CVS

PBL

☑ Sheet   ◯ Slide   ◯ Handout

Number

1

Subject

Cardiac Surgery

Done By

Omar Saffar

Corrected by

Asma kilani

Doctor

Mahmoud Abu-Abeeleh

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❋ There's no need to refer to the slides, this sheet is more than enough 😉

Outline:

❋ HISTORY OF CARDIAC SURGERY
❋ CORONARY ARTERY ANATOMY
❋ ISCHEMIC HEART DISEASES
❋ DIAGNOSIS OF CORONARY HEART DISEASES
❋ TREATMENT OF CADₛ
❋ VALVULAR PROBLEMS
❋ SURGICAL CONCEPTS CONCERNING VALVES

☎ HISTORY OF CARDIAC SURGERY:

Cardiac surgery started to develop in the 1950s, before that there were trials to operate on the heart but it all failed because the heart is a continuously beating organ and they didn't know how to stop it properly and safely, also no surgeon could do anything to the heart in fear of bleeding or injury.

Before the 50s the only thing doctors could know is that the patient's cause of death was a clot in his heart…

- In the 1940's a brilliant doctor named Arthur Vineberg tried "and actually succeeded" to attach the **LIMA** "left internal mammary artery" to subclavian artery at one side and make a tunnel to bring the blood to the wall of the heart directly "يشرشر عالحيط"   in a IHD (Ischemic Heart Disease) patient, yet it was an abrupt way and not very successful, because of high bleeding and mortality rate and more required blood transfusion.

- Another surgeon proposed to wrap the **omentum** (from the abdomen) around the heart (free omental graft), it was a good idea but didn't deliver that much of blood and preventing the acute infarction…

- In 1953 Dr. John Gibbon did his first open heart surgery using the (heart-lung machine), the machine took the blood from right atrium (outside the body) → oxygenate it → then bring it back to the aorta, make it possible to stop and empty the heart and give the ability to operate on it, Dr. Gibbon operation was on a girl with ASD (Atrial Septal Defect)…

- Another great milestone in CV surgery was the invention of **"stent"** in 1986

> A **stent** is a small mesh tube that's used to treat narrow or weak arteries..(from wiki).

- Another big step was done by a Russian doctor *(Dr. Kosolov)* who thought a little and said "why not anastomosing the mammary artery with the coronary artery directly?"

- Then the idea of anastomosing the saphenous vein & the radial artery came and so on…

- In **1962, Dr. Mason Sones** made the best achievement in the history of cardiac surgery which is the direct and reproducible **catheterization** of the coronary arteries.

Heart Lung Machine

♧ CORONARY ARTERY ANATOMY

We have two main arteries: Left & Right coronary artery,

1. Right from anterior Aortic sinus
2. Left from left posterior Aortic sinus

RCA :

Extends between the right atrium and the right ventricle, gives branches that supplies them,

Gives acute marginal branch

Gives the **PDA** posteriorly on posterior interventricular groove "makes collateral communication on the apex with **LAD**", supplies posterior one third of the IV septum,

LCA:

extends for 1.5-2.5 cm to the left, then bifurcates to **LAD** *(left anterior descending artery)* and circumflex artery

The LAD gives diagonal then extends on the anterior interventricular groove, beneath it is the septum which gets septal branches,

Then goes all the way to the apex …

The circumflex from extends on the left atrio-ventricular groove, then gives branches to the left ventricle like the obtuse marginal artery
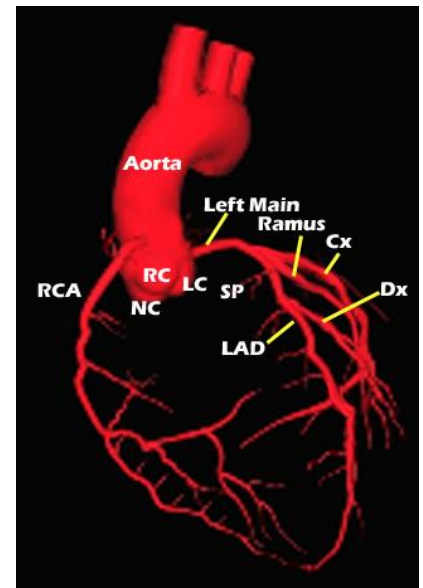
The concept of "dominant coronary artery":

