

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
- 

Modes of Presentation of Cardiac Diseases

- Chest pain
 - Symptoms due to lung congestion
 - Symptoms due to systemic congestion
 - Palpitations
 - Symptoms due to low cardiac output
 - Cyanosis and Clubbing in Congenital Defects
 - Other Symptoms (fever, sweating, G.I. symptoms, pressure 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.

Cardiovascular 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 obstruction
 - a) Aortic stenosis
 - b) H.O.C.M
- 

Non – cardiac causes:

A. Causes in the chest wall & vertebrae:

1. Diseases of the breast, myositis, rib fractures.
2. Diseases of the shoulder joint & costochondritis.
3. Cervical spondylosis & prolapsed cervical disc
4. Thoracic outlet syndrome e.g. cervical rib
5. Diseases of the spinal cord / nerve roots. e.g. radiculitis, Tabes dorsalis.

B. Causes in the lungs, pleura & mediastinum:

6. Pleural causes: Pleurisy, acute pneumothorax.
 7. Lung disease: e.g: bronchitis, pulm. Infarction, pneumonia
 8. Mediastinitis & mediastinal emphysema & tumor.
- 

Non – cardiac causes:

c. Abdominal causes:

1. Stomach : Hiatus hernia, peptic ulcer.
2. Esophagus : reflux esophagitis, spasm
3. Gall bladder : cholecystitis

D. Anxiety & Cardiac neurosis:

- Stabbing or stitching in nature occurs after exercise assoc. e soghing, palpitation, sense of suffocation, precordial tenderness & emotional upset

Lung Congestion

Congestive lung symptoms in cardiac patients occur as a result of :

1. Stagnation of blood behind a failing left atrium or left ventricle (left sided heart failure)
2. Left -to- Right shunts.

L.V Failure – Causes:

1. Excessive pressure

- A.S
- Coarctation
- ↑ B.P

2. Excessive volume

- A.R
- M.R
- V.S.D
- P.D.A

3. Disease in the myocardium

- I.H.D & M.I
- Myocarditis

L.V failure:

- ◆ When the L.V fails □ unable to pump all the blood to the circulation.

1. ↓ C.O.P :
 - a) Fatigue
 - b) ↓ Blood supply to the kidneys □ salt & water retention □ Blood volume □ L.L edema
 - c) ↓ Blood □ skin □ pallor & peripheral cyanosis
 - d) ↓ Cold extremities
2. ↑ Sympathetic activity □ tachycardia
3. Blood accumulates in the lungs : □ pulm. Venous congestion
 - a) Dyspnea on effort
 - b) Orthopnea
 - c) P.N.D
 - d) Acute pulm. Edema
 - e) Cough
 - f) Hemoptysis
 - g) Crepitations
 - h) Pleural effusion

Clinically:

- ◆ Symptoms:
 - Dyspnea| orthopnea| PND| Pulm. Edema| cough with expectoration of mucoid sputum| easy fatigue & hemoptysis
- ◆ Signs:
 - Rapid small pulse volume| Pale, cold extremities, crepitations, gallop rhythm, pulsus alternans functional M.R



Dyspnea: other causes

- ◆ 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
- ◆ Poor physical fitness

Systemic Venous Congestion

Causes of systemic venous congestion:

1. Right atrium:


tricuspid stenosis / regurgitation, right atrial tumor

2. Right ventricle:

pressure overload, volume overload, myocardial damage.

3. Obstruction to venous inflow: pericardial effusion, constrictive pericarditis.

R.V failure – causes:

1. Excessive pressure
 - P.S
 - Pulmonary ↑ B.P.
 2. Excessive blood volume
 - T.R
 - A.S.D
 3. Disease in the myocardium
 - R.V infarction
 - Myocarditis
- 

R.V failure:

1. Low C.O.P □ fatigue, pale cold skin, peripheral cyanosis. Rapid small volume pulse, L.L edema
2. Blood accumulates behind the failing R.V = the R.A □ systemic veins
 - a) Neck vein congestion
 - b) Tender hepatomegaly
 - c) L.L edema
 - d) G.I congestion □ anorexia, nausea, flatulence
 - e) Pleural effusion, pericardial effusion
 - f) Ascites
3. Functional T.R

Clinically:

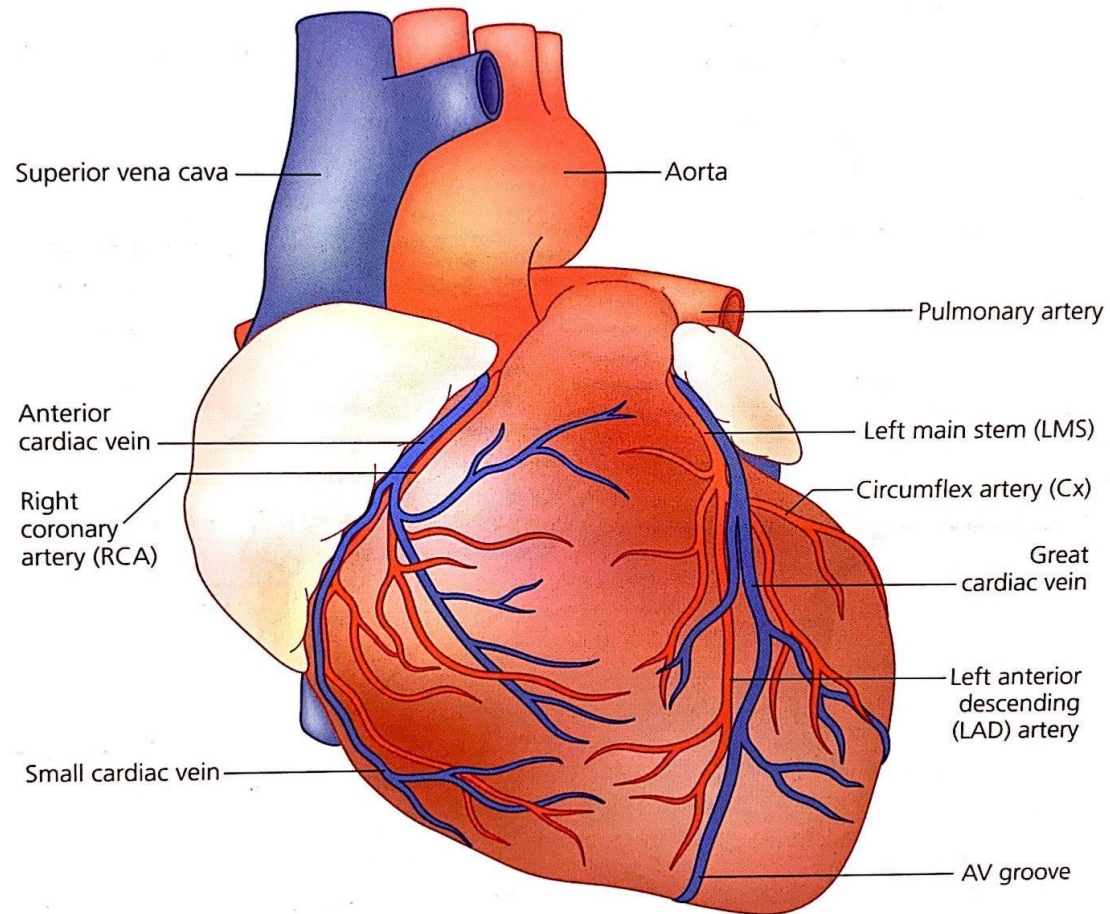
- ◆ Symptoms:
 1. Fatigue
 2. Anorexia, nausea & abd. distension
 3. Epigastric pain from liver congestion
- ◆ Signs:
 1. Edema
 2. Congested neck veins
 3. Enlarged tender liver
 4. Ascites
 5. Pleural effusion/pericardial
 6. T.R. (functional)
 7. Cold extremities

Palpitations

- ◆ Awareness of the heart beats could be due to change in :
 - Rate
 - Rhythm
 - Contractility

Symptoms due to low cardiac output

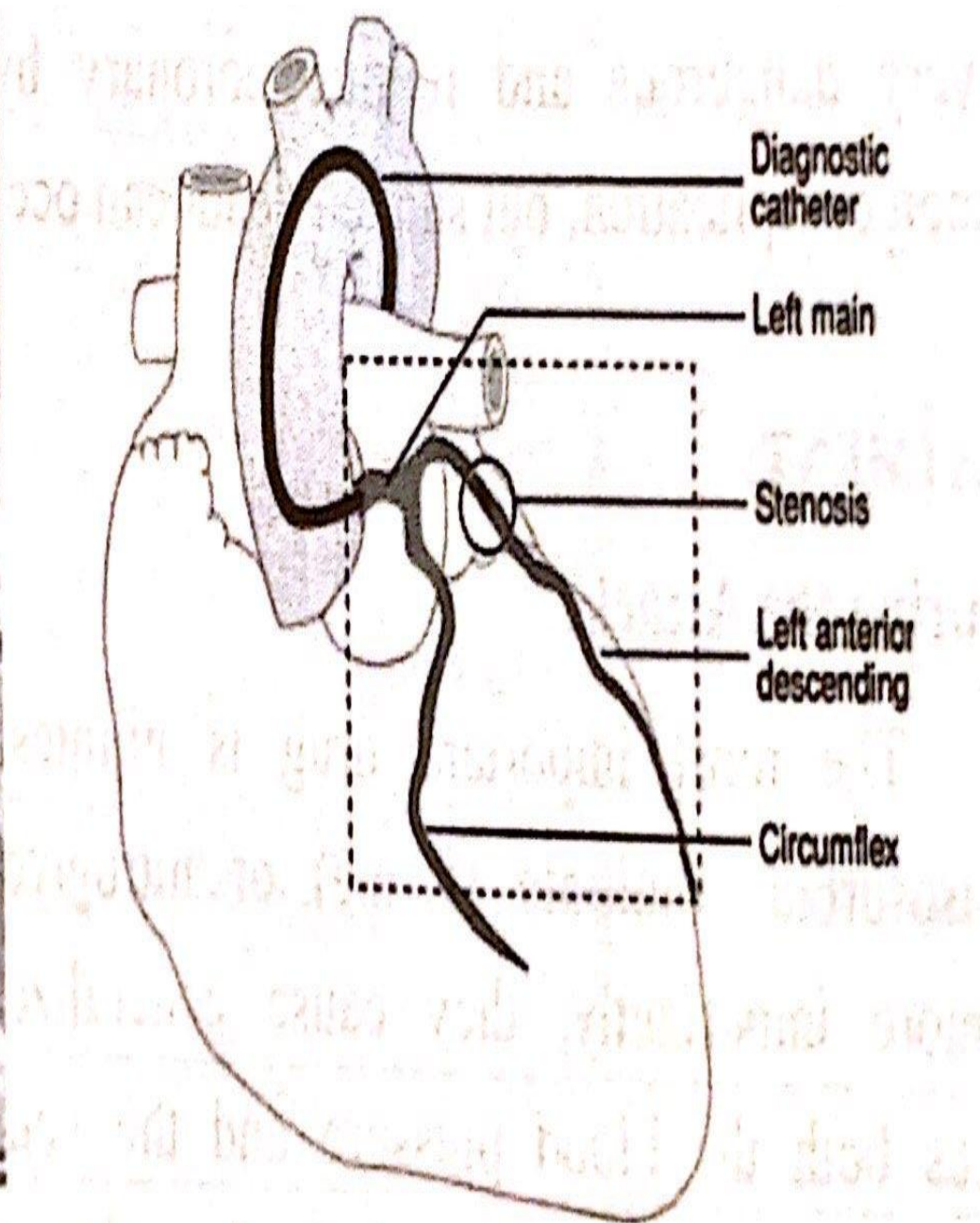
- Blurring of vision
- Dizziness
- Headache
- Oliguria
- Easy fatiguability
- Angina pectoris



Vascular anatomy.


Clinical syndromes of ischemic heart diseases

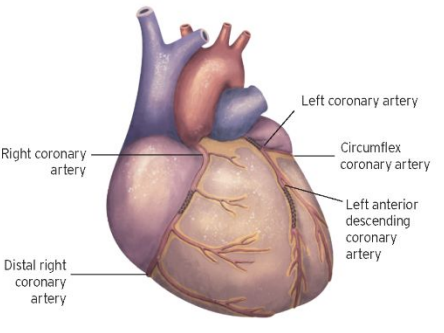
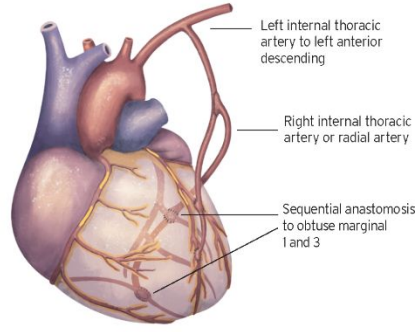
Clinical Presentation	Mechanism
1. Chronic stable angina pectoris	Transient myocardial ischemia during exercise.
2. Acute coronary syndromes: a) S-T elevation acute myocardial infarction.	Atherosclerotic plaque disruption resulting in a total arterial occlusion with myocardial tissue necrosis.
b) Unstable angina and non S-T elevation acute myocardial infarction.	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	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



Ischemic Heart Disease

Indications of surgery:

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

<p style="text-align: center;">PCI</p> 	<p style="text-align: center;">CABG</p> 
<p style="text-align: center;">FAVOURS PCI</p> <p>Clinical characteristics</p> <ul style="list-style-type: none"> Presence of severe co-morbidity (not adequately reflected by scores) Advanced age/frailty/reduced life expectancy Restricted mobility and conditions that affect the rehabilitation process <p>Anatomical and technical aspects</p> <ul style="list-style-type: none"> MVD with SYNTAX score 0-22 Anatomy likely resulting in incomplete revascularization with CABG due to poor quality or missing conduits Severe chest deformation or scoliosis Sequelae of chest radiation Porcelain aorta* 	<p style="text-align: center;">FAVOURS CABG</p> <p>Clinical characteristics</p> <ul style="list-style-type: none"> Diabetes Reduced LV function (EF \leq35%) Contraindication to DAPT Recurrent diffuse in-stent restenosis <p>Anatomical and technical aspects</p> <ul style="list-style-type: none"> MVD with SYNTAX score \geq23 Anatomy likely resulting in incomplete revascularization with PCI Severely calcified coronary artery lesions limiting lesion expansion <p>Need for concomitant interventions</p> <ul style="list-style-type: none"> Ascending aortic pathology with indication for surgery Concomitant cardiac surgery

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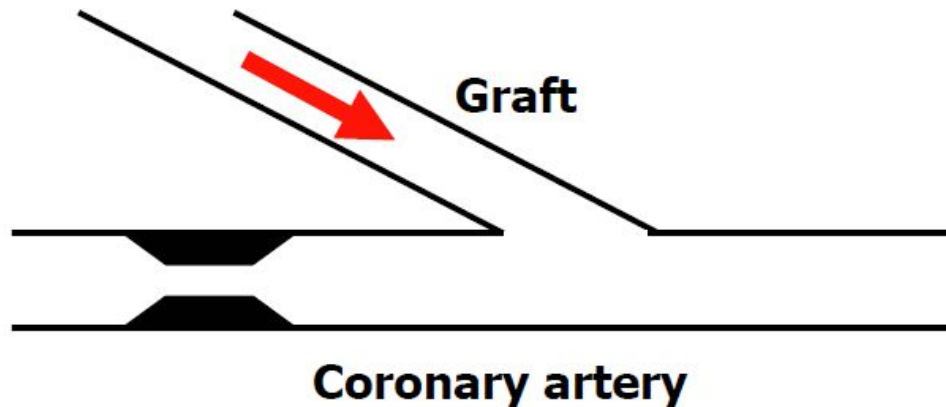
CABG = coronary artery bypass grafting; Cx = circumflex; DAPT = dual antiplatelet therapy; EF = ejection fraction; LAD = left anterior descending coronary artery; LIMA = left internal mammary artery; LV = left ventricular; MVD = multivessel coronary artery disease; PCI = percutaneous coronary intervention; PDA = posterior descending artery; RA = radial artery; RIMA = right internal mammary artery; SYNTAX = Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery.

