

Cardiac Surgical Diseases



Surgery Team
MED 433



Objectives :

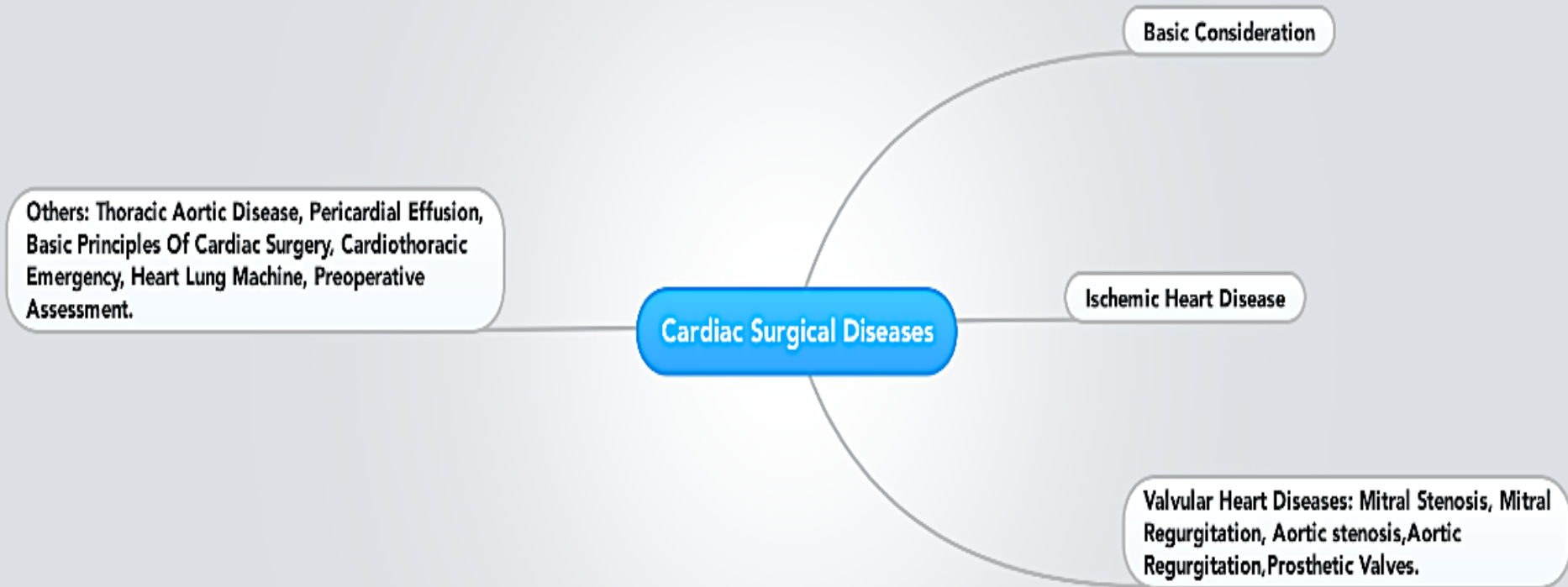
**This lecture had no slides, and the doctor told us that it is not included in the exam ..
However, the team made the lecture for those who are interested.**

- 1. Basic consideration:** (Pathophysiological assessment, Assessment of risk, Specific aspect of surgical technique, Post-operative care)
- 2. Acquired cardiac disease**
- 3. Ischaemic heart disease:** (Coronary artery disease, Surgery for the complications of coronary artery disease)
- 4. Cardiac valvular disease** (Assessment, Surgical management, Endocarditis, Aortic valve disease, Mitral valve disease, Tricuspid valve disease, Multiple and repeat valve procedures)
- 5. Aortic aneurysm** (Tubulosaccular aneurysms, False aneurysms, Aortic dissection, Aorto-annulo ectasia, Assessment, Surgery for aortic pathology)
- 6. Pericardial pathology** (Pericardial effusion, Pericardial constriction)
- 7. Congenital cardiac disease** (Atrial septal defect, Ventricular septal defect, Patent ductus arteriosus, Coarctation of the aorta, Tetralogy of fallot)

Sources : Slides, Raslan's Notebook, Principles & Practice of Surgery by: O. James Garden

Color Index : Slides & Raslan's | Textbook | Doctor's Notes | Extra Explanation

Mind Map



Basic Consideration



Pathophysiological assessment

Careful history and **appropriate examination** suggest the presence of possible cardiac pathology. The initial clinical assessment is then refined and specific investigations used to confirm and quantify any disease identified.