The dominant coronary artery is the one that gives the PDA,

80% of people is the RCA, 10% from circumflex *(from LCA)*, 10% from both "co-dominant or balanced circulation" it only matters to know which one is dominant during mitral valve surgery
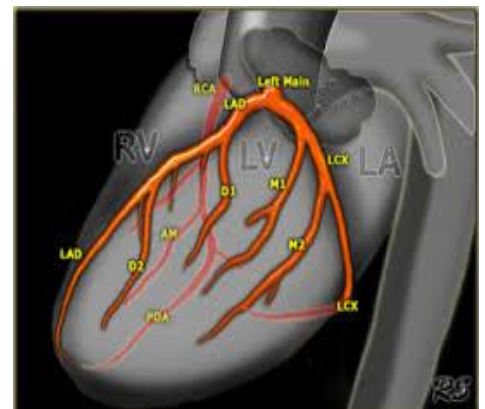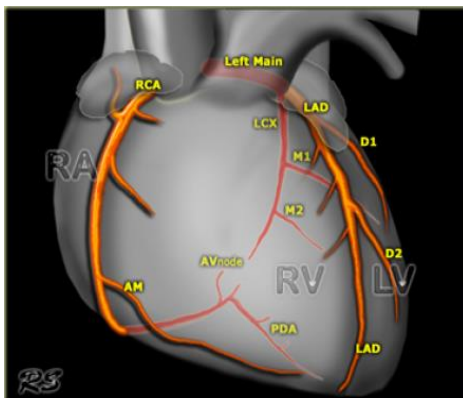
☿ ISCHEMIC HEART DISEASES (IHDₛ)

It results from imbalance between oxygen demand and supply

Myocytes takes up to 70% of oxygen that comes from the coronary arteries, so if it needs more oxygen there have to be more blood flow (by vasodilation → more CO → more flow)

So <u>stenosis</u> in the coronary artery to some extent makes the blood flow unable to meet the demand of myocytes to oxygen, which may lead to ischemia

But how much is the percentage of that stenosis??

<u>70% and above</u>, will make significant limitation of flow in that artery and causes ischemia

The main symptom of coronary stenosis (IHD) is chest pain "angina"

ANGINA:

Angina means <u>chest pain from cardiac origin due to decreased blood supply</u>

The Canadian Cardiovascular Society grading of angina pectoris:

I: <u>No angina</u> with ordinary physical activity "heavy exercise produces angina"

II: <u>Slight</u> limitation of <u>ordinary activity</u> "ex: walking for 500-1000m may produce angina, aka slight limitation"

III: <u>Marked</u> limitation of <u>ordinary activity</u> "walking for short distances produces angina, e.g. walking from bedroom to the bathroom"

IV: Symptoms with any activity or<u> at rest</u> "chest pain comes to him, at rest" eating may produce chest pain

<u>What determines level of severity?</u>

The **extent of narrowing** in the coronary artery.

- Characteristics of angina pectoris:
    - Chest pain in the pericardium
    - Related to exercise and relieved by rest
    - Patient feels like there's a rock on his chest
    - Radiation of pain to shoulder and jaw
    - Sublingual nitrates and aspirin relieves the pain

Acute Myocardial Infarction due to Angina:

If angina lasts more than 60 mins it turn to myocardial infarction, with increased cardiac enzymes and ECG changes and other symptoms like:

Vomiting, nausea, diaphoresis "sweating", shortness of breath, acute pulmonary edema 15:50,

And may aggravate to heart failure and ascites lower limb edema and palpitation

Lipid plaques and, narrowing artery

Etiology of Angina:

- **Atherosclerosis (>90%)**
- **Embolization**
- **Coronary spasm "prinzmetl angina"**
- **Vasculitis**
- **Ostial stenosis**
- **Severe LVH** *"left ventricular hypertrophy"*
- **Congenital anomalies of the coronary arteries (e.g. anomalous origin of LAD artery from pulmonary artery)**
  Other anomalies: coronary are not from their ordinary origin, like LAD from right, right from circumflex, circumflex from right

⇨ Atherosclerosis pathology

Narrowing of the coronary artery lumen by either accumulation of plaques or by a muscle spasm "contraction of the smooth muscles" *less relevant*.

