

The Cardio-

# VASCULAR

System

- Anatomy
- Histology
- Pathology
- Pharmacology
- Physiology
- Microbiology
- PBL

Lec #: 2

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# CARDIAC SURGERY

## OUTLINE

INDICATIONS FOR CARDIAC SURGERY

HISTORY OF CARDIAC SURGERY

CORONARY ARTERY ANATOMY

ATHEROSCLEROSIS CAD

DIAGNOSIS

MANAGEMENT

SURGICAL INDICATIONS /TECHNIQUES

VALVULAR HEART DISEASES

## HISTORY

The Heart was a restricted area until the beginning of 1950s. Actually, the first cardiac surgery was in 1953. The first open heart surgery when the heart-lung machine was used was for ASD. The heart-lung machine facilitates the surgery by making the heart empty and not beating by taking the role of the heart and lung as we'll see later.

In 1940s, a surgeon tried to work on the heart without that machine. He used the left internal mammary artery (LIMA) which is also called left internal thoracic artery (a branch from left subclavian artery and has branches in the parasternal area "1 inch lateral to the lateral border of the sternum". In each intercostal space, it gives 2 branches). He took it and sewed it onto the wall of the left ventricle. It was difficult to identify the lesion site exactly because the catheterization wasn't known yet. So, he made the LIMA يشرشر in the wall of the left ventricle. The mortality was 40%.

Now, catheterization gives an anatomical outline where the narrowing or the lesion is.

John Gibbon was the first surgeon to use the lung-heart machine in 1953. And from here heart surgery started to improve.

The acceptance of Coronary Artery Bypass Grafting (CABG) was delayed until 1960s because catheterization wasn't known yet.

KOLSOV in Russia was the first surgeon who made direct anastomosis between LIMA and LAD (a branch from left coronary artery in anterior interventricular groove).

Cardiac was known as first choice treatment for IHD in 1970s.

Not all patients with atherosclerosis of coronary arteries or ischemic heart disease need a heart surgery.

## **CORONARY ARTERY ANATOMY**

### **\* 2 main coronary arteries:**

1. Right coronary artery: in the right atrioventricular groove to the inferior surface and gives the posterior descending interventricular artery.
2. Left coronary artery: gives two main branches; LAD and circumflex.

### **\* 3 layers: intima, media and adventitia.**

## **Atherosclerotic Process**

There are many theories. It may be related to hyperlipidemia, calcium metabolism, certain mediators, it might be an intimal disease or endothelial cell disease.

Atherosclerosis is a result of accumulation of plaques تكلسات داخل الشرايين التاجية that narrow the diameter. It's clinically significant if the narrowing exceeds 70% of the diameter which affects the flow markedly.

By doing catheterization, contrast dye is given through a catheter and is inserted into the femoral artery and reaches the origin of the coronary artery in the aortic root.

The progression of the atherosclerotic process is going gradually depending on many things; whether the patient has hyperlipidemia, his blood pressure, Smoking...etc. But sometimes, the atherosclerosis (this narrowing in the artery) progresses from 20% to 100% suddenly causing Acute MI, why? If the plaque is ruptured, the endothelial layer and subendothelial collagen will be exposed which attracts VWF and platelets resulting in Acute MI. because of that, ambulance technicians give Aspirin to prevent the propagation of platelets aggregation.

## Risk Factors

### **A. Modifiable (controllable).**

2. Hyperlipidemia. We can give lipid lowering agents.
3. Smoking (a major risk factor)
4. Physical inactivity
5. Obesity
6. DM
7. Stress

- **CAD is number one killing disease worldwide.**
- **Premature atherosclerosis (<45 years for males, and <50 for females) is common in Middle East where smoking rates are very high.**

### **B. Non-modifiable (uncontrollable).**

1. Sex (more in males, <55 years)
  2. Hereditary
    - \* Familial hyperlipidemia
    - \* Familial Hypertension
  3. Race
  4. Age

## INDICATIONS for CABG

1. more than one affected Coronary artery (occlusion >70%)  
triple vessel disease, class one evidence for the surgery in these three arteries (left circumflex, LAD, right CA)
2. left main CA disease
3. unstable angina with failed medical treatment
4. complication during PTCA (catheterization surgeries when the balloon closes suddenly)
5. life threatening complication of MI
6. congenital anomalies of CA

## **How is this surgery done?**

Firstly, median sternotomy is done using a saw and the sternum is fixed using stainless steel wires in the SC tissue. Then, the patient will be connected with the heart-lung machine which takes the deoxygenated blood from the right atrium and oxygenates it and pumps it back to the aorta (thus taking the role of

the lungs and the heart). Now, the heart is empty and is switched off by giving  $K^+$  containing fluids ( $K^+$  arrests the heart in diastolic phase). At that time, the grafts must be prepared.

