



**Division of Cardiac Surgery**  
**Department of Cardiac Sciences**  
**King Saud University Medical city**  
**King Saud University, Riyadh.**

**Presentation and  
management of cardiac  
surgical diseases**



# Objectives of the lecture

- ◆ Overview of diseases of heart, where surgery can play a role
- ◆ Surgical indications
- ◆ Understanding of the Basic Principles of Cardiac Surgery




# Cardiac Diseases

- ◆ Coronary Artery Disease
- ◆ Valvular Heart Diseases
- ◆ Congenital Heart Diseases
- ◆ Miscellaneous :
  - Aortic Diseases
  - Pericardial Disease
  - Cardiac Tumors
  - Trauma
  - Heart failure
  - Arrhythmia surgery

# Approach:

- ◆ 1. History
- ◆ 2. Physical examination
- ◆ 3. Chest x-ray
- ◆ 4. E.C.G.
- ◆ 5. Investigations (non-invasive & invasive).

# **Modes of Presentation of Cardiac Diseases**

- ◆ **Chest pain**
  - ◆ **Shortness of Breath**
  - ◆ **Palpitations**
  - ◆ **Dizziness, Syncope**
  - ◆ **Congestive Cardiac Failure**
  - ◆ **Cyanosis and Clubbing in Congenital Defects**
  - ◆ **Other Symptoms (fever, sweating, G.I. symptoms, embolic symptoms, loss of weight)**
- 

# Chest pain

Differential diagnosis:

- ◆ 1. Cardiac causes
- ◆ 2. Non-cardiac causes

Life threatening causes:

- ◆ Myocardial infarction
- ◆ Aortic dissection
- ◆ Pulmonary embolism.

# Shortness of breath

- ◆ **Cardiac causes:** Heart failure, myocardial ischemia, congenital heart disease, arrhythmias, pericardial diseases, and valvular heart diseases.
- ◆ **Respiratory causes:** COPD, pneumothorax, infections, pulmonary embolism, pleural effusion, restrictive lung disease.

# Shortness of breath

- ◆ Others:
- ◆ Anemia, renal failure, obesity, anxiety and hyperthyroidism.



# Ischemic Heart Disease

## Clinical manifestations:

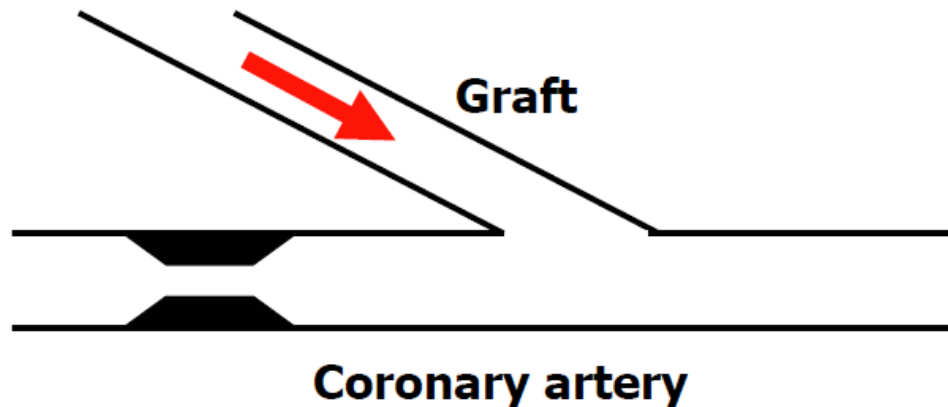
- ◆ 1. Asymptomatic
- ◆ 2. Symptomatic:
  - angina pectoris: stable- unstable
  - myocardial infarction
  - V.S.D., Ischemic mitral regurgitation, Ventricular aneurysm, Heart failure, Conduction defects.

# Ischemic Heart Disease

- ◆ Indications of surgery:
  1. Failure of medical therapy or percutaneous intervention.
  2. Left main disease more than 50%.
  3. proximal LAD & proximal Cx more than 70%.
  4. 3-vessel disease with left ventricular dysfunction
  5. Mechanical complications of myocardial infarction.
  6. Associated valve disease

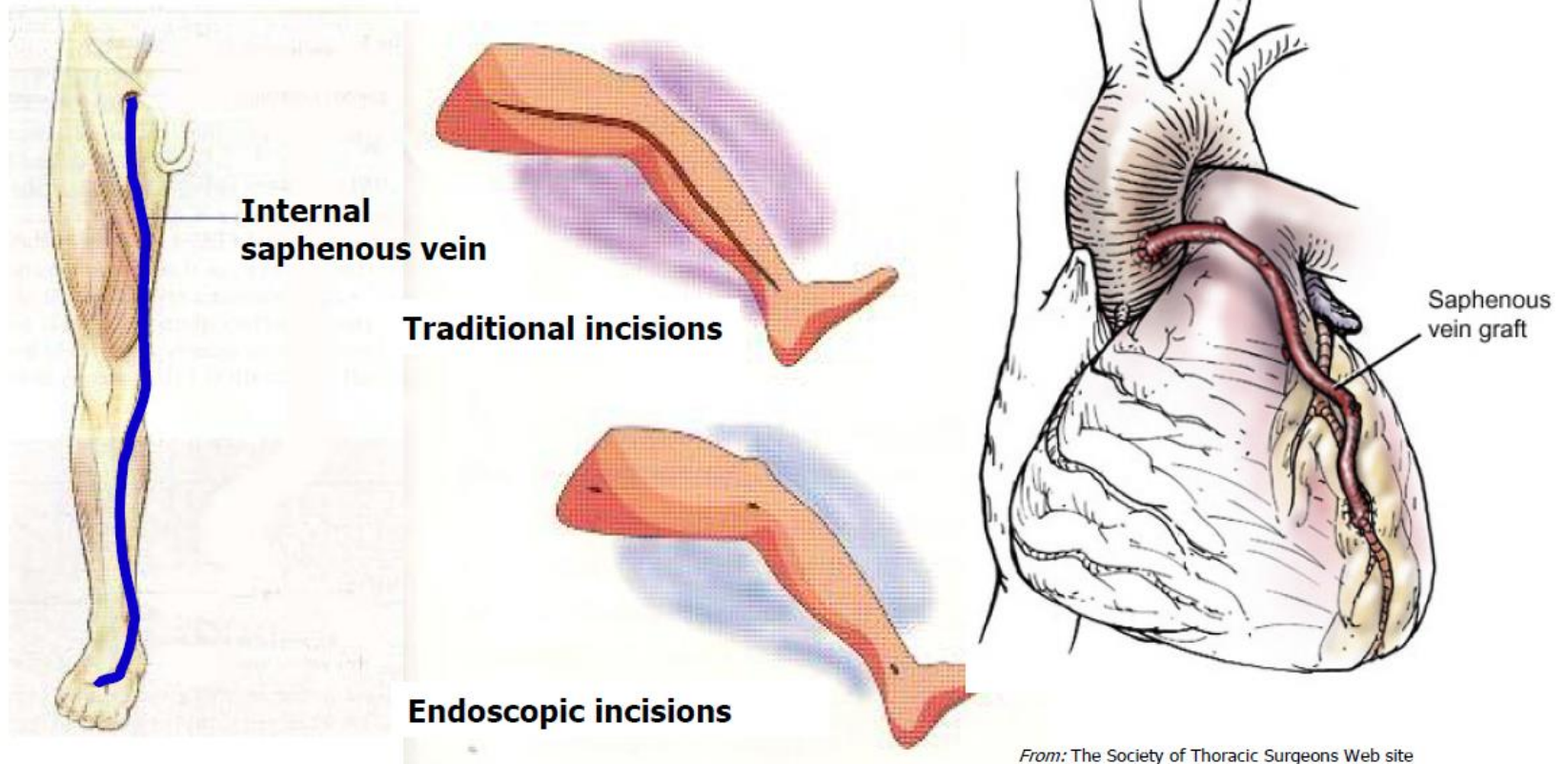
# What is a CABG ?

- A vascular graft is sutured to the coronary artery beyond the stenosis



- ◆ **Coronary conduits:**
  1. **Arterial: Internal thoracic artery**
  2. **Venous : Long saphenous vein.**
  
- ◆ **Types of surgery:**
  1. **Conventional: using the heart lung machine, and cardioplegic arrest**
  2. **Off-pump (beating heart surgery)**

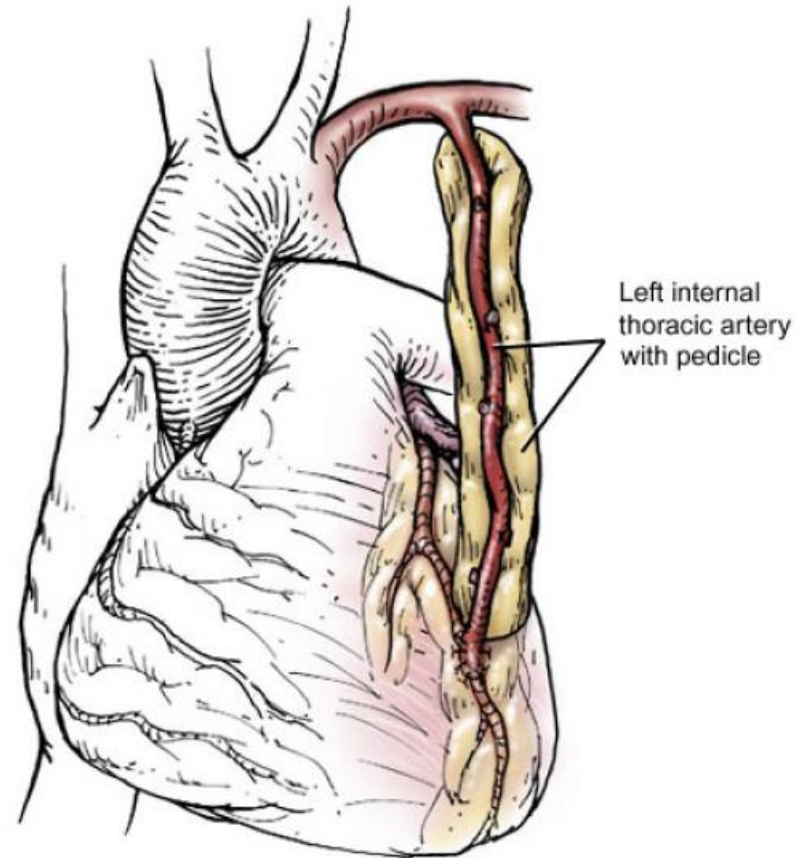
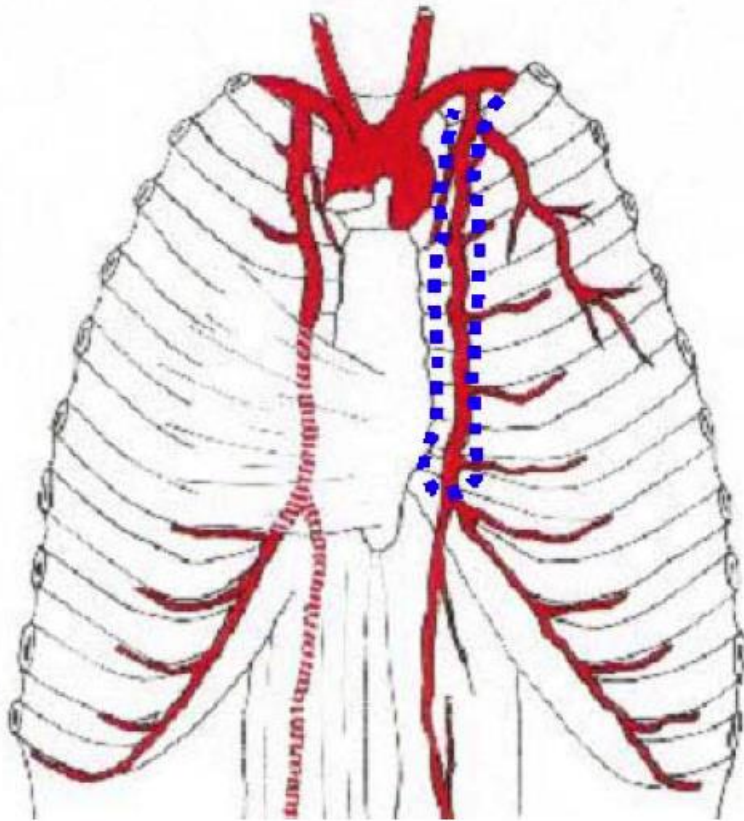
# Saphenous vein graft

