Introduction TO CARDIAC SURGERY Journey Inside the Heart

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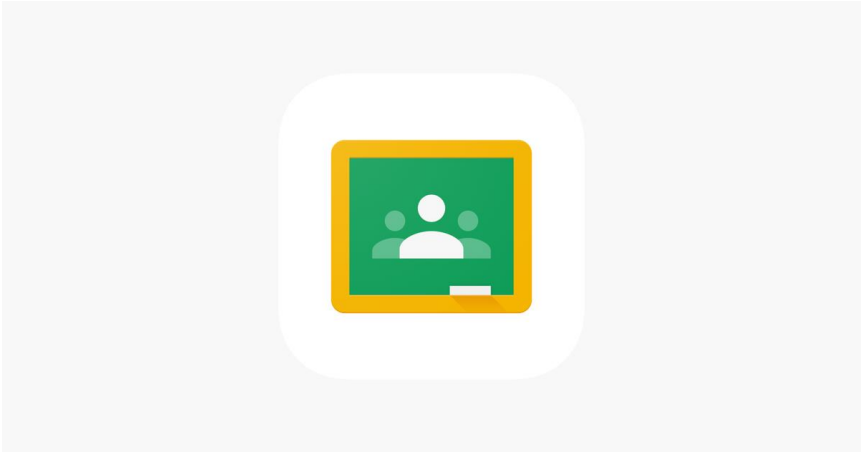
TARGET: 4TH YEAR MEDICAL STUDENTS

DURATION: 50–60 MINUTES



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Historical aspect

Anatomy and physiology

The role of investigation and preoperative assessment in

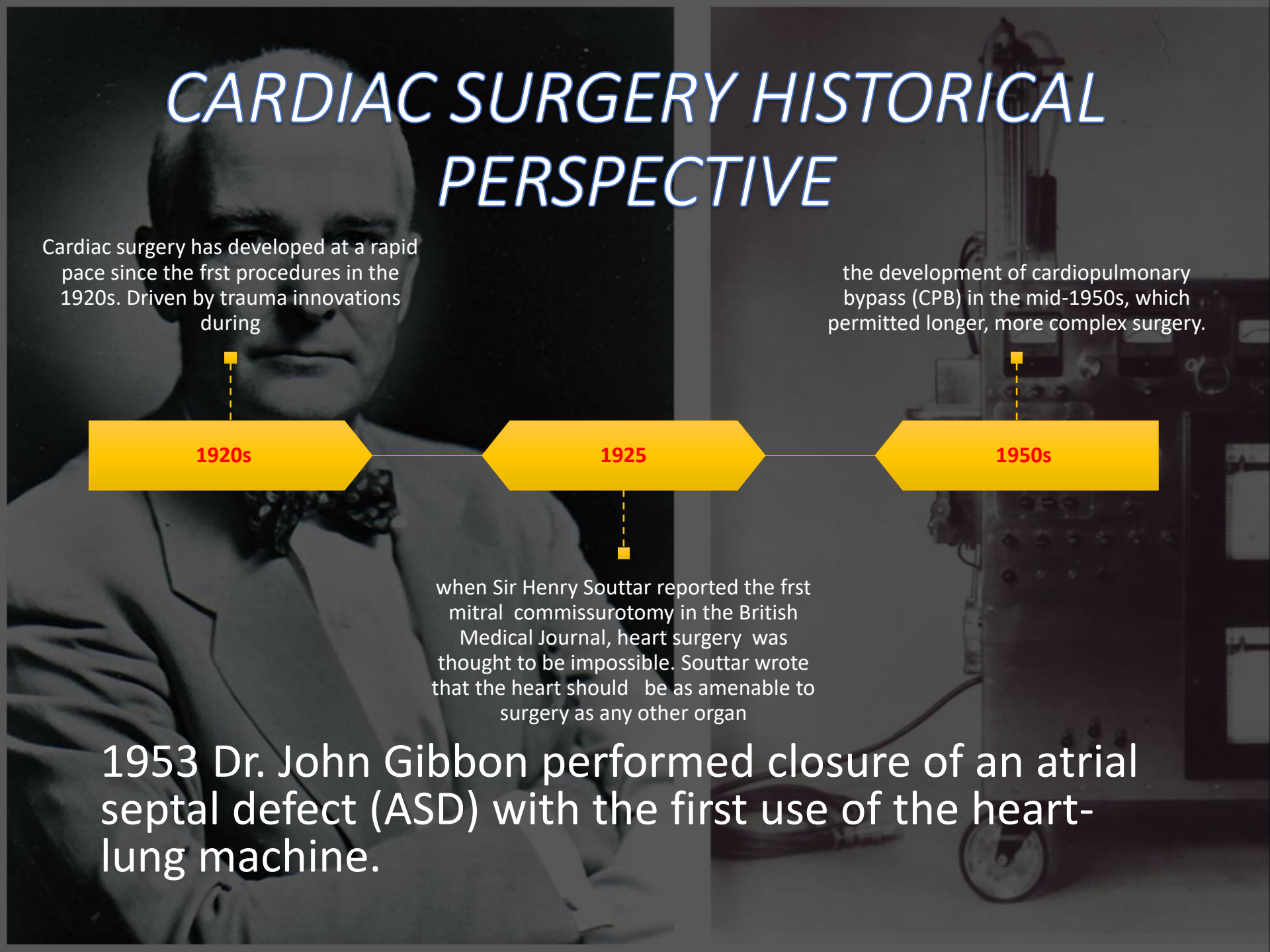
The principles of cardiopulmonary bypass

Surgical approach to the heart

Coronary artery bypass graft and conduits options in surgery

The management of coronary heart disease cardiac surgery

CARDIAC SURGERY HISTORICAL PERSPECTIVE



Cardiac surgery has developed at a rapid pace since the frst procedures in the 1920s. Driven by trauma innovations during

