CORONARY ARTERY DISEASE SURGICAL ASPECTS

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INTRODUCTION

HISTORY OF CARDIAC SURGERY

CORONARY ARTERY ANATOMY

ATHEROSCLEROSIS CAD

main cause of ischemic heart disease

DIAGNOSIS

MANAGEMENT

SURGICAL INDICATIONS /TECHNIQUES

Adult Cardiac Surgery: Ischemic Heart Disease

- **Alexis Carrel-** the first one who diagnose the calcification of coronary artery disease
  the first one who think to do anastomosis from descending aorta to coronary artery

"In certain cases of angina pectoris, when the mouth of the coronary is calcified, it would be useful to establish a complementary circulation for the lower part of the arteries. I attempted to perform an…anastomosis between the descending aorta and the left coronary. It was, for many reasons, a difficult operation."

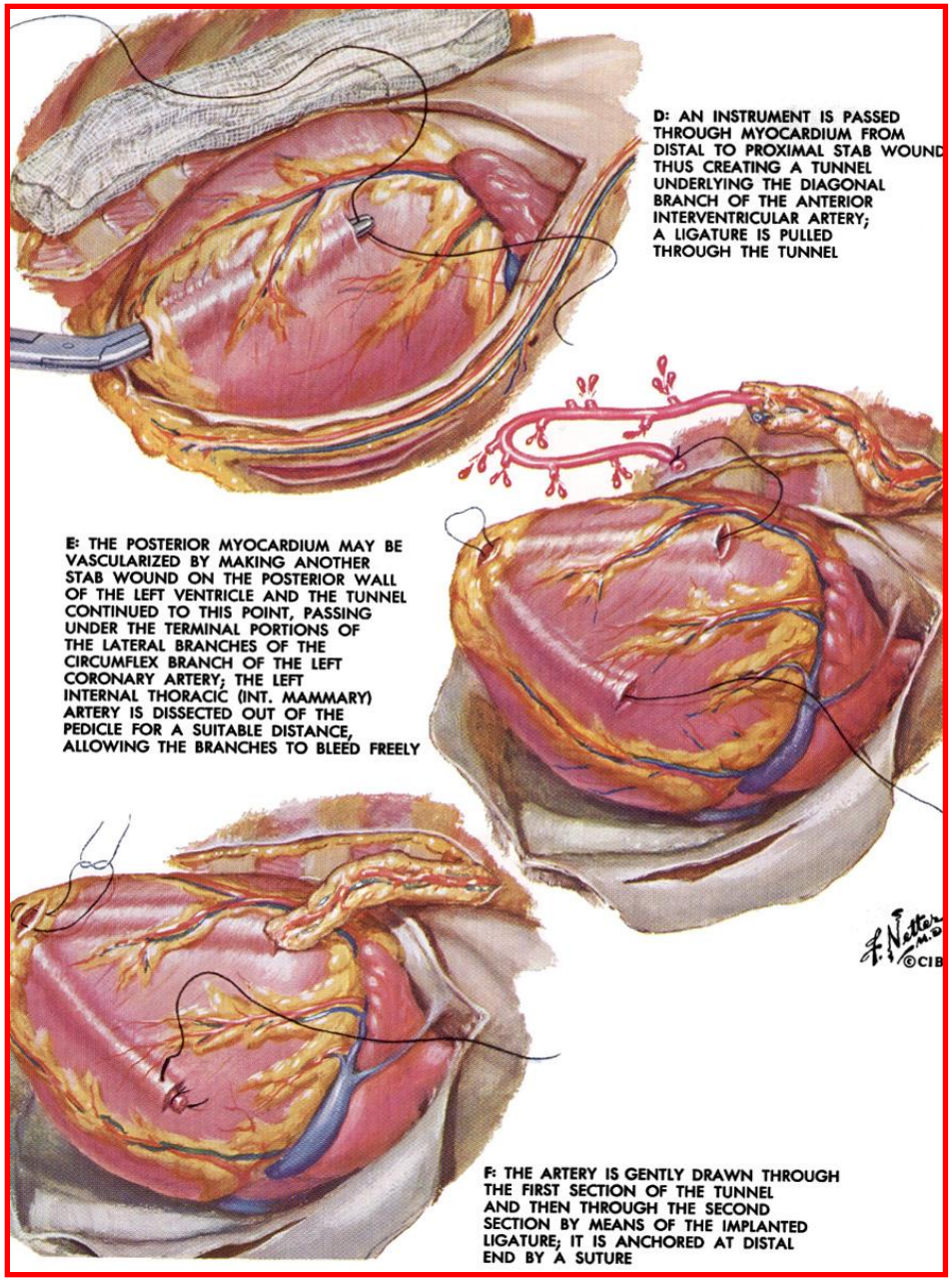
American Surgical Association, 1910

Adult Cardiac Surgery: Ischemic Heart Disease (History)

- **Claude Beck** wrapping the heart with omentum (do neoangigenesis
  - **1930's**- sought to increase myocardial blood flow indirectly with pericardial fat and omentum.
- **Arthur Vineberg** the first one who try to perfuse the heart (he try to implant the internal mammary artery in the wall of the heart as a tunnel)
  - **1940's**- Mobilization of left internal mammary artery with implantation of bleeding end into the left ventricle.
  - **1964**- follow-up study on 140 patients

    33% mortality

    85% relief from angina


D: AN INSTRUMENT IS PASSED THROUGH MYOCARDIUM FROM DISTAL TO PROXIMAL STAB WOUND THUS CREATING A TUNNEL UNDERLYING THE DIAGONAL BRANCH OF THE ANTERIOR INTERVENTRICULAR ARTERY; A LIGATURE IS PULLED THROUGH THE TUNNEL
E: THE POSTERIOR MYOCARDIUM MAY BE VASCULARIZED BY MAKING ANOTHER STAB WOUND ON THE POSTERIOR WALL OF THE LEFT VENTRICLE AND THE TUNNEL CONTINUED TO THIS POINT, PASSING UNDER THE TERMINAL PORTIONS OF THE LATERAL BRANCHES OF THE CIRCUMFLEX BRANCH OF THE LEFT CORONARY ARTERY; THE LEFT INTERNAL THORACIC (INT. MAMMARY) ARTERY IS DISSECTED OUT OF THE PEDICLE FOR A SUITABLE DISTANCE, ALLOWING THE BRANCHES TO BLEED FREELY
F. Netter M.D.
©CIB
F: THE ARTERY IS GENTLY DRAWN THROUGH THE FIRST SECTION OF THE TUNNEL AND THEN THROUGH THE SECOND SECTION BY MEANS OF THE IMPLANTED LIGATURE; IT IS ANCHORED AT DISTAL END BY A SUTURE

Adult Cardiac Surgery: Ischemic Heart Disease (History)

- **Mason Sones,** the first one who create the angiogram

  1950's- cine coronary arteriography.

  1962- direct and reproducible catheterization of the coronary arteries.

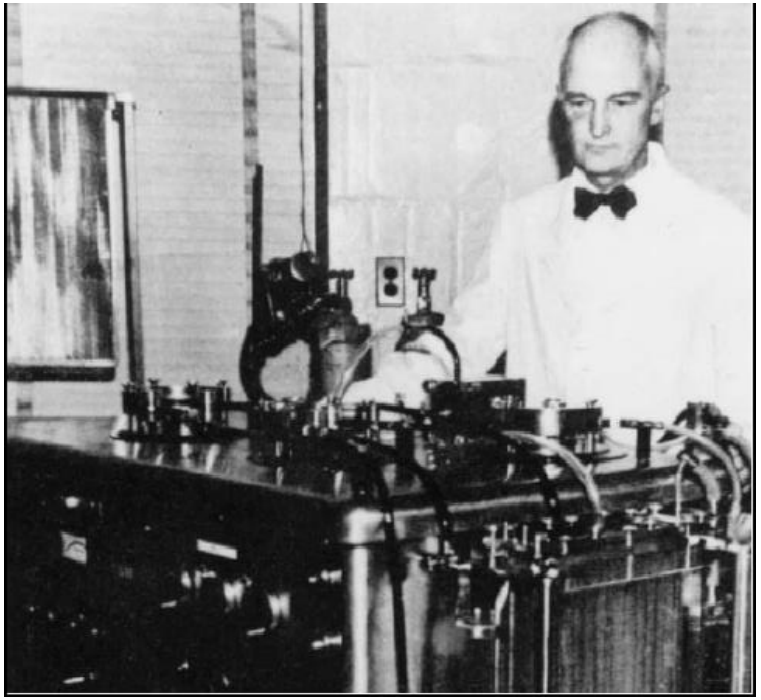
  "Collectively, all of the cardiological advances in this century pale in comparison with this priceless achievement."

  Floyd Loop, MD

Adult Cardiac Surgery: Ischemic Heart Disease (History)

John H. Gibbon, Jr.

"During the long night, helplessly watching the patient struggle for life as her blood became darker and her veins more distended, the idea naturally occurred to me that if it were possible to remove some of the blue blood…put oxygen into that blood and allow carbon dioxide to escape from it, and then to inject continuously the now-red blood back into the patient's arteries, we might have saved her life."



- Heart-lung machine
- May 6, 1953- ASD closure

Heart Lung Machine

Adult Cardiac Surgery: Ischemic Heart Disease (History)

- 1962- **David C. Sabiston, Jr.-** the first one who do a direct anastomosis between the aorta and coronary artery
  - Aortocoronary saphenous vein bypass
- **KOLOSOV** LIMA -LAD 1964 IN Russia
- **Frank Spencer/George Green**
  - Internal mammary artery

Adult Cardiac Surgery: Ischemic Heart Disease (CABG)

- Early and widespread acceptance of coronary bypass was delayed.

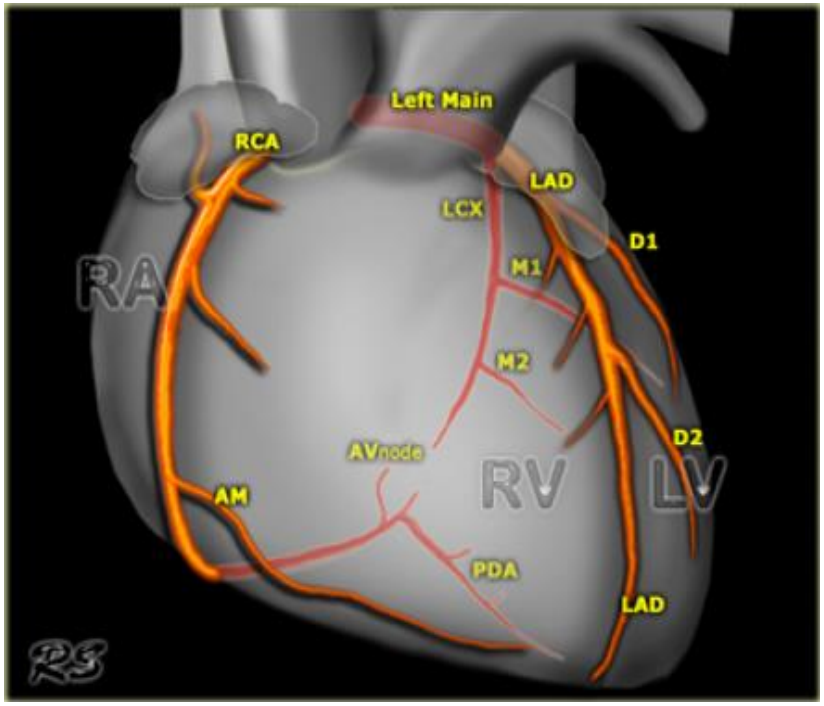
- Best known cooperative studies (1970-80's) were the;

