# Cardiac Sciences

## Objectives

- To identify the indications for surgical intervention in coronary artery disease.
- To identify the indications for surgical intervention in valvular heart disease.
- To identify the indications for surgical intervention in end stage heart failure patients.
- To identify the main objectives of coronary bypass surgery.
- To compare different prostheses used in surgical valve replacement.
- To explain differences in different surgical therapies for end stage heart failure patients.

- **We highly recommend you to study the internal medicine's lecture VHD before studying this lecture**

### Colour Index

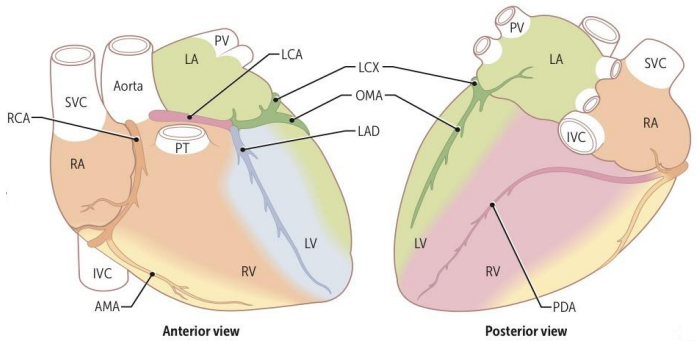
- Main Text
- Males slides
- Females slides
- Doctor notes
- Textbook
- Important
- Golden notes
- Extra

Summary File

Editing File

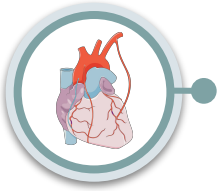
# Overview

## Heart anatomy:

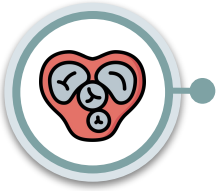



- The mitral valve has 2 leaflets and it is attached to the left ventricle via chordae tendineae
- Tricuspid valve has 3 leaflets and it is attached to the right ventricle via chordae tendineae
- We have two main coronary arteries:
  - Left coronary artery (LCA) supplies 75% of the heart
  - Right coronary artery (RCA) supplies 25% of the heart
- LCA gives:
  - Left anterior descending (LAD) supplies 75% (most commonly involved in ischemic heart disease)
  - Left circumflex (LCX) supplies 25%
- That's why we do surgery when LCA stenosed or its equivalent (proximal LAD or LCX), we can't save 75% of the heart by PCI

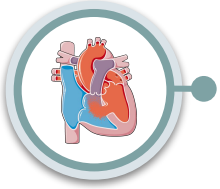
## Common cardiac operations: Click on icons & enjoy



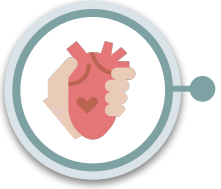
**Coronary Artery Bypass Grafting (CABG) most common**



**Valve Replacement/Repair**



**Repair of congenital defects: VSD or ASD**



**Heart Transplantation**

# Cardiac diseases

## Cardiac surgical diseases:

### Coronary artery diseases

Most common cardiac disease and it makes up more than 70% of the cardiac surgery indications.

### Arrhythmia

- Atrial fibrillation

### Aortic valve

- Aortic stenosis
- Aortic regurgitation

### Mitral valve

- Mitral stenosis
- Mitral regurgitation

### Aortic diseases

### Cardiac tumors

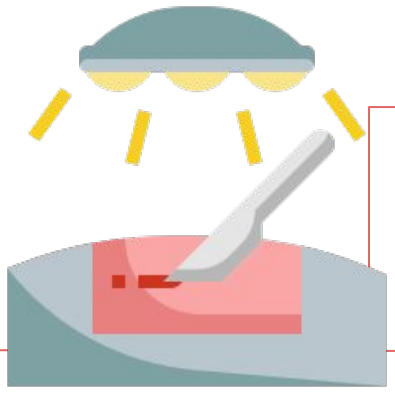
- Benign
- Malignant

### Heart failure

- Assist devices
- Transplantation

### Endocarditis

## Classes of surgical indications:



**Class I**

There is confirmed benefit from surgery
**We have to do surgery**

**Class IIb**

The studies which show no benefit is more than studies show benefit

**Class IIa**

The studies which show benefit is more than studies show no benefit

**Class III**

No study shows benefit
**Do not do it**

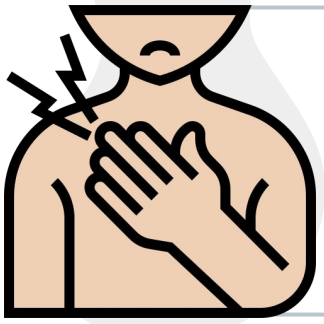
# Presentation of Cardiac Diseases

## 1 Chest pain

Most common presentation to the ER

### Life threatening causes:

- Myocardial infarction
- Aortic dissection
- Pulmonary embolism
- Tension pneumothorax



### Cardiac causes:

1- Ischemic heart disease
2- Pericarditis
3- Aortic aneurysm
4- Aortic dissection
5- Pulmonary embolism
6- Mitral valve prolapse
7- L.V.O.T (Left ventricular outflow tract) obstruction
   - Aortic stenosis
   - H.O.C.M (hypertrophic obstructive cardiomyopathy)

### Non cardiac causes:

- **In the chest wall & vertebrae:**
  - Diseases of the breast, myositis, rib fractures
  - Diseases of the shoulder joint & costochondritis
  - Cervical spondylosis & prolapsed cervical disc
  - Thoracic outlet syndrome e.g. cervical rib
  - Diseases of the spinal cord / nerve roots. e.g. radiculitis, Tabes dorsalis.
- **In the lungs, pleura & mediastinum:**
  - Pleural causes: Pleurisy, acute pneumothorax.
  - Lung disease: e.g: bronchitis, pulmonary Infarction, pneumonia
  - Mediastinitis & mediastinal emphysema & tumor.
- **Abdominal:**
  - Stomach: Hiatus hernia, peptic ulcer
  - Esophagus: reflux esophagitis, spasm
  - Gallbladder: cholecystitis, pancreatitis
- **Anxiety & Cardiac neurosis:** You need to exclude all the organic causes first to diagnose the patient with anxiety
  - Stabbing or stitching in nature occurs after exercise, associated coughing, palpitation, sense of suffocation, precordial tenderness & emotional upset

## 2 Lung Congestion

**Blood will accumulate in the lung**

- Related to the left side of the heart at the level of aortic and mitral valve.
- In case of aortic stenosis/regurgitation, hypertension, mitral stenosis/regurgitation or ventricular septal defect.
- Congestive lung symptoms in cardiac patients occur as a result of :
  - Stagnation of blood behind a failing left atrium or left ventricle (left sided heart failure)
  - Left to right shunts

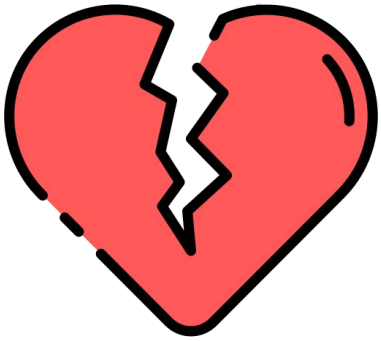
# Presentation of Cardiac Diseases

## 2 Lung Congestion

### Clinically:

- **Symptoms:** Dyspnea, orthopnea, PND, pulmonary edema, cough with expectoration of mucoid sputum, easy fatigue & hemoptysis.
- **Signs:** Rapid small pulse volume, pale, cold extremities, crepitations, gallop rhythm, pulsus alternans, functional mitral regurgitation.