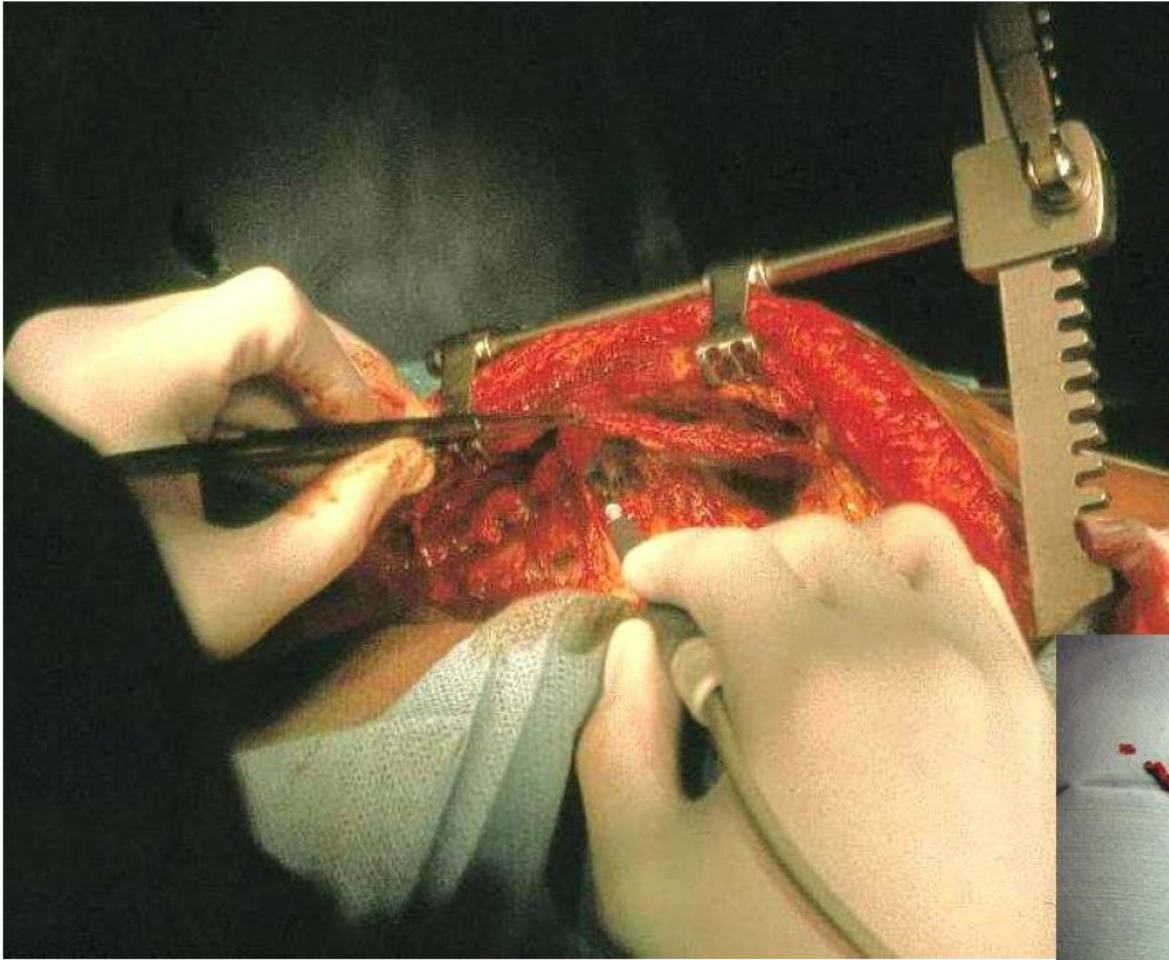


From: The Society of Thoracic Surgeons Web site  
<http://www.sts.org>



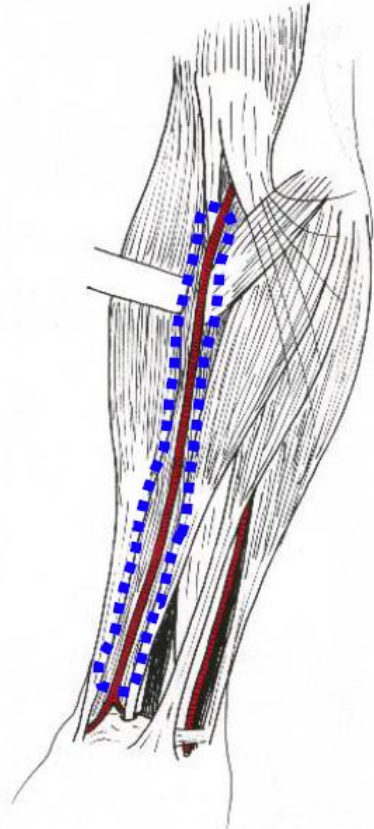
# Internal thoracic artery graft



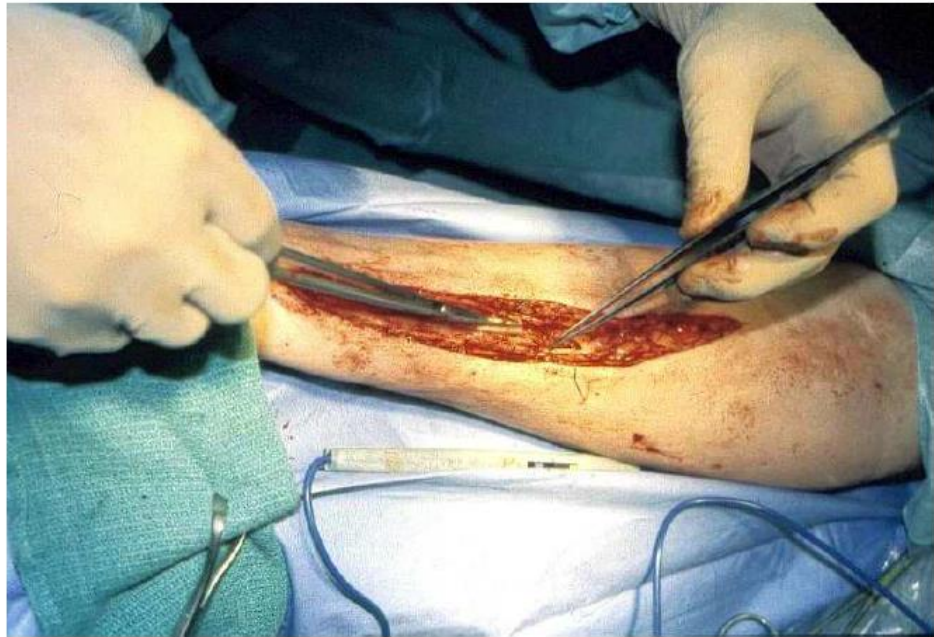




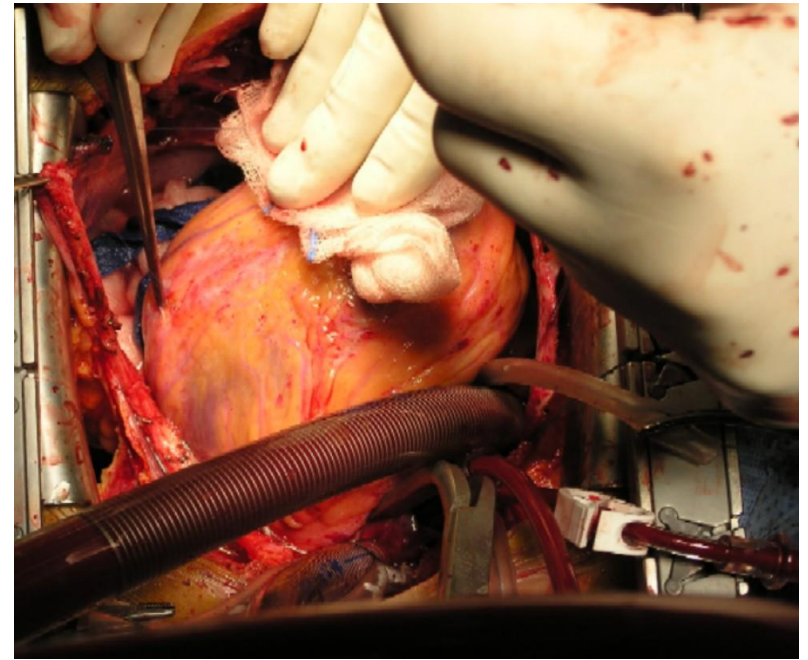
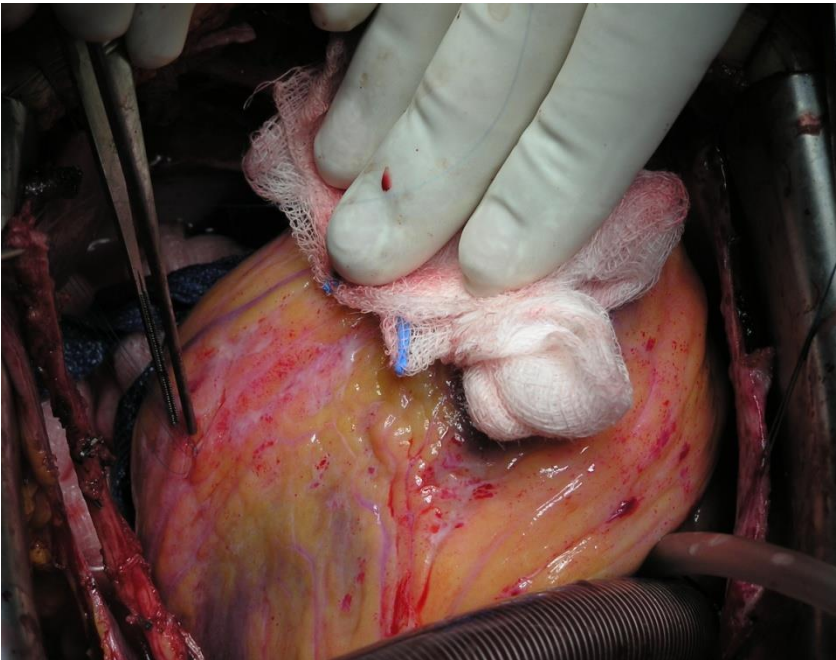
# Other arterial grafts



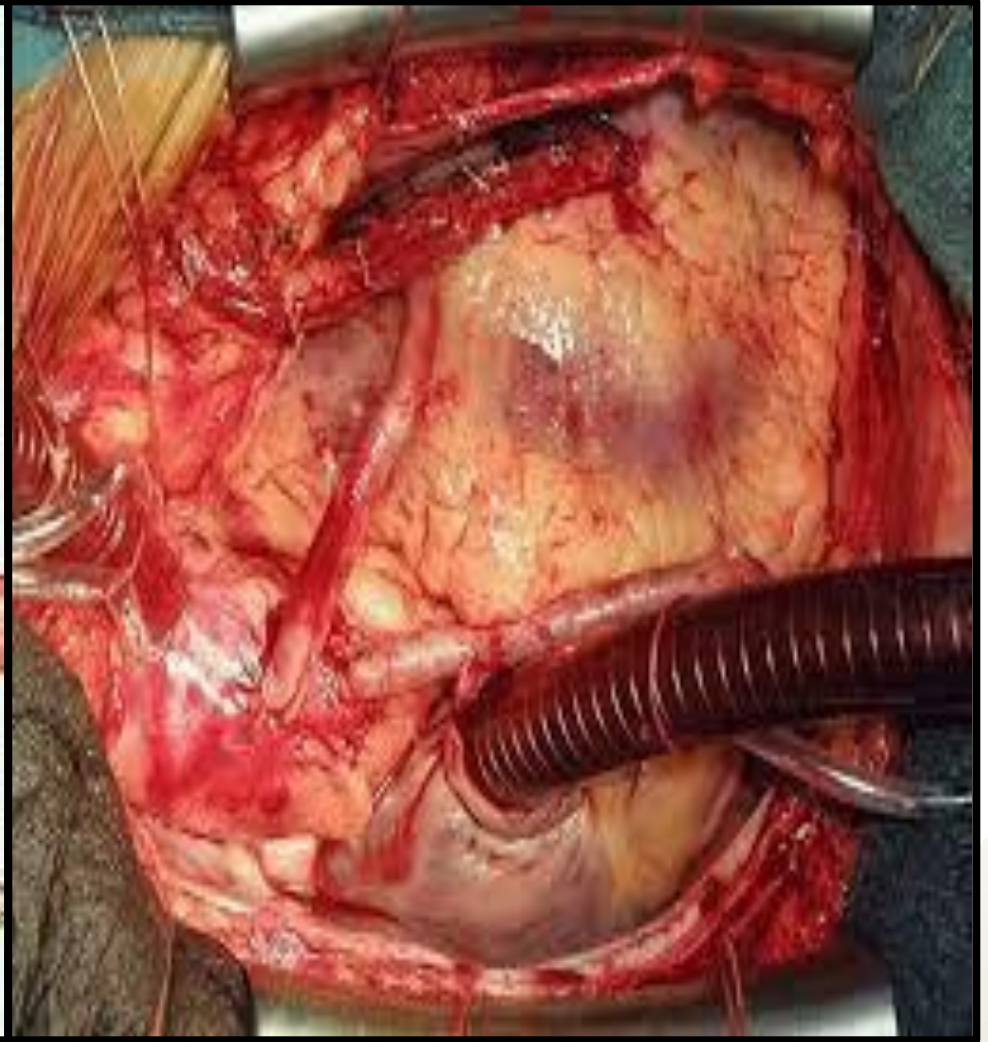
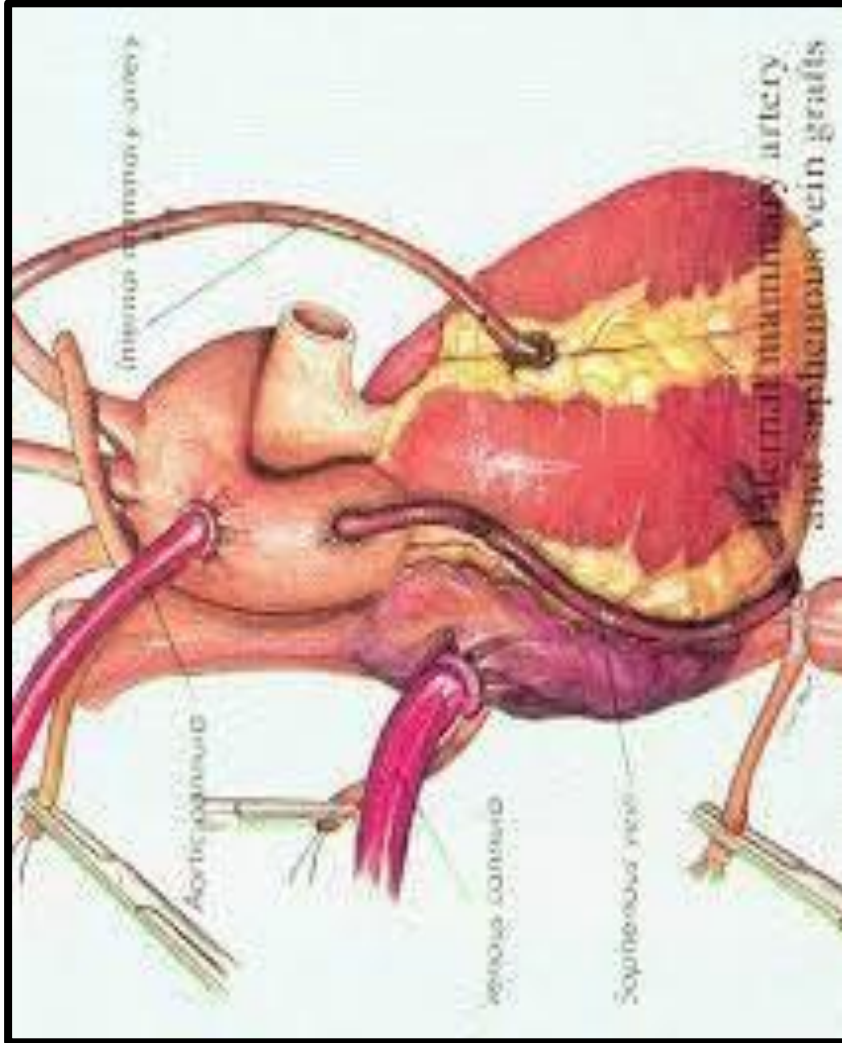
**Radial artery**