This narrowing is gradual and increases by time, yet sometimes it may increase suddenly and markedly "from 30% to 100%", this condition is called (Acute Coronary Syndrome)

Atherosclerosis with blood clot
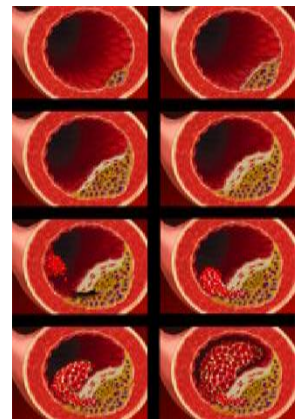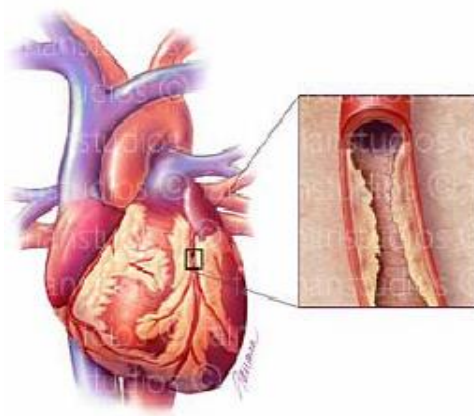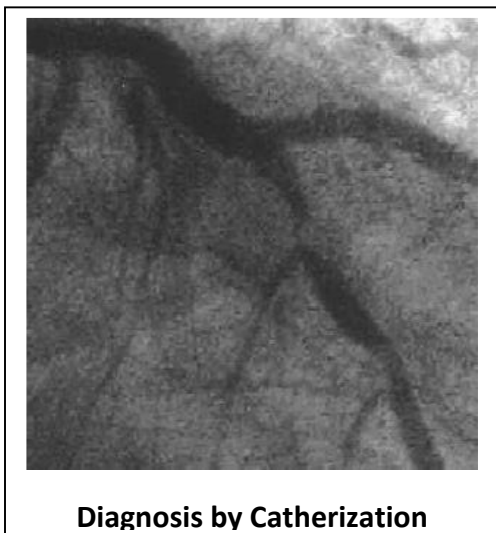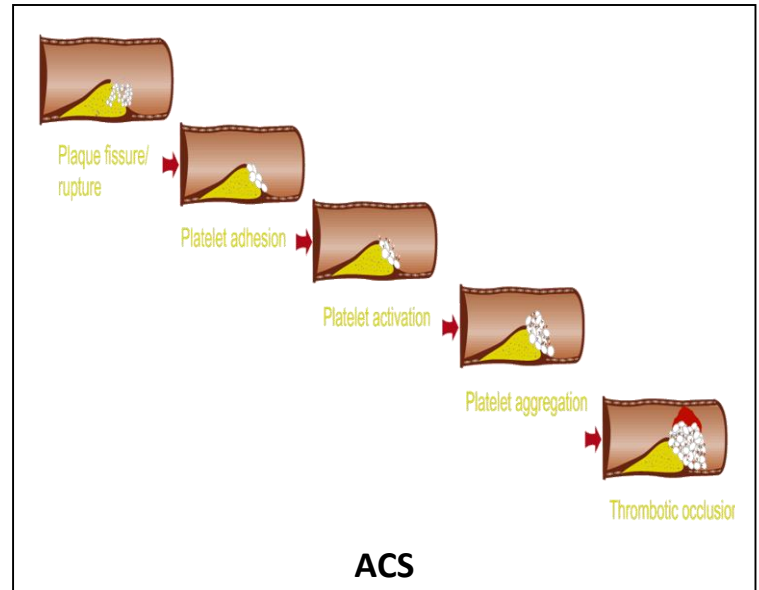
Atherosclerosis

Spasm
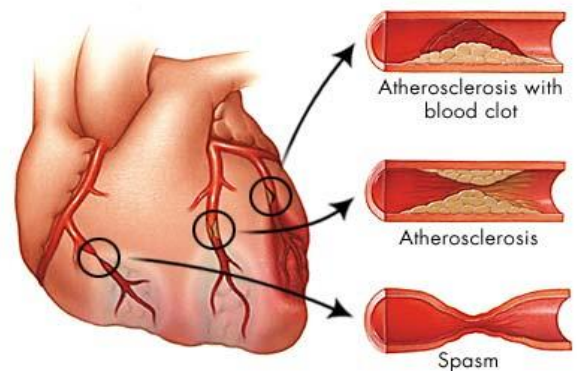
Acute coronary syndrome (ACS):

- Basically if there was ~30% of narrowing in the coronary artery, acute MI may happen, this process is done by:
  presence of a plaque, producing not so much narrowing but suddenly this plaque may rupture and cause ulceration, and exposure of sub-endothelial collagen, which attach to vWF and causes platelet to aggregate and so on…