*Consider no-touch off-pump CABG in case of porcelain aorta.

Surgery for Cardio-thoracic Diseases

What is a CABG ?

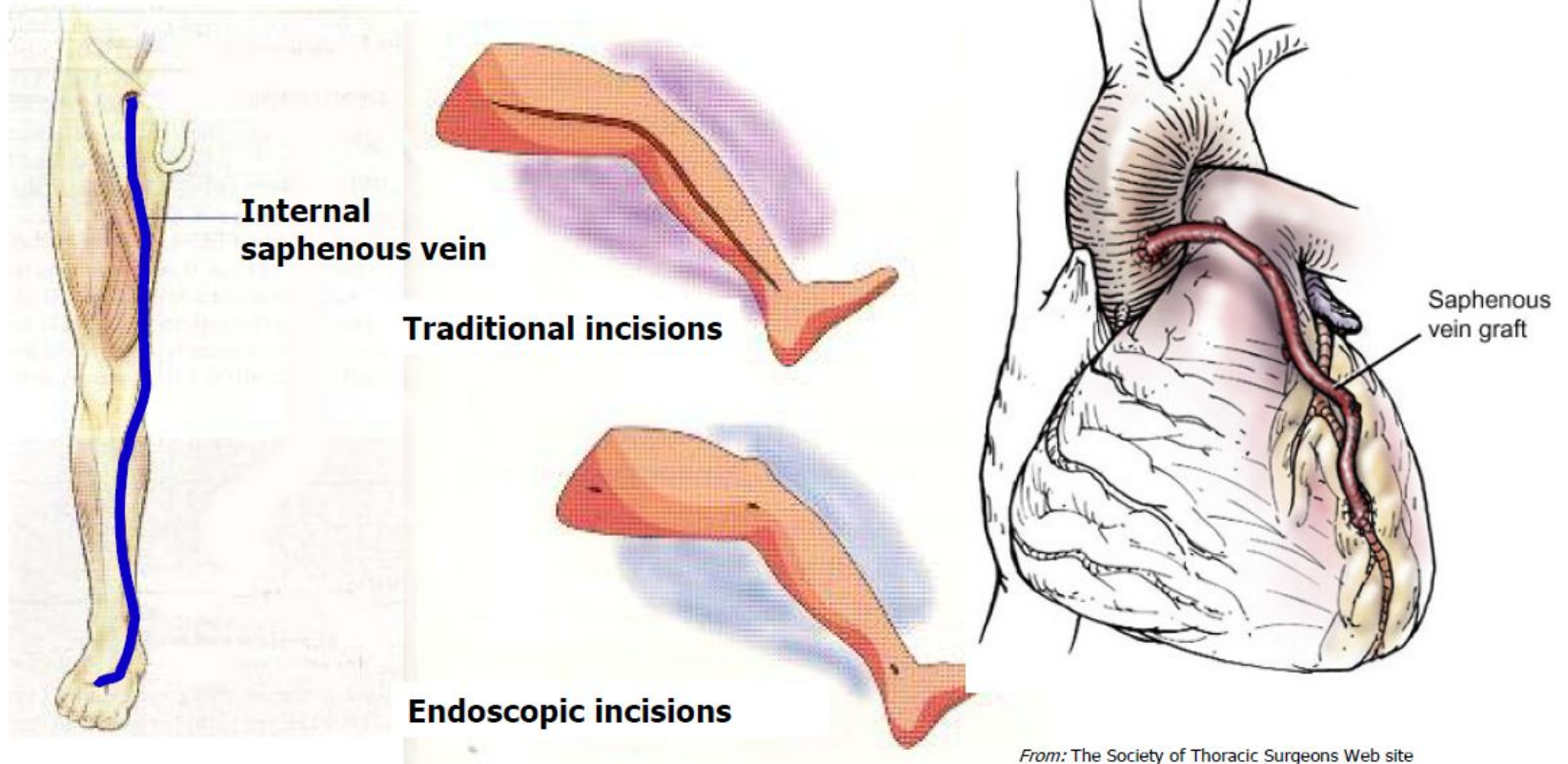
- A vascular graft is sutured to the coronary artery beyond the stenosis



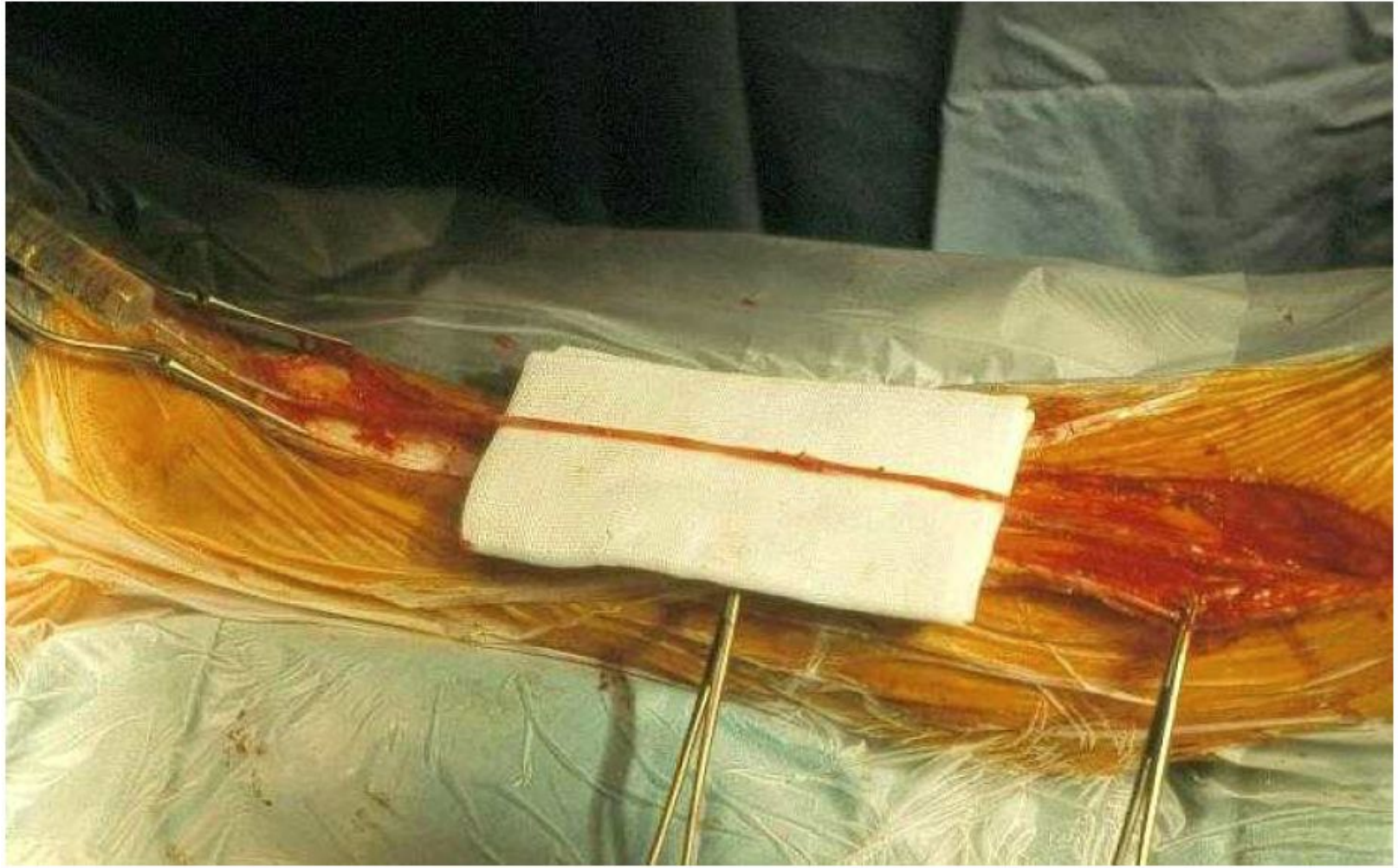
CABG: choice of conduits

- ◆ Coronary conduits:
 1. Arterial: Internal thoracic artery
 2. Venous : Long saphenous vein.

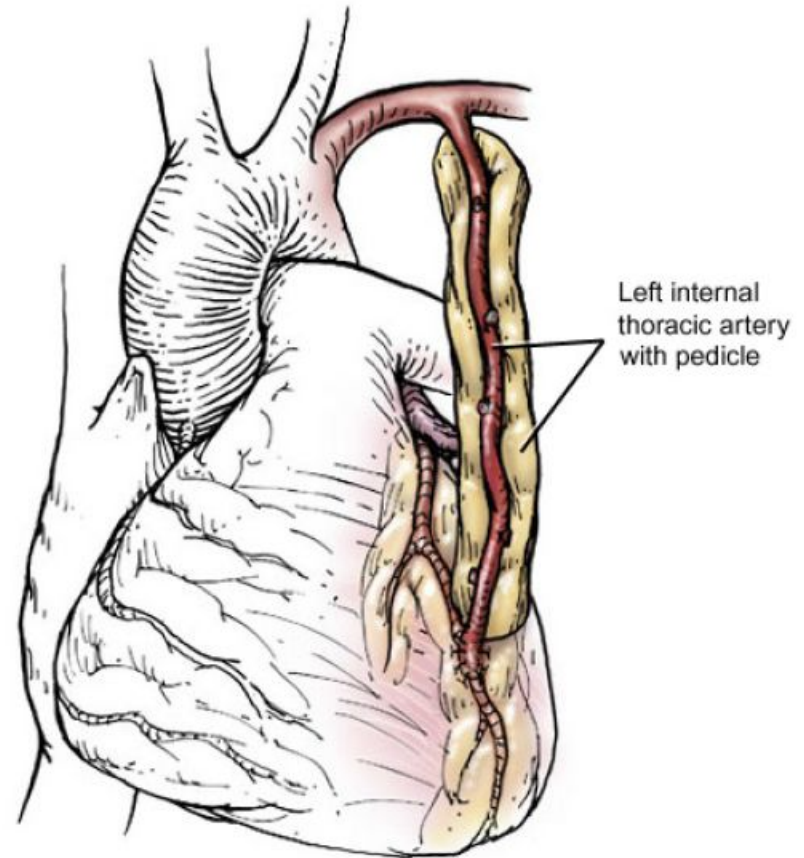
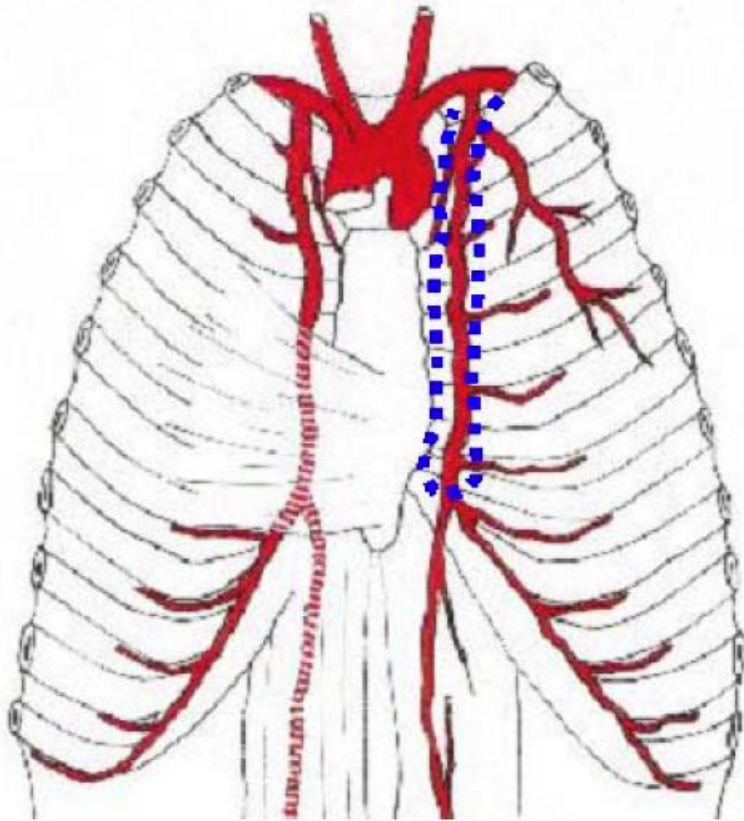
Saphenous vein graft

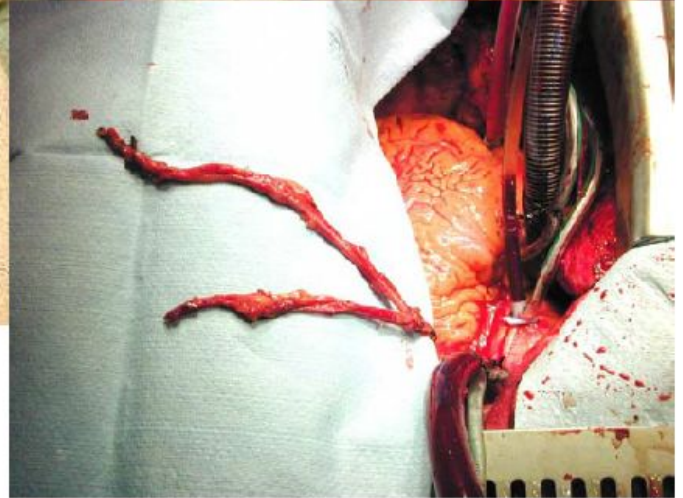
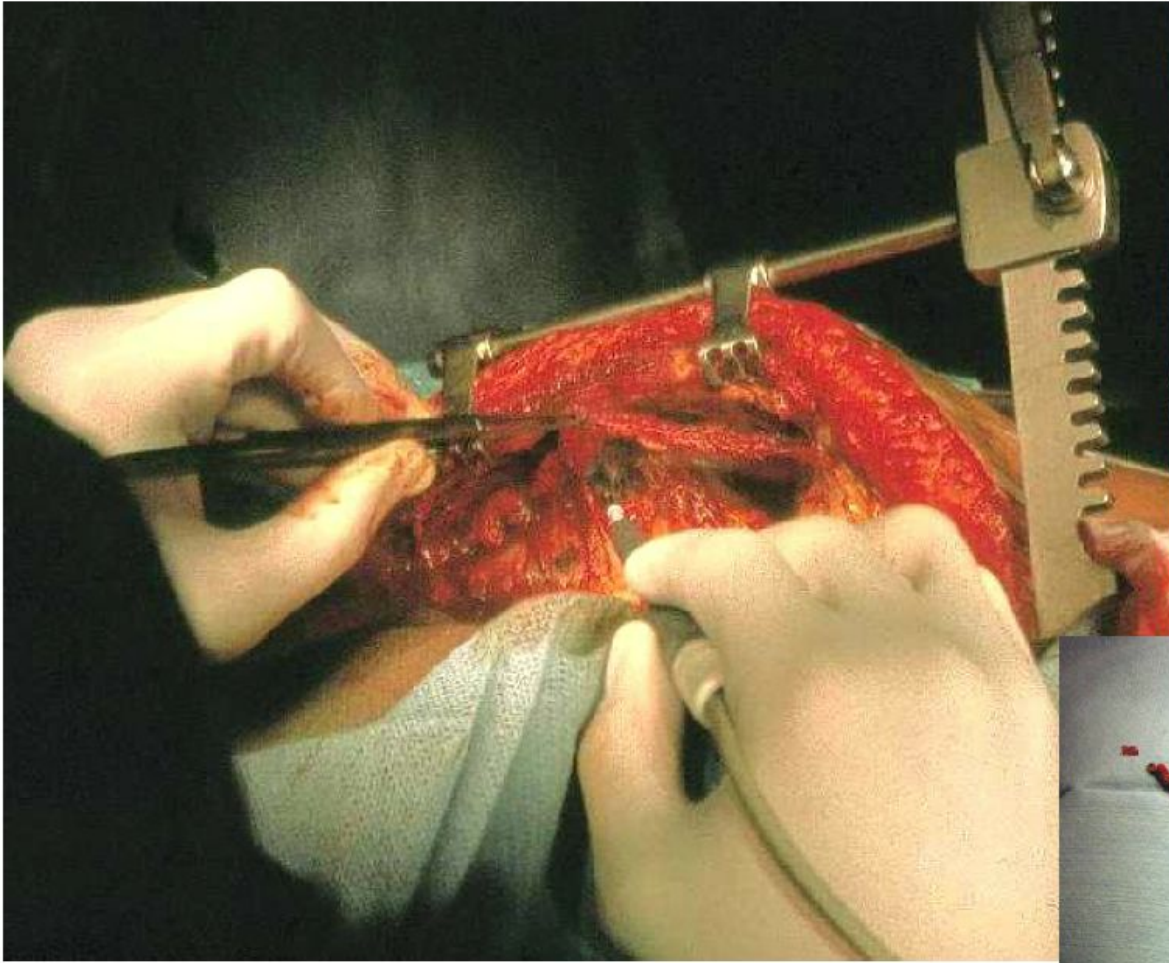