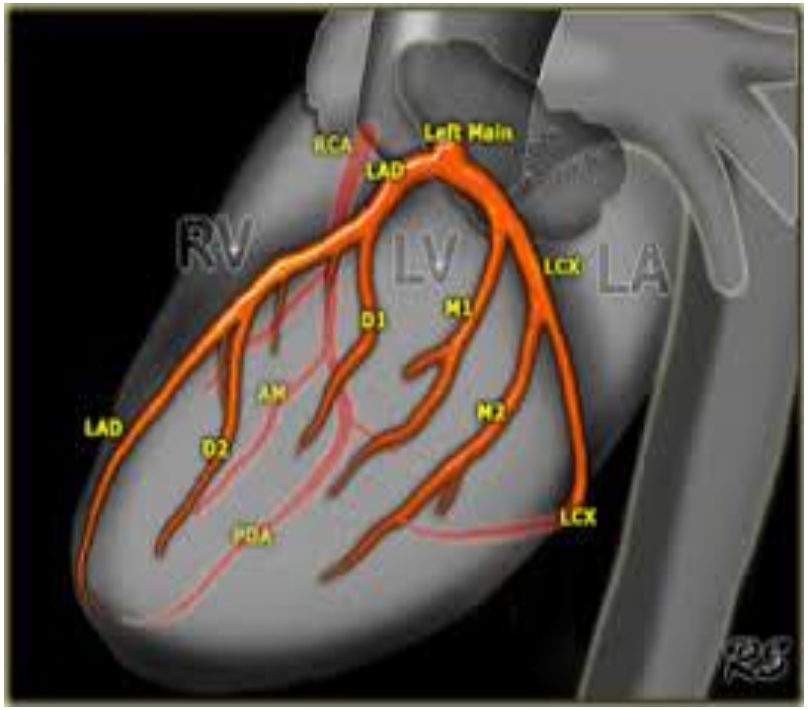
  VA

  Coronary **A**rtery **S**urgery **S**tudy

  European Coronary Surgery Study

The Normal Heart - Coronary Artery Anatomy

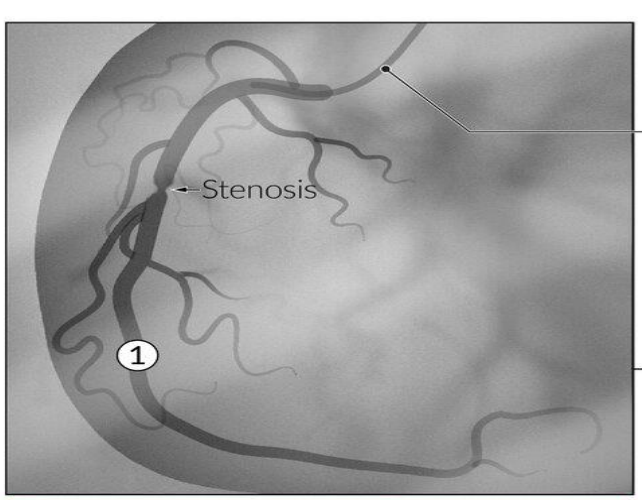


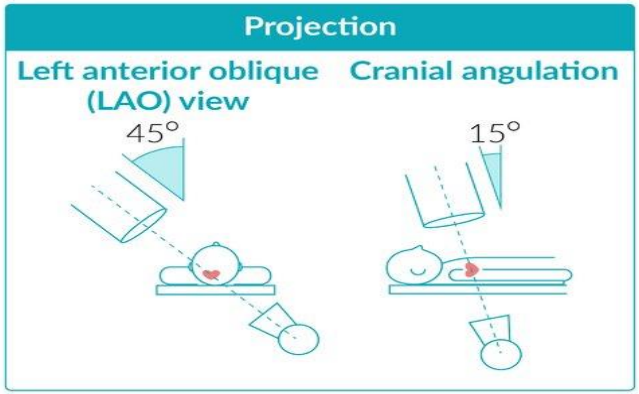


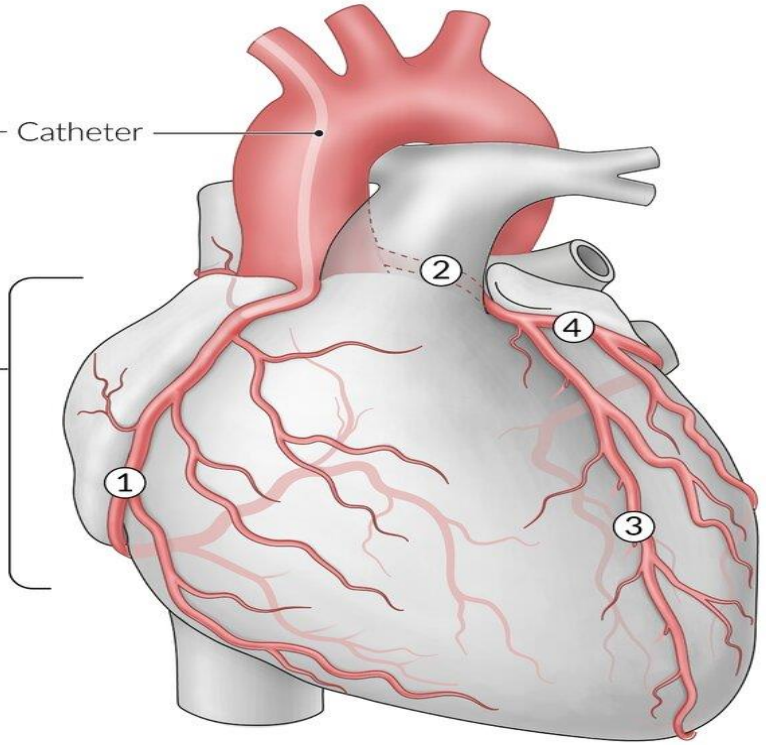
-right coronary artery (dominant artery) --> arise from the right anterior coronary sinus of aorta --> supply right atrium / right ventricle / posterior descending artery PDA (supply inferior 1/3 of the septum and the AV node)
-left main coronary artery (short artery)--> arise from left posterior sinus of the aorta --> branch to 1- left anterior descending (LAD) down to the apex supply the left ventricle and the septum 2- circumflex
-posterior sinus of the aorta --> called non coronary (on the right side)
in 80% of population --> the right coronary artery is the dominant one and supply the PDA which supply the AV node
in 10% of population --> the circumflex is the dominant and supply the PDA which supply the AV node
in 10 % of population --> the PDA supplied from both right coronary artery and circumflex

Ischaemic Heart Disease

- It results from imbalance between oxygen demand and supply







1. Right coronary artery (RCA) using in cath
2. Left coronary artery (LCA)
3. Left anterior descending artery (LAD)
4. Left circumflex artery (LCx)

left coronary artery --> behind the pulmonary artery --> branching to LAD and circumflex

Aetiology

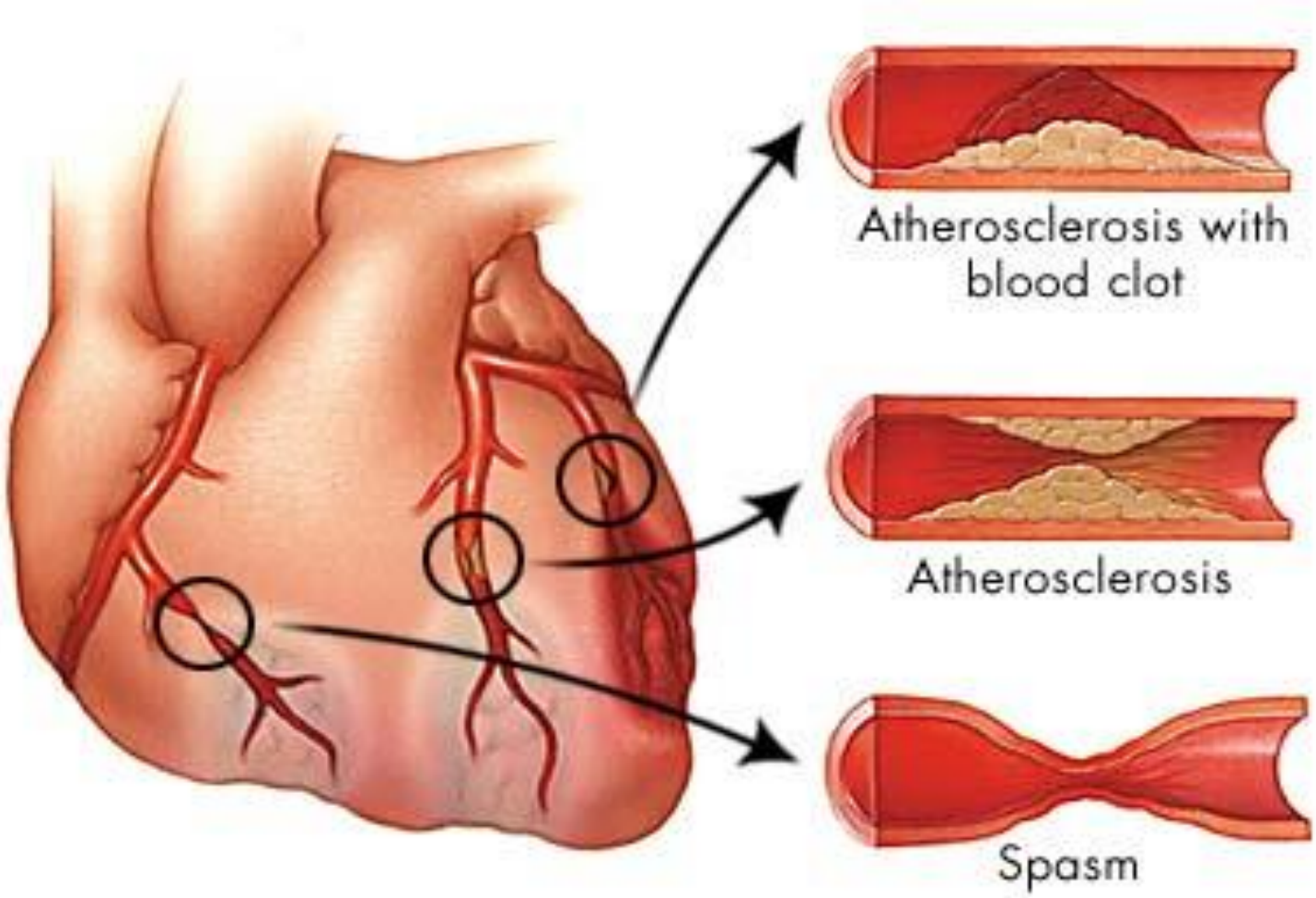
cause of decrease blood supply in the heart through the flow of blood in coronary arteries

- **Atherosclerosis (>90%)** deposition of plaques in coronary artery most common cause
- **Embolisation**
- **Coronary spasm**
- **Vasculitis**
- **Ostial stenosis**
- **Severe LVH**
- **Congenital anomalies of the coronary artereis (e.g anomalous origin of LAD artery from pulmonary artery)** the cause of sudden death in athletes people when they do heavy exercise

rare causes

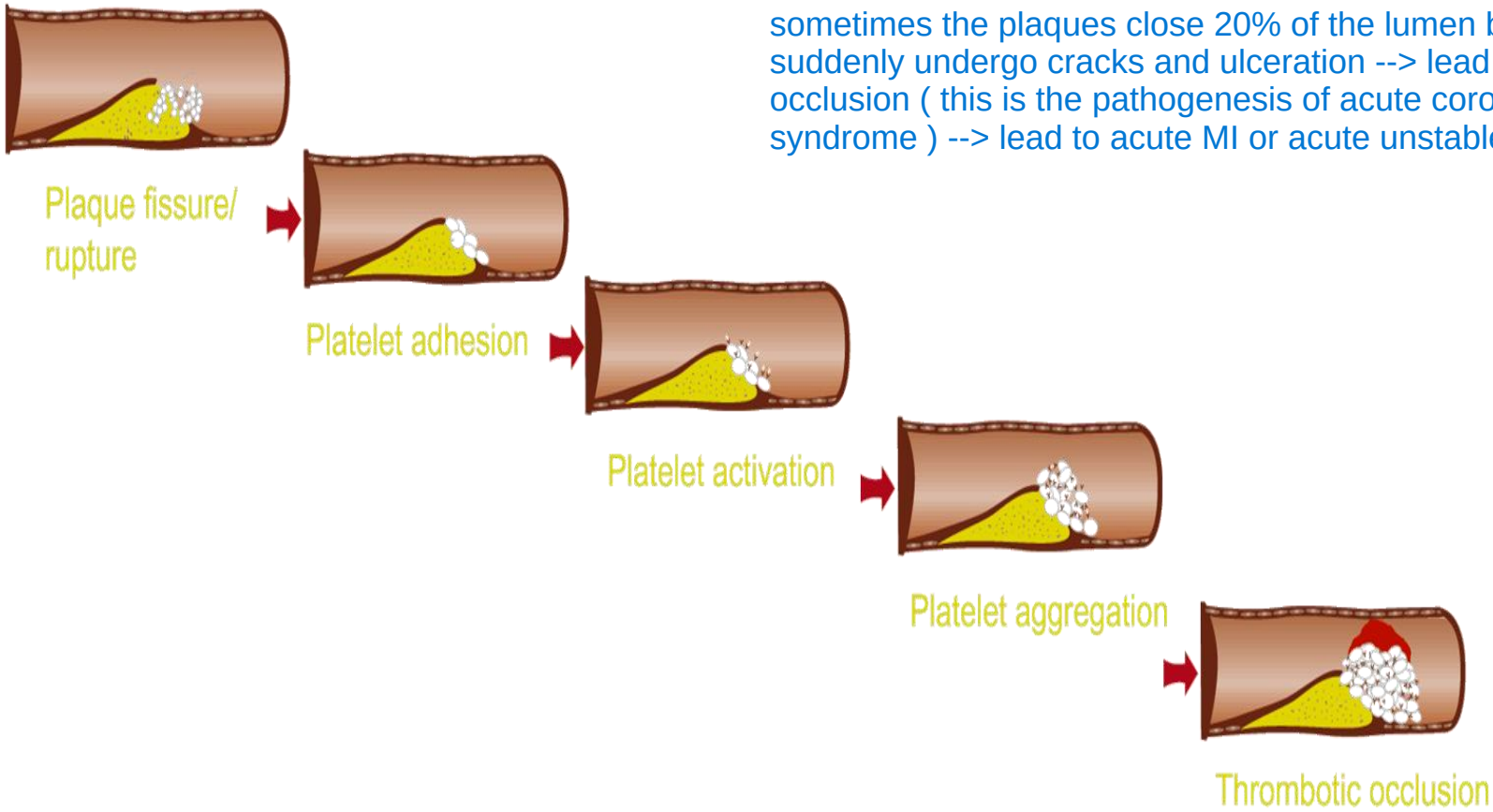
- the right coronary artery arise from the posterior sinus (between the pulmonary artery and aorta and get compressed) rather than the anterior sinus
-the LAD arise from the right coronary rather than the left one
-the circumflex arise from right coronary rather than the left one