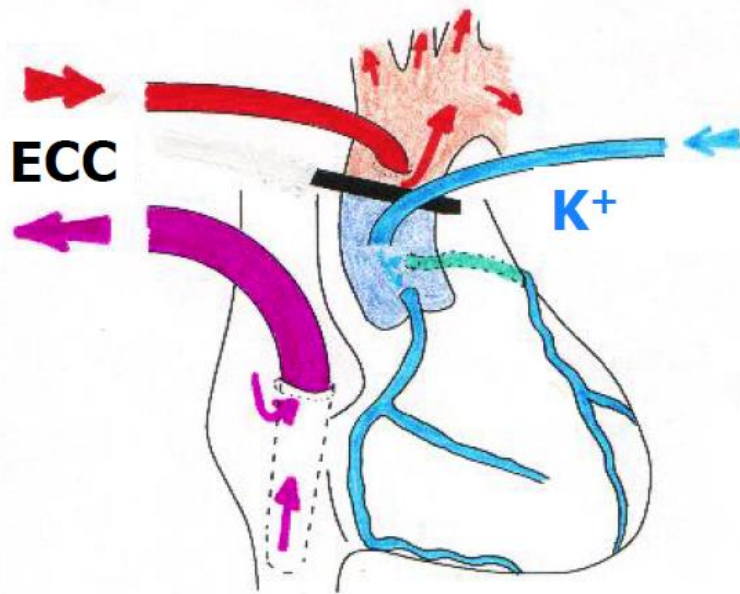
# Coronary Artery Bypass Grafting



# Coronary Artery Bypass Surgery

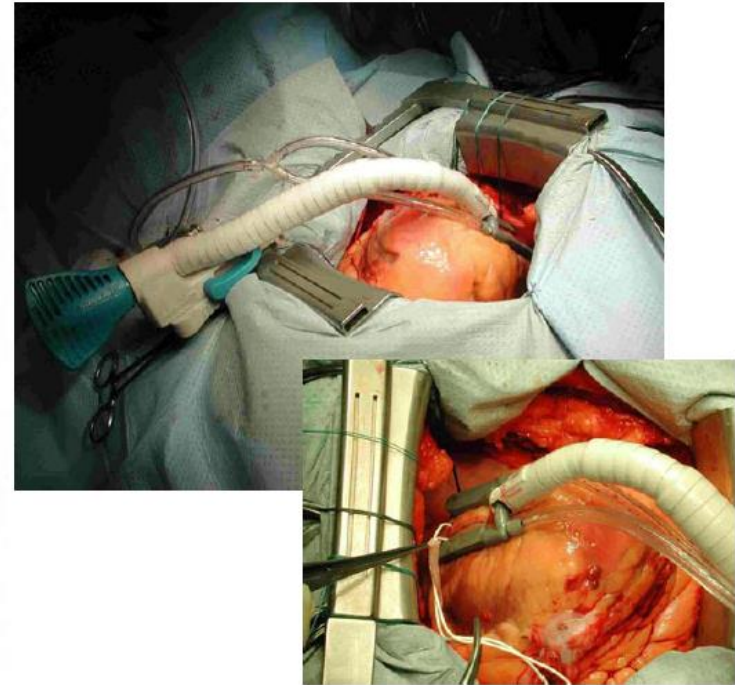


# CABG – Operative technique



**Under ECC with  
cardioplegia**

**Video**



**Beating-heart surgery  
(without ECC)**

**Video**

# Valvular Heart Diseases

- ◆ 1. Mitral stenosis:
  - Etiology: Rheumatic, Congenital
  - 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 of mitral stenosis

- ◆ 1. Asymptomatic for many years.
- ◆ 2. Easy fatiguability.
- ◆ 3. Dyspnea, Orthopnea and PND.
- ◆ 4. Palpitations
- ◆ 5. Dysphagia, compression of left main bronchus

# Signs of mitral stenosis

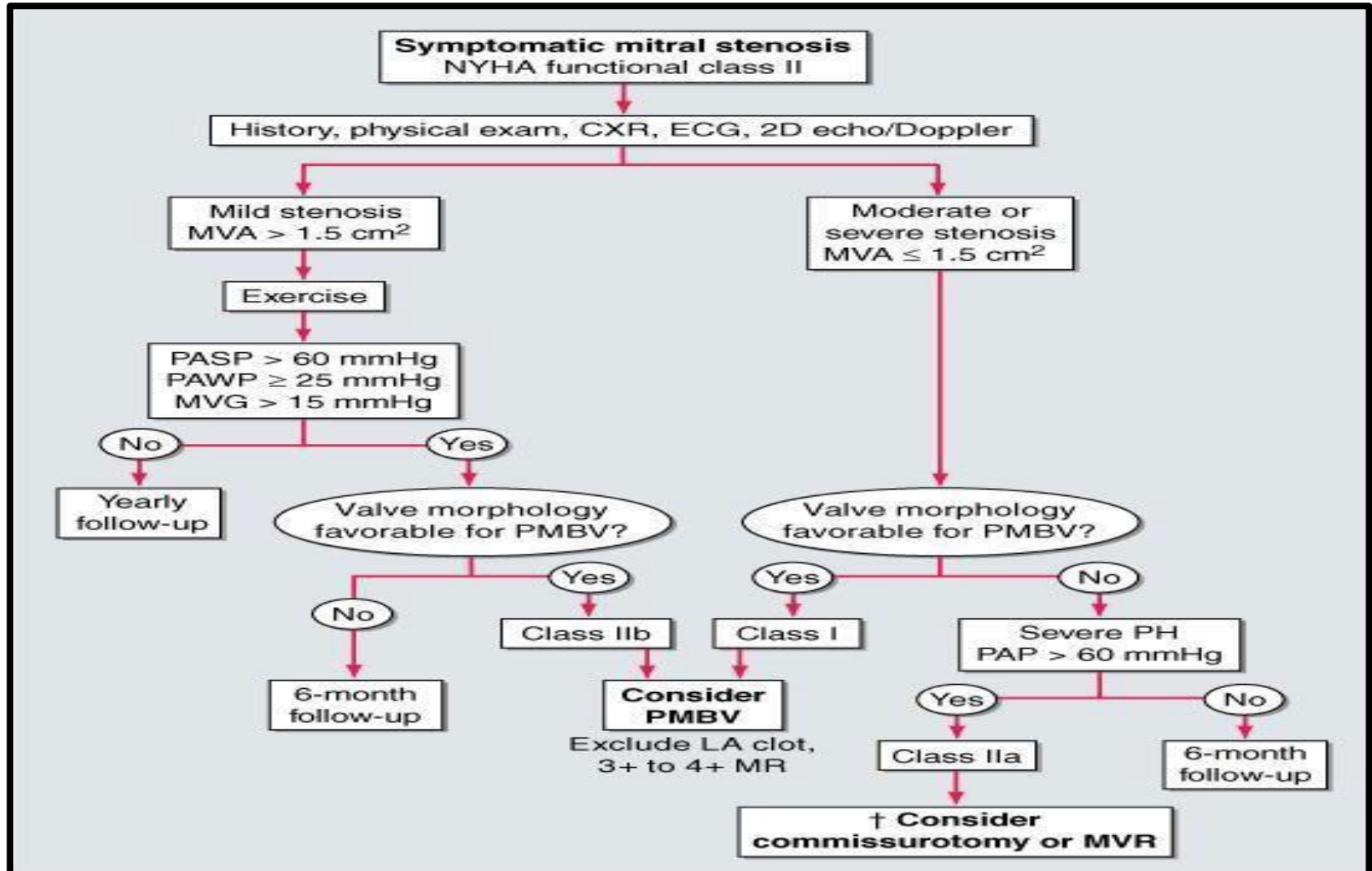
- ◆ 1. Low volume pulse.
- ◆ 2. Irregular pulse.
- ◆ 3. Tapping non-displaced apex beat.
- ◆ 4. Loud S1
- ◆ 5. Mid-diastolic rumbling murmur.
- ◆ 6. signs of PH: central cyanosis, Loud P2, T.R. P.R.

# Mitral Stenosis

- ◆ **Treatment:**
- ◆ **1. Medical**
- ◆ **2. Balloon valvuloplasty**
- ◆ **3. Closed mitral commissurotomy**
- ◆ **4. Open mitral commissurotomy**
- ◆ **5. Mitral valve replacement / repair**



# Mitral Valve



◆ **2. Mitral Regurgitation:**

**Etiology: Rheumatic, Degenerative, Endocarditis, Ischemic, Traumatic**

**Chronic mitral regurgitation: Rheumatic fever, Myxomatous degeneration, ischemic cardiomyopathy.**

**Acute mitral regurgitation: chordal rupture, infective endocarditis, papillary muscle rupture following MI.**

# Mitral Regurgitation

- ◆ 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.

# Mitral Regurgitation

**Symptoms of mitral regurgitation:**

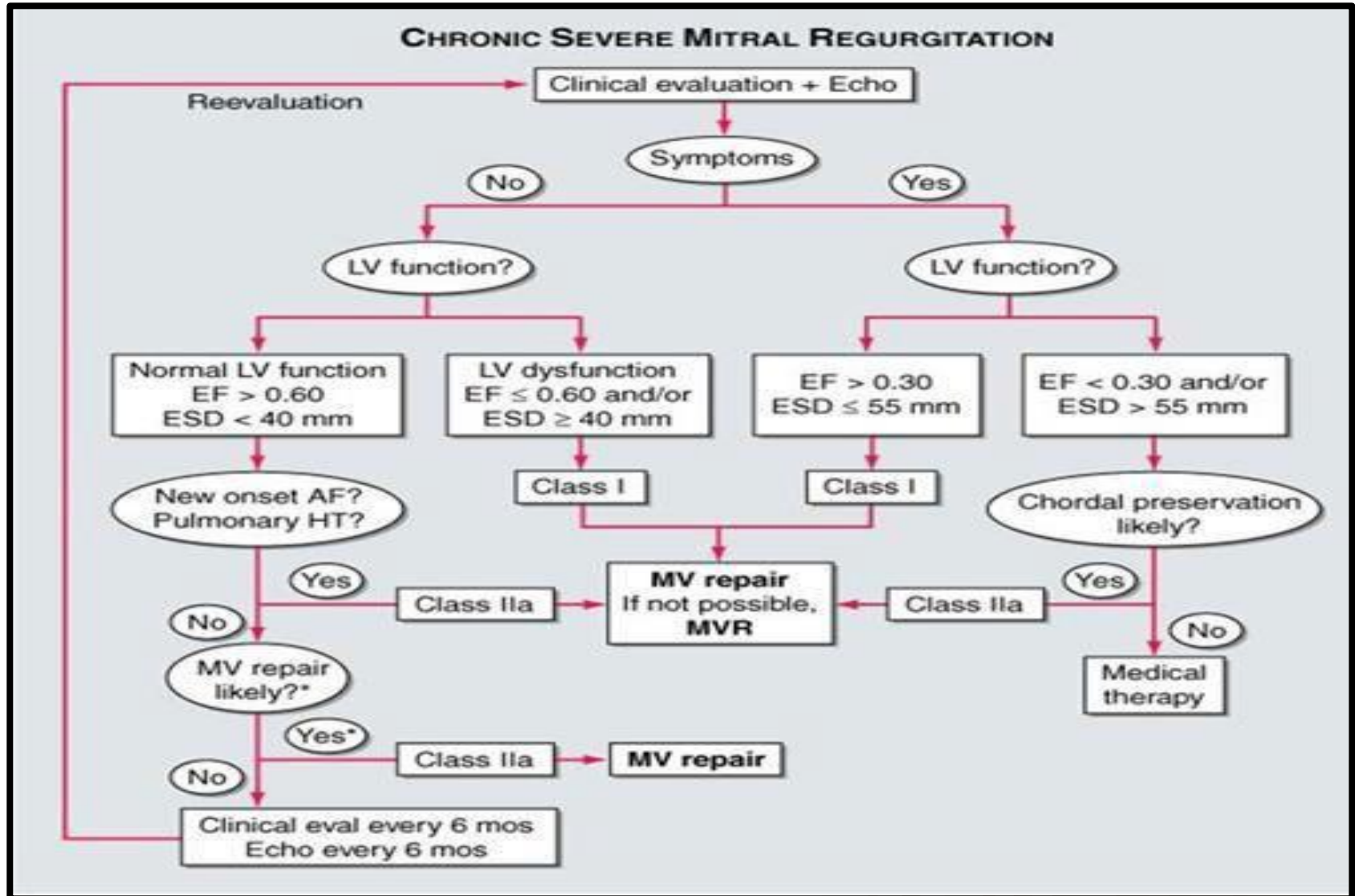
- ◆ **1. fatigue and weakness**
- ◆ **2. Dyspnea, Orthopnea, PND**
- ◆ **3. Pulmonary hypertension and right heart failure.**

# Mitral Regurgitation

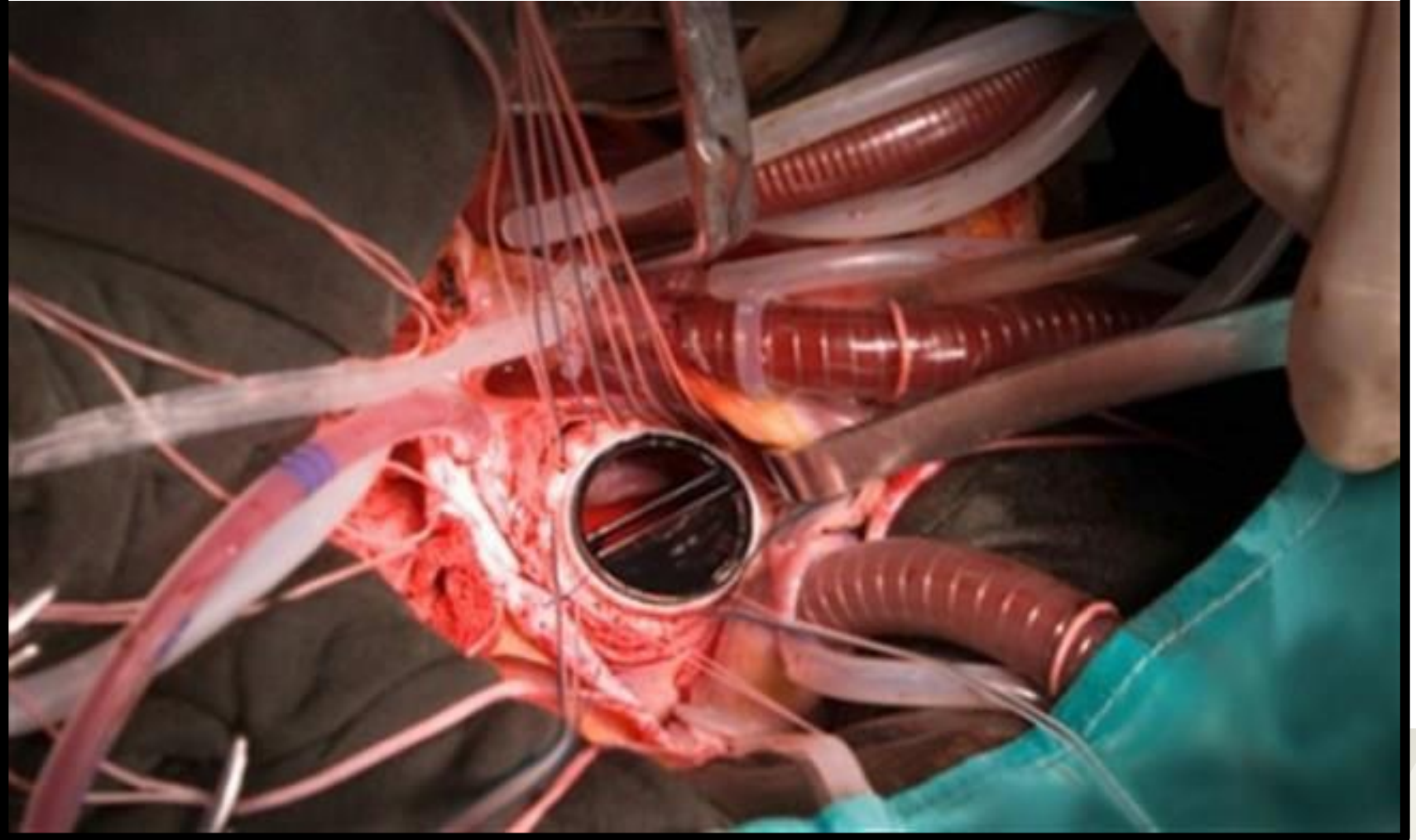
## Signs of mitral regurgitation:

- ◆ 1. displaced apex beat
- ◆ 2. apical thrill
- ◆ 3. apical pan-systolic murmur
- ◆ 4. signs of pulmonary hypertension

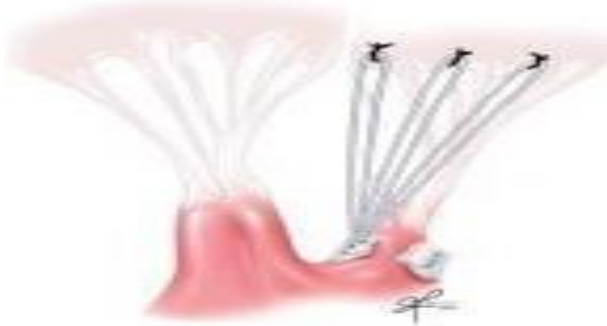
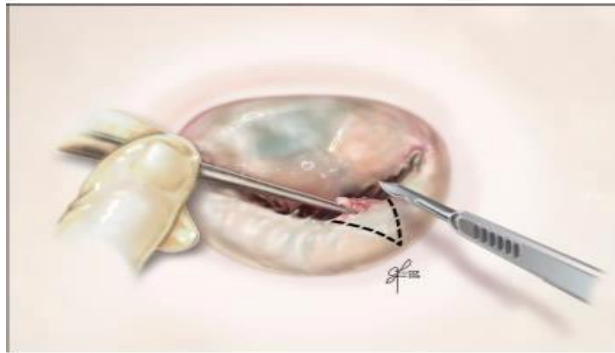
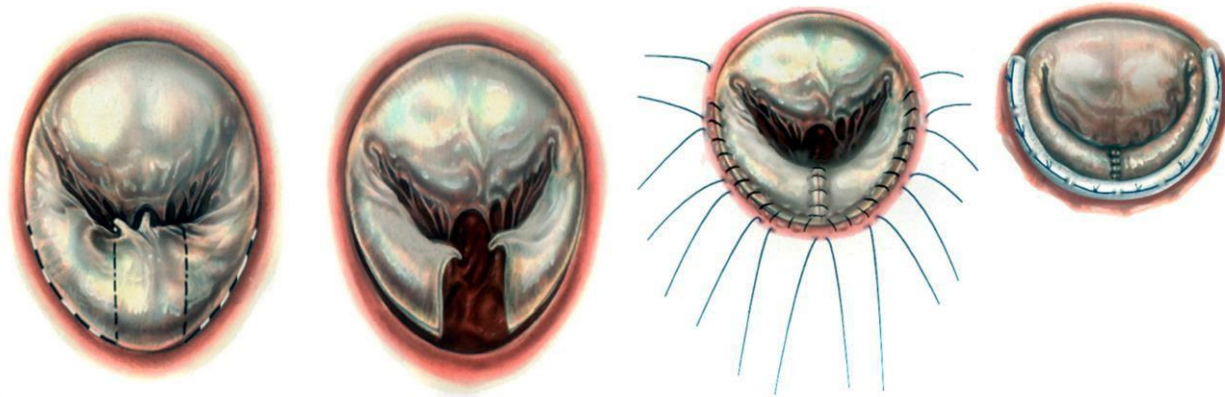
# Mitral Valve



# Mitral Valve replacement



# Mitral Valve Repair





# Aortic stenosis

**Etiology: Rheumatic, Congenital, Degenerative.**

**Symptoms:**

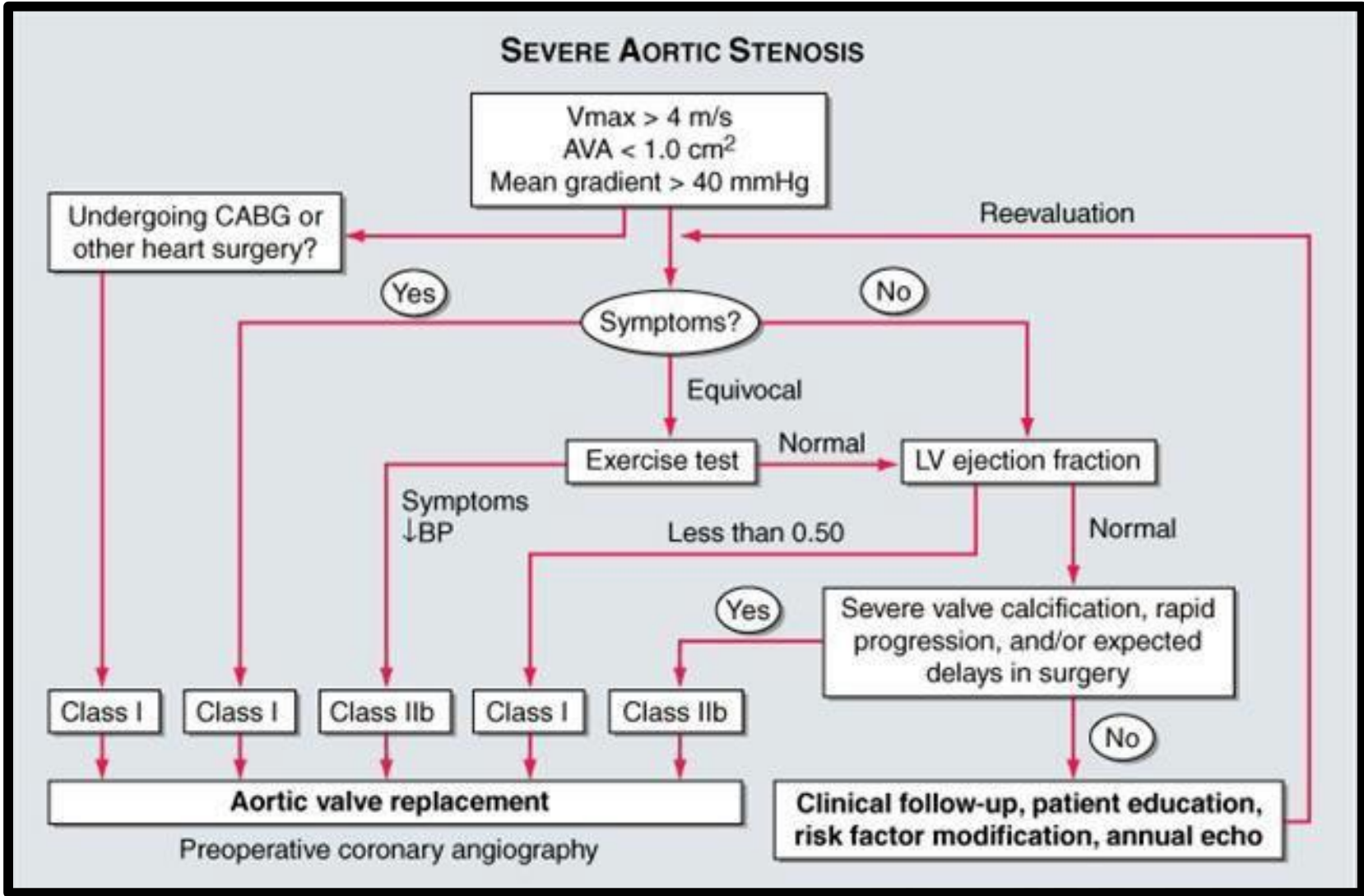
1. Asymptomatic
2. Chest pain
3. Syncopal attacks
4. Dyspnea and CHF

# Aortic stenosis

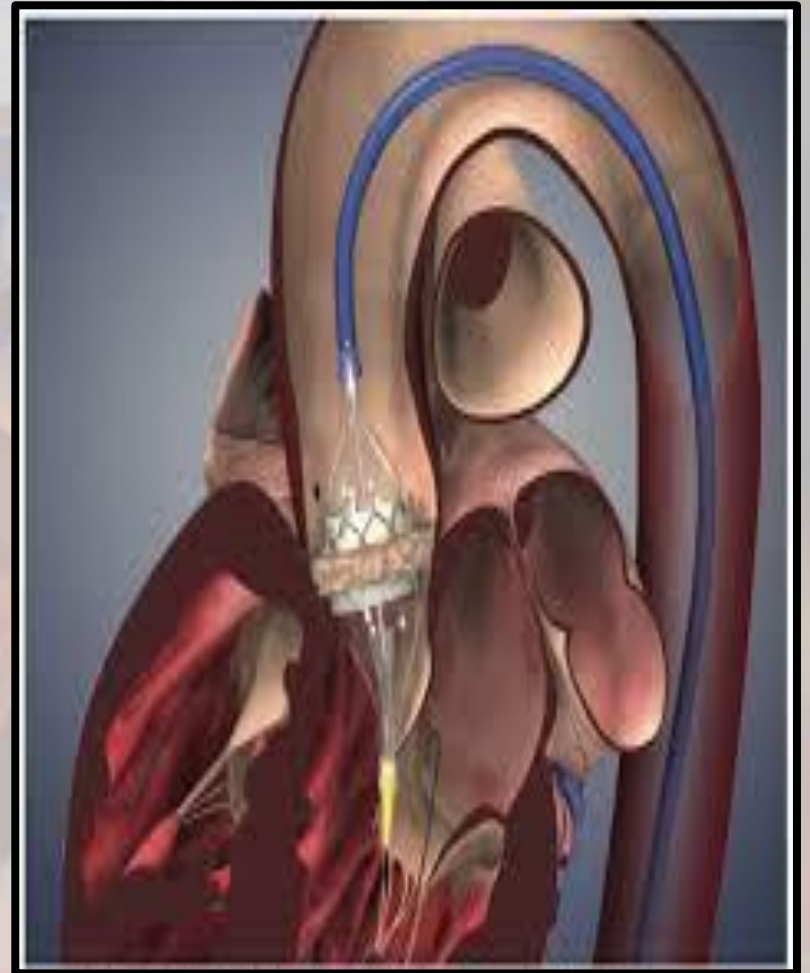
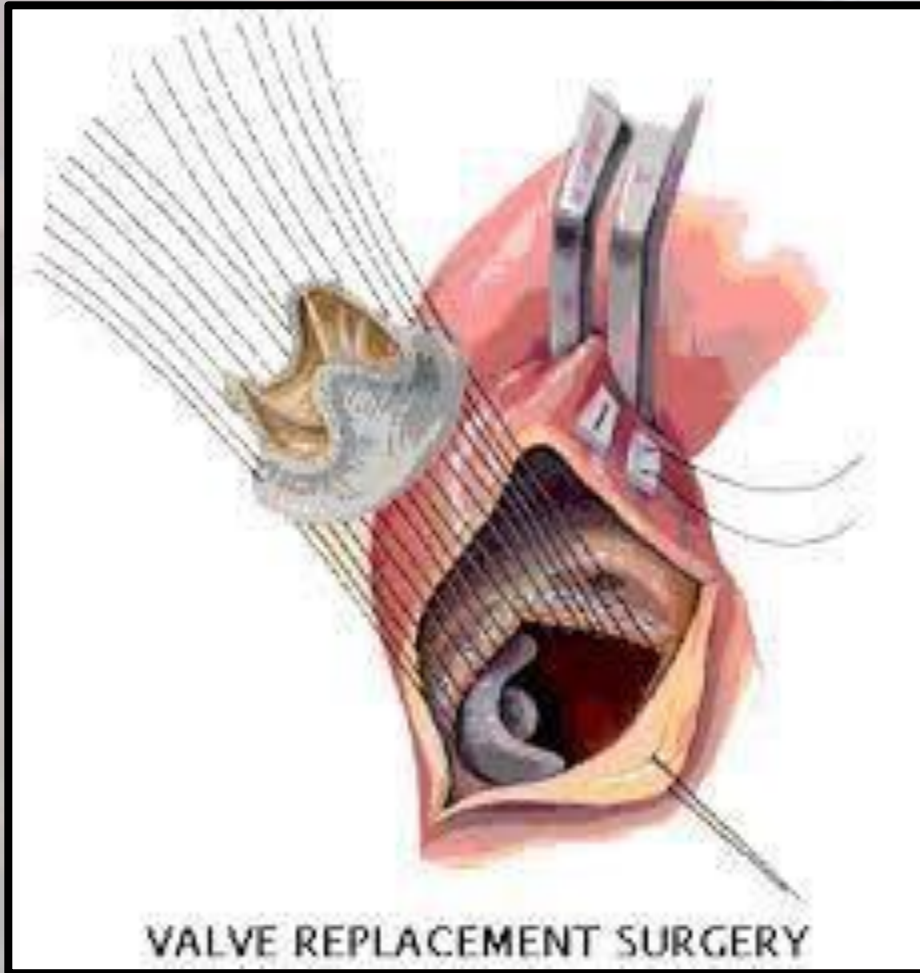
## Signs of aortic stenosis:

- ◆ 1. slow-rising pulse
- ◆ 2. small amplitude pulse
- ◆ 3. sustained apical pulse
- ◆ 4. harsh ejection systolic murmur.