From: The Society of Thoracic Surgeons Web site
<http://www.sts.org>

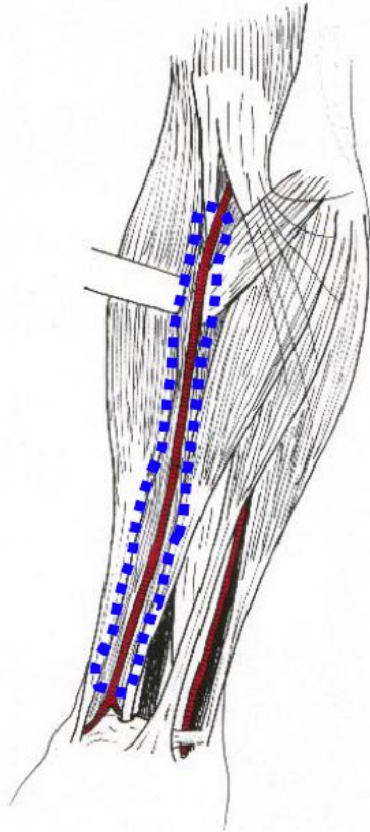


Internal thoracic artery graft

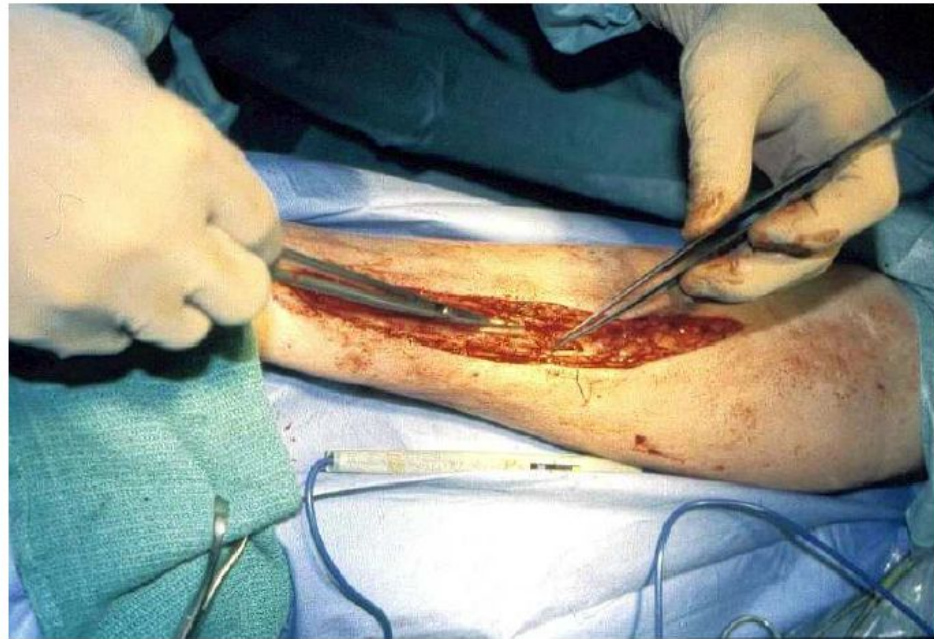




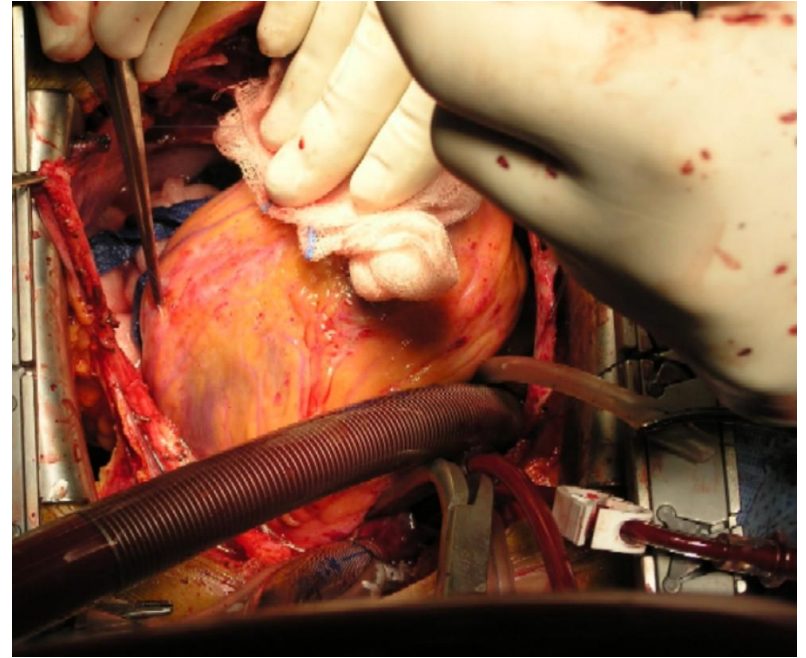
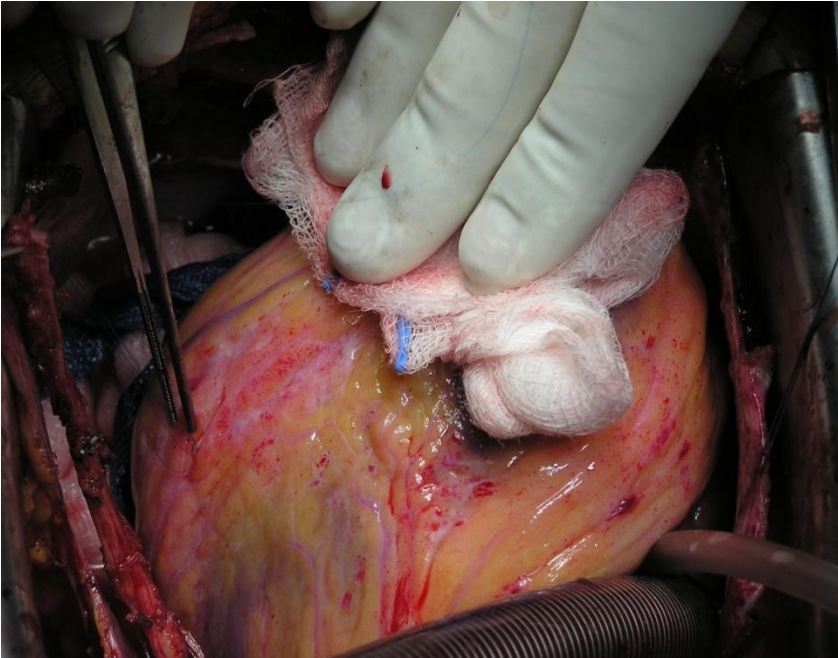
Other arterial grafts



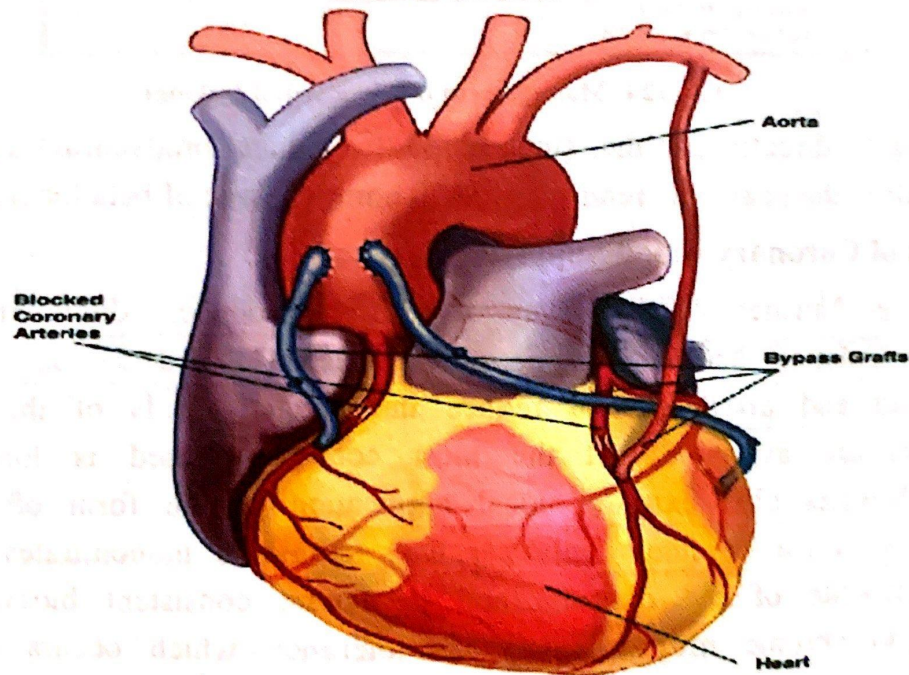
Radial artery



Coronary Artery Bypass Grafting



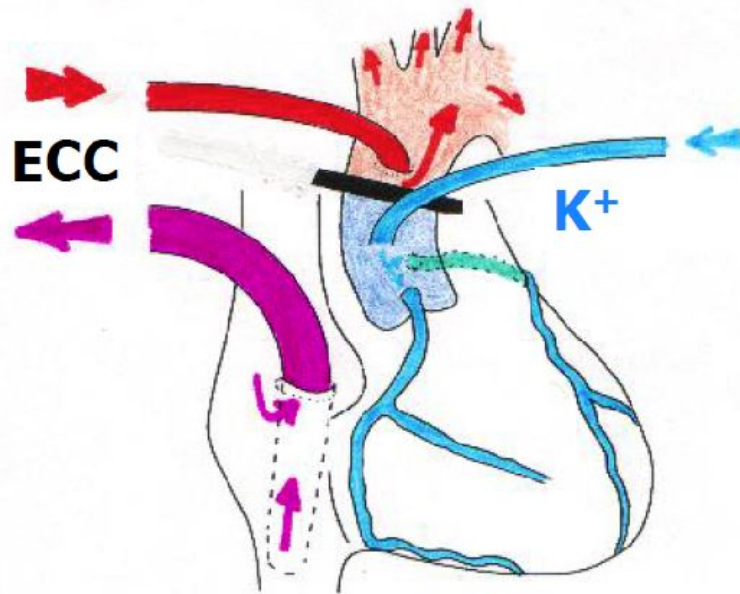
Arterial conduit vs Venous conduit



CABG

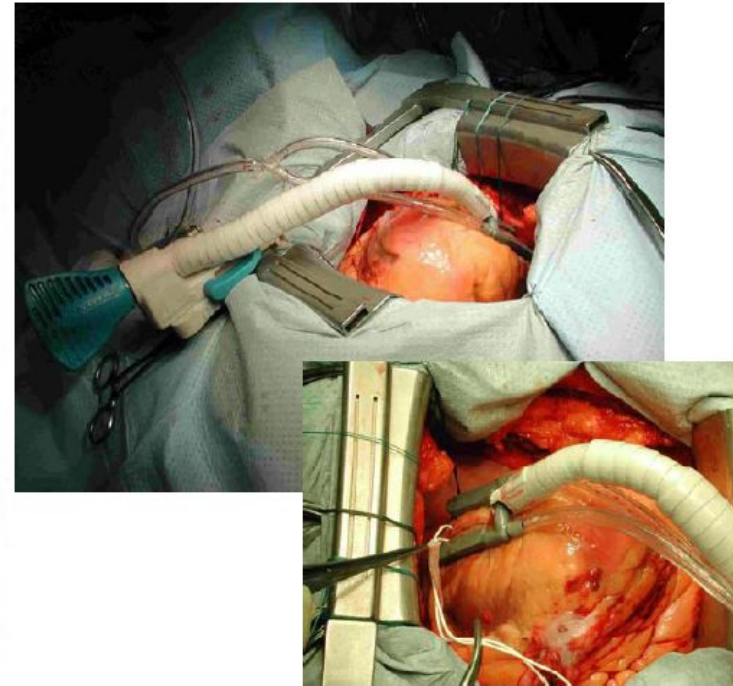
- ◆ Types of surgery:
 1. Conventional: using the heart lung machine, and cardioplegic arrest
 2. Off-pump (beating heart surgery)

CABG – Operative technique



**Under ECC with
cardioplegia**

Video



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

Video

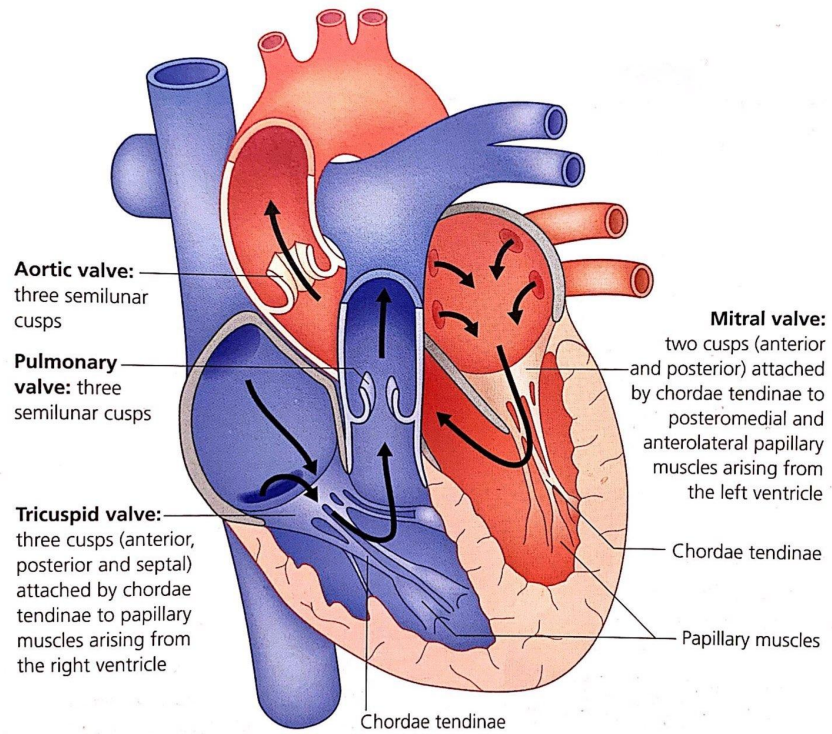


Figure E Valve anatomy.

Valvular Heart Diseases

1. Mitral stenosis:

Etiology: Rheumatic, Congenital, L.A. Myxoma

- 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. Symptoms of pulmonary congestion
3. Palpitations
4. Dysphagia, compression of left main bronchus
5. Symptoms of low C.O.P.

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 commissurotomy.
3. Closed mitral commissurotomy
4. Open mitral commissurotomy
5. Mitral valve replacement

Mitral Stenosis

Indications for surgery:

Mitral valve surgery for mitral stenosis is recommended for symptomatic severe M.S. when the valve is not favorable for Percutaneous balloon commissurotomy (presence of L.A. clot, significant mitral regurge).

Valvular Heart Diseases

2. 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.

Etiology:

1. Rheumatic, Degenerative, Endocarditis
2. Dilatation of the L.V. and mitral valve ring.
3. Dysfunction of the papillary muscle.
4. Congenital abnormalities
5. Calcification of the mitral valve annulus.