plaques buildup slowly in the coronary arteries and cause narrowing

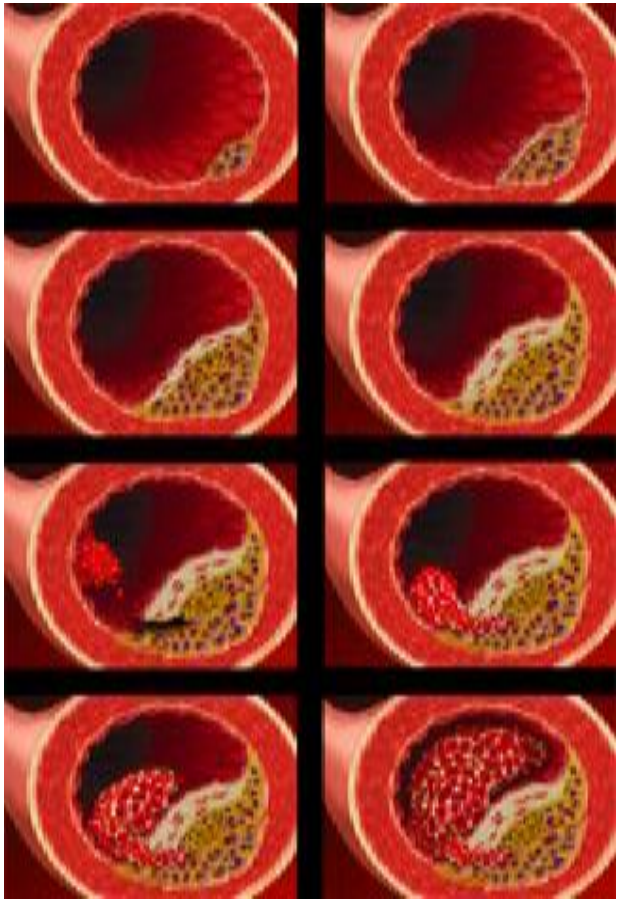


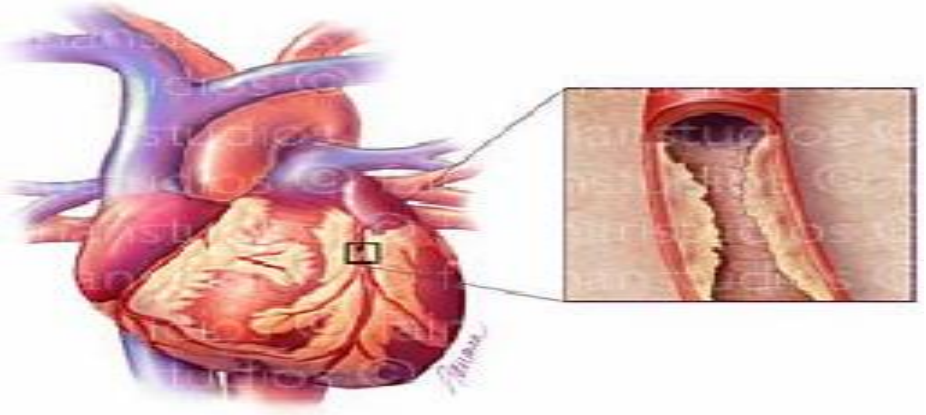
Pathogenesis of ACS

sometimes the plaques close 20% of the lumen but suddenly undergo cracks and ulceration --> lead to acute occlusion (this is the pathogenesis of acute coronary syndrome) --> lead to acute MI or acute unstable angina



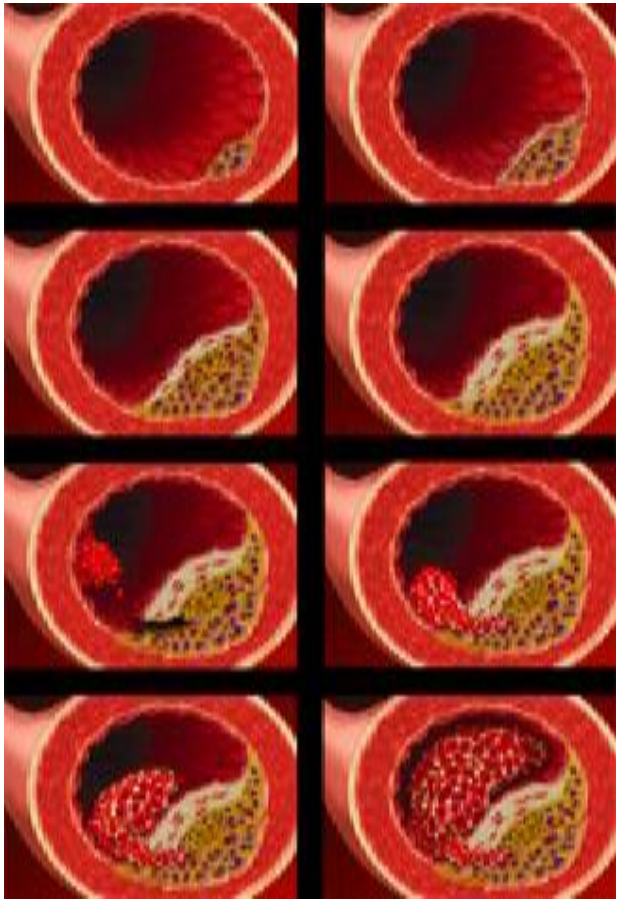
ATHEROSCLEROSIS

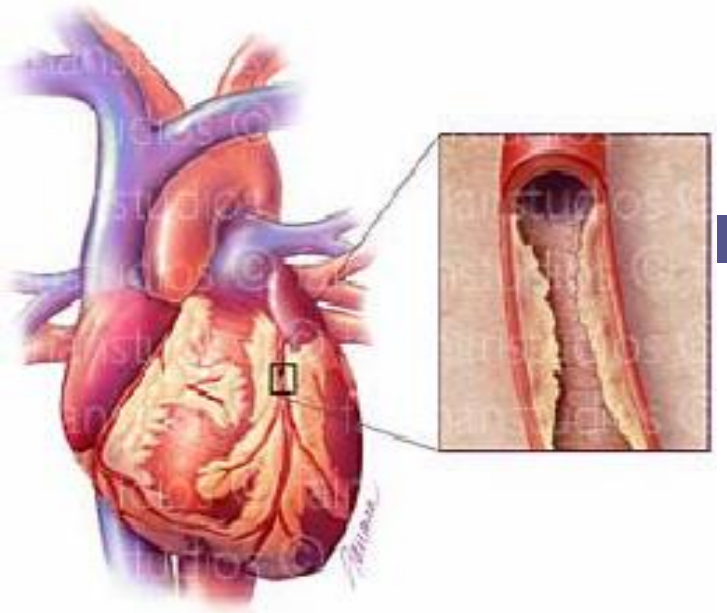


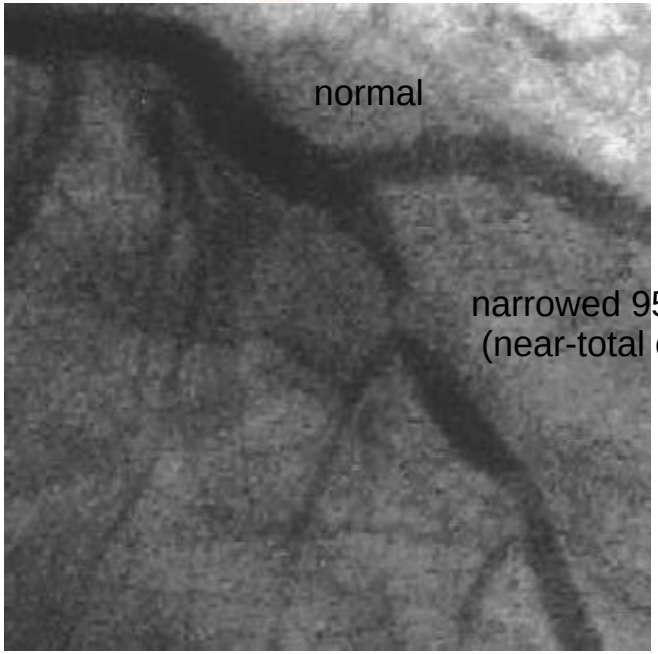


when the lumen narrowed 70% of the lumen diameter --> lead to significant reduction in the flow of coronary artery

ATHEROSCLEROSIS







atherosclerosis is a systemic disease

Risk Factors

of atherosclerosis of coronary artery

Uncontrollable

- Sex
- Hereditary
- Race
- Age

Controllable

- High blood pressure
- High blood cholesterol
- Smoking
- Physical activity
- Obesity
- Diabetes
- Stress and anger

CAD

- **Diagnosis**

1. History
2. Physical examination
3. ECG findings
4. cardiac enzymes

Investigations

- **ECG**
- **Cardiac enzymes**
- **Chest x-ray** for cardiomegaly
- **FBS**
- **Serum lipids**
- **TMT** tredmel test
- **Stress or pharmacologic stress myocardial perfusion studies**
- **Cardiac CT-Scan** show the calcification
- **Coronary angiography**

Treatment of CAD

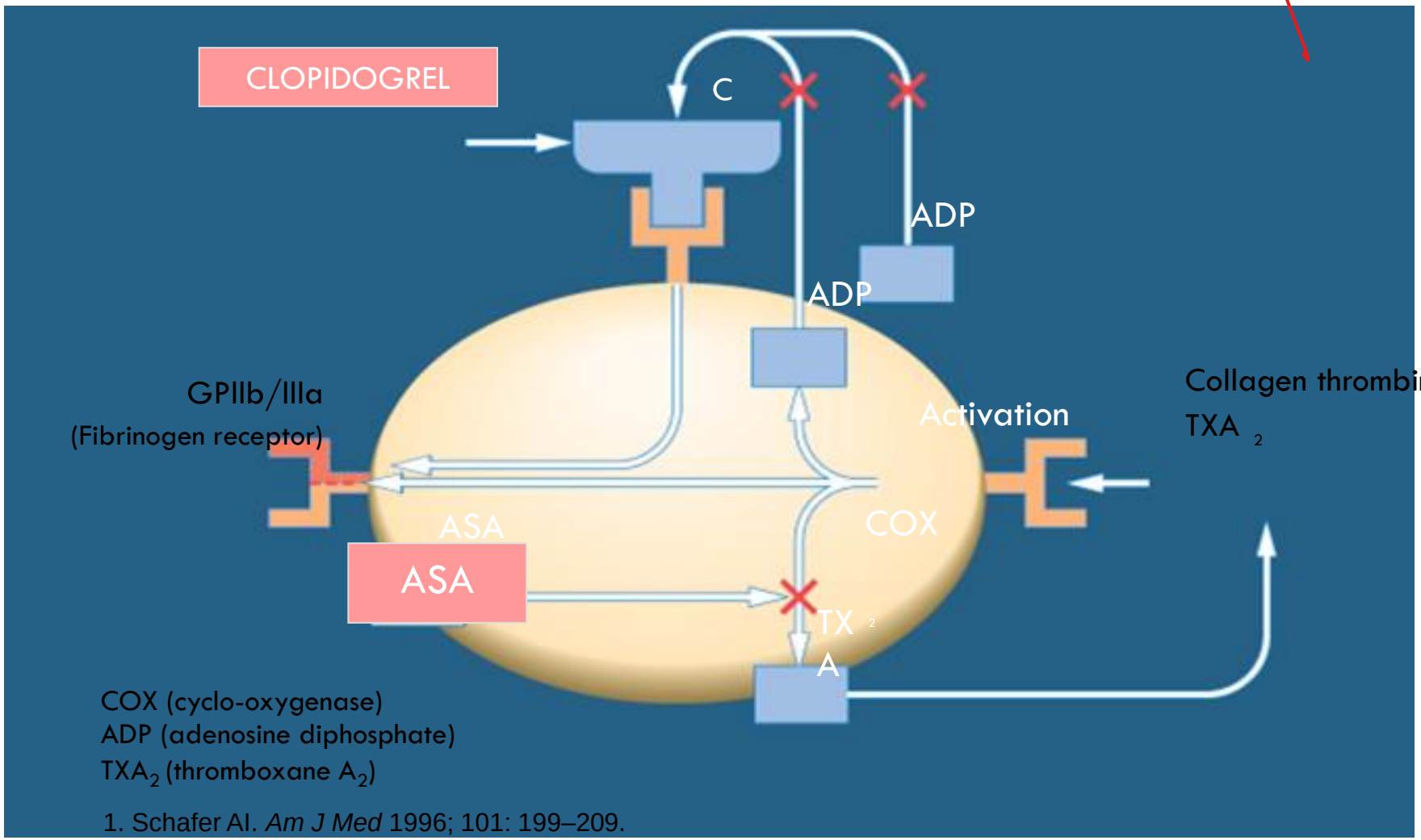
- Nitrates vasodilator
- Beta blockers
- Aspirin/PLAVIX DUAL ANTIPLATELT THERAPY
- Ca-channel blockers(in coronary spasm)
- Treating the associated risk factors
- Treating the precipitating factor
- Revascularization (if indicated)

  SURGICAL VS INTERVENTIONAL

ADP pathway inhibitors

cyclooxygenase enzyme inhibitor

Synergistic Mode of Action with Clopidogrel and ASA[1]