1920s

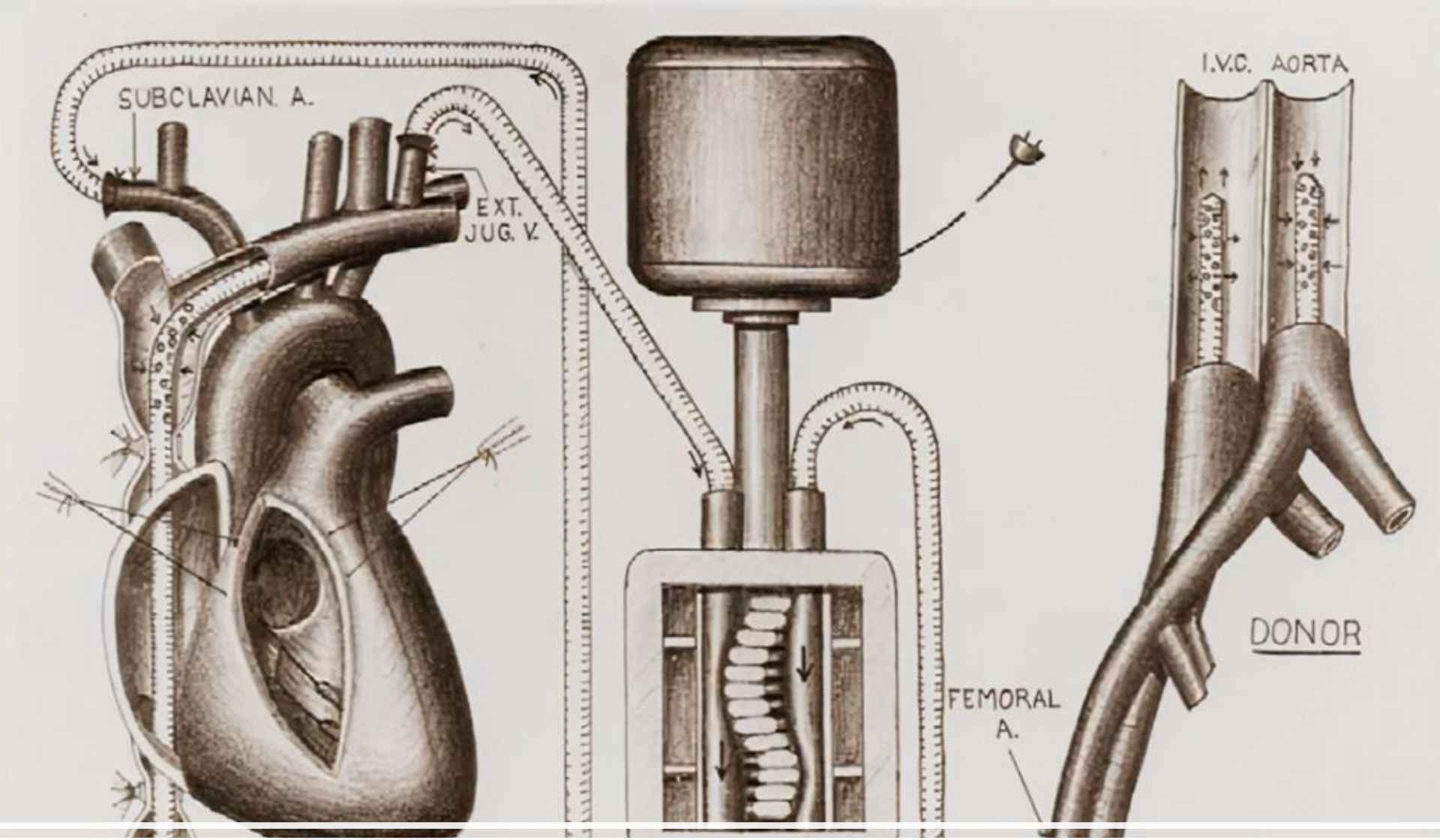
1925

when Sir Henry Souttar reported the frst mitral commissurotomy in the British Medical Journal, heart surgery was thought to be impossible. Souttar wrote that the heart should be as amenable to surgery as any other organ

1950s

the development of cardiopulmonary bypass (CPB) in the mid-1950s, which permitted longer, more complex surgery.

1953 Dr. John Gibbon performed closure of an atrial septal defect (ASD) with the first use of the heart-lung machine.



Cross-Circulation

First successfully performed in 1954 on children with congenital heart defects (mainly VSD, TOF).The donor was usually the child's mother or father.

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Anatomy & Physiology

1. General Features Hollow **muscular organ**, cone-shaped.location: **Mediastinum**, behind sternum, between lungs.

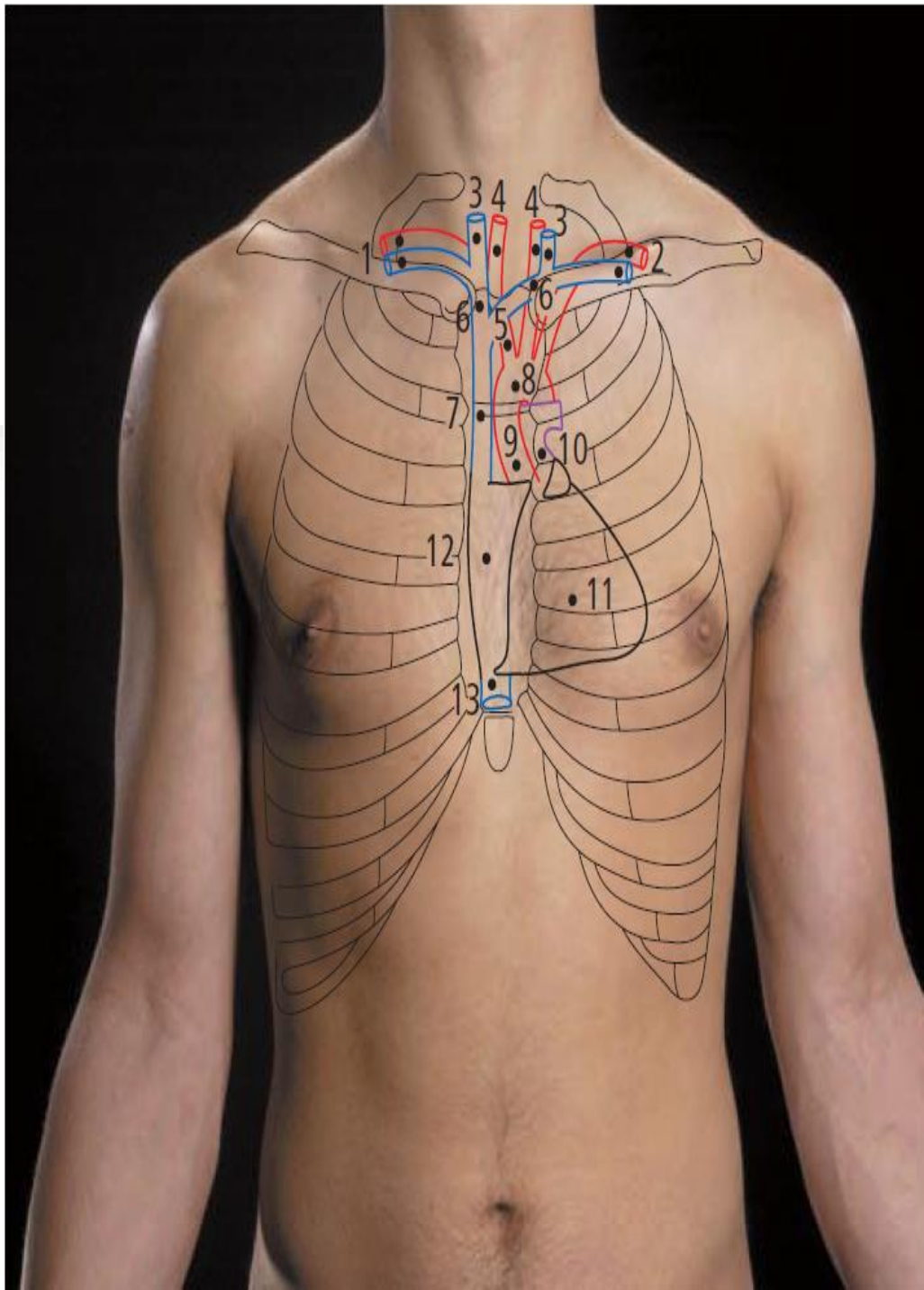
2. Surfaces & Borders Surfaces: Sternocostal (anterior) → mostly **right ventricle**. Diaphragmatic (inferior) → mainly **left ventricle**. Base (posterior) → **left atrium**.

Borders: Right border → right atrium. Left border → left ventricle.