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 (low C.O.P)
4. Congestive heart failure (L.L. edema, congested neck veins, enlarged tender liver).

Mitral Regurgitation

Signs of mitral regurgitation:

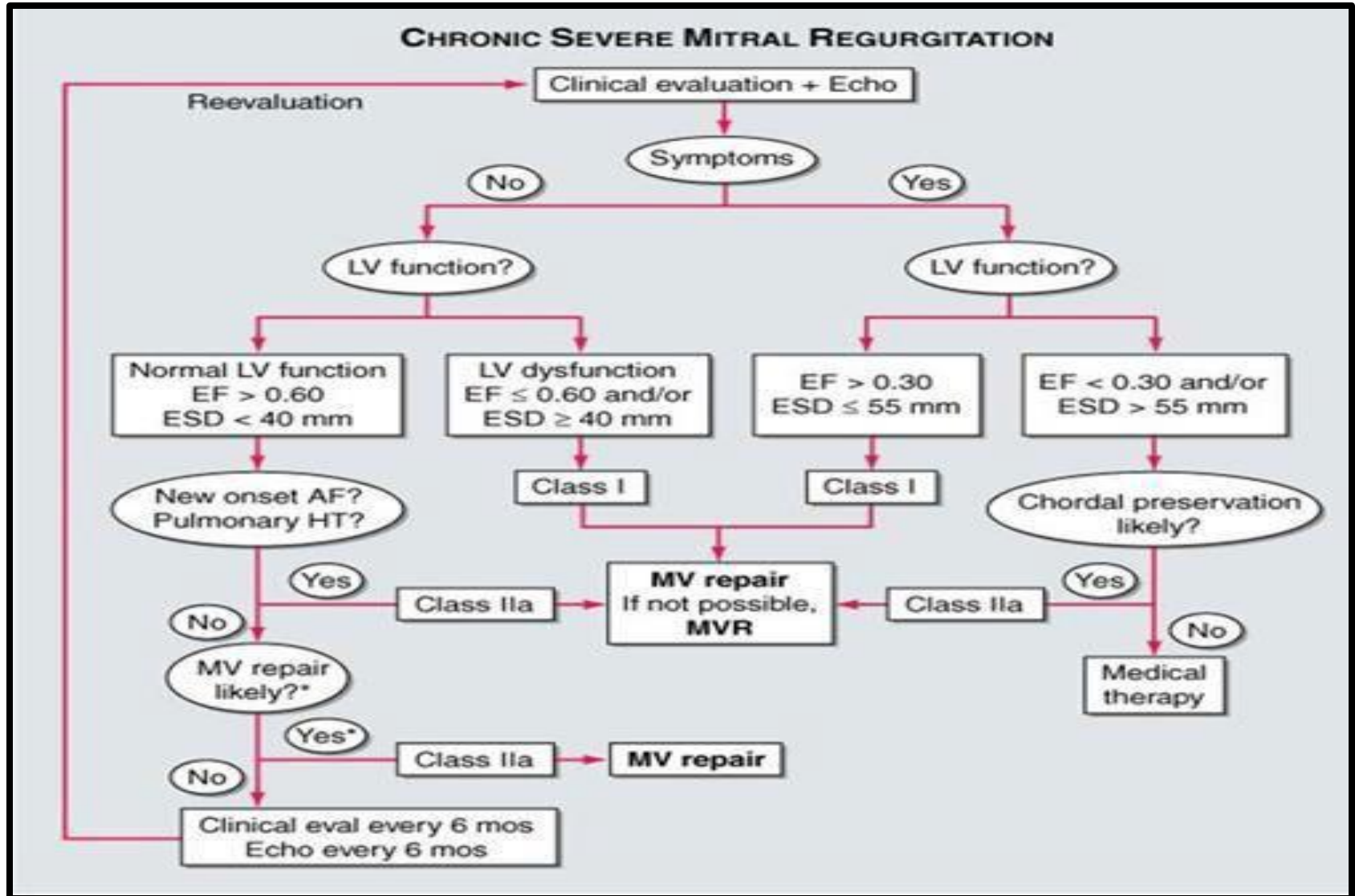
1. displaced apex beat
2. apical thrill
3. apical pan-systolic murmur
4. signs of pulmonary hypertension

Mitral Regurgitation

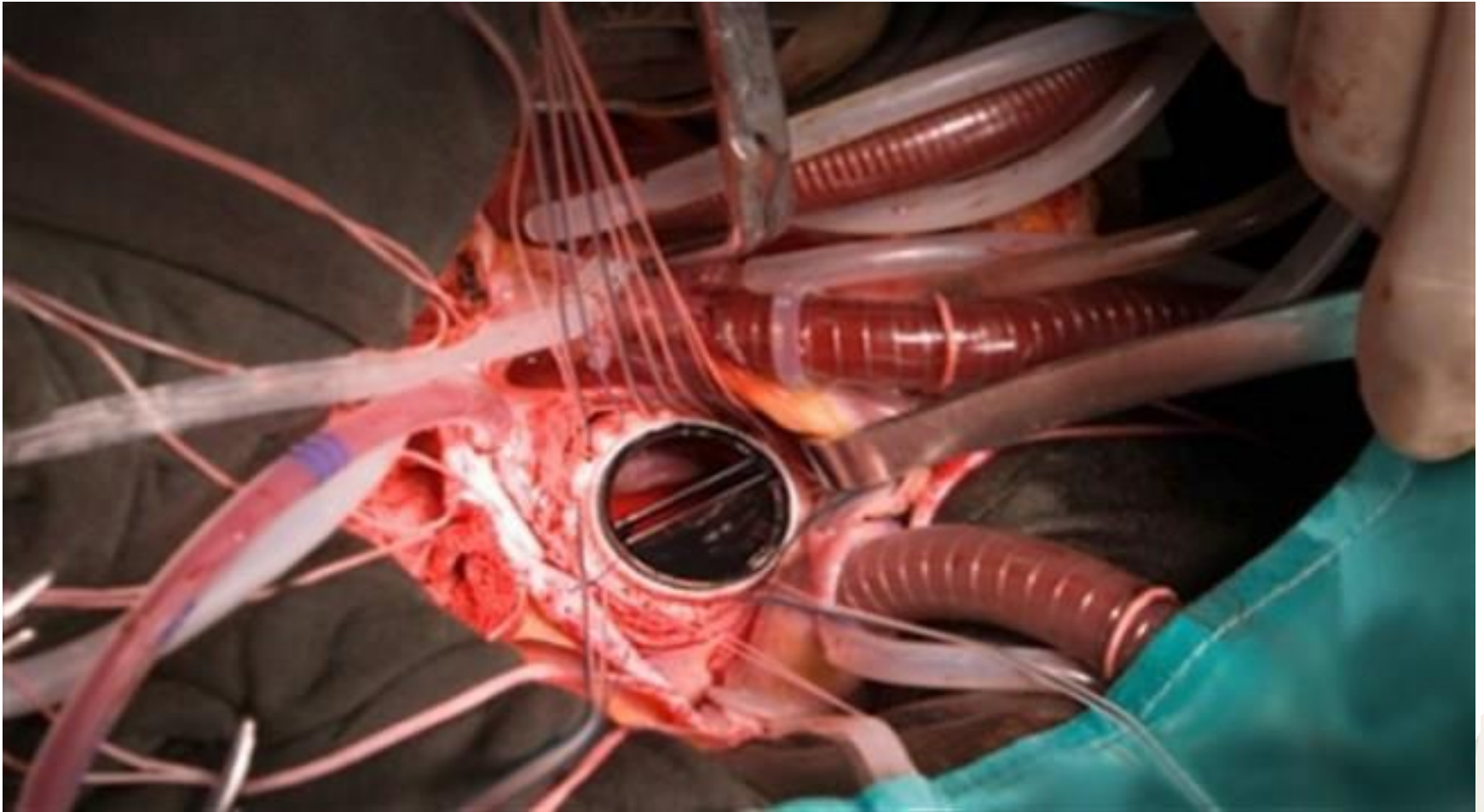
Indications for surgery:

1. Prompt mitral valve surgery is indicated for the symptomatic patient with acute severe primary MR.
2. In chronic mitral regurgitation, surgery is done for symptomatic or asymptomatic patients with evidence of LV dysfunction (E.F <60%, L.V.E.S.D. >40mm, new onset A.F., or pulmonary hypertension).
3. Asymptomatic patients with chronic severe MR and preserved LV (EF>60% and ESD <40mm) in experienced centers with likelihood of repair >90%.

Mitral Valve

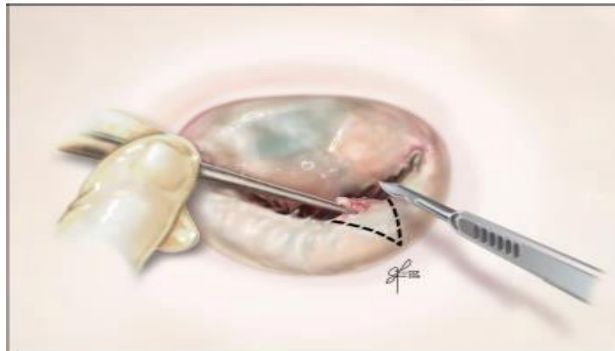
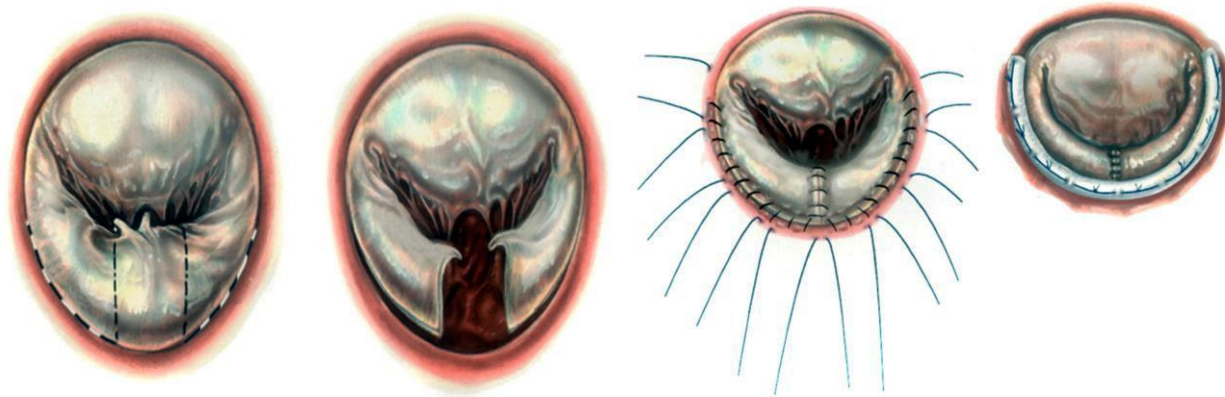


Mitral Valve Replacement



Surgery for Cardio-thoracic
Diseases

Mitral Valve Repair



Aortic stenosis

Etiology: Rheumatic, Congenital, Degenerative.

Symptoms:

1. Chest pain
2. Syncopal attacks
3. 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.

Aortic stenosis

Signs of aortic stenosis:

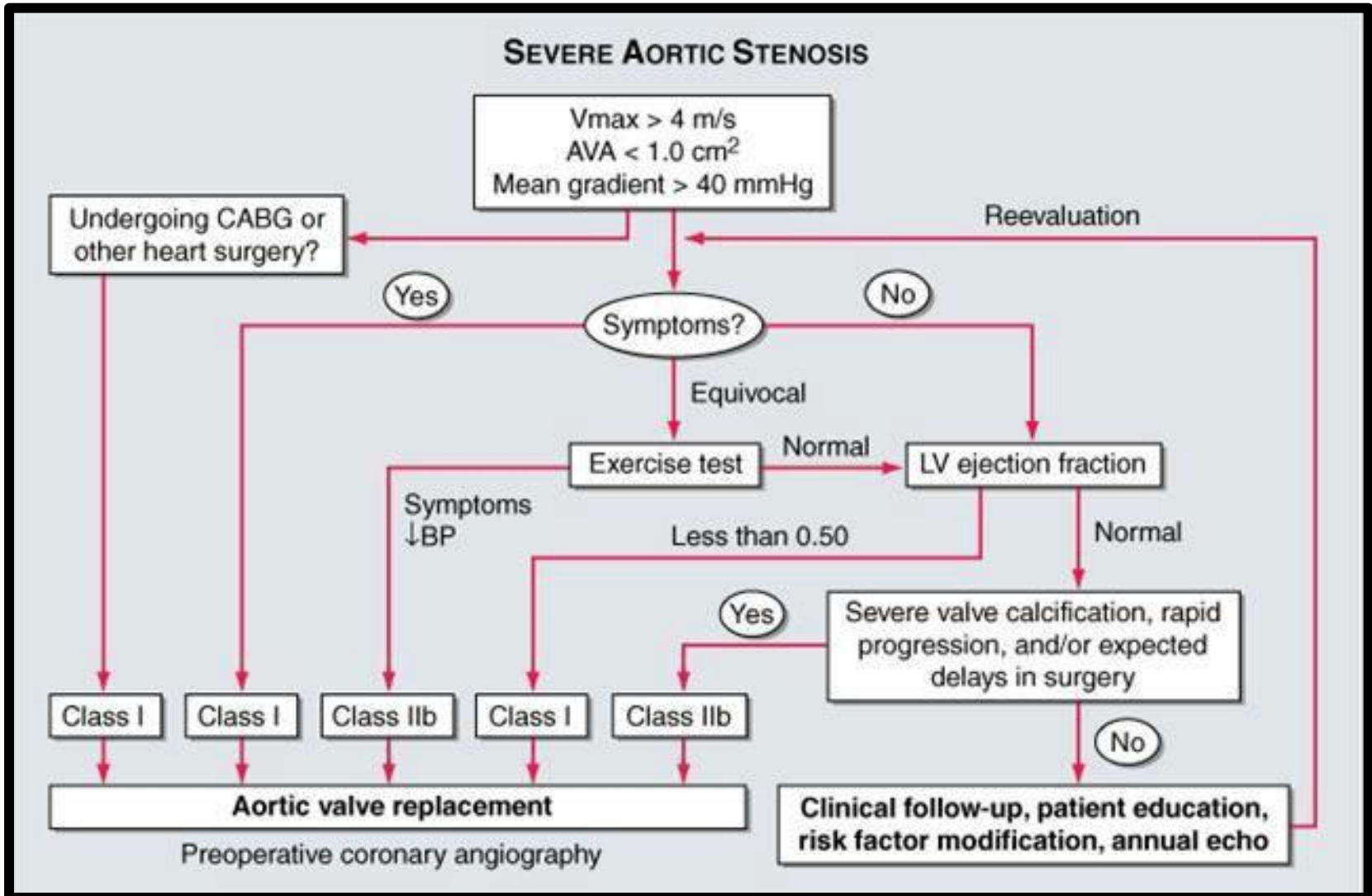
- ◆ 1. slow-rising pulse
- ◆ 2. small amplitude pulse
- ◆ 3. sustained apical pulse
- ◆ 4. harsh ejection systolic murmur.
- ◆ 5. aortic component of S2 is soft.

Aortic stenosis

Surgical indications for AVR include:

1. Patients with severe symptomatic AS
2. Asymptomatic patients with moderate or severe AS undergoing cardiac surgery for coronary or other valve disease.
3. Asymptomatic patients with severe AS and reduced EF.