1. Schafer AI. *Am J Med* 1996; 101: 199–209.

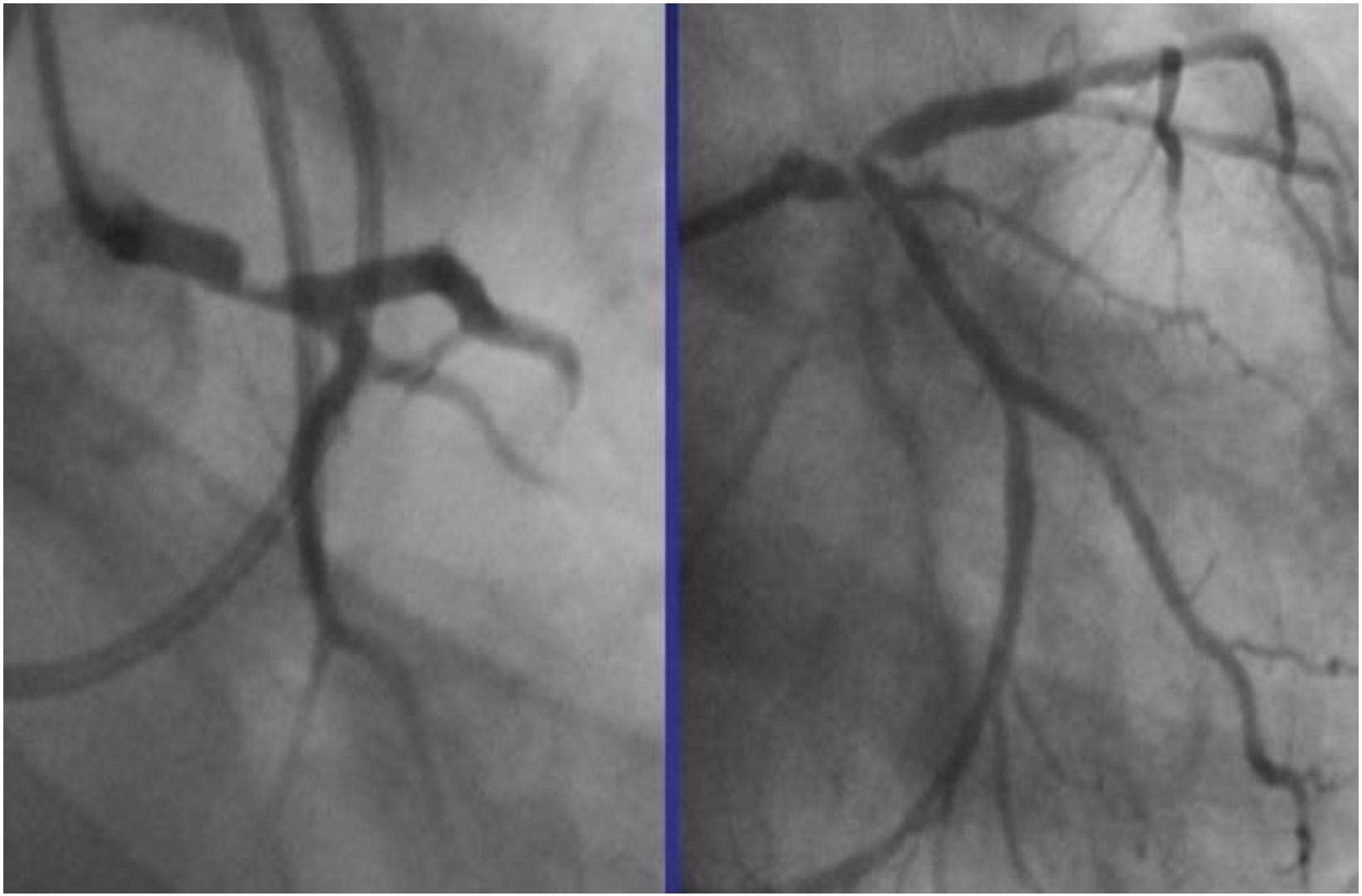
Indications for open-heart surgery

the most important and strongest class one indications of CABG --> depressed cardiac function

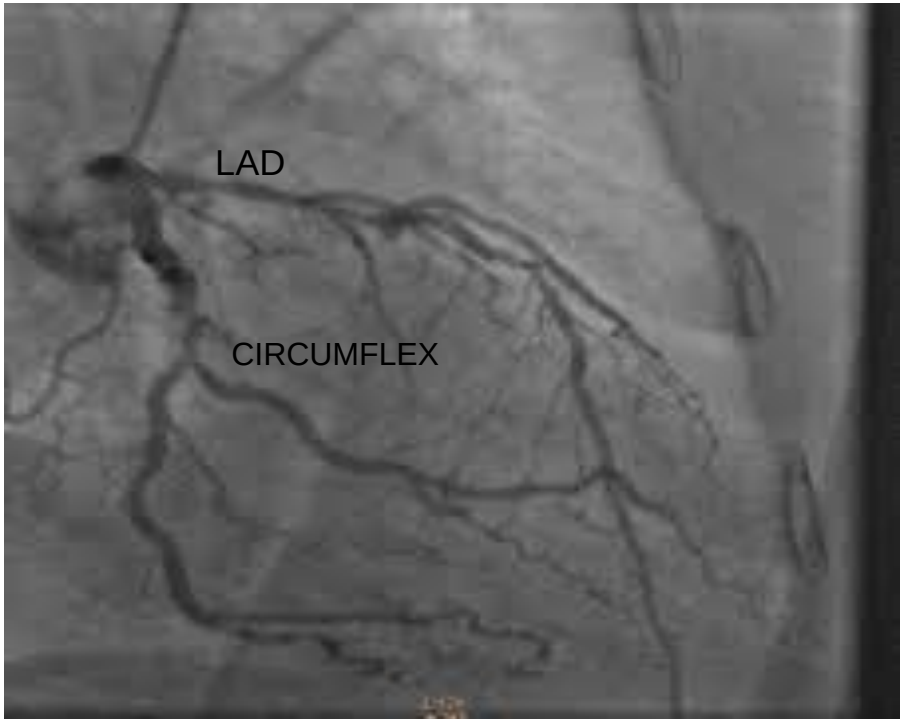
Coronary Artery Bypass Grafting: (CABG)

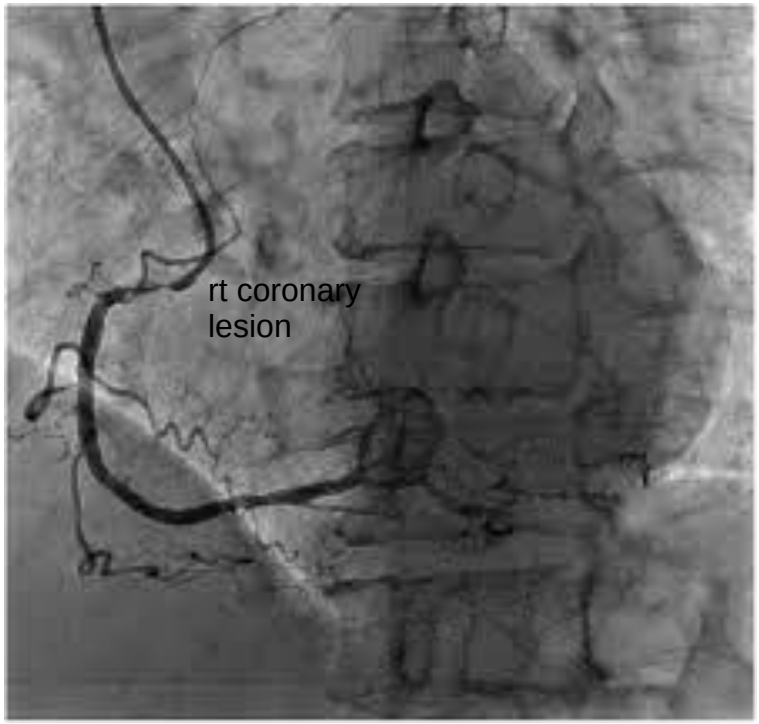
- Triple vessel disease — RCA / LAD / circumflex
- Lf main coronary artery disease — 50% narrowing of left main coronary artery --< strong indication
- Unstable angina ,failed Mx therapy — medical
- Complications of PTCA — percutaneous translumenal coronary angioplasty (like thrombosis / dissection / perforation of coronary artery)
- Life threatening complications of MI — important indication
  -cardiogenic shock (irreversible to treatment and drug)
  -post MI ventricular septal defect
  -post MI with muscle necrosis and severe acute Mitral valve regurgitation
- Anomalies of Coronary arteries.

tight left main coronary artery (significant)



circumflex lesion and LAD lesion and right coronary artery
(triple coronary disease) --> very strong indication



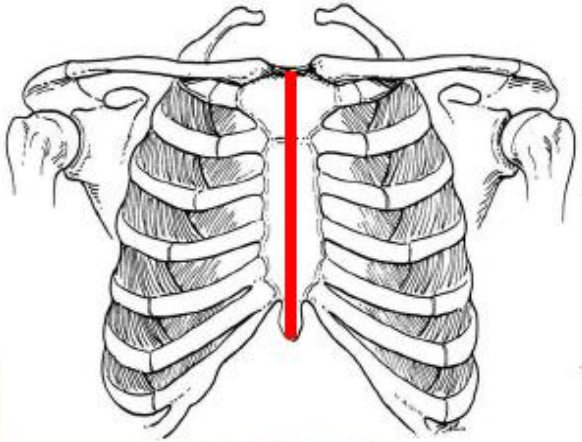


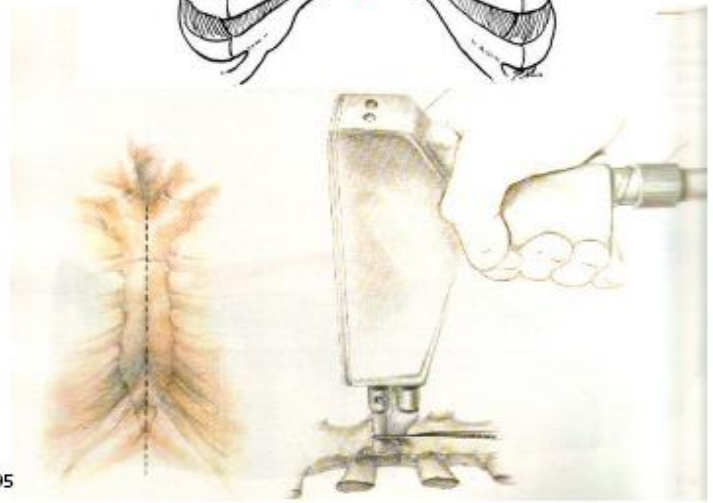
Adult Cardiac Surgery: CABG Techniques

- Median sternotomy
- Cardiopulmonary bypass
- Cardioplegic arrest
- Mammary artery, reversed saphenous vein, radial artery.

Sternotomy

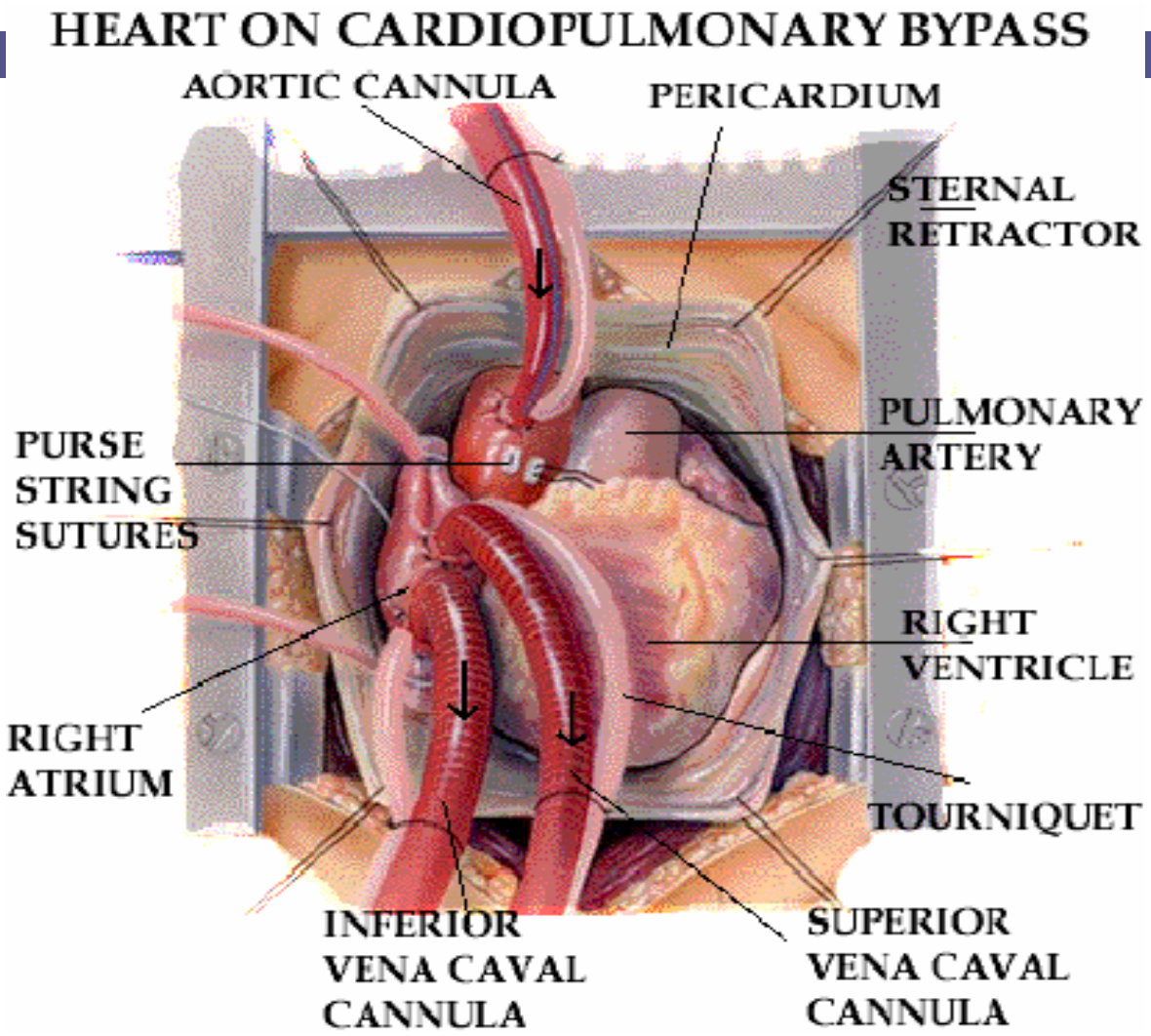
- Sternotomy approach
  - allows almost all cardiac procedures
  - best overall access to the heart
- The sternum is divided with a saw



