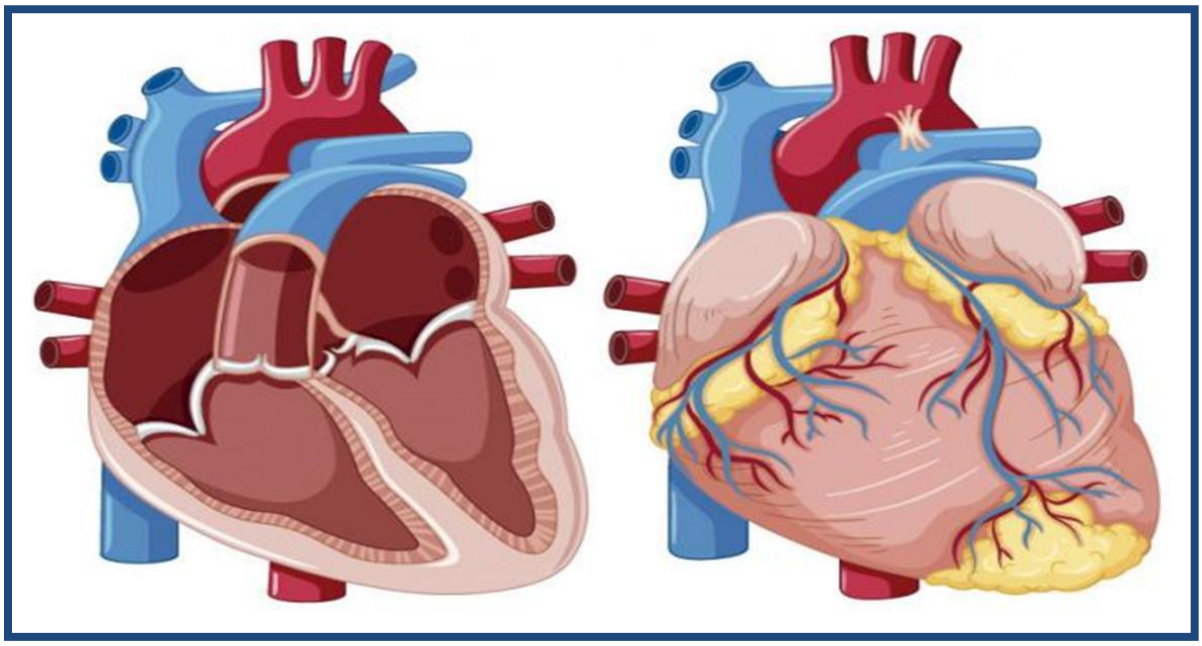
Faculty of Physical therapy
South Valley University

# Cardiothoracic Surgery



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# Clinical presentation of cardiothoracic diseases & indications for cardiothoracic surgical interventions

## Cough

**Definition: -** Cough is a defensive mechanism aiming at expulsion of secretions or inhaled particles from the respiratory tract

**Etiology: (Reflex - Central - hysterical)**
**I- Reflex cough:** Due to irritation of cough receptors:
**A- Respiratory causes**

| | |
|---|---|
| ***1. Pharyngeal diseases***: pharyngitis, tonsillitis,<br>ulcers, tumors, post-nasal discharge. | Painful, nonproductive ± nausea & vomiting |
| ***2. Laryngeal diseases***: Foreign body, laryngitis,<br>ulcers, tumors. | Paroxysmal, painful, **barking** ± hoarseness of voice or stridor. |
| ***3. Trachea- bronchial diseases***<br>- Bronchiectasis<br>- Bronchial asthma<br>- Bronchial tumors<br>- Pressure as mediastinal syndrome | According to the cause + expectoration<br>(see the table below) |
| ***4. Parenchymatous lung diseases:***<br>- Pneumonia, abscess, T.B.<br>- Collapse, fibrosis, interstitial lung disease.<br>- Pulmonary infarction | |
| ***5. Pleural diseases:***<br>Pleurisy, effusion, pneumothorax, hydropneumothorax & pleural fibrosis. | Usually, dry cough due to irritation exaggerated by activity and body movement. |

***Some types of expectoration (sputum):-***

| | |
|---|---|
| ***Frothy-(serous)*** | ▪ Pulmonary oedema (pink frothy sputum).<br>▪ Pulmonary venous congestion.<br>▪ Broncho alveolar carcinoma |
| ***Mucoid*** | ▪ Chronic bronchitis.<br>▪ Bronchial asthma. |
| ***Purulent - mucopurulent*** | ▪ Abscess and bronchiectasis.<br>▪ Any form of broncho pulmonary infection. |
| ***Rusty= Golden brown*** | ▪ Pneumonia. (Altered blood pigment) |
| ***Chocolate*** | ▪ Amebic lung abscess (Anchovy Sauce) |
| ***Red – current jelly*** | ▪ Bronchial carcinoma |
| ***Caseous*** | ▪ Tuberculosis = nummular sputum (coin like) |
| ***Black*** | ▪ Inhalation of carbon |

**B- Extra-respiratory causes**
**cardiovascular diseases**:
σ Pulmonary congestion e.g. left ventricular failure & MS
σ Pulmonary embolism
σ Pressure: aortic aneurysm, massive pericardial effusion or huge left atrium.
**Mediastinal diseases:** Aortic aneurysm, tumor, L.N. retrosternal goiter
1. **Brassy:** - tracheal causes (metallic form = mediastinal synd.)
2. **Bovine**: - Lt. RLN paralysis (hollow).
**Other causes:**
**Abdominal causes**: e.g. subphrenic abscess
**Meningeal causes:** e.g. meningitis & subarachnoid hemorrhage.
**Aural causes:** e.g. otitis media.
**Drugs:** ACEI
II- **Central cough:** Due to irritation of cough center.
**Causes:** Brain tumors, cerebrovascular strokes, encephalitis.
**Features:** Dry cough and neurological manifestations.
III- **Hysterical** (Psychogenic) cough: Usually in young females.
Dry & barking cough occurring in front of audience.

***Complications of Chronic Cough***

| **Thoracic** | **Extra thoracic** |
|---|---|

| | |
|---|---|
| 1. Muscular (chest) pain<br>2. Pneumothorax<br>3. Emphysema.<br>4. Hemoptysis | 6. Eye puffiness<br>7. Subconjunctival hemorrhage.<br>8. Retinal detachment<br>9. Subarachnoid or cerebral hemorrhage.<br>10. Hernia<br>11. Rectal prolapsed<br>12. Stress incontinence of urine<br>13. Cough syncope<br>14. Insomnia & exhaustion<br>15. Dissemination of infection. |

## Approach to the patient:

1. **Is the cough acute or chronic:**
   - Acute (less than 3 weeks): pneumonia, laryngitis, smoking.
   - Subacute (3-8 weeks)
   - Chronic (more than 8 weeks): COPD, GERD.
2. **Is the cough dry or productive:**
   - Dry cough: pleurisy, drugs.
   - Productive cough: chronic bronchitis, bronchiectasis, lung abscess.
3. **Characteristic:**
   - Whooping
   - Hoarse
   - Brassy
   - Moist
   - Wheezy
4. **Timing**:

- Morning cough (“wash up cough”) – smokers cough
- Day cough
- Night cough (“nocturnal cough”)
- All day long cough
- Spring/Autumn: allergic cough
- Winter: asthma, bronchitis.

## Threatening symptoms:

- Cough with increasing intensity that lasting for more than one week.
- Cough accompanied by hyperthermia above 38 °C for 3 days or more.
- Cough accompanied by dyspnea and chest pain on breathing.
- Cough associated with hemoptysis.
- Cough with dyspnea.
- Cough associated with weakness, and weight loss.
- Cough associated with excessive sweating and shivering.
- Sudden attack of severe cough.
- Severe cough during an hour without any interval.
- Abundant expectoration of sputum.

## Sputum production (expectoration)

**Definition:** Expectorated respiratory secretions.

**What is the color:**

(A) White: Clear, mucoid asthma, COPD without infection, bronchogenic carcinoma.