**L.V Failure:** when the L.V fails unable to pump all the blood to the circulation



1-↓Cardiac output:
- Fatigue
- ↓Blood supply to the kidneys > increase salt & water retention > ↑Blood volume > Lower limb edema
- ↓Blood > skin pallor & peripheral cyanosis
- Cold extremities

2-↑Sympathetic activity > tachycardia

3- Blood accumulates in the lungs (pulmonary congestion):
- Dyspnea on effort
- Orthopnea
- P.N.D (Paroxysmal nocturnal dyspnea)
- Acute pulmonary edema
- Cough
- Hemoptysis
- Crepitations
- Pleural effusion

**L.V Failure causes:**

**1- Excessive pressure**
- Aortic stenosis
- Coarctation of the aorta
- ↑B.P

**2- Excessive volume**
- Aortic regurgitation
- Mitral regurgitation
- Ventricular septal defect
- Patent ductus arteriosus

**3- Disease in the myocardium**
- Ischemic heart disease & myocardial infarction
- Myocarditis

**Other causes for dyspnea**
- Respiratory causes: obstruction to respiratory passages, COPD, pneumothorax, infections, pulmonary embolism, pleural effusion, restrictive lung disease
- Anemia
- Metabolic causes: uremia, diabetic ketoacidosis
- Abdominal causes: Ascites
- Anxiety

## 3 Systemic venous congestion

Symptom related to the right side of the heart

**Causes:**

**1- Right atrium**
- Tricuspid stenosis
- Tricuspid regurgitation
- Right atrial tumor

**2- Right ventricle**
- Pressure overload
- Volume overload
- Myocardial damage

**3- Obstruction to venous inflow**
- Pericardial effusion
- Constrictive pericarditis

# Presentation of Cardiac Diseases

## 3 Systemic venous congestion

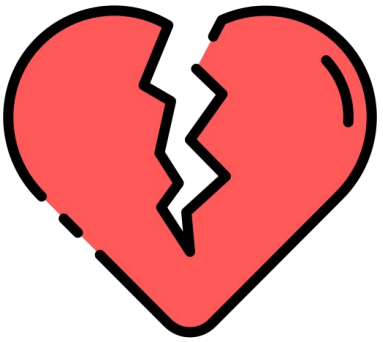
**Right ventricle Failure:**

1- Low cardiac output, fatigue, pale cold skin, peripheral cyanosis. rapid small volume pulse, lower limb edema

2- Blood accumulates behind the failing right ventricle > the R.A > systemic veins

- Neck vein congestion
- Lower limb edema
- G.I congestion: anorexia, nausea, flatulence
- Pleural effusion, pericardial effusion
- Ascites

3- Functional tricuspid regurgitation



**R.V Failure causes:**

**1- Excessive pressure:**
- Pulmonary stenosis
- Pulmonary hypertension

**2- Excessive volume:**
- Tricuspid regurgitation
- Atrial septal defect

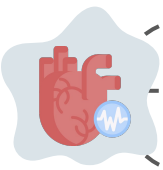
**3- Disease in the myocardium:**
- Right ventricle
- Infarction
- Myocarditis

**Clinically:**

- **Symptoms:** Fatigue, anorexia, nausea & abdominal distension, epigastric pain from liver congestion
- **Signs:** Edema, congested neck veins, enlarged tender liver, ascites, pleural effusion/pericardial, functional tricuspid regurgitation, cold extremities

## 4 Palpitations

**Awareness of the heart beats could be due to change in:**



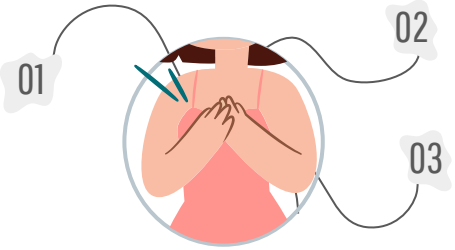
01 **Rate**

02 **Rhythm**

03 **Contractility**

## 5 Symptoms due to low cardiac output

- Blurring of vision
- Headache




- Easy fatiguability
- Dizzines

- Angina pectoris
- Oliguria

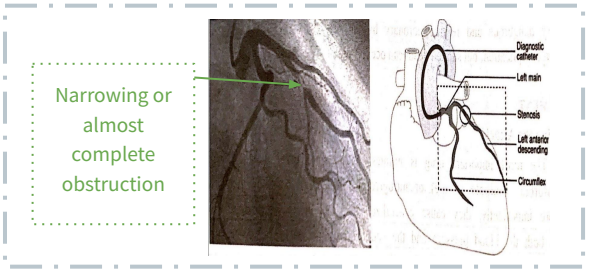
# Coronary Artery Bypass Surgery

## Clinical syndromes of ischemic heart diseases:

Some of them asymptotic (diabetic, old age)

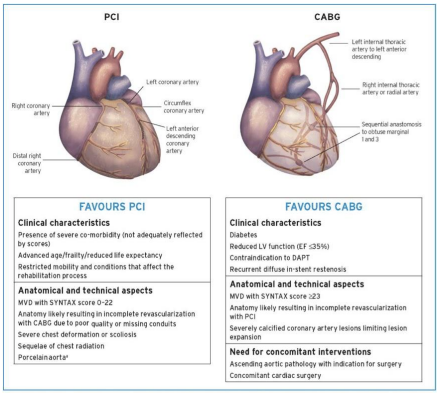
| Clinical Presentation | Mechanism |
|---|---|
| **1. Chronic stable angina pectoris** | Transient myocardial ischemia during exercise. |
| **2. Acute coronary syndrome S-T elevation acute myocardial infarction** | Atherosclerotic plaque disruption resulting in a total arterial occlusion with myocardial tissue necrosis. |
| **2. Acute coronary syndrome non S-T elevation acute myocardial infarction & unstable angina** | Plaque disruption with non-occlusive thrombus formation resulting in prolonged severe myocardial ischemia with or without foci of myocardial necrosis. |
| **3. Heart Failure** | Loss of contractile myocardium by infarction or gradual fibrosis. |
| **4. Conduction Disturbances RBBB or LBBB** | Necrosis, fibrosis or edema of conduction system. |
| **5. Arrhythmias** | Electrical instability of ischemic myocardium. |
| **6. Sudden Death** | Any of the above complicated by ventricular fibrillation. |

## Indications:




- Options for IHD:
  - Medical treatment and control of risk factors.
  - Non-medical interventions (It depends on the estimation of benefit risk ratio).

- Non-medical interventions can be done to coronary artery disease:
  - Percutaneous coronary intervention (PCI) patients with incipient or established MI fare better with PCI and supportive medical therapy, as the mortality of surgery in this setting is much increased
  - Open heart surgery coronary artery bypass surgery (CABG)




- **Indications for CABG:**
  - Failure of medical therapy or percutaneous intervention.
  - Mechanical complications of myocardial infarction (rupture of wall of the heart, septum and chordae tendineae. Tamponade. Valve weakening)
  - Associated valve disease.
  - (Further details about vascular diseases in the next page)

# Coronary Artery Bypass Surgery

| Indication | Asymptomatic or mild angina | Stable angina | Unstable angina / NSTEMI | Poor LV function |
|---|---|---|---|---|
| **Left main stenosis > 50% (most important vessel)** | Class I | Class I | Class I | Class I |
| **Stenosis of proximal LAD (Most commonly affected artery in IHD) and proximal circumflex > 70%** | Class I | Class I | Class I | Class I |
| **3 vessel disease with left ventricular dysfunction/Diabetes** | Class I | Class I | | Class I, with proximal LAD stenosis |
| **2 vessel disease** | | Class I if there is large area of viable myocardium in high-risk area | | |

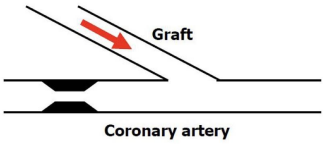
- When the stenosis occurs in the middle or the end of the artery means less area will be affected, as the area affected be smaller as we use PCI instead because if the stent blocks after months it won't be a big problem.