Aortic Valve

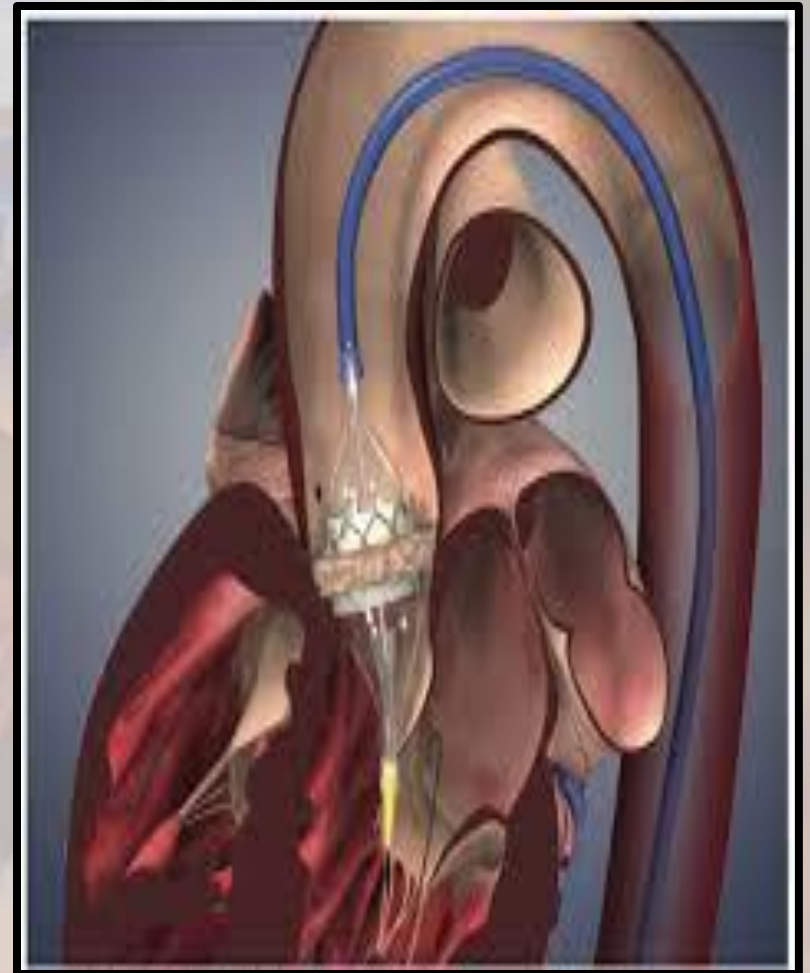
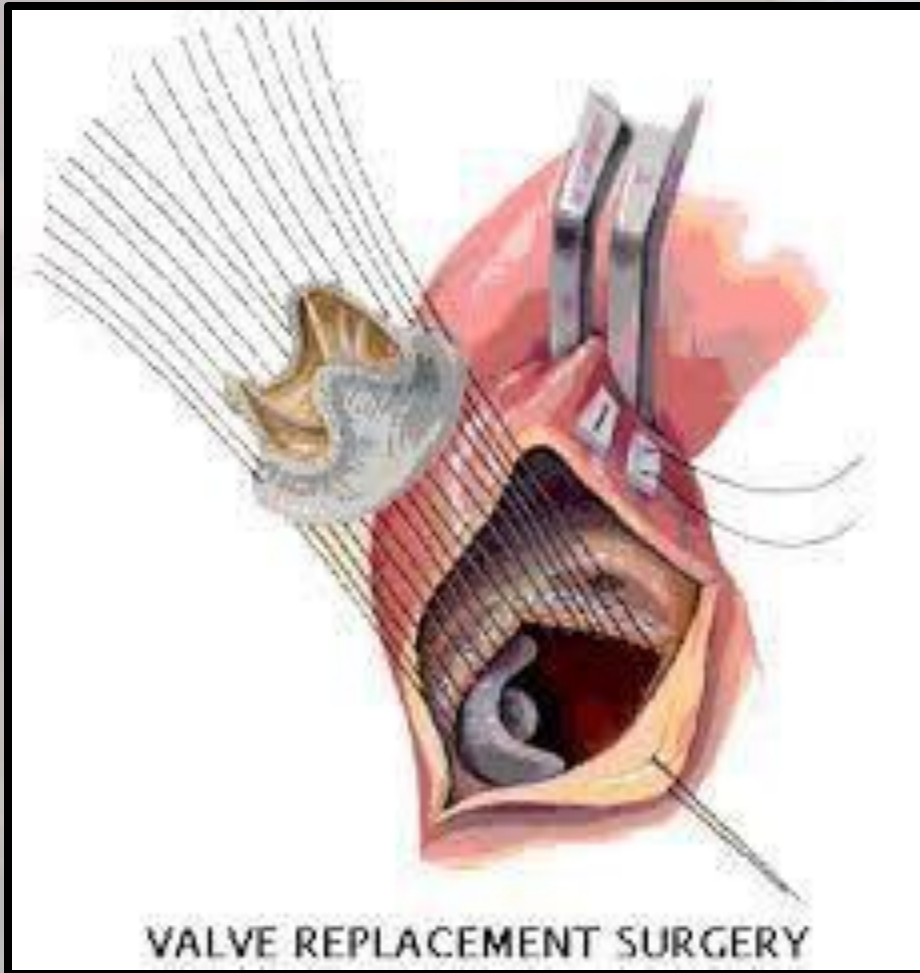


Aortic stenosis

Surgical treatment:

1. Surgical AVR
2. Trans-cutaneous aortic valve implantation (TAVI)
3. Percutaneous balloon valvuloplasty

Aortic Stenosis



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.
- Etiology: Rheumatic, Endocarditis, Connective tissue disorders, Aortic dissection or Aneurysm.
- AR can be acute or chronic.

Symptoms:

1. Asymptomatic
2. Palpitations due hyperdynamic L.V. contraction.
3. L.V. failure: dyspnea. Orthopnea, P.N.D
4. Angina in severe cases only

Aortic dissection should be suspected in any patient presenting with angina and recent onset aortic regurgitation .

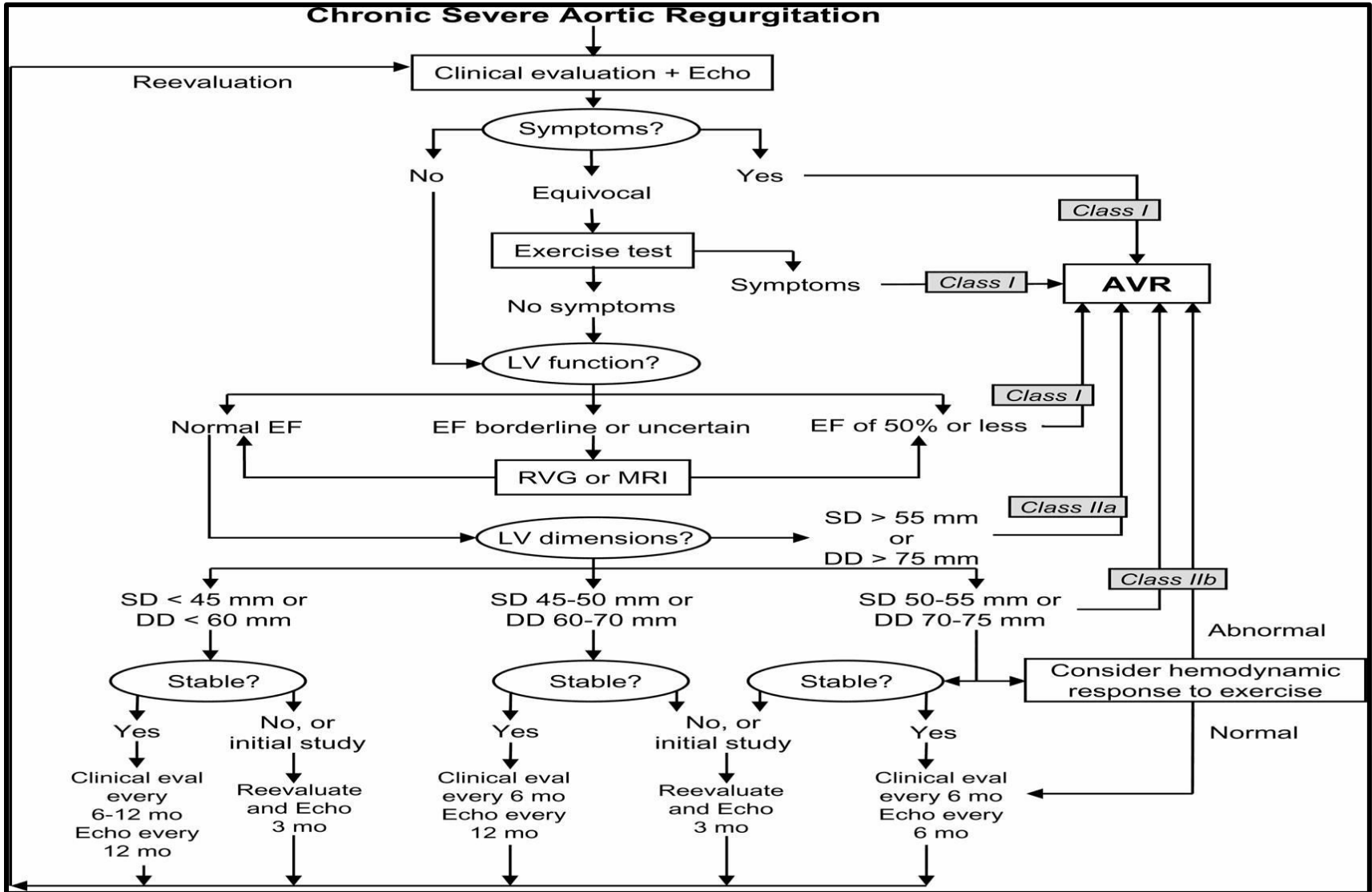
Signs:

1. Wide pulse pressure
2. Peripheral signs of aortic regurge
3. Generalized vasodilatation resulting in warm hands and feet, and increased sweating.
4. Hyperdynamic displaced apex
5. Early diastolic murmur

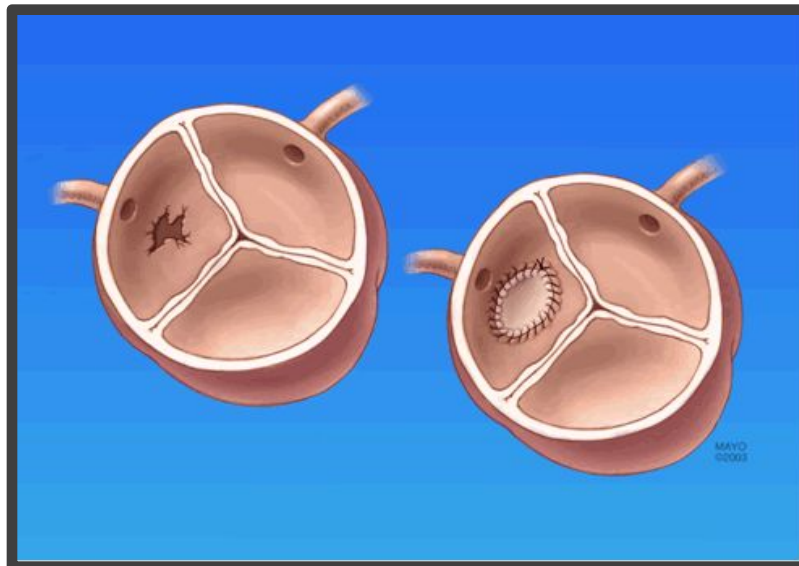
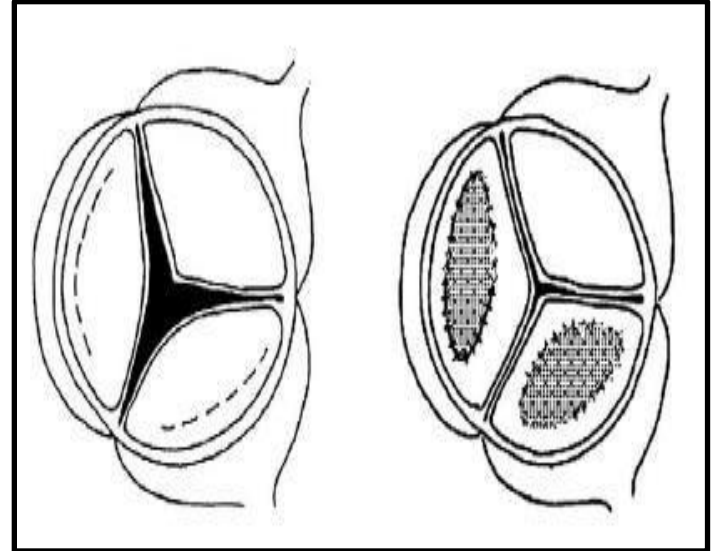
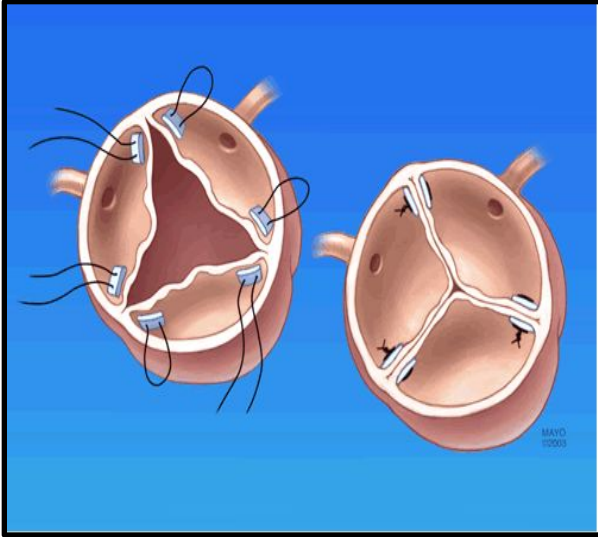
Aortic regurgitation

- ◆ 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.E.D.D $>70\text{mm}$ and E.S.D $> 50\text{mm}$)

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



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	

Valvular Prostheses

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

Infective 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.

Endocarditis

Modified Duke criteria

Major criteria:

1. **Microbiologic evidence**

a. Typical microorganisms consistent with IE from 2 separate blood cultures.

b. 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*

Endocarditis

2. Evidence of endocardial involvement:
 - a. Oscillating intracardiac mass
 - b. Abscess
 - c. New partial dehiscence of prosthetic valve
 - d. New valvular regurgitation.

A definitive clinical diagnosis can be made on the following:

2 major criteria, 1 major and 3 minor, or 5 minor criteria.

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.

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

- ◆ Involving the ascending aorta
- ◆ Are a medical emergency and require immediate surgery.
- ◆ Mortality rate up to 1-2% 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.

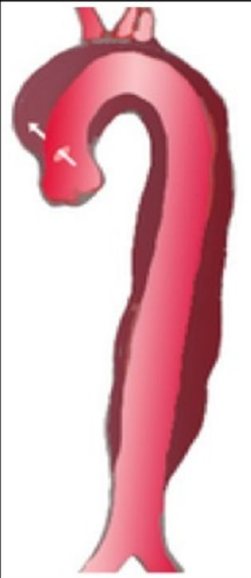

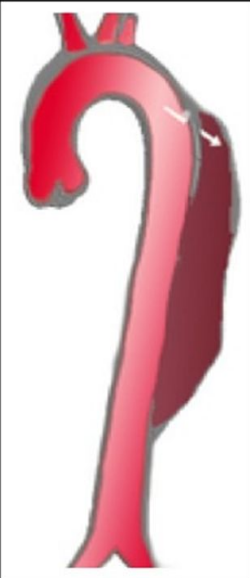
Daily (Stanford) classification system

Divided into 2 groups; A and B depending on whether the ascending aorta is involved.