  ACS results in sudden increase of narrowing from 30% to 100% "total block", leading to acute MI

Signs of acute coronary syndrome appear in **ECG** and **cardiac enzymes** levels plus common symptoms

- Coronary artery narrowing is diagnosed now by catherization "قسطرة", contrast dye is injected to the suspected site of stenosis, and an image is taken…

Plaque fissure/ rupture

Platelet adhesion

Platelet activation

Platelet aggregation

Thrombotic occlusion

ACS

Diagnosis by Catherization

Risk Factors of Atherosclerosis

Uncontrollable

- Sex
- Hereditary "Caucasians more effected"
- Race
- Age

Controllable

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

....

⚕ DIAGNOSIS OF CADs "CORONARY ARTERY DISEASES"

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

Note: **CAD** is the same thing as **IHD**! ☺

➢ **Complete history:** We must take accurate history of the patient because usually chest pain is not related to cardiac problems!

Physical examination: may help in CAD diagnosis like:

HTN, high HR, JVP "jugular vein pressure", bulging jugular vein or distended neck veins, abnormal heart sounds & rhythm, ascites ,lower limbs edema, pleural effusion "we hear fluid sounds on the lungs".

> **Tests to confirm** → ECG "mandatory", Cardiac Enzymes, chest X-ray, blood sugar level, serum lipids level and treadmill test if possible.
Cardiac CT "new test" used instead of catherization which is <u>less invasive</u>

☞ TREATMENT OF CADs

☐ Nitrates

☐ Beta blockers *"decreasing workload on the heart"*

☐ Aspirin/PLAVIX **"Clopidogrel"** DUAL ANTIPLATELT THERAPY

☐ Ca⁺⁺-channel blockers (in coronary spasm)

☐ Treating the associated risk factors

☐ Treating the precipitating factor

☐ Revascularization (if indicated)

Clopidogrel and aspirin work on platelets
Aspirin as Cox inhibitor → less TXA
Clopidogrel work on ADP receptor

At the end we have to do one of these 3 things:

1. Medical treatment "drugs"
2. Catherization
3. Open heart surgery

When do we say "let's do an operation"? (CABG) "Coronary Artery Bypass Grafting"

❖ 3 coronary arteries with 70% narrowing (RCA, Cx, LAD) "triple vessel disease" → surgery
❖ Left main disease "left coronary artery stenosis" → surgery
❖ When giving maximum drugs and still there is angina <u>"failed medical treatment"</u> → surgery
❖ Complications of catherization (PTCA) → surgery
❖ Anomalies of coronary arteries → surgery
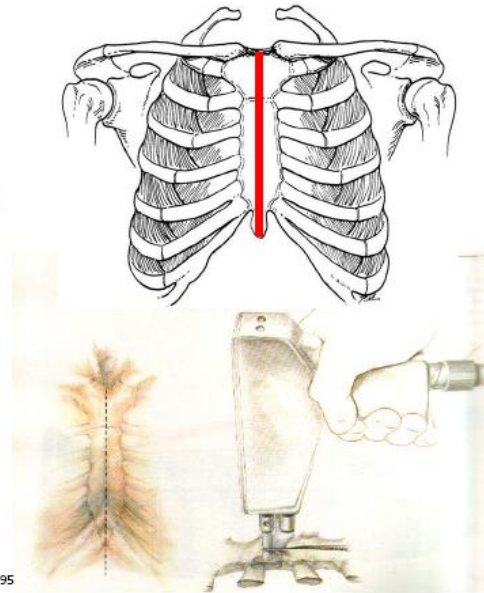❖ *Life threatening complications of MI → surgery*

