


**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

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

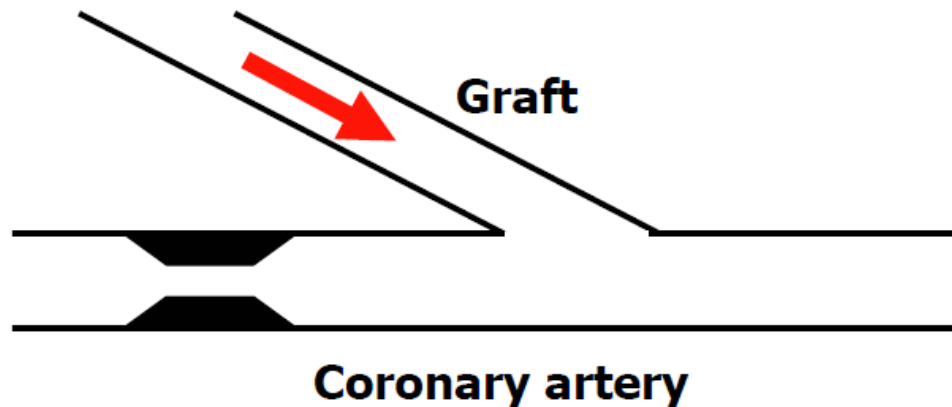
-V.S.D., Ischemic mitral regurge,
Ventricular aneurysm, Heart failure,
Conduction defects.

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



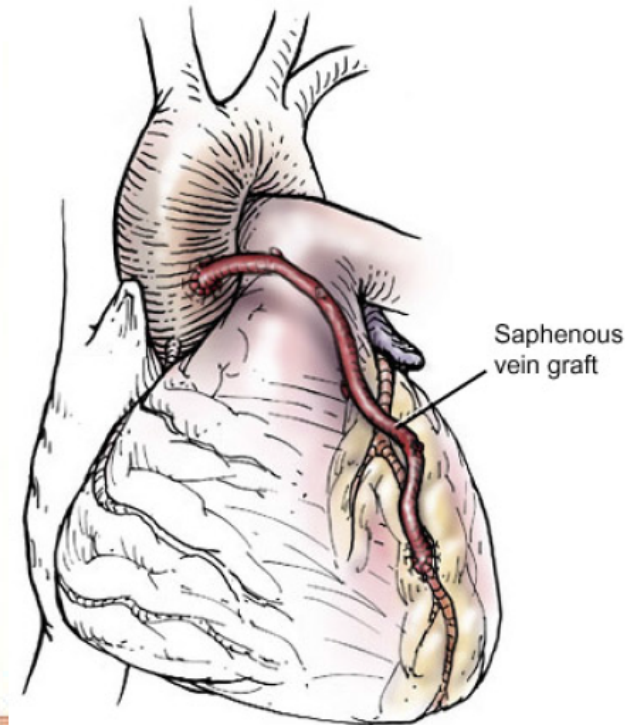
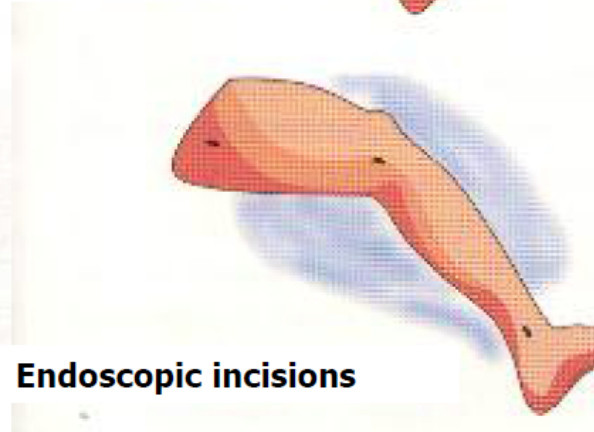
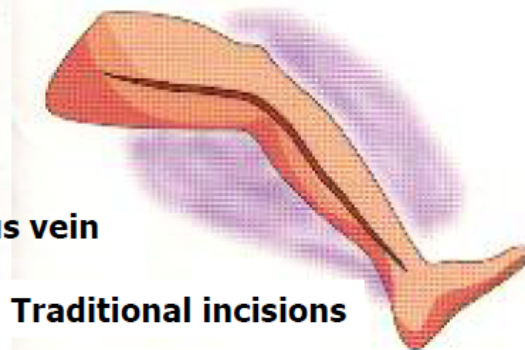
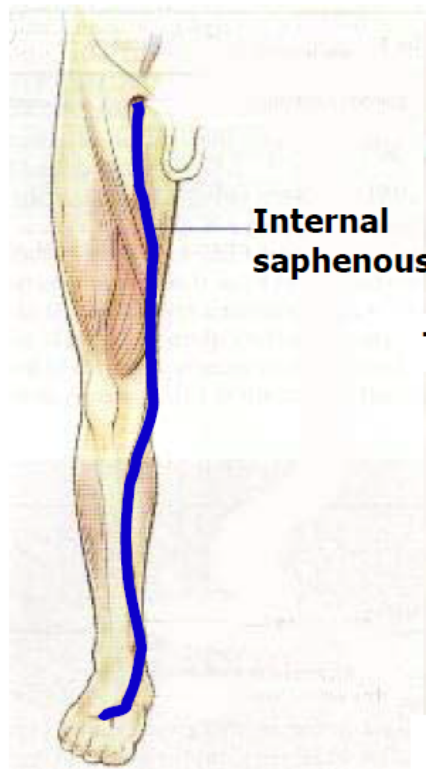
◆ Coronary conduits:

1. Arterial: Internal thoracic artery
2. Venous : Long saphenous vein.

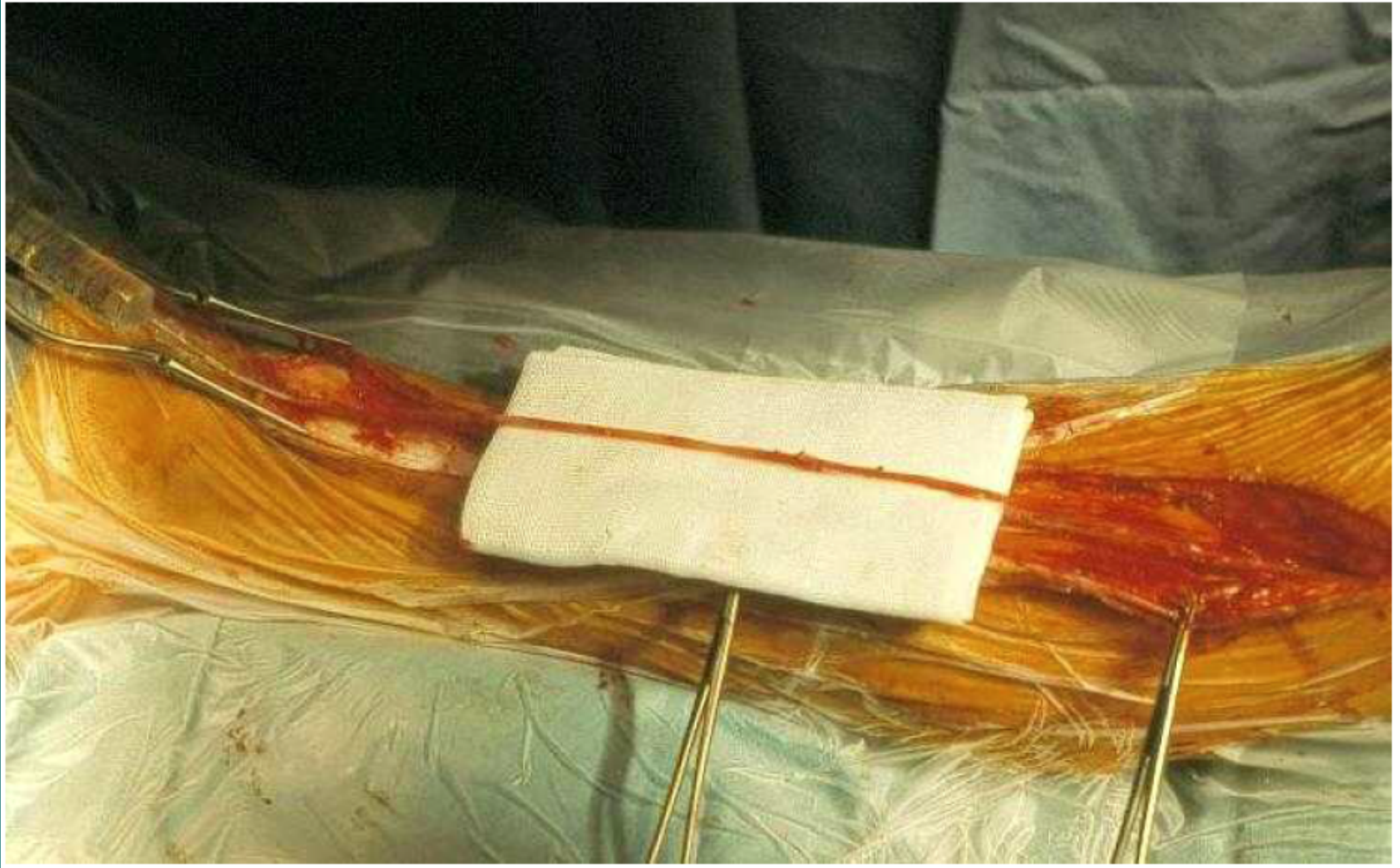
Types of surgery:

1. Conventional: using the heart lung machine, and cardioplegic arrest
2. Off-pump (beating heart surgery)

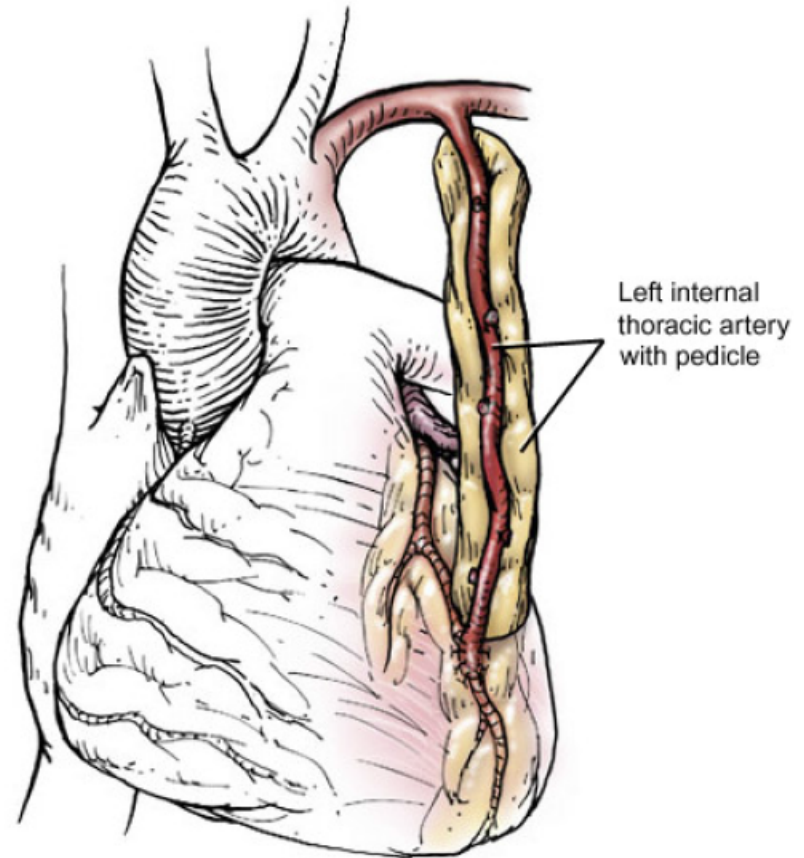
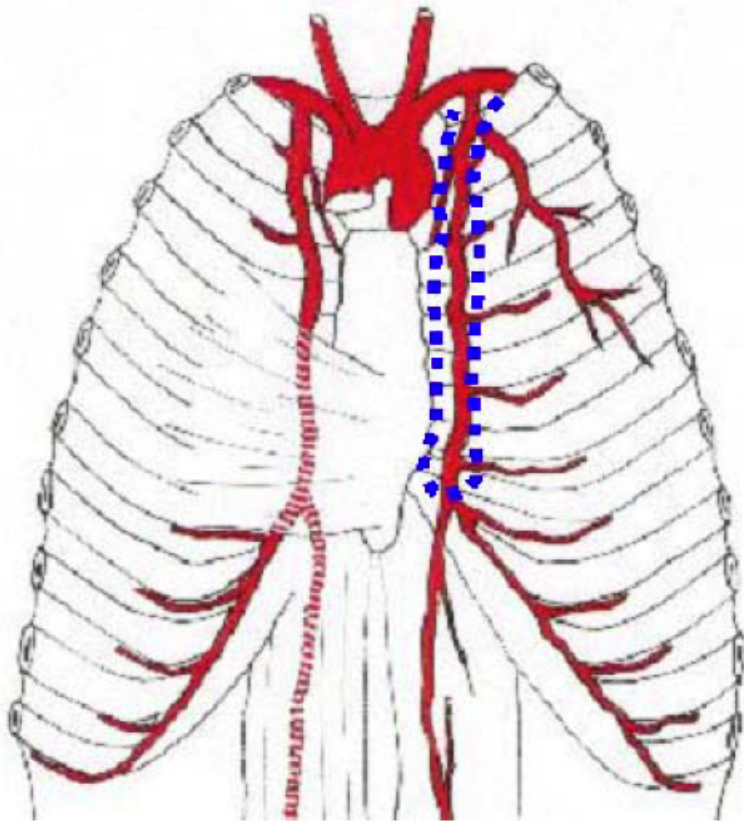
Saphenous vein graft

