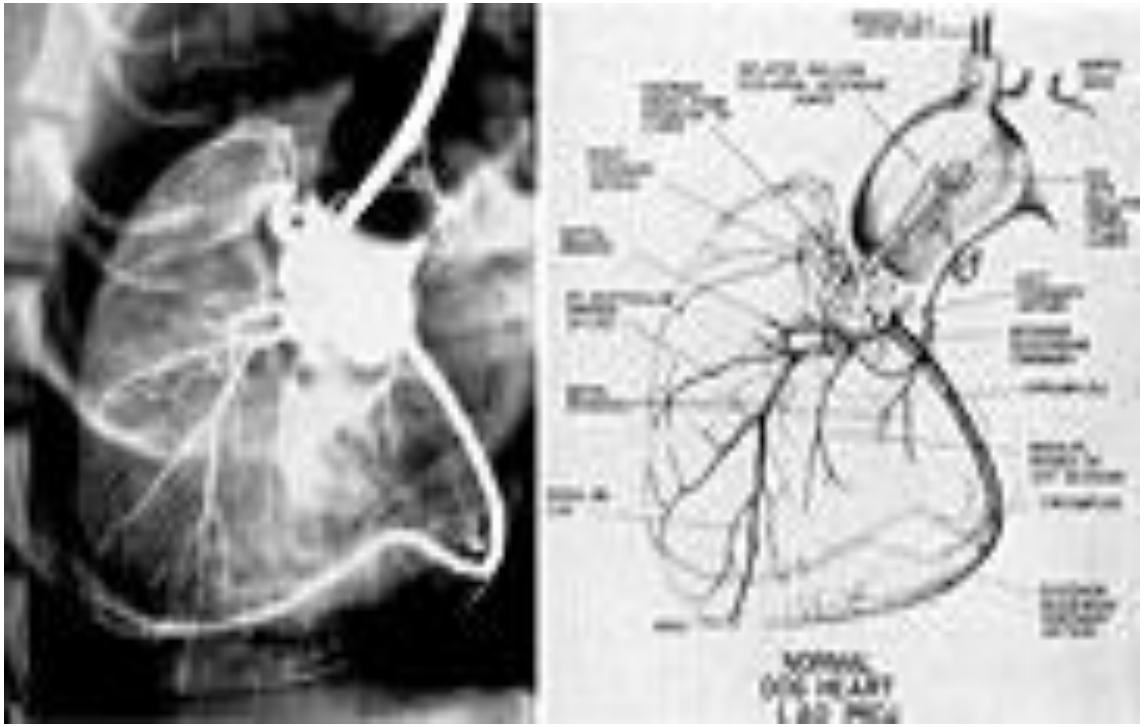
Heart


Aorta
Superior vena cava
Left pulmonary artery
Left atrium
Right pulmonary veins
Left pulmonary veins
Right atrium
Inferior vena cava
Left ventricle
Right ventricle
A.D.A.M.

Blood supply to the Heart



Blood supply to the heart



Ischaemic heart disease

- Causes
  - Obstruction to coronary blood flow
    - Atheroma
    - Thrombosis
    - Spasm
    - Embolus
    - Coronary ostial stenosis
    - Coronary arteritis

Ischaemic heart disease

- Causes
  - Decrease in flow of oxygenated blood to myocardium
    - Anaemia
    - Carboxyhaemoglobin
    - Hypotension
  - Increase in demand for O2
    - increase in COP; thyrotoxicosis
    - Aortic stenosis

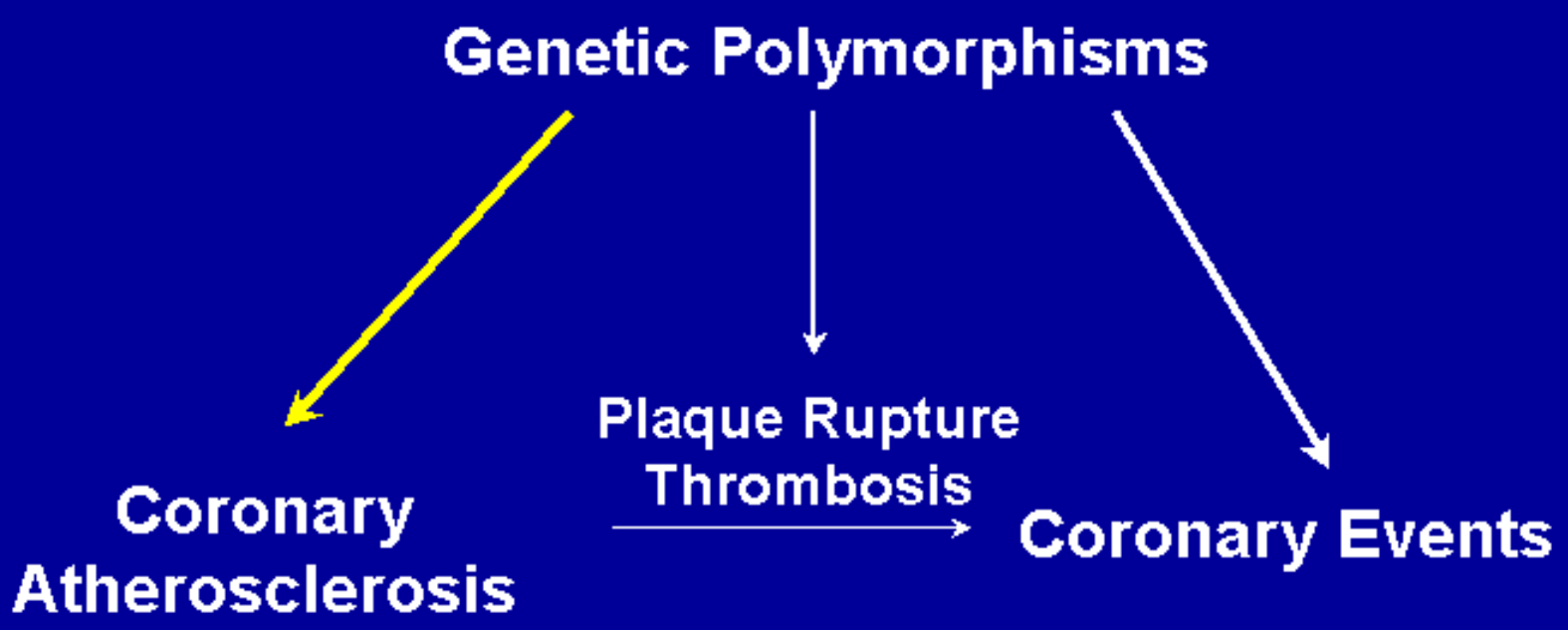
Atherosclerosis

- Is the process underlying the formation of focal obstruction
- In large and middle sized arteries
- When lumen reduced by >70% symptomatic
- When > 90% symptomatic at rest
- Atherosclerosis
  - Atherosis; accumulation of cholesterol
  - Sclerosis; expansion of fibrous tissue
  - Inflammation; monocytes/ macrophages/ T lymphocytes

Atherosclerosis

- Mechanism of atherosclerosis
  - **Initiation**
    - (clinically silent; little known, target for 1ry prevention)
  - **Progression**
    - (due to continuation of risk factors; increase in s. cholesterol/ impaired endothelial NO)
  - **Destabilization**
    - (increased stress of plaque, chronic inflammation with thinning of fibrous capsule/ smooth muscle cells)
  - **Repair**
    - (following rupture; thrombosis/ haemorrhage-organisation)