The heart is empty, so it is easy to find the narrowed site. A small opening is made using scissors and the new artery is sewed onto it as a BYPASS. (we can't dissect and take away the CAs).

We can do nothing about the narrowing in the artery; we can't dissect the CA from the heart, but sometimes, we need to clean some of the plaques from the CA which is aggressive. CAs are very delicate arteries.

What is worse that if the suture is not in its place or you occlude the new artery, the patient will not wake up. THAT'S IT!

### Grafts used in CABG

We can take a vein from the thigh and **LIMA**. The vein will be connected with the right CA and LIMA with LAD.

Why do we use LIMA?

Evidences show that it's the best one because there is 90% chance for it to stay open for a long time ( $>10$  years) which is PERFECT, better survival and quality of life.

**Great saphenous** vein is used.

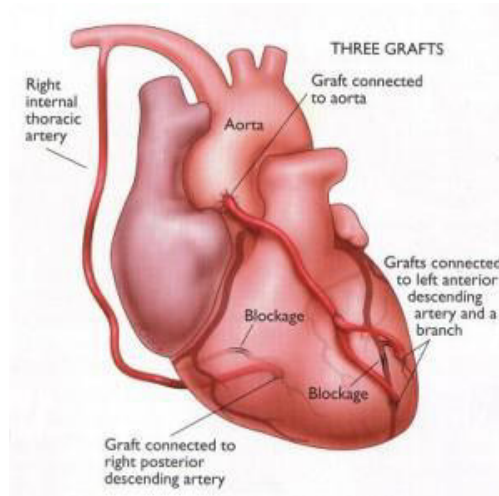
**Short saphenous** vein can be used.

**Right and left internal mammary artery, radial artery and right gastroepiploic** (of the great curvature of the stomach) can be also used.

Arteries are better grafts than veins. Since veins (saphanous vein) have a maximum chance of 60% to stay open after 10 years, they close because of many things we'll talk about later on.

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- These arteries and veins aren't end vessels and can be easily taken without affecting other parts. They are spare parts in our body.
  - Complications are very rare. Swellings can be seen after 6 months caused by the superficial collaterals (esp in the leg).
  - If the radial artery is taken, the hand will have ischemia if the ulnar artery was not very sufficient.
  - The stomach has many collaterals which give huge numbers of submucosal plexuses.
  - LIMA can be taken without affecting any organ.

- If the mammary artery is used, one end will be kept connected with the subclavian artery and the other end will be sewed onto the CA after the occlusion.



- If radial artery or saphenous vein is taken, one end will be sewed onto the CA and the other end onto the Ascending Aorta, so the blood will flow from the aorta to the new artery.
- The hand has 2 collateral circulation (superficial and deep arcades). If the ulnar artery is codominant (we can test this by a clinical test called Allen's test), we can judge that we can take the radial artery safely.

## **BALLOON ANGIOPLASTY** توسيع الشريان عن طريق القسطرة

A catheter is inserted into the CA and dilates it under pressure.

Angioplasty may narrow the CA because we are implanting many stents (دعامات داخل الشرايين التاجية)

There is a revolution in IHD management. Previously, metallic stents were used. Now, we have drug-eluting stents and after 2 years we'll find stents that auto dissolve after some time.

For sure, all patients should take anti-platelets drugs (esp. acetylsalicyclic acid "ASPIRIN" that works as COX inhibitor and ADP receptor blocking agents like clopidogrel and ticlopidine).

We have to control diabetes, hyperlipidemia, to enhance the quality of life (Quit SMOKING) and to monitor the BP.

## VULVULAR HEART DISEASE

- 2 AV valves; tricuspid and mitral.
- 2 semilunar valves; aortic and pulomanry.

Aortic valve is the most common valve to be affected and that degenerates by age. Previously, it was the mitral valve because of rheumatic fever.

Aortic valve has 3 leaflets normally. It may have 2 leaflets congenitally.