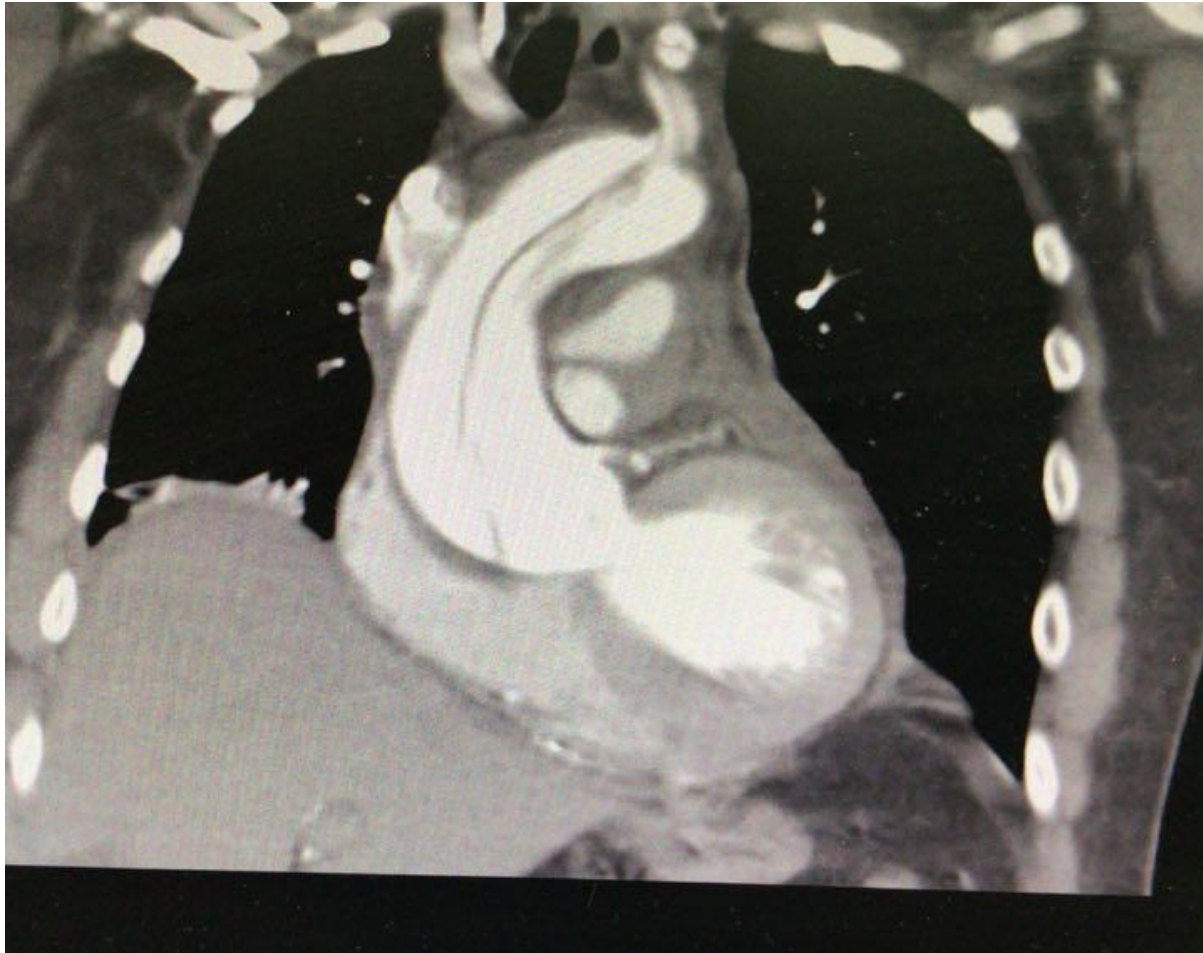
A = **Type I** and **II** DeBakey

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 Dissection



Surgery for Cardio-thoracic
Diseases

Aortic Aneurysm

When to Operate ?

> 6.0 cm

> 5.5 cm

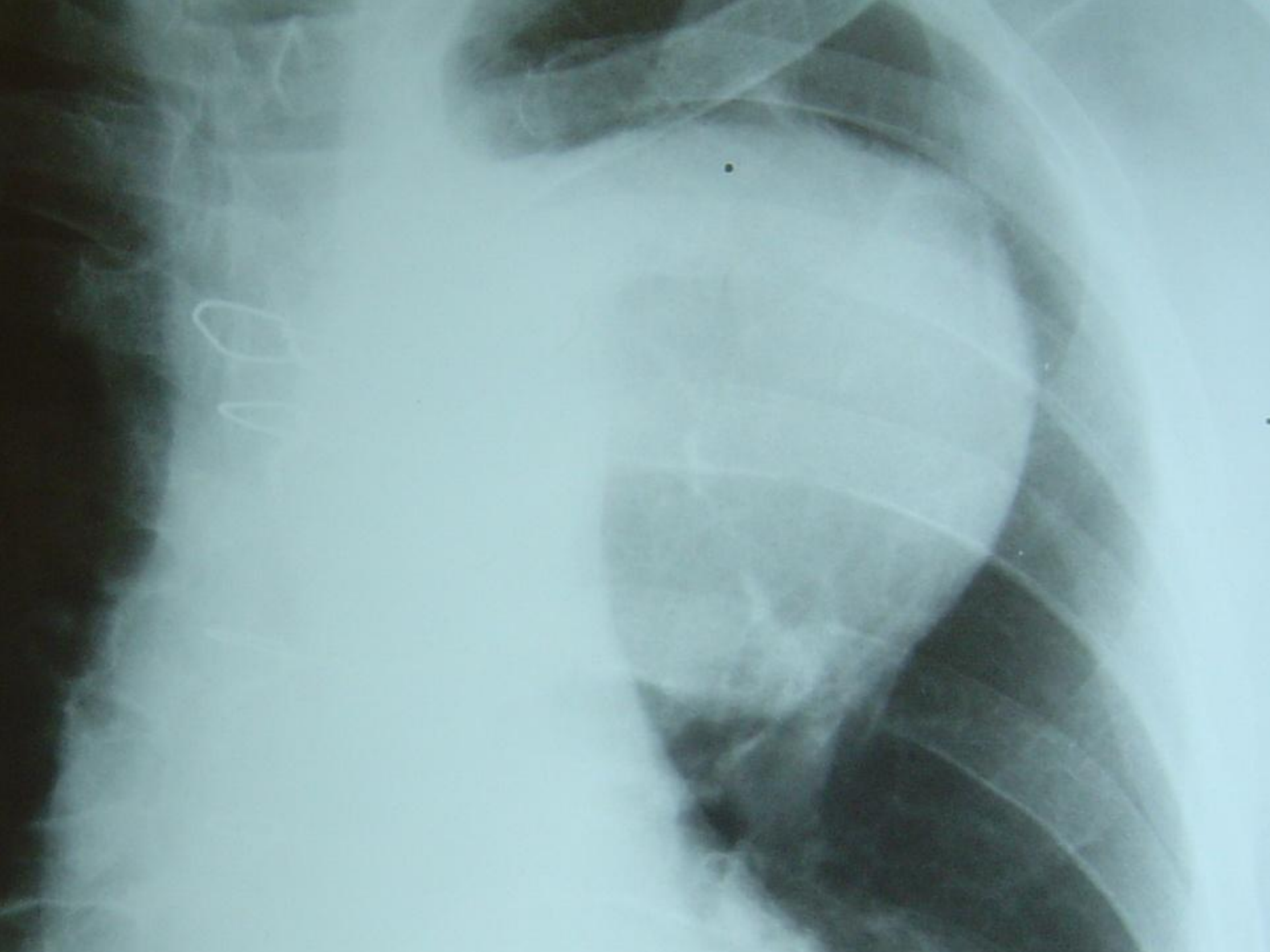


> 6.5 cm

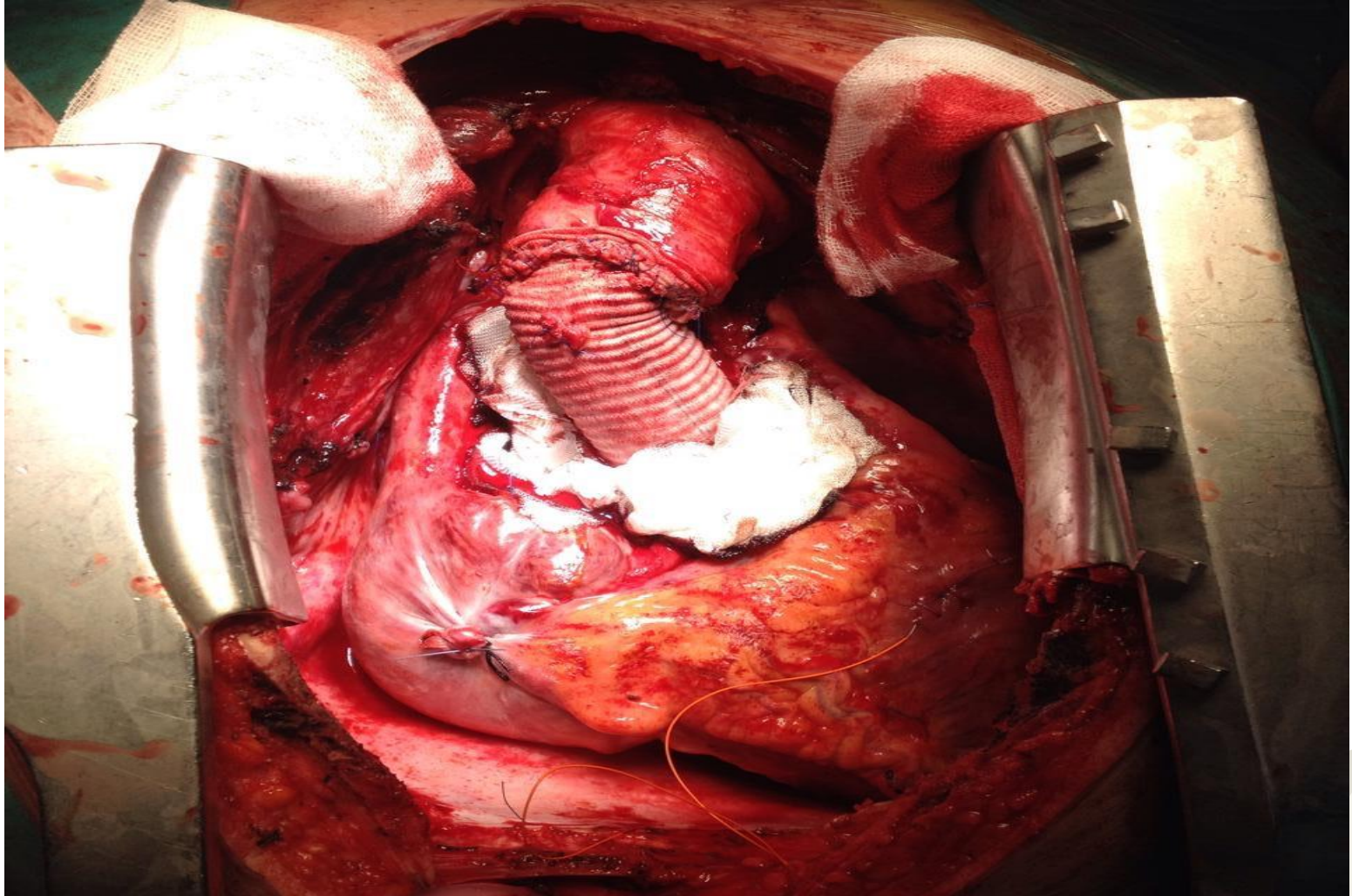
Aortic Aneurysm

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

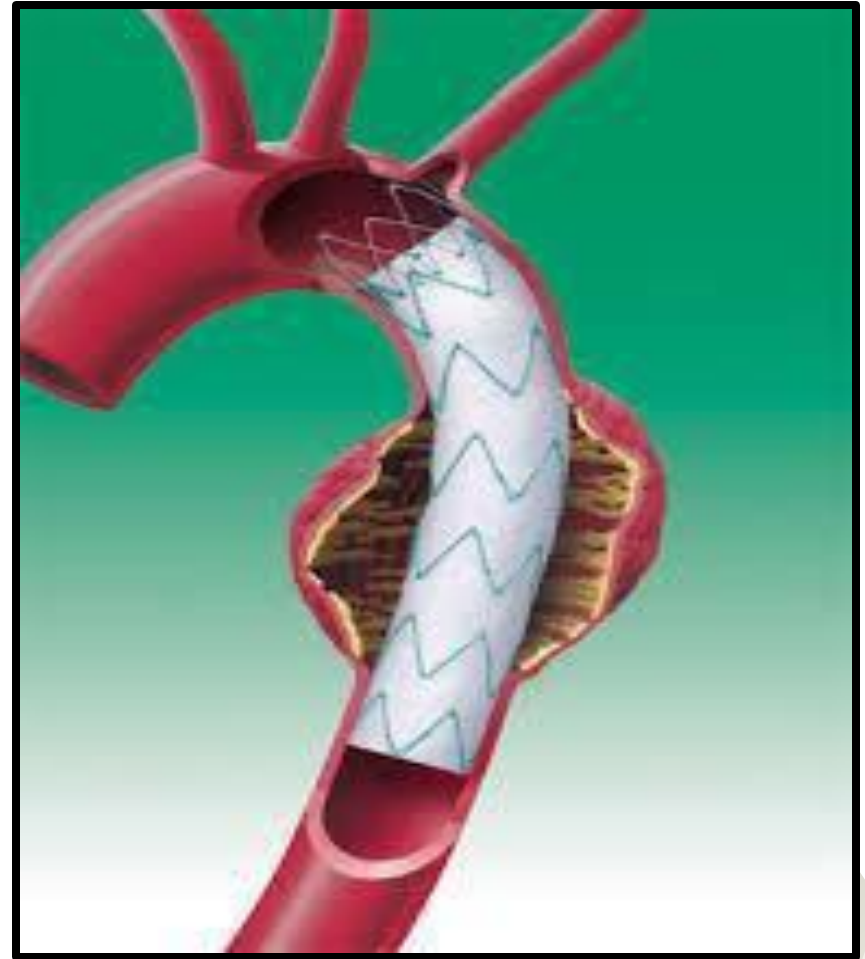
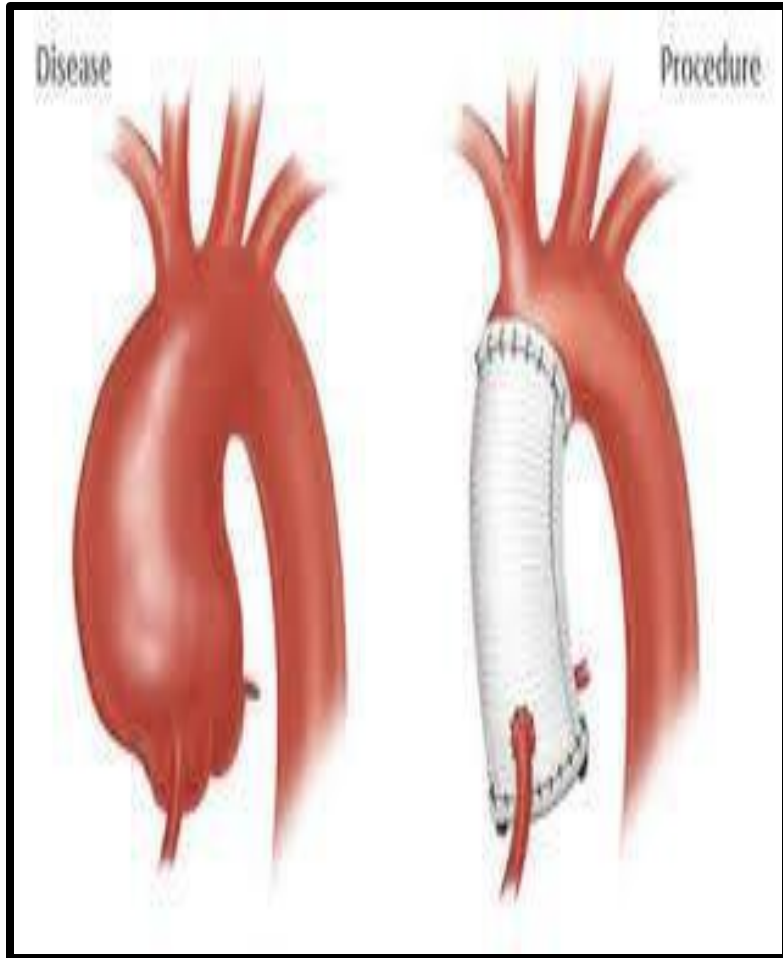


Handwritten markings on the X-ray, including a vertical line and two ovals, likely indicating anatomical landmarks or findings.