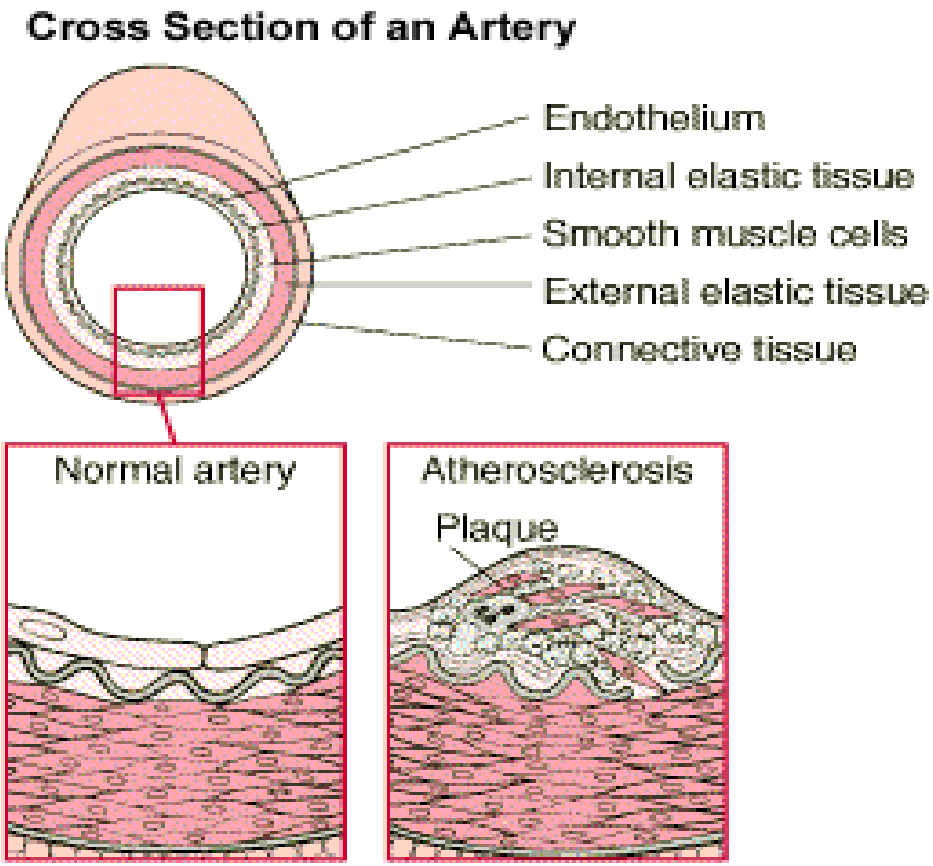
Genetics and Coronary Disease



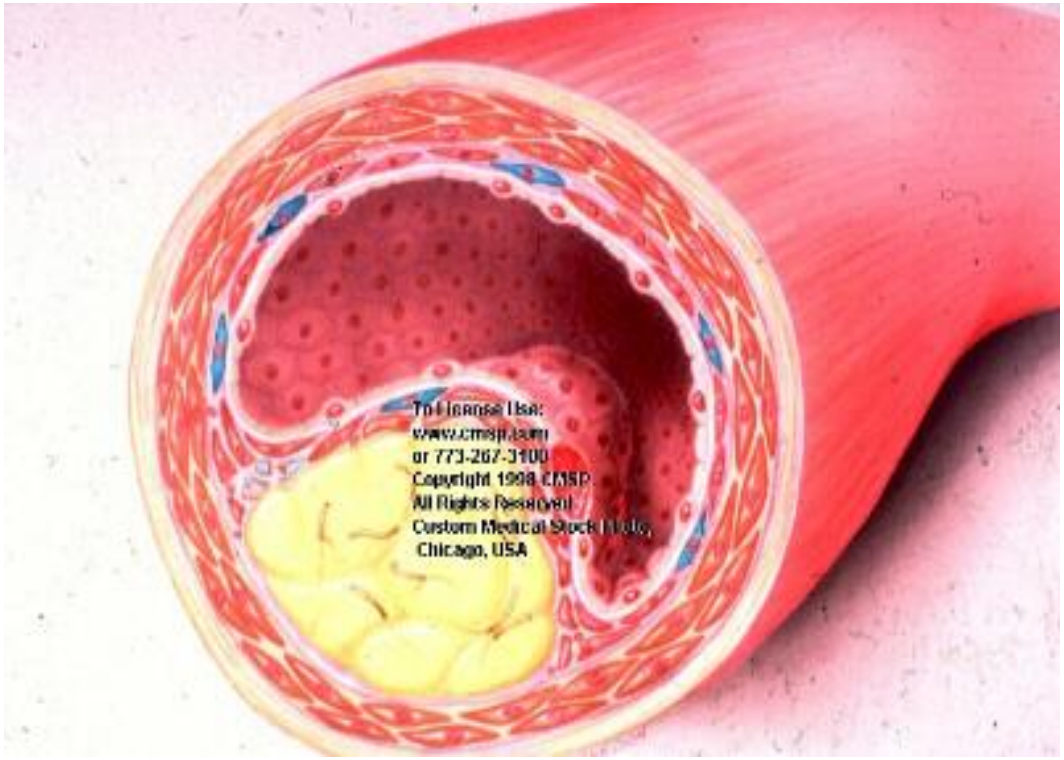
Atherosclerosis

- Initiation:
  - The vascular endothelium plays an important role in maintaining vascular integrity and homeostasis
  - Following may initiate vascular injury
    - mechanical shear stress (hypertension)
    - Biochemical abnormalities (DM, LDL, homocysteine)
    - Immunological (Free radicals from smoking)
    - Inflammation *(Chlamydia, H. pylorii)*

Atherosclerosis



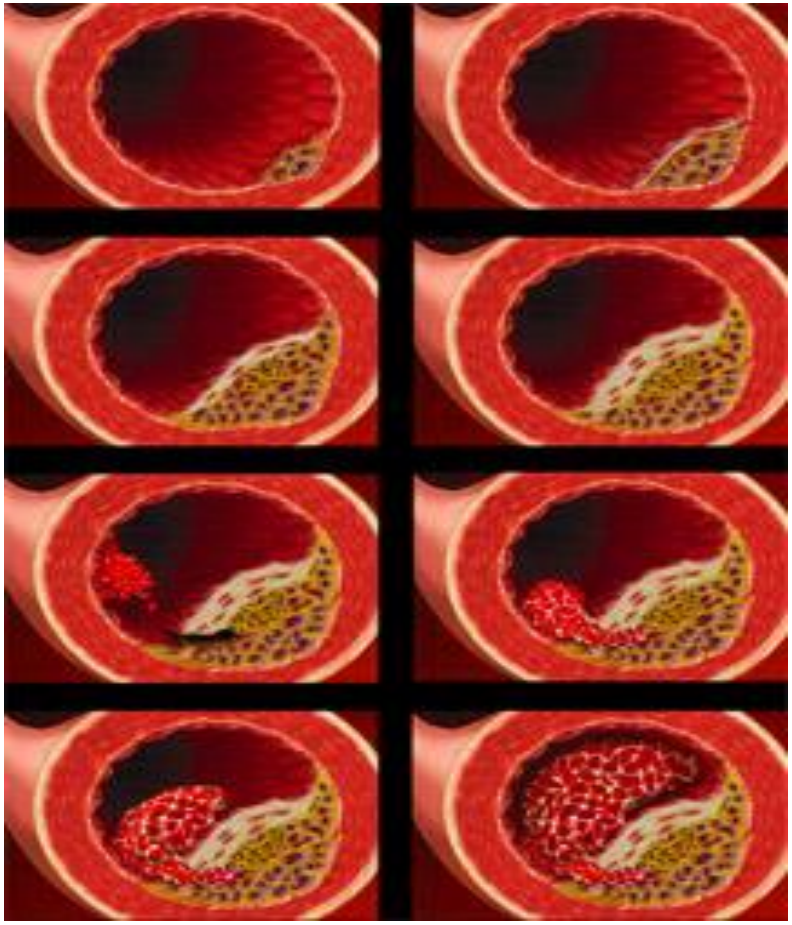
Atherosclerosis



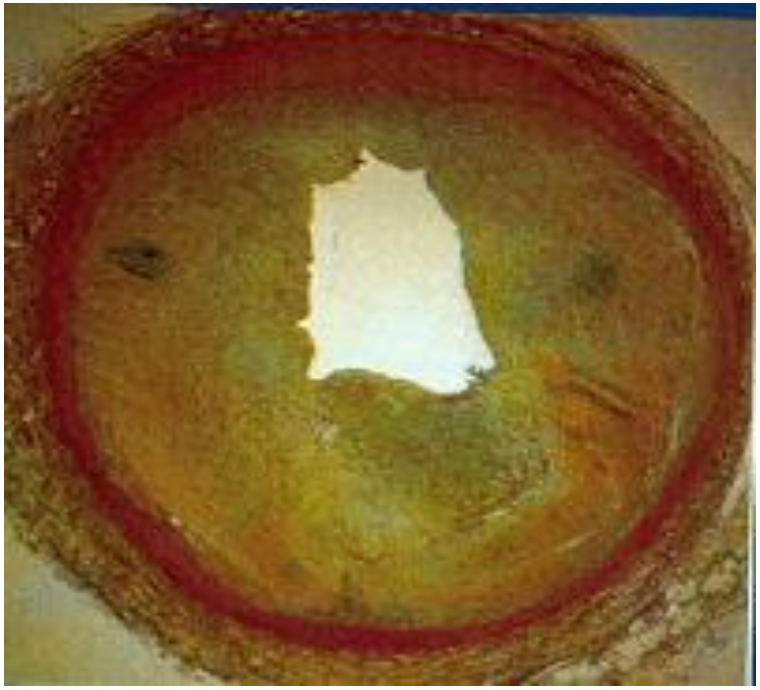
Thrombosis on a plaque

- Superficial endothelial injury
  - Damage to endothelial covering
  - Exposure of collagenous matrix
  - Platelet adhesion to collagen
- Deep endothelial fissuring
  - Involves an advanced plaque with a lipid core
  - Plaque cap tears (ulcerates, fissures or ruptures)
  - Blood enter into the plaque
  - Thrombosis extend into lumen