The valves may be calcified and degenerate which is natural process with age (of course, it differs between individuals) that's why **aortic valve stenosis surgeries** are really common now.

### Symptoms

1. Exertional dyspnea
2. Angina
3. Pulmonary edema
4. Exertional syncope
5. Sudden death

### Signs

1. Ejection systolic murmur
2. Slow rising carotid pulse
3. Reduce pulse pressure
4. LV hypertrophy
5. Signs of LV failure (crepitations, pulmonary edema)

If there's AS, we hear new sounds by the stethoscope "murmurs" during systole or diastole (which might be related to aortic regurgitation). So, according to the murmur we can diagnose the patient.

### Investigations

- ECG
- CHEST X-RAY

- **ECHOCARDIOGRAM** (ultrasound of the heart) which shows the calcified and stenosed valve and measure its surface area and the pressure gradient before and after the valve.
- **CATHETERIZATION**  
if we're not sure if the patient has problems with his valves and he's above 40 years old, we do catheterization to see if he has CAD. 20% of patients with Aortic valve disease have concomitant CAD and we do CABG.

We must measure the **surface area** of the aortic valve using ultrasound of the heart (normally, it's 3-4 cm<sup>2</sup>).

Also, **Pressure Gradient** is important (pressure difference before and after the valve).

Severity	Mean gradient (mmHg)	Aortic valve area (cm <sup>2</sup> )
Mild	<25	>1.5
Moderate	25-50	1-1.5
Severe	>50	<1
Critical	>80 (pressure in left ventricle is while in aorta 100 mmhg)	<0.7

### Some **INDICATIONS** for aortic valve replacement

1. Symptoms of severe AS
2. Severe AS undergoing CABG surgery
3. Severe AS without symptoms and aortic valve area <0.6 cm<sup>2</sup>

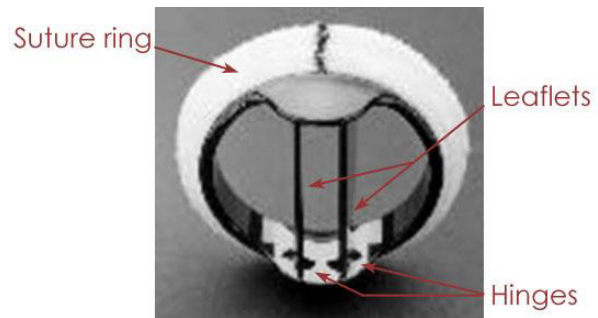
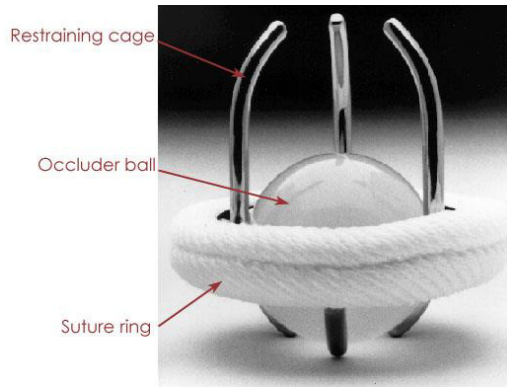
### **TYPES OF VALVES in valve replacement surgery**

#### **1. Mechanical valves.**

- \* from carbonic substances.
- \* 2 types: ball and socket (not used anymore)  
bileaflet (most common)
- \* for patients <65 years
- \* advantage: High durability (doesn't degenerate)
- \*disadvantage: warfarin is needed (anticoagulant), otherwise, thrombosis



will occur. Warfarin is coumadin **ان سم فيران** and causes bleedings in patients >65 years.



## 2. Tissue valves.

\* from living sources (**Pigs** "mostly", cows and humans (cadavers))

\* for patients >65 years

Tissue valves in patients whose life expectancy is < 10 year

\* Advantage: don't need warfarin

\* disadvantage: low durability (start to degenerate after 10-15 years)

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- Aortic valve replacement:  
median sternotomy → heart-lung machine → switch off the heart → open the aorta → take away the valve → the new valve is sewed
  - INR test: to monitor the effects of warfarin  
INR = prothrombin time of patient / prothrombin time of the control  
- standard values:  
aortic: 2-3  
mitral: 2.5-3.5
  - Tissue valves are treated with glutaraldehyde (deantigenized) → NO rejection.