# Aortic Valve



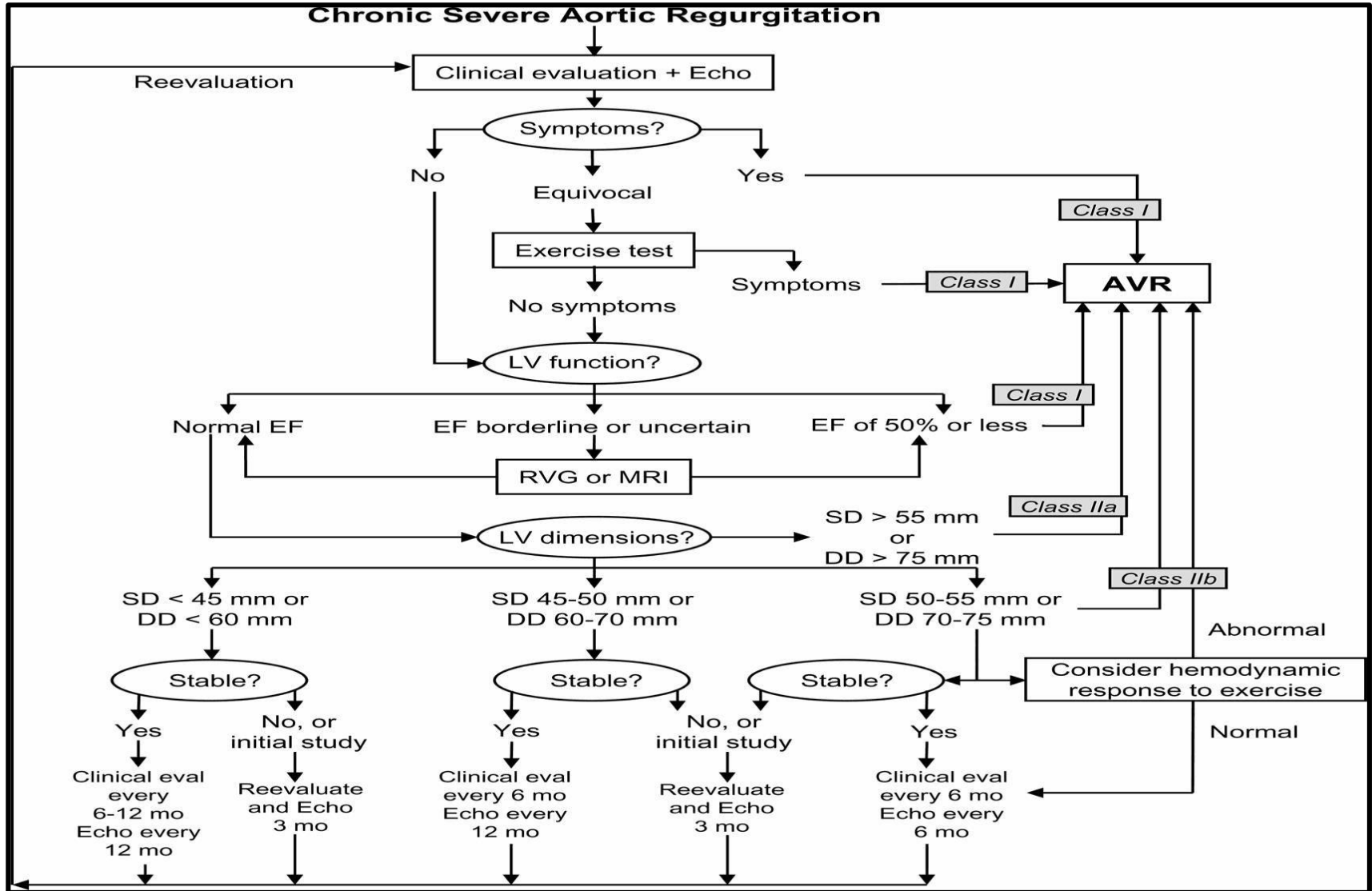
# Aortic Stenosis



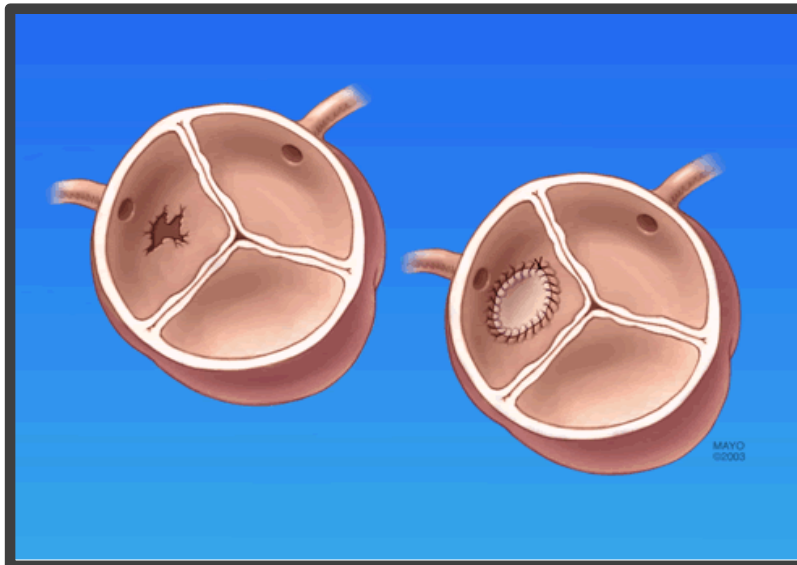
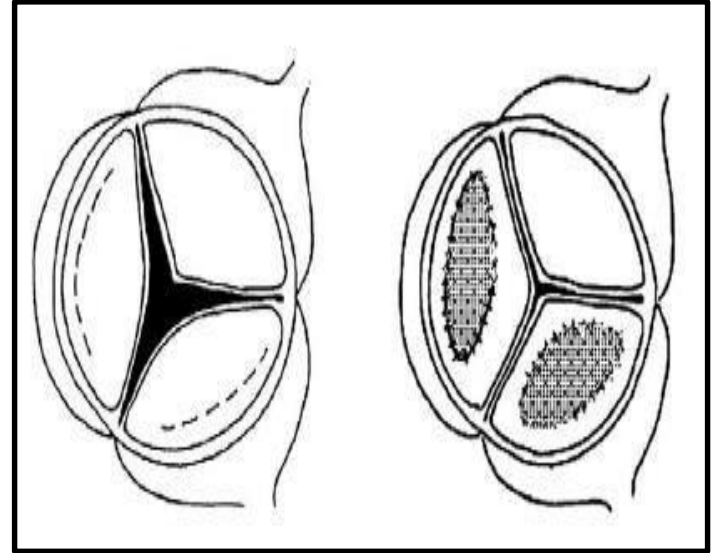
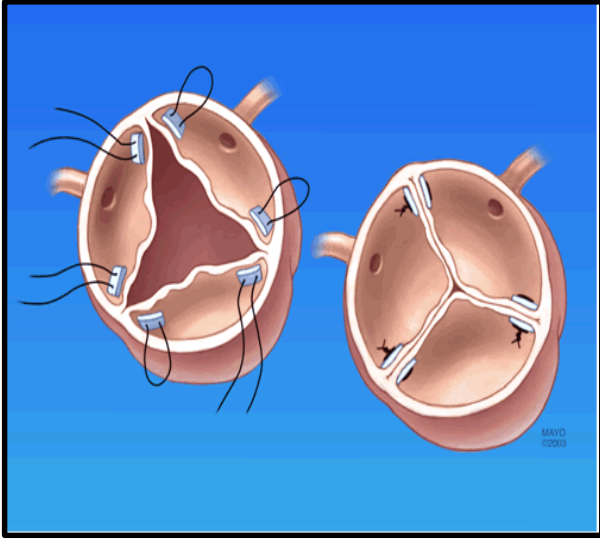
# Aortic regurgitation

- ◆ Etiology: Rheumatic, Endocarditis, Connective tissue disorders, Aortic dissection or aneurysm.

# Aortic Valve



# Aortic Regurgitation



# Valvular Prostheses

## Prosthetic Heart Valves



### Biologic

- Lasts 8-10 years
- No anticoagulation
- No Click



### Mechanical

- Lasts > 20 years
- Lifelong anticoagulation
- Click



# Valvular Prostheses



# Valvular Prostheses

- ◆ Complications of prosthetic valves:
  - ◆ 1. Thrombosis
  - ◆ 2. Bleeding complications
  - ◆ 3. Infective endocarditis
  - ◆ 4. Paravalvular leak
  - ◆ 5. Degeneration of biological valves

# Endocarditis

**Table 2.** Indications for and Timing of Surgery in Patients with Left-Sided, Native-Valve Infective Endocarditis.\*

Indication	Timing of Surgery†
<b>Heart failure</b>	
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
Aortic or mitral-valve infective endocarditis with severe acute regurgitation or obstruction and persistent heart failure 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
<b>Uncontrolled infection</b>	
Locally uncontrolled infection (abscess, false aneurysm, fistula, enlarging vegetation, or dehiscence of prosthetic valve)	Urgent
Persistent fever and positive blood cultures for >5–7 days	Urgent
Infection caused by fungi or multidrug-resistant organisms, such as <i>Pseudomonas aeruginosa</i> and other gram-negative bacilli	Elective
<b>Prevention of embolism</b>	
Aortic or mitral-valve infective endocarditis with large vegetations (>10 mm in length) after one or more embolic episodes, despite appropriate antibiotic therapy, especially during the first 2 weeks of therapy	Urgent
Aortic or mitral-valve infective endocarditis with large vegetations (>10 mm) and other predictors of complicated course (heart failure, persistent infection, or abscess)	Urgent
Isolated, very large vegetations (>15 mm); surgery may be preferred if a procedure preserving the native valve is feasible	Urgent

# Heart Failure

## Ventricular Assist Devices:

### Indications

Frequent hospitalisations for HF

Intolerance to neurohormonal antagonists

NYHA IIIb–IV functional limitations despite OMT

End-organ dysfunction owing to low CO

Increasing diuretic requirement

CRT nonresponder

Inotrope dependence

Low peak  $\text{Vo}_2$  (<14mL/kg/min)

### Absolute Contraindications

Irreversible hepatic disease

Irreversible renal disease

Irreversible neurological disease

Medical nonadherence

Severe psychosocial limitations

*HF = Heart failure; OMT = optimal medical therapy; NYHA = New York Heart Association; CO = cardiac output; CRT = cardiac resynchronisation therapy. Adapted from Peura et al.<sup>11</sup> and published with the permission of the American Heart Association.*

# Heart Failure

## ***Indications for Heart Transplant:***

- Cardiogenic shock requiring mechanical assistance.
- Refractory heart failure with continuous inotropic infusion.
- NYHA functional class 3 and 4 with a poor 12 month prognosis.
- Progressive symptoms with maximal therapy.
- Severe symptomatic hypertrophic or restrictive cardiomyopathy.
- Medically refractory angina with unsuitable anatomy for revascularization.
- Life-threatening ventricular arrhythmias despite aggressive medical and device interventions.
- Cardiac tumors with low likelihood of metastasis.
- Hypoplastic left heart and complex congenital heart disease.

# Heart Failure

## **Table 3. Contraindications to cardiac transplantation.<sup>9</sup>**

- Pulmonary hypertension (TPG > 15 mm Hg, SPAP > 50 mm Hg, PVR > 4 WU, PVRI > 6)
- Systemic disease (anticipated to limit long-term survival)
- Elevated creatinine (> 200  $\mu$ mol/L)
- Active infection
- Psychosocial (substance abuse, smoking, medical noncompliance)
- Malignancy (within 5 years)
- Morbid obesity (> 140% ideal body weight)
- Marked cachexia (< 60% ideal body weight)
- Osteoporosis
- Peripheral or cerebrovascular disease
- Diabetes mellitus with end organ damage

# Arrhythmia

Recommendations	Class <sup>a</sup>	Level <sup>b</sup>
Surgical ablation of AF should be considered in patients with <u>symptomatic AF undergoing cardiac surgery.</u>	IIa	A
Surgical ablation of AF may be performed in patients with <u>asymptomatic AF undergoing cardiac surgery if feasible with minimal risk.</u>	IIb	C
<u>Minimally invasive surgical ablation</u> of AF without concomitant cardiac surgery is feasible and may be performed in patients with <u>symptomatic AF after failure of catheter ablation.</u>	IIb	C

# Thoracic Aortic Disease

## ◆ 1. Thoracic aortic aneurysm

Symptoms are usually due to pressure on surrounding structures.

## 2. 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



# Type A dissections

- ◆ Arising in the ascending aorta
- ◆ Are a medical emergency and require immediate surgery.
- ◆ Mortality rate up to 5% per hour.

# Type B dissections

- ◆ 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.

# Aortic Dissection

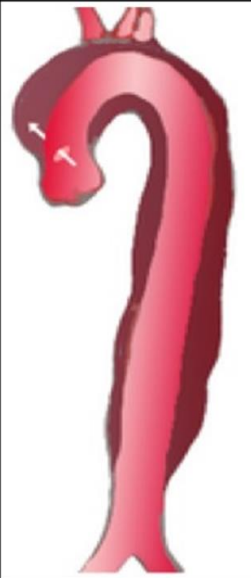

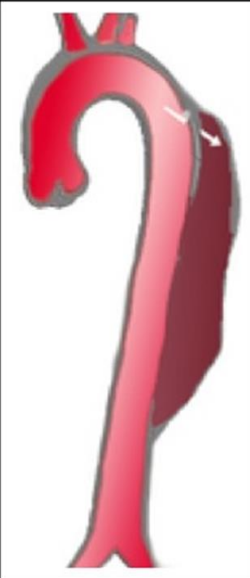
## DeBakey classification system

- **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

Classification of aortic dissection

			
Percentage	60%	10–15%	25–30%
Type	DeBakey I	DeBakey II	DeBakey III
	Stanford A (Proximal)		Stanford B (Distal)