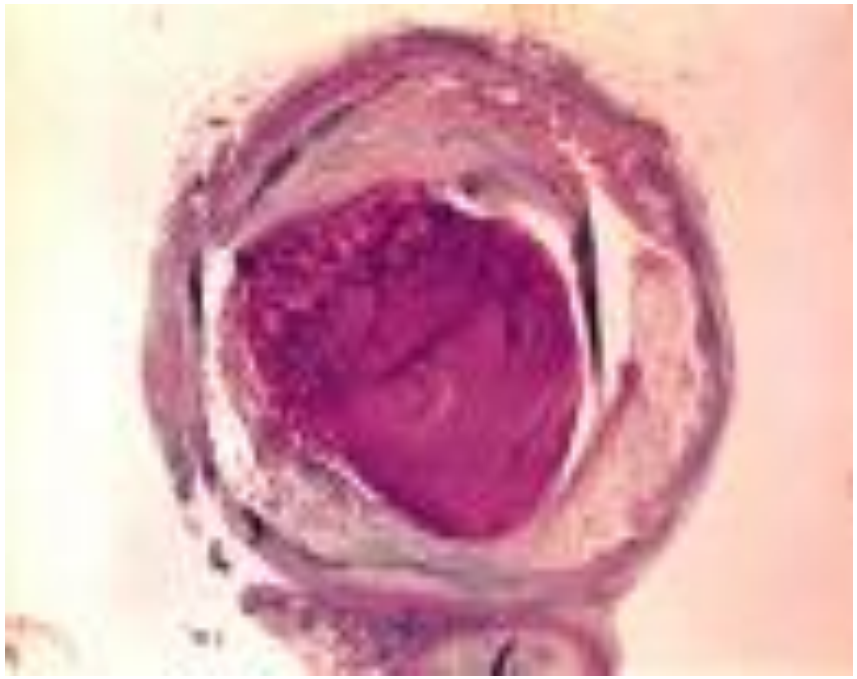
Atherosclerosis



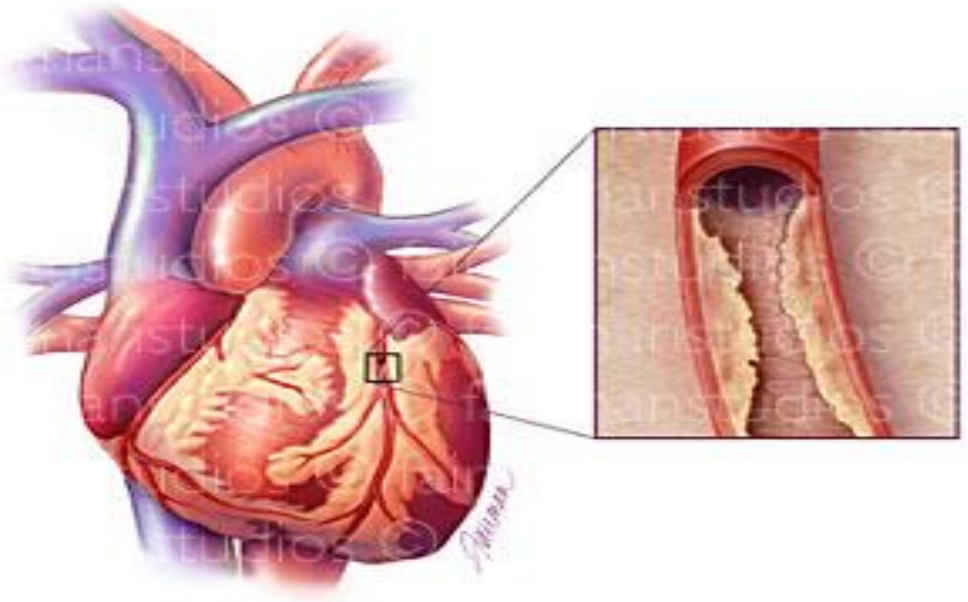
Atherosclerosis



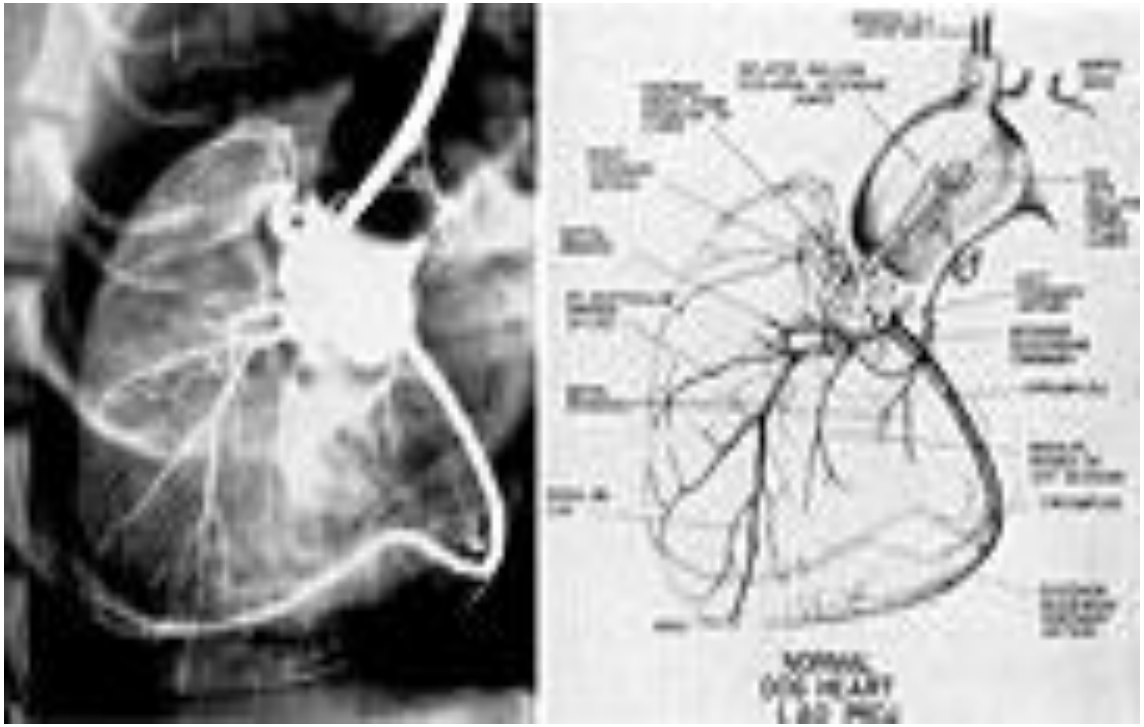
Thrombosis



Atherosclerosis

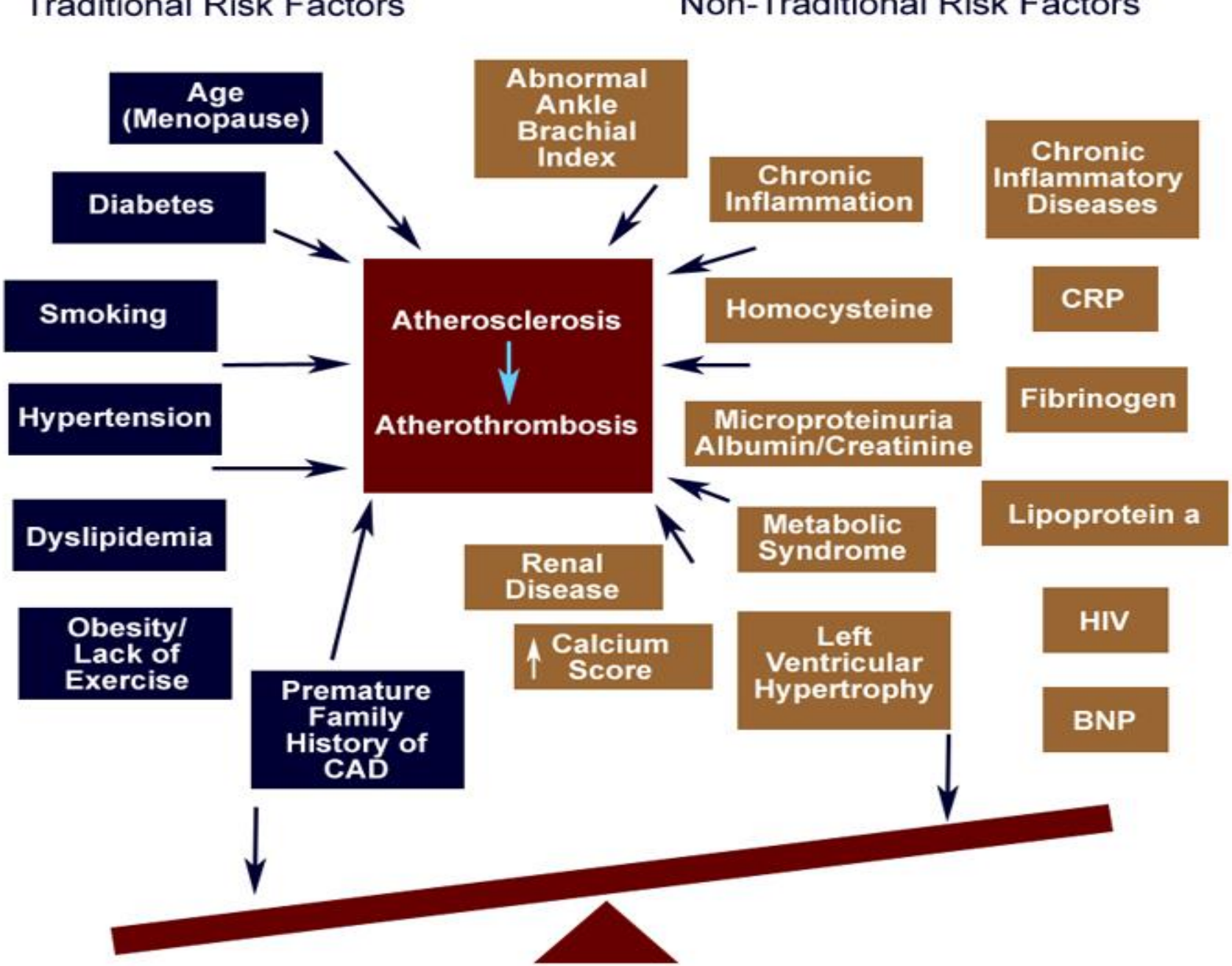


Coronary Angiography



Atherosclerosis disease

- Intermittent claudication – 2-4 fold increase in CAD
- Following initial MI – 3-6 fold increase in stroke / heart failure
- Following stroke – heart failure / MI – two fold increase


Traditional Risk Factors
Non-Traditional Risk Factors
Age (Menopause)
Diabetes
Smoking
Hypertension
Dyslipidemia
Obesity/ Lack of Exercise
Premature Family History of CAD
Abnormal Ankle Brachial Index
Chronic Inflammation
Chronic Inflammatory Diseases
Atherosclerosis
Atherothrombosis
Homocysteine
CRP
Fibrinogen
Microproteinuria Albumin/Creatinine
Lipoprotein a
Metabolic Syndrome
Renal Disease
Calcium Score
Left Ventricular Hypertrophy
HIV
BNP

Major Risk Factors for Coronary Artery Disease

-Age (men ≥ 45 years; women ≥ 55 years)
-Family history of premature coronary artery disease
(CAD in male first-degree relative < 65 years)
-Hypertension (BP > 140/90 mmHg or on antihypertensive medications)
-Cigarette Smoking
-Diabetes
-Hypercholesterolemia
-Low HDL cholesterol (< 40 mg/dl)
-Hypertriglyceridemia (> 200 mg/dl)
-Obesity

Others considered as risk factors:

- Tissue plasminogen activator (tPA)
  - An imbalance of the clot dissolving enzymes (eg, tPA) and their respective inhibitors (plasminogen activator inhibitor-1 [PAI-1]) may predispose individuals to myocardial infarctions
- Low serum testosterone levels
  - Have a significant negative impact on patients with CAD
- Hysterectomy
  - A study suggests that this becomes a risk factor later in life in women who have the surgery at or before age 50 years
- Lack of sleep

Ischaemic heart disease

- Risk factors
  - Non modifiable
    - Age
      - **(15 fold for men and 30 fold for females increase from 35-44 to 55-64 yrs)**
    - Male sex
      - **(men 35-44; 5-6x higher than women in same age)**
    - Family history
      - **(F/H/O first degree at early age; <50yrs)**
    - Genetic
      - **Deletion polymorphism in the ACE gene (DD)**

Ischaemic heart disease

- Risk factors
  - Modifiable
    - Hyperlipidaemia
      - **(total cholesterol / LDL / Lp(a) ; TGs independent risk**
    - Smoking
      - **(smokers 3x non smokers)**
    - Hypertension
      - **(BP >160/95 ; 2x increase than <140/90)**
    - Lack of exercise
      - **(moderate physical activity during leisure times; regular brisk walking is adequate)**
    - Diabetes mellitus
      - **(two fold increase of a major IHD event)**

Ischaemic heart disease

- Risk factors….contd.
  - Modifiable
    - Lack of exercise
    - Blood coagulation factors-
      - high fibrinogen, factor VII
    - C-reactive protein
    - Homocysteinaemia
    - Personality
    - Obesity
    - Gout
    - Soft water
    - Contraceptive pill, nucleoside analogues, COX-2 inhibitors, rosiglitazone
    - Heavy alcohol consumption

Smoking

- 20% CAD deaths in males & 17% CAD deaths in females are due to smoking
- Stopping smoking reduce risk by 25%
- Risk decline to almost non-smoker after 10 years

Diet and obesity

- 30% deaths from CAD are due to unhealthy diets
  - Diet with high fat; esp. saturated fatty acids
  - Diet low in antioxidants
  - High salt intake

- 5% deaths from ACD are due to obesity (BMI>30kg/m2)
  - Abdominal adeposity; high Waist: Hip ratio

Lack of exercise

- Exercise:
  - Reduction in weight
  - Minimum of 30 min moderate intensity activity (Brisk walking, cycling or climbing stairs at least 5 days a week) – 30% reduction in vascular events

  – Studies have also shown that even 15 minutes a day or 90 minutes a week of moderate-intensity exercise may be beneficial.