3. Chambers Right Atrium Right Ventricle Left Atrium Left Ventricle

4. Valves Atrioventricular valves:Tricuspid., **Mitral (bicuspid)**. **Semilunar valves:**Pulmonary valve.Aortic valve.

5. Great Vessels Arteries: Aorta, Pulmonary trunk. **Veins:** SVC, IVC, Pulmonary veins.



Anatomy & Physiology

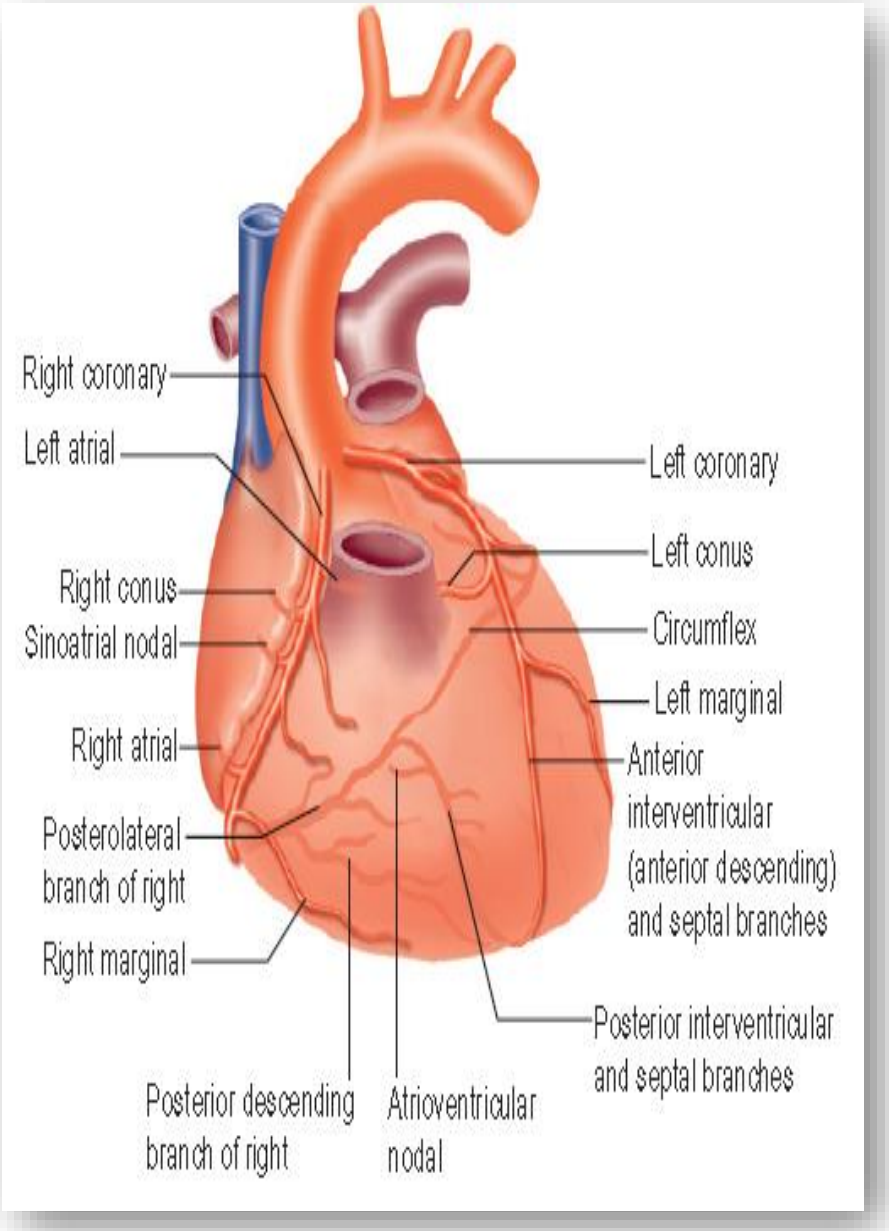
Coronary Circulation

Right coronary artery (RCA): SA node (60%), right ventricle, inferior wall.

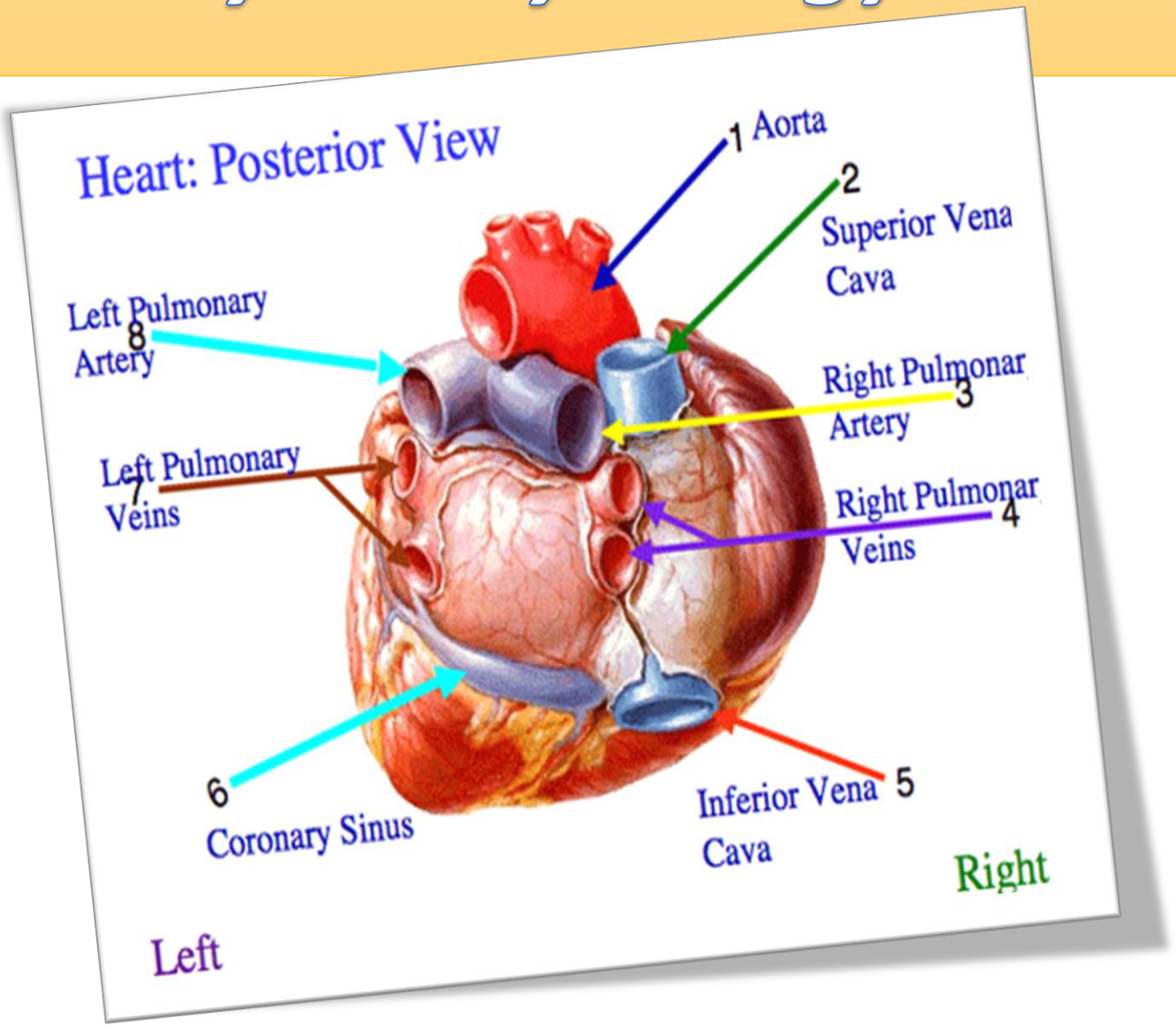
Left coronary artery (LCA): LAD → anterior LV + septum. LCX → lateral LV, LA.

Conduction System SA node → AV node → Bundle of His → Bundle branches → Purkinje fibers.