Cx = Circumflex artery

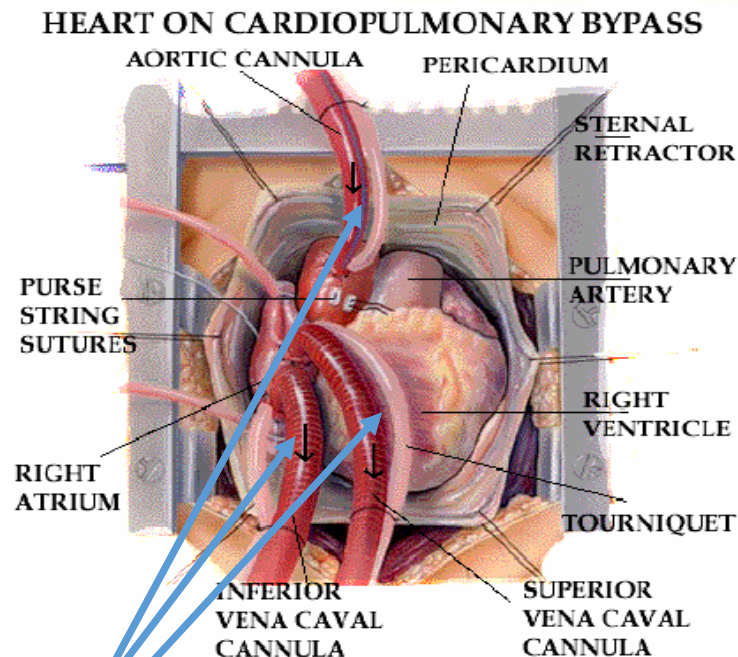**How is the open heart surgery done?**

1ˢᵗ **open a window to the heart by →**

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 ON CARDIOPULMONARY BYPASS

AORTIC CANNULA
PERICARDIUM
STERNAL RETRACTOR
PULMONARY ARTERY
PURSE STRING SUTURES
RIGHT VENTRICLE
RIGHT ATRIUM
TOURNIQUET
INFERIOR VENA CAVAL CANNULA
SUPERIOR VENA CAVAL CANNULA

2ⁿᵈ

Special tubes to the bypass device "heart lung machine"

3rd

Then the heart is stopped with a solution containing potassium,

- The heart will be flaccid, paralyzed, empty → ready for work
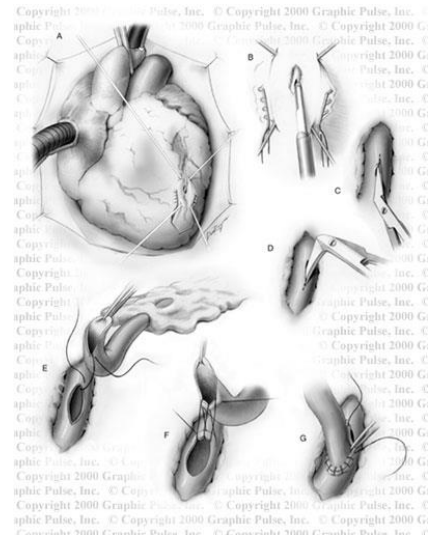
These three steps are done so that the surgeon can put a new **graft** on the ischemic area (i.e. new artery that supplies the heart)

- The surgeon Attach "**anastomoses**" artery or vein to the coronary artery and suture it.
- Like for example the **LIMA** "which is still attached to subclavian" will be connected to the **LAD** after the area of stenosis.

   "we don't do anything to the stenosed artery we just bypass it!"
- Other options is to take the **saphenous** vein or the **radial** artery "*or other grafts*" and attach them between the coronary and the aorta!
- These grafts are called conduits
- We have other conduits that can be used « spare parts » !
- The total possible conduits which are commonly used are :
   - a- Arteries: left & right internal mammary artery (LIMA & RIMA), radial artery, right gastroepiploic artery, inferior epigastric artery.
   - b- Veins: great saphenous short saphenous and cephalic vein
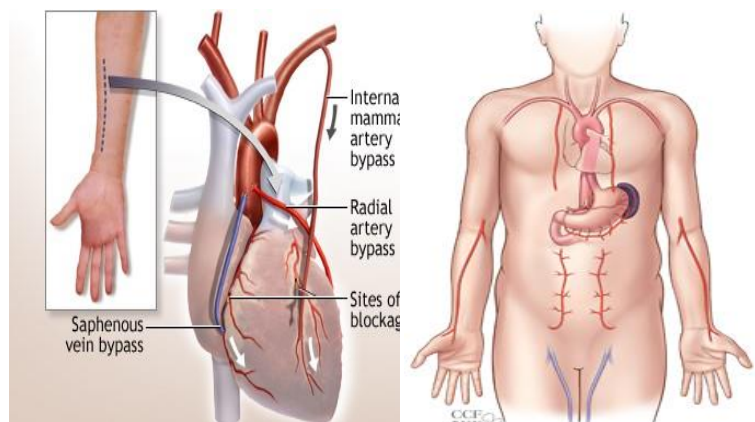
Coronary Artery Bypass Grafts
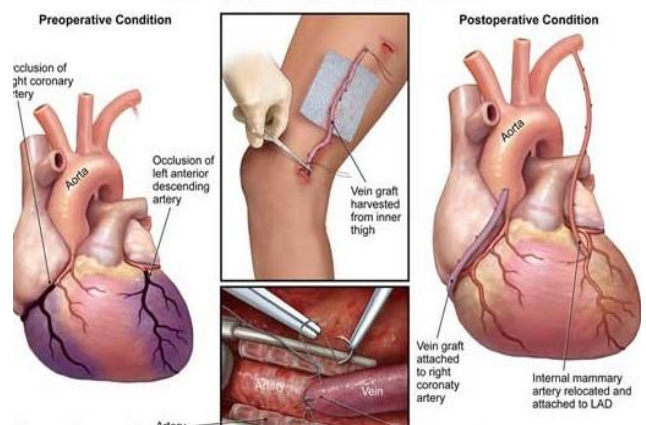
Vein or Artery, Which is better?