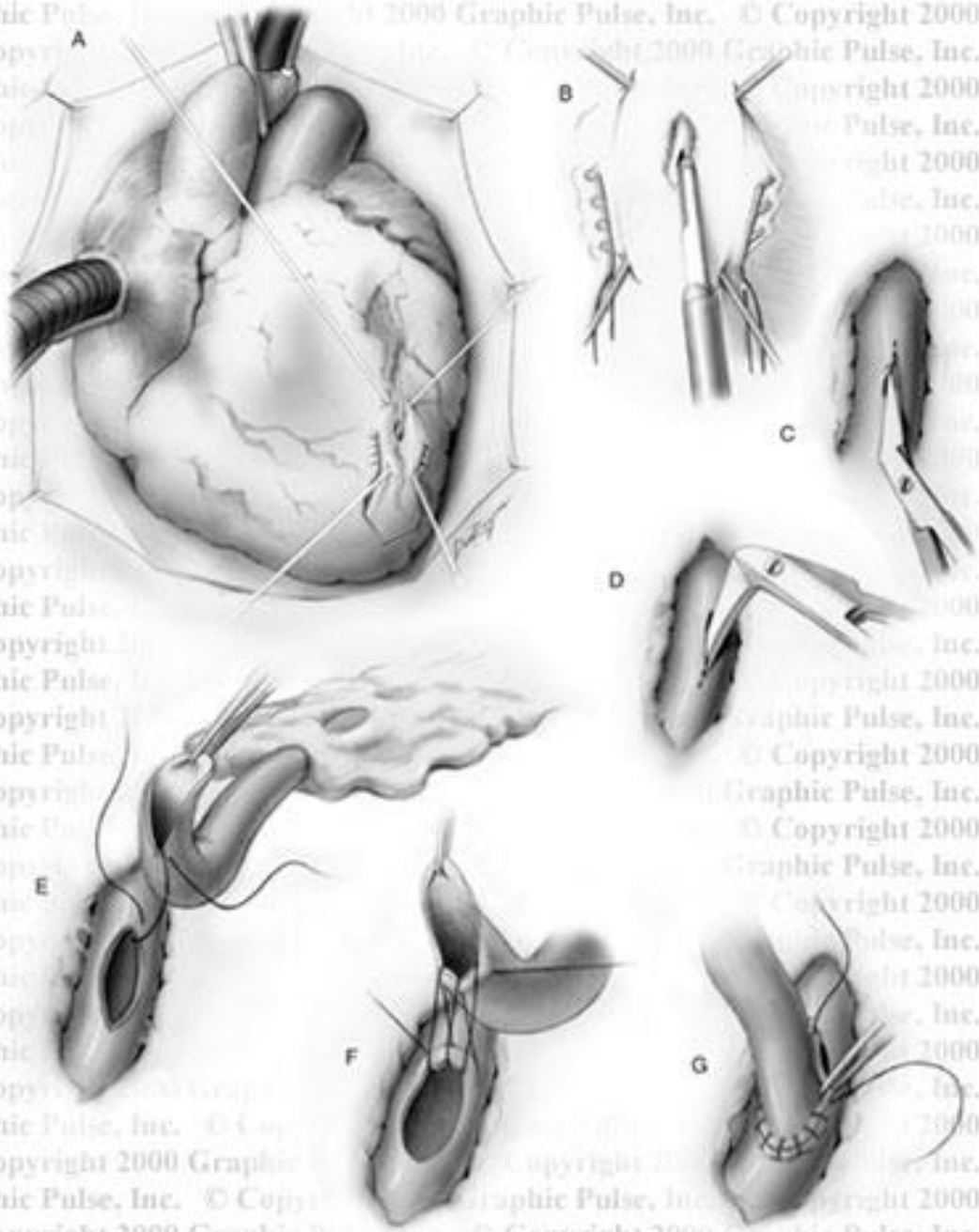


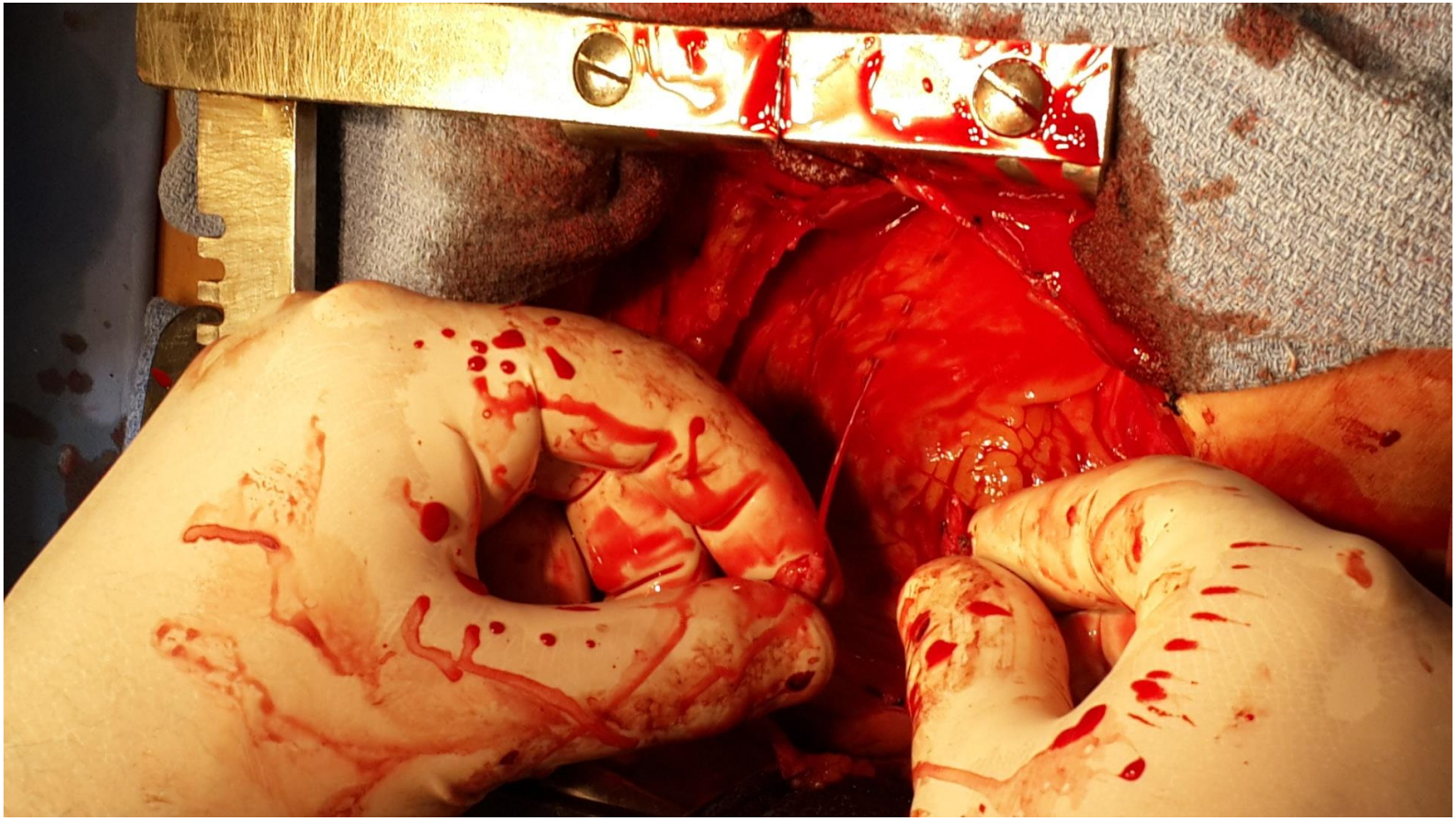
From : Manual of Cardiac Surgery, Harlan & Starr, Springer-Verlag, New York , 1995

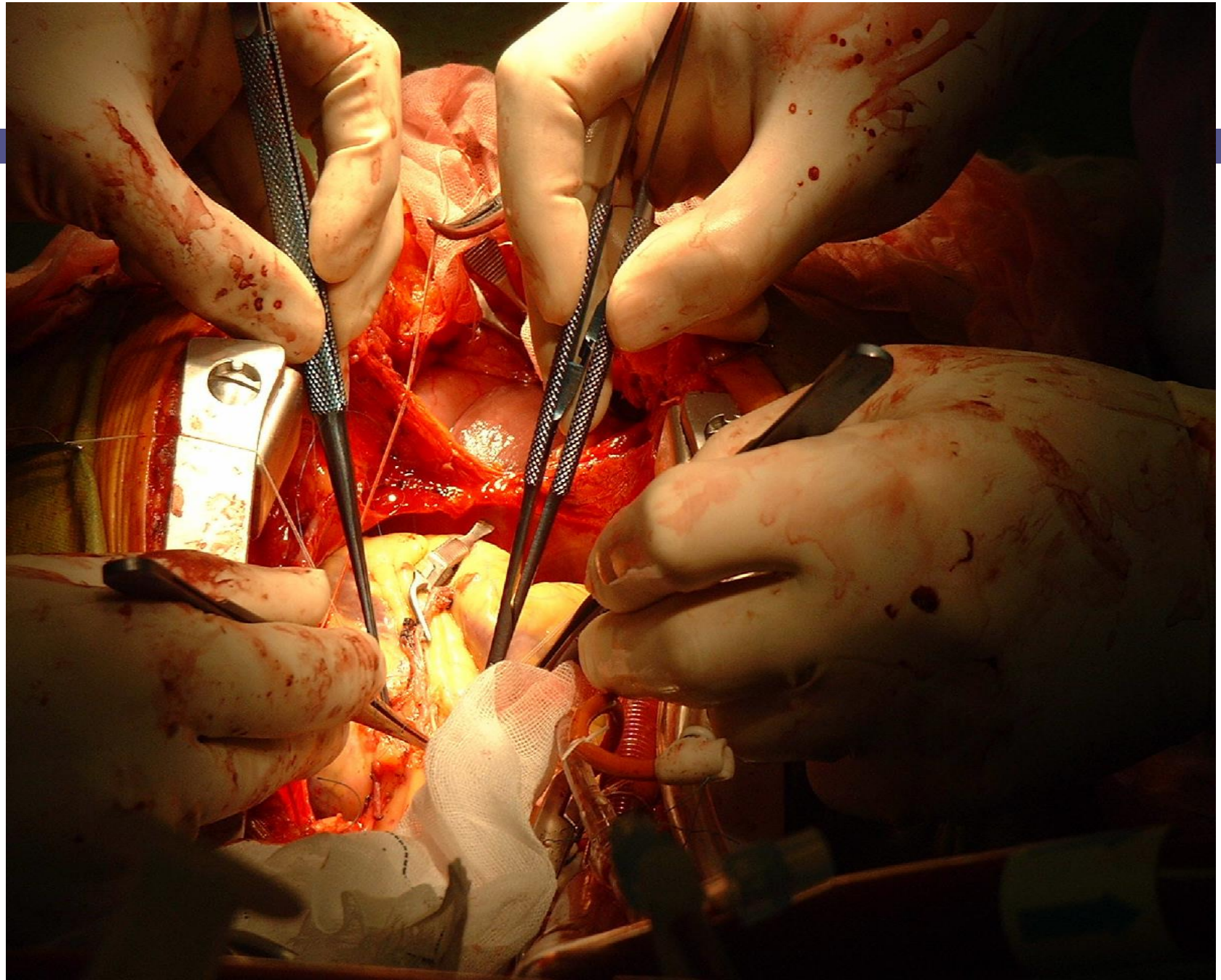
heart-lung machine
we put canula in the right atrium (deoxygenated blood) and canula in the ascending aorta (to return the oxygenated blood from the machine to the heart) so its a pump that do the job of the heart as a pump and the job of the lung in oxygenation
-the purpose from heart-lung machine --> to empty the heart from the blood and stop the heart from beating (by giving the heart potassium in rich solution) so the heart become paralyzed and arrested