(B) Yellow: Asthma, respiratory tract infections.

(C) Green: Chronic infection e.g. COPD, Bronchiectasis.

(D) Red: Pneumonia, heart failure, other causes of hemoptysis.

## Amount of sputum

1. **Small**
2. **Large Cups:**
   - Bronchiectasis
   - Lung abscess
   - Empyema
   - Bronchogenic carcinoma (watery sputum)

### Odor

**Foul odor due to anaerobic infections:** Lung abscess **–** Bronchiectasis**-** Empyema.

# Hemoptysis

**Def:** Coughing of blood that originates below the vocal cords.

**Etiology:**

**1. Larynx: e.g.** laryngitis, foreign body, tumors, ulcers.

**2. Tracheobronchial: -**

- Bronchogenic carcinoma
- Bronchiectasis
- Acute & chronic bronchitis.

**3. Pulmonary:**

- Infections: Pulmonary tuberculosis, Lung abscess, Pneumonia.
- Massive pulmonary embolism.
- Trauma.
- Pulmonary arteriovenous malformations.

**4. Cardiovascular causes:**

- Pulmonary congestion: due to left-sided heart failure.
- Pulmonary oedema

**5. Systemic causes:** Hemorrhagic blood diseases as hemophilia.

**Appearance:**

**Streaking of clear sputum or large blood clots:** Lung cancer **-** Pulmonary infarction **-** Pulmonary edema

**Hemoptysis with purulent sputum:** Pneumonia **–** Bronchiectasis **-** Lung abscess

**Pinkish frothy:** Pulmonary edema **-** Mitral valve disease **-** Heart failure

**Amount:**

Massive hemoptysis: amount of blood about 200-600 ml, in these cases:

1. Cavitating T.B.
2. Bronchogenic Carcinoma.
3. Pulmonary Infarction
4. Bronchial Carcinoid

**Duration & frequency:**

Daily for weeks & months:

T.B.

Lung cancer

Lung abscess

Intermittently for years: Bronchiectasis

Single episode (Massive, chest pain, dyspnea): Pulmonary infarction

## Dyspnea (breathlessness)

***Definition:*** abnormally uncomfortable awareness of breathing (Shortness of breath).

***Etiology****: -*

***I- cardiovascular diseases:***

- Pulmonary congestion: e.g. mitral stenosis & heart failure.
- Massive pulmonary embolism & pulmonary infarction.
- Massive pericardial effusion.

***II- respiratory diseases:***

- Laryngeal diseases: Inhaled FB, tumors, laryngeal spasm or oedema.
- Tracheal diseases: Chronic obstructive lung disease, bronchial asthma, bronchiectasis or tumors.
- Lung diseases: consolidation, collapse, Interstitial lung diseases, acute respiratory distress syndrome (ARDS), or bronchogenic carcinoma.
- Pleural causes: effusion, pneumothorax & pleural fibrosis.
- Chest wall: chest wall deformity, fracture ribs.

***III-General diseases:***

Anemia, thyrotoxicosis, hemorrhage & shock.

***Pathogenesis of Cardiac Dyspnea:***

***A. Mechanical factors***

1. Pulmonary congestion: Interstitial pulmonary oedema which leads to diminished alveolar compliance (the most important factor), oedema of bronchial mucosa & bronchospasm.
2. Low cardiac output.
3. Pleural effusion: Leading to mechanical compression of the lungs.
4. Other causes: Right-sided heart failure, massive pericardial effusion lead to ascites

and enlarged tender liver which may elevate the diaphragm and decrease its mobility.

***B. Nervous factors:*** due to activation of neurohormonal mechanisms.

***C. Chemical factors:***

- Hypoxia (decrease oxygen) occurs due to low cardiac output & pulmonary congestion.
- Hypercapnia (increase Co2) occurs due to tissue hypoxia.

***Variants of Dyspnea:***

***A. Exertional dyspnea*:**

- Occurs on during exertion and subsides with rest.

– Commonly due to heart failure or lung disease**.**

*NYHA (New York Heart Association ):*

∗ Grade I: dyspnea on extraordinary effort (severe exertion).
∗ Grade II: dyspnea on ordinary effort (moderate exertion).
∗ Grade III: dyspnea on less than ordinary effort (mild exertion)
∗ Grade IV: dyspnea at rest.

***B. Orthopnea:*** Dyspnea on lying flat which relieved by sitting. It is a symptom of left ventricular failure.

***occurs due to:***

1- Redistribution of fluid from the lower extremities to the lungs that increase the venous return which aggravates pulmonary congestion.
2- Elevation of the **diaphragm**.
3- Interference with the action of **respiratory muscles**.

***C. Paroxysmal Nocturnal Dyspnea (PND):*** dyspnea that awakes patient from sleep.

***Clinical picture:***

The patient awakes one or two hours after sleep with severe dyspnea, cough and frothy sputum. Sometimes, wheeze may be present due to bronchial oedema & bronchospasm.

***Pathogenesis:***

*1. Increased venous return aggravates pulmonary congestion.*
*2. Elevation of the diaphragm.*
*3. Interference with the action of respiratory muscles.*
4. Absorption of oedema fluid into the circulation (increase the venous return).
5. Decreased sympathetic activity during sleep.

## *Oedema*

***Definition:*** Accumulation of excessive fluid in the interstitial spaces.

***Pathogenesis:***

***1. Increased capillary hydrostatic pressure:***

- Increased venous pressure in cases of heart failure, pericardia effusion, venous occlusion e.g. thrombosis.

- Salt & water retention.

***2. Decreased plasma osmotic pressure:*** Due to hypoproteinemia and decrease albumin in blood***.*** This occurs in cases of: Malnutrition, Malabsorption, Liver cell failure, Nephrotic syndrome.

***3. Increased capillary permeability:***

- Inflammation: e.g. Infection, Allergy.

***4. Lymphatic obstruction***

***Generalized Oedema:***

- ***Cardiac***: Right-sided heart failure, pericardial effusion.
- ***Hepatic***: Liver cell failure.
- ***Renal***: Nephrotic syndrome.
- ***Nutritional***: Malnutrition, Malabsorption.
- ***Severe allergy.***

**Pathogenesis of Cardiac Oedema:**

***A. Increased capillary hydrostatic pressure:***

1. Increased venous pressure: due to stagnation of blood in the systemic veins.
2. Salt & water retention (see later)

***B. Hypo-albuminemia:***

1. Diminished protein **intake** due to anorexia & vomiting.
2. Diminished protein **absorption** due to intestinal congestion.
3. Diminished albumin **synthesis** in the liver.
4. Increased protein **loss** in urine.

***C. Increased capillary permeability:*** due to hypoxia.

1. *Decrease Glomerular filtration rate & urine output:* (Low cardiac output).

*2. Secondary hyperaldosteronism: -*

- Secondary to low CO (reduction of renal blood flow ----- rennin)

- Diminished destruction ------congested liver.

*3. Increased ADH: due to:*

- Increased production secondary to low CO - Diminished destruction.

*4. Decreased secretion of renal prostaglandins.*

**Clinical picture of Cardiac oedema: -**

1. ***Dependent:*** Oedema of lower limbs.
2. ***Bilateral & equal***.
3. ***Lower limbs precede ascites:*** however, ascites may be the first " Ascites precox".
4. ***Pitting & not tender***.
5. ***Associated*** with other features of cardiac disease.

**Causes of Local Oedema**

1. Venous obstruction.
2. Lymphatic obstruction.
3. Inflammatory oedema.

## Syncope

***Definition:***

Sudden transient loss of consciousness.

***Pathophysiology:***

Decreased cerebral perfusion is the final common pathway leading to syncope.

***Clinical pictures:***

Patients may describe a syncopal episode in many ways, including blackout, dizzy spell, and
seizure or unexplained falls, particularly in elderly persons.