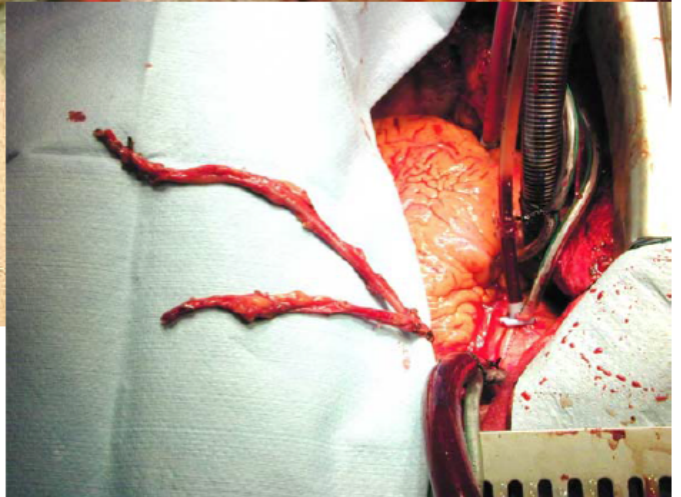
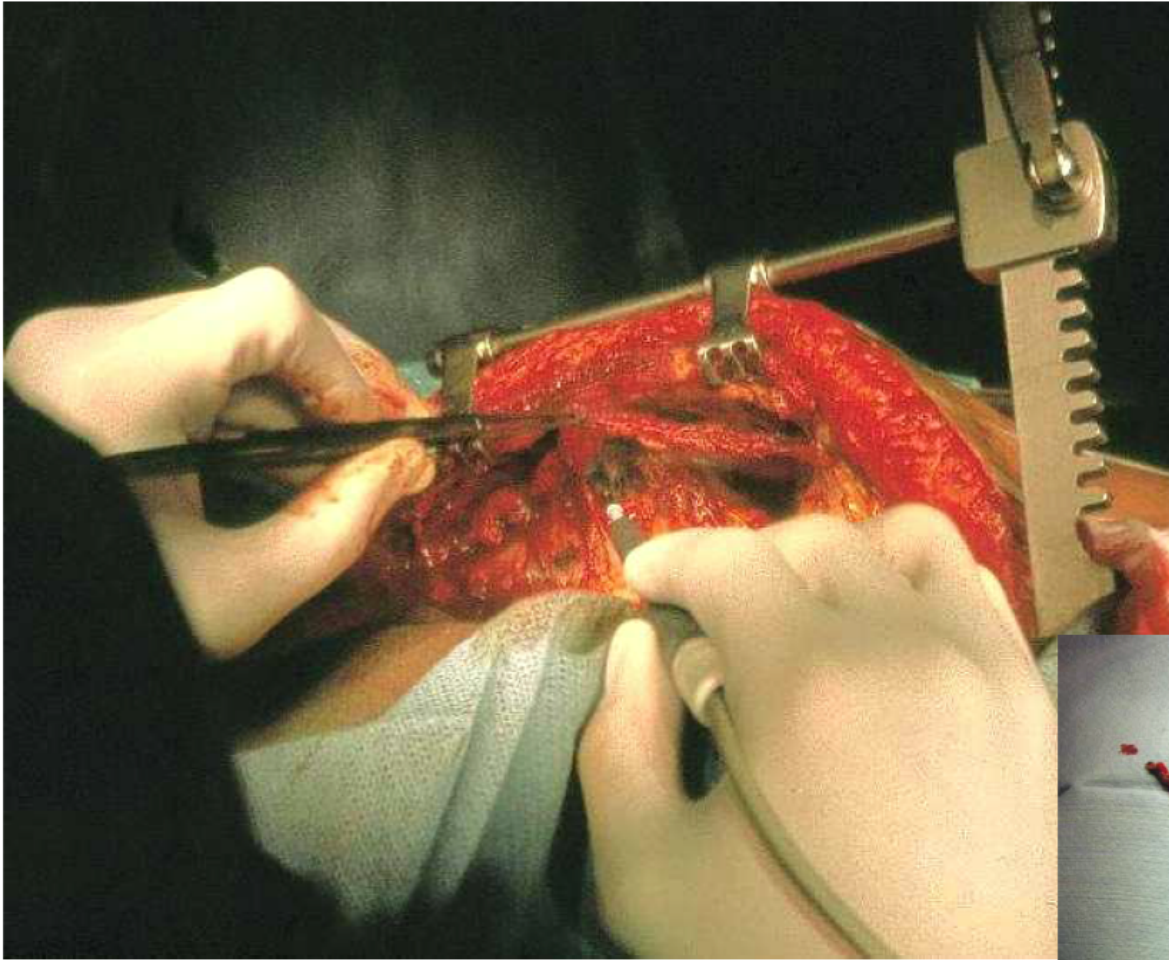


From: The Society of Thoracic Surgeons Web site
<http://www.sts.org>

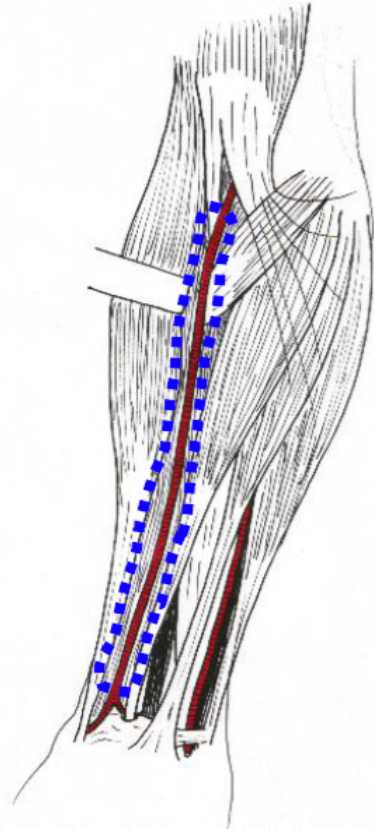


Internal thoracic artery graft

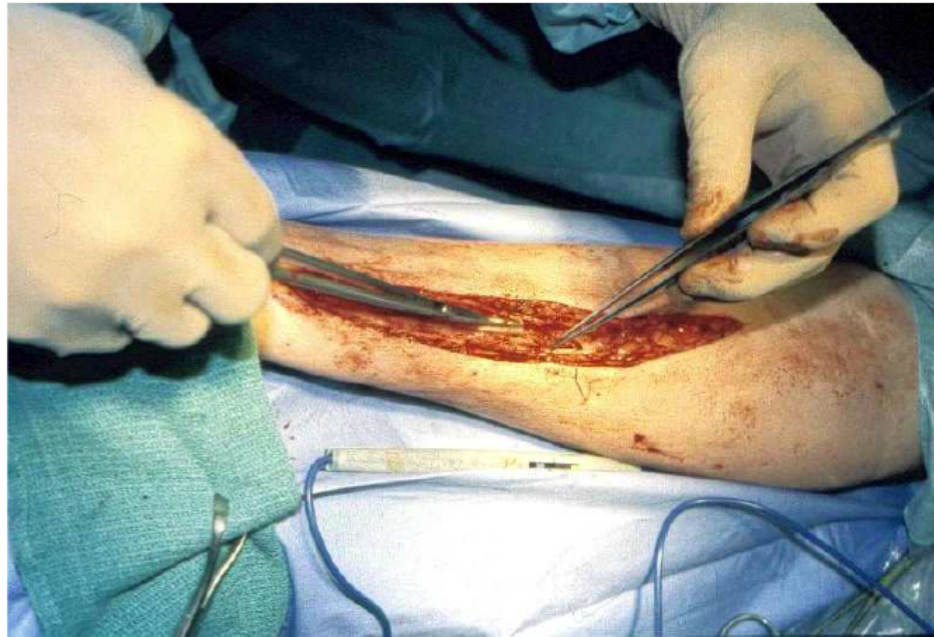




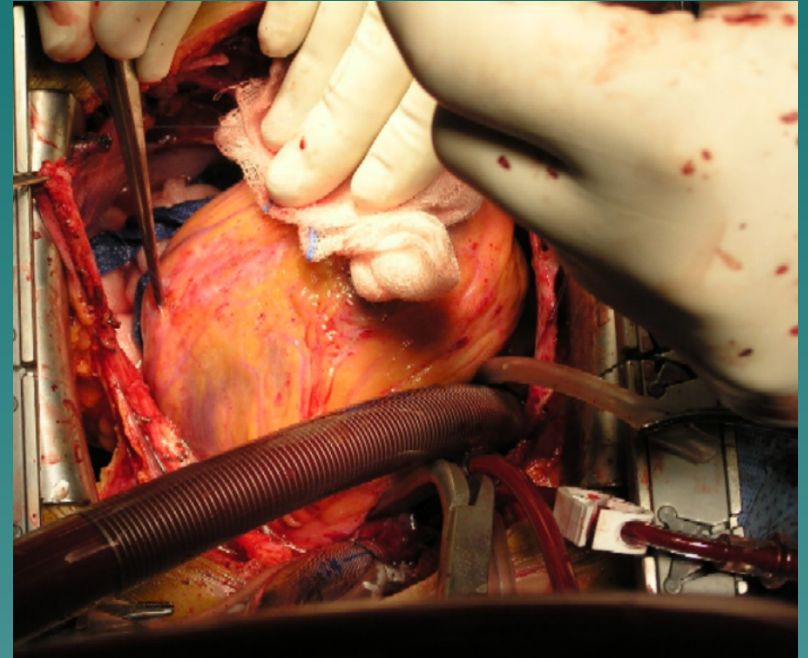
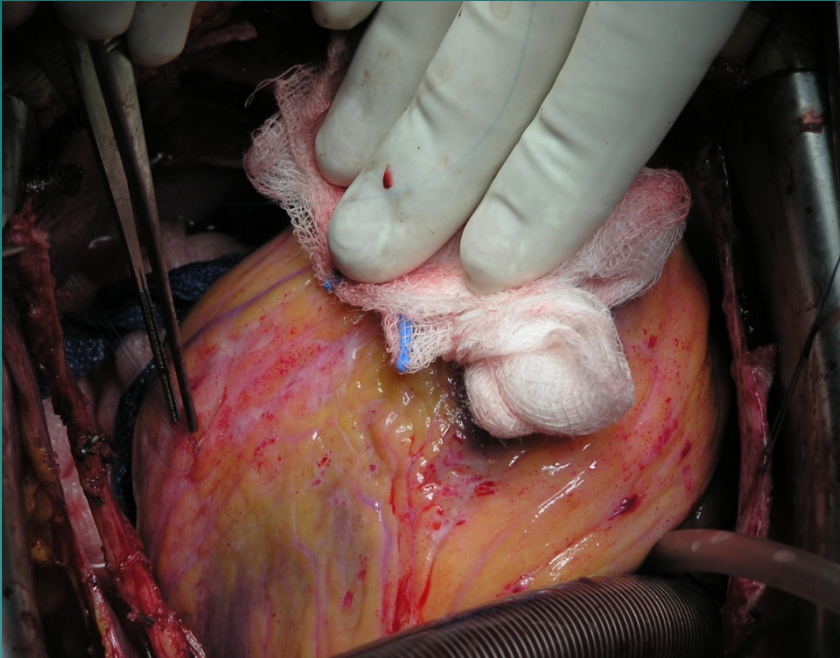
Other arterial grafts