Hypertension

- Both systolic & diastolic BP is associated with CAD
- 14% deaths due to CAD in males and 12% in females are due to HT

- weight loss, increase physical activity, reduce salt, alcohol intake reduces high BP

Hyperlipidaemia

- High serum cholesterol esp. when associated with low HDL; strongly associated with atheroma
- Increasing evidence; high TG is associated with CAD

– 45% of deaths from CAD in males and 47% in females is due to hypercholesterolaemia

– 1% reduction of cholesterol reduce risk of CAD by 2-3%

High blood cholesterol levels

- The Framingham Heart Study:
  - higher the cholesterol level, the greater the risk of coronary artery disease (CAD);
  - CAD was uncommon in people with cholesterol levels below 150 mg/dL.
- Lipid Research Clinics-Coronary Primary Prevention Trial (1984)
  - lowering total and LDL levels significantly reduced CAD.
- More recent series of clinical trials using statin drugs conclusive evidence that lowering LDL cholesterol
- reduces the rate of myocardial infarction (MI),
- the need for percutaneous coronary intervention and the mortality associated with CAD-related causes.

Diabetes mellitus

- Men with type II DM; 2-4 fold annual risk of CAD and 3-5 fold risk for females

- Also magnifies the effect of other risk factors for CAD; high cholesterol, BP, smoking and obesity

Risk factors for IHD

- Sedentary lifestyle

- Psychological well-being;
  - Work stress, lack of social support, depression, anxiety, personality (esp. hostility)

Alcohol

- Moderate alcohol (1- 2 drinks / day) reduces risk
- High levels of intake- esp binge drinking increases risk.

C-reactive protein (CRP)

- High CRP demonstrates the presence of inflammation
- The inflammation process appears to contribute to the growth of arterial plaque
- inflammation characterizes all phases of atherothrombosis
- actively involved in plaque formation and rupture

Lp(a)

- An elevated lipoprotein(a) [Lp(a)] level is an independent risk factor of premature CAD
- Is particularly a significant risk factor for premature atherothrombosis and cardiovascular events
- Measurement of Lp(a) is more useful for young individuals with a personal or family history of premature vascular disease and repeat coronary interventions.

Homocysteine

- Natural by-product of the dietary breakdown of protein methionine
- In the general population, mild to moderate elevations are due to insufficient dietary intake of folic acid.
- Homocysteine levels may identify people at increased risk of heart disease
- Due to the lack of agents that effectively alter the homocysteine levels, studies have not shown any benefit from lowering the homocysteine level.

Risk factors for IHD in Sri Lanka

- The following risk factors were identified:

  hypertension 12.6%,

  one or more lipid abnormality 37.0%,
  smoking 18.4%,

  physical inactivity 14.1%,

  obesity 8.9%,

  diabetes 11.5% and

  family history of IHD 22.9%.

Ischaemic heart disease

Ischaemic heart disease

- Angina
- Acute coronary syndromes

Ischaemic heart disease

- Angina
  - Classical or exertional angina
  - Decubitus angina
  - Nocturnal angina
  - Varient (Prinzmetal's) angina
- Acute coronary syndromes
  - Unstable angina
  - Acute myocardial infarction

Ischaemic heart disease

- Angina
  - Diagnosis:
    - Largely depends on the history
    - Chest pain; described as ‘heavy’, ‘tight’ or ‘gripping’
    - Typically central / retro-sternal may radiate to neck, jaw, arms
    - May be associated SOB

Ischaemic heart disease

- Angina
  - **Classical / exertional angina**
    - Provoked by physical exertion, esp after meals, cold weather
    - Aggravated by anger or excitement
    - Pain fades quickly; within minutes with rest
    - In some; predictable exertion

Ischaemic heart disease

- Angina
  - **Decubitus angina**
    - When patient lies down
    - Usually occurs in association with heart failure
    - Associated with severe coronary heart disease
  - **Nocturnal angina**
    - Occurs during sleep
    - Provoked by vivid dreams
    - Tend to occur in critical CAD
    - May result from vasospasm

Ischaemic heart disease

- Angina
  - **Variant (Prinzmetal's) angina**
  - Angina that occurs without provocation
  - Usually at rest
  - Due to coronary artery spasms
  - Characteristically there is ST elevation.
  - Needs provocation tests in the diagnosis eg: Hyperventilation, ergometrine challenge

Ischaemic heart disease

- **Angina**
- Cardiac symdrome X
  - History of angina
  - Positive exercise test
  - Normal angiography
  - Common in females
  - Due to an abnormal metabolic response to stress

Diagnosis of angina

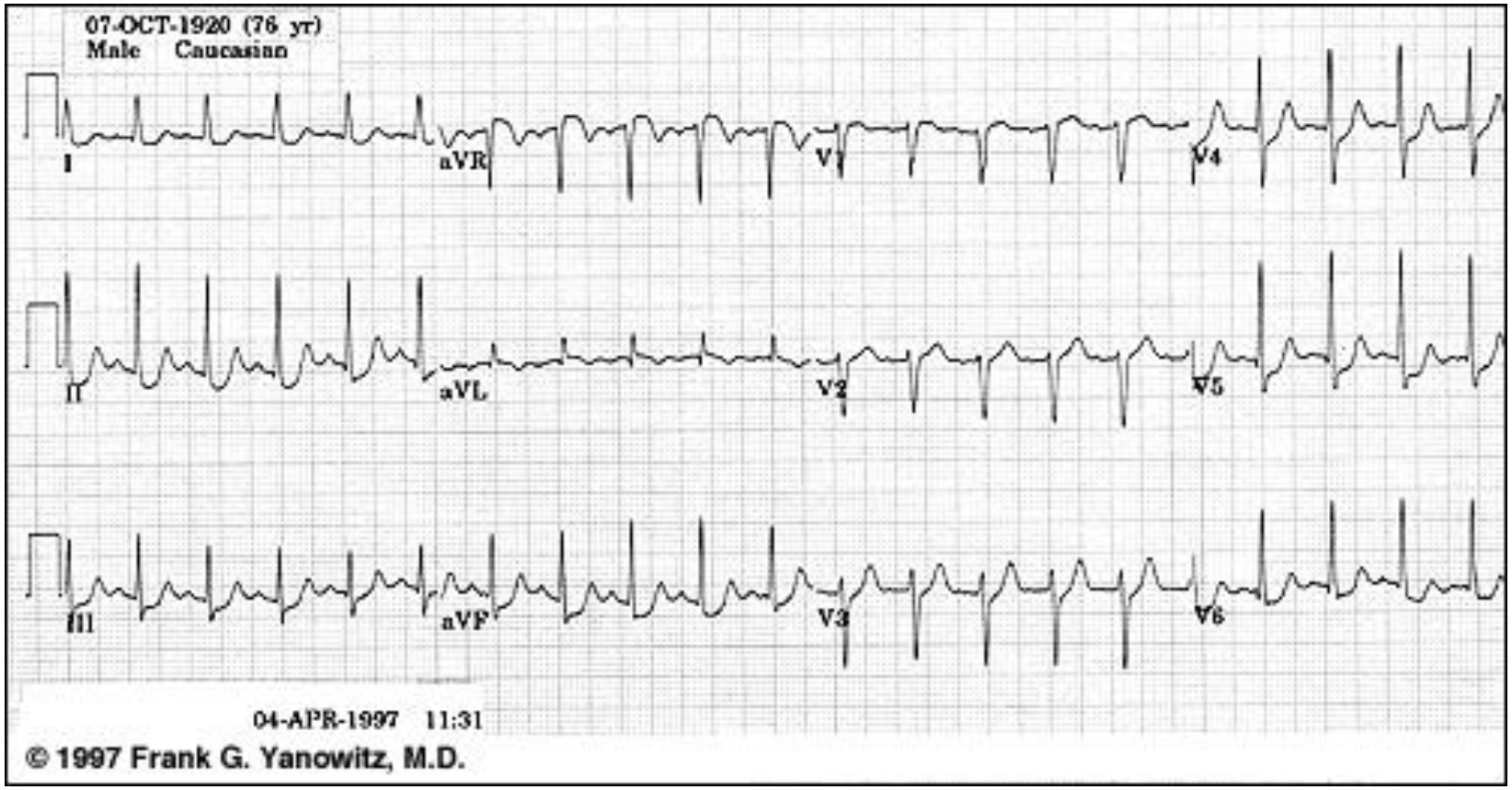
- History: is the most important
- Examination: usually no abnormal findings

- Look for aetiological / presipitating cause/s
  - Anaemia
  - Hyperlipidaemia
  - Hypo/hyper thyriodism
  - Aortic stenosis
  - Hypertension
  - Smoking

Diagnosis of angina

- Investigations:
  - ECG:
    - Is usually normal between attacks
      - LVH, LBBB, evidence of old MI
    - During an attack
      - Transient ST depression, T-wave inversion

ECG changes during angina



Diagnosis of angina

– Exercise ECG (Bruce protocol)
  - Can be very useful for diagnosis and assess severity
  - ST depression >1mm
  - 80% specificity & 70% sensitivity
  - A normal test does not exclude CAD (false –ve)
  - 20% +ve test have no CAD (false +ve)