| Revascularization<br>N = no, Y = yes, C = need consultation | CABG | | | DES (drug eluting stent) | | |
|---|---|---|---|---|---|---|
| | No-risk | DM | LVD | No-risk | DM | LVD |
| **LMC +/- other lesions** | Y | Y | Y | N | N | N |
| **3 vessel + proximal LAD** | Y | Y | Y | N | N | N |
| **3 vessel** | Y | Y | Y | C | C | C |
| **2 vessel + proximal LAD** | Y | Y | Y | N | N | N |
| **2 vessel with LAD** | Y | Y | Y | Y | Y | Y |
| **2 vessel without LAD** | N | N | N | Y | Y | Y |
| **Proximal LAD** | Y | Y | Y | N | N | N |
| **1 vessel** | N | N | N | Y | Y | Y |

- To remember it in a simple way, think of the most important vessels (always CABG):
  - The most important is **LMC** (Left main coronary artery)
  - The second most important are **LMC equivalents (proximal LAD or LCX)**
  - The third most important if **3 vessels** are affected
  - The rest is any disease affect **proximal LAD**

# Coronary Artery Bypass Surgery

- A vascular graft is sutured to the coronary artery beyond the stenosis
- Improves blood flow to the heart.

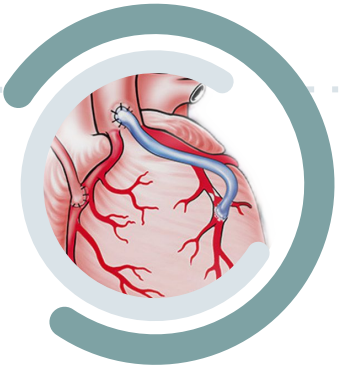


Distal to the stenosis

## Coronary conduits for CABG:

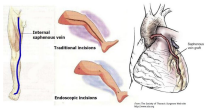
### Venous

- **Long saphenous vein** with antiplatelets, statins It gives a better outcome has patency rates of around 70% at 5 years



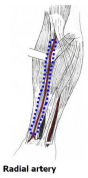
### Arterial

- **Internal thoracic artery** (internal mammary artery) It has a very high graft patency exceeds 95% at 5 years



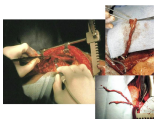
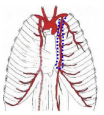

**Long saphenous vein**

Make sure that it is not the patient's dominant artery by doing (Allen's test)



**Radial artery**

Originate from subclavian artery You separate it from the chest wall and do only one anastomoses


**Internal thoracic artery**

## Types of surgery:

- Do the surgery while the heart is working
- Used only for CABG
- Risk of bleeding
- No end organ damage

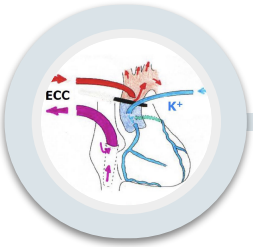
Without pump

With pump

- Conventional: using the heart lung machine, and cardioplegic arrest
- High concentration of potassium into the coronary arteries which will increase the concentration of potassium in the extracellular space leading to cardiac arrest
- Can affect the organs > severe systemic Inflammatory reaction
- May cause end organ damage
- The younger the patient > The better, because they can tolerate inflammation more [Not recommended for elderly patients]

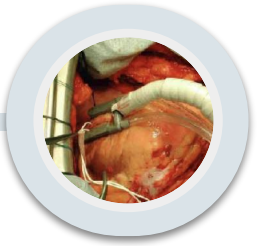
# Coronary Artery Bypass Surgery

## CABG
## Operative technique




**Under ECC with cardioplegia**

- Drain the heart
- The blood get oxygenated in the machine and returns to the aorta



**Beating heart surgery (without ECC " without extracorporeal circulation")**

- Stabilizer around the coronary artery

### Benefits of off pump CABG (it's better than the ones with pump)

- Reduced incidence of stroke and cognitive problems
- Lesser renal dysfunction
- Reduced inflammatory response (elderly can't tolerate the inflammatory response associated with the pump)
- Lesser coagulopathy requirements of blood transfusion and less bleeding
- Reduced length of time in intensive care & hospital stays
- Reduced morbidity and mortality rates

# Valvular Heart Disease

## General notes from dr. Turki

- For your level i want you to remember that we send patient to surgery if:
  - **Symptomatic**
  - **LV dilatation**
  - **LV dysfunction**
  - **Pulmonary hypertension**
  - **Atrial fibrillation**
- L.V dysfunction and dilatation is class I indication
- Pulmonary hypertension and atrial fibrillation are class II indication for all valvular diseases
- We have 20 techniques for valve repair, i just want you to know when you send patient to surgery and determine whether repair or replacement:
  - **Valve replacement:** mainly for aortic stenosis, regurgitation and mitral regurgitation
  - **Valve repair:** mitral stenosis and regurgitation
  - **Valvuloplasty:** mitral stenosis

## Aortic stenosis:

### Etiology

- Rheumatic common in underdeveloped countries
- Calcific aortic stenosis most frequent aetiology in the Western world
- Congenital: a congenital bicuspid valve calcifies at an earlier age
- Degenerative

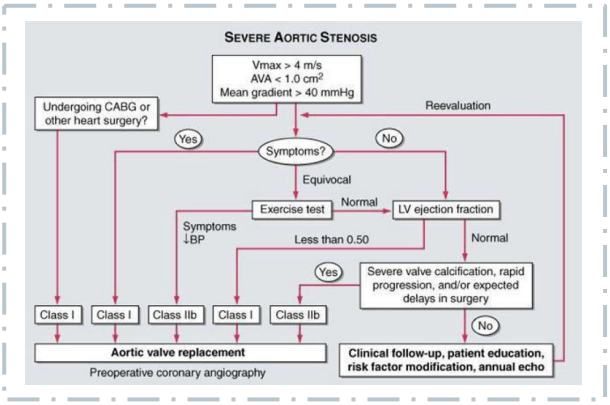
### Symptoms

- Chest pain (effort angina)
- Syncopal attacks
- Dyspnea and CHF
- The interval from onset of symptoms to death tends to be 2 years for CHF, 3 years for syncope, and 5 years for angina
- The ventricle will be hypertrophied and then dilate trying to accommodate the volume and eventually develop L.V dysfunction
- When the back pressure reaches the atrium it will dilate > stretch on fibers > **atrial fibrillation**

### Signs

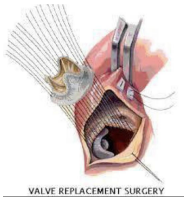
- Slow-rising pulse (pulsus parvus and tardus)
- Small amplitude pulse
- Sustained apical pulse
- Harsh ejection systolic murmur. Heard in the right second intercostal space
- Aortic component of S2 is soft

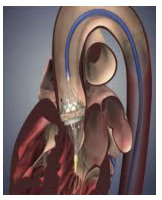
# Valvular Heart Disease




## Treatment

- Vmax: flow speed, AVA: aortic valve area, mean gradient: the difference between the pressure inside and outside the ventricle. I don't want you to memorize numbers just know how we consider patients who have severe aortic stenosis and send them to surgery
- **Medical:** treat the symptoms
- **Surgical (indication):**
  - Patients with severe symptoms
  - Asymptomatic patients with moderate or severe as undergoing cardiac surgery for coronary or other valve disease
  - Asymptomatic patients with severe AS and reduced EF (less than 50%)
- **Procedures:**
  - **Surgical AVR (aortic valve replacement)** mostly used via femoral artery Low to moderate surgical risk, Higher surgical risk AND severe multivessel coronary artery disease
  - **Transcutaneous aortic valve implantation (TAVI)**: via femoral artery, for patient who have contraindication or high risk for surgery. In some patients, e.g., the elderly, those with patent coronary grafts or significant other comorbidities
  - **Percutaneous balloon valvuloplasty** Indicated in children, adolescents, and young adults without AV calcification