Assessment of risk

As the risks of **perioperative mortality** and **stroke** are significantly higher with cardiac surgery than with many other forms of surgery.

A frank informed discussion of these risks, recognizing potential benefits of a successful operation, are essential elements of the preoperative consultation between the patient and surgeon.

1. Mortality

Risk stratification is important in cardiac surgery and Euroscore is a valuable tool for quantifying operative risk across all types of non-congenital cardiac surgery. Patient, condition, and procedure related factors contribute to a score which predicts 30-day mortality. Predicted operative mortality ranges from < 1% for routine elective procedures to more than 50% for complex emergency operations.

2. Stroke

Stroke risk varies from 1% to over 10%, and is associated with intracardiac thrombus and severe atheromatous disease of the proximal aorta and carotids. Patients with evidence of peripheral vascular disease have a higher risk of stroke and those with high-grade symptomatic carotid disease may benefit from carotid endarterectomy prior to cardiac surgery.

Basic Consideration



Specific aspects of surgical technique

1- Cardiopulmonary bypass (CPB)

Modern cardiac and great vessel surgery became feasible with the development of cardiopulmonary bypass.

Steps:

1. Venous blood is drained via cannulae inserted into the right atrium or venae cavae and passes to a reservoir.
2. It is then pumped through an oxygenator, which adds O₂ and removes CO₂,
3. finally, the blood is returned to the arterial circulation via a cannula in the ascending aorta or other suitable artery (femoral, axillary).
4. Full anticoagulation with intravenous heparin is required to prevent blood clotting in the tubing, oxygenator and pump mechanisms.

Complications: Not common but it may cause

1. renal and cerebral dysfunction.
 2. Cerebral damage due to intracerebral bleeding,
 3. Embolization of microbubbles or arterial debris, or inadequate cerebral perfusion.
1. Subtle deterioration in cerebral function.
 2. Coagulopathy and haemolysis (Prolong bypass)

- Roller or centrifugal pumps are used, as these minimize red cell trauma.
- Semipermeable membranes, or more commonly hollow fibres, form the blood–gas interface within the oxygenator.
- A trained perfusion technician controls the bypass machine.
- CPB stimulates a systemic inflammatory response mediated by cytokine release, complement activation and white cell activation.

2- Myocardial preservation (Cardioplegia)

Cardioplegia is intentional and temporary cessation of cardiac activity, for cardiac surgery (still bloodless heart).

Steps: A crossclamp is applied across the ascending aorta → preventing blood flow into the coronary arteries → inject cardioplegic solution (delivered either antegradely via the aortic root or coronary artery ostia utilizing the native coronary arteries, or retrogradely via a catheter placed in the coronary sinus).

Cardioplegia combined with mild systemic hypothermia (32°C) provides the surgeon with a safe period of cardiac arrest of up to 120 minutes permitting surgery while minimizing the risk of myocardial damage.

- Coronary bypass surgery (CABG) can be performed using a technique in which an aortic clamp is intermittently applied to cut coronary flow while the heart is electrically fibrillated so as to reduce movement.

Postoperative Care



Intensive care

Postoperatively, patients are usually **ventilated** for a few hours until they are fully rewarmed, and have satisfactory **stable haemodynamics, pulmonary gas exchange and acid-base status**. Urine output is copious and potassium levels are, therefore, checked frequently so that potassium is administered intravenously to correct urinary losses. Invasive measurement of arterial and central venous pressure is standard. Pulmonary artery catheters may be used to measure pulmonary artery pressure, pulmonary artery capillary wedge pressure and cardiac output.