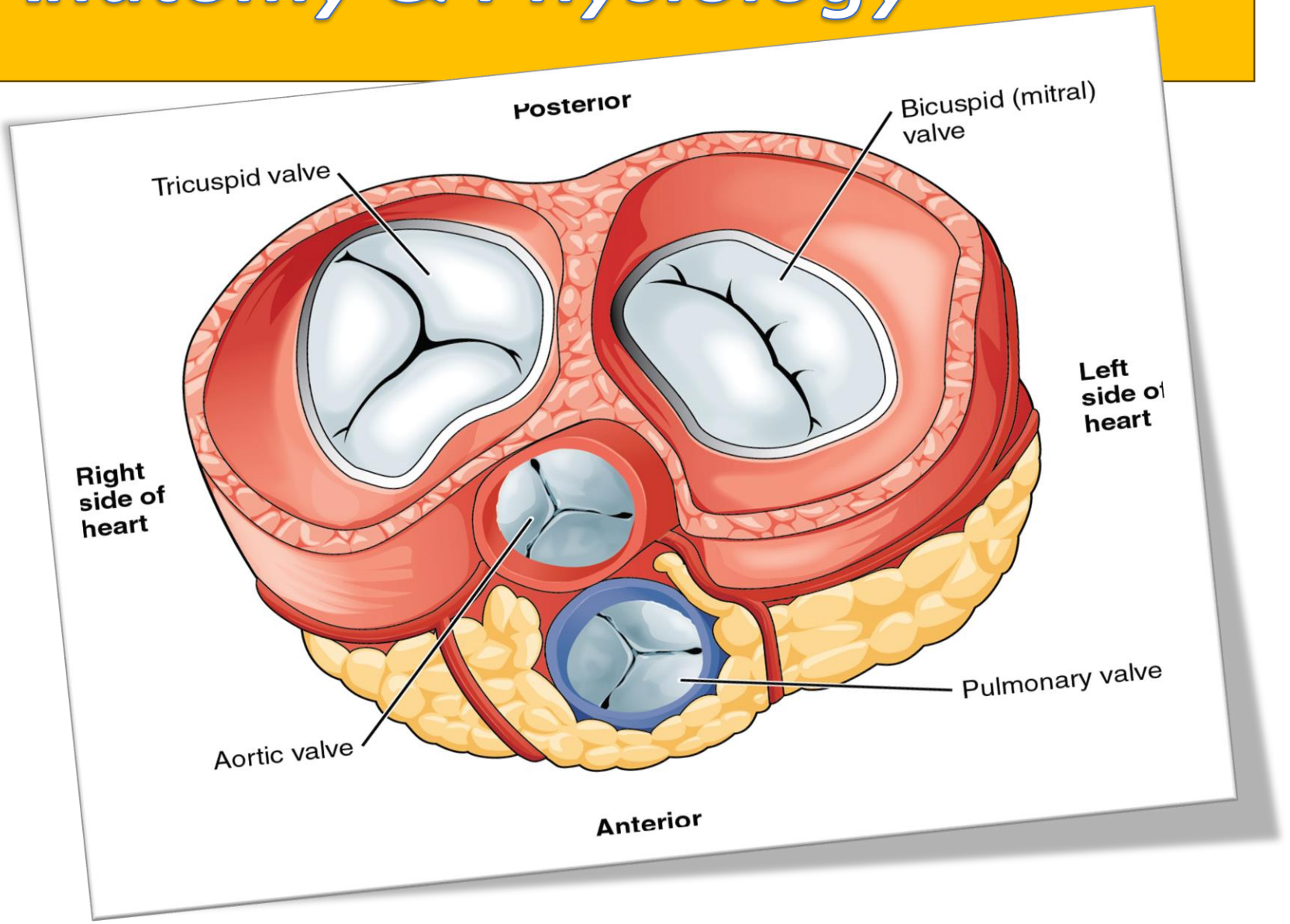
Pericardium Fibrous + serous (parietal & visceral). Pericardial cavity → contains small amount of fluid.



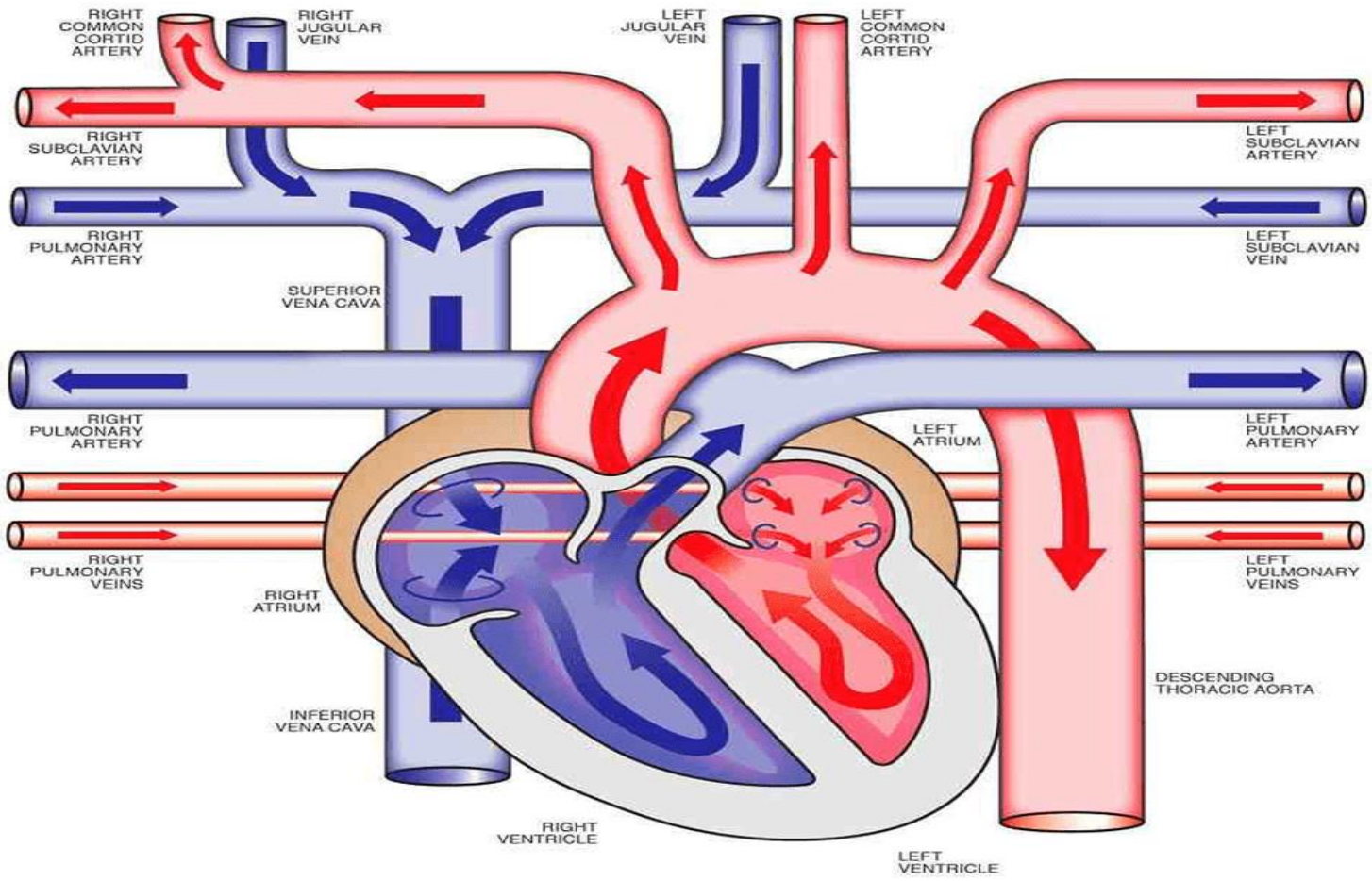
Anatomy & Physiology



Anatomy & Physiology



Pathway of Blood in the Heart



Preoperative Preparation for Cardiac Surgery

Why Do We Need Preoperative Preparation?

Cardiac surgery is **major and high-risk**.The patient's heart will be stopped, and a **cardiopulmonary bypass (CPB)** machine will take over circulation.

Surgery stresses **all organs** (heart, lungs, kidneys, brain).

👉 **Goal: minimize risks, prepare the patient's body, and ensure the surgical team is ready**

History & Physical Exam

Symptoms: angina (chest pain), dyspnea (shortness of breath), palpitations, syncope.

Comorbidities: diabetes, hypertension, kidney disease, COPD (lung), liver disease.

History: previous MI, stents, surgeries, anticoagulant use.

Physical exam: murmurs (valvular disease), edema (heart failure), lung sounds (infection or fluid).