VALVE REPLACEMENT SURGERY



## Aortic Regurgitation:

- AR is the diastolic reflux of blood from the aorta into the LV due to failure of coaptation of the valve leaflets at the onset of diastole
- AR can be acute or chronic

## Etiology

- Rheumatic
- Endocarditis
- Connective tissue disorders
- Aortic dissection or Aneurysm
- Rarely, a bicuspid valve

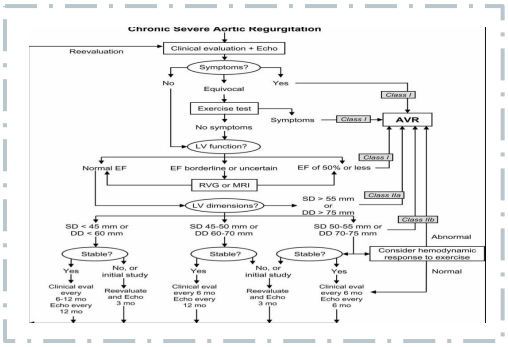
# Valvular Heart Disease

## Symptoms

- Asymptomatic
- Palpitations due hyperdynamic L.V. contraction
- L.V. failure: dyspnea. Orthopnea, P.N.D
- Angina in severe cases only
- Aortic dissection should be suspected in any patient presenting with angina and recent onset aortic regurgitation

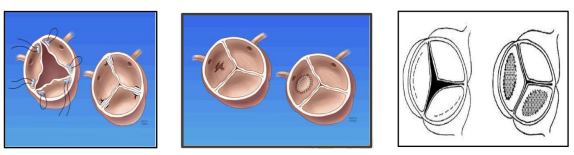
## Signs

- Wide pulse pressure
- Peripheral signs of aortic regurge
- Generalized vasodilation resulting in warm hands and feet, and increased sweating
- Hyperdynamic displaced apex
- Collapsing pulse
- Diastolic murmur in the left parasternal area
- Chronic aortic regurgitation is well tolerated and often asymptomatic. In severe cases, the patient may complain of dyspnoea and angina, and may exhibit features of congestive cardiac failure




## Treatment

- **Surgical (indication):**
  - Management of acute aortic regurge is by early surgery
  - Current recommendations for management of chronic AI depend on the presence of symptoms, LV function, and LV dimensions
  - A.V.R should be considered if there is excessive dilatation of the L.V. (L.V end diastolic dimension >70mm and end systolic dimension > 50mm)
  - Acute aortic regurgitation produces severe dyspnoea, with rapid onset of LV failure and pulmonary oedema require emergency ventilation and urgent surgery
- **Procedures:** Aortic valve replacement (AVR)



# Valvular Heart Disease

Important to distinguish whether the Aapex is displaced or not

## Mitral stenosis:

- It is the restriction and narrowing of the Mitral valve + impairment of left ventricular filling

### Etiology

- Rheumatic most common cause
- Congenital
- L.A. Myxoma the most common tumor in the heart obstruct the valve

### Prognosis

- The natural progression of MS causes the mitral valve area to reduce by 0.1-0.3 cm per year
- The progression from the onset of rheumatic fever to onset of signs of MS takes 10-20 years
- The progression from signs of MS to mild symptoms of MS takes 10-20 years
- The progression from mild symptoms to decompensation takes 10-20 years
- In patients with severe PH the mean survival is 3 years

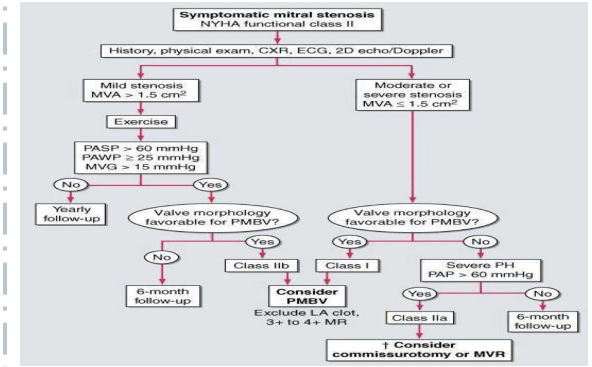
### Symptoms

- Asymptomatic for many years
- Symptoms of pulmonary congestion
- Palpitations
- Dysphagia, compression of left main bronchus
- Symptoms of low cardiac output

### Signs

- Low volume pulse
- Irregular pulse
- Tapping non-displaced apex beat
- Loud S1
- Mid-diastolic rumbling murmur
- Signs of pulmonary hypertension: central cyanosis, Loud  P2, T.R. P.R

# Valvular Heart Disease




- **Medical:** For mild cases
- **Surgical (indication):**
  - Asymptomatic patients with severe mitral stenosis (valve area <1.0 $cm^2$) and in those with severe mitral stenosis and new onset atrial fibrillation, severe mitral stenosis undergoing cardiac surgery for other primary indications
  - Symptomatic patients (NYHA class III or IV) with moderate or severe mitral stenosis (an echocardiographic calculated **mitral valve area <1.5$cm^2$**)
  - Evidence of a LA thrombus, recurrent emboli or development of pulmonary hypertension (PAP >50 mmHg)
  - Surgery for severe cases EXCEPT in bulging valve, calcified valve, mitral regurgitation over mitral stenosis

## Treatment

**Procedures:** For mitral stenosis we only do replacement or valvuloplasty

01 **Percutaneous balloon mitral valvuloplasty**: in patients with a pliable valve, with no evidence of a LA clot or mitral regurgitation

02 Closed mitral commissurotomy not performed anymore

03 Open mitral commissurotomy: separation of the fused leaflets, and reconstruction of the valve in some younger patients, permitting more extensive surgery under direct visualization

04 **Valve replacement/ repair:** if there is extensive leaflet calcification, with involvement of the subvalvular apparatus. There is shortening and thickening of the papillary muscles and chordae tendineae, tethering the leaflets to the tips of the papillary muscles. Mitral valve replacement should be performed in patients in whom mitral valve repair is not suitable (e.g., extensive valve destruction from endocarditis, severe leaflet calcification and fibrosis from rheumatic heart disease, or select patients with ischemic cardiomyopathy)

## Mitral Regurgitation:

- MR is defined as retrograde flow of blood from the LV into the LA due to impaired systolic coaptation between the anterior and posterior leaflets

# Valvular Heart Disease

## Etiology

- Rheumatic most common cause, Degenerative, Endocarditis
- Dilatation of the L.V. and mitral valve ring
- Dysfunction of the papillary muscle
- Congenital abnormalities
- Calcification of the mitral valve annulus

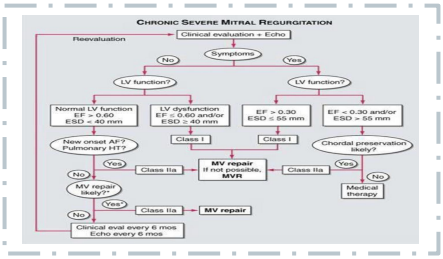
## Symptoms

- **Asymptomatic patients:** can have a long latent period before the onset of symptoms as chronic M.R is well tolerated if L.V function is still preserved
- **Symptoms of mitral regurgitation:**
  - Fatigue and weakness
  - Dyspnea, Orthopnea, PND
  - Pulmonary hypertension (low cardiac output)
  - Congestive heart failure (lower limb edema, congested neck veins, enlarged tender liver)

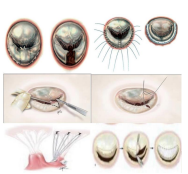
## Signs

- Displaced apex beat
- Apical thrill
- Apical pansystolic murmur
- Signs of pulmonary hypertension