# Aortic Disease

## When to Operate ?

> 6.0 cm

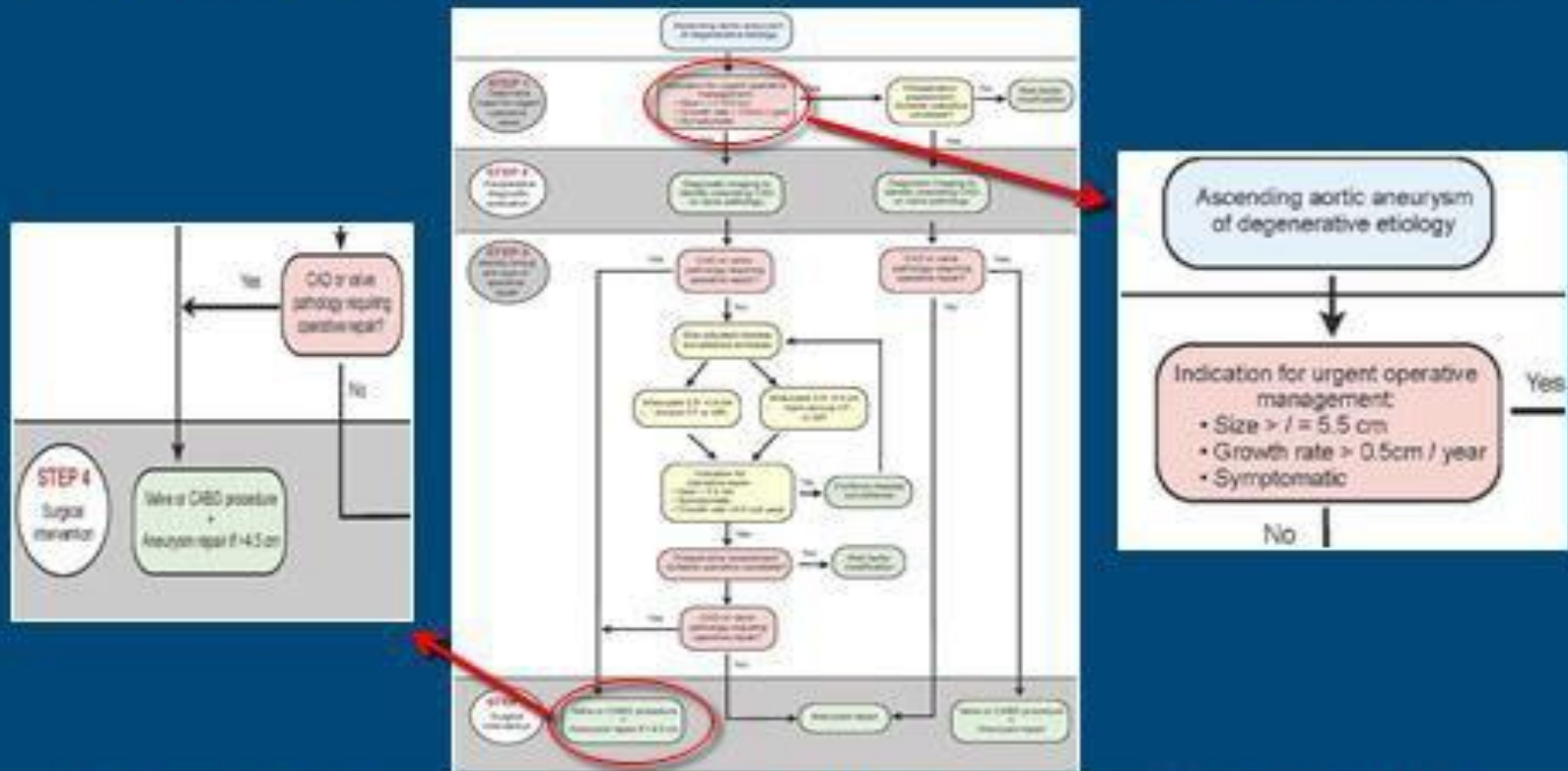
> 5.5 cm



> 6.5 cm

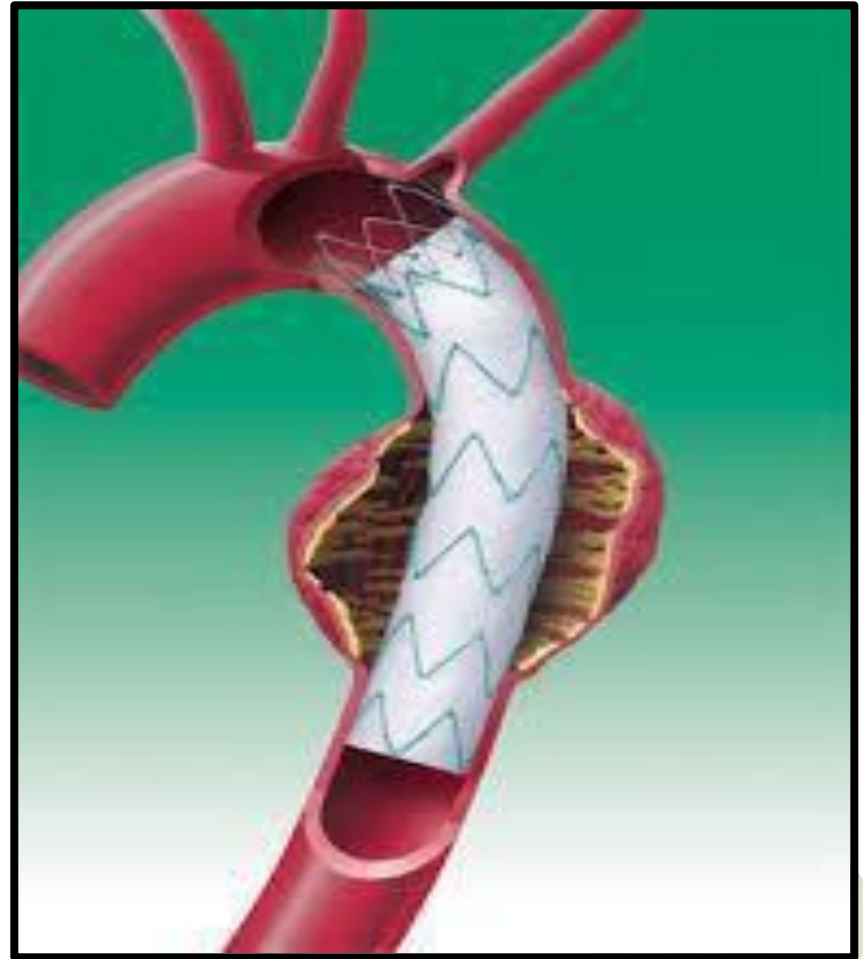
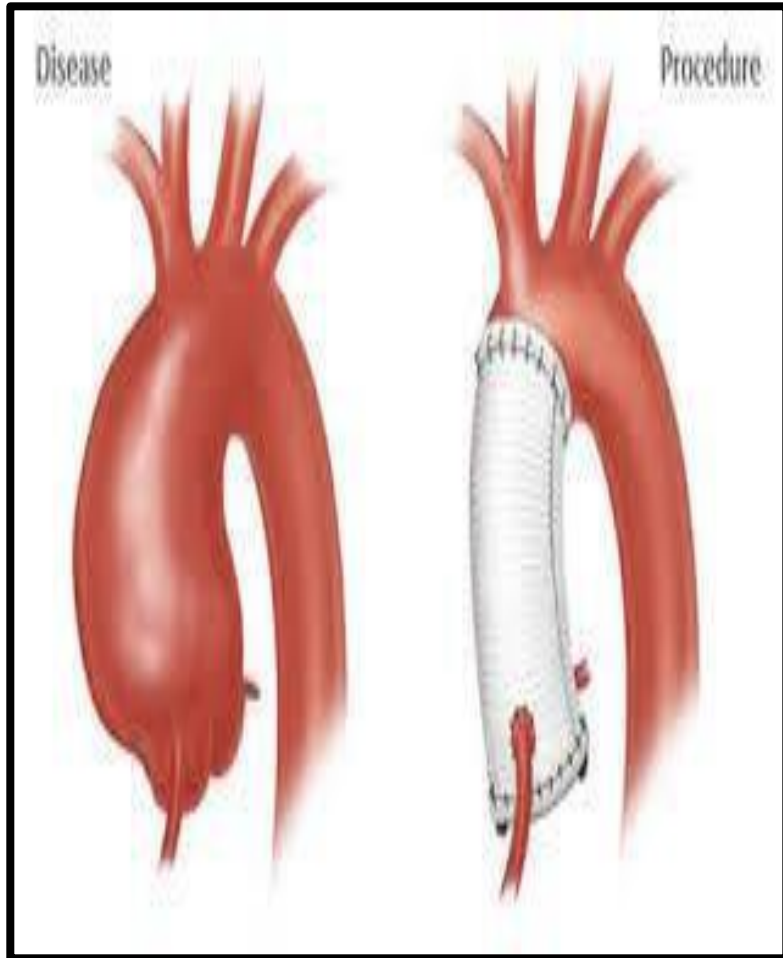
# Aortic Disease

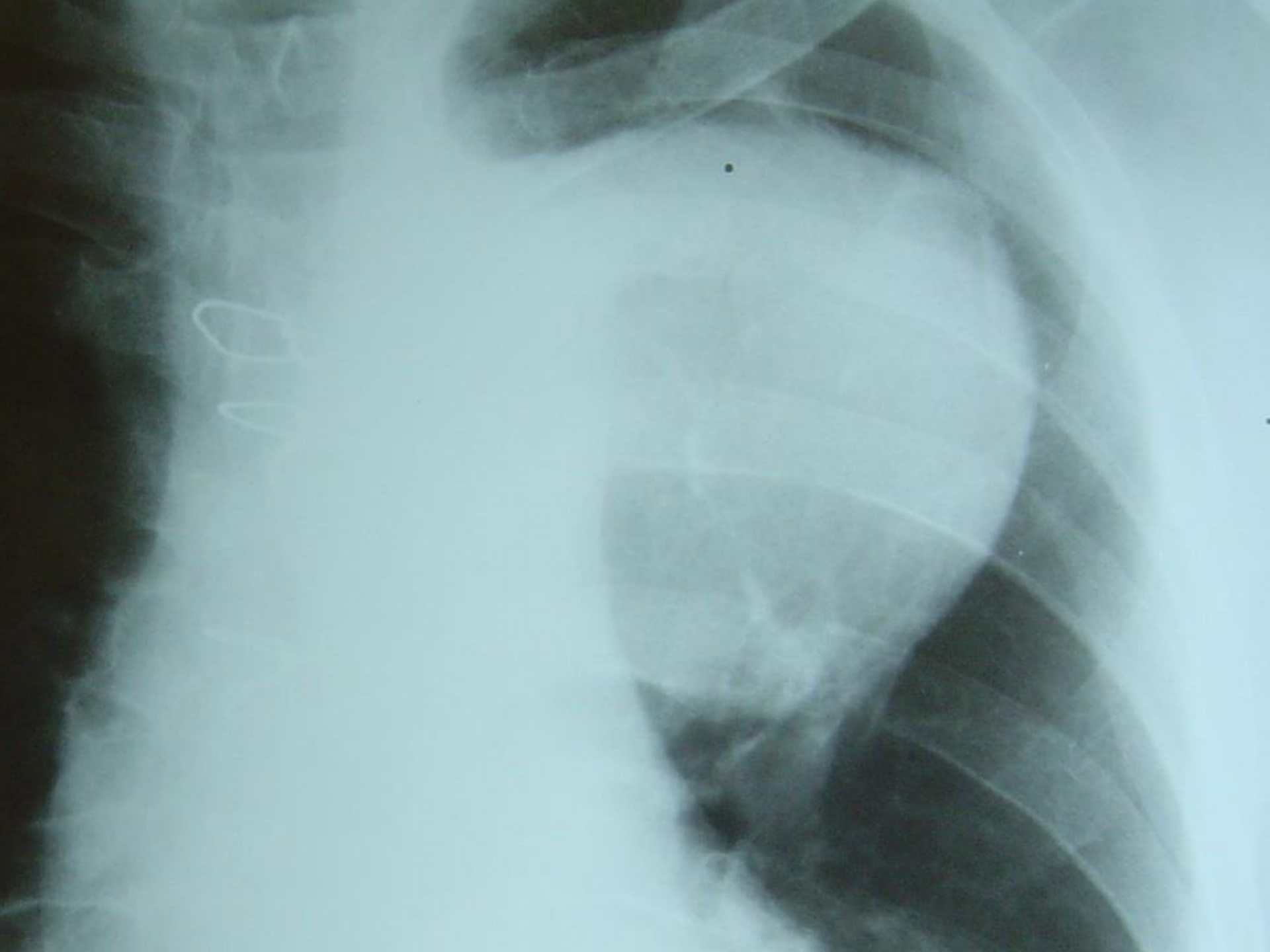
## Asymptomatic/ Low Risk Patients



American College of Cardiology Foundation, et al. J Am Coll Cardiol 2010;55:1509-1544

# Aortic Surgery





R







# Cardiac Tumors

**Table I – Primary cardiac tumors**

Benign (75% of the cases)

Myxoma

Rhabdomyoma

Fibroma

Lipoma

Atrioventricular node tumor

Papillary fibroelastoma

Hemangioma

Malign (25% of the cases)

Angiosarcoma

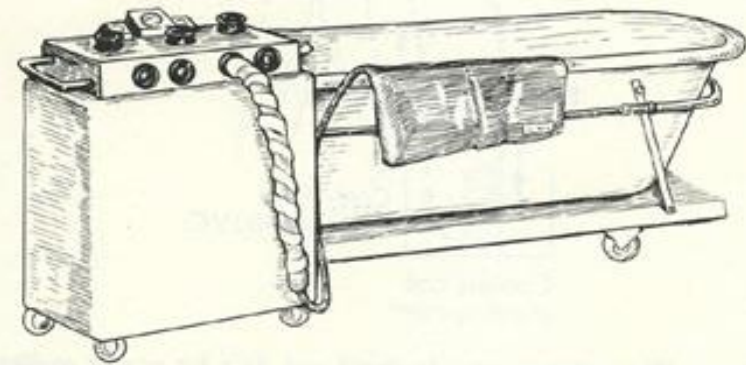
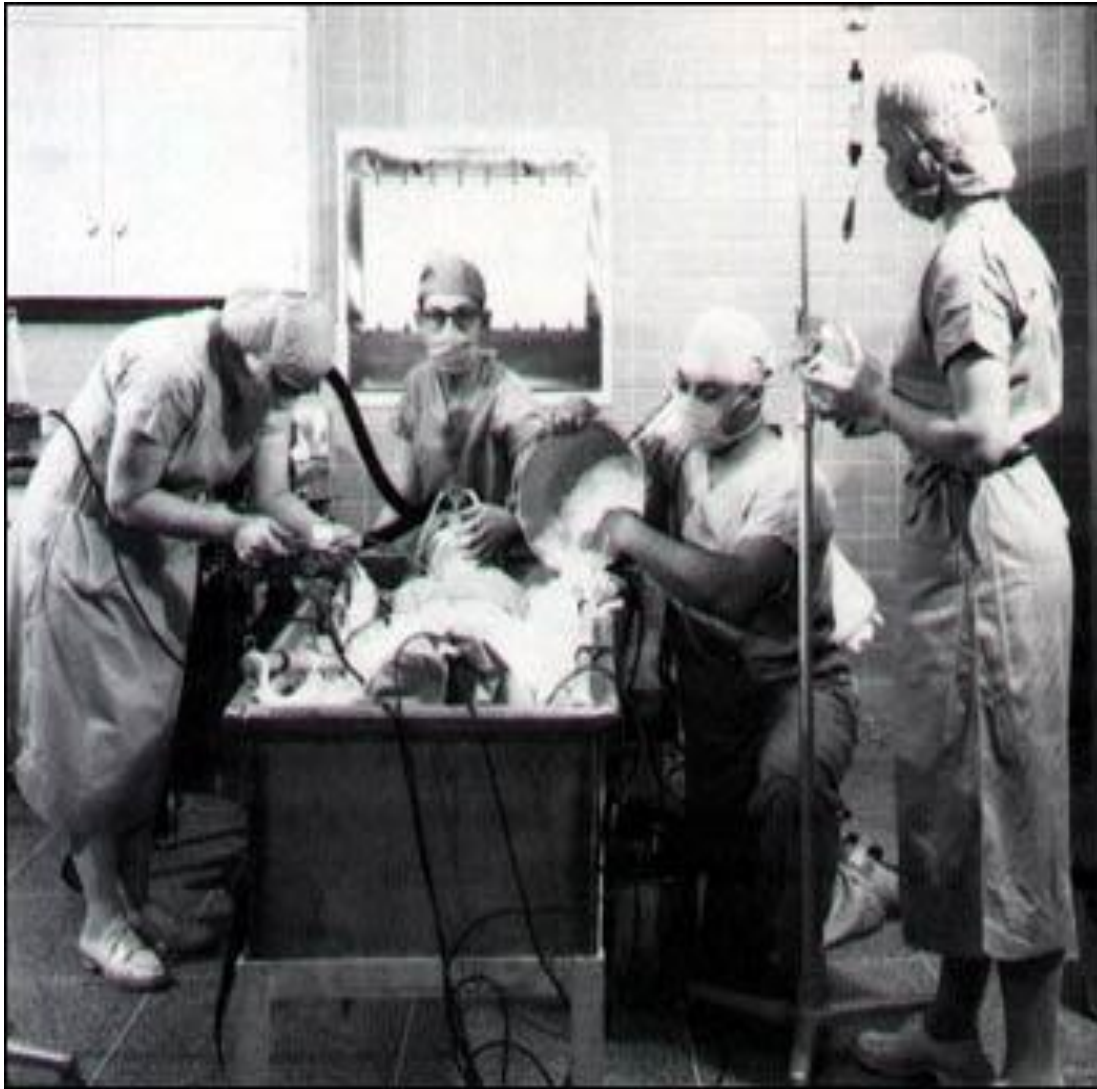
Rhabdomyosarcoma