Diagnosis of angina

- Investigations:
  - Echocardiography
    - To assess ventricular wall involvement & ventricular function
  - Coronary angiography
    - used in selected patients esp. when the diagnosis is unclear.
    - In patients an interventional procedure is planned

Acute coronary syndromes

- ST-elevation Myocardial infarction (STEMI)
- Non ST-elevation Myocardial infarction (non-STEMI)
- Unstable angina

Acute coronary syndromes

- Pathophysiology
- Coronary thrombosis on a pre existing plaque
  - Plaque rupture
    - If lipids > 40% of plaque content
    - Thin fibrous cap
    - Dense macrophage infiltration
    - Few smooth muscle cells in the fibrous cap
  - Plaque erosion
    - Thrombus formation on the eroded plaque
  - Intermittent occlusion
    - Intermittent occlusion and re-opening of an infarct related artery

Acute coronary syndromes

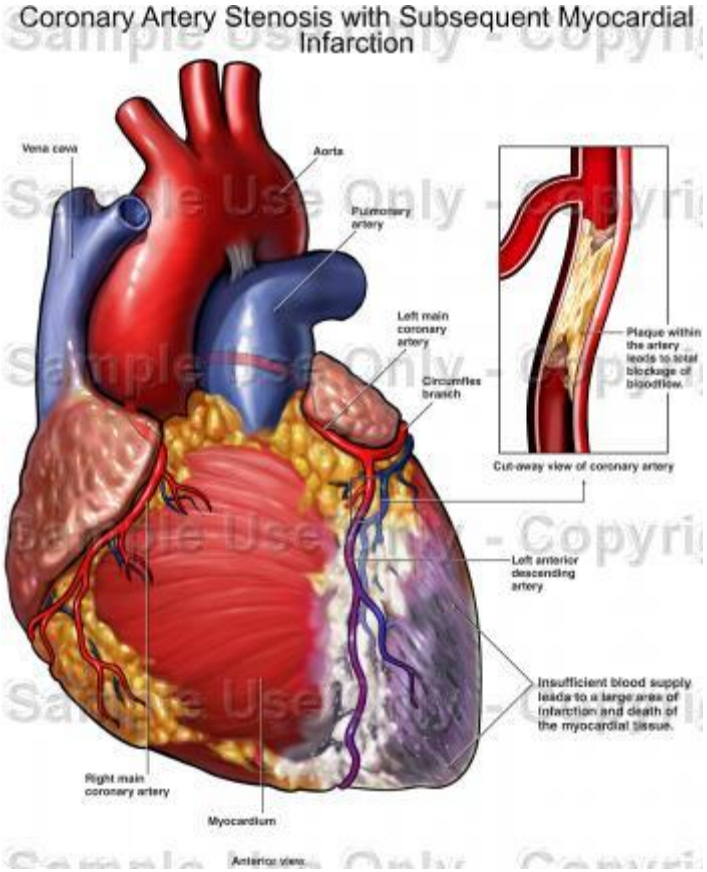
- Symptoms
  - New onset chest pain
  - Chest pain at rest
  - Deterioration of pre existing angina

  Atypical
  - Indigestion
  - Pleuritic chest pain
  - Acute dyspnoea, weakness, faintness
  - Silent (elderly / diabetics)

Myocardial infarction

Myocardial infarction

- Death of myocardium due to acute severe myocardial ischaemia



Diagnosis of myocardial infarction

- WHO criteria

Needs TWO of

- History suggestive of MI
- ECG changes
- Cardiac enzymes

‘Acute myocardial infarction’ (AMI)

should be used when there is evidence of myocardial necrosis in a clinical setting consistent with myocardial ischaemia

Table 3 Universal definition of myocardial infarction[a]

Detection of rise and/or fall of cardiac biomarker values (preferably troponin) with at least one value above the 99th percentile of the upper reference limit and with at least one of the following:

- Symptoms of ischaemia;
- New or presumably new significant ST-T changes or new 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.

Definition contd..

Cardiac death with symptoms suggestive of myocardial ischaemia, and presumably new ECG changes or new LBBB, but death occurring before blood cardiac biomarkers values are released or before cardiac biomarker values would be increased.
Stent thrombosis associated with MI when detected by coronary angiography or autopsy in the setting of myocardial ischaemia and with a rise and/or fall of cardiac biomarker values with at least one value above the 99th percentile URL.

ECG = electrocardiogram; LBBB = left bundle branch block.

[a]Excluding myocardial infarction associated with revascularization procedures or criteria for prior myocardial infarction.

Patients presenting with ischaemic symptoms and

Persistent ST-segment elevation on the electrocardiogram (ECG).

Most of these patients will show a typical rise in biomarkers of myocardial necrosis and progress to Q-wave myocardial infarction.

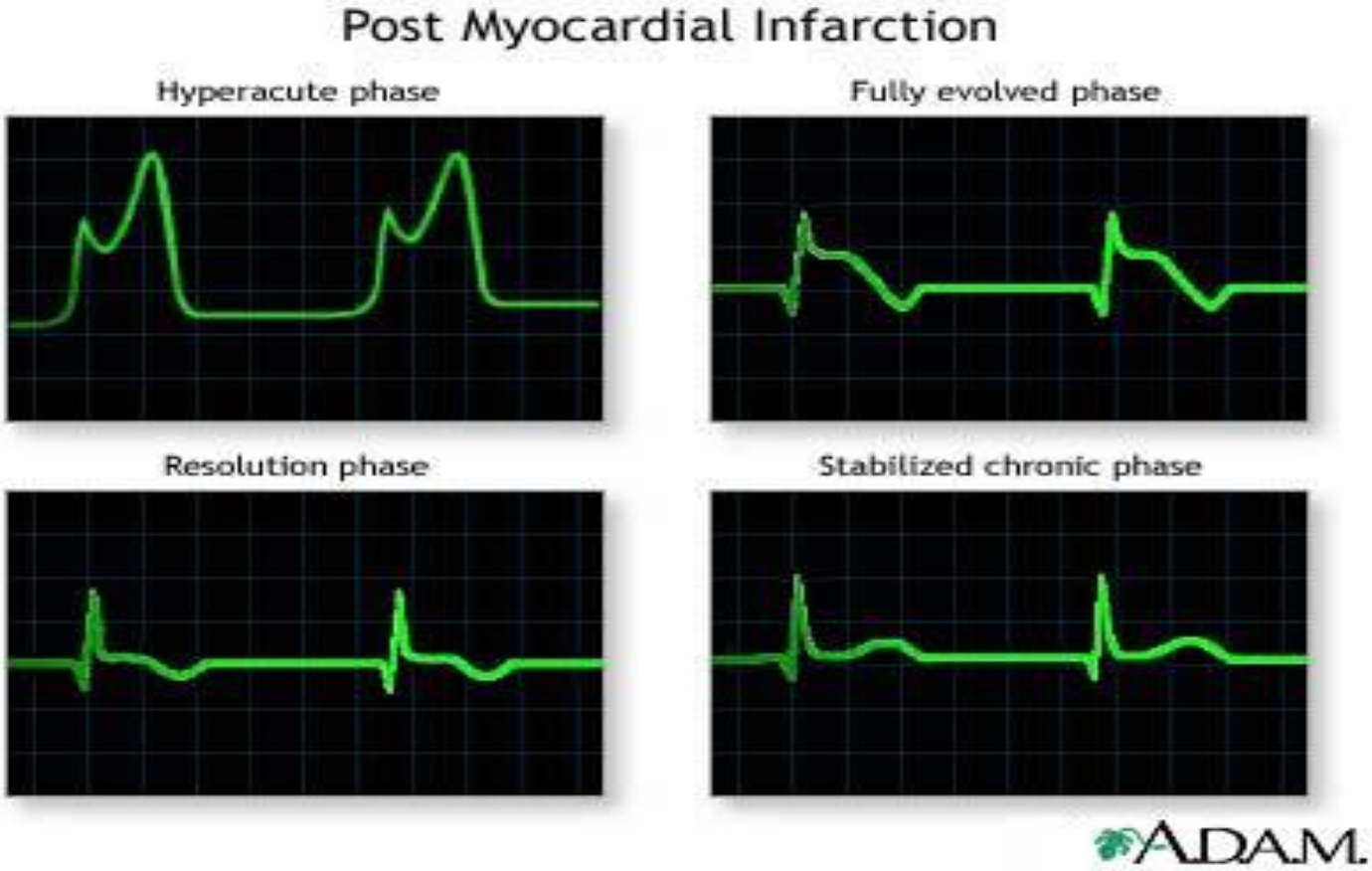
MI: Symptoms

- Retro-sternal tightening pain lasting >20min
- Radiation; left arm, neck, jaw
- Associated with sweating, vomiting, palpitations, faintishness, weakness
- Not relieved by GTN
- Acute shortness of breath
- (about 20%; no pain ‘silent’ esp in diabetics, elderly)
- No definite signs; sinus tachy, 4^{th} heart sound, basal crackles, pericardial rub later