***Etiology:***

1. Vasomotor syncope **(the commonest)**

Vasovagal syncope (neurogenic syncope): (known as *simple fainting)*
- occurs due to severe vagal stimulation --- *severe bradycardia, hypotension, pallor & sweating.*

***- Causes***: *sudden severe fear, pain, and trauma (***e.g.** *to testicles).*

2. Cardiac syncope: Any cause of **low cardiac output**:

– ***A***ortic stenosis.
– ***A***cute heart failure.
– ***A***rrhythmias.

3. Cerebral syncope (Reduced cerebral blood flow)

– Vertebrobasilar TIAs.

4. Hypoxic syncope **(↓ O2 content of the cerebral blood flow)**

– occurs in cases of cyanotic heart diseases or severe anemia.

5. Postural syncope **(Orthostatic syncope)**

# Cardiovascular causes of chest pain

| | |
|---|---|
| ***Myocardium*** | Ischemic heart disease: angina – myocardial infarction. |
| ***Pericardium*** | Pericarditis - pericardial effusion. |
| ***Endocardium*** | Mitral valve prolapse. |
| ***Aorta*** | Aortic aneurysm - dissection. |
| ***Pulmonary*** | P. embolism. |

| ***Cardiac neurosis:*** |
|---|
| • Neurotic patients especially females.<br>• Pain: - Localized left inframammary.<br>• Stitching, of variable duration. No relation to exertion. -Not relieved by rest.<br>• Associations other neurosis.<br>• Normal cardiac examination. |

| ***Don't forget*** |
|---|
| • ***Analysis:*** as any pain (11 points with stress on the 3 variants) |
| 8 as usual |
| ✓ Onset - Course - Duration.<br>✓ Association.<br>✓ What 🡅 and what 🡇.<br>✓ Effect of treatment.<br>✓ Date of last attack. |
| + 3 |
| ✓ Site.<br>✓ Radiation.<br>✓ Character |

History is very important.

Although a cardinal manifestation of heart disease, also originates from:

Non-cardiac intrathoracic structures:

Aorta, pulmonary artery, bronchopulmonary tree, pleura, mediastinum, esophagus and diaphragm.

Tissues of the neck and thoracic wall:

Skin, thoracic muscles, cervicodorsal spine, costochondral junctions, breasts, sensory nerves and spinal cord.

Subdiaphragmatic organs:

Stomach, duodenum, pancreas and gallbladder.

**Points to note in the history:**

– Location

– Radiation

– Character

– Aggravating factors

– Relieving factors

– Time relationships

duration, frequency and pattern of occurrence

– Setting in which it occurs

– Associated factors

**Causes of acute chest pain:**

1. ischemic heart disease: Angina pectoris and acute myocardial infarction.
2. Acute pleurisy and acute pericarditis.
3. Massive pulmonary embolism and pulmonary infarction.
4. Aortic dissection.
5. Acute massive lung collapse
6. Pneumothorax
7. Esophageal spasm, esophagitis.
8. Mediastinal emphysema.

## Palpitations

***Definition:***

– unpleasant awareness of forceful or rapid beating of the heart

– caused by disorders of cardiac rhythm and rate

***History in palpitation:***

– isolated jump or skips: extrasystoles

– attacks with abrupt beginning, rapid heart rate with regular or irregular rhythm: paroxysmal tachycardias

– independent of exercise or excitement to account for the symptom: atrial fibrillation, atrial flutter, thyrotoxicosis, anemia, anxiety states

- Associated with drug use: tobacco, coffee, tea, alcohol epinephrine, Aminophylline.

- On standing postural hypotension.

- Middle aged women associated flushes and sweats: menopausal syndrome.

- Associated with normal rate and rhythm: anxiety state.

## Fatigue

- Non-specific.
- Common in patients with impaired cardiovascular function consequent to a reduced cardiac output.
- Associated with muscular weakness.
- May be caused by drugs e.g. β-blockers.
- May also result for excessive blood pressure reduction in patients with hypertension or heart failure.
- Caused by excessive diuresis or diuretic induced hypokalemia**.**

## Other symptoms

- Nocturia: common in early heart failure
- Anorexia
- Abdominal fullness
- Right upper quadrant abdominal discomfort
- Weight loss
- Cachexia

## Heart failure (HF)

*1. Left sided HF associated with pulmonary congestion*

- ✓ *Dyspnea*
- ✓ *Orthopnea*
- ✓ *Paroxysmal nocturnal dyspnea*

*2. Right sided HF associated with generalized congestion*

- ✓ *Liver congestion and jaundice*
- ✓ *Ascites*
- ✓ *Bilateral LL edema*

## Pre-operative assessment of patients before cardiothoracic surgery

**Definition**: The preoperative period runs from the time that the patient is admitted to the hospital to the time that the surgery begins.

**Types of patients:**

1- Out-Patient Department: Usually seen 1-2 weeks before surgery at preadmission clinic.
2- Emergency department: Need initial assessment & immediate resuscitation.

**Pre-operative plan:**

- Gather and record all relevant information
- Optimize patient condition
- Choose surgery with minimal risk and maximum benefit.
- Anticipate and plan for adverse events
- Inform everyone concerned.

**Steps of pre-operative assessment**

- History
- Examinations
- Investigations
- Preoperative treatments
- Documentation
- Communications – Valid consent

**Clinical evaluation**

- Complete history.
- Smoking, poor exercise tolerance, unexplained dyspnea or cough unrecognized chronic lung disease should be determined.
- Good physical examination: -

- directed toward evidence for obstructive lung disease.
- decreased breath sounds, wheezes, rhonchi, or prolonged expiratory phase.

## Examination

- General: positive findings even if not related to the proposed procedure.
- Surgery related: type and site of surgery, complications which have occurred due to underlying pathology.
- Systemic: Comorbidities and their severity.
- Specific: For example, suitability for positioning during surgery.

### General Physical Ex:

To check fitness for anesthesia & surgery.

General physical examination.

Systemic:

- CVS

- CNS

- GIT

- Respiratory system

**Specific Surgical Ex:** Its aim: to confirm previous findings & diagnosis, to determine severity & to gauge extent.

**Specific Medical Ex:** Its aim: to evaluates the presence & severity of other problems. E.g. Diabetic patient undergoing surgery need careful examination for sepsis, neuropathy or microvascular disease.

| | |
|---|---|
| General | Anaemia, jaundice, cyanosis, nutritional status, sources of infection (teeth, feet, leg ulcers) |
| Cardiovascular | Pulse, blood pressure, heart sounds, bruits, peripheral oedema |
| Respiratory | Respiratory rate and effort, chest expansion and percussion note, breath sounds, oxygen saturation |
| Gastrointestinal | Abdominal masses, ascites, bowel sounds, hernia, genitalia |
| Neurological | Consciousness level, cognitive function, sensation, muscle power, tone and reflexes |

**Investigations (Routine)**

- ▶ Every unit and ward have its own protocol.
- ▶ The tests which normally performed on most
- ▶ patient coming to surgery:

* Full Blood Count

* Basic Biochemistry: urea & creatinine, random blood sugar, prothrombin time and concentration & INR.

* Chest Radiography (Chest x ray)

**Investigations – Targeted tests**

- ❑ Hematology: to exclude anemia, for platelets count & to assess the amount of blood may be needed during or after operation.
- ❑ Urea, Creatinine & Electrolytes: state of dehydration & renal insufficiency.
- ❑ Liver Function Tests: Albumin & protein guide to nutritional status & shows any clotting problems.

## Investigations – Others

- ECG: It's recommended in all patients.
- Urinalysis: used for determination of renal function, inflammation, infection & metabolic disorders.
- Serology: HCsAg, HBsAg & HIV testing.
- Random blood sugar & HbA1c: Diabetes mellitus
- Blood gas analysis: needed in some cases

## Risk factors

1.Patient related risk factors.