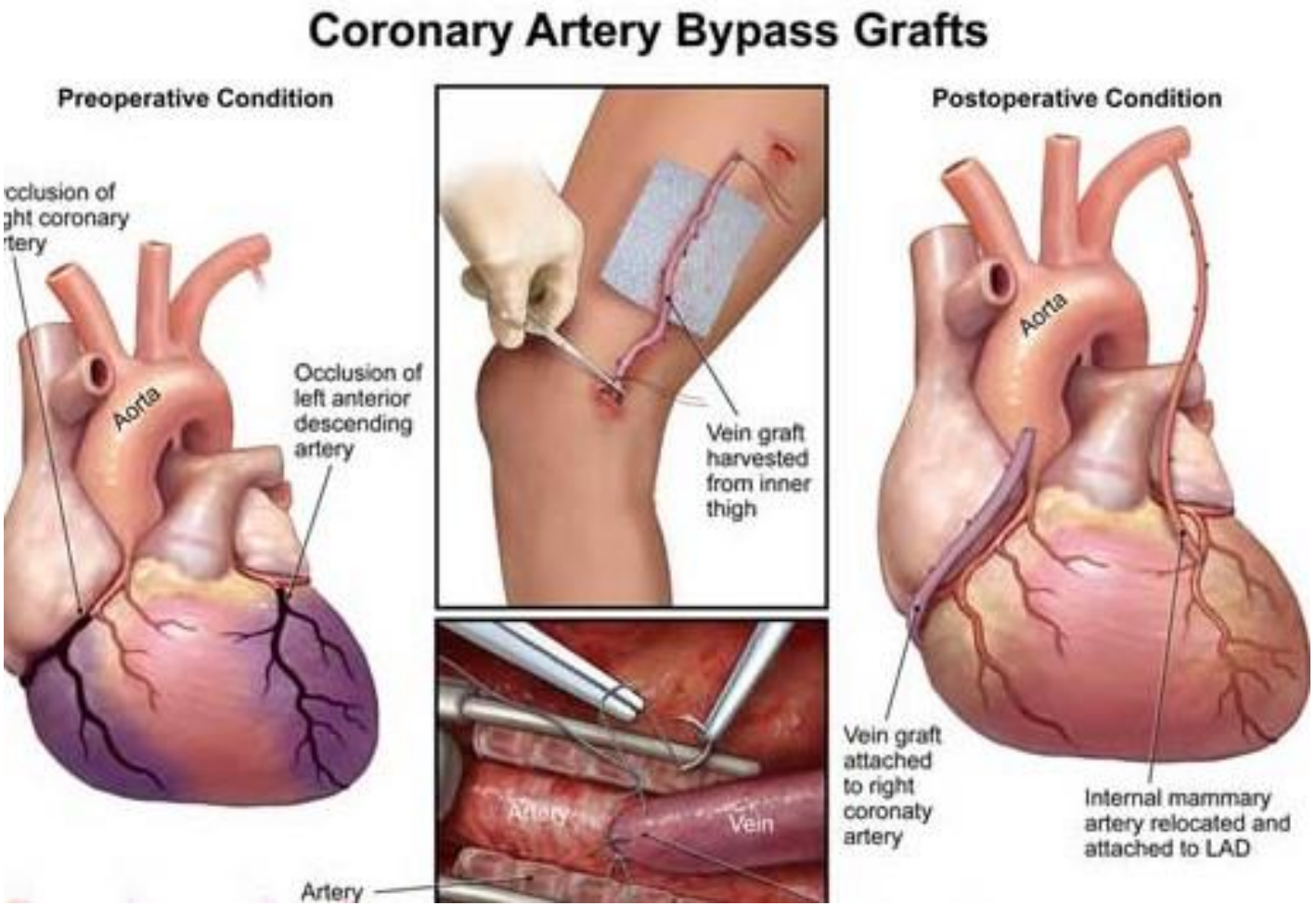
Heart Lung Machine



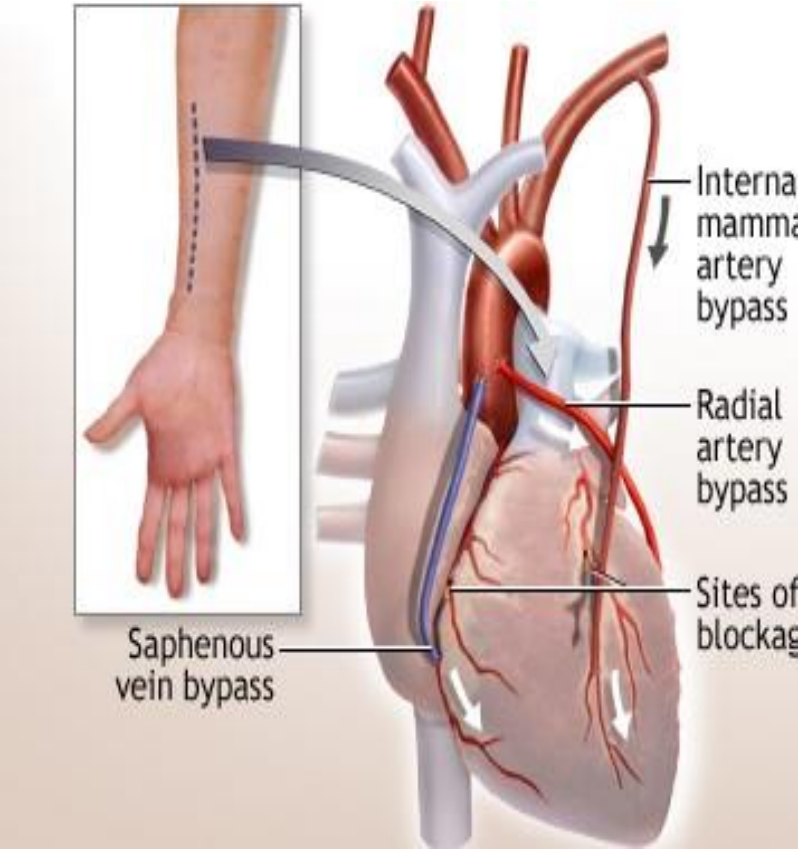


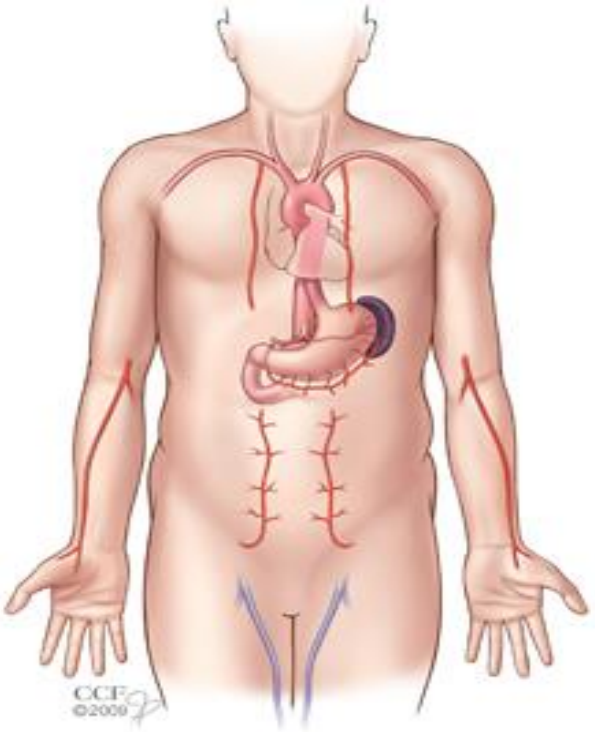


the condouts that we do to do grafting (from veins (lower limb) and arteries)
1- long saphenous vein (commonly used)
2- left internal mammary artery (LIMA) (commonly used)
right internal mammary artery (RIMA) (commonly used)
3- radial artery (commonly used)
4- gastroepiploic artery (around the stomach
5- inferior epigastric artery