Diseases

Aortic Surgery



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

Cardiac Tumors

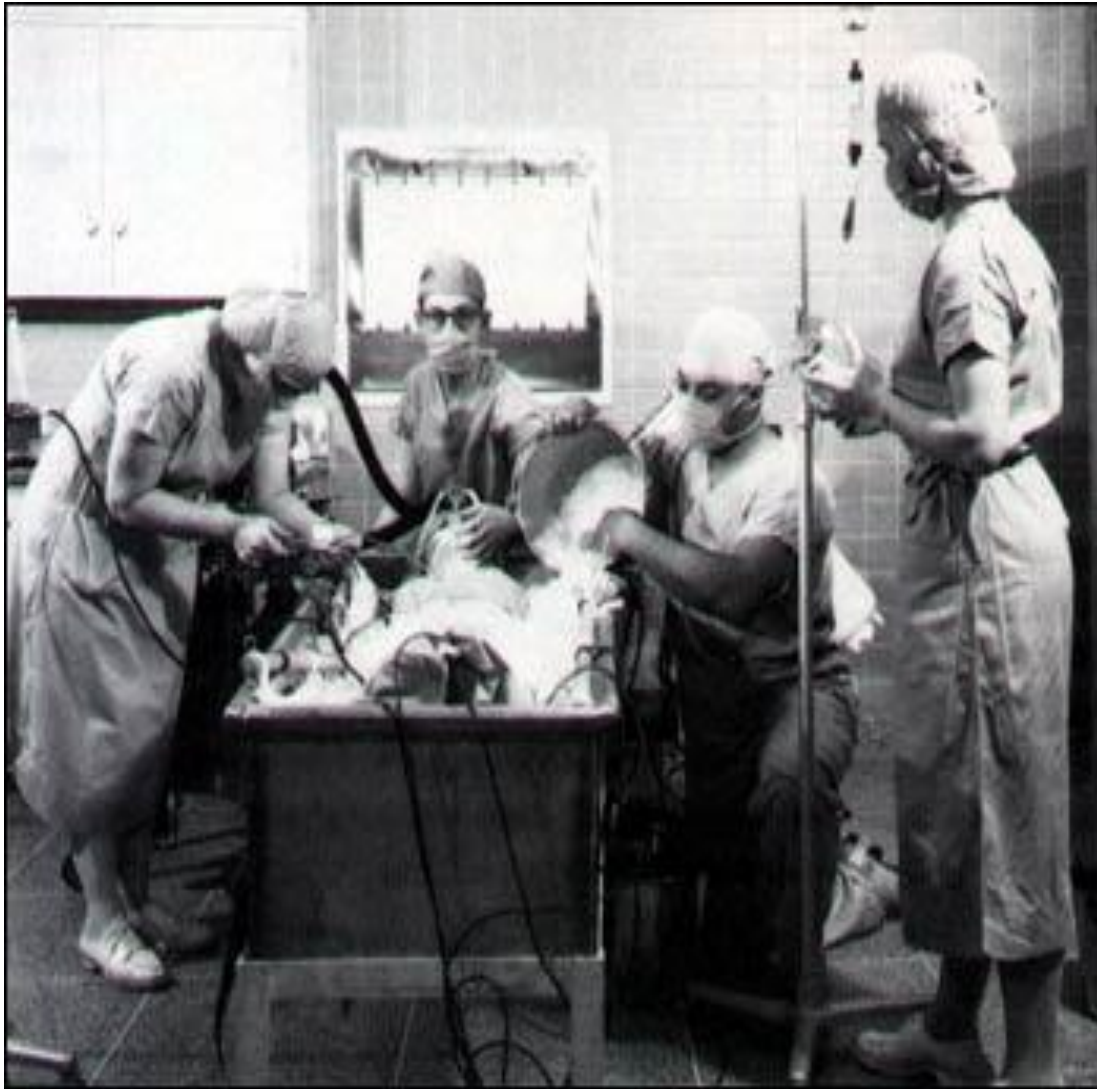
- ◆ The 2 most common manifestations of cardiac tumors are:
 1. Obstruction
 2. Embolization

Nonspecific symptoms as fever, fatigue, and myalgias can be associated with cardiac tumors.

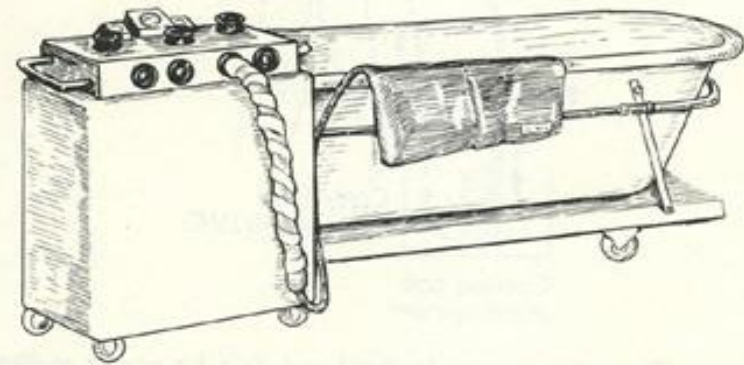
Echocardiography, CT, MRI can be used as diagnostic modalities.

Basic Principles of Cardiac Surgery

- ◆ Access
 - Full or Partial Sternotomy / Thoracotomy / Robotic or Endoscopic
- ◆ Bloodless Operative Field
 - Suction and re-transfusion / Snaring
- ◆ 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

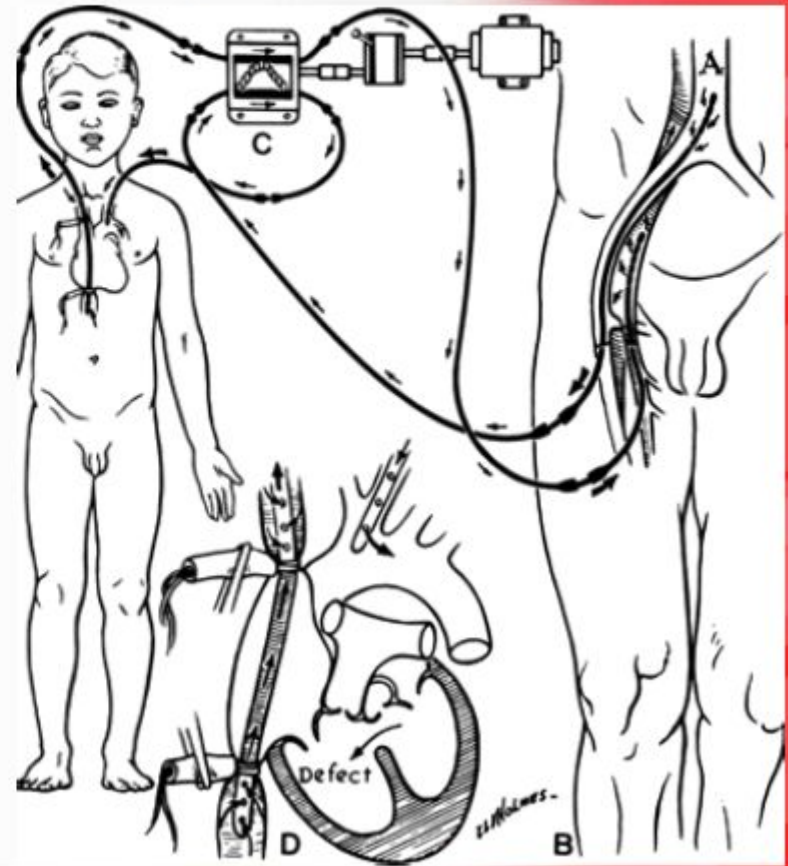


Surface Cooling Hypothermia
(28°C) for ASD Closure in
Children, 1952



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:

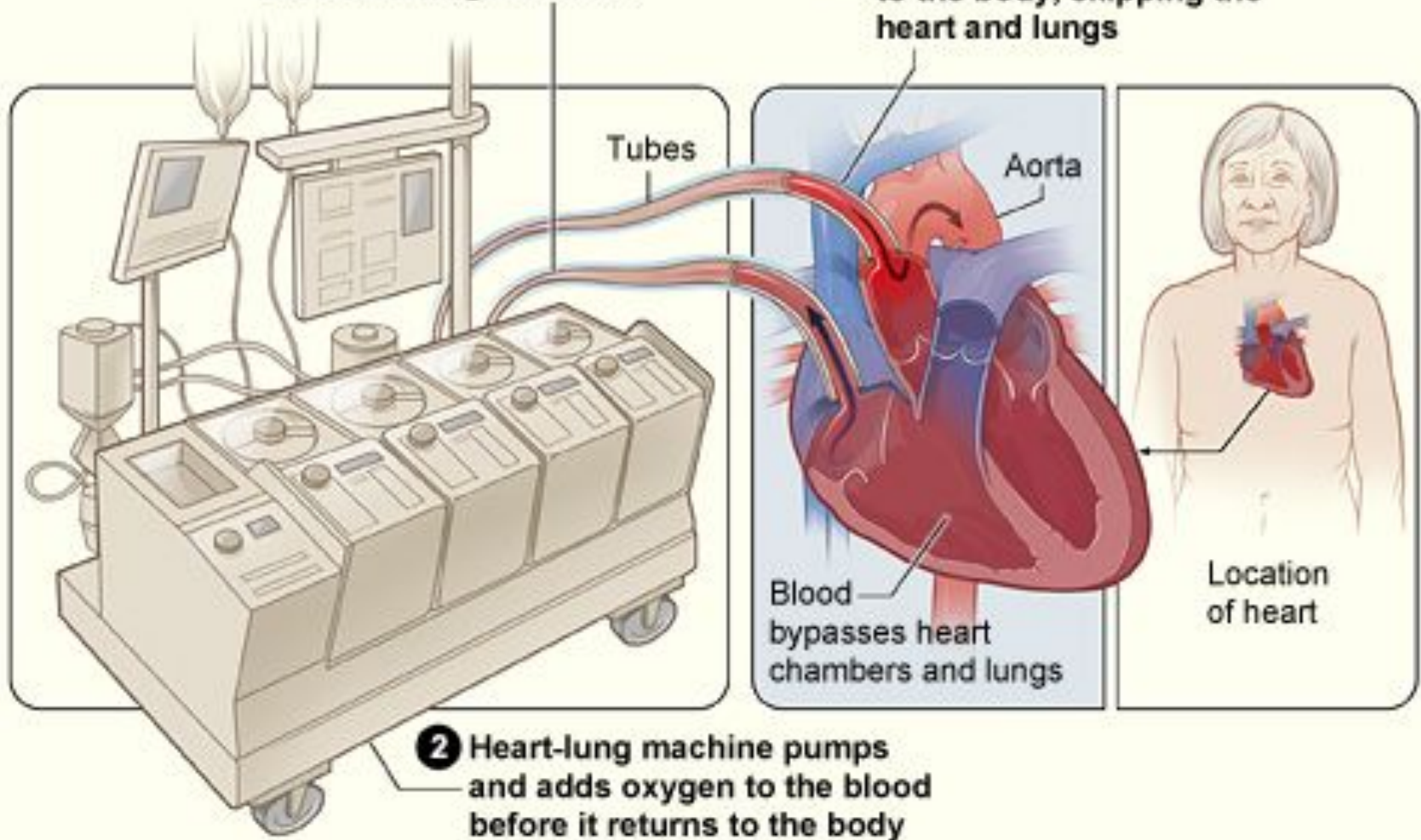
1. adequate gas exchange
2. systemic organ perfusion
3. controlling body temp.

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

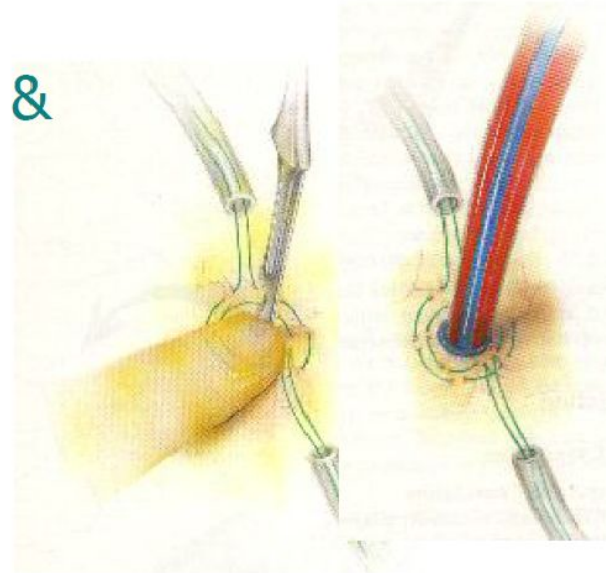
1 Oxygen-poor blood leaves the heart to enter the heart-lung machine

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**

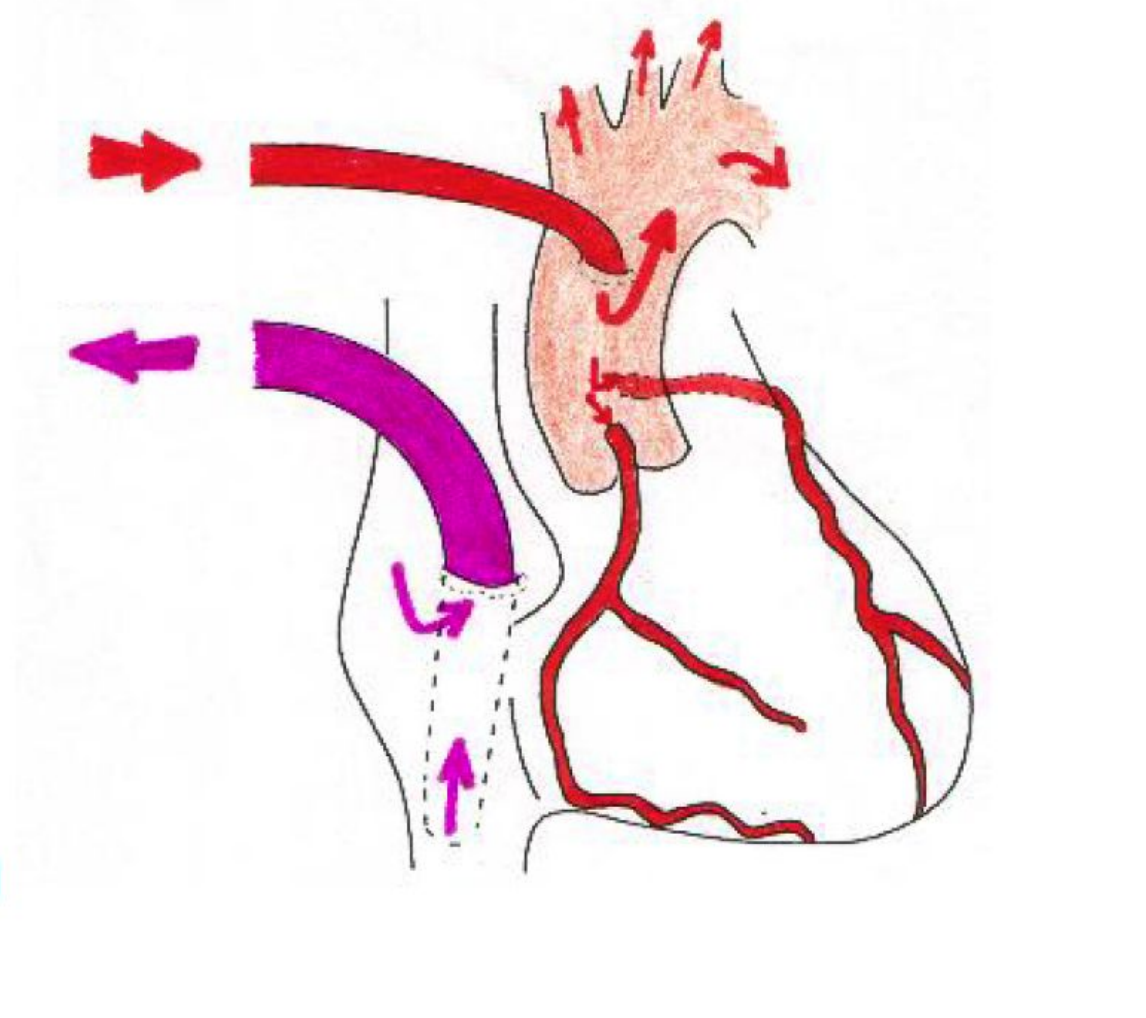


From : Manual of Cardiac Surgery, Harlan & Starr, Springer-Verlag, New York , 1995