2. Procedure related risk factors.

3. Preoperative risk assessment.

4. Risk reduction strategies.

## 1. Patient related risk factors

### A. Age:

- Minor risk factor
- independent predictor
- ASA risk class 3 or 4, and advanced age (> 50yr) independent risk factors.
- Surgery should not be declined in elderly patients who are otherwise acceptable surgical candidates.

**Table 1: American Society of Anesthesiologists Classification**

| |
|---|
| **Class I:** There is no organic, physiologic, biochemical, or psychiatric disturbance. The pathologic process for which the operation is to be performed is localized and is not a systemic disturbance. |
| **Class II:** Mild to moderate systemic disturbance caused either by the condition to be treated surgically or by other pathophysiological processes. |
| **Class III:** Severe systemic disturbance or disease from whatever cause, even though it may not be possible to define the degree of disability with finality. |
| **Class IV:** Indicative of the patient with severe systemic disorder already life-threatening, not always correctable by the operative procedure. |
| **Class V:** The moribund patient who has little chance of survival but is submitted to the operation in desperation. |

**B. Obesity:** Morbid obesity lead to lung restriction, decrease thoracic compliance, alveolar hypoventilation.

**C. Smoking:** It is an important risk factor. Smoking history of more than 40 years or more increase risk of pulmonary complications

**D. General health status:** American Society of Anesthesiologists (ASA) classification. Goldman cardiac risk index include factors from history, physical examination and laboratory data.

**E. COPD:**

Patient with severe COPD are 6 times more likely to have major postoperative pulmonary Complication.
A careful preoperative evaluation of patients with COPD and identification of high-risk patients. Optimizing their treatment before surgery.

**F. Asthma:**

Inadequate control of asthma →↑risk of postoperative complications.
Well controlled, peak flow measurement of >80% of predicted or personal best → average risk.
Asthmatic patients treated with corticosteroids before surgery have a low incidence of complications.

## Goldman cardiac risk index

| Variable | Point score |
|---|---|
| **History** | |
| Age >70 years | 5 |
| Preoperative MI within six months | 10 |
| **Physical examination** | |
| S3 gallop or increased JVP >12 cm H2O | 11 |
| Significant valvular aortic stenosis | 3 |
| **ECG** | |
| Rhythm other than sinus, or atrial ectopy | 7 |
| VPBs >5/minute at any time | 7 |
| **General medical status - one or more of the following:** | **3** |
| PO2 <60 or PCO2 >50 mmHg | |
| Serum K <3.0 or HCO3 <20 meq/L | |
| BUN >50 or creatinine >3.0 mg/dL | |
| Chronic liver disease or debilitation | |
| **Operation** | |
| Intraperitoneal, intrathoracic, or aortic | 3 |
| Emergency | 4 |
| **Total possible points** | **53** |
| | |
| Class I | 0-5 |
| Class II | 6-12 |
| Class III | 13-25 |
| Class IV | >25 |

Table 2: Patient related risk factors for postoperative pulmonary complications[8]

| Risk Factors | Type Of Surgery | Incidence of Pulmonary Complications (%) | |
|---|---|---|---|
| | | Factor Present | Factor Absent |
| Age>65 yr | Unselected | 09 – 17 | 04 - 09 |
| | Thoracic or abdominal | 17 – 22 | 12 – 21 |
| Obesity | Unselected | 11 | 09 |
| | Thoracic or abdominal | 19 – 36 | 17 – 27 |
| Smoking | Coronary bypass | 39 | 11 |
| | Abdominal | 15 – 46 | 06 – 21 |
| ASA class >II | Unselected | 26 | 16 |
| | Thoracic or abdominal | 26 – 44 | 13 – 18 |
| COPD | Unselected | 06 – 26 | 02 – 08 |
| | Thoracic or abdominal | 18 | 04 |

## 2. Procedure related risk factors

### 1. Surgical site:

The most important predictor of pulmonary complications.

The complication rates for upper abdominal and thoracic surgery are the highest (range 10% to 40%).

Upper abdomen: - Incisions cross the abdominal muscle, ↓ diaphragmatic motility → ↓Vital capacity.

Lateral thoracotomy: - Incision of the intercostal muscle, introduction of a pleural drain → pleural effusion, post-operative pain → ↓ thoracic compliance.

Thoracotomy: -

a. Without pulmonary disease: -

Vital capacity ↓ to 60~70% of the pre-operative value

Recovering the baseline value from one to two weeks, even if the restrictive defect can last longer, if thoracic pain persists.

b. With pulmonary disease: -

The effects of thoracotomy are amplified by the coexistence of a pulmonary disease

Thoracotomy → thoracic pain → ↓deep breathing, effective coughing → atelectasis, bronchial mucous retention, worsening of gas exchange.

c. Video-assisted thoracoscopic surgery (VATS):- reduced pain, postoperative complications, and better ventilatory function during very early postoperative period after lung resection than standard thoracotomy. same or better prognosis with a lesser resection by wedge resection with VATS in patients with small lung cancer.
d. Heart-surgery: - usually require median sternotomy functionally better tolerated than lateral thoracotomy (due to preserves the pleural space). respiratory function is generally well preserved, except for a transitory reduction in pulmonary volumes.

**2. Size of removed lung parenchyma**

a. Removal of non-functional lung:

- Bulla may cause an improvement or at least no deterioration in lung function
- Bronchiectasis ↓secretions and purulent exudates
- Benign diseases (ex. thickened pleura decortication) may allow the remaining lung to re-expand.
- However, in most patients, thoracic surgery results in some function impairment

b. Lobectomy:-

- Lobectomy shows less functional consequences than pneumonectomy.
- The remaining lobes on that side rapidly expand to fill the vacant space.
- Only a modest reduction in VC.
- After surgery, the adaptation of the remaining lobe may take up to three months.

**3. Duration and type of anesthesia**

**4. Type of neuromuscular blockade**

## 3. Preoperative risk assessment

- Resective thoracic surgery
- Extra-thoracic and thoracic surgery without lung resection

**Resective thoracic surgery**

Clinical evaluation

History & physical examination

Pulmonary function test

Blood gas analysis

Cardiopulmonary exercise test

## Pulmonary function testing

All candidates for lung resection should have preoperative PFT

PFTs should not be ordered routinely prior to abdominal surgery or other high-risk surgeries.

Patients undergoing coronary bypass with a history of smoking or dyspnea.

These tests simply confirm the clinical impression of disease severity in most cases, adding little to the clinical estimation of risk.

At-risk patients require a closer diagnostic examination to estimate the likely post-resection pulmonary reserve

Table 2 . Criteria for estimating the post-operative risk in lung resective surgery

| Lung Function Test | Parameters | Increased Risk | High risk |
|---|---|---|---|
| Spirometry | $FEV_1$<br>MVV | < 50 % of the predicted value or < 2 Litres | < 1 Litre<br>< 50 % of the predicted value |
| Diffusion Capacity | $DL_{CO}$ | < 60 % of the predicted value | |
| Blood Gas Analysis | $SaO_2$<br>$PaCO_2$ | < 90%<br>> 45 mm Hg | |

## Table-4: Risk reduction strategies for postoperative complications

**Preoperative measures**
Cessation of cigarette smoking for at least 8 weeks before surgery
Treat airflow obstruction
Treat respiratory infection if present
Educate for lung-expansion maneuvers
**Intra-operative measures**
Limit duration of surgery to less than 3 hours
Avoid use of pancuronium
Use spinal or epidural anaesthesia when possible
Use laproscopic procedures when possible
**Postoperative measures**
Epidural analgesia or intercostals nerve bloc for pain control
Early mobilization
Chest physical therapy (including deep breathing and incentive spirometry)
Continuous positive airway pressure in selected patients

## Thoracic surgical interventions

### *Purpose of thoracic surgery:*

- Diagnose by endoscopic or open biopsy
- Treat disease by resection, replacement, or repair of tissue
- Correct structural deformity
- Traumatic injury repair

### *Types of cardiothoracic surgery:*

1. Cardiac Surgery:
   – Acquired (IHD, RHD).
   – congenital heart disease.
2. Vascular Surgery:
   – aneurysms.
   – aortic dissection.
3. General Thoracic Surgery:
   – Pulmonary – Pleura
   – Chest Wall – Mediastinum
   – Pericardial – Esophagus

### *Indications for thoracic surgery:*

1. Malignancy.
2. Inflammatory.
3. Trauma.
4. Degenerative.
5. Congenital.

## Thoracic surgery approaches

1. **Conventional surgery:**
   - Mediastinotomy / Chamberlains procedure.
   - Mini thoracotomy.
   - Full thoracotomy.
   - Median sternotomy.