Complications

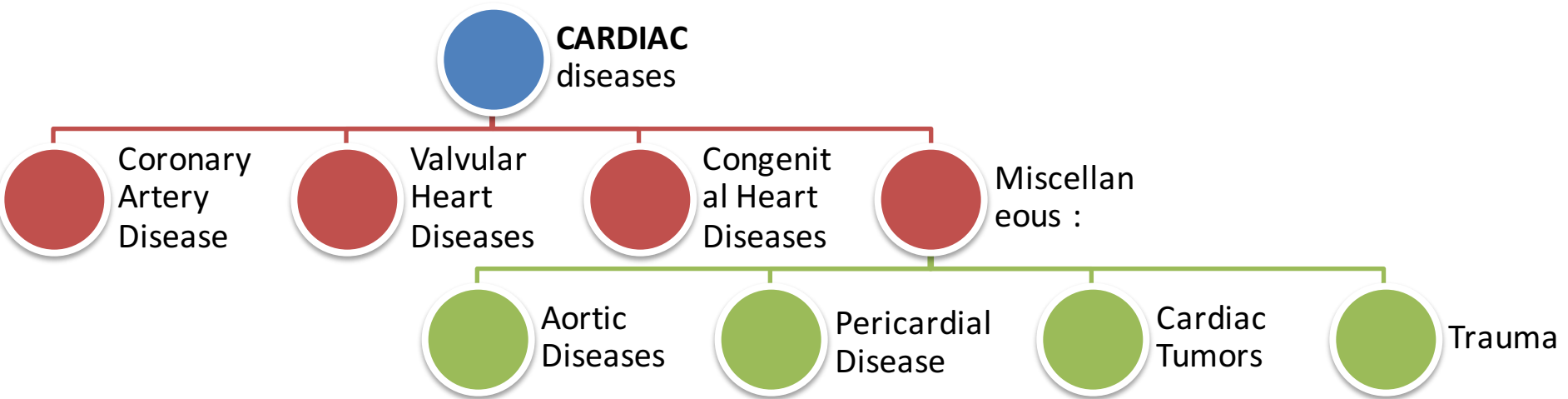
Other than death or stroke, established complications include:

- bleeding – multifactorial causes including hypothermia, platelet dysfunction, CPB and pharmacological (aspirin, clopidogrel)
- low cardiac output – poor myocardial protection, previous poor left ventricular (LV) function
- arrhythmias – atrial fibrillation occurs in up to 40%
- infection – wound, respiratory
- short-term memory impairment.

Recovery time

Patients undergoing routine elective coronary or valve surgery will usually leave acute hospital care within **one week**. Those requiring more extensive surgery or emergency procedures may take longer to recover. Most patients will have undergone a median sternotomy. This wound heals quickly and, as the sternal edges are approximated securely by wire or heavy sutures, chest discomfort eases rapidly. Leg vein donor sites may take longer to heal, particularly around the knee. By 2 weeks the patient should be able to walk a few hundred metres, and by 3 months should have returned to full activity, including work.

Introduction.



★ Presentation Of Cardiac Diseases :

✓ Chest pain :

- IHD (Ischemic Heart Disease)
- Aortic disease:
 - Dissection
 - Aneurism

◆ Chest pain and Shortness of breath are the most common presentations of cardiac Patients.