Myocardial infarction

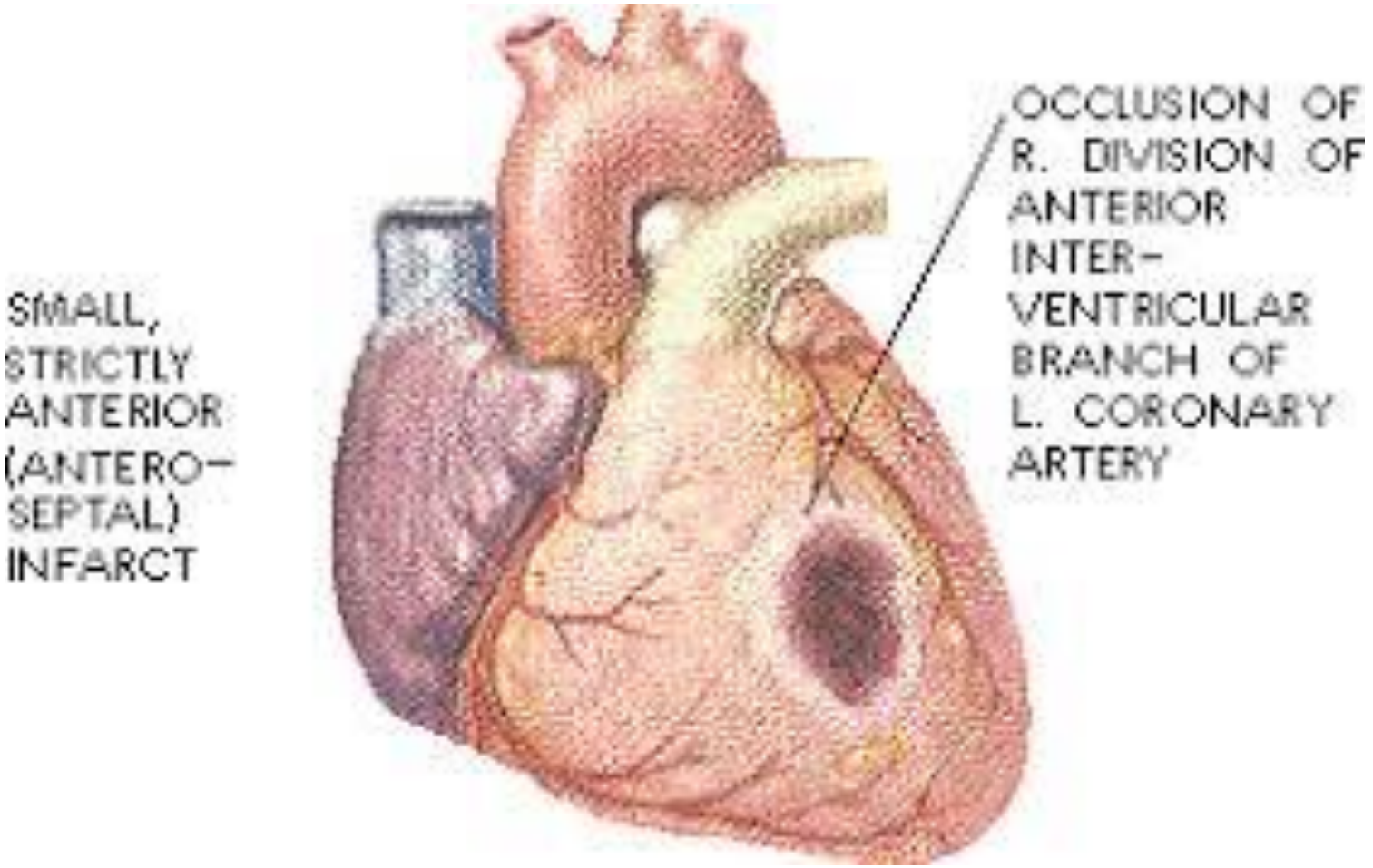
- Investigations
  - ECG
    - Acute:
      - ST elevation (STEMI), new onset LBBB,
      - non-ST elevation (non-STEMI)
  - Cardiac enzymes

ECG changes in myocardial infarction



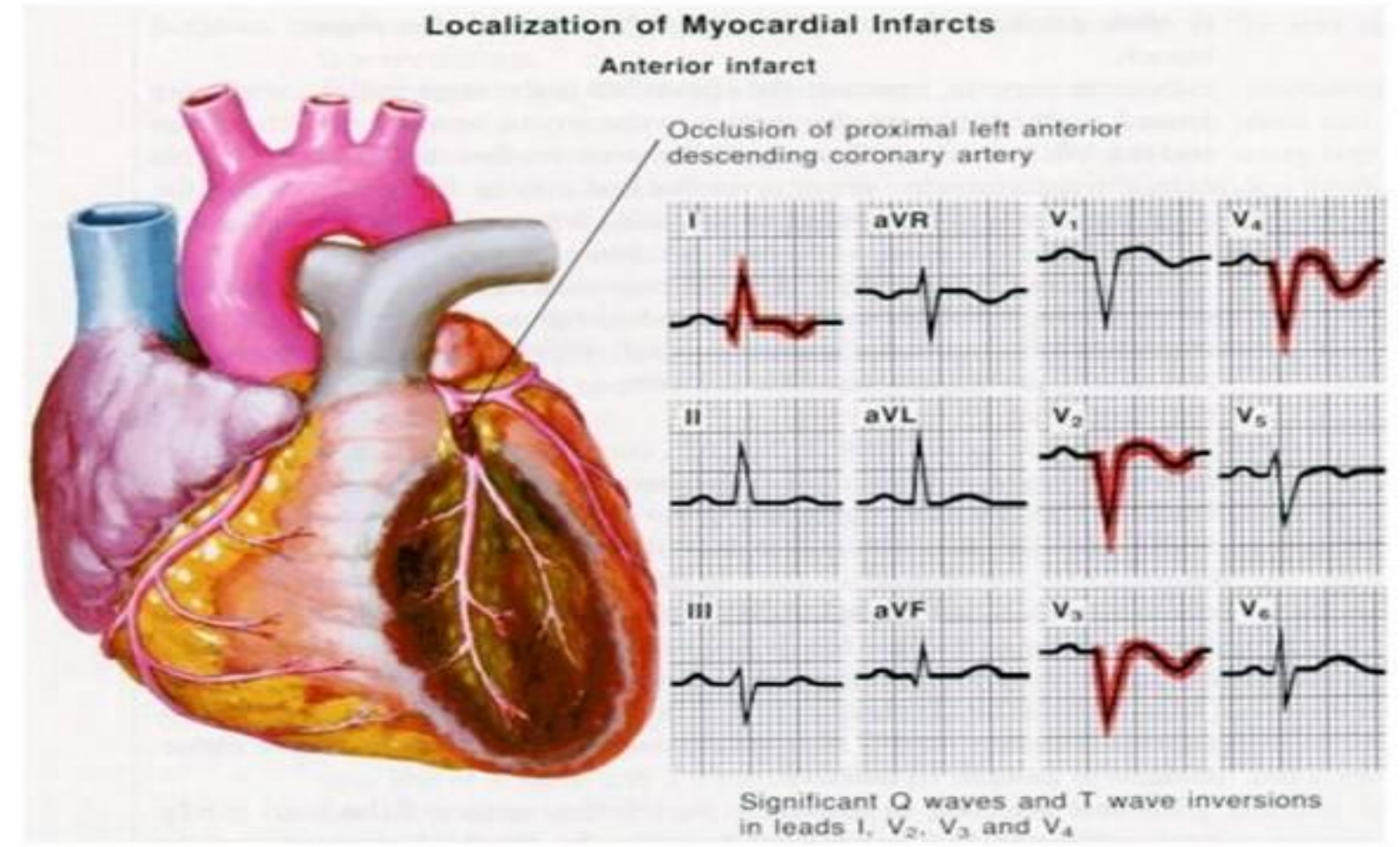
Corresponding leads

- Anterio septal: V1-V3 (V4)