2. **Endoscopies & minimally invasive thoracic surgery:**
   - Bronchoscopy & esophagoscopy.
   - Video-assisted thoracoscopic surgery (VATS).
   - Mediastinoscopy.
   - Robotic surgery.

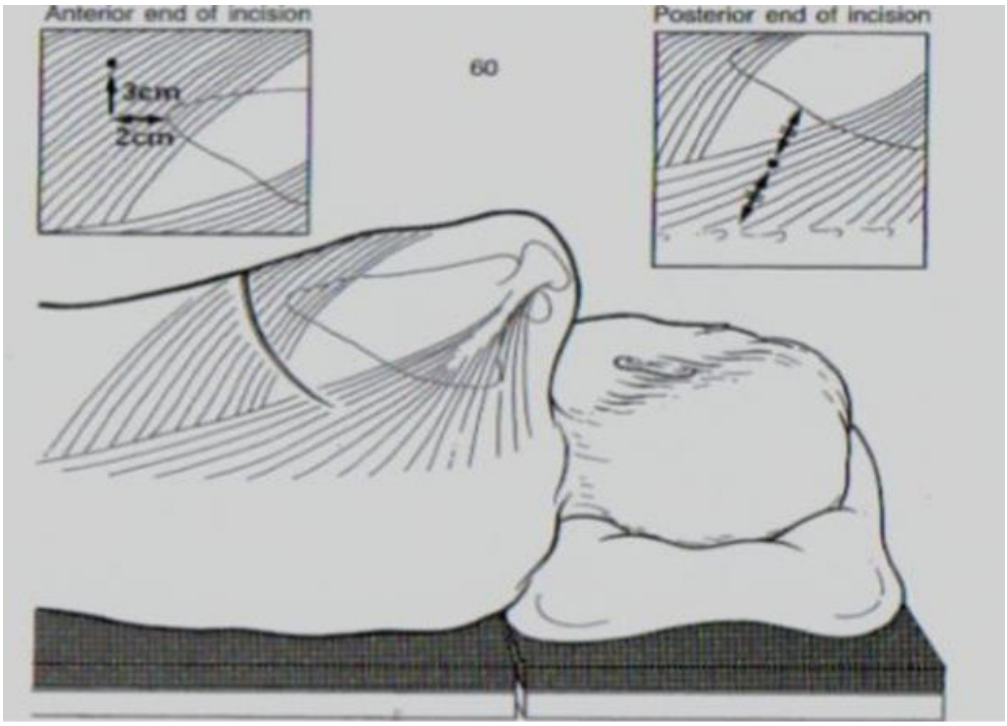
## Advantages of VATS over thoracotomy

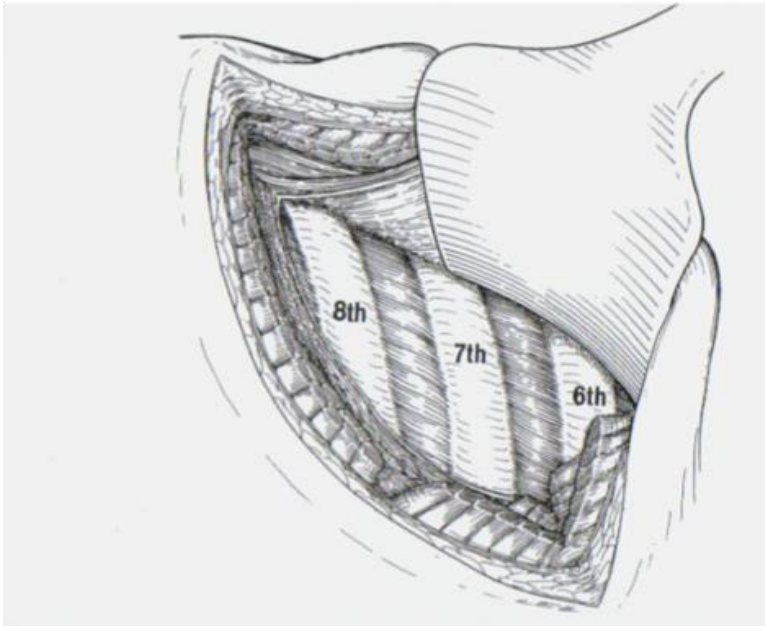
- Operative time is faster or equivalent.
- Small incision which is more cosmetic.
- Less pain.
- Less blood loss.
- Lower incidence of post thoracotomy pain.
- Less postoperative shoulder dysfunction.
- Short term respiratory function test is better.
- Shorter hospital stays.
- Improved quality of life.