◆ Life threatening causes of chest pain:

- IHD, Pulmonary
- Embolism, aortic
- dissection, tension
- pneumothorax

✓ Shortness of Breath

- Palpitations
- Peripheral Edema
- Congestive Cardiac Failure
- Cyanosis and Clubbing in Congenital Defects
- Uncommon presentations :
 - Pleural Effusion
 - Hemoptysis

★ Common Cardiac Operations

- Coronary Artery Bypass Grafting (CABG) (**most common**)
- Valve Replacement / Repair
- Repair of congenital defects like ventricular septal defect (VSD) or atrial septal defect (ASD)
- Heart Transplantation

1st : Ischemic Heart Disease



Risk Factors

1. Smoking
2. Diabetes mellitus
3. Hypertension
4. Hyperlipidemia
5. Hereditary factors

Clinical Features

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

Laboratory Investigations:

- Routine investigations
 - Cardiac enzymes
 - E.C.G.
 - Echocardiography
 - Coronary angiography
- Angiography is used to decide the type of Rx:
- 1- Medical
 - 2- Angioplasty 80%
 - 3- Surgery 20% (2+3 Revascularization therapy)

Types Of Surgery

1. Conventional: the heart is stopped using the heart lung machine, and cardioplegic arrest. The machine is used to maintain blood and oxygen supply. Used in valvular and congenital cardiac surgeries (because we have to open the heart)
2. Off-pump (beating heart surgery); When working on the coronaries, we don't need to stop the heart because they're external features. But we must stabilize the area.

Indications Of Surgery :

1. Failure of medical therapy or percutaneous intervention.
2. Left main coronary artery disease.
3. **3-vessel** disease with left ventricular dysfunction
(three coronary arteries are affected)
4. Mechanical complications of myocardial infarction, include :
 - A. Tamponade .
 - B. Wall rupture.
 - C. Chordae tendinae rupture.
 1. Valve weakening
5. Associated valve disease (patient with IHD + valve problems = refer to surgery.)

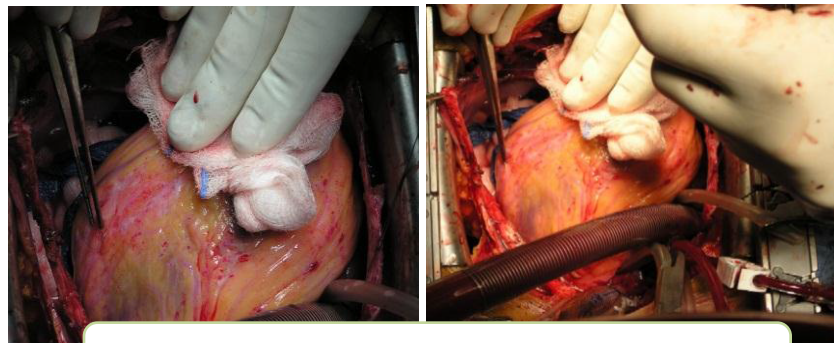
Percutaneous intervention:

angioplasty, balloon dilatation and stenting.
- **Left main coronary artery:** this is the main stem of the left coronary circulation. If the blockage is before it branches to left anterior descending and circumferential artery then its indicated for surgery.

Coronary Conduits

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

- Arterial grafts are better than venous : they have longer patency (In 10 years, 95% arterial grafts are patent, but only 50% of veins remain patent.
- Veins are normally under low pressure, so if they are used as coronary grafts, they are prone to high pressure from the aorta and atherosclerosis.
- The internal mammary artery is preferred (it is a smooth muscle artery, as opposed to the radial artery which is a muscular artery and may undergo spasm).
- Venous graft's patency may be improved by using antiplatelet medication and statins. But they are still not as patent as the internal mammary artery.



Coronary Artery Bypass Grafting

★ Surgery for the complications of coronary artery disease :

Mitral valve regurgitation (MR) :

Chronic

Chronic ischemia may cause regurgitation, owing to **papillary muscle fibrosis**. Surgery may be indicated to repair or replace the valve as an elective procedure, usually concurrently with CABG. The operative mortality is around 8–11%.

Acute

Acute myocardial infarction involving a **papillary muscle may cause this to rupture**, causing gross regurgitation. The patient is usually very unwell with pulmonary edema due to MR and low cardiac output due to infarction, and often requires emergency ventilation. Emergency mitral valve replacement and CABG is associated with a mortality of 15–40%, mainly due to poor ventricular function and secondary multi-organ failure.