## Treatment




- **Medical:** in acute MR temporarily while surgery is planned. In chronic MR to optimize cardiac function but surgery is the definitive treatment
- **Surgical (indication):** depending on L.V dimensions & functions
  - Prompt mitral valve surgery is indicated for the symptomatic patient with acute severe primary MR
  - In chronic mitral regurge, surgery is done for **symptomatic** or **asymptomatic patients with evidence of LV dysfunction** ( E.F <60%, left ventricular end systolic diameter > 40mm **LV dilatation**, **new onset A.F**, or **pulmonary hypertension** valve reparability. Sometimes asymptomatic patient may undergo mitral valve replacement surgery to prevent further complications
  - Asymptomatic patients with chronic severe MR and preserved LV (EF>60% and ESD <40mm) in experienced centers with likelihood of repair >90%
- **Procedures:** Valve repair/ replacement repair is preferred over replacement if a successful and durable repair can be achieved we have to try repair first because its outcomes are better



# Valvular Prosthesis

## Prosthetic Heart Valve:

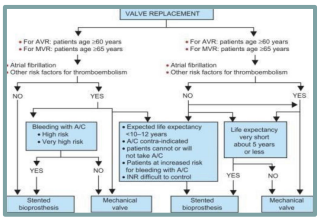
Mechanical (metallic)

Unstented

Stented

Biologic (Bioprosthetic valve)

- Lasts > 20 years
- Lifelong anticoagulation
- Click
- ★ Unless there is contraindication to anticoagulation, mechanical valves are commonly used in a younger age group




- Lasts 8 – 10 years
- No anticoagulation
- No click
- We use biological valve for old age and contraindication for anticoagulant like in female childbearing age

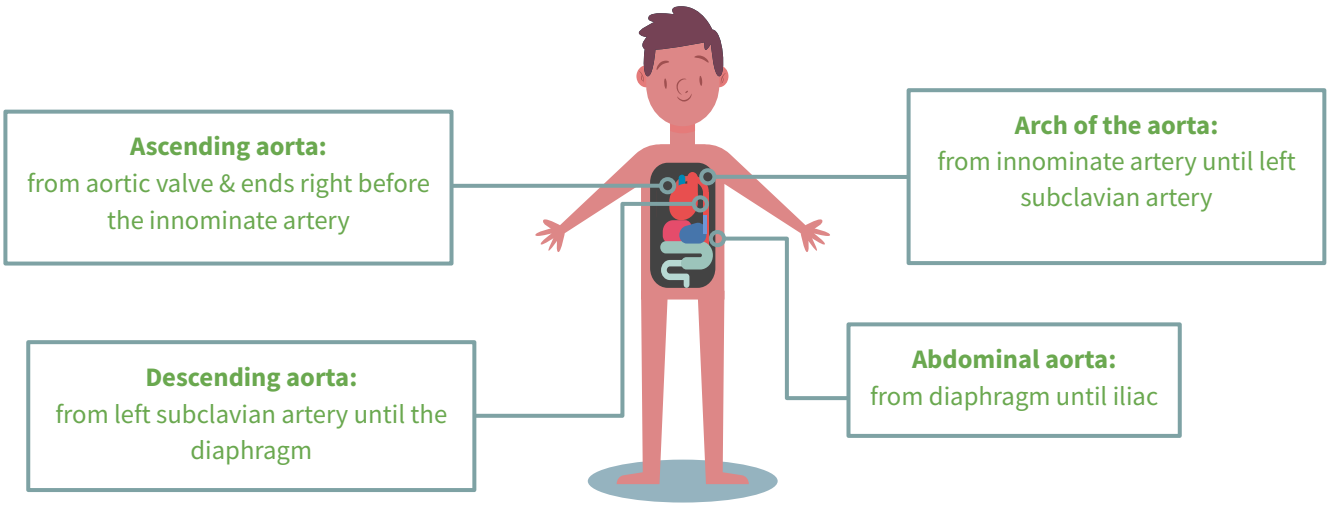
| Overview of AVR Options | | | | |
|---|---|---|---|---|
| **Prosthesis** | **Description** | **Advantages** | **Disadvantages** | **Lifespan** |
| **Mechanical** | Bileaflet | Best durability | Anticoagulation | Lifetime |
| **Stented Bioprosthesis** | Porcine/ Bovine pericardial | No anticoagulation | Durability | 10 – 15 years |
| **Homografts/ Autografts** | Human aortic valves | No anticoagulation, excellent dynamics | Technical complexity | |

## Complications of Prosthetic Valve:

1. **Thrombosis**
2. **Bleeding complications**
   Anticoagulant related
3. **Infective endocarditis**
   In some cases endocarditis prophylactics are needed
4. **Degeneration of biological valves**
5. **Paravalvular leak**

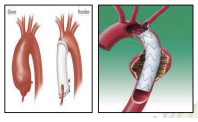
# Aortic Disease

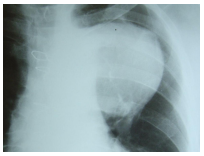
The aorta starts from aortic valve until the iliac, we divide it into 4 parts because the pathophysiology for the aneurysm and indication for surgery are different according to the area:



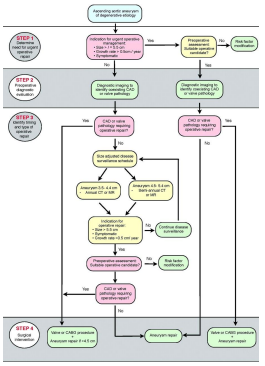

## Aortic aneurysm

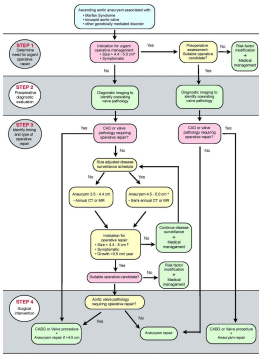
- **Thoracic aortic aneurysm:** abnormal dilatation of the aorta, Symptoms are usually due to pressure on surrounding structures
- The absolute criteria for aortic aneurysm: we operate if the aneurysm reaches
  - Ascending aorta > 5.5 cm
  - Arch of the aorta > 6.0 cm
  - Descending aorta > 6.5 cm
- Not all patients are the same, we treat each patient depend on his age, height, morbidity (bicuspid valve, connective tissue disease, Marfan's syndrome) certain patient we call them high risk patients (we operate on them in 0.5 cm smaller)
- Rate of growth criteria: if the aneurysm was 4 cm i have to send him for another CT in 6 months, normal rate of growth is 0.1 cm per year, rapid rate of growth > 0.5 cm per year
- Coexisting surgeries is an indication to decrease our limits (the same concept applied to all cardiac surgeries)
- Commonly accepted criteria for surgical intervention on ascending Aortic aneurysm:
  - Connective tissue disorders: 4.5
  - Bicuspid aortic valve: 5 cm
  - Sporadic: >5.5cm
  - Undergoing AVR: >4.5cm
  - Growth of aneurysm >0.5cm/year





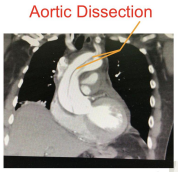
Aneurysm of the distal arch





# Aortic Disease

## Aortic dissection



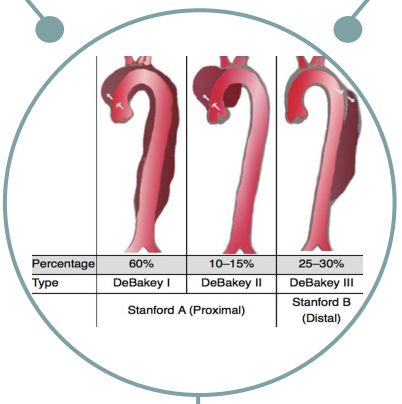

- **Aortic dissection:** Tear in the intima allowing blood to enter and flow in a false channel. There are 2 lumens separated by the dissecting membrane

★ Sudden onset of " knife like " pain in the chest radiating to the back and epigastric region

### Type A

1

- Involving the ascending aorta
- Medical emergency and require immediate surgery
- Mortality rate up to 1-2% per hour




2

### Type B

- Arising in the descending aorta
- Carry a lower mortality rate and can be managed medically
- May cause symptoms due to vascular compromise to other areas e.g. acute limb ischemia, renal ischemia, paraplegia, mesenteric ischemia.