Blood tests

CBC → check for anemia, infection, platelets.

Kidney & liver function → ensure organs can handle surgery & drugs.

Electrolytes → potassium & sodium imbalances can cause arrhythmias.

Coagulation (PT, INR, aPTT) → detect bleeding risk.

Blood group & cross-match.

Imaging

Chest X-ray → lungs (infection? effusion?), heart size.

Echocardiogram → EF (pump strength), valve status, pulmonary pressure.

Coronary angiography → locate coronary blockages before CABG.

CT/MRI → if aortic disease or congenital anomaly.

Other tests

ECG → arrhythmias, ischemia.

Carotid Doppler → stroke risk (if elderly or vascular disease).

Pulmonary function test → if COPD or smoker.

Optimization Before Surgery

Control blood pressure & diabetes: uncontrolled cases ↑ mortality.

Treat infections: even dental infections → can cause infective endocarditis post-op.

Stop smoking: improves oxygenation, reduces lung complications.

Nutrition: malnutrition → poor wound healing; obesity → infection risk.

Medications

Antiplatelets: stop **clopidogrel/ticagrelor** 5–7 days before (reduce bleeding).

Anticoagulants: stop **warfarin** 4–5 days before, bridge with heparin if high risk.

Aspirin: usually **continued** (esp. CABG).

Continue **beta-blockers** (prevent arrhythmias).

Hospital & Surgical Preparations

Blood products ready: cardiac surgery often needs transfusion.

Antibiotic prophylaxis: give within 60 min of incision → prevent mediastinitis.

Skin preparation: antiseptic shower, clip hair (never shave → ↑ infection risk).

Mark graft harvest site:Saphenous vein (leg).Radial artery (arm).

Lines & monitoring: central venous line, arterial line, urinary catheter → inserted before or in OR.

Patient & Family Counseling

Procedure (CABG, valve replacement, etc.). Risks (bleeding, infection, stroke, death). Post-op: ICU stay, ventilator, chest drains.

Informed consent signed.

Psychological support: many patients are anxious → relaxation, reassurance.

Specific Preoperative workup in CABG

Preoperative work up In Coronary Surgery :

History *:*

of chest pain, exertional dyspnea.Coexisting disease such as DM, renal problems.Previous operations or radiation to thorax.Drug allergies. Drug intake sp Aspirin, warfarin on heparin is also important

Physical examination

the heart & lungs should be correlated with the CXR & Echo. We should check for carotid bruits. Record strength of peripheral pulses which is important if an intra-aortic balloon pump is required. Observation of the skin for sign of systemic or local lesions that may adversely affect the operative procedure is important.The quality of the saphenous v. should be assessed.

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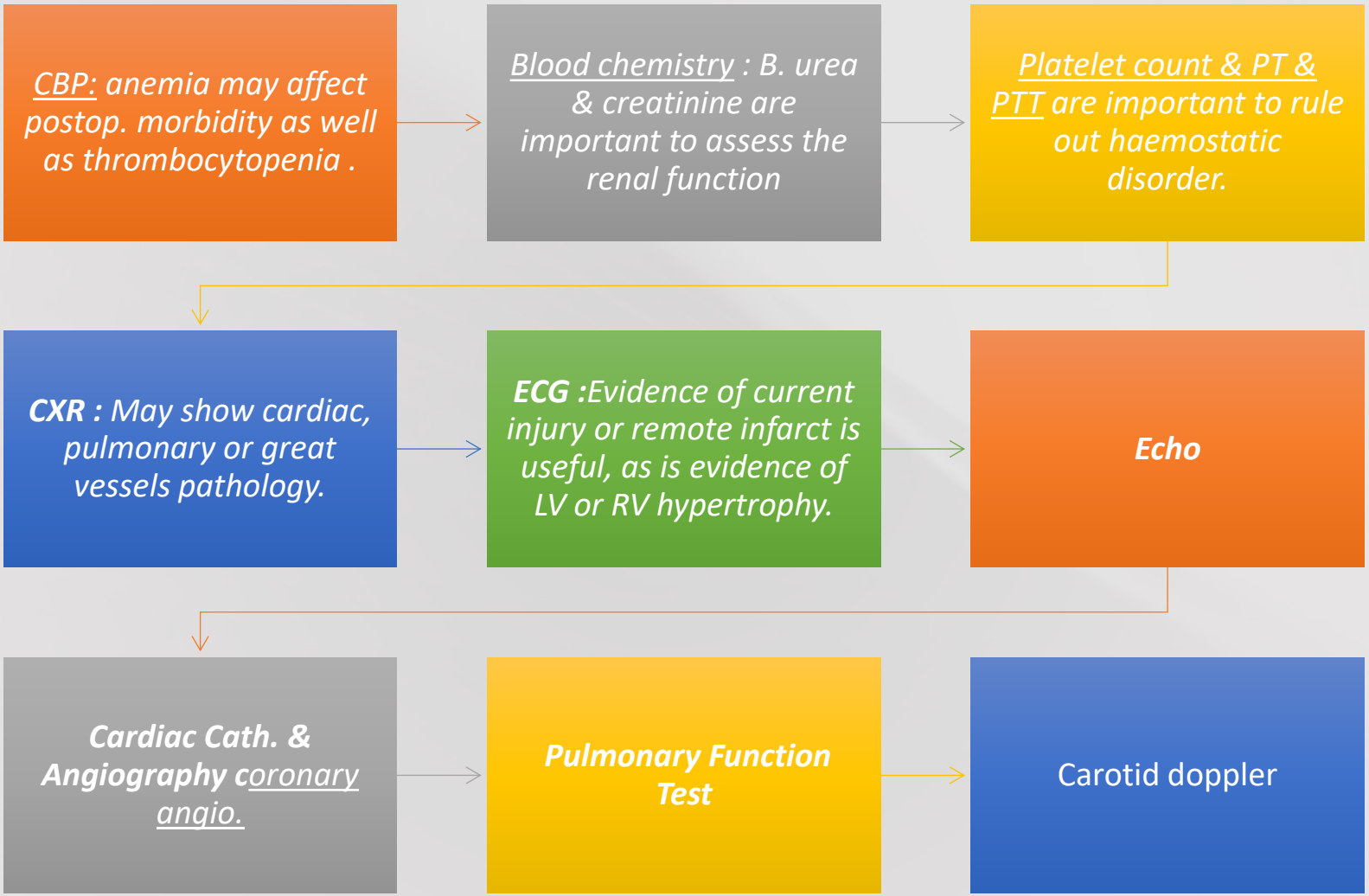
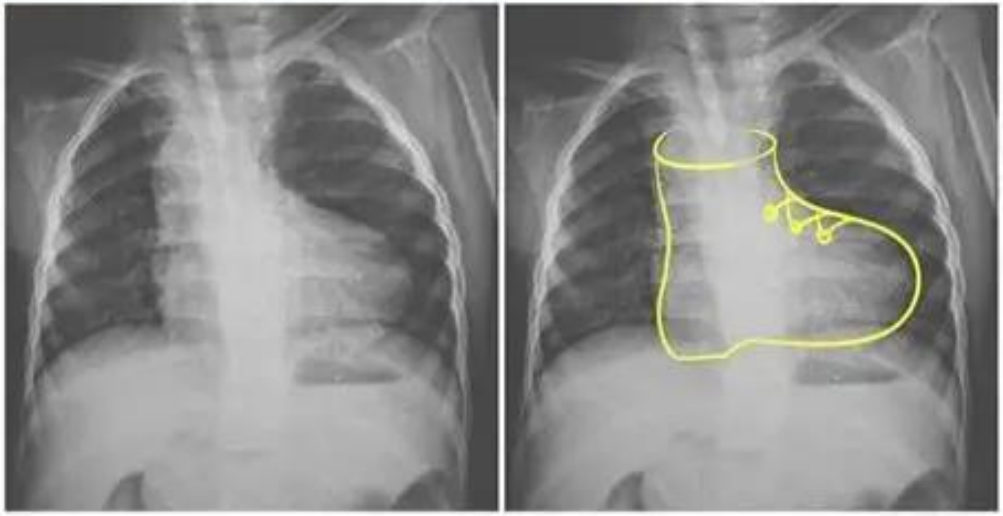
Preoperative workup in Acquired Heart diseases