Postmyocardial infarction ventricular septal defect :

Necrosis of the intraventricular septum due to MI may lead to a **ventricular septal defect**. Blood flows from the high-pressure left to the low-pressure right ventricle (left-to-right ‘shunt’). This increases right ventricular work and pulmonary blood flow and decreases cardiac output. Typically, the patient complains of sudden, severe breathlessness 3–8 days after an MI and is noted to have developed a pansystolic murmur. The diagnosis is confirmed by echocardiography and coronary angiography is performed. Typically, such patients will require mechanical support of their ventricle with an intra-aortic balloon pump. Surgical mortality ranges from 20–50%.

Left ventricular aneurysm :

Occurs when a large left ventricular free-wall MI scar becomes aneurysmal **as a result of intraventricular pressure**. A large aneurysm impairs cardiac contraction and increases myocardial work. Complications include clot formation within the aneurysm, which may embolize, and arrhythmias generated within the zone of ischaemic myocardium around the periphery of the aneurysm. Surgery performed electively has a mortality of 6–10% and an increased risk of stroke.

Valvular Heart Diseases.



Endocarditis

Abnormal native heart valves are prone to subacute bacterial endocarditis and artificial valves is prone to prosthetic valve endocarditis. Patients with endocarditis require prolonged parenteral antibiotic therapy which may be effective. However, surgery may be required if the **infection does not respond** or if the **valve develops a significant paravalvular leak or annular abscess**. Surgery is a high-risk venture as the patient is systemically septic, the erivalvular tissues are of poor quality.

Tricuspid valve disease

Stenosis is very rare. Tricuspid endocarditis is occasionally encountered in intravenous drug abusers. Tricuspid incompetence secondary to enlargement of the tricuspid annulus is the most common pathology and occurs when the right ventricle is dilated, as in advanced mitral valve disease.

Patients have the features of underlying mitral valve disease, an elevated jugular venous pressure with 'v' waves, an enlarged pulsatile liver, peripheral edema and, occasionally, ascites. Liver function tests are frequently deranged and clotting is impaired. The preferred surgical option is to restore the normal dimensions of the valve through annuloplasty.

Multiple and repeat valve procedures

Multiple valve procedures are typically aortic and mitral valve replacement, or mitral replacement with tricuspid annuloplasty. Revisional valve surgery to replace a valve for a second time is technically more difficult and will involve a prolonged procedure against a background of impaired cardiac function or sepsis related to the defective prosthesis.

Valve	Etiology	Investigations	Indications for surgery	Treatment
Mitral Stenosis:	Rheumatic, Congenital	ECG, X-ray chest, Echocardiography	<ul style="list-style-type: none"> Symptomatic exertional dyspnea, pulmonary hypertension, hemoptysis Severe mitral stenosis: area less than 1 cm Left atrial thrombus. 	<ol style="list-style-type: none"> Medical Balloon valvuloplasty (dilatation in stenosis w/o regurgitation) Closed mitral commissurotomy (doesn't need heart-lung machine) Open mitral commissurotomy (needs heart-lung machine)
Mitral Regurgitation:	Rheumatic, Degenerative, Endocarditis, Ischemic, Traumatic		<ul style="list-style-type: none"> Symptomatic Dilated left ventricle Diminished ejection fraction 	<ol style="list-style-type: none"> Medical Mitral valve repair Mitral valve replacement.
Aortic Stenosis:	Rheumatic, Congenital, Degenerative.		<ul style="list-style-type: none"> Symptoms (angina, shortness of breath, syncopal attacks) Severe aortic stenosis 	<ol style="list-style-type: none"> Medical Aortic valve replacement
Aortic Regurgitation:	Rheumatic, Endocarditis, Connective tissue disorders, Aortic Dissection		<ul style="list-style-type: none"> Symptomatic patients. Progressive left ventricular dilatation. 	—

- Mitral and Aortic are the most common diseased valves, sometimes the tricuspid as well.