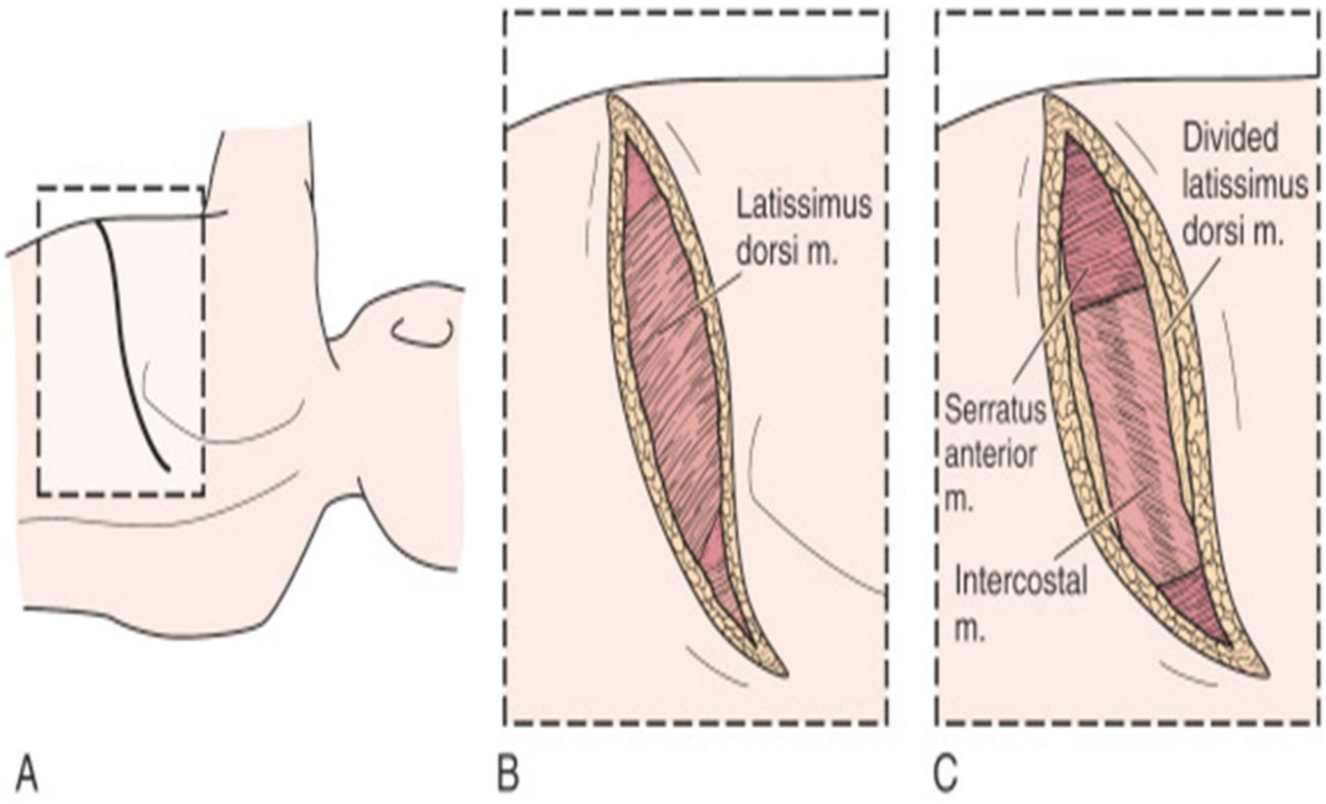
**Types of thoracotomies:**

- Posterolateral
- Lateral
- Anterolateral
- Mini thoracotomy
- Muscle sparing

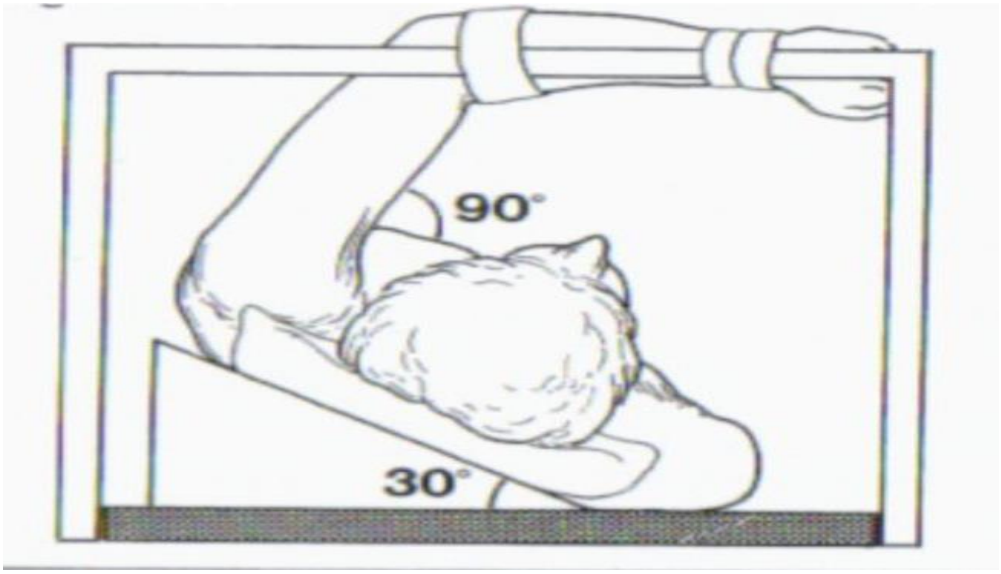
**Posterolateral thoracotomy:**

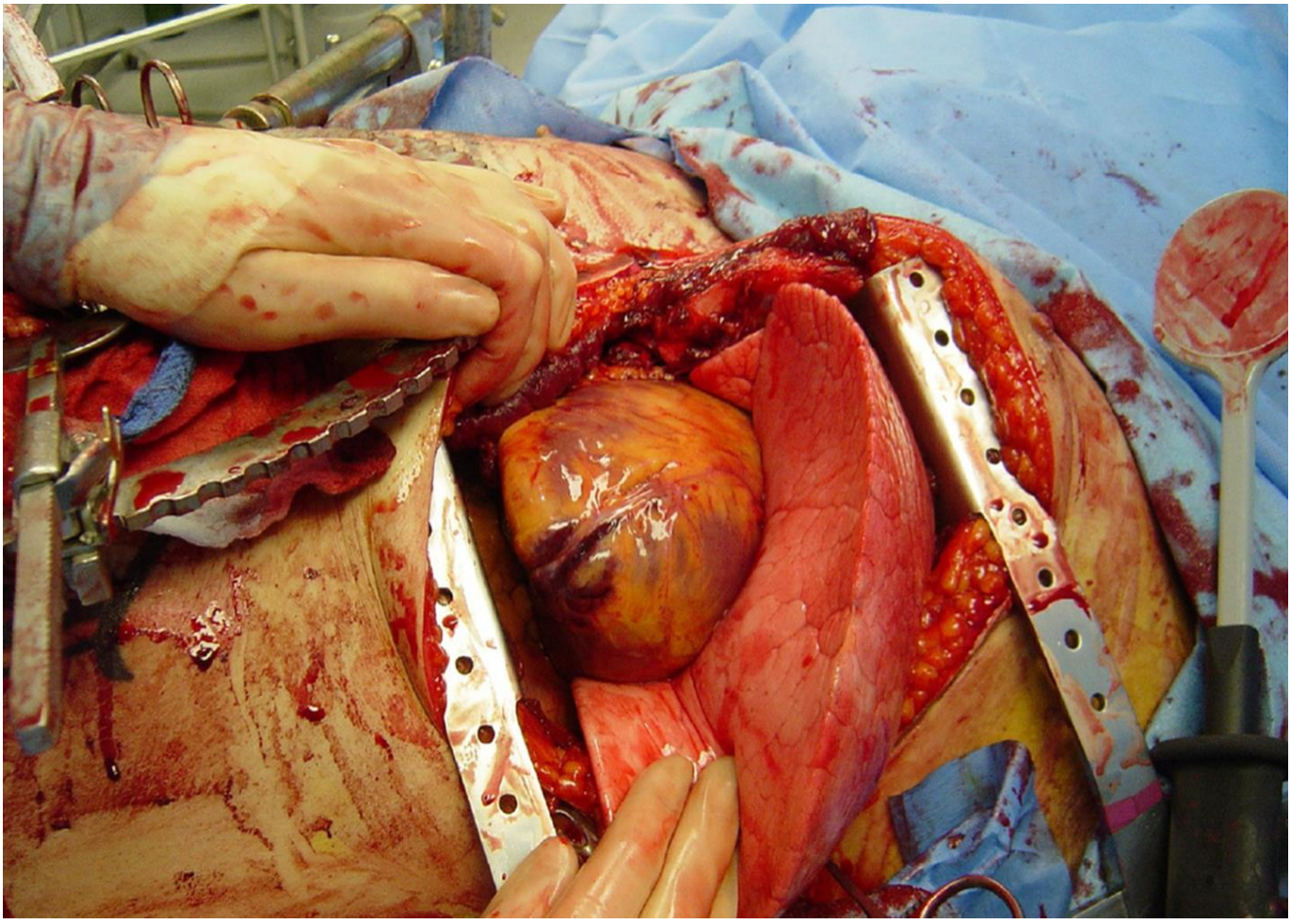


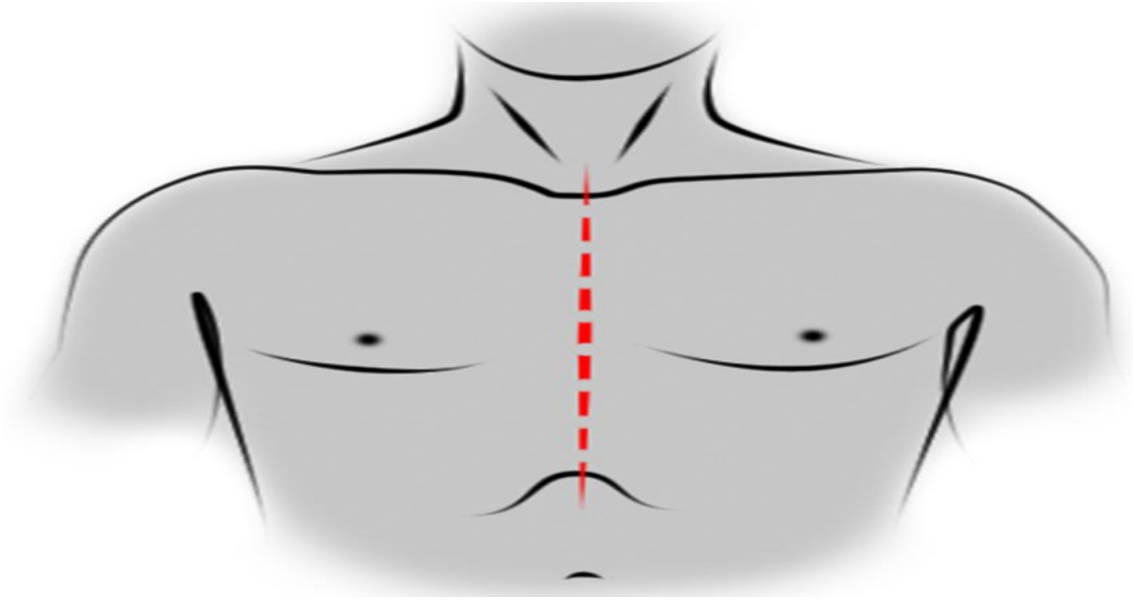

Latissimus
dorsi m.
Divided
latissimus
dorsi m.
Serratus
anterior
m.
Intercostal
m.
A
B
C