- There's a disadvantage of placing a <u>vein</u> instead of an artery and force it to work as an artery, letting it face a higher pressure, so the vein wall will be thickened "new intima formation", produces bad result after <u>10 years.</u>
- So it's better to use arteries, yet saphenous vein is easier to harvest "new concept"
- Saphenous is easier because it's subcutaneous and easy to take without significant side effects of its removal, but the problem is as we said by turning it to an artery will show bad effects after 10 years.
- Note that the best place for LIMA is to be attached to LAD "because it's close to it", which is the best conduit with the efficiency of 90% after 10 years, while saphenous after 10 years is 60-65%.
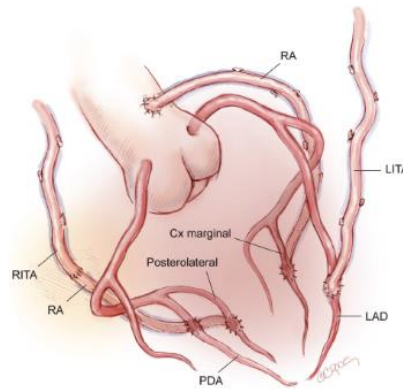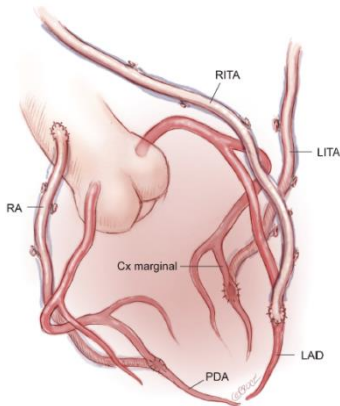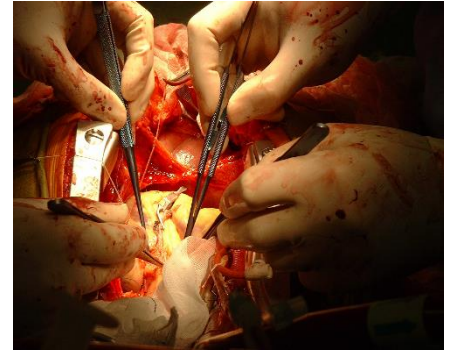

Another name for LIMA & RIMA is LITA & RITA "left & right internal thoracic artery"

The other option to treat coronary problems instead of open heart surgery is **"Catherization"**

Percutaneous transluminal coronary angioplasty (PTCA)

Insertion of a catheter in a vessel to the place of stenosis and dilate it by applying pressure via inflation of a balloon (PTCA), then a stent is placed to support and widen the narrowed artery.