- Mitral valve replacement, Open mitral commissurotomy and mitral valve replacement are the only surgical procedures in the treatment list.

- Closed mitral commissurotomy is a surgical procedure but it is not performed anymore.

PROSTHETIC VALVES : TYPES, MERITS AND DEMERITS

1. Tissue Valves (Bio prosthesis):

1. No need to use long term anticoagulation.
2. Limited and unpredictable durability
3. When to use tissue valves :
 - i. Old patients
 - ii. Patient with contraindication to anticoagulants i.e. bleeding disorders
 - iii. Non-compliant patients to anticoagulants e.g. psychiatric patients
 - iv. Pregnant woman due to the teratogenic effect.

2. Mechanical Valves:

- a. Anticoagulation for life
- b. Prolonged durability

Complications of prosthetic valves:

1. Thrombosis
2. Bleeding complications (1,2 Anticoagulant related complications)
3. Infective endocarditis
4. Paravalvular leak
5. Degeneration of biological valves



Thoracic Aortic Disease.



Thoracic aortic aneurysm:

-Tubulosaccular aneurysm:

These are true aneurysms that form either a fusiform (tubular) or a focal (saccular) types of swelling. They are lined by layered thrombus. Mostly secondary to smoking and hypertension.

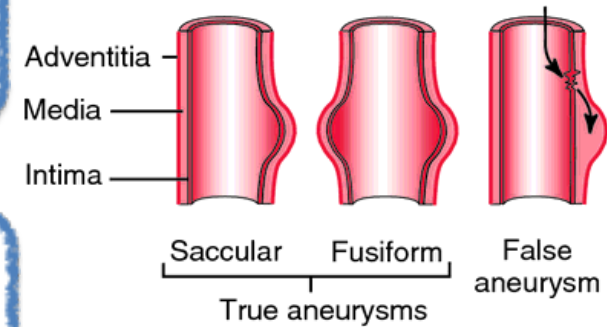
-False aneurysm:

These result from an aortic injury. The aneurysm wall is formed only by fibrous tissue and organized thrombus. Patients with history of trauma (road traffic accident or fall).

- Both true and false aneurysms may rupture and present as an acute emergency with chest pain.
- Often noted as incidental chest X-ray findings.
- Symptoms are usually due to pressure on surrounding structures.

Aortic dissection:

Tear in the intima allowing blood to enter and flow in false channel. A dissected aorta may dilate over months to years causing progressive aneurysmal process. There may be severe interscapular pain, collapse, shock, aortic incompetence, unequal peripheral pulses, features of a left haemothorax, stroke, paraplegia, abdominal discomfort and lower limb ischaemia.



Thoracic Aortic Disease.



Aorto-annulo ectasia:

This is characterized by a flask-shaped aneurysmal dilatation of the aortic root and ascending aorta. *Aorto-annulo ectasia* is frequently associated with connective tissue disorders, most commonly *Marfan's disease*.

-A patient with an incidentally discovered aneurysm should be thoroughly investigated, including tests of respiratory function and coronary angiography with contrast CT or MRI angiogram to fully delineate the extent of the aneurysm.

-In patients presenting with acute rupture of an aneurysm the diagnosis may have been made by transthoracic or transoesophageal echocardiography.

Surgery is recommended if they are potentially salvageable and considered likely to benefit from operative intervention.

-Lesions of the aortic root and ascending aorta are repaired on bypass via a median sternotomy. A woven Dacron tube graft is used to replace an ascending aortic aneurysm, but in aortic annulo-ectasia a composite graft containing an aortic valve prosthesis is used to replace the whole aortic root.

-Descending aortic aneurysms can often be repaired using a local shunt in order to deliver blood to the lower body. Clamps are applied to exclude the aneurysm, which is excised and replaced with a suitable length of graft.

Pericardial Pathology.