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

Operation under ECC (2)

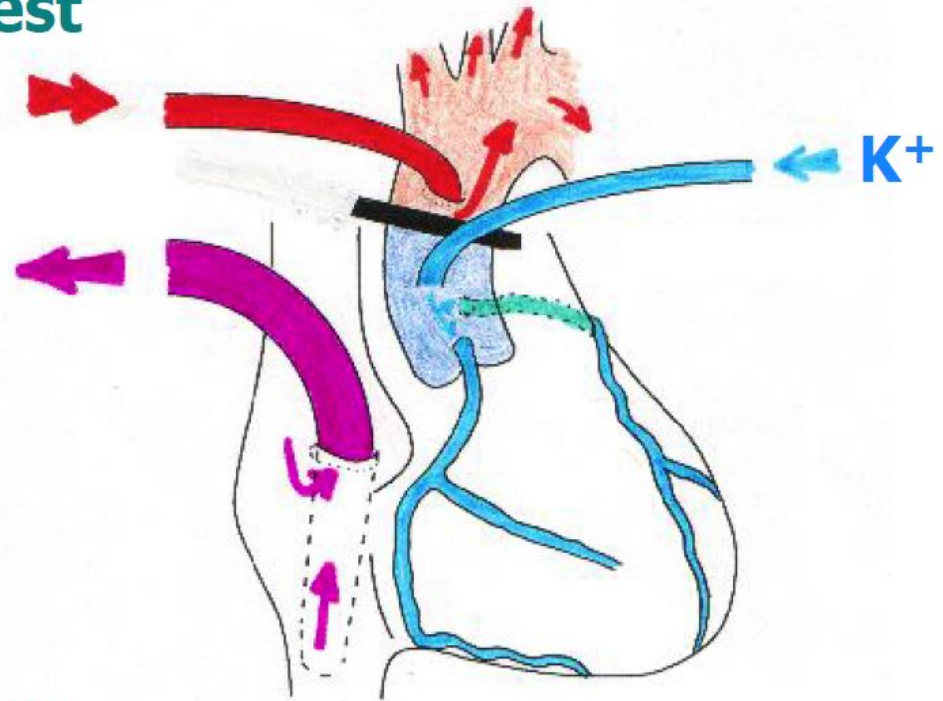
- Initiation of ECC



- Cooling

Operation under ECC (3)

- Cardioplegic arrest



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

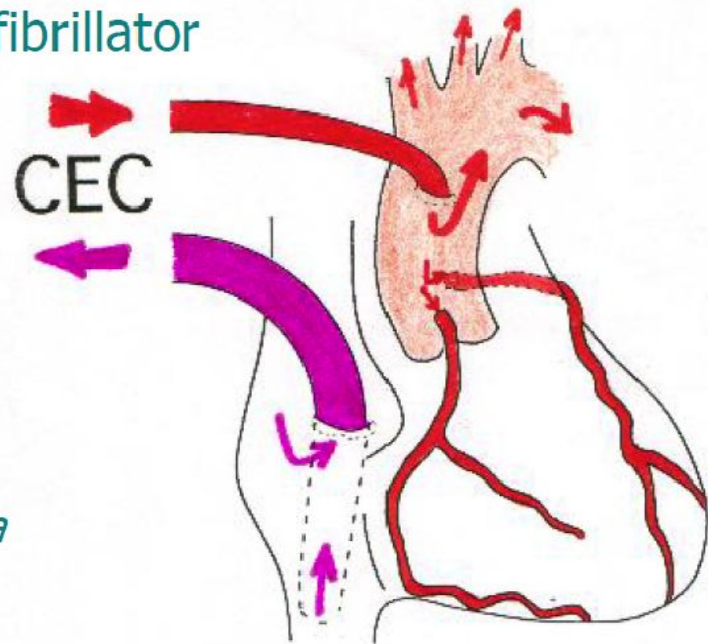
Operation under ECC (4)

- **Release of the aortic clamp**

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

Sinusal rythm

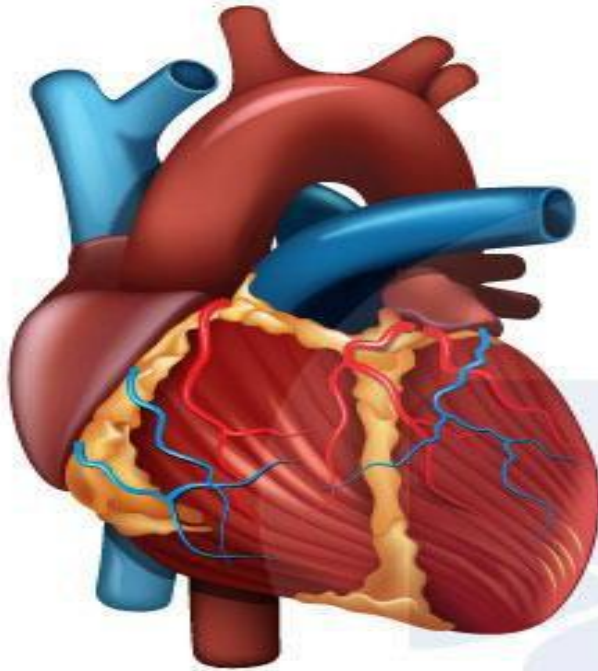
*If open-heart surgery
deairing before unclamping the aorta
(air embolization)*



Complications of CPB

- ◆ 1. Systemic inflammatory response due to contact of blood with the non-endothelialized 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.
- ◆ 3. Hemolysis.
- ◆ 4. Cerebrovascular accident

Off-pump CABG



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

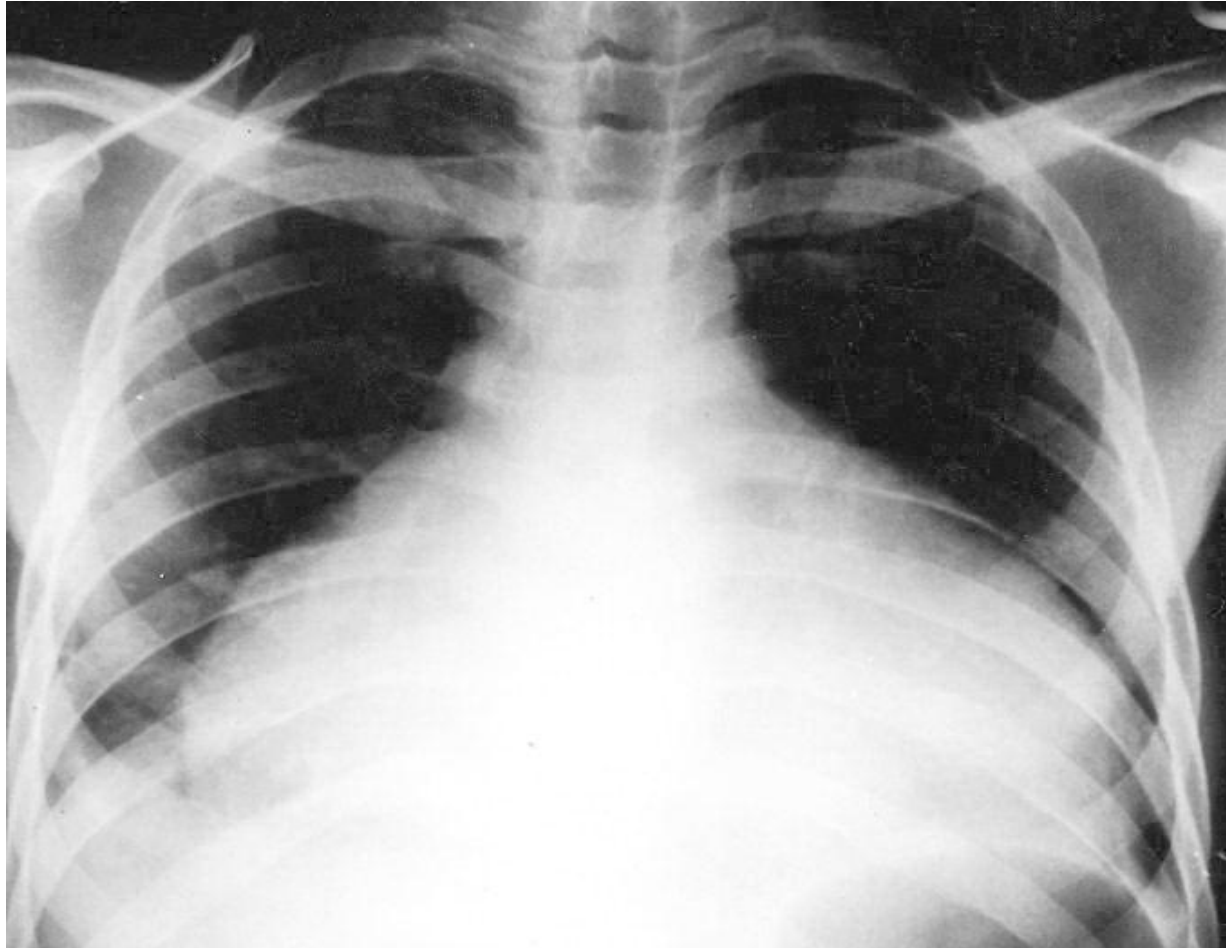
Pericardial effusion

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

Pericardial effusion

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

Pericardial effusion



Surgery for Cardio-thoracic
Diseases

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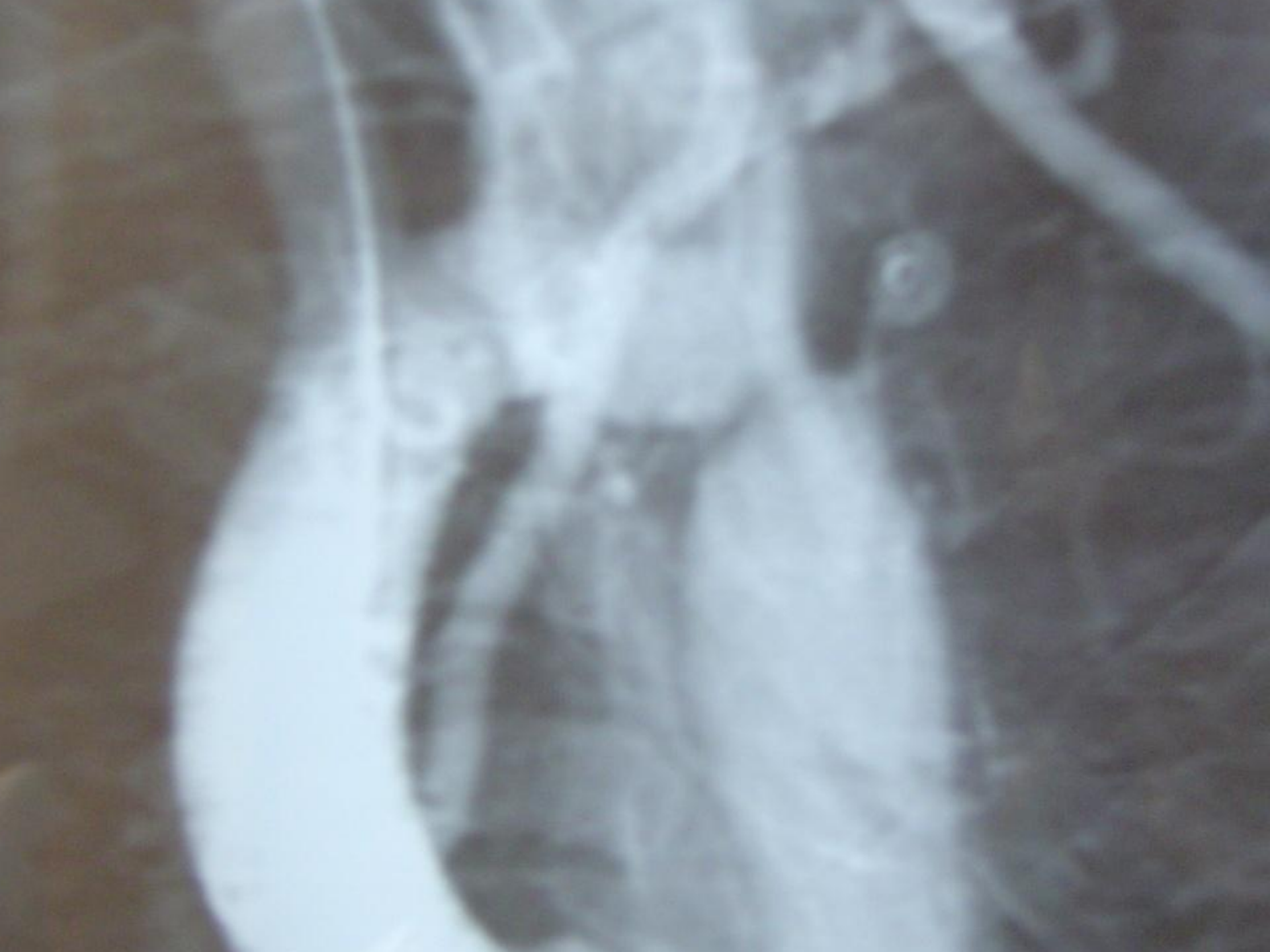
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Congenital Heart Diseases

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 Assessment for Cardiac Surgery

Evaluation of patients referred for cardiac surgery aims to answer the following questions:

1. Is surgery appropriate for the condition
2. Is the patient fit to undergo the planned operation
3. Is there any co-morbidity that may affect operative management
4. Is the patient agreeable to surgery given the benefit-to-risk ratio.

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.

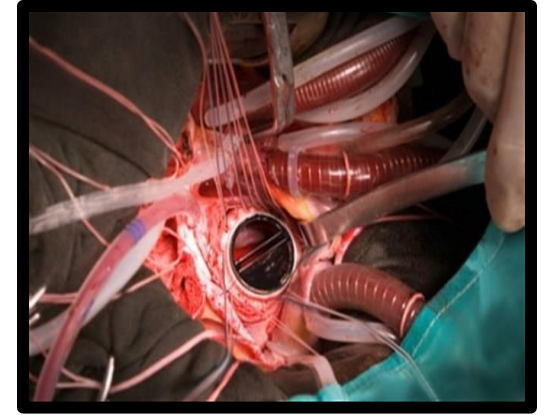
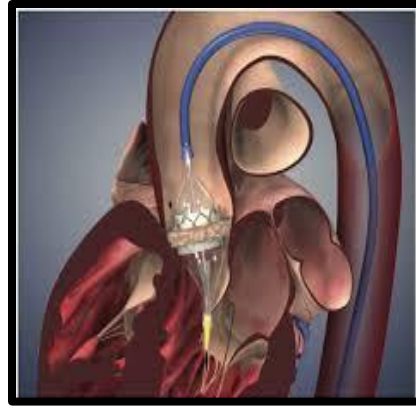
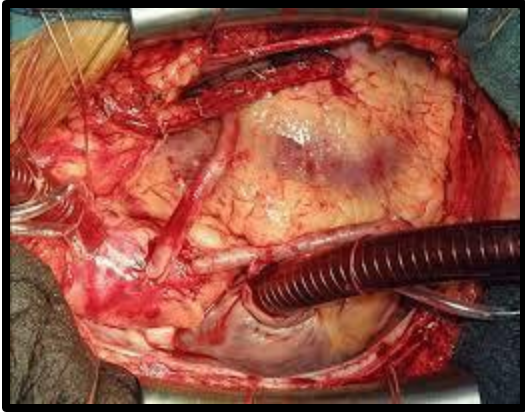


Penetrating Cardiac Trauma

- ◆ 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