Not all patients given this procedure, only certain patients with special needs and standard of care ...
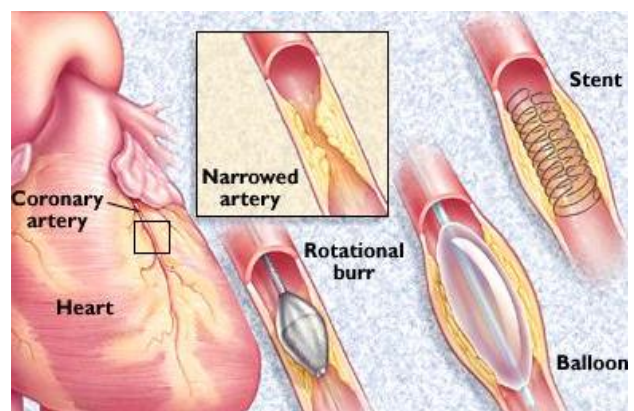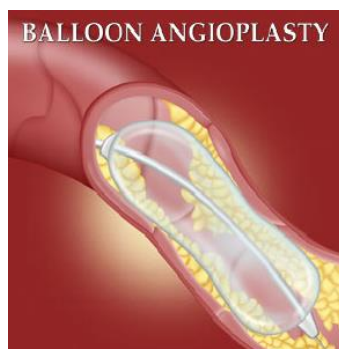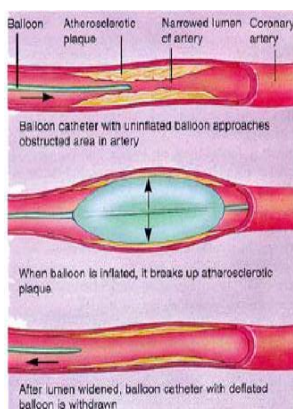
🩺 VALVULAR PROBLEMS

Most common valve replacement is done to the aortic valve

Which is damaged due to degeneration "causes regurgitation" and calcification "causes stenosis" which leads to lower blood flow during the systole, which causes problems to the patient.

Impaired function of the valve → increased load on heart

So the valve have to be replaced!

Mitral valve is the same as aortic "stenosis and regurgitation"

Stenosis of mitral is related to rheumatic valvular heart diseases

This valve has the capability of being <u>repaired!</u>

From the slides:

- **Aortic stenosis-**
  - Age-related degenerative
  - **Mild** AS: AVA > 1.5cm^2 ; **Moderate** 1-1.5cm^2 ; **Severe** <1cm^2
  - Indications for surgery largely based on symptoms
 - Syncope, angina, dyspnea and CHF
- **Aortic regurgitation-**
  - Calcific aortic disease, idiopathic degenerative disease, endocarditis, rheumatic disease, bicuspid valve, aortic dissection, Marfan, etc.
  - Indications for surgery
  - Acute AR- inadequate time for ventricular compensation
  - Chronic AR- symptoms, decreasing EF, LVEDD >75mm, LVESD >55mm

- **Mitral Regurgitation-**
  - Myxomatous degeneration, ischemic, rheumatic valve disease, endocarditis, chordal rupture, dilated cardiomyopathy, etc.
  - Surgical indications
  - Symptomatic with 3+ to 4+ MR, asymptomatic with 3+ to 4+ MR and a decrease in EF, LV dilatation, new onset of atrial fibrillation
- **Mitral Stenosis-**
  - Rheumatic heart disease, annular/leaflet calcification, congenital deformities, endocarditis, etc.
  - Surgical indications
  - MVA ≤ 1.0cm^2
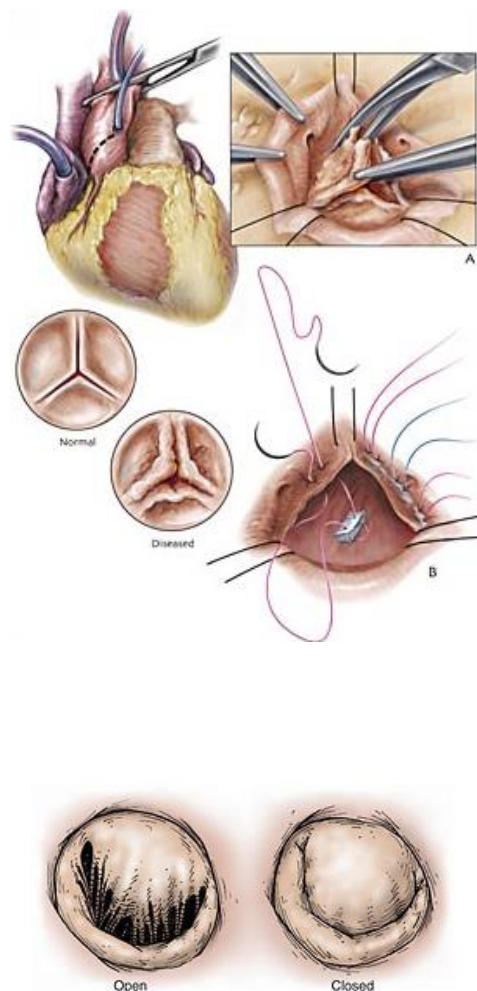
valves are of two types:

I.   Biological valves: from pigs or cows or even from cadavers
II.   Mechanical valve:
- *Caged-ball valves*
- *Tilting disc valves:*
  - ➢ *single leaflet*
  - ➢ *bileaflet*

<u>What type of valve to use?</u>

Each one has an advantage and disadvantage

Mechanical valves advantage is that it last <u>forever</u>
(durable), yet patient have to always to anticoagulant
(**warfarin**) warfarin is rat poison so patient literally will take poison forever "disadvantage"!