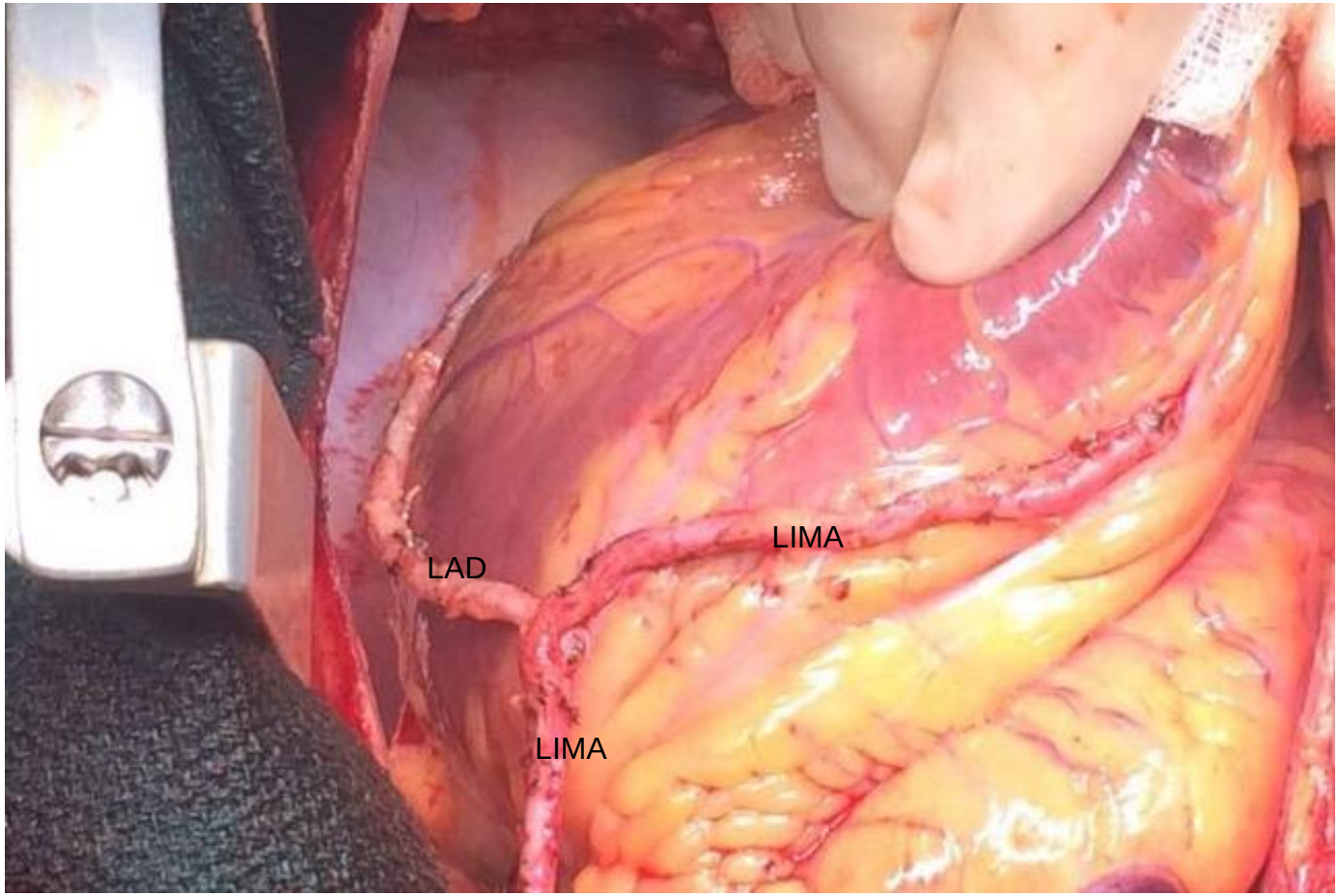


Arterial vs Venous conduits



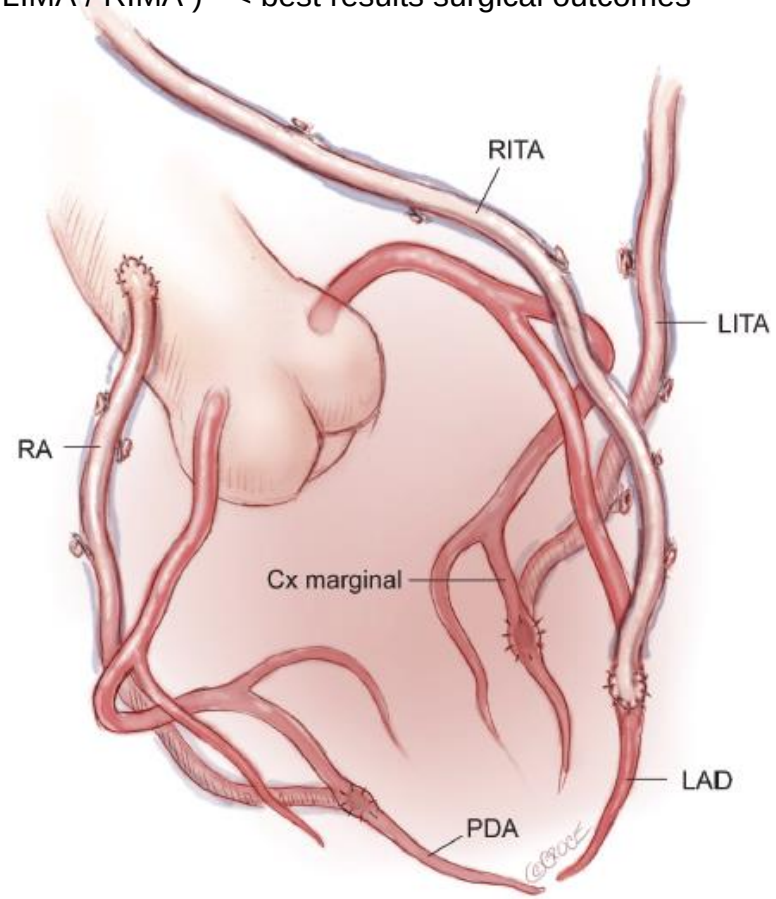


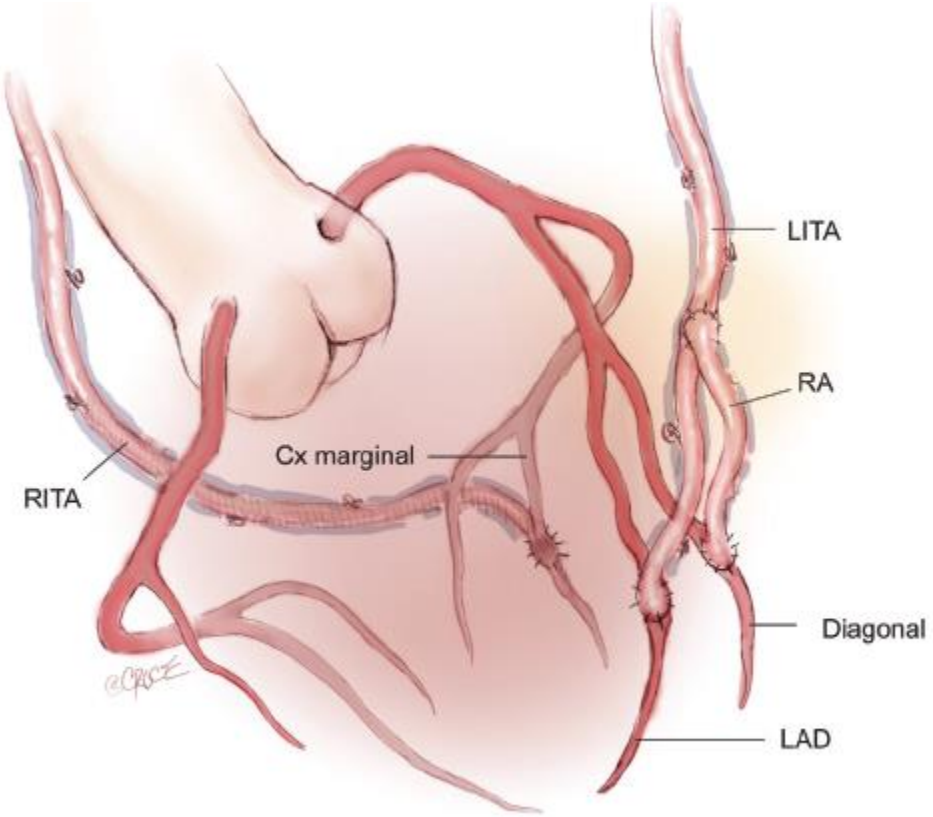
LIMA anastomosed to LAD



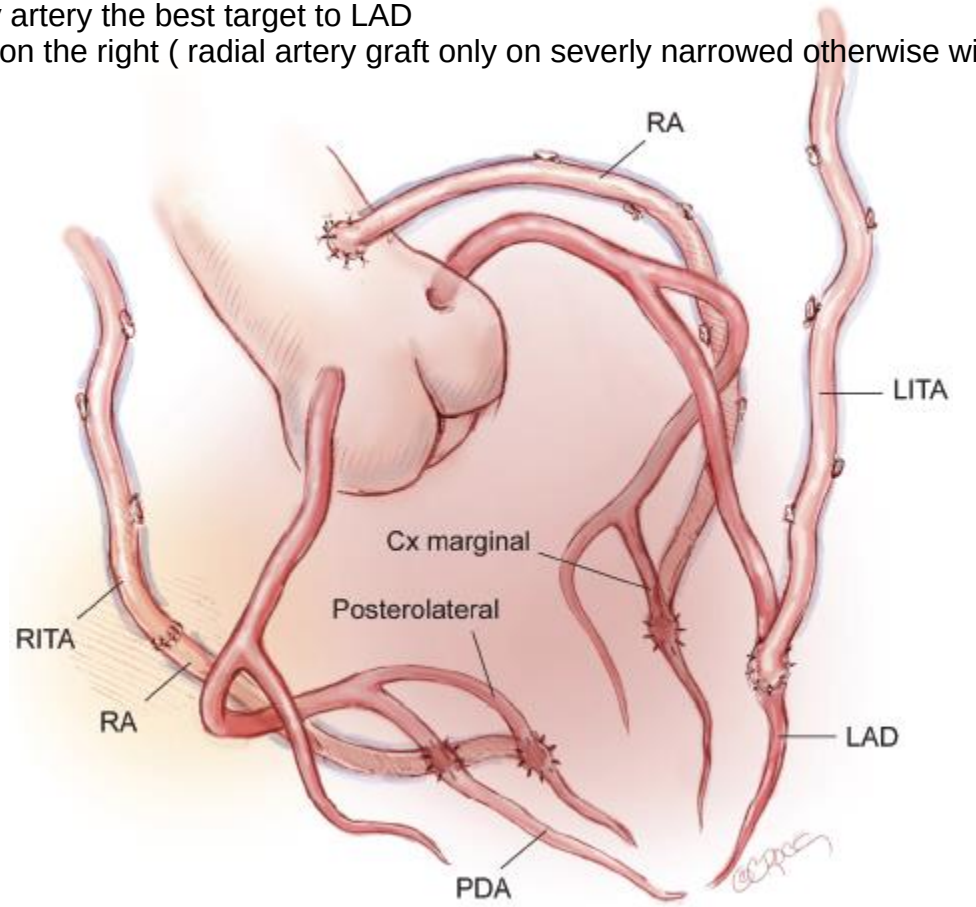
Total arterial revascularization

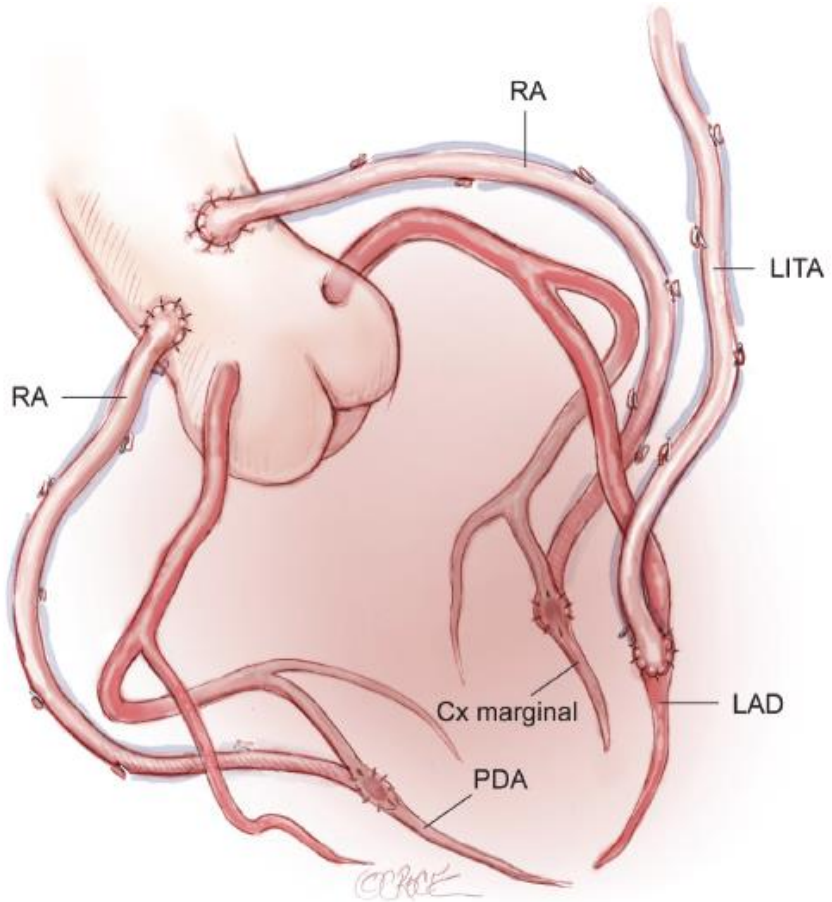
all the grafts are arteries (radial A / LIMA / RIMA) --< best results surgical outcomes

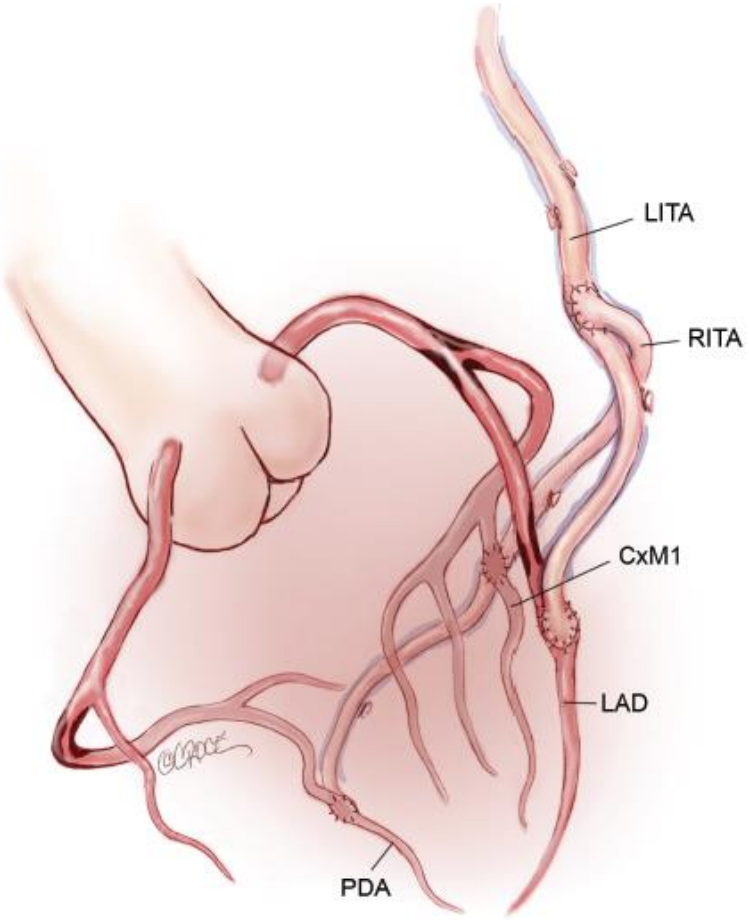



LITA
RA
Cx marginal
RITA
Diagonal
LAD

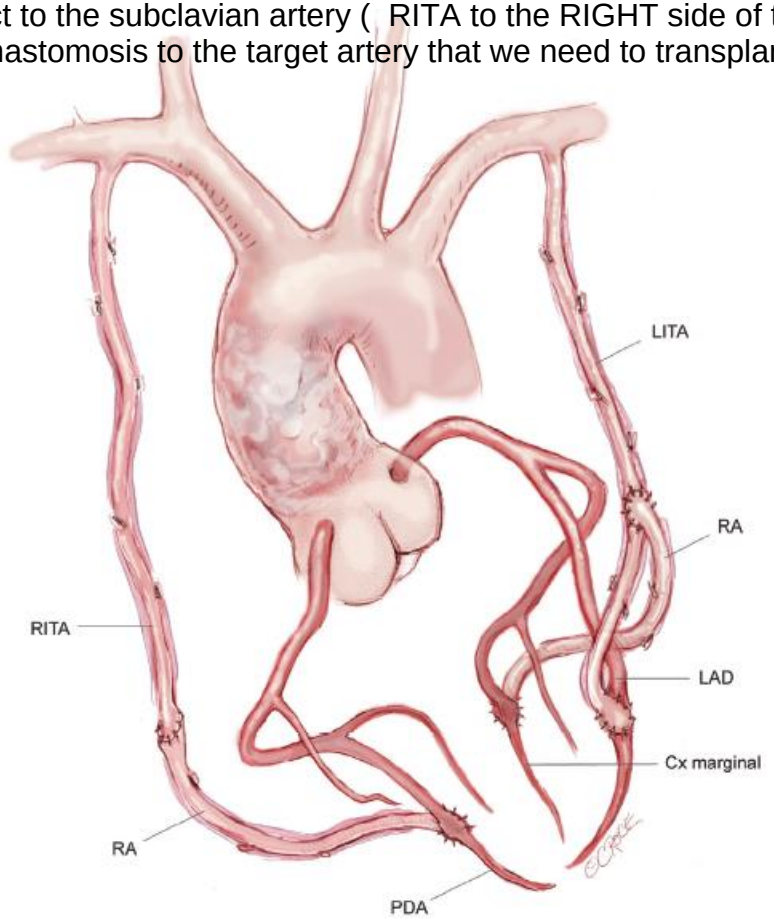
left internal thoracic/mammary artery the best target to LAD
radial artery --> circumflex or on the right (radial artery graft only on severly narrowed otherwise will lead to spasm)