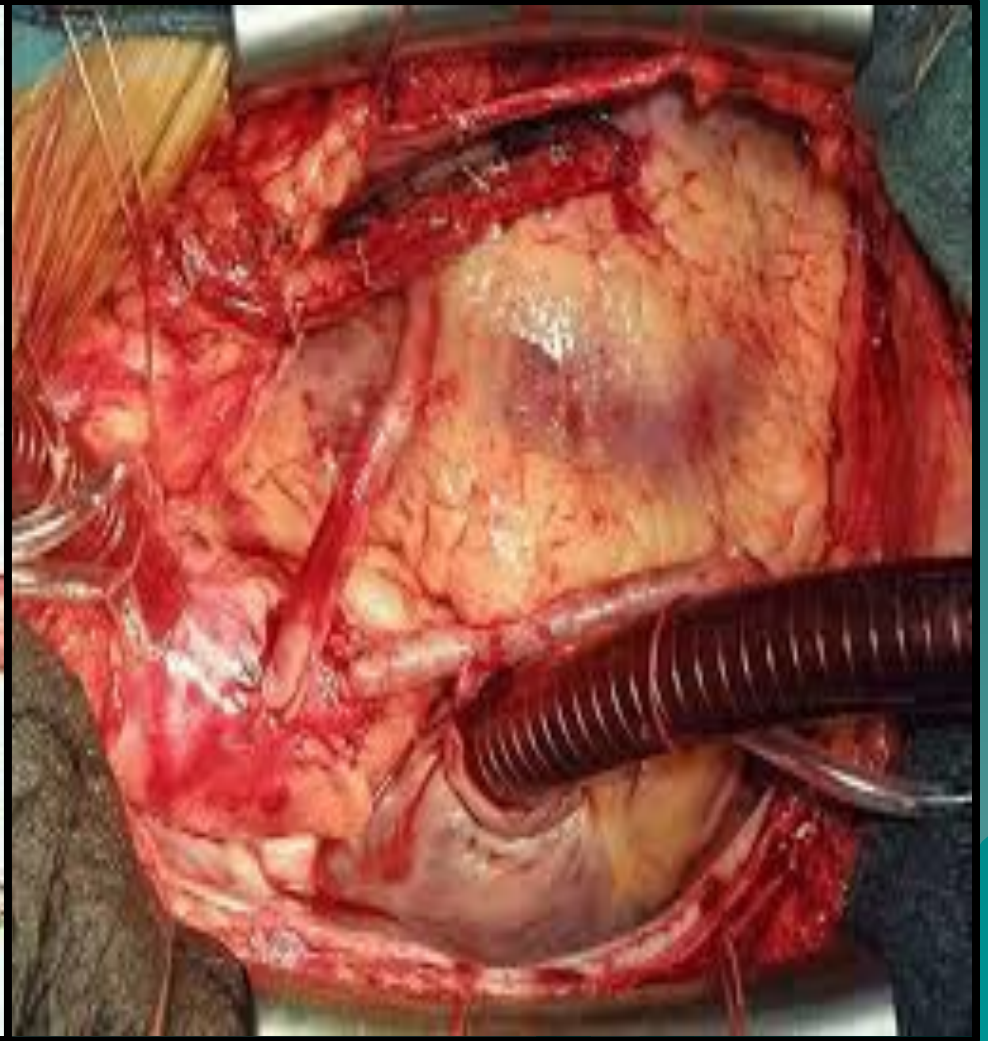
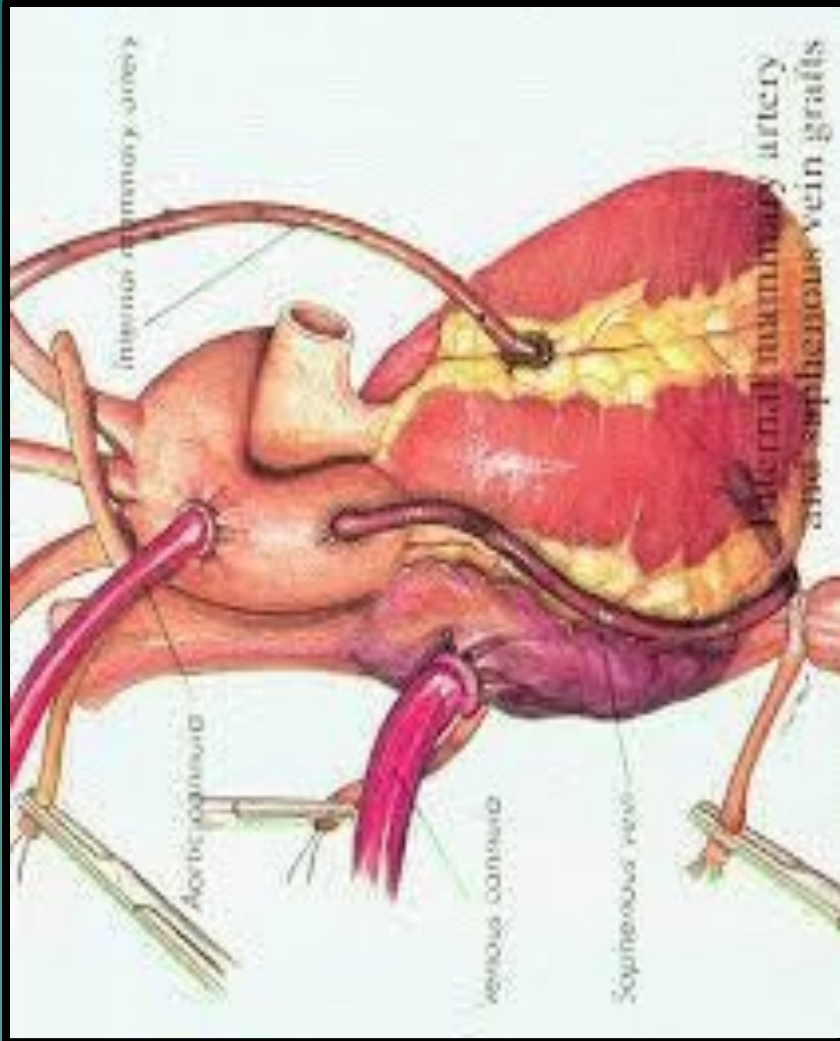
Radial artery



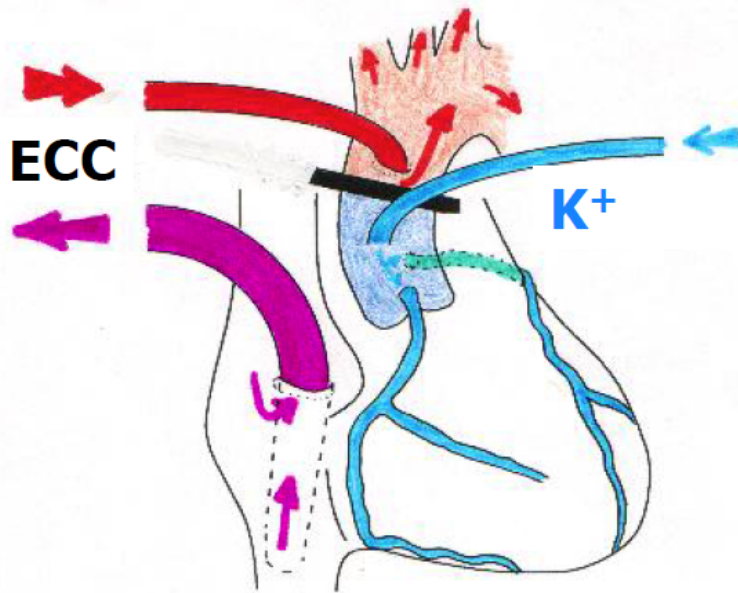
Coronary Artery Bypass Grafting



Coronary Artery Bypass Surgery

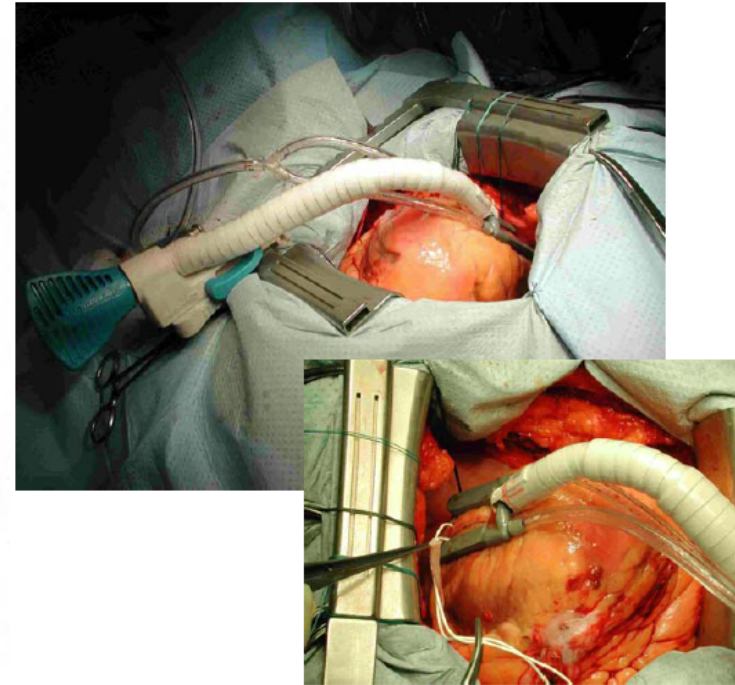


CABG – Operative technique



**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

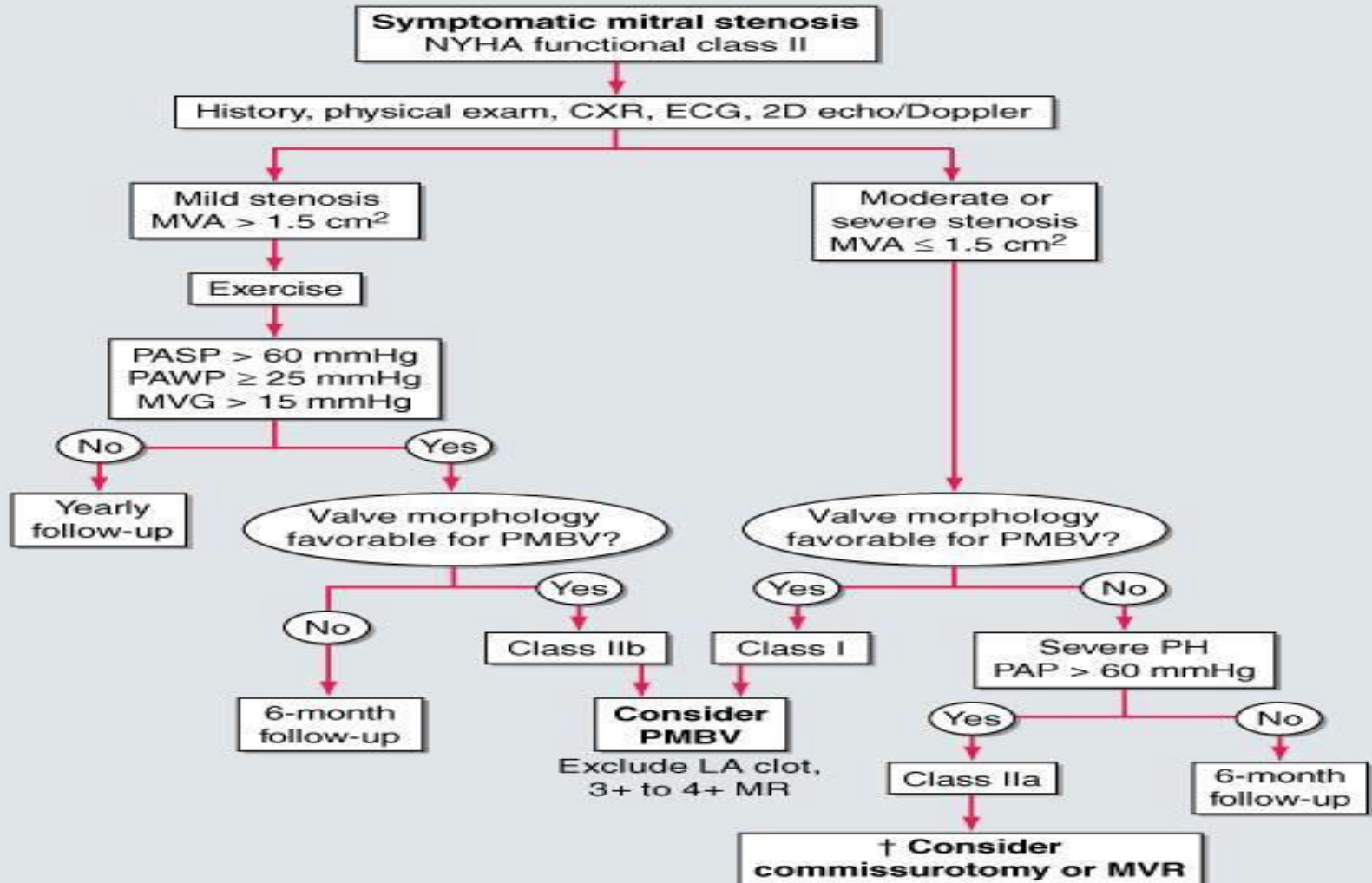
Signs of mitral stenosis

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.

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

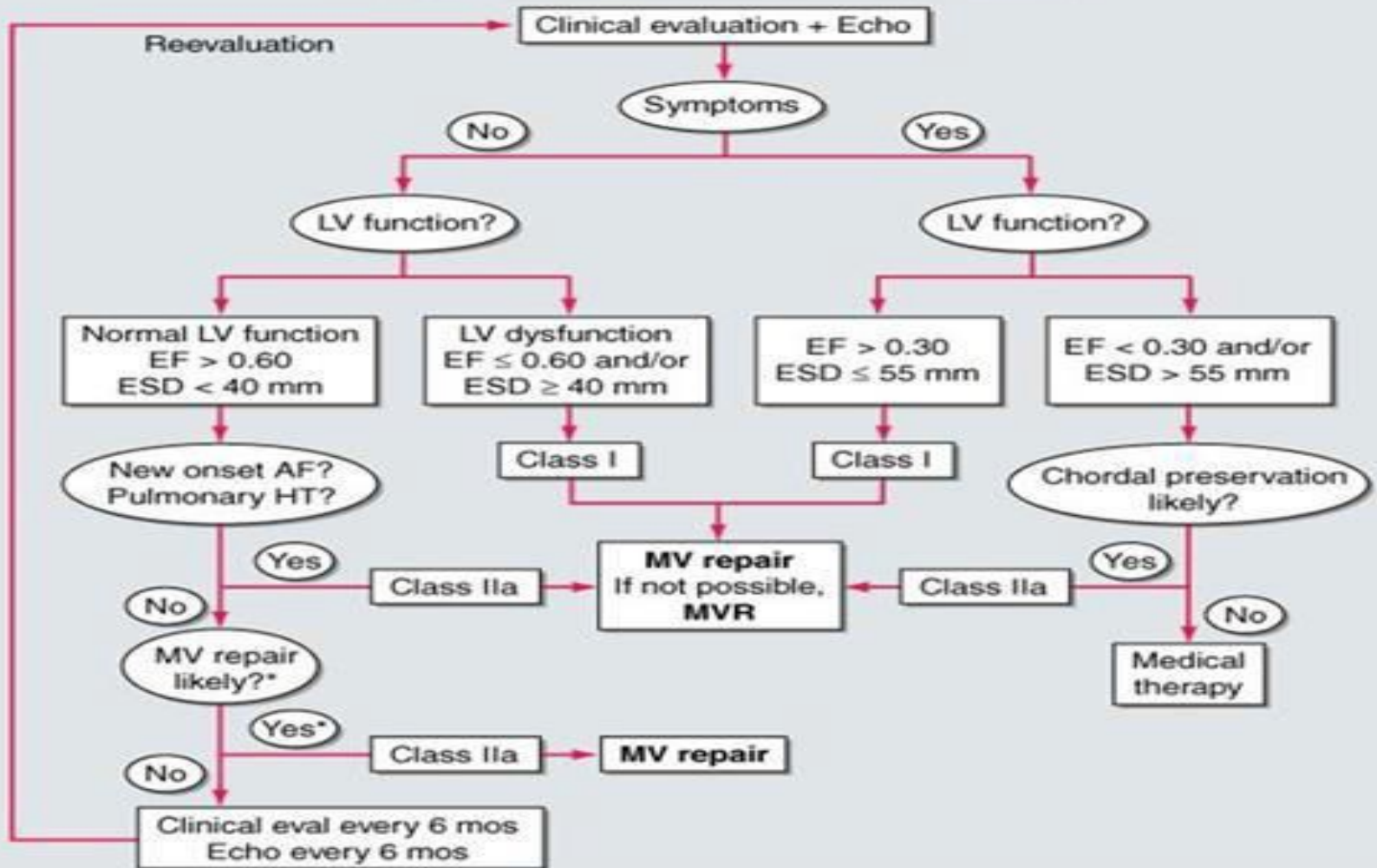
Mitral Regurgitation

Signs of mitral regurgitation:

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

Mitral Valve

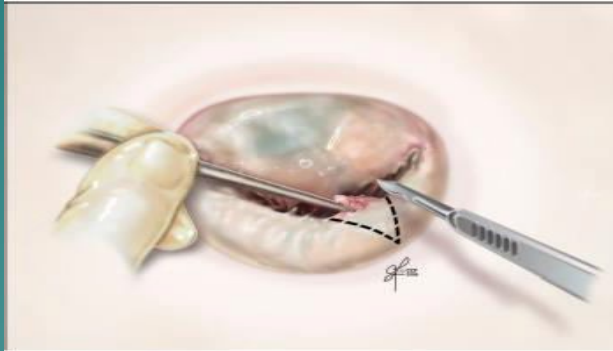
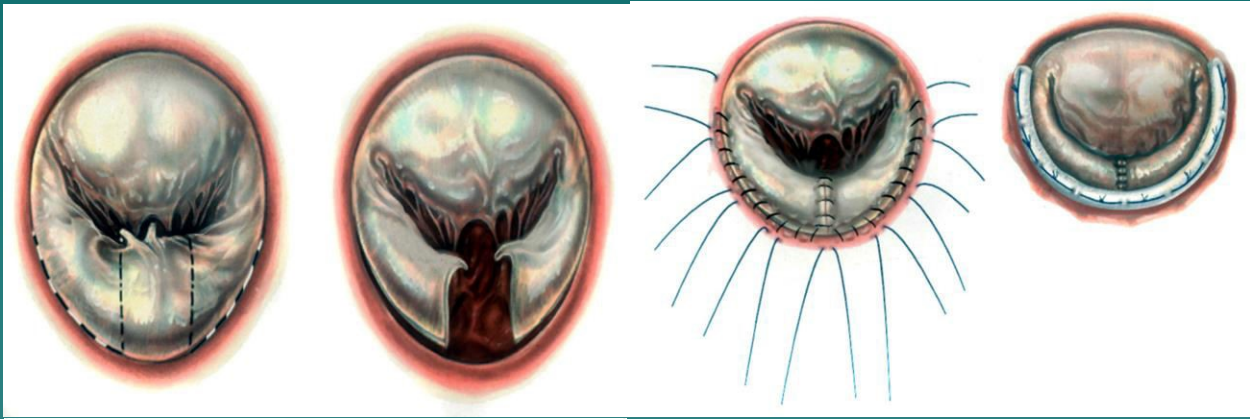
CHRONIC SEVERE MITRAL REGURGITATION



Mitral Valve replacement



Mitral Valve Repair



Aortic stenosis

Etiology: Rheumatic, Congenital, Degenerative.

Symptoms:

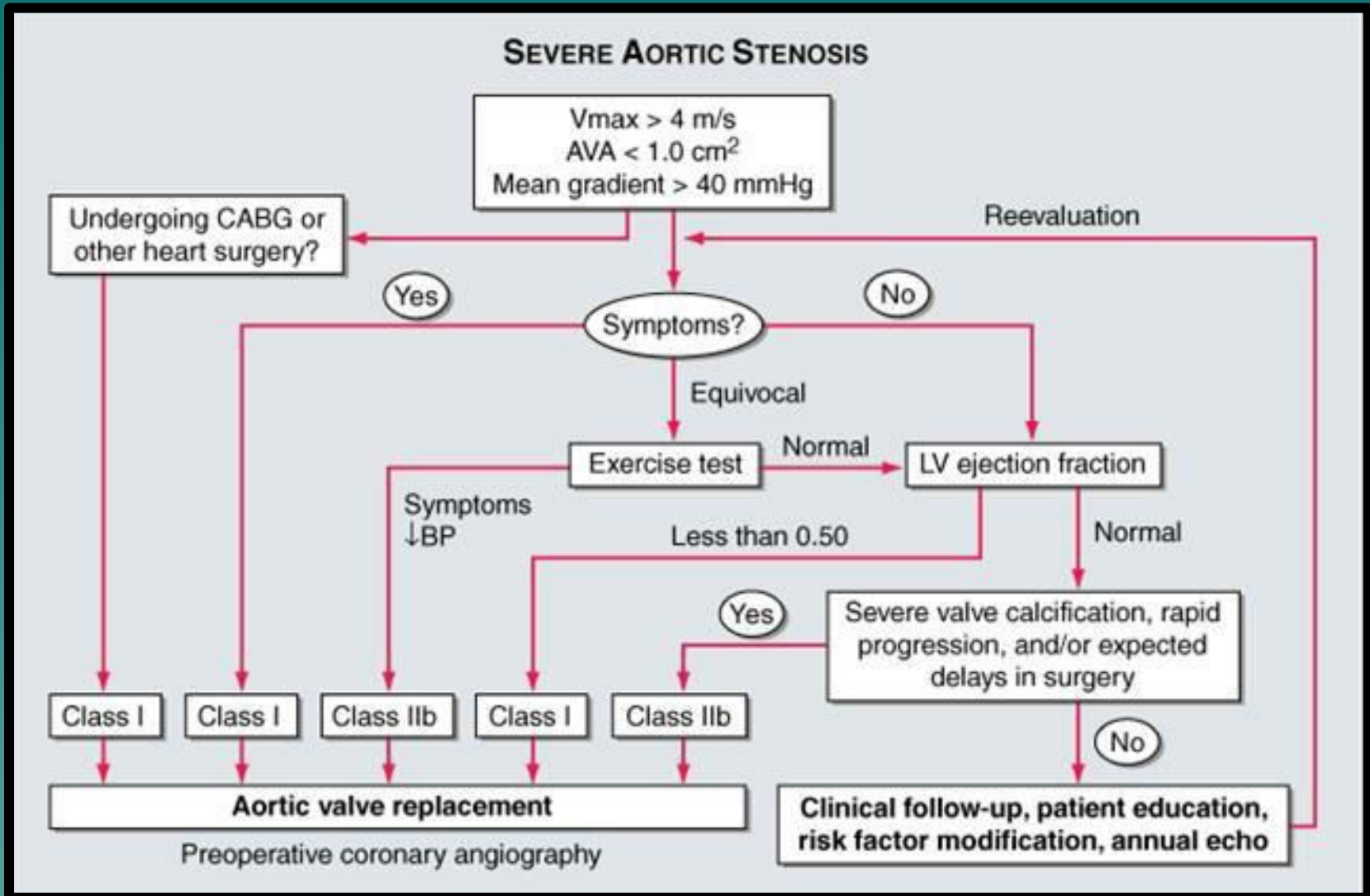
1. Asymptomatic
2. Chest pain
3. Syncopal attacks
4. Dyspnea and CHF

Aortic stenosis

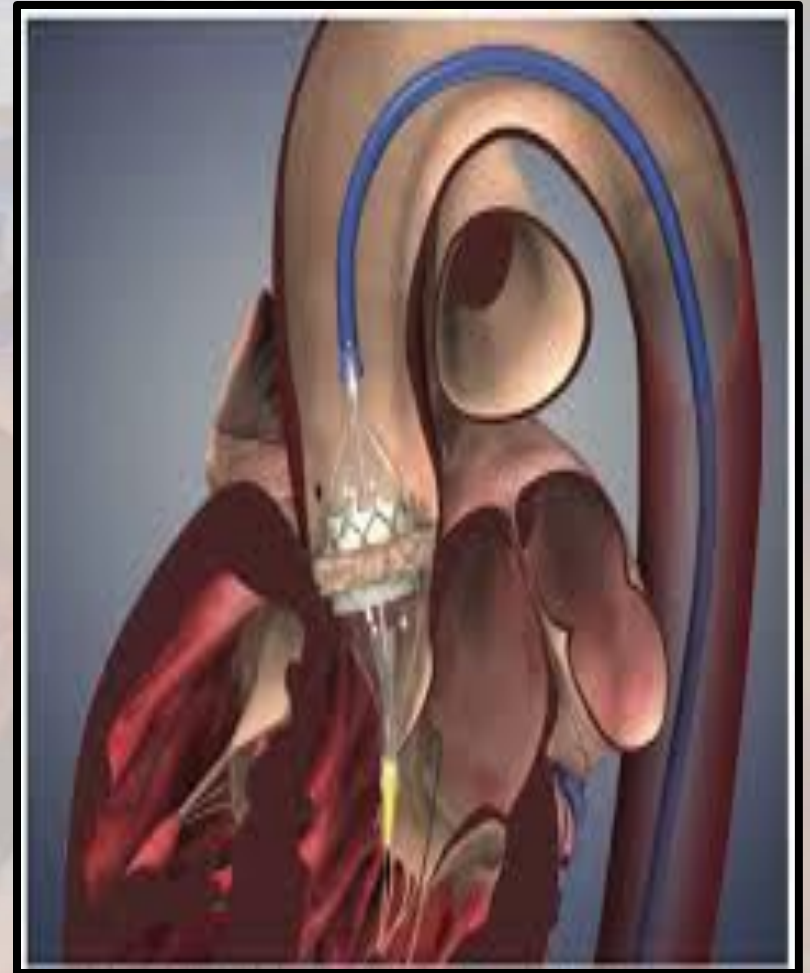
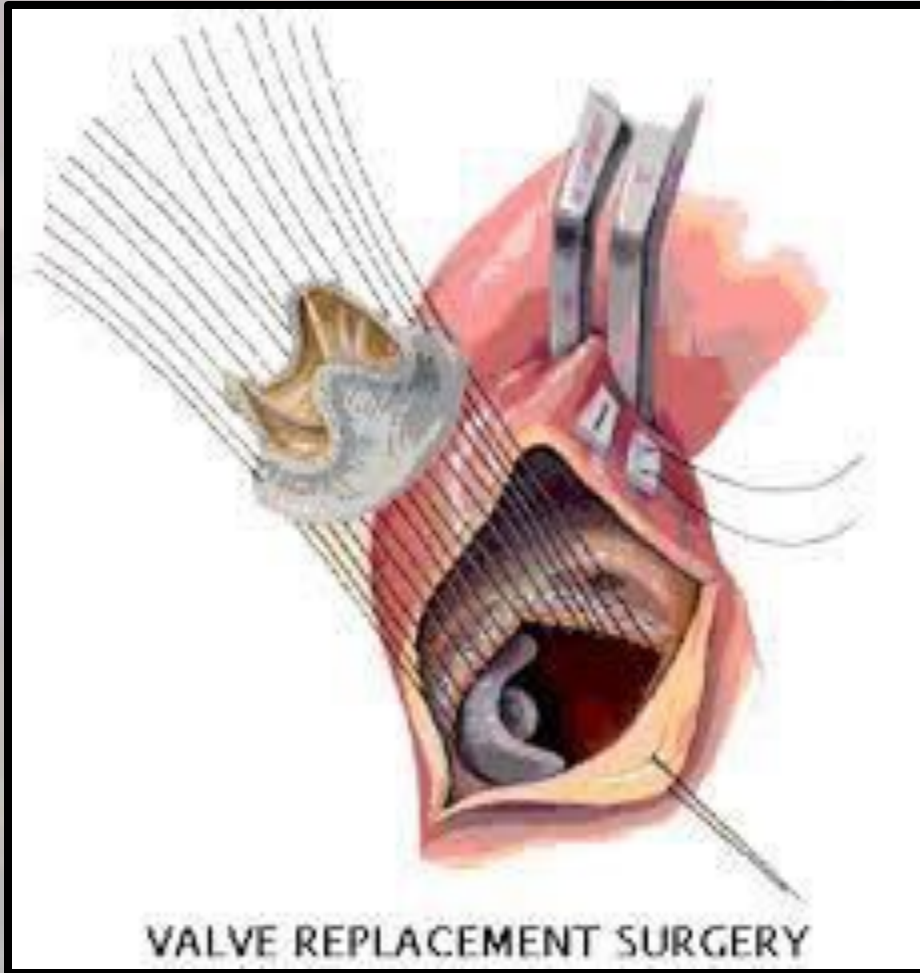
Signs of aortic stenosis:

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

Aortic Valve



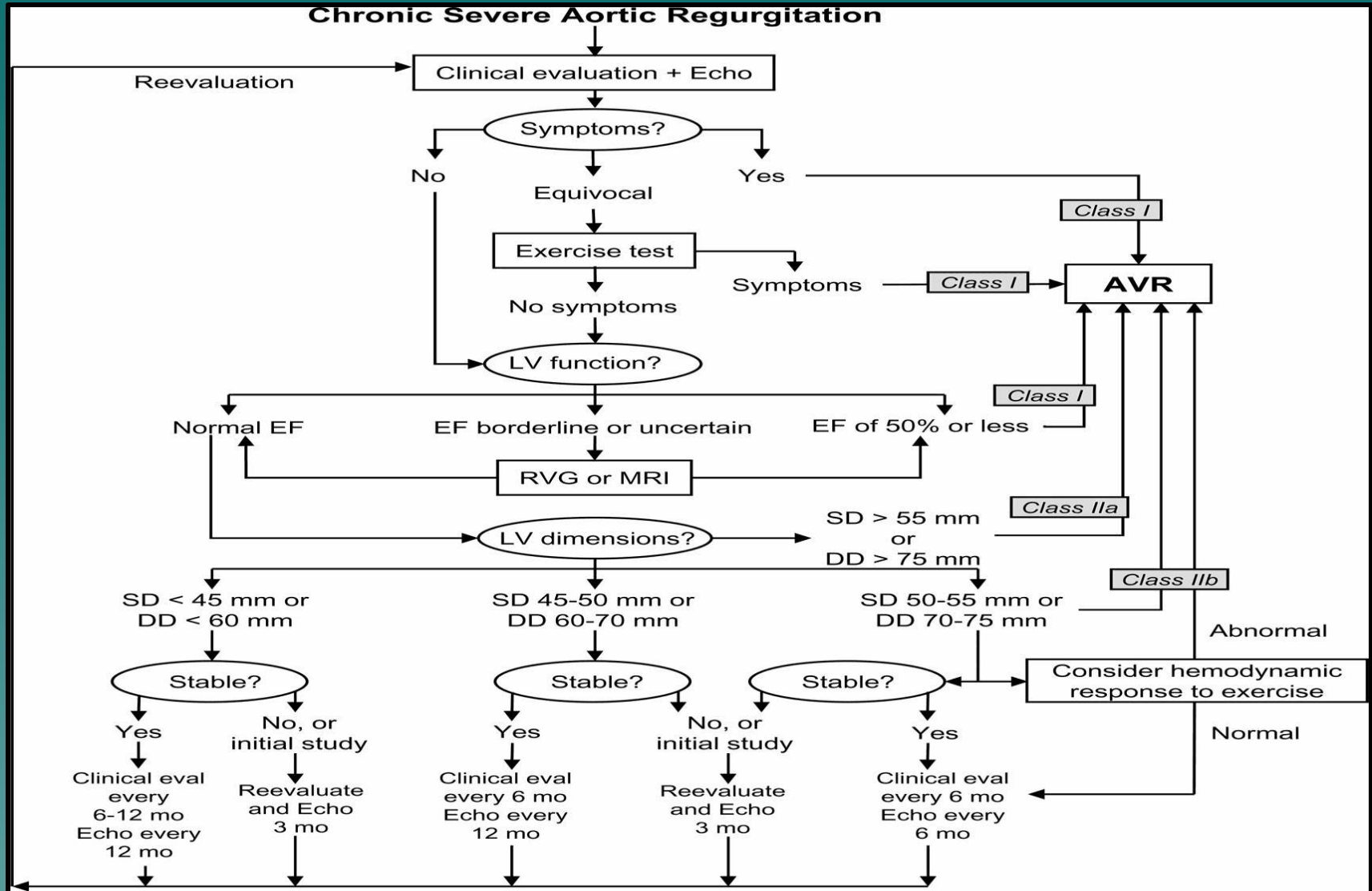
Aortic Stenosis



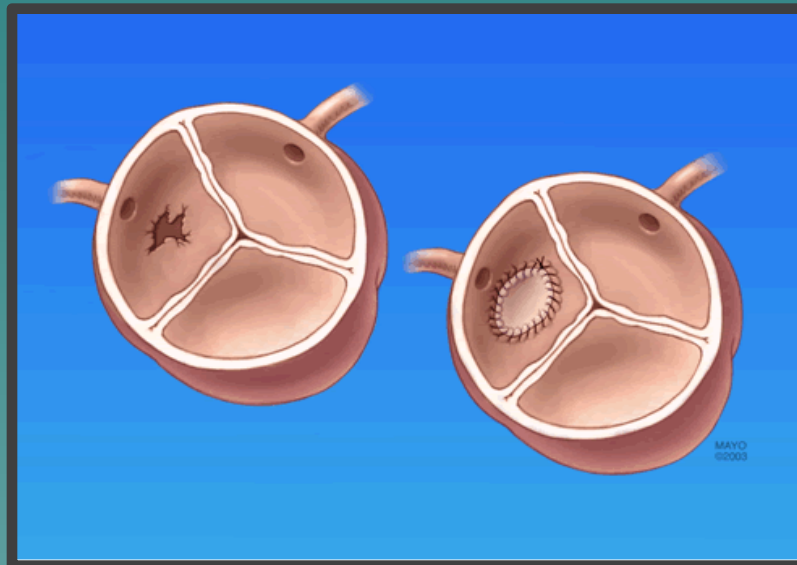
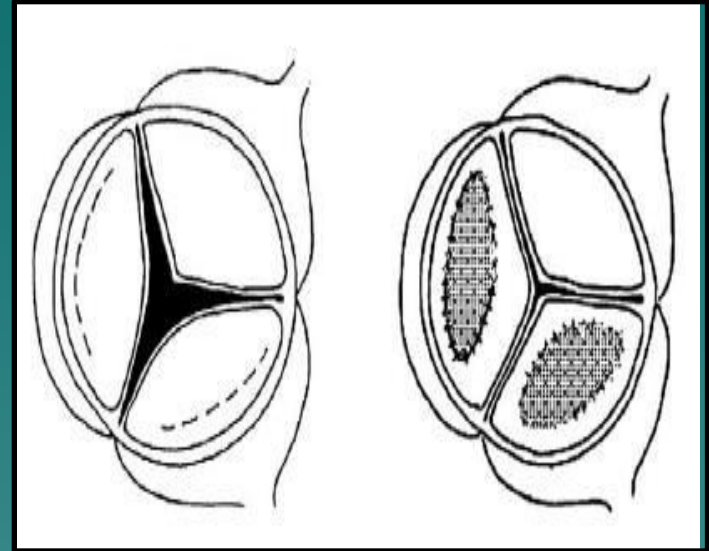
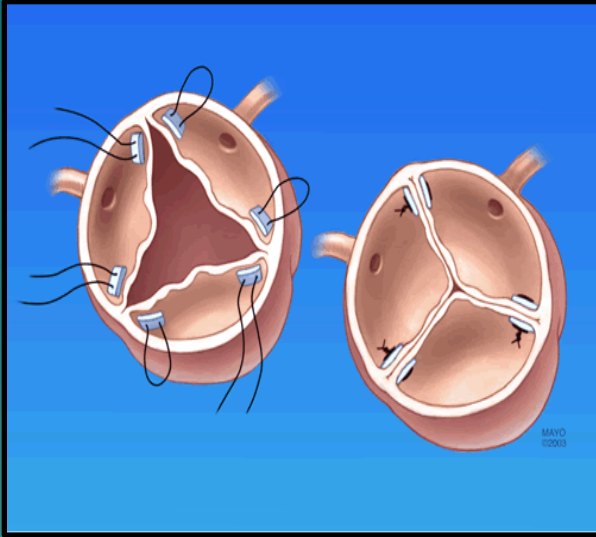
Aortic regurgitation

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

Aortic Valve



Aortic Regurgitation



Valvular Prostheses

Prosthetic Heart Valves



Biologic

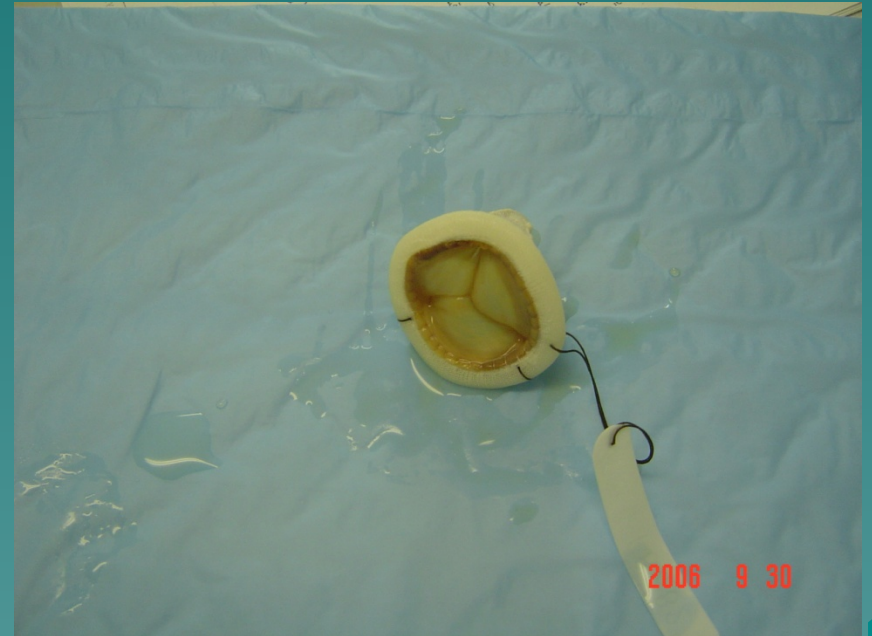
- Lasts 8-10 years
- No anticoagulation
- No Click



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†
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
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
Uncontrolled infection	
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
Prevention of embolism	
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 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.¹¹ 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.⁵

- 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 $\mu\text{mol/L}$)
- 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 ^a	Level ^b
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 Disease

When to Operate ?