### DeBakey classification system

**Type I**

Originates in ascending aorta, propagates at least to the aortic arch and often beyond it distally

**Type II**

Originates in and is confined to the ascending aorta

**Type III**

Originates in descending aorta, rarely extends proximally but will extend distally

- **Daily (Stanford) classification system:** Divided into 2 groups; A and B depending on whether the ascending aorta is involved
  - **A** = Type I and II DeBakey
  - **B** = Type III DeBakey

# Heart Failure

- In some cases of reduced ejection fraction everything seems to be normal and refractory to medical treatment, so we move to an advanced therapy:
  - **Cardiac resynchronization therapy** because RV & LV don't contract at the same time
  - if he relapses so we implant **ventricular assist device** or **transplant heart** depend on the indications

## Heart Transplant:

| Indications | Absolute Contraindication |
|---|---|
| Cardiogenic shock requiring mechanical assistance=Medications didn't work | Pulmonary hypertension (TPG "transpulmonary gradient" > 15 mmHg, SPAP "systolic pulmonary pressure" > 50 mmHg, PVR "pulmonary vascular resistance" > 4 WU, PVRI "pulmonary vascular resistance index" >6) because they will have acute RV failure |
| Refractory heart failure with continuous inotropic infusion. | Diabetes mellitus with end organ damage |
| NYHA functional class 3 and 4 with a poor 12 months' prognosis | Elevated creatinine (>200 umol/L). |
| Progressive symptoms with maximal therapy | Psychosocial (substance abuse, smoking, medical noncompliance) |
| Severe symptomatic hypertrophic or restrictive cardiomyopathy | Active infection |
| Medically refractory angina with unsuitable anatomy for revascularization | Malignancy (within 5 years) |
| Life-threatening ventricular arrhythmias despite aggressive medical and device interventions | Marked cachexia (<60% ideal body weight) won't tolerate surgery<br>Morbid obesity (>140% ideal body weight) |
| Cardiac tumors with low likelihood of metastasis | Osteoporosis |
| Hypoplastic left heart and complex congenital heart disease | Peripheral or cerebrovascular disease |
| Sometimes we know the reason of HF and we transplant heart because we know the patient won't make it out with any other surgery or the ejection fraction very low | Systemic disease (anticipated to limit long-term survival) won't live long, we may transplant heart for patient with chronic diseases if another organ gonna transplant for him, like patient with end stage kidney disease will transplant a kidney (for some reason transplanting 2 organs have higher success rate) |

# Heart Failure

## Ventricular Assist Devices:

- All the indications for heart transplant are indications for assist device. Why we have two therapies for the same indications? Because heart transplant donor pool is limited, so if patient have an indication for hearts transplant and we don't have a heart yet we put him on waiting list (patient fails medical therapy his mortality 50% in two years so we have to implant an assist device)

### Indications

- Frequent hospitalizations for HF
- Intolerance to neurohormonal antagonists
- NYHA IIIb-IV functional limitations despite OMT
- End-organ dysfunction owing to low CO
- Increasing diuretic requirement
- CRT non responder
- Inotrope dependence
- Low peak Vo2 (<14mL/Kg/min)

### Absolute Contraindication

- Irreversible hepatic disease
- Irreversible renal disease
- Irreversible neurological disease
- Medical nonadherence (don't take thrombolytic therapy)
- Sever psychosocial limitations

**1**

**Bridge to decision making:**

implanting an assist device for patient had a cardiogenic shock even with no indication for transplant

**2**

**Bridge to transplant:**

implanting an assist device for patient on a long waiting list & may die

**3**

**Destination therapy:**

implanting an assist device as a last resort for patients with end stage heart failure who are ineligible for heart transplantation

## NYHA classification: ★

**Class I**

No limitations of activities. Symptoms only **occur with vigorous activities**, such as playing a sport. Patients are nearly asymptomatic.

**Class II**

Slight or mild limitation of activity. Symptoms **occur with prolonged or moderate exertion**, such as climbing a flight of stairs or carrying heavy packages. Slight limitation of activities.

**Class III**

Marker limitation if activity. Symptoms **occur with usual activities of daily living**, such as walking across the room or getting dressed. Comfortable at rest.

**Class IV**

Symptoms **occur at rest**. Incapacitating.

# Endocarditis

- Infective endocarditis is an infection of cardiovascular structure including valves and intra-cardiac foreign bodies as pacemaker leads, prosthetic valves and surgical patches
- It most commonly occurs at sites of previous endocardial damage caused by high pressure jets of blood
- Endocarditis of the tricuspid valve occurs in I.V. drug abusers
- Some people got IE because their valve is affected

## Modified Duke criteria

- 2 major criteria, 1 major and 3 minor, or 5 minor criteria
- **Major criteria:** A definitive clinical diagnosis can be made on the following:

**1- Microbiological evidence:**

- Typical microorganisms consistent with IE from 2 separate blood
- cultures persistently positive blood cultures with other organisms:

  i. At least 2 +ve cultures drawn >12 hours apart

  ii. All 3 or majority of 4 separate cultures with the first and last at least 1 hour apart

  iii. Single +ve culture for Coxiella burnetti

**2- Evidence of endocardial involvement:**

- Oscillating intracardiac mass
- Abscess
- New partial dehiscence of prosthetic valve
- New valvular regurgitation

## Treatment:

- Not All patients with endocarditis will need surgery, some will be treated by medications. When do we decide that this patient needs surgery? If he has affected valve
- course of antibiotics [Right valves 2W, left valves 6W]

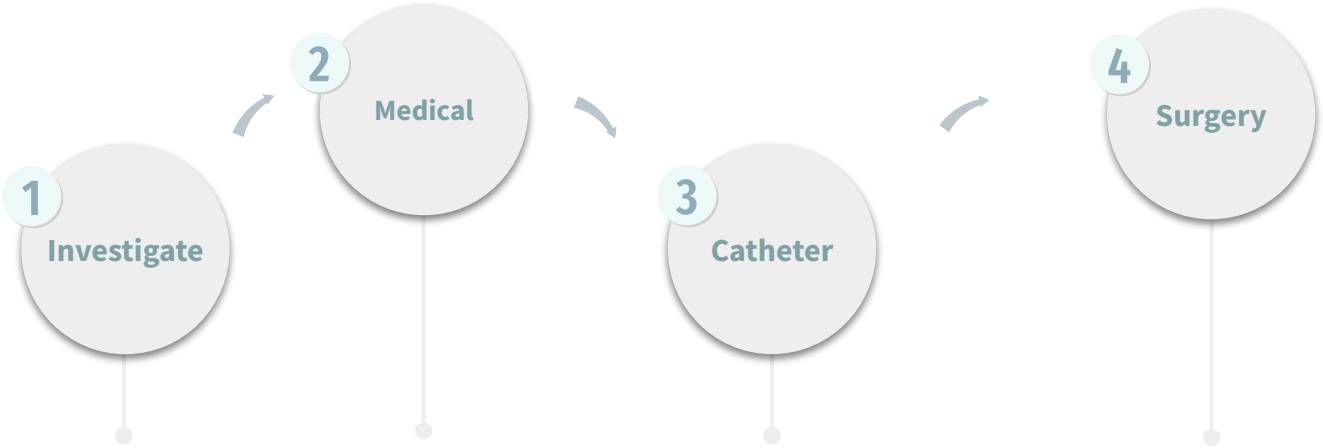
| Indication for and timing of surgery in patient with left sided , native valve infective endocarditis | |
|---|---|
| **Indication** | **Timing of surgery** |
| **Heart failure** | |
| Aortic or mitral valve infective endocarditis with severe acute regurgitation or obstruction causing refractory pulmonary edema or cardiogenic shock | Emergency |
| Aortic or mitral valve infective endocarditis with fistula into a cardiac chamber or pericardium causing refractory pulmonary edema or cardiogenic shock | Emergency |