Preoperative workup in Congenital Heart diseases

- ***History :*** *the child tachypneic, cyanotic? Is the child full term or premature ? Are there any other congenital defects (e.g., skeletal, renal, GIT) ? Is there a family history congenital defects ?*
- ***Physical examination :*** *Looking for cyanosis or tachypnea is important. Examination of arterial pulses. Palpation for thrills Auscultation of the heart for systolic or diastolic murmurs. Examination of the liver & spleen.*
- ***Lab. Test :*** *Pulse oximeter or blood gas analysis can help to confirm cyanosis (SPO_2 < 88%).High hematocrit is consistent with cyanotic heart defect.*
- ***CXR :*** *Look for cardiomegally & dextrocardia Look for classic Boot shape heart of TOF or Egg shaped in TGA Look for rib notching in coarctation of aorta.Are the pulmonary marking normal, decreased or increased.*

Tetralogy of Fallot

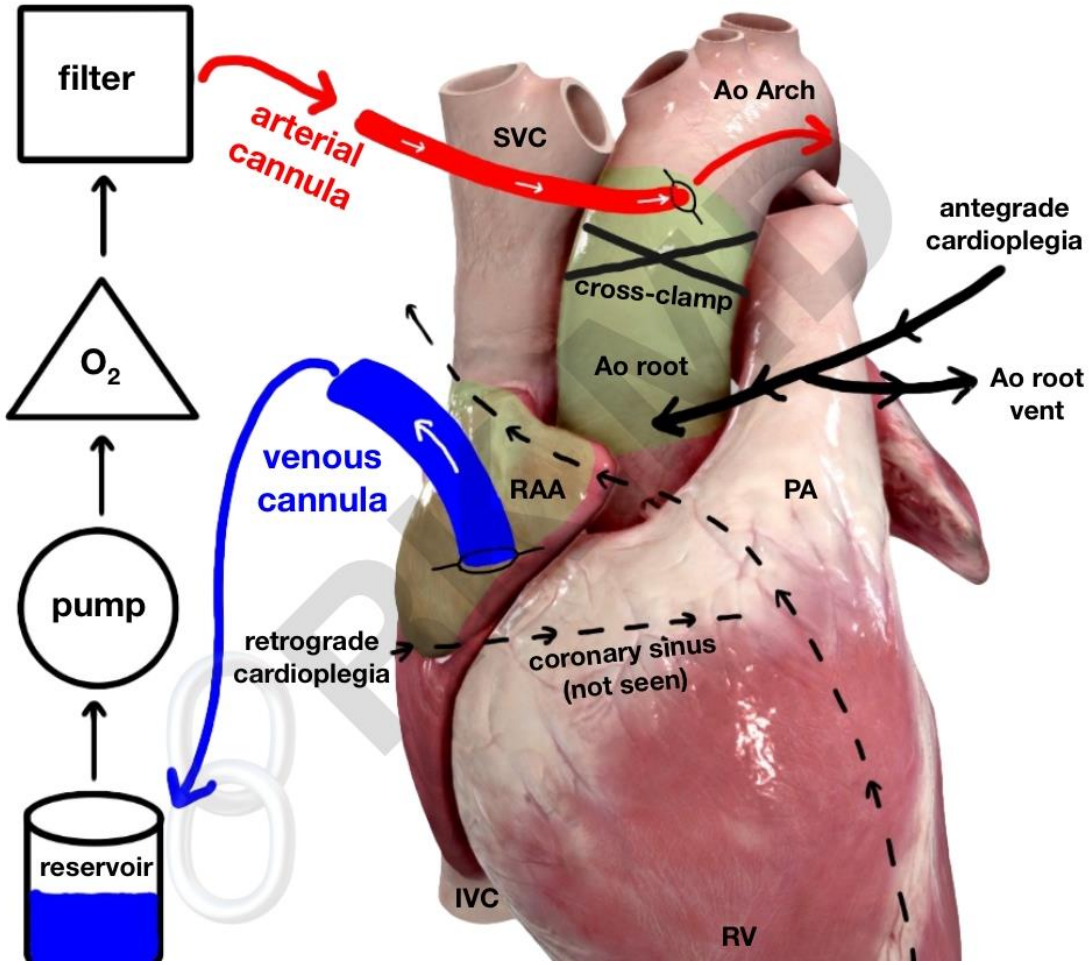


CARDIAC RADIOLOGY

COARCTATION OF THE AORTA/RIB NOTCHING

CARDIOPULMONARY BYPASS CIRCUIT

It can be used in any procedure in which the heart and lungs need to be stopped temporarily, and their function replaced artificially.



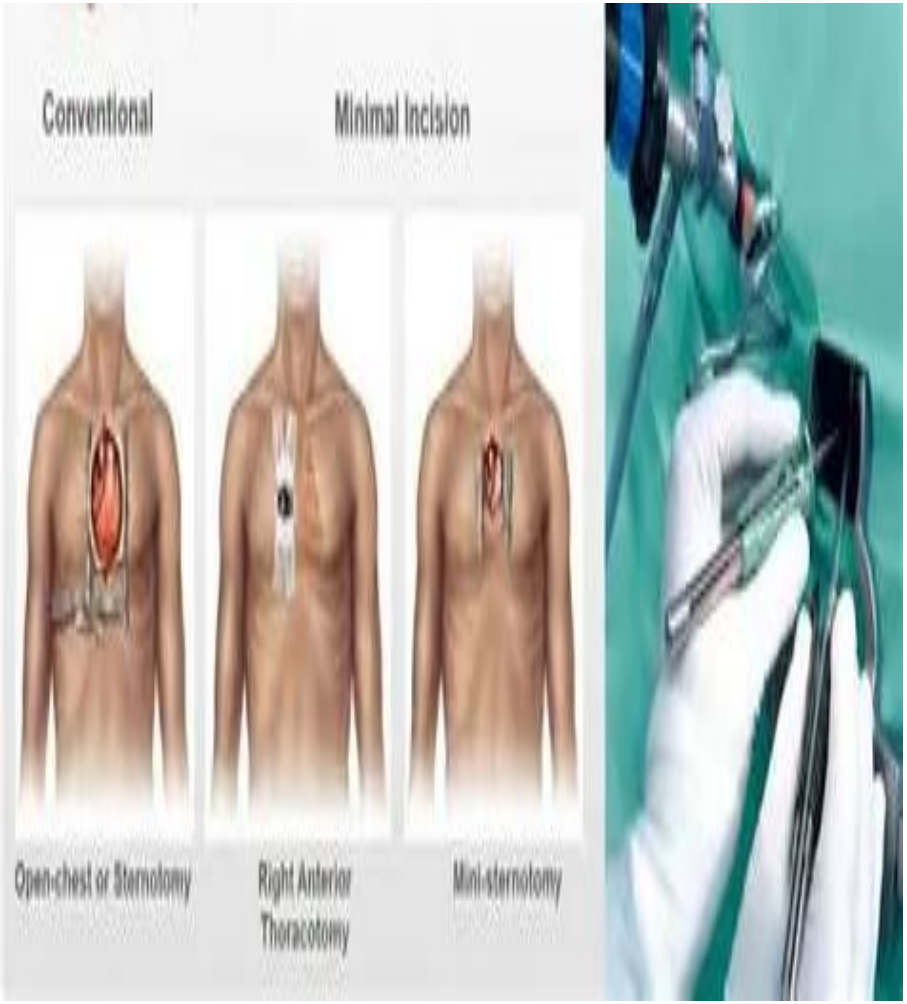
Cardiopulmonary bypass circuit

ALTERNATIVE USES OF CPB

- **Rewarming in hypothermia**
- **Resuscitation in severe respiratory failure**
- **As an adjunct in pulmonary embolectomy**
- **Single- and double-lung transplantation**
- **In cardiopulmonary trauma**
- **Certain non-cardiac surgical procedures (e.g. resection of highly vascular tumours or those invading large blood vessels; e.g. the inferior vena cava in renal tumours)**

Potential complications of CPB

- Coagulopathy
- Infection
- Air embolism
- Gastrointestinal complications (bowel and liver ischaemia/pancreatitis)
- Myocardial depression
- Neurological dysfunction
- Postcardiotomy syndrome (similar to Dressler's)
- Pulmonary injury
- Systemic organ dysfunction
- Microembolisation (eyes, brain)
- Vascular injury



Surgical Approach

Standard Approach Median Sternotomy (most common) A vertical midline incision through the sternum.