> 6.0 cm

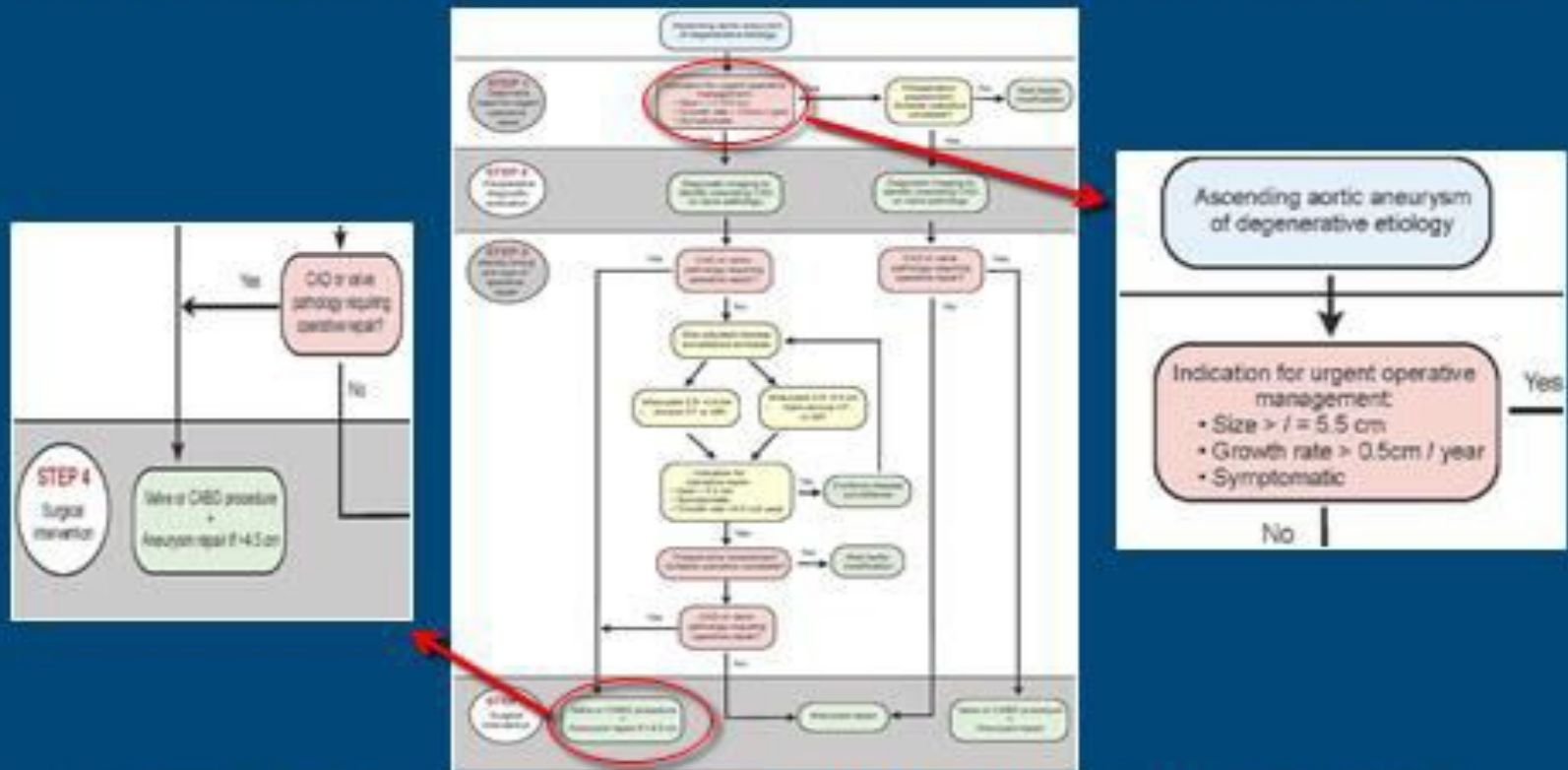
> 5.5 cm



> 6.5 cm

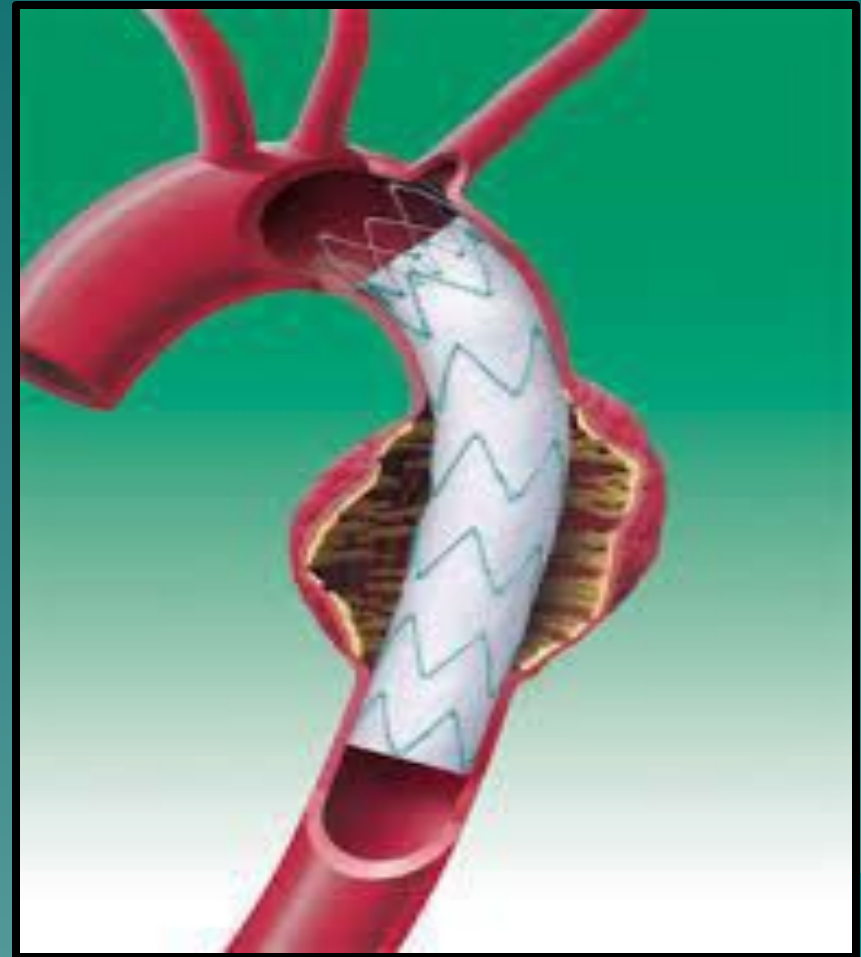
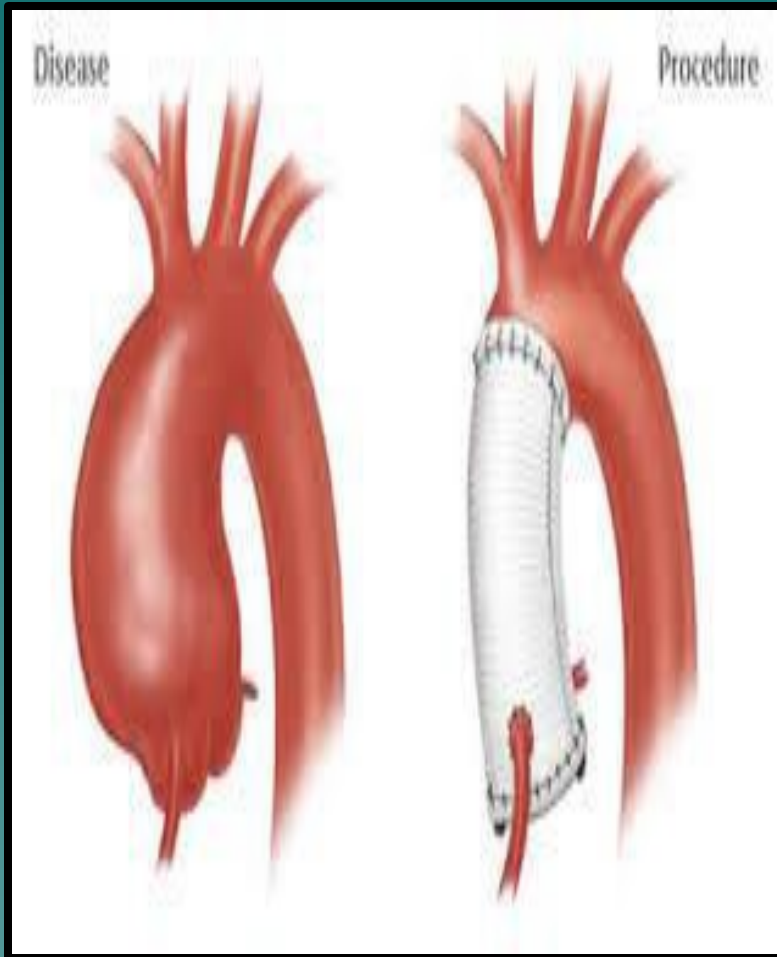
Aortic Disease

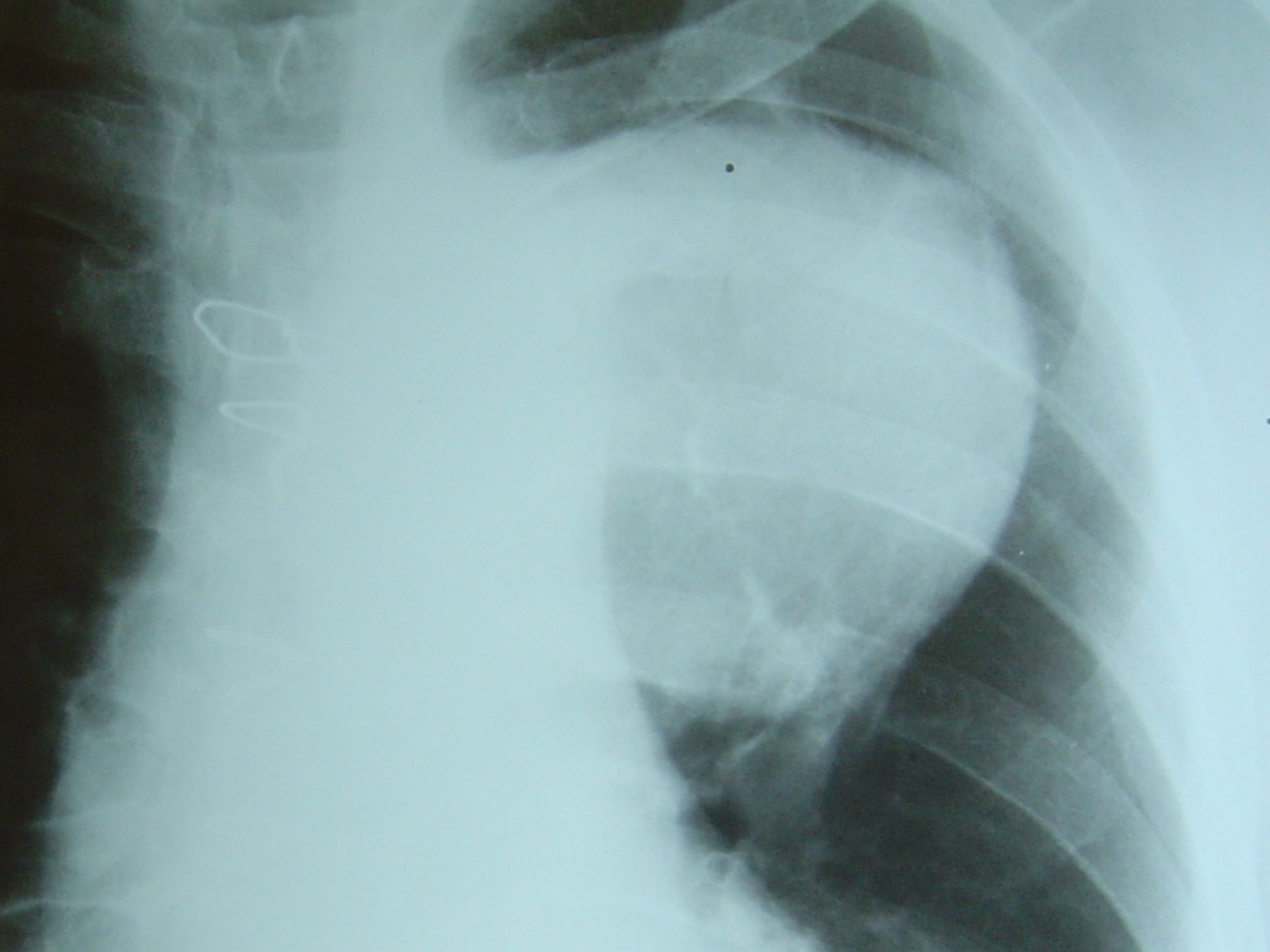
Asymptomatic/ Low Risk Patients



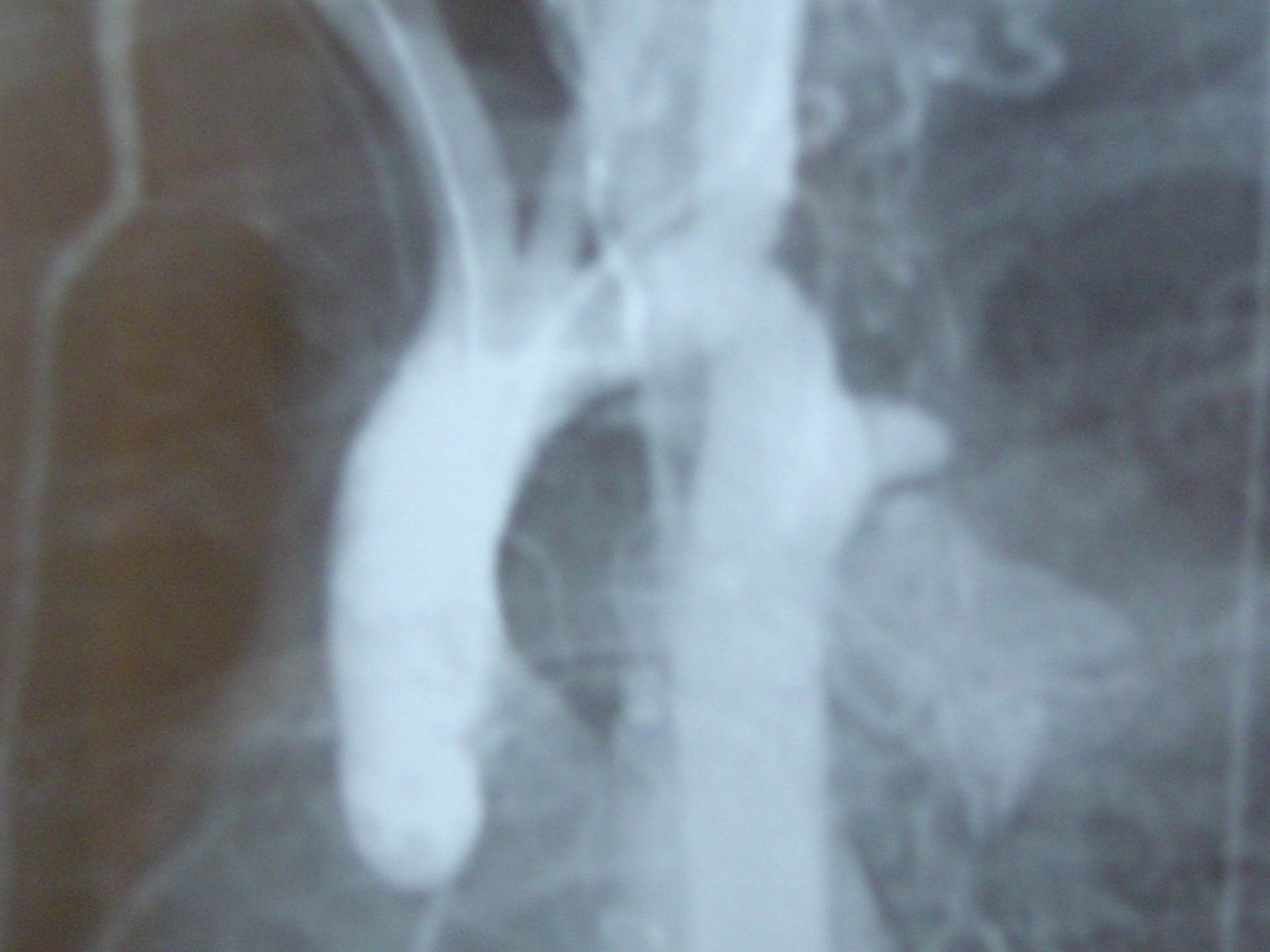
American College of Cardiology Foundation, et al. J Am Coll Cardiol 2010;55:1509-1544

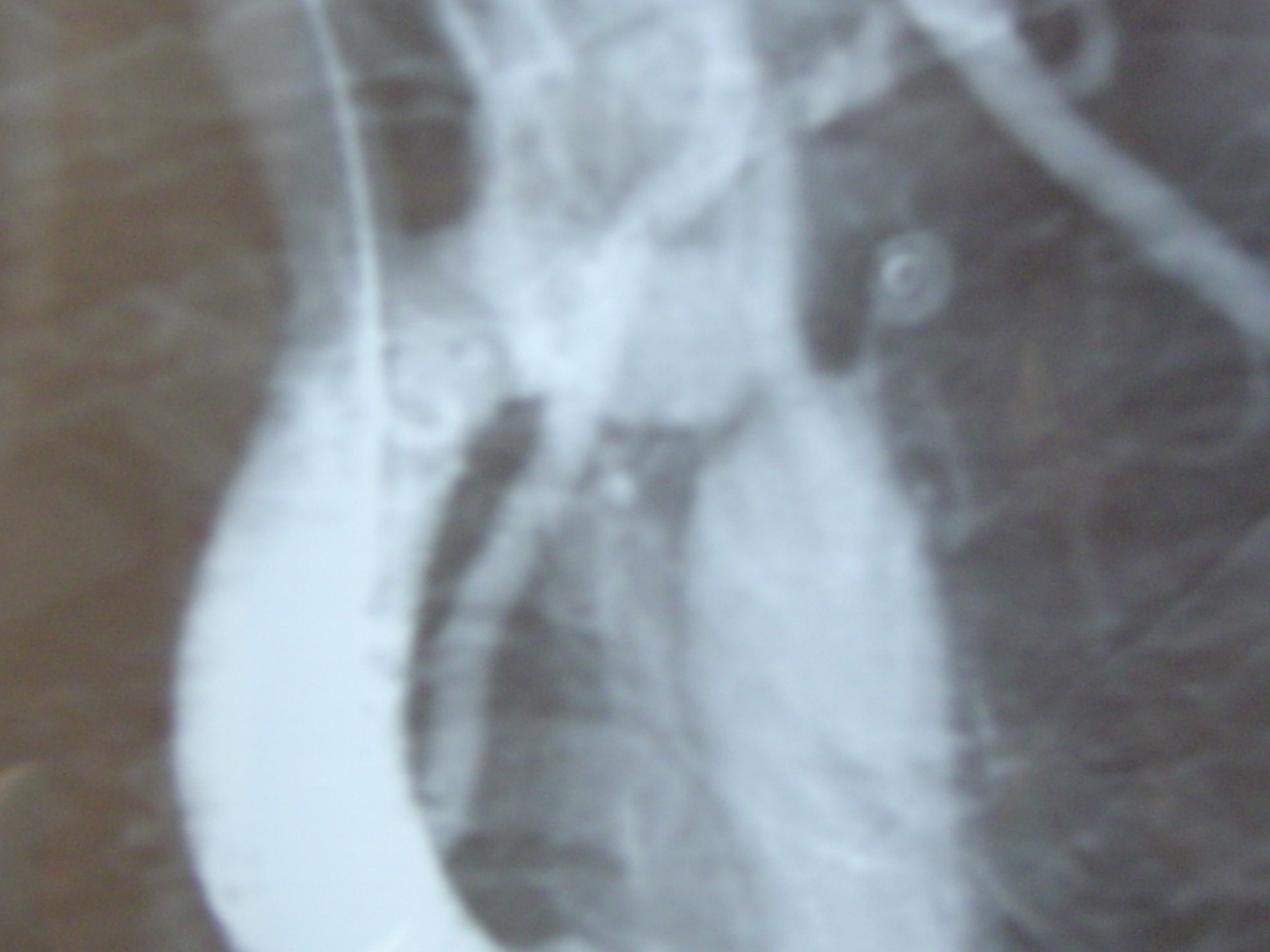
Aortic Surgery





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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