-Pericardial effusion:

Progressive accumulation of fluid inside the pericardial cavity, may compress the cardiac chambers. A rapidly evolving effusion will prevent the heart from filling in diastole (tamponade) and lead to a low stroke volume. The body will try to compensate by tachycardia and peripheral vasoconstriction. The raised intrapericardial pressure leads to elevation of atrial pressure.

- -Etiology:
 - -Trauma.
 - -Pericarditis.
 - -Malignancy.
 - -Uremia, post irradiation.
 - -Postoperative.
- -Investigations:
 - -Plain chest X-ray.
 - -Echocardiography.
 - -CT scan.
- -Management:
 - -Treat the cause.
 - -Aspiration.
 - -Pericardiostomy.(if the fluid is not accessible)

-Pericardial constriction: Chronic pericardial inflammation, often from *tuberculosis*, may heal by intense fibrosis and calcification. This leads to chronic tamponade and investigations should include echocardiography, right heart catheterization with record of chamber pressures and CT or preferably MRI.

Management: Surgery is undertaken via a median sternotomy to remove the parietal pericardium and any fibrotic visceral pericardium.

Congenital Heart Diseases.



1-Acyanotic:

1. Patent ductus-arteriosus:

Pulmonary blood flow is abnormally high producing pulmonary congestion and hypertension. Infants have retarded growth and a continuous 'machinery' murmur is audible over the precordium and back. The chest X-ray shows pulmonary congestion. -Endovascular closure is an option in older children.

2. Co-arctation of the aorta:

-This condition is caused by a narrowing of the thoracic aorta, usually at the level of the ligamentum arteriosum. Upper body hypertension develops and may lead to heart failure in infancy. Untreated adults develop hypertensive cerebrovascular and renal problems and accelerated coronary atheroma. *The femoral pulses may be impalpable.* -A *systolic murmur may be audible over the back.* -LVH is seen on the ECG and the chest X-ray shows an enlarged heart.

- Balloon angioplasty has been used to dilate some coarctations in infants, but surgical correction is usually required.

3. Atrial septal defect (ASD):

-This is the most common abnormality. A left-to-right atrial shunt which increases the right heart and pulmonary blood flow. Patients may be asymptomatic or may present with frequent chest infections.

-There is fixed splitting of the second heart sound and a pulmonary ejection systolic murmur. ECG demonstrates frequently right ventricular hypertrophy and echocardiography is diagnostic. Closure is recommended and may be undertaken percutaneously or by open operation depending on the size and morphology of the defect.

-Three anatomical types exist: *ostium secundum defects, sinus venosus defects, partial atrioventricular canal defects.*

Congenital Heart Diseases.



4. Ventricular septal defect (VSD):

- Many ventricular septal defects are small and close within the first year of life. Larger lesions cause a left-to-right shunt and pulmonary congestion.

- A pansystolic murmur is audible.

- Asymptomatic defects are observed, but early operation is preferred for larger defects to prevent irreversible pulmonary hypertension.

5. Pulmonary stenosis.

2-Cyanotic:

1. Tetralogy of Fallot: (VSD, overriding aorta, pulmonary stenosis, RV hypertrophy)

- The most common cause cyanotic congenital heart disease.

- Comprises a high ventricular septal defect, an aorta that overlies the interventricular septum, pulmonary valvular stenosis and right ventricular hypertrophy.

- Right ventricular outflow obstruction causes cyanosis as a result of **right-to-left shunting** across the ventricular septal defect. (Child may become blue and faint during feeding or crying.)

- Right ventricular hypertrophy is evident on ECG and the pulmonary artery shadow is small on chest X-ray.

- Echocardiography is diagnostic but is complemented by right ventricular angiography.

- Correction entails closing the ventricular septal defect with a patch, resecting muscle bands contributing to right ventricular outflow obstruction, and enlarging the right ventricular outflow tract with a patch placed across the pulmonary valve annulus and along the pulmonary artery if necessary.