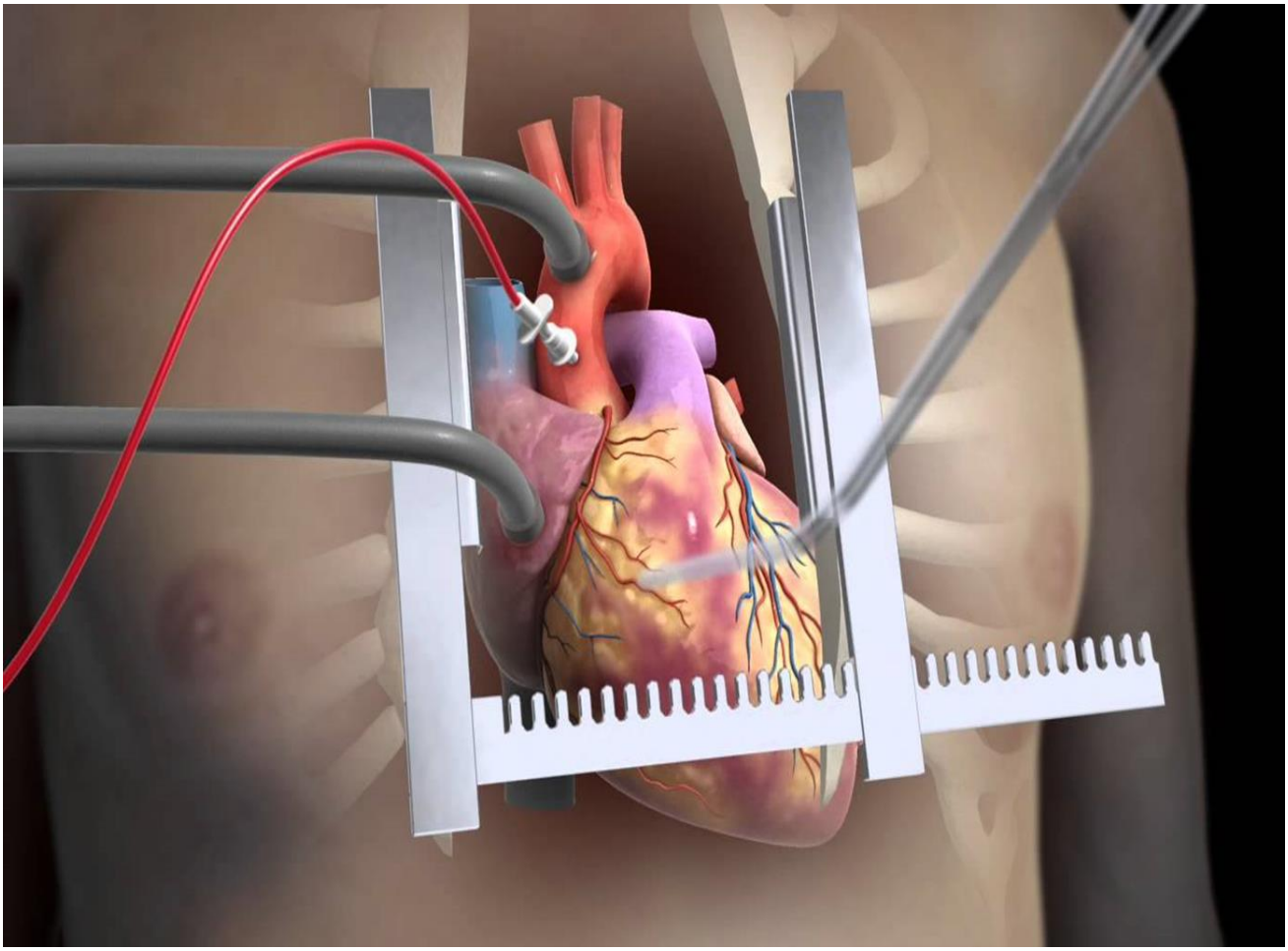
## Anterolateral thoracotomy:



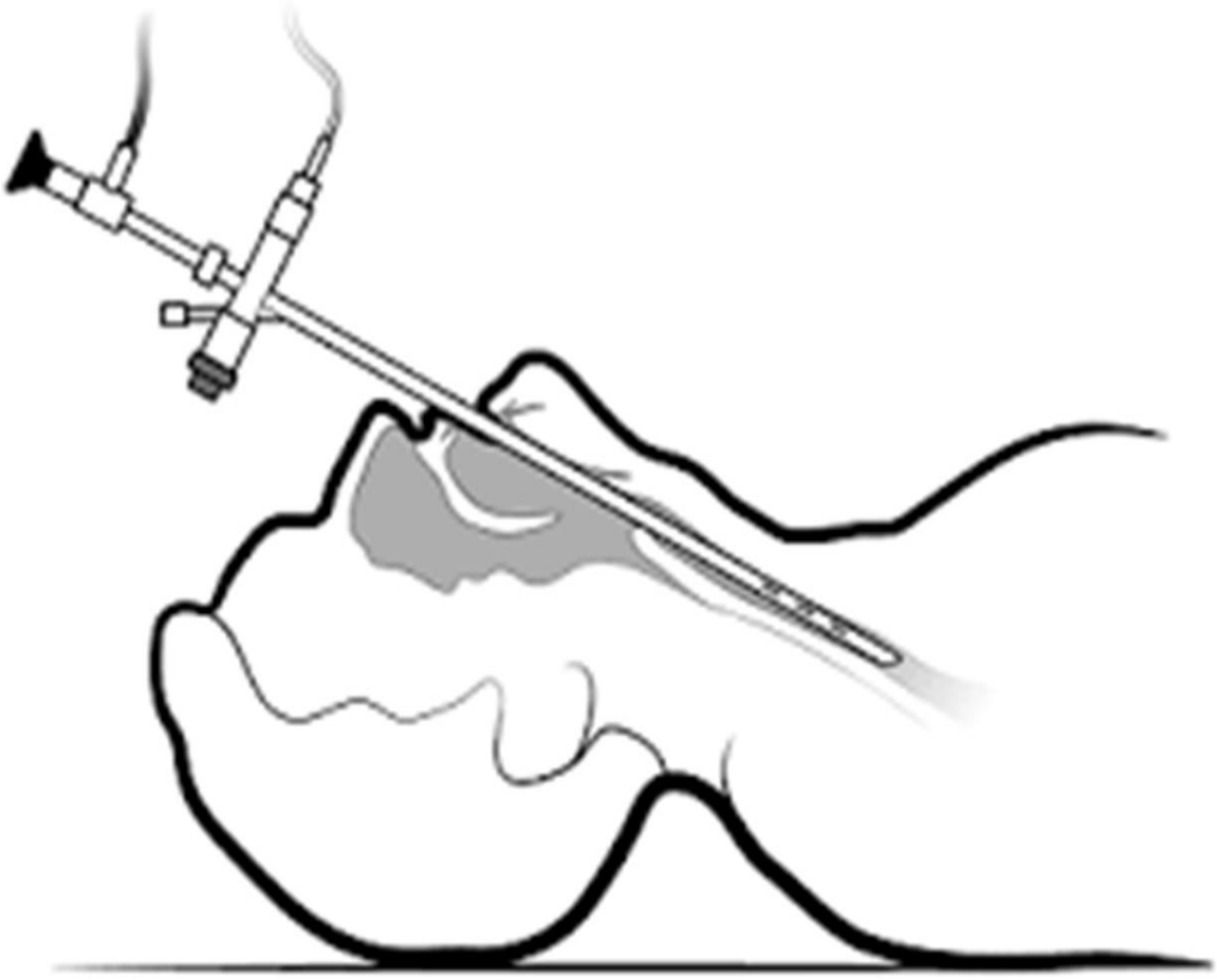



## Median sternotomy

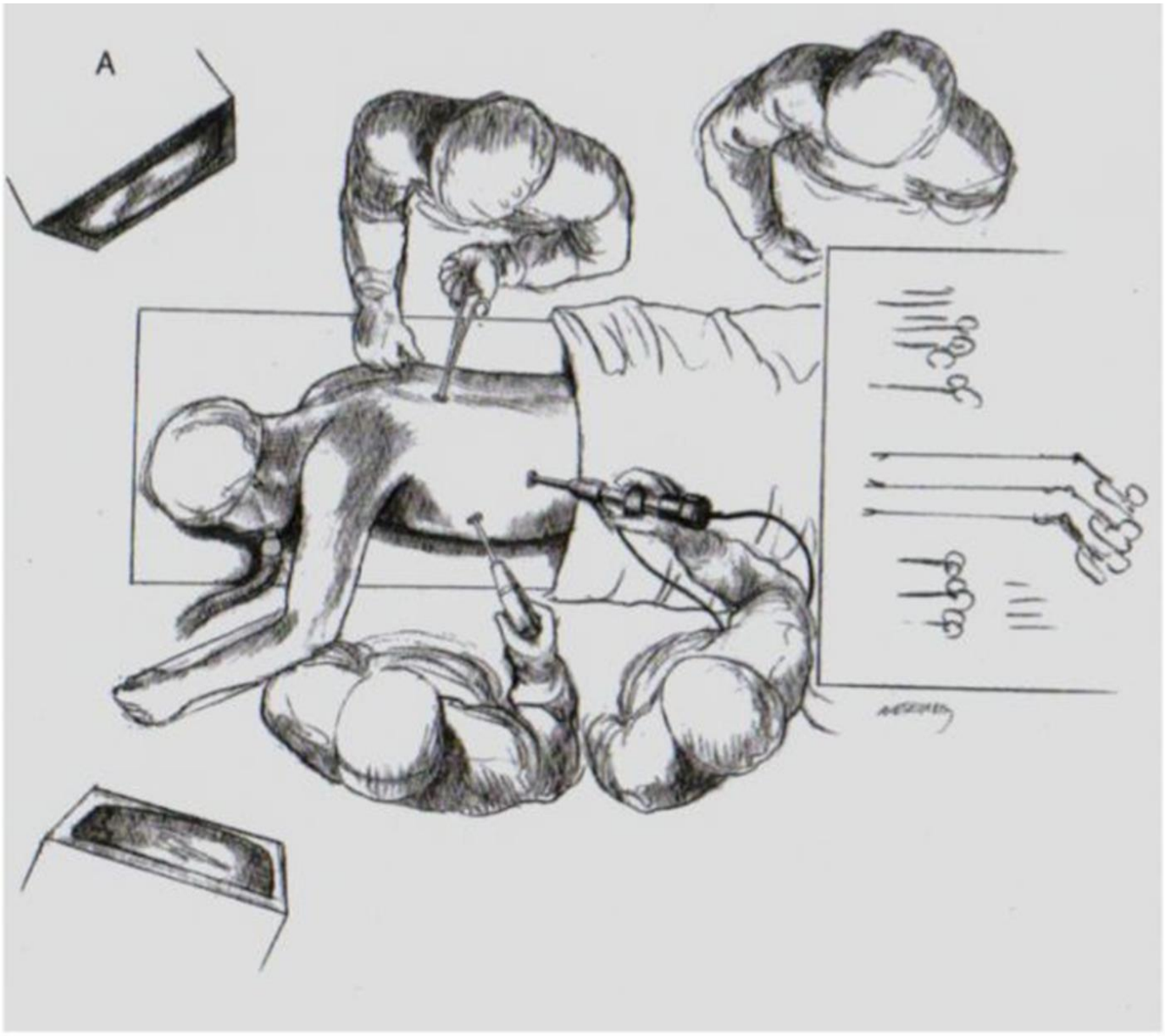


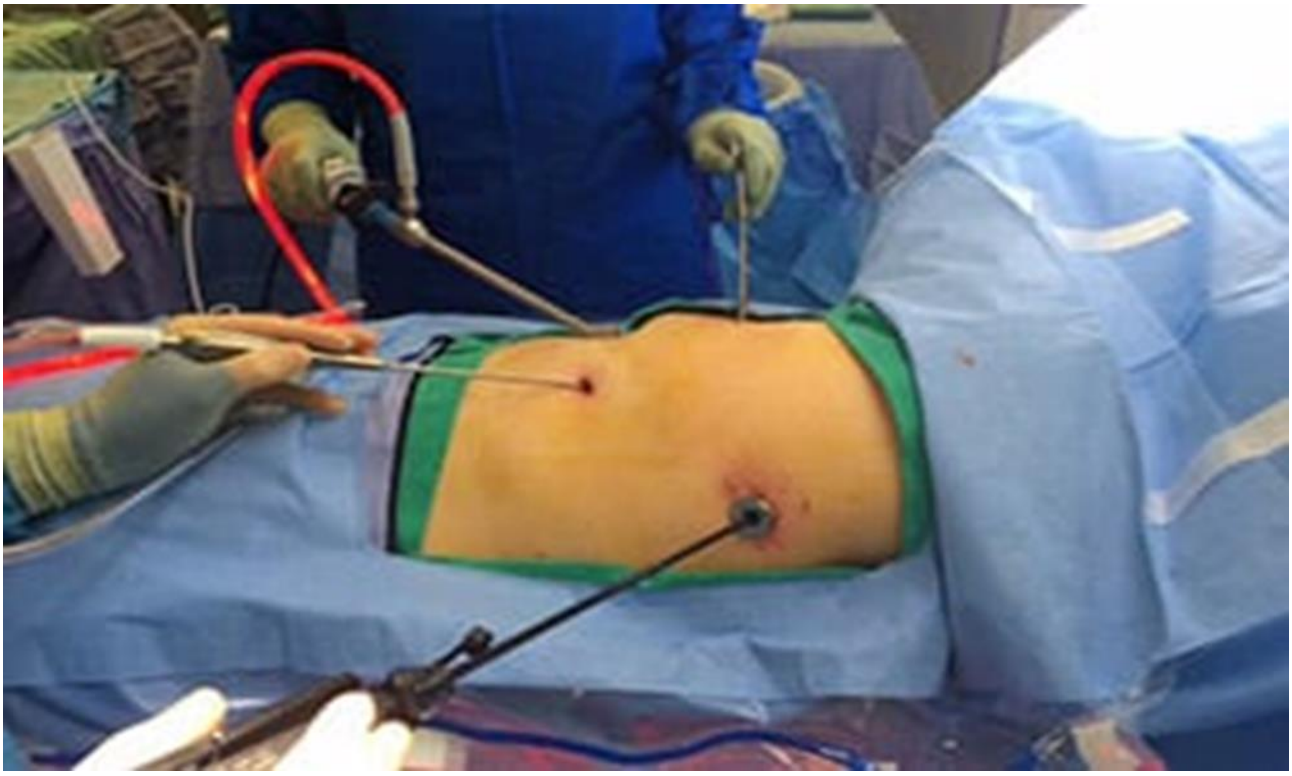