# Endocarditis

| Indication for and timing of surgery in patient with left sided , native valve infective endocarditis | |
|---|---|
| **Indication** | **Timing of surgery** |
| **Heart failure** | |
| Aortic or mitral valve infective endocarditis with severe acute regurgitation or obstruction and persistent heart failure (not responding to therapy) or signs of poor hemodynamic tolerance ( early mitral valve closure or pulmonary hypertension) | Urgent |
| Aortic or mitral valve infective endocarditis with severe regurgitation and heart failure easily controlled with medical treatment | Elective |
| **Uncontrolled infection** | |
| Locally uncontrolled infection (abscess , false aneurysm, fistula, enlarging vegetation, or dehiscence of prosthetic valve) | Urgent |
| Persistence fever and positive blood cultures for >5-7 days | Urgent |
| Infection caused by fungi or multi drug resistance organisms , such as pseudomonas aeruginosa and other gram negative bacilli | Elective |
| Lack of response on antibiotics (repeat the culture, if shown that you are using the right antibiotic and there is no response do surgery) | - |
| **Prevention of embolism** | |
| Aortic or mitral valve infective endocarditis with large vegetation (>10mm=1cm in length) after one or more embolic episode, despite appropriate antibiotic therapy, especially during the first 2 weeks of therapy | Urgent |
| Aortic or mitral valve infective endocarditis with large vegetation (>10mm in length) and other predictors of complicated course (heart failure, persistence infection with staph aureus or fungal, or abscess) most likely they will not respond to antibiotics. if they respond well it will be recurrent again even if the valve is still normal | Urgent |
| Isolated, very large vegetation (>15mm) : surgery may be preferred if a procedure preserving the native valve is feasible | Urgent |
| Re-embolism on treatment because he is not responding to treatment.(embolism it self is not an indication for surgery it should be a (re-embolism) | - |

# Arrhythmia

- Patient with AFib what do you do?




Investigate for the reason, and correct it

first line of treatment is medical therapy

if didn't respond to medical therapy and with no other cardiac problems expect arrhythmia and he we do ablation by **cath**

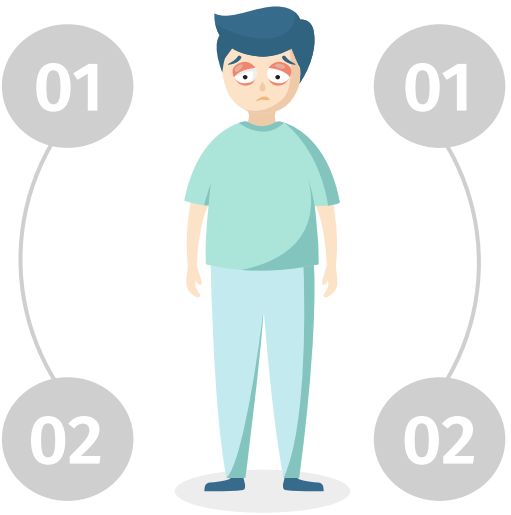
If cath failed or the patient already has another indication for surgery coexist with arrhythmia we perform the surgery and do ablation with the surgery. Success rate for cath 30%-60%, Success rate for surgery 70%-90%, but we don't open a patient's chest for just AF

| Recommendations | Class | Level |
|---|---|---|
| Surgical ablation of AF should be considered in patients with symptomatic AF undergoing cardiac surgery | IIa | A |
| Surgical ablation of AF may be performed in patients with asymptomatic AF undergoing cardiac surgery if feasible with minimal risk | IIb | C |
| Minimally invasive surgical ablation of AF without concomitant cardiac surgery is feasible and may be performed in patients with symptomatic AF after failure of catheter ablation | IIb | C |

# Cardiac Tumors

## Clinical Features

- The 2 most common manifestations of cardiac tumors are:
  - Obstruction most common
  - Embolization
- Nonspecific symptoms as fever, fatigue, and myalgias can be associated with cardiac tumors




## Investigations

- **Echocardiography**
- CT, MRI can be used as diagnostic modalities

| Primary Cardiac Tumors | |
|---|---|
| **Benign (75% of the cases)** | **Malignant (25% of the cases)** |
| • Myxoma<br>• Rhabdomyoma<br>• Fibroma<br>• Lipoma<br>• Atrioventricular node tumor<br>• Papillary<br>• Fibroelastoma<br>• Hemangioma | • Rhabdomyosarcoma<br>• Fibrosarcoma<br>• Angiosarcoma |

## Management

- Benign? We excise it but we take the size under consideration
- Malignant? Regardless the size we never excise it (not surgical)
- We can't do ventricular assist device because it's contraindicated

# Basic Principles of Cardiac Surgery

### Access

- Full or Partial Sternotomy
- Thoracotomy
- Robotic or Endoscopic

### Static Operative Target

- Cardiac Arrest
- Ventricular Fibrillation
- Mechanical Stabilizers

### Bloodless Operative Field

- Suction and re-transfusion
- Snaring

### Preservation of Myocardium

- Off-pump Techniques
- Hypothermia
- Cardiac Arrest with cardioplegia

### Preservation of body perfusion

- Use of Heart Lung Machine
- Off-pump Techniques

## Heart Lung Machine:

- It gives the ability to stop the heart by causing hyperconcentration of potassium in pulmonary arteries leading to cardiac arrest
- Aim of cardiopulmonary bypass: to facilitate cardiac and thoracic aortic procedures by excluding the heart and lungs from the circulation whilst providing:

**Adequate gas exchange**

**Systemic organ perfusion**

**Controlling body temperature**

# General Notes

## 437 teamwork notes

## First part: Surgical Indications

### Coronary bypass surgery

- The best intervention is medical therapy (for stable angina), once the Condition reach the level of MI and unstable angina, we do the other interventions
- We have 2 intervention for coronary diseases (Rather than medical):
  - Percutaneous intervention (PCI)
  - Surgery
- We decide the type of the intervention according to the following:
  - **Left main coronary Disease** > Class I > Bypass Surgery [regardless patient symptoms]. Why left? Left coronary serve 75% of the heart muscle. Why Not PCI? because any mistake happen during PCI > patient arrest
  - **Stenosis at proximal LED and proximal circumflex** > Bypass surgery. why proximal? because Left main bifurcate to give these to so proximal is equivalent to left main
  - **3 Vessels disease [All the coronary Arteries are blocked]** > Bypass surgery . Why?
    1) because the whole muscle is ischemic
    2) number of stents that needed to open All the arteries will cause high risk of occlusion of stent that is why surgery is preferred
- If we have single vessel occlusion > one stent then PCI
- If we have double vessels occlusion > 2 Stents [40% Risk > Acceptable]
- More than 2 stents > better to go with surgery

### Aortic valve [Stenosis or Regurgitation]

Think about 5 things:

- Class 1 indications:
  1- LV Symptoms (most important one) (think about onset not severity or duration)
  2- Size
  3- LV Function (EF)
- Class 2 indications
  4- Pulmonary pressure
  5- AFib
- If any of these 5 get affected > indication of surgery [stenosis or regurgitation]
- If the patient is going to have another surgery better to have the valvular surgery at the same time [Even if moderate stenosis]
- Sever AS, AR > confirm the diagnosis by ECHO + do stress test if there's symptom or not > look for the 5 things (Any one is present > surgery)

# General Notes

## Aortic Diseases

- Morphology and the ability to expand of the Aorta is different in different parts of the Aorta
- Autopsy Studies shows that rupture of aorta when they exceeded 6 cm for the ascending aorta, 6.5 cm for the arch of aorta and 7 cm for the descending aorta.
- People are not same, So we make the decision according to the patient normal not autopsy criteria [but for exam stick to the Autopsy value]
- Divide patients into low / High risk according to the quality of the tissues
- Marfan's syndrome and Connective tissue disease, bicuspid aortic valve [high risk conditions]. very weak tissue > High Risk to rupture or grow quickly
- High risk > expected to rupture earlier
- For low risk patient, There is 4 important factors:
  - Symptoms or patients under surgery
  - Absolute size
  - Growth rate
  - If the patient is going for another surgery (the number is depending upon the surgeon)
- For High risk patient we drop of 0.5-1 cm from the criteria (e.g: The highest limit for Ascending aorta is 5.5 normally but in high risk patients it is 4.5cm)
- The autopsy criteria for aortic rupture The aorta should be below the written values

## Heart Failure

- Indications for heart transplant are basically 2 things:
  - Patient have problem that can't be corrected by any other method = End stage heart disease
  - Expected survival > 1 year (if the patient is expected to die due to any other cause? No transplantation)
- Contraindications (We don't do cardiac transplantation):
  - Patient not expected to survive > 1 year
  - Patient that expected that the transplant will fail (e.g pulmonary HTN because the HTN will cause HF for the transplanted heart
  - Systemic disease that affect survival
  - High creatinine
  - Active infection
  - Psychosocial reasons
- We use Assist devices [Artificial devices that take over the function of the heart] , it has multiple roles: “only remember these 3"
  - Bridge to transplant [long waiting list]
  - Bridge to recovery
  - Destination therapy [Not candidate for any other therapy]
- Don't have to worry about HF transplant technique

# General Notes

## Endocarditis

- 1st thing to do is to confirm the diagnosis
- Not All patients with endocarditis will need surgery, some will be treated by medications
- When do we decide that this patient need surgery? If he has structural problem, e.g.. As
- The second question is do we do it now or after 1 month or after a full course of antibiotics [Right valves 2W, left valves 6W]? "The initial duration can be extended if blood culture is still positive after antibiotic course until we get it negative
- There is certain conditions that need urgent surgical intervention [immediate]:
  - Vagitations > 1cm
  - Staph. Aureus:"Iits aggressive and causes tissue damage
  - Abscess in the heart
  - Heart block
  - Fungal infection
  - Patients with prosthetic valve(with period less than 1 year) and he develops endocarditis
- Conditions that we wait for treatment and we assess [early intervention]:
  - Stroking on antibiotics [emboli and on antibiotics]
  - HF not responding to therapy
  - Sepsis not responding to antibiotics
- Conditions that we wait until he finish his course [Late intervention]:
  - Patient doesn't have any criteria but he has valve structural problem ex: AS,MR,MS

## Arrhythmias

- Some patients get Arrhythmia, because of other problems, e.g. MS > AFib [secondary]
- Some patients have only AFib [primary]
- The aim of the surgery is to maintain the conduction between SA and AV nodes, and cut All the other pathways by interrupt them with different lines
- When do we do surgery?
  - Symptomatic AFib undergoing another cardiac surgery (eg. patient has AFib and going for coronary bypass) if only AFib we don't do surgery unless he failed to be controlled by any other methods
  - Asymptomatic patients undergoing cardiac surgery with minimal risk
- Patient with AFib only what do you do?
  - Investigate for the reason
  - Go for medication
  - Medication failed? go for catheter
  - Catheter failed? go for surgery

## Cardiac Tumors

- Benign? We excise it but we take the size under consideration
- Malignant? Never excise it not surgical therapy

# General Notes

## Second part: Cardiac Surgical Treatment

[Not that important if you don't remember it, it is fine]

### Cardiopulmonary bypass machine

- Take the blood from venous system > oxygenator > back to the arterial system

### Aortic stenosis

Can be done by:

- Surgery [open intervention]: Surgical replacement of the valve
- Catheter [percutaneous intervention we enter from the groin]:
  - For patients who can't go for surgery
  - Have a risk of causing stroke
  - Cause paravalvular leak
  - Not recommended for younger patients

### Aortic Regurgitation

- Only surgical intervention to:
  - Repair the valve
  - Replace the valve

### Mitral

- Stenosis: surgical replacement
- Regurgitation: Replace it or Repair it (For any valvular regurgitation do that)
- In any valvular problem Repair is better than Replacement when feasible

### Prosthetic values

- Bio-prosthetic valve (usually better for elderly above 60)
  - Degenerate (need another surgery in the future)
  - 70%-80% will have it for 10-15 years
  - If we put it for child it will degenerate in 3 years
  - If we put it for an adult (e.g. 35 y.o) it will degenerate in 10-15 years
  - If we put it for elderly people (e.g 70 y.o) it will degenerate in 30 years
- Metallic value [usually better for younger below 60)
  - Will not degenerate
  - 40% will need replacement due to clotting and infection
  - At the end the patient has the right to choose whatever he want

Q: Females in childbearing age we recommend to put bio prosthetic, why? Because if they have metallic valve they Should take warfarin → fetal congenital anomalies # Again the patient will make the decision at the end

# 439's Quiz

Q1: A 75-year-old woman with history of angina is admitted to the hospital for syncope. Examination of the patient reveals a systolic murmur best heard at the base of the heart that radiates into the carotid arteries. Electrocardiogram (ECG) is notable for left ventricular hypertrophy with evidence of left atrial enlargement. ECG reveals an aortic valve area of 0.7 cm2. What is the most appropriate next step in her management?

A) Medical management with a nitrate and an angiotensin-converting enzyme inhibitor
B) Percutaneous coronary artery angioplasty and stenting
C) Aortic valve replacement
D) Tricuspid valve replacement

Q2: A 70-year-old woman undergoes a cardiac catheterization for exertional chest pain. Her pain continues to worsen and she is interested in having either surgery or percutaneous coronary intervention (PCI). Which of the following would be an indication for her to undergo either coronary artery bypass grafting or PCI?

A) Two-vessel coronary disease with proximal left anterior descending artery stenosis and depressed left ventricular ejection fraction
B) Isolated left main stenosis, no diabetes, and normal left ventricular ejection fraction
C) Left main stenosis and additional coronary artery disease with depressed left ventricular ejection fraction
D) Three-vessel coronary artery disease and diabetes

Q3: which patient should have mitral valve replacement?

A) Patient with Mild mitral valve stenosis
B) Symptomatic Patient with severe MV stenosis not favorable for PMBV
C) Symptomatic patient + No chordal preservation
D) None of the above

Q4: Which of the following is a malignant cardiac tumor?

A) Hemangioma
B) Myxoma
C) Rhabdomyosarcoma
D) Rhabdomyoma

## Answers

| | | | |
|---|---|---|---|
| Q1 | C | Q4 | C |
| Q2 | A | | |
| Q3 | B | | |

Extra Questions

# Good Luck!

## Team leaders:

Reem Alqahtani

Shayma Alghanoum

Sarah AlQuwayz

Mona Alomirainy

## This lecture was done by:

- Naif Mansour Alsulais
- Omar Abdullatif Alsuliman
- Homoud abdulrahman algadheb
- Wesam Alhuways
- Naif Mansour Alsulais

Note taker Reviser

Feedback