Thoracotomy Approaches Anterolateral Thoracotomy Incision through intercostal space (usually 4th–6th).**Posterolateral Thoracotomy** More for descending thoracic aorta surgery than for intracardiac operations.

Minimally Invasive and Endoscopic Approaches Mini-Sternotomy Camera-assisted (video-assisted thoracoscopic surgery

Principles of Myocardial Protection

Permanent myocardial damage can develop within 15–20 minutes, therefore most cardiac operations require some form of myocardial protection.

Decrease the heart's energy demand

- Stop the heart (cardioplegia).
- Lower the temperature (hypothermia).

Maintain oxygen & nutrient supply

- Give special solutions to the coronary arteries.
- Provide oxygenated blood if possible.

Prevent damage from ischemia & reperfusion

- Use buffers, electrolytes, and drugs in solutions.

Methods of Myocardial protection

Cardioplegia solutions (vary in temperature, pH, osmolality and the presence of red cells. Potassium is the most commonly used arresting agent, stopping the heart in diastole)

- Cold (4–10°C) isotonic crystalloid or blood solutions aid myocardial protection by reducing metabolic requirements through local hypothermia.

- Warm cardioplegic solutions, on the other hand, may facilitate better myocardial recovery postoperatively by aiding activation of intramyocardial enzymes. Cardioplegia solutions will need to be given repeatedly every 15–20 minutes during surgery.

Intermittent cross-clamp fibrillation(is a technique in which intermittent ventricular fibrillation (VF) is induced by a small electrical charge. The heart does not eject and is relatively still but not bloodless. The aorta is cross-clamped to render the heart ischemic. The heart can tolerate short periods (10–20 minutes) of ischemia, providing it is reperfused when the cross-clamp is released and allowed to beat following cardio version for short periods.)

Temperature Total circulatory arrest (core body temperature reduced to 15–18°C (pro found hypothermia). The metabolic rate of all body organs is reduced by 50% with every 7°C drop in temperature. Using this technique, circulatory arrest (in which the CPB machine is switched of) can be tolerated for up to 20–30 minutes.

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Coronary artery bypass graft clinical manifestations

The principal symptoms of IHD are chest pain or angina, breathlessness, fatigue, peripheral oedema, palpitations and syncope. The severity of symptoms and the extent to which the symptoms interfere with everyday activities and quality of life are important aspects of the clinical history.

Investigations

Resting electrocardiography As a baseline test, a 12-lead resting electrocardiogram (ECG)

Troponin and cardiac isoenzymes These are useful in assessing patients with an acute coronary syndrome

Exercise tolerance testing Exercise tolerance testing (ETT) is a valuable technique for assessing myocardial ischemia, both for diagnostic purposes and as a prognostic tool

Echocardiography Performed through either a transthoracic or transoesophageal approach,

Stress echocardiography can detect regional wall motion abnormalities brought on by exercise or the use of dobutamine or dipyridamole. It is reliable in identifying viable myocardium.

Radionuclide studies and cardiac magnetic resonance imaging

Positron emission tomography Positron emission tomography (PET) provides information on myocardial perfusion

Computed tomography With the development of ECG-gated

Coronary angiography

Coronary angiography

- Gold standard for imaging coronary anatomy
- Demonstrates extent, severity and location of stenosis
- Demonstrates quality and size of distal arterial tree
- Aids diagnosis of ischaemia
- Evaluates suitability for surgery
- Aids in prognostic assessment

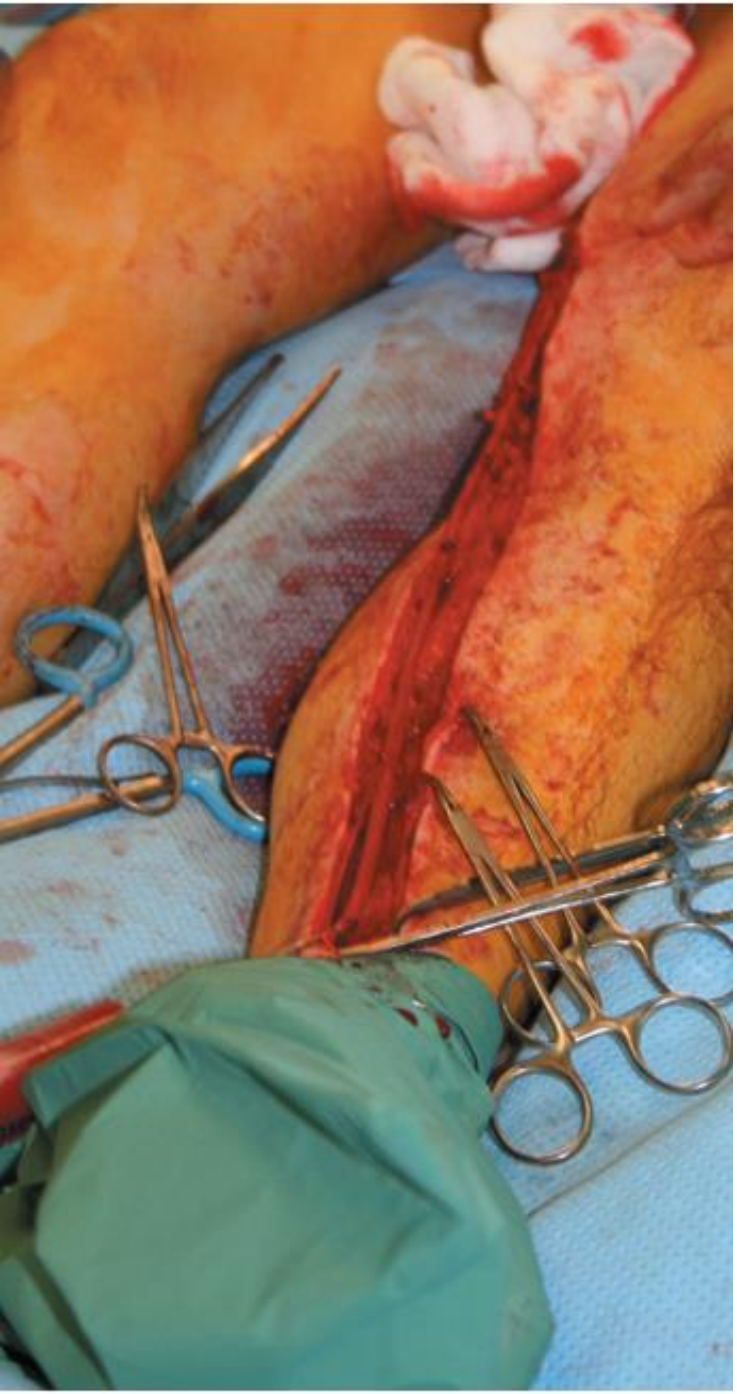
The myocardial revascularization guidelines of the Euro pean Society of Cardiology and the European Association for Cardio-Thoracic Surgery (EACTS) Indications for surgery