RA
LITA
RA
Cx marginal
LAD
PDA

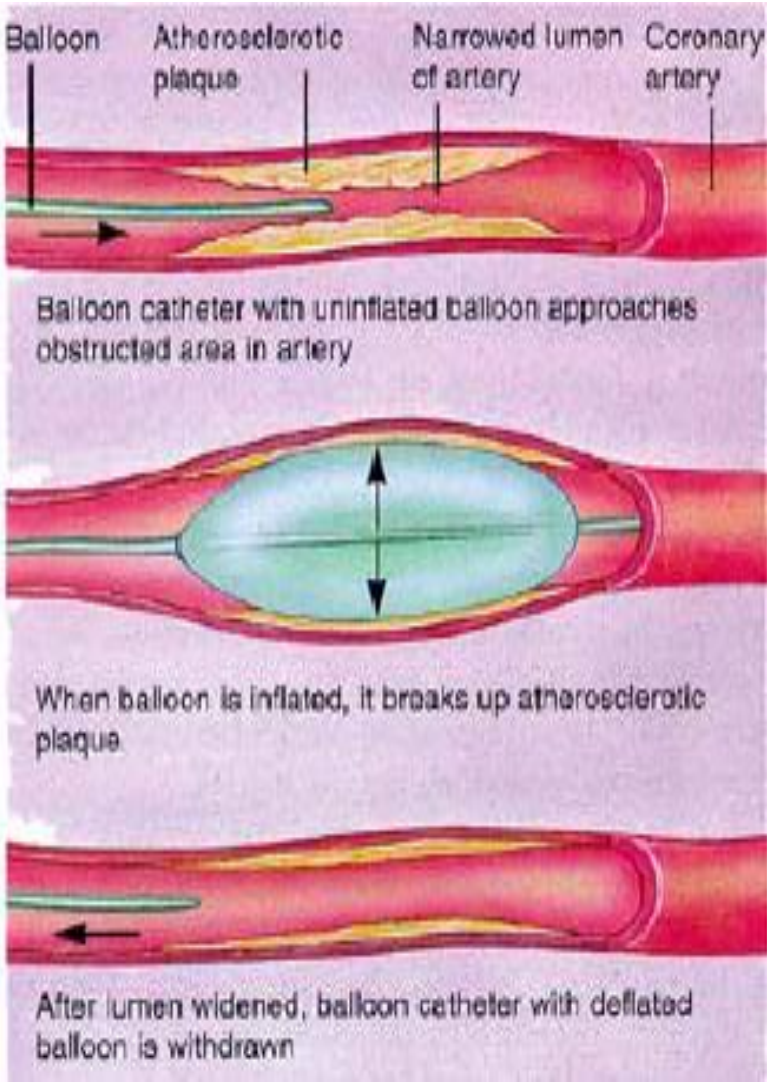

LITA
RITA
CxM1
LAD
PDA

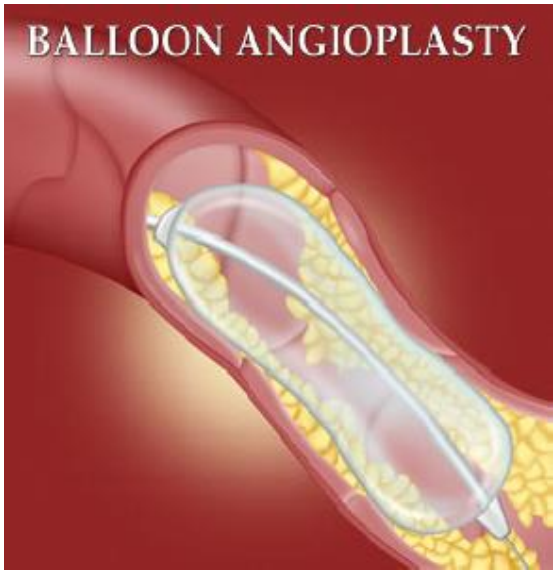
the mammary/thoracic artery connect to the subclavian artery (RITA to the RIGHT side of the subclavian / the LITA to the left side of the subclavian) with distal anastomosis to the target artery that we need to transplant it

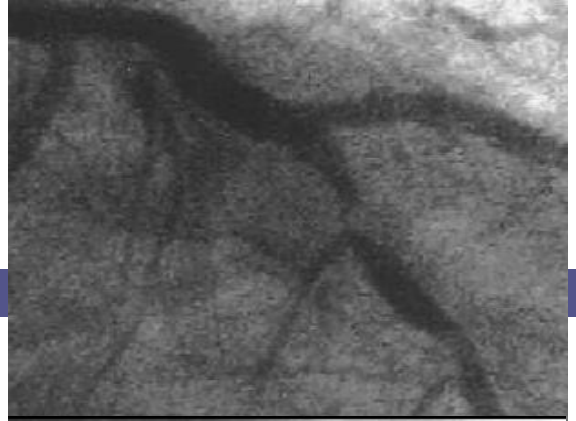


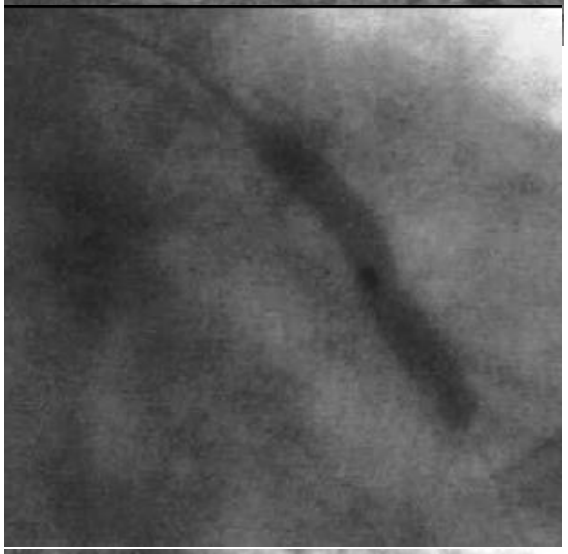
percutaneous transluminal coronary angioplasty (balloon / stent)
indicated in single or second vessel disease
- in patient with triple vessel disease with DM / low ejection fraction --> bad outcome (we cant do angioplasty)

PTCA



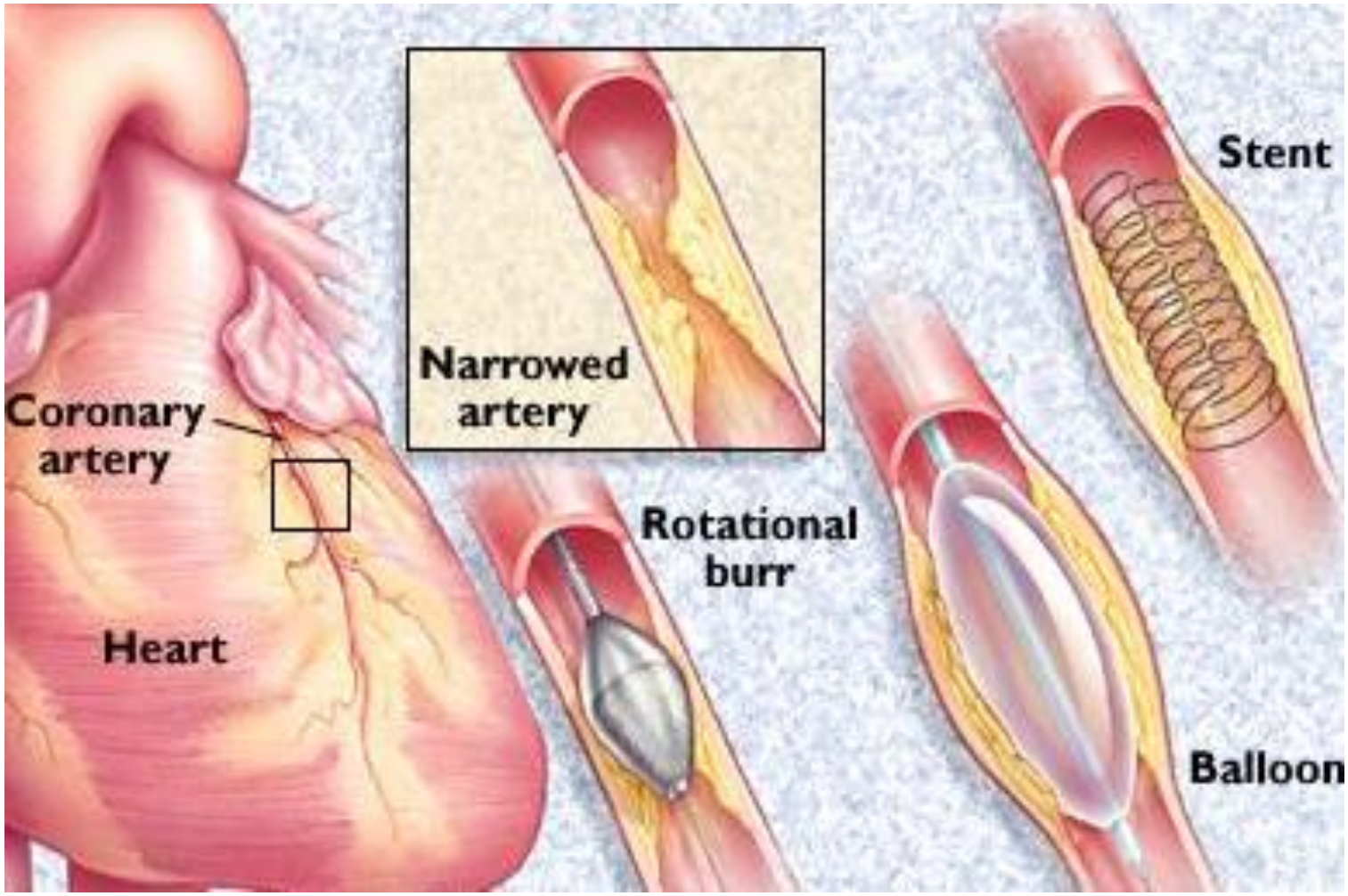

BALLOON ANGIOPLASTY





types of stent :
- metal stent (old)
- drung inulutining stent ??

rotational burr (drill the calcification to open the way) --> when the artery is hard to open with the stent or balloon (can reoccur on the long term but good outcome on the short outcome)



Off-Pump Coronary Artery Bypass (OPCAB)

we operate upon the heart while the heart is beating

Procedure

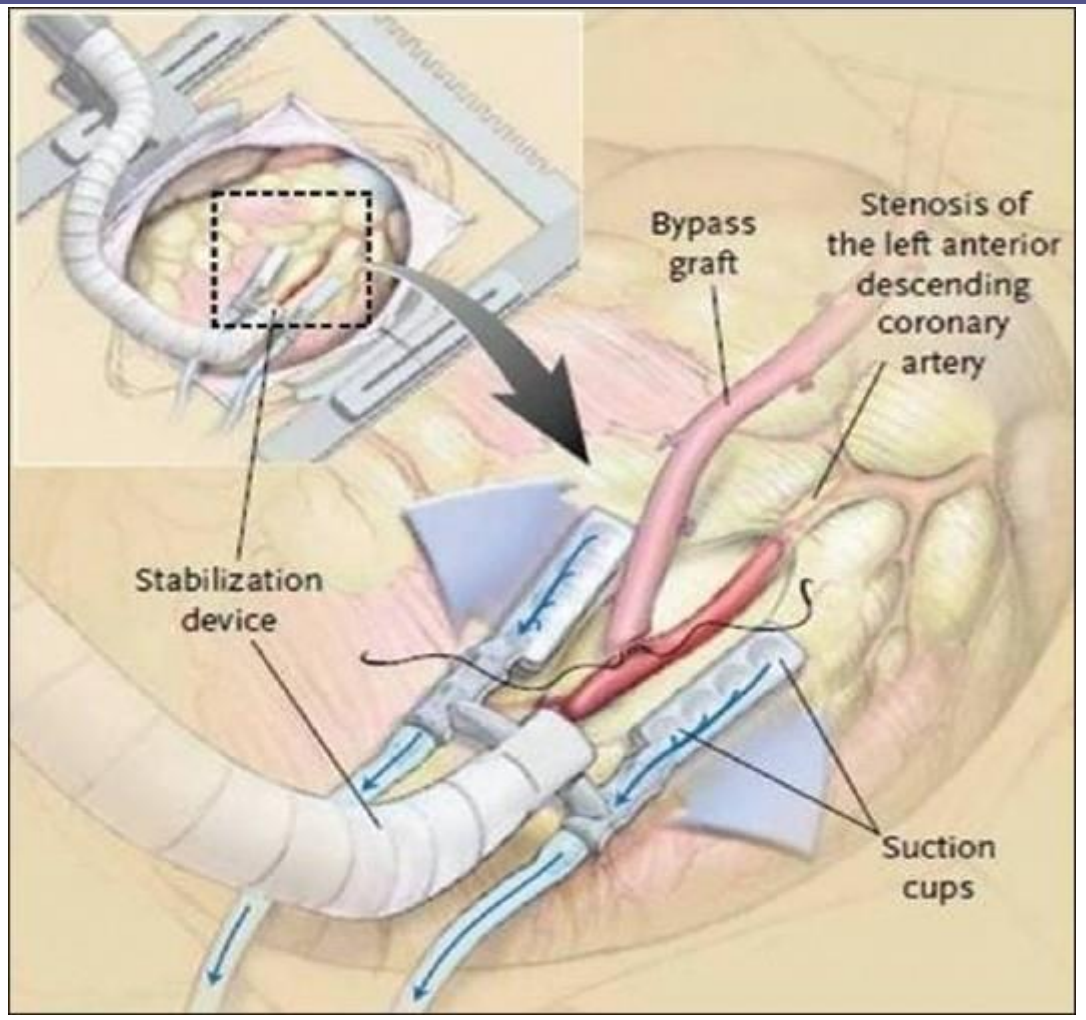
- Median sternotomy of varying sizes.
- Depending on the physiology of the patient, the smallest incision will be made.
- Arteries or veins can be harvested from the patients chest wall, arm, and or leg.
- Adenosine and Esmolol are used to slow the heart rate.
- Deep pericardial sutures and the use of specialized instruments to prop the heart in a position that will allow the surgeon to access occluded arteries.

off pump procedure (the heart still beating)--> we stabilize the area that we need to transplant the artery in only --> open the coronary artery --> put shunt inside it to avoid bleeding--> anastomose the coronary artery directly

Instrumentation

- **Octopus Device**
  - Has multiple small suction cups that are applied to the heart surface.
  - When suction is turned on, the cups stick to the surface, and hold the heart steady, with movement being less than 1 mm.

- **Drug Therapy**
  - Esmolol and Adenosine have been found effective in slowing, and even temporarily stopping the heart beat for short periods (around 20 seconds).


Bypass graft
Stenosis of the left anterior descending coronary artery
Stabilization device
Suction cups

- Any Questions

SUMMARY