Fibrosarcoma

# Basic Principles of Cardiac Surgery

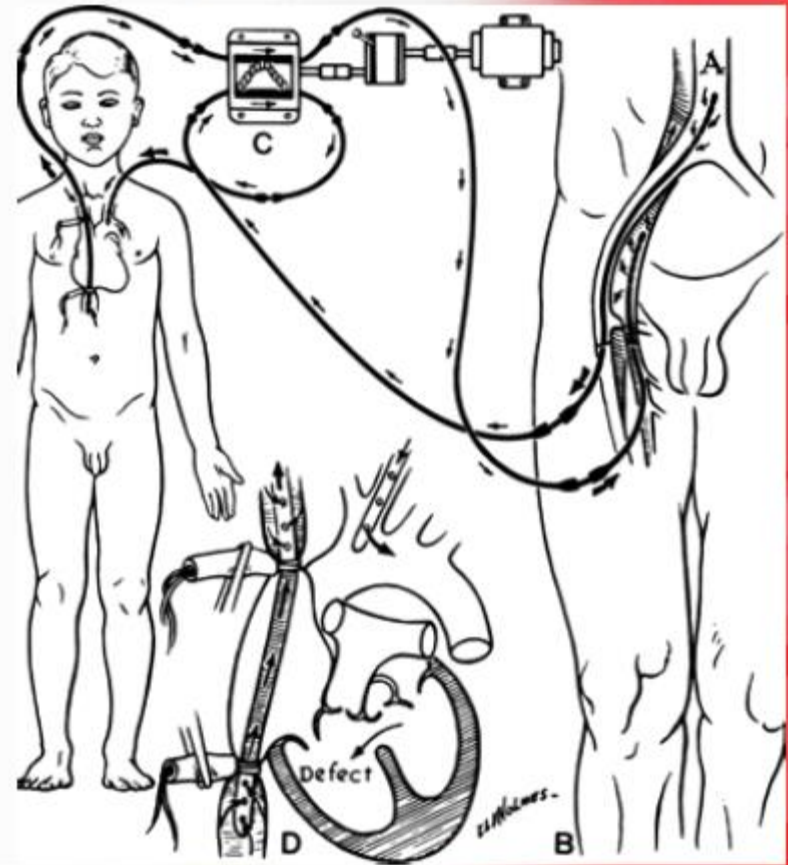
- ◆ **Adequate Exposure**
  - Full or Partial Sternotomy / Thoracotomy / Robotic or Endoscopic
- ◆ **Bloodless Operative Field**
  - Suction and re-transfusion / Snaring or clamping of bleeding vessels
- ◆ **Static Operative Target**
  - Cardiac Arrest / Ventricular Fibrillation / Mechanical Stabilizers
- ◆ **Preservation of body perfusion**
  - Use of Heart Lung Machine / Off-pump Techniques
- ◆ **Preservation of Myocardium**
  - Off-pump Techniques / Hypothermia / Cardiac Arrest with cardioplegia

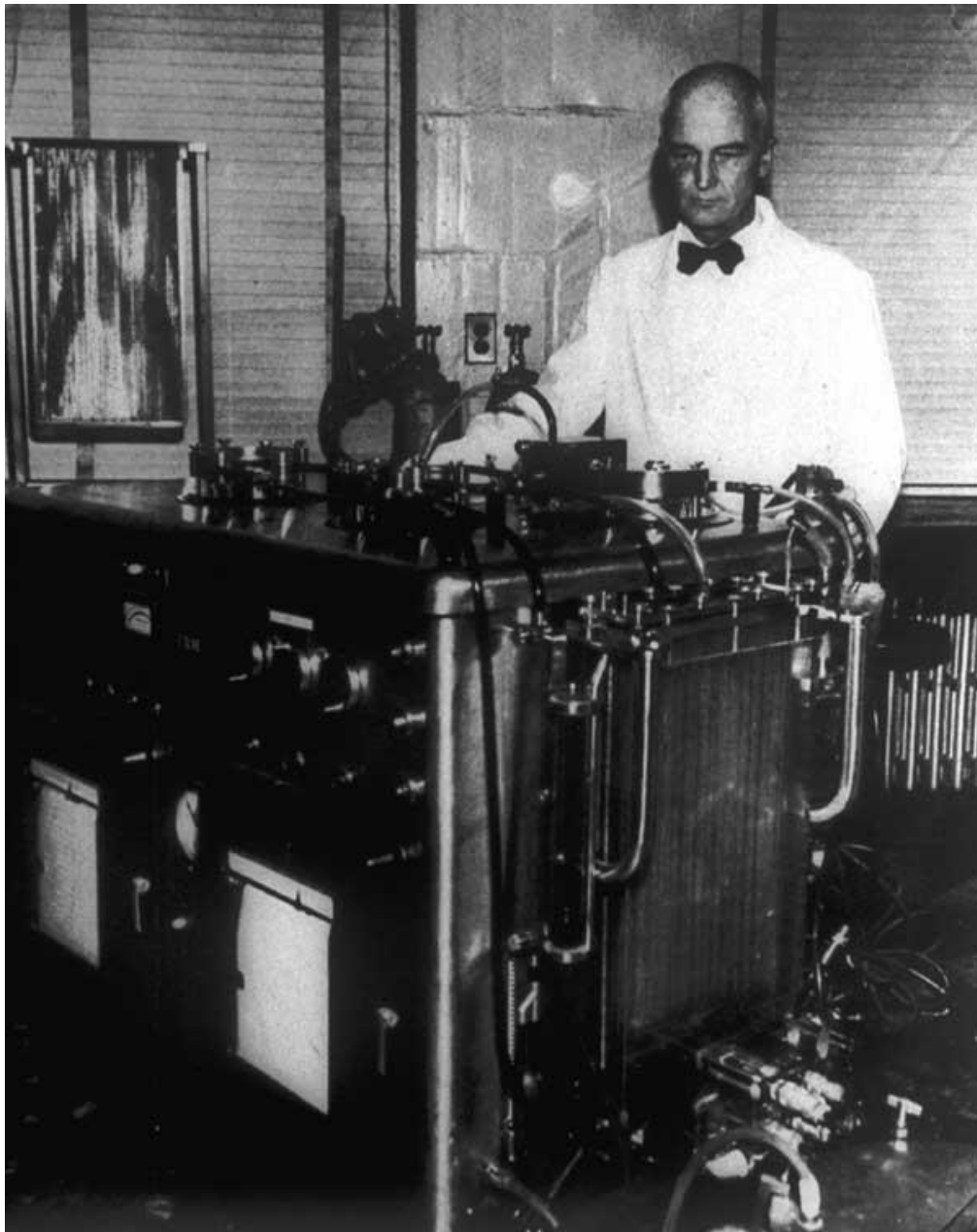
Surface Cooling Hypothermia  
( $28^{\circ}\text{C}$ ) for ASD Closure in  
Children, 1952



# Natural Heart/Lung Machine (the parent)

- Cross Circulation  
1954-1955
- Controversy- 200%  
Mortality
  - (parent and child)





In 1953, John Gibbon reported the first successful ASD closure using his heart-lung machine. It took him 20 years of work and experiments!

# Heart Lung Machine

**Aim of cardiopulmonary bypass:**

**The principal aim of CPB is to facilitate cardiac and thoracic aortic procedures by excluding the heart and lungs from the circulation whilst providing:**

- 1. adequate gas exchange**
- 2. systemic organ perfusion**
- 3. controlling body temp.**

# Heart Lung Machine

## ◆ Components :

- Roller pumps
- Blood Reservoir (cardiotomy reservoir)
- Oxygenator
- Heater-cooler unit
- Tubing and Monitoring console etc

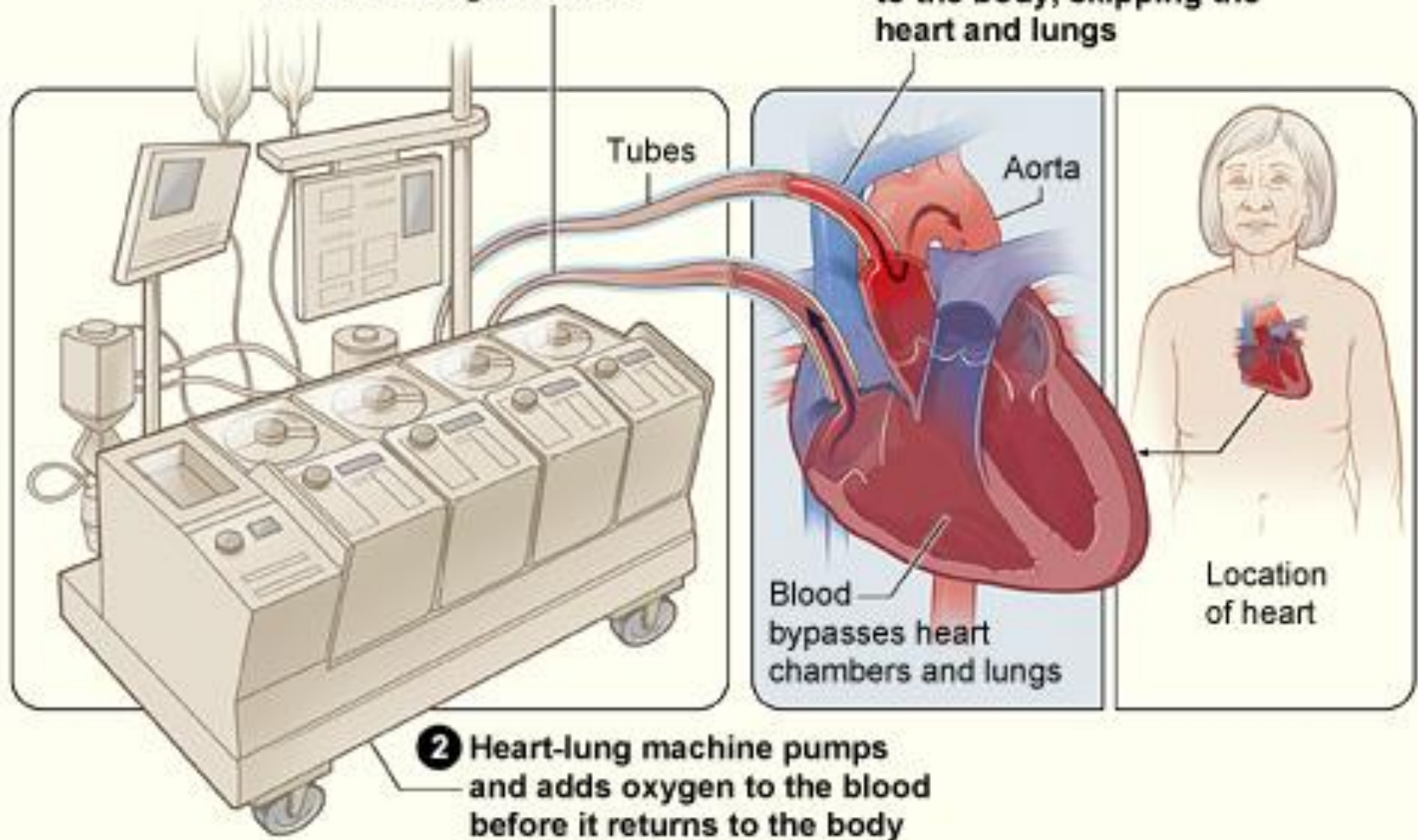
## ◆ Limitation/Problems :

- Requires full anticoagulation
- Can cause micro embolism
- Initiates Systemic Inflammatory Response



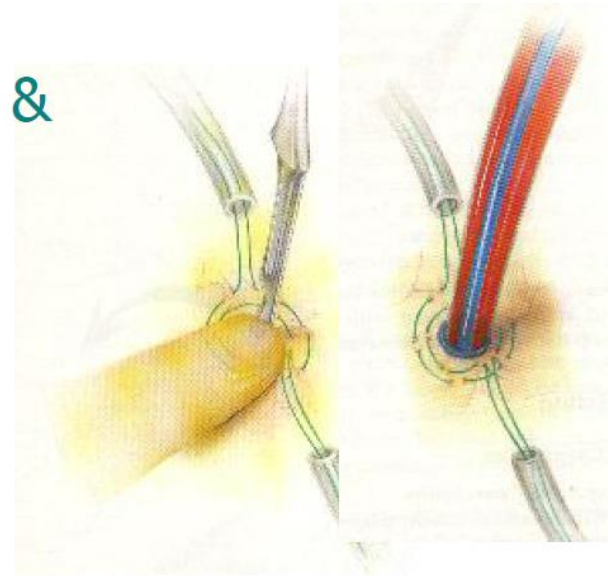
**1** Oxygen-poor blood leaves the heart to enter the heart-lung machine

**3** Oxygen-rich blood returns to the body, skipping the heart and lungs



# Operation under ECC (1)

- **Sternotomy**
- Opening of the pericardium & exposure of the heart
- Confection of **pursestring**

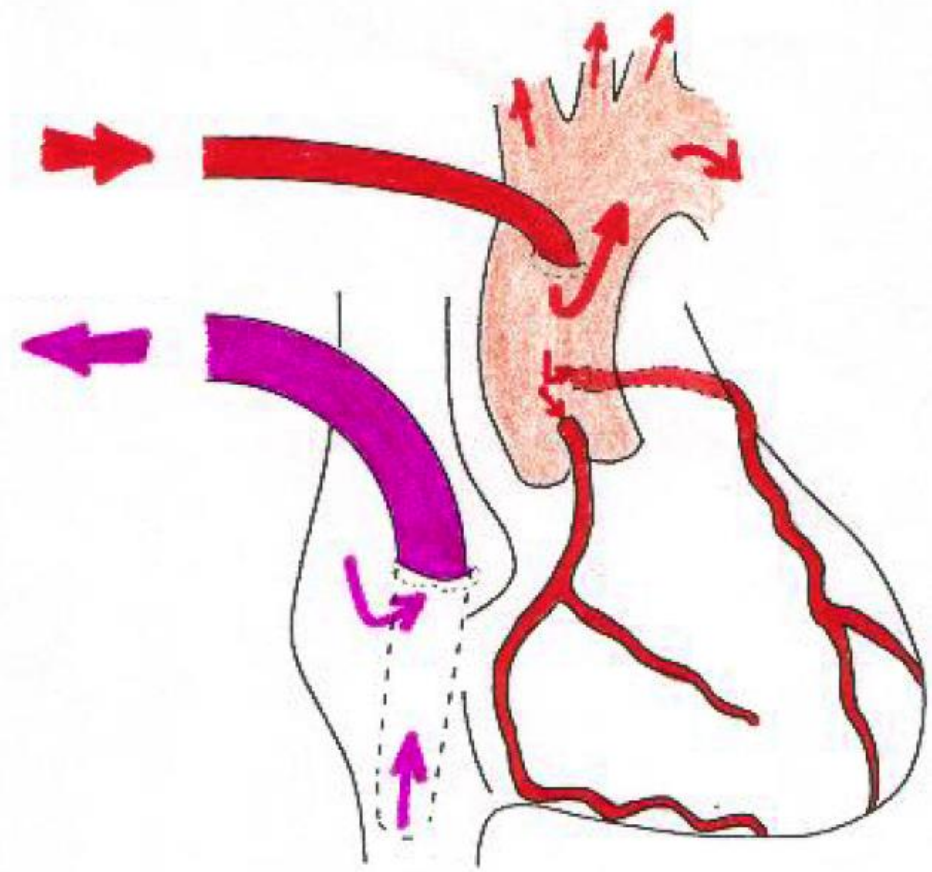


*From : Manual of Cardiac Surgery, Harlan & Starr, Springer-Verlag, New York , 1995*