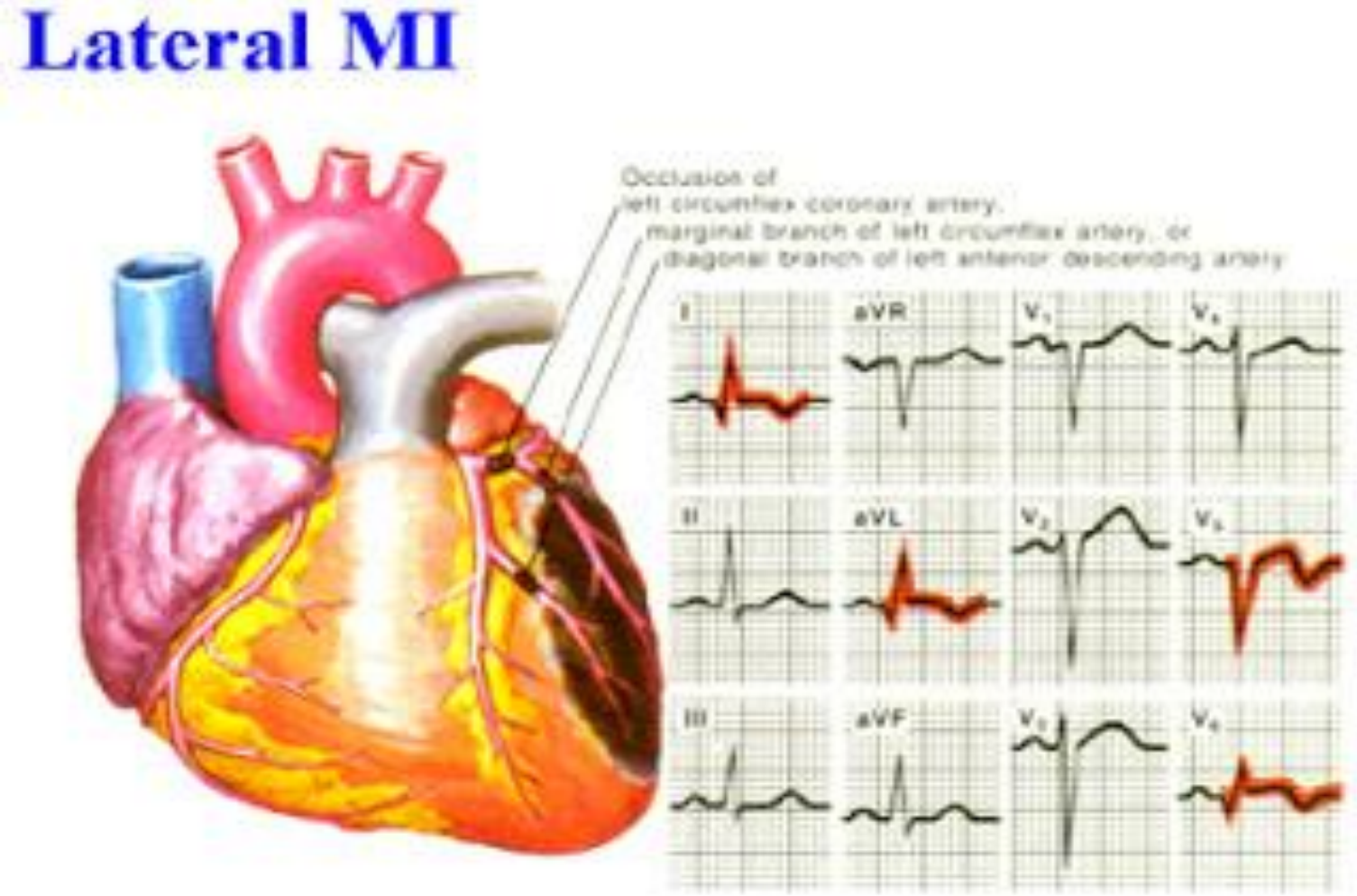
Corresponding leads

- Anterior: V1- V4



Corresponding leads

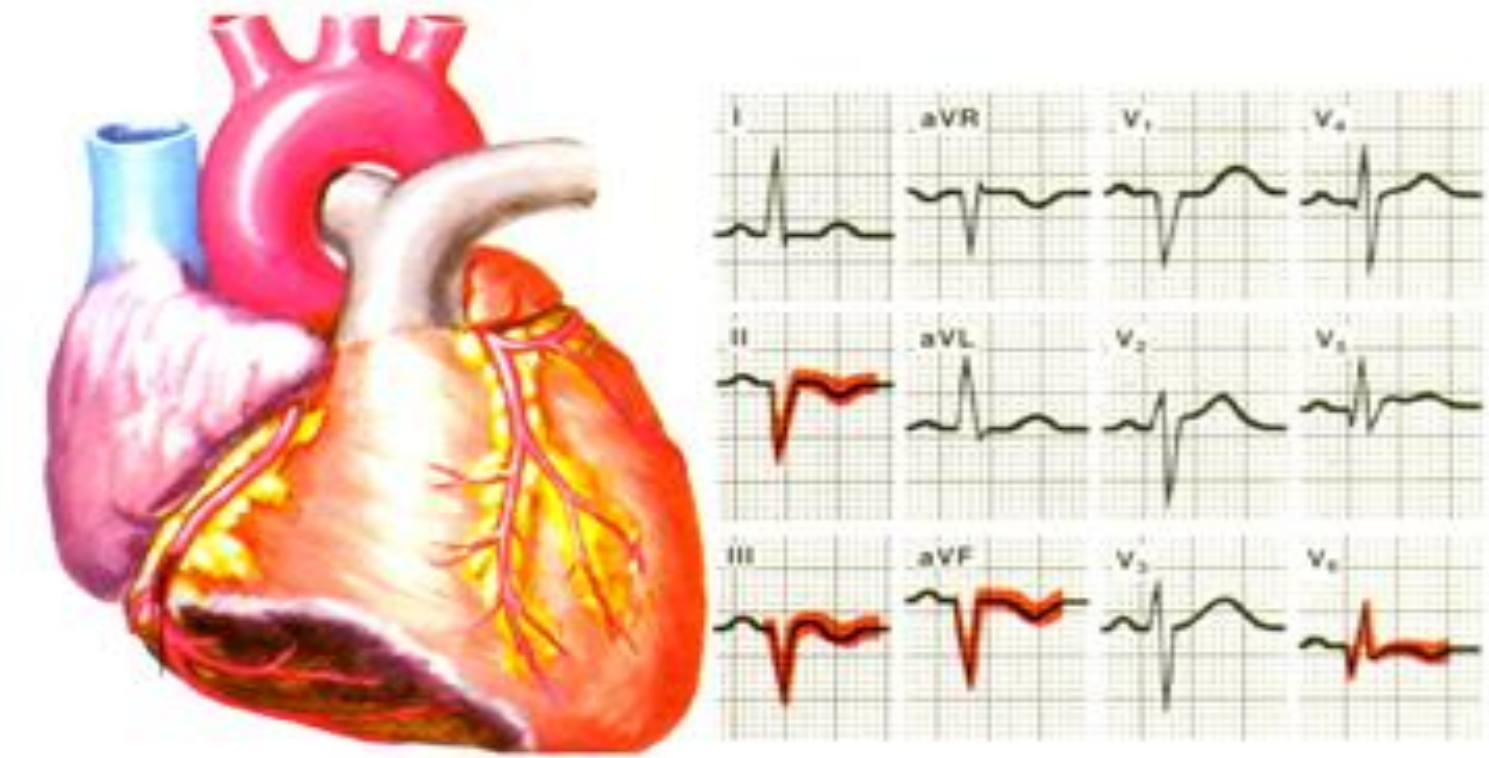
- Lateral: V5, V6, L1, aVL



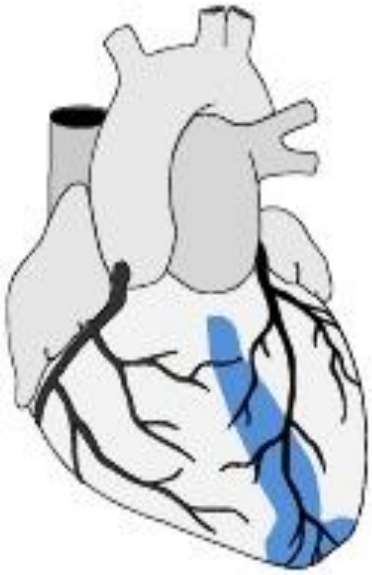
Corresponding leads

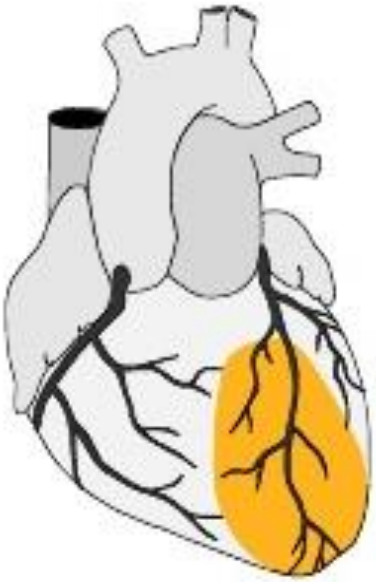
- Inferior: LII, LIII, aVF

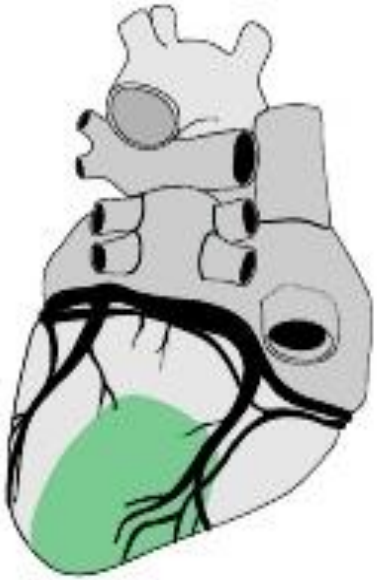
Inferior MI



Localization



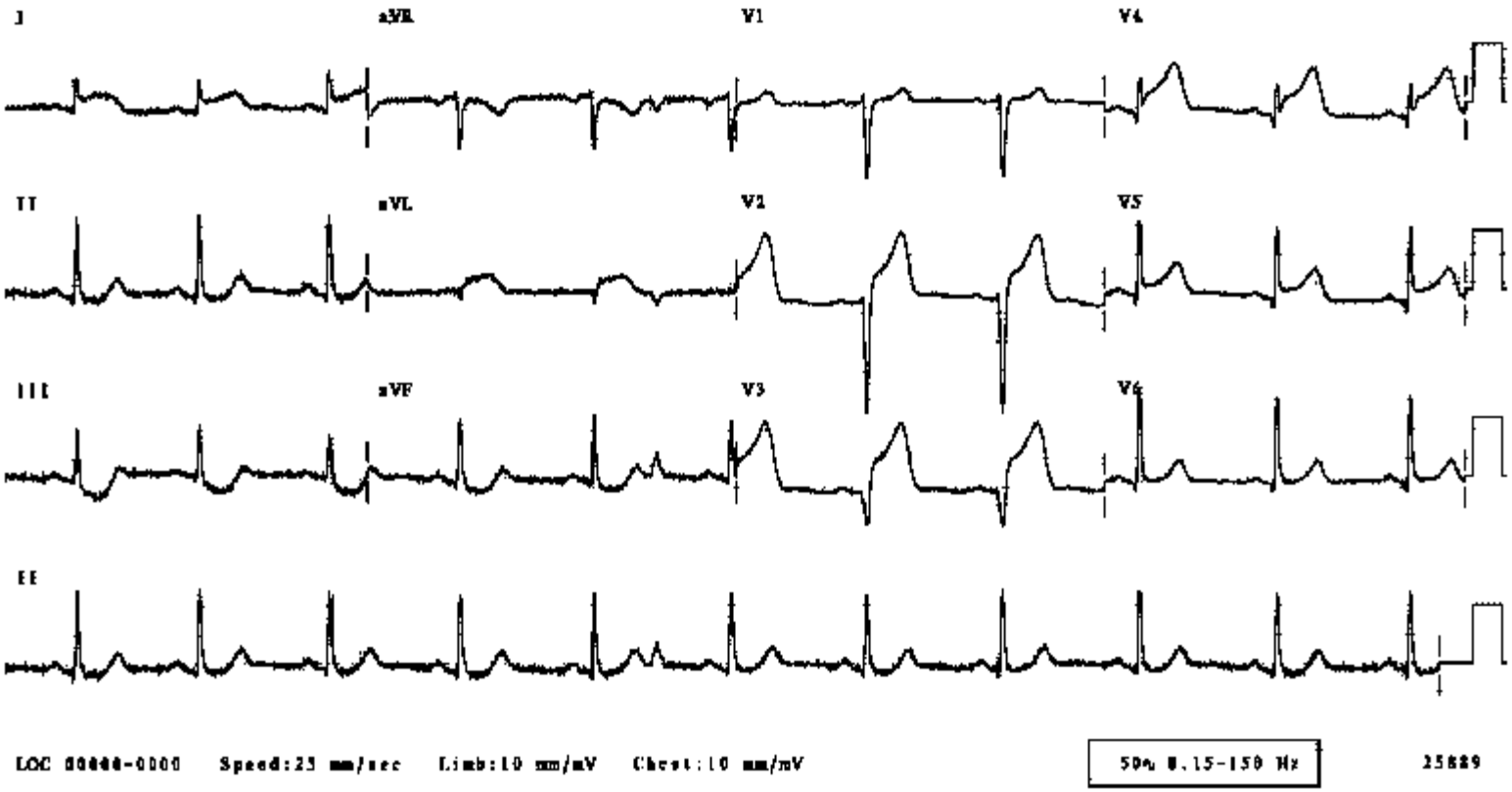




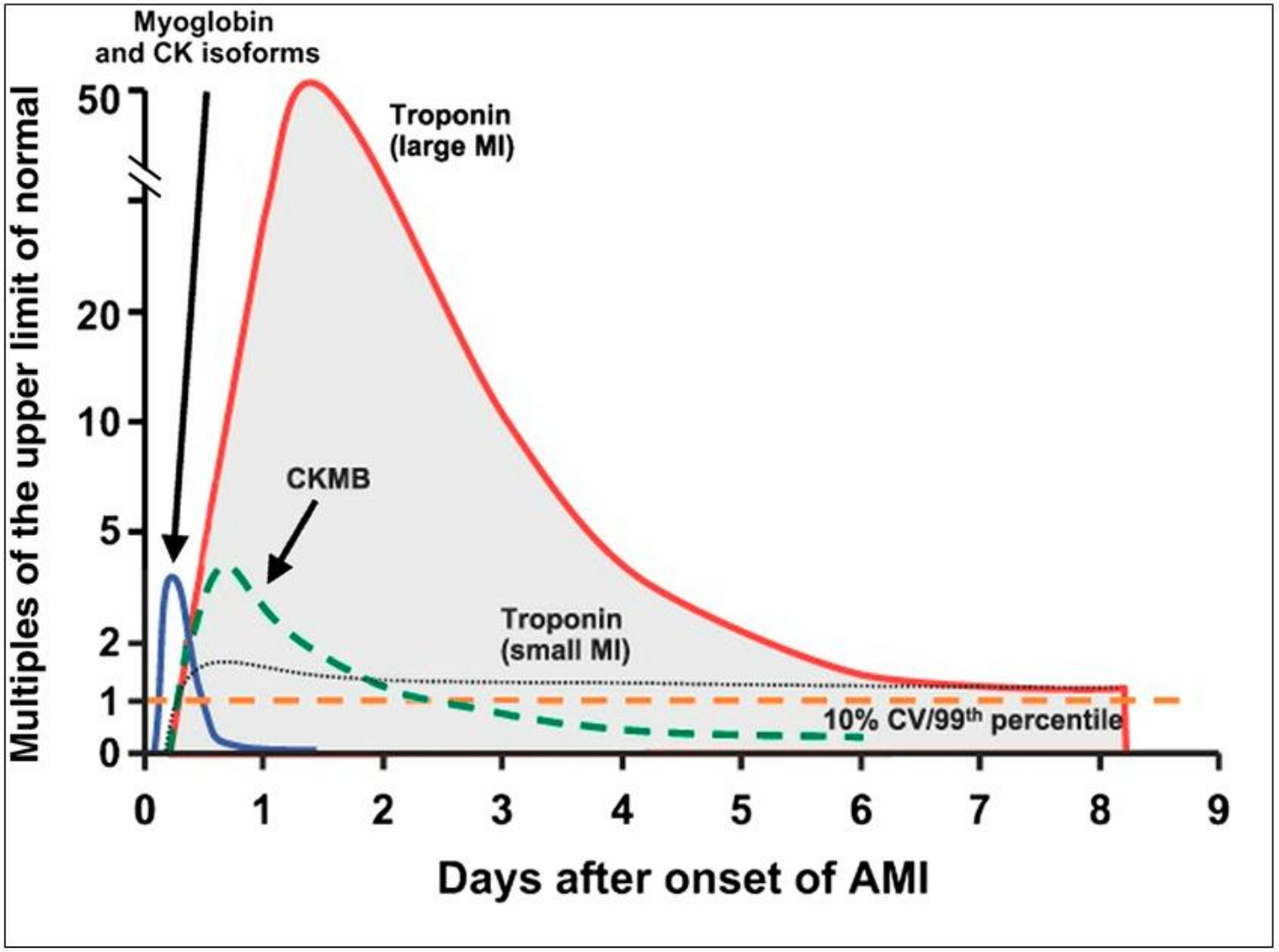
I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

Inferior: II, III, AVF
Septal: V1, V2
Anterior: V3, V4
Lateral: I, AVL, V5, V6

Acute anterior myocardial infarction



Cardiac enzymes in MI



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Increasingly sensitive and precise troponin assays

- Up to 80% of patients with acute MI will have an elevated troponin level within 2-3 hours
- 6-9 hours or more with CK-MB and other cardiac markers.

- Some rely solely on troponin and discontinuing the use of CK-MB and other markers

- CK-MB and other markers continue to be used in some hospitals to rule out MI and to monitor for additional cardiac muscle injury over time

- Cardiac markers are not necessary for the diagnosis if they present with ischemic chest pain and diagnostic ECGs with ST-segment elevation.

- These patients may be candidates for thrombolytic therapy or primary angioplasty.

- Treatment should not be delayed for cardiac marker results, especially since the sensitivity is low in the first 6 hours after symptom onset.

Complications following MI

- Acute
  - Cardiac arrhythmias (tachy arrhythmias / brady arrhythmias)