While biological "tissue" valves doesn't need warfarin, yet after 10 years it should be replaced

So for an old man with 70 years of age, tissue valve is more suitable for him والله كريم بعد ١٠ سنين

And also after the age of 65 warfarin complications are high and many "this is the main cause
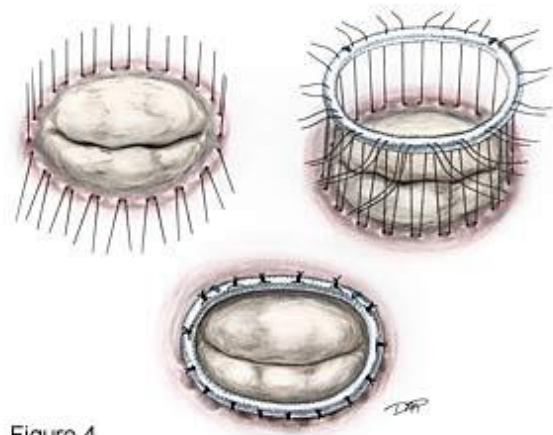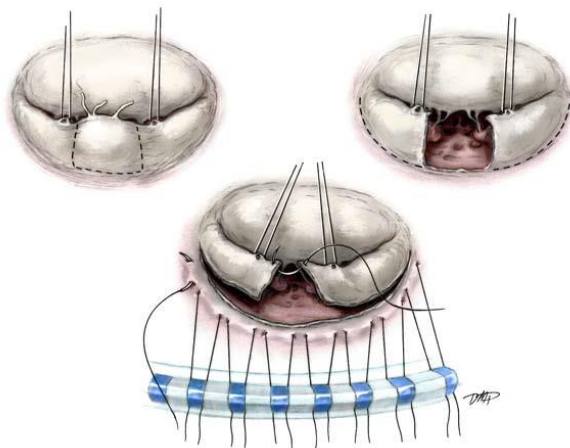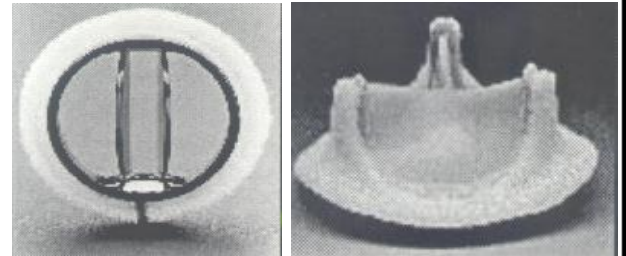not that he would be dead in 10 years!!" الاعمار بيد الله

Figure 4

from the slides, Mitral vs Aortic:

Mitral Valve Surgery

- ☐ *Repair more commonly performed than replacement.*
- ☐ *Replacement necessary in some cases*
  - ☐ *Rheumatic heart disease, endocarditis, complications of MI, etc.*
- ☐ *Median sternotomy*

Aortic Valve Replacement surgery:

- ☐ *Median sternotomy, hemi-sternotomy*
- ☐ *Cardiopulmonary bypass*
- ☐ *Cardioplegic arrest*
- ☐ *Excision of the valve*
- ☐ *Debridement*
- ☐ *Implantation*

When giving warfarin to a patient with mechanical valve we test the level of *dilution (تمييع)* by a test called "**INR**"

INR normal range for these patients is:

a. 2-3 for aortic valve
b. 2.5-3.5 for mitral valve

If it's elevated the patient could suffer from <u>bleeding</u>

Note: tissue *"biological"* valves patients are given warfarin after the surgery for the first three months (mandatory).

Recovery for all patients after heart surgery by:

☐ Quitting smoking (mandatory)

☐ minimize cholesterol intake and decrease lipid intake

☐ Managing high blood pressure and diabetes

☐ Exercising regularly

☐ Maintaining a healthy weight

☐ Eating a heart-healthy diet

☐ Participating in a cardiac rehabilitation program

☐ Following up for regular clinic visits

Le Fin.

"French is the language that turns dirt into romance."

Omar Saffar