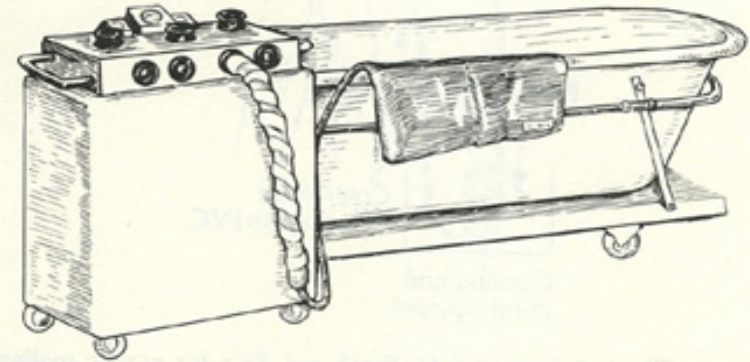
Rhabdomyosarcoma

Fibrosarcoma

Basic Principles of Cardiac Surgery

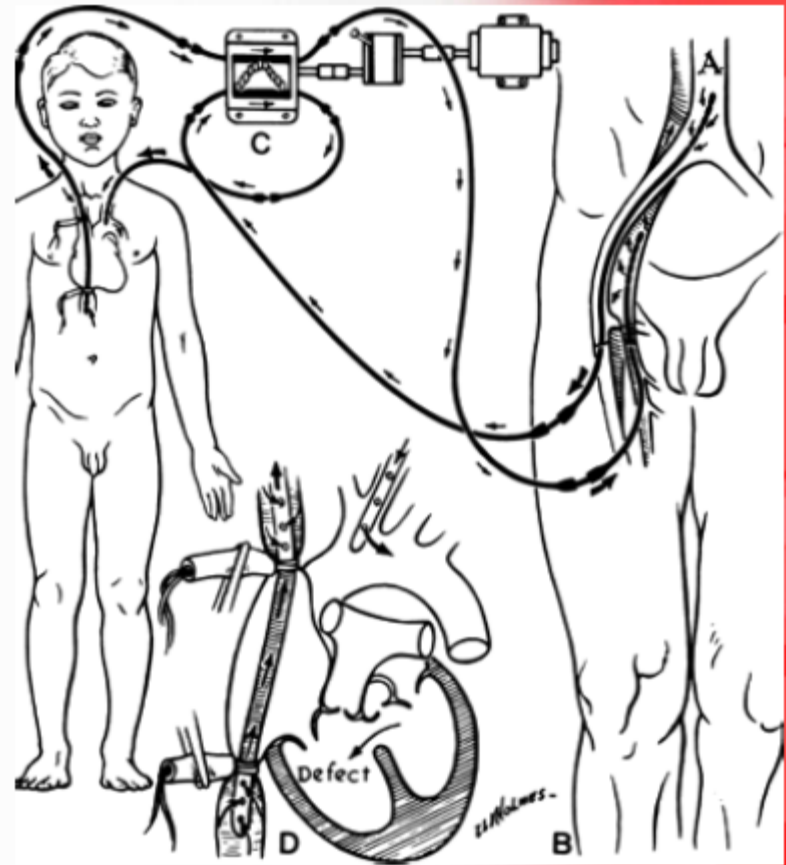
- ◆ Adequate Exposure
 - Full or Partial Sternotomy / Thoracotomy / Robotic or Endoscopic
- ◆ Bloodless Operative Field
 - Suction and re-transfusion / Snaring or clamping of bleeding vessels
- ◆ Static Operative Target
 - Cardiac Arrest / Ventricular Fibrillation / Mechanical Stabilizers
- ◆ Preservation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

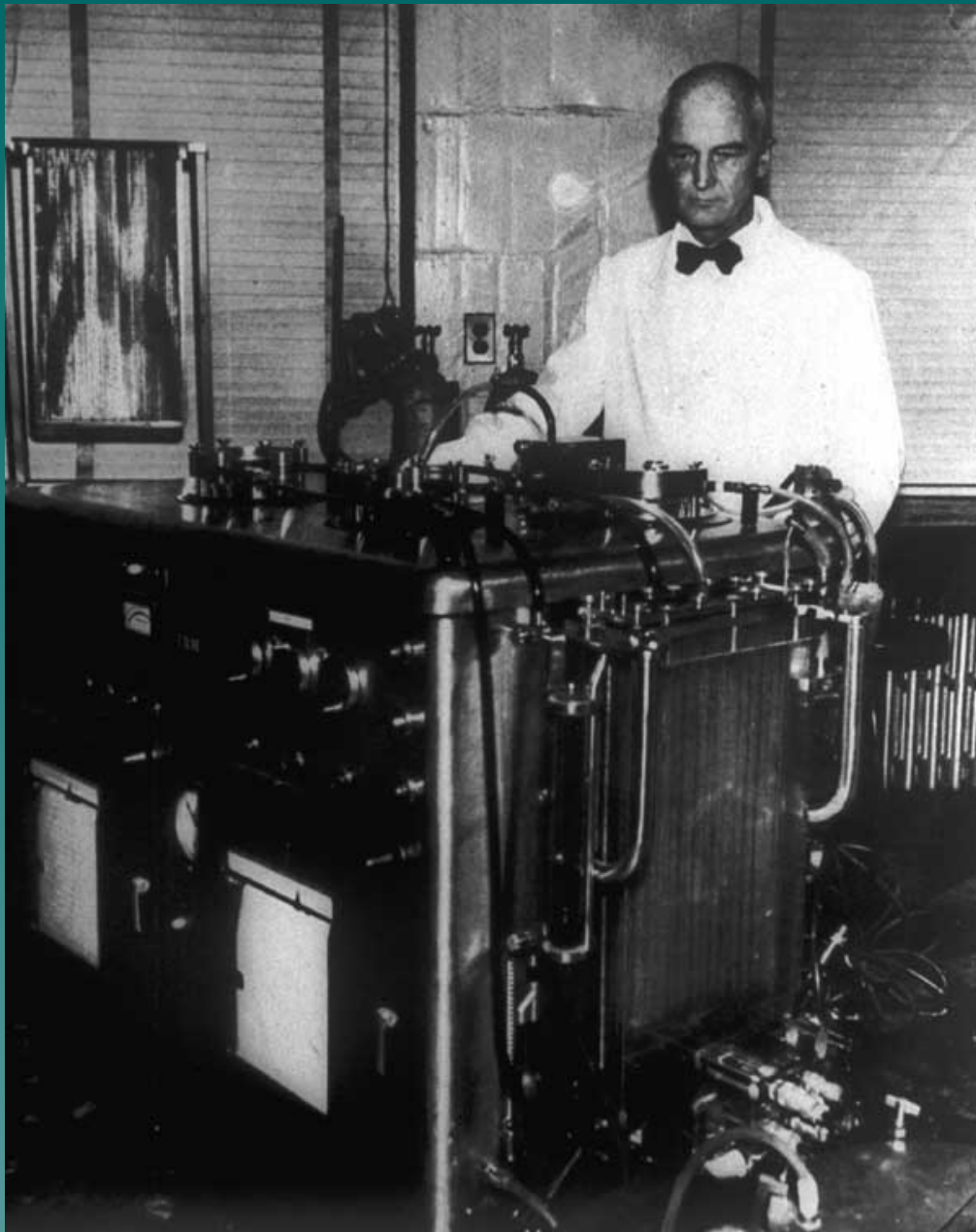
Surface Cooling Hypothermia
(28c°) for ASD Closure in
Children, 1952



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:

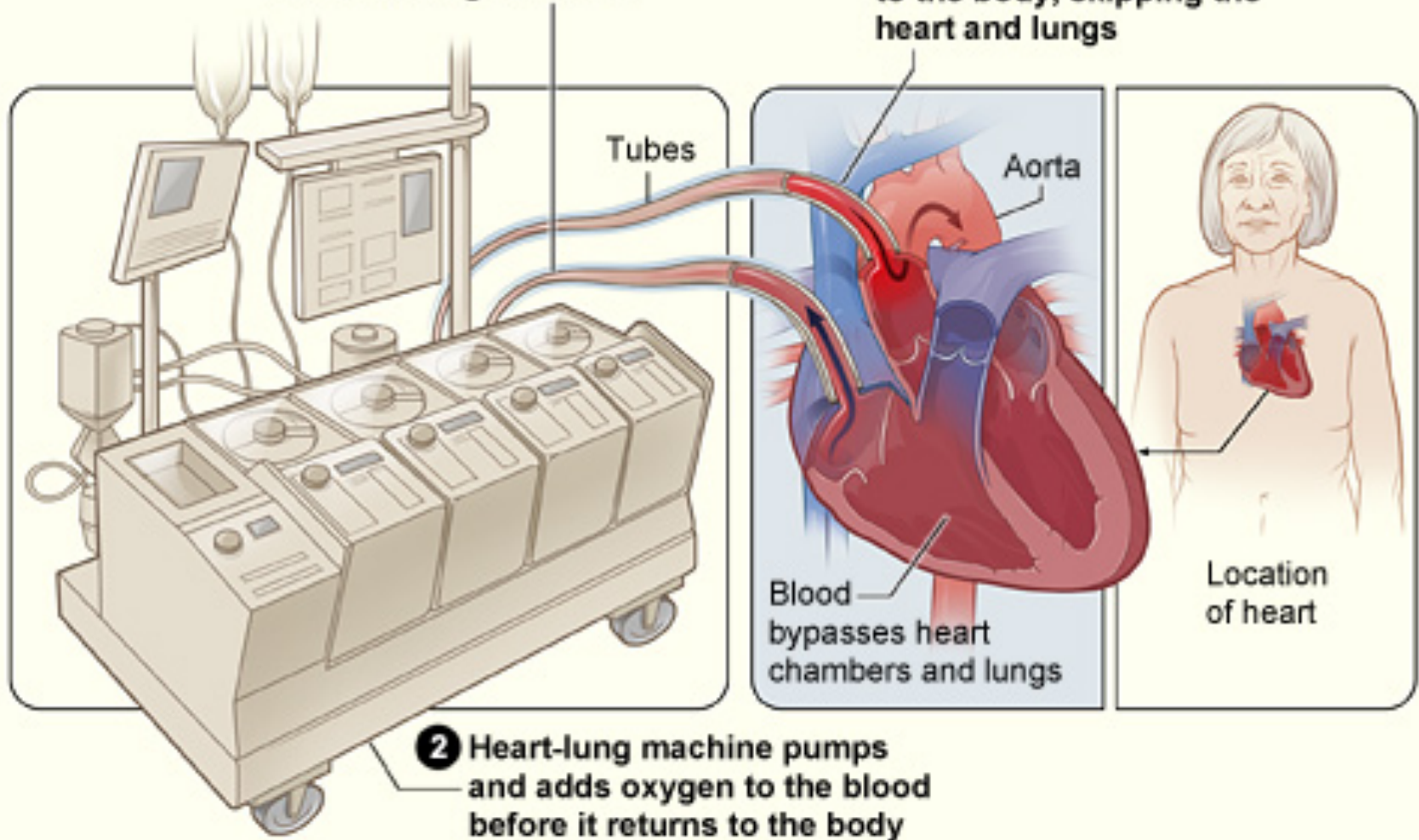
1. adequate gas exchange
2. systemic organ perfusion
3. controlling body temp.