  - Cardiac failure and cardiogenic shock
  - Pericarditis
  - Myocardial rupture
- Late
  - Thrombo-embolism
  - Sub-acute myocardial rupture; tamponade
  - Acute septal defects
  - Acute mitral regurgitation
  - Post MI syndrome (Dressler’s syndrome)
  - Left ventricular aneurism

Unstable angina

Unstable angina

- Accelerating angina
- New-onset angina
- Angina – unstable
- Progressive angina
- Post MI angina

Unstable angina

- Unstable angina describes a syndrome
  - intermediate between stable angina and myocardial infarction
  - an accelerating or "crescendo" pattern of chest pain that lasts longer than stable angina,
  - occurs with less exertion or at rest,
  - less responsive to medication.

Unstable angina

- Pathophysiology
  - Atheromatous stenosis
    - Progressive and more severe stenosis
    - Commonly poor coronary reserve
    - Two or three vessel disease
    - Frequently need surgery
  - Coronary thrombosis
    - Small thrombi on diseased vessels
  - Coronary vasoconstriction
    - In a normal vessel/ diseased vessel

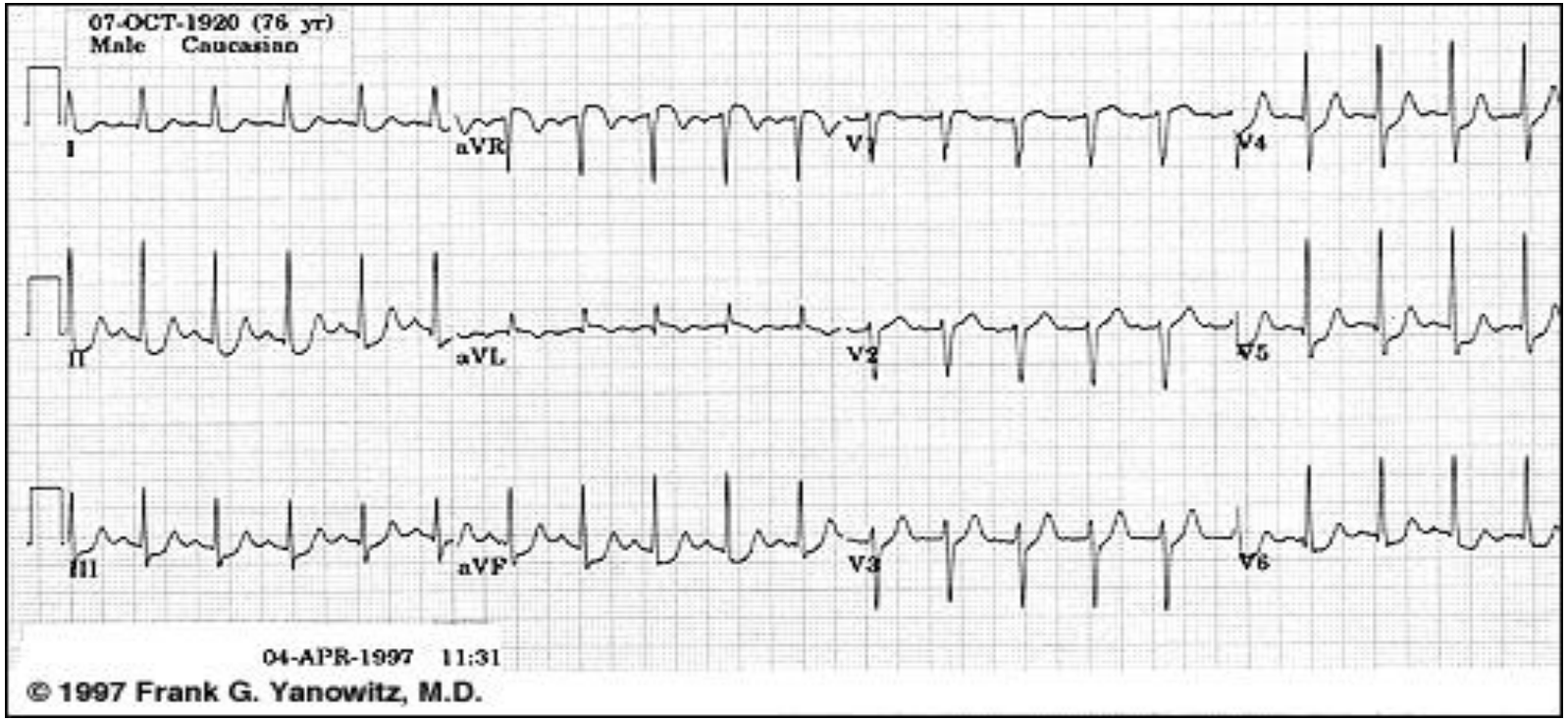
Unstable angina

- Diagnosis:
  - History- similar to MI / progressive angina
  - Examination-
  - Investigations-
    - ECG: ST depression, T wave abnormalities
    - Cardiac enzymes: “normal”

Non STEMI

- Diagnosis:
  - History- similar to MI / progressive angina
  - Examination-
  - Investigations-
    - ECG: ST depression, T wave abnormalities
    - Cardiac enzymes: deranged

A 55 years old male presented with acute severe retostenal tightening chest pain of 20 min duration



If cardiac enzymes normal: Unstable angina

If cardiac enzymes elevated: Non-STMI