>50% stenosis of the left main stem (‘critical left main stem disease’)

>50% stenosis of the proximal left anterior interventricular artery

Three main coronary arteries diseased (‘triple-vessel disease’)

Two-vessel disease including the proximal LAD

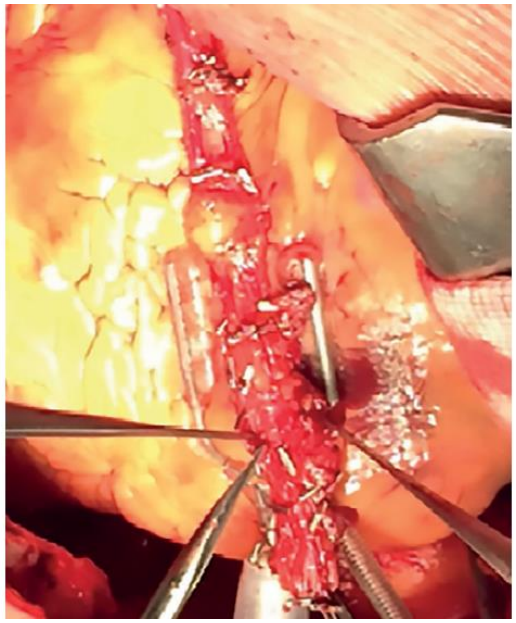


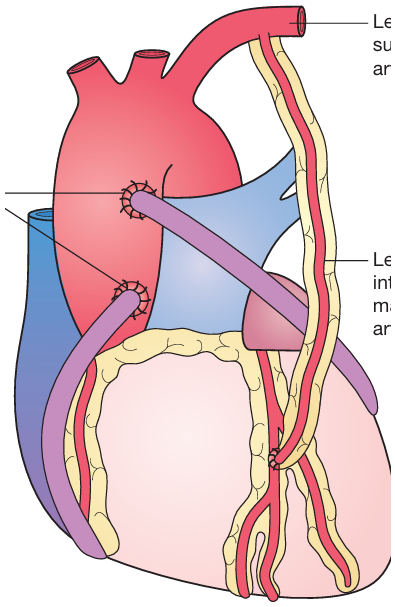
Selection of conduit

Venous grafts

- The long saphenous vein is the most commonly used venous conduit as it is straightforward to harvest, provides good length and is easy to handle. Historical studies showed a limited long term patency rate for long saphenous vein grafts (50–60% at 10 years). However, recent studies suggest that early postoperative use of lipid-lowering agents and antiplatelet agents such as low-dose aspirin can improve vein graft long-term patency.

- Alternative vein conduits include the short saphenous vein or upper limb veins such as the cephalic vein; however, these grafts are associated with poorer long-term patency rates.





Completed coronary artery bypass grafts.

Arterial grafts

- The left internal mammary artery (LIMA), or internal thoracic artery, has become the conduit of choice for LAD grafting. Evidence from the mid-1980s to the present day suggests a 10-year patency rate of >95%, with a lower reoperation rate.
- The use of the radial artery as an alternative arterial bypass graft has undergone a recent revival. This has been driven by the belief that total arterial revascularization (avoiding venous conduits) might improve long-term results of coronary surgery. Diferent studies have demonstrated excellent patency rates at 1 and 5 years with this strategy.

Postoperative complications

Bleeding Signifcant bleeding occurs in approximately 2–3% of patients.

Arrhythmias The most common postoperative arrhythmia is atrial fibrillation (AF). 30–60% of patients

Poor cardiac output state Myocardial function typically declines in the frst few hours following cardiac surgery

Neurological dysfunction Stroke occurs in approxi mately 2% of patients following CABG

Wound infection Significant deep wound infection resulting in sternal dehiscence and mediastinitis occurs in around 0.5–2% of patients.

Mortality In the UK, the mortality rate for patients undergoing CABG is 1–3%. M

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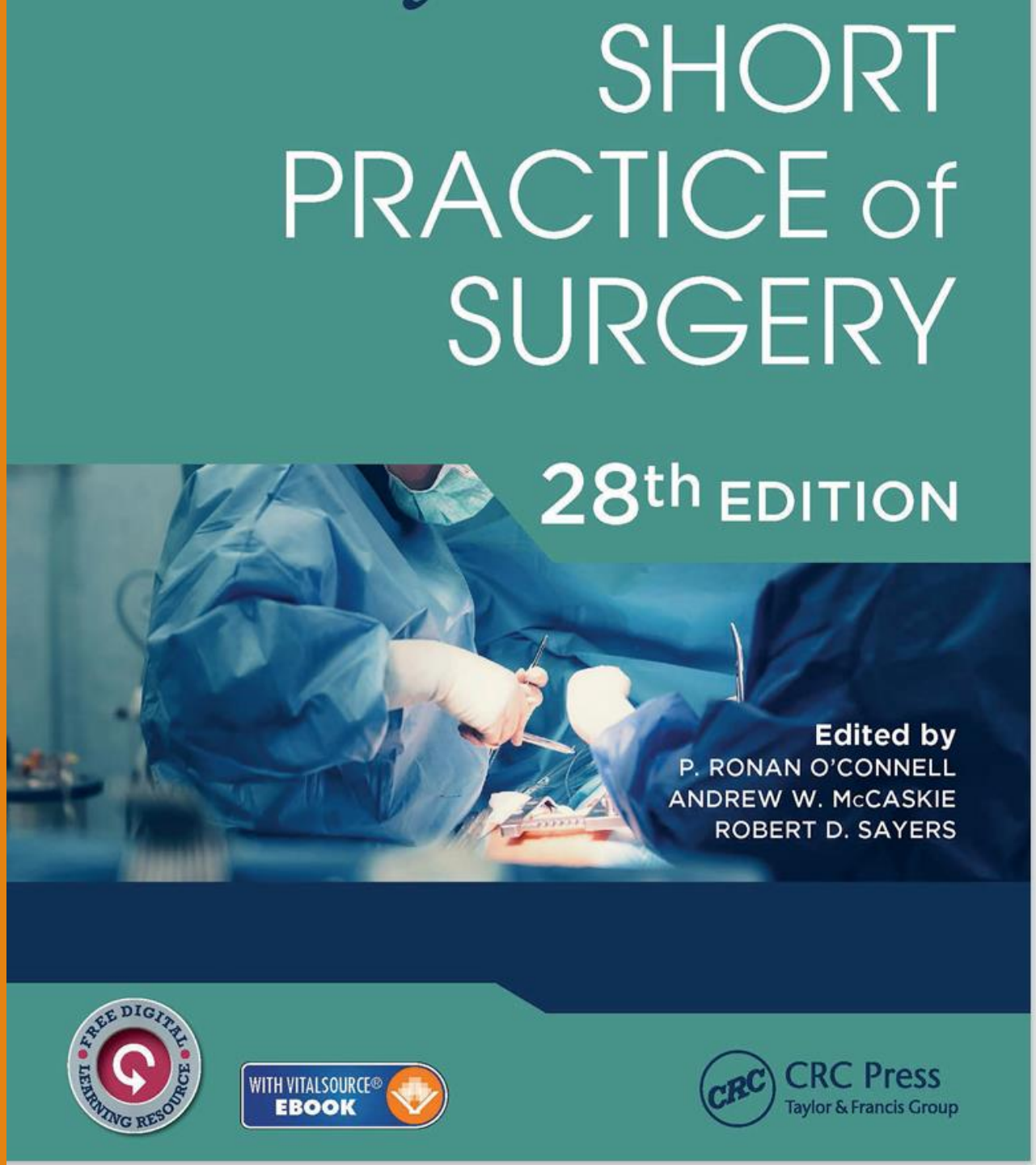
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