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

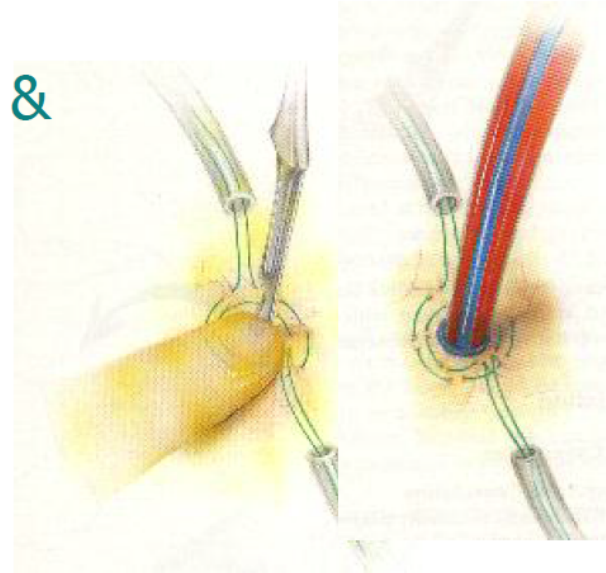
3 Oxygen-rich blood returns to the body, skipping the heart and lungs



2 Heart-lung machine pumps and adds oxygen to the blood before it returns to the body

Operation under ECC (1)

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

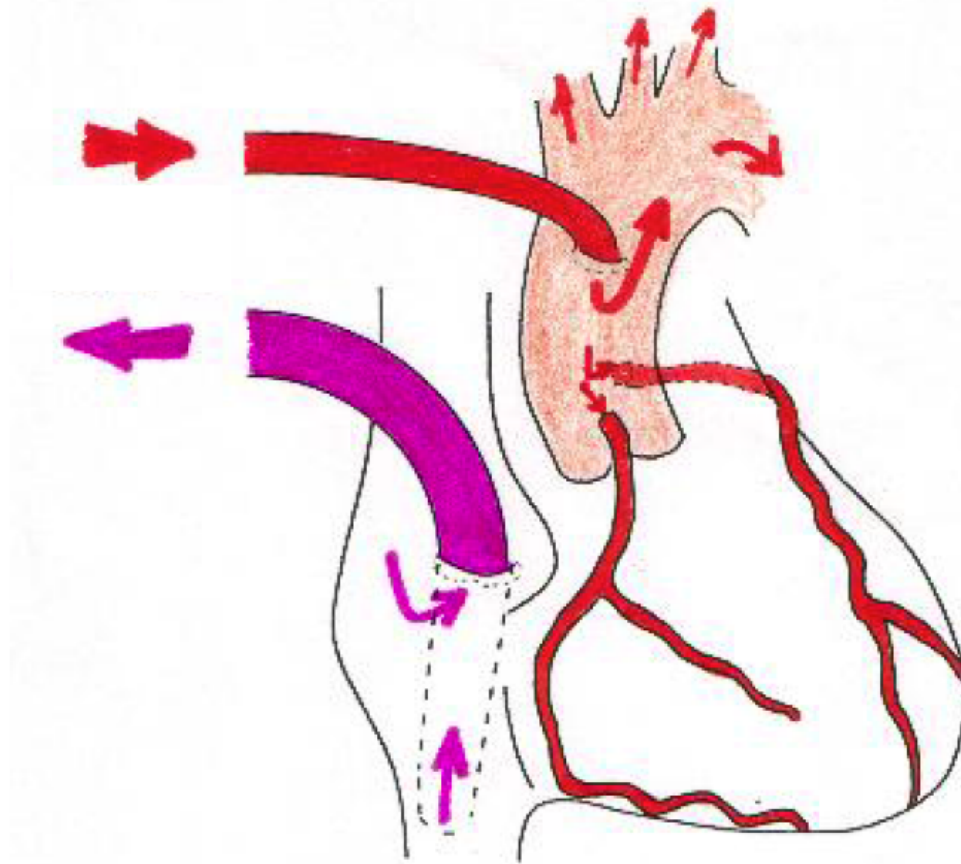


From : Manual of Cardiac Surgery, Harlan & Starr, Springer-Verlag, New York , 1995

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

Operation under ECC (2)

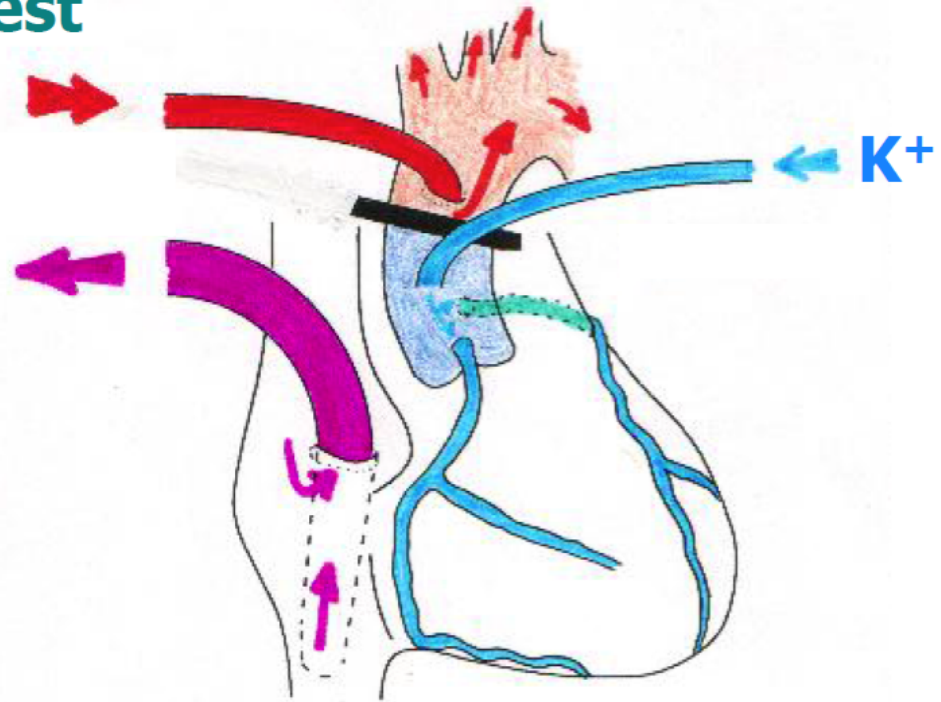
- Initiation of ECC



- Cooling

Operation under ECC (3)

- Cardioplegic arrest



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

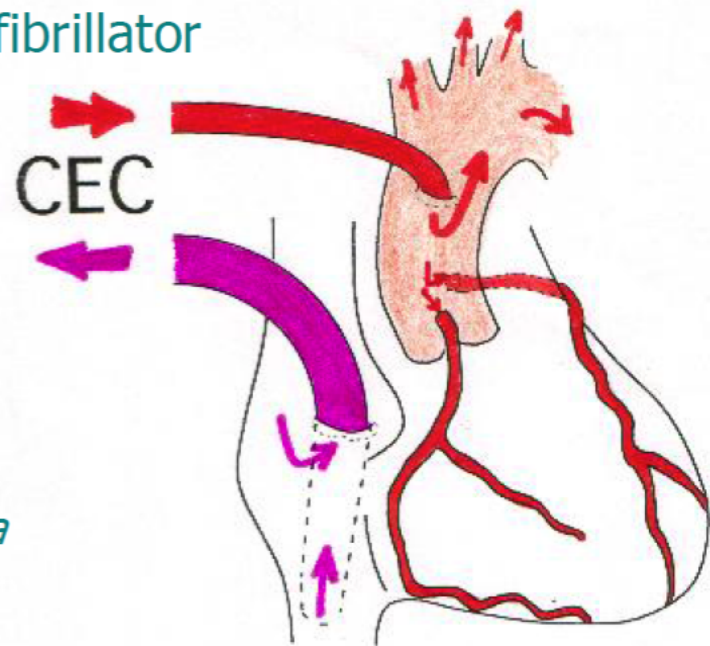
Operation under ECC (4)

- **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)*



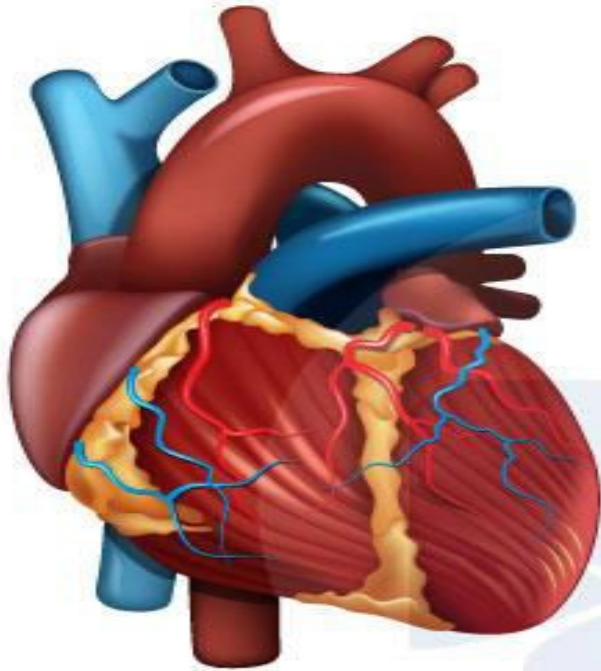
Complications of CPB

- ◆ 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

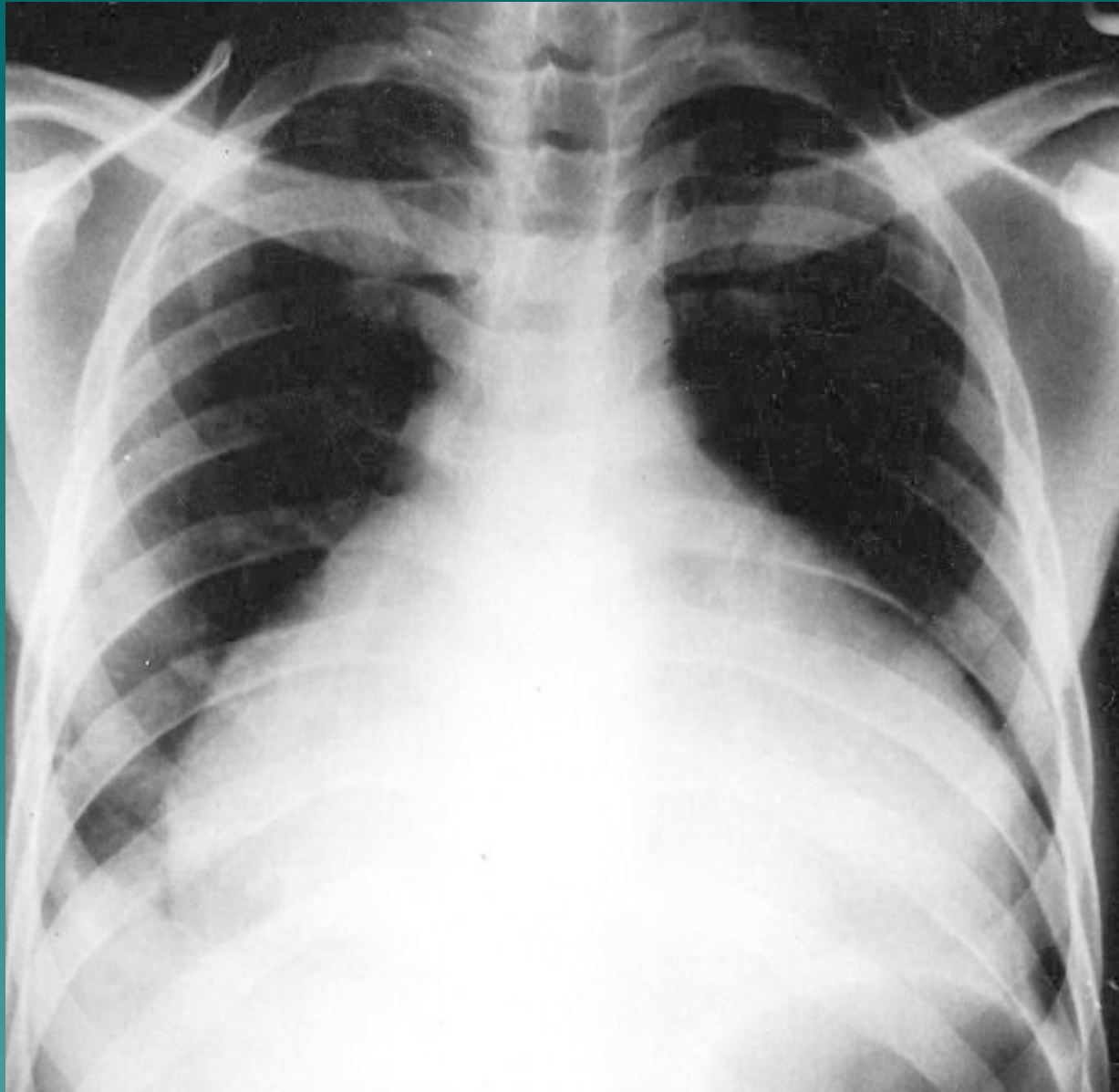
Pericardial effusion

- ◆ 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
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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

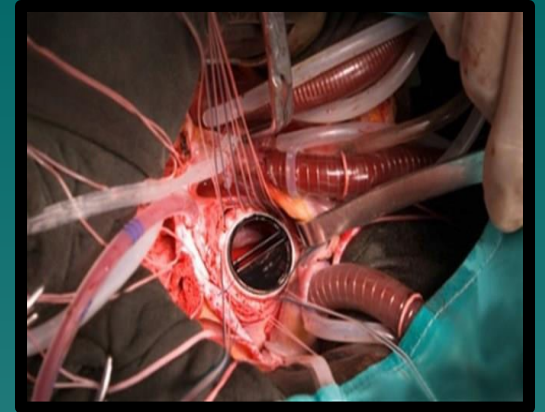
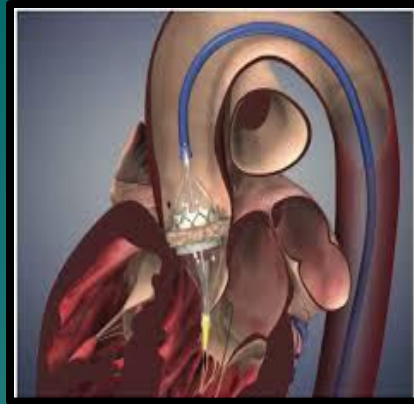
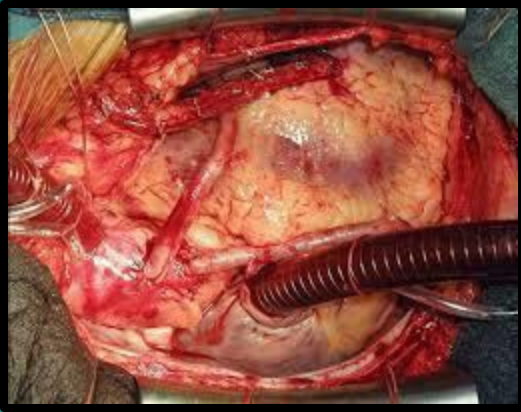
Pre-Operative Investigations for Cardiac Surgery

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



Thank You