2. Transposition of the great vessels. 3. Tricuspid atresia. 4. Total anomalous venous drainage.

5. Truncus arteriosus.

Basic Principles Of Cardiac Surgery .



- 1. Adequate exposure:** Full or Partial Sternotomy/ Thoracotomy/ Robotic or Endoscopic.
- 2. Bloodless Operative Field:** Suction and re-transfusion/Snaring or clamping of bleeding vessels.
- 3. Static Operative Target:** Cardiac Arrest/ Ventricular Fibrillation/ Mechanical stabilizers.
- 4. Preservation of body perfusion:** Use of Heart Lung Machine/ Off-pump Techniques.
- 5. Preservation of Myocardium:** Off-pump Techniques/ Hypothermia/ Cardiac Arrest with cardioplegia.

Heart Lung Machine

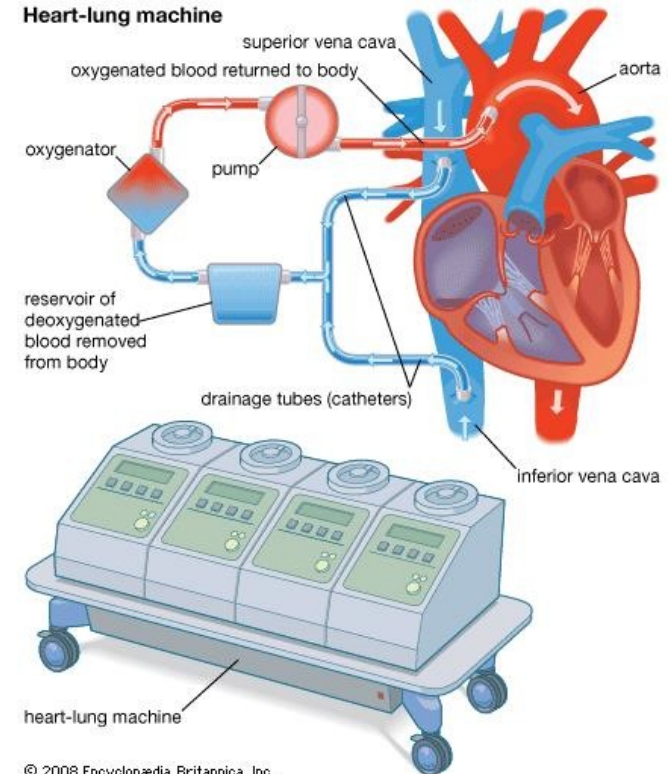


-Components:

1. Roller pump.
2. Blood reservoir (cardiotomy reservoir).
3. Oxygenator.
4. Heater-cooler unit.
5. Tubing and monitoring console.

-Limitation/Problems:

1. Requires full anticoagulation.
2. Can cause micro embolism.
3. Initiates systemic inflammatory response.



Cardiothoracic Emergency.



Chest pain:

- 1- Myocardial infraction.
- 2- Pulmonary embolism.
- 3- Spontaneous pneumothorax.
- 4- Bronchial asthma.
- 5- Foreign body aspiration.
- 6- Stuck mechanical valve.

Acute dyspnea:

- 1- Myocardial ischemia.
- 2- Pulmonary embolism.
- 3- Aortic dissection.
- 4- Tension pneumothorax.
- 5- Rupture esophagus.

Chest trauma:

- 1- Flail chest.
- 2- Traumatic hemo/pneumothorax.
- 3- Hemopericardium.

Summary

- Chest pain and Shortness of breath are the most common presentations of cardiac patients.
- Coronary angiography is the gold standard in diagnosing IHD.
- The risk factors for IHD are: DM, Smoking, Hypertension, Hyperlipidemia, Hereditary factors.
- Patient with mechanical valve, anticoagulation is required for life but not in patient with tissue valve.
- There' s Two types of aortic aneurysms: True aneurysm, false aneurysm.
- Congenital heart diseases are divided into cyanotic and acyanotic.

Thank You..

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