- **Heparin:** high dose
- **Cannulation, connections to tubing**

# Operation under ECC (2)

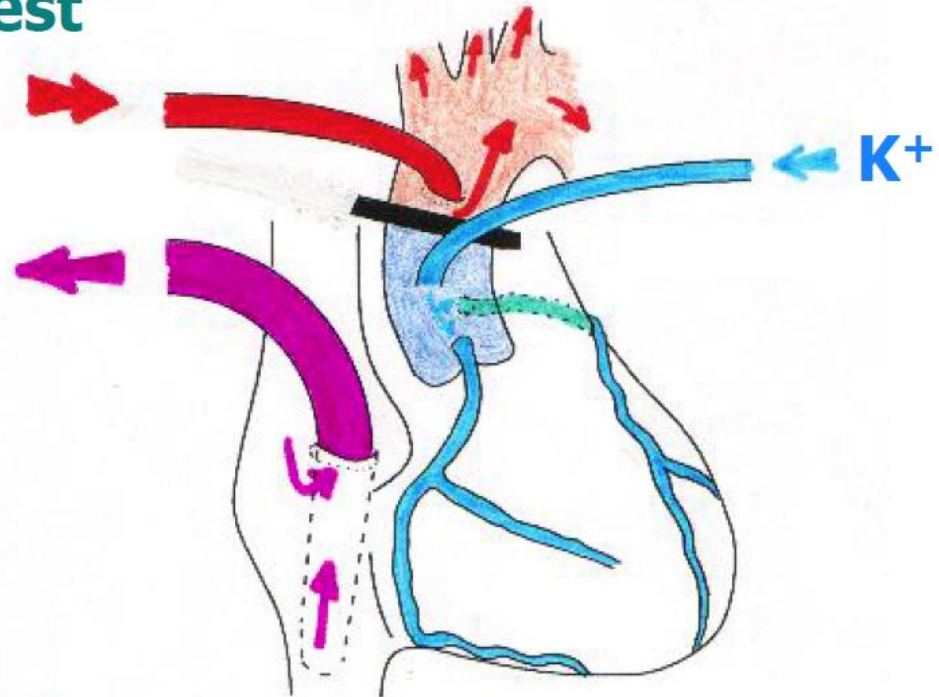
- Initiation of ECC



- Cooling

# Operation under ECC (3)

- Cardioplegic arrest



- Clamping of the aorta
- $K^+$  injection into the coronary system:  
« chemical arrest » of the heart », flaccid heart

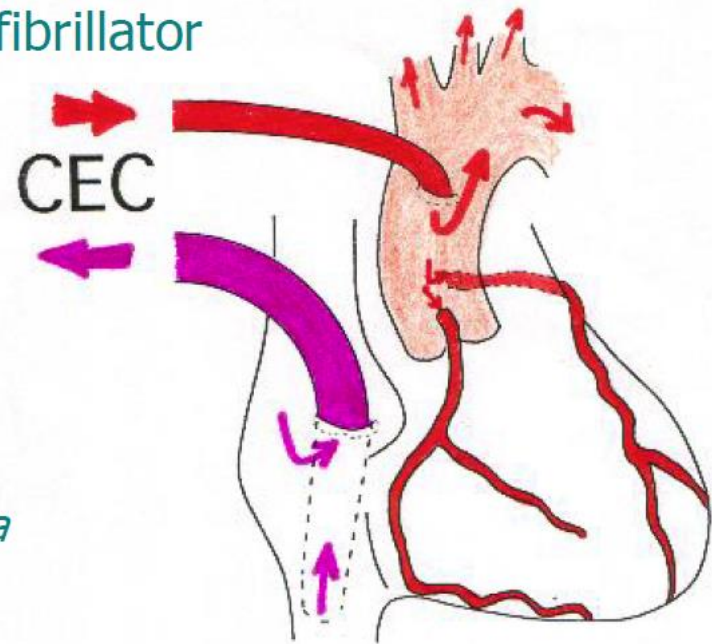
# Operation under ECC (4)

- **Release of the aortic clamp**

- Sinusal rhythm
- Ventricular fibrillation: defibrillator
- Block: pace-maker

Sinusal rythm

*If open-heart surgery  
deairing before unclamping the aorta  
(air embolization)*



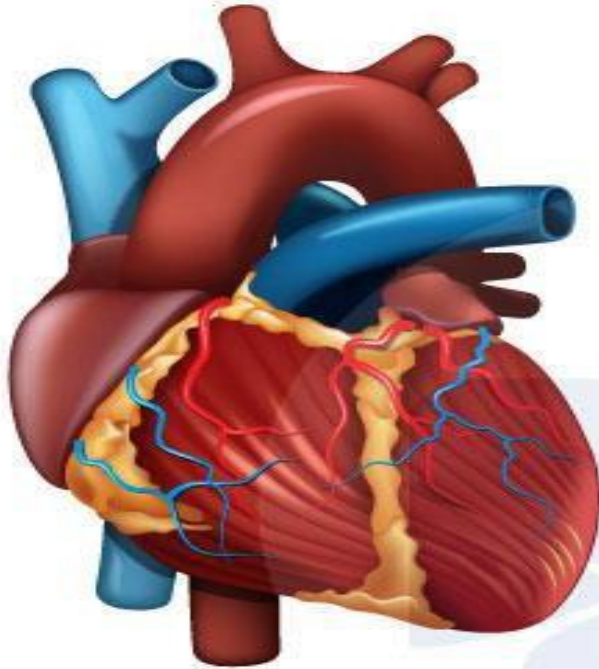
# Complications of CPB

- ◆ 1. systemic inflammatory response due to contact of blood with the foreign surface of CPB circuit resulting in increased capillary permeability, interstitial edema, and subsequent organ dysfunction.
- ◆ 2. coagulopathy caused by platelet dysfunction as well as dilution and consumption of coagulation factors.

# Complications of CPB

- ◆ 3. hemolysis.
- ◆ 4. renal and splanchnic hypoperfusion
- ◆ 5. cerebrovascular accident

# Coronary Artery Bypass Surgery



## **BENEFITS OF OFF PUMP CABG**

Reduced incidence of stroke  
& cognitive problems

Lesser renal dysfunction

Reduced inflammatory  
response

Lesser coagulopathy &  
requirement of  
blood transfusion

Reduced length of time in  
intensive care & hospital  
stays

Reduced morbidity &  
mortality rates



# Heart Lung Machine



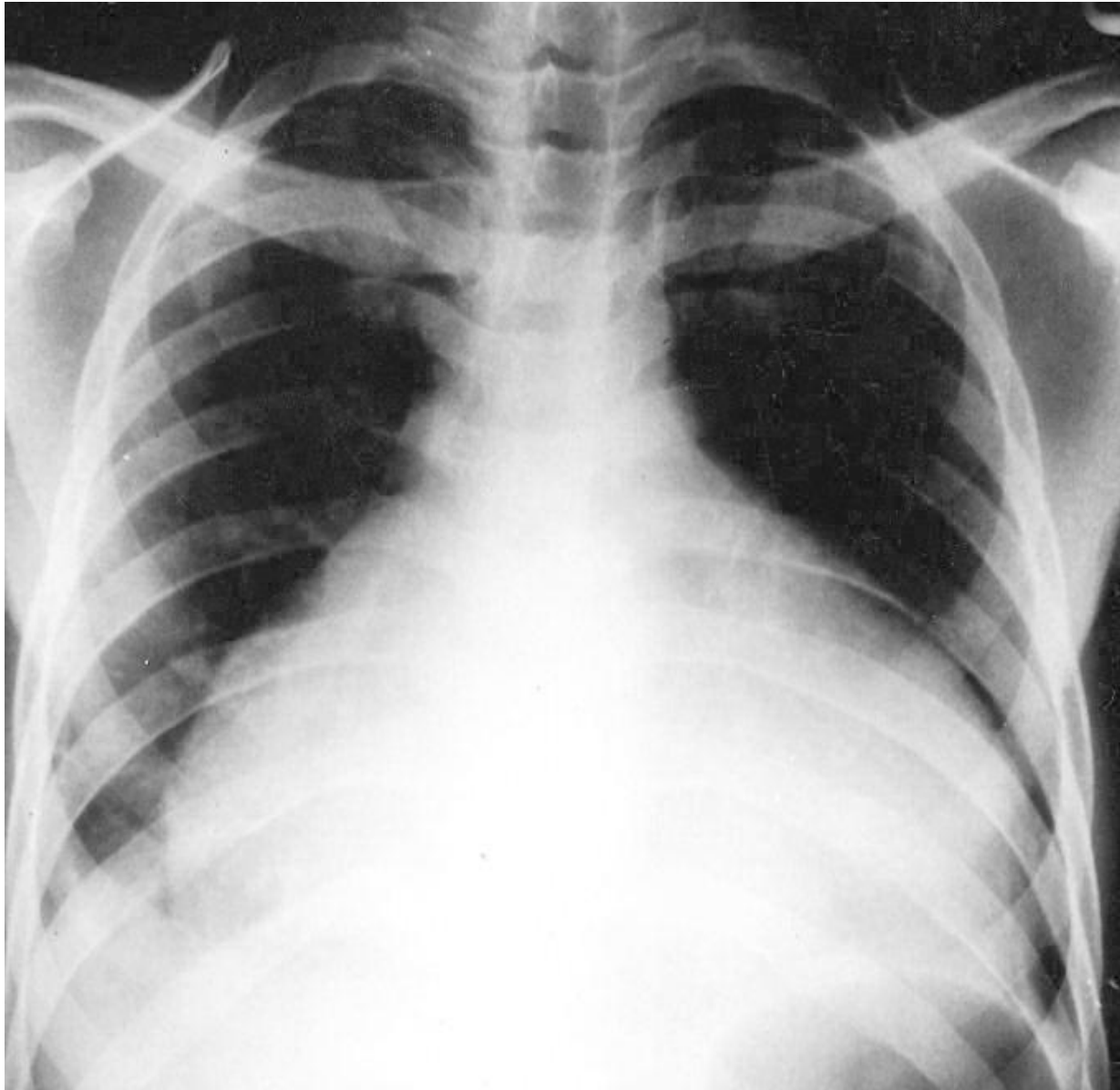
Surgery for Cardio-thoracic  
Diseases

# Pericardial effusion

- ◆ Progressive accumulation of fluid inside the pericardial cavity, may compress the cardiac chambers.
- ◆ Etiology:
  - ◆ -Traumatic
  - ◆ -pericarditis
  - ◆ -malignancy
  - ◆ -uremia, post irradiation
  - ◆ -postoperative.

# Pericardial effusion

- ◆ Investigations:
  - ◆ -Plain x-ray chest
  - ◆ -Echocardiography
  - ◆ -CT scan
  
- ◆ Management:
  - ◆ - treat the cause
  - ◆ -Aspiration
  - ◆ -Pericardiostomy



**Surgery for Cardio-thoracic  
Diseases**

# Congenital Heart Diseases

## 1. Acyanotic:

- ◆ -Patent ductus arteriosus
- ◆ -Coarctation of the aorta
- ◆ -Pulmonary stenosis
- ◆ -Atrial septal defect
- ◆ -Ventricular septal defect

# Congenital Heart Diseases

## 2. Cyanotic:

- ◆ -Tetralogy of Fallot
- ◆ -Transposition of the great vessels
- ◆ -Tricuspid atresia
- ◆ -Total anomalous venous drainage
- ◆ -Truncus arteriosus

# Pre-Operative Investigations for Cardiac Surgery

- ◆ Full Blood Count
- ◆ Blood Biochemistry
- ◆ ECG
- ◆ Chest X-ray
- ◆ Pulmonary Function Tests.
- ◆ Other test according to systemic review of patient

- ◆ Echocardiography
- ◆ Angiography
- ◆ Carotid Duplex Scan
- ◆ Peripheral Duplex Scan

# Usual Duration of Stay in Hospital

- ◆ One day before surgery
- ◆ 3-6 hours OR time
- ◆ One day in ICU
- ◆ 4-5 Days in Ward
- ◆ Total 5-7 days



# Cardiac Trauma

- ◆ Blunt

- ◆ Penetrating

In blunt cardiac trauma, the major challenge is **diagnosis**, while in penetrating cardiac trauma, the major challenges are **rapid resuscitation followed by emergent definitive surgery**

# Blunt Cardiac Trauma

- ◆ Myocardial contusion
- ◆ Pericardial tamponade
- ◆ Arrhythmia with cardiac arrest
- ◆ Disruption of valves and septum
- ◆ Coronary artery injuries
- ◆ Cardiac rupture

# Blunt Cardiac Trauma

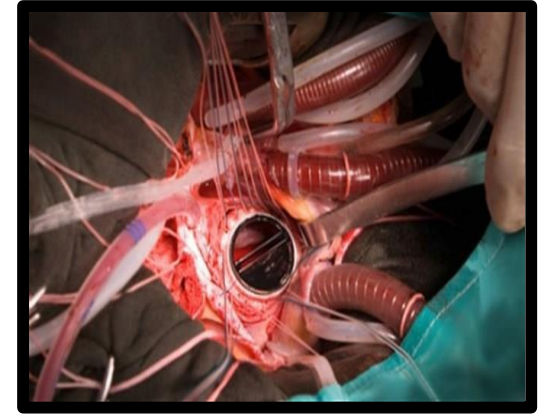
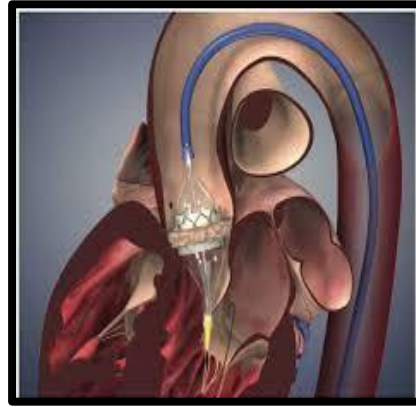
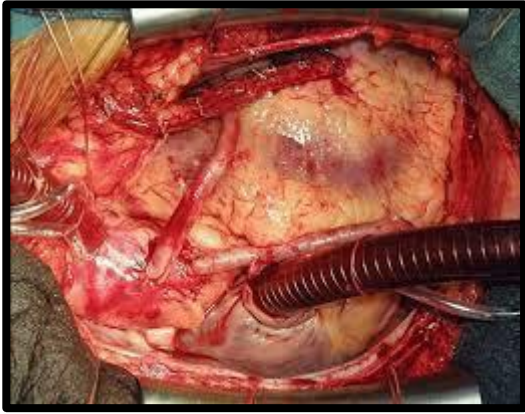
- ◆ All patients with blunt chest trauma should undergo physical examination, CXR, ECG, and baseline cardiac enzymes.
- ◆ ECHO, C.T. may be needed
- ◆ Treatment depends on the nature of the injury.

# Penetrating Cardiac Trauma

- ◆ All patients with penetrating wounds between the right mid-clavicular and left mid-axillary lines from the epigastrium to the clavicles should be assumed to have injuries involving the heart until proven otherwise.

# Penetrating Cardiac Trauma

- ◆ The most commonly injured chamber is the right ventricle.
- ◆ The typical patient presents with signs of tamponade or hemorrhage.
- ◆ Emergent surgical exploration may be needed.



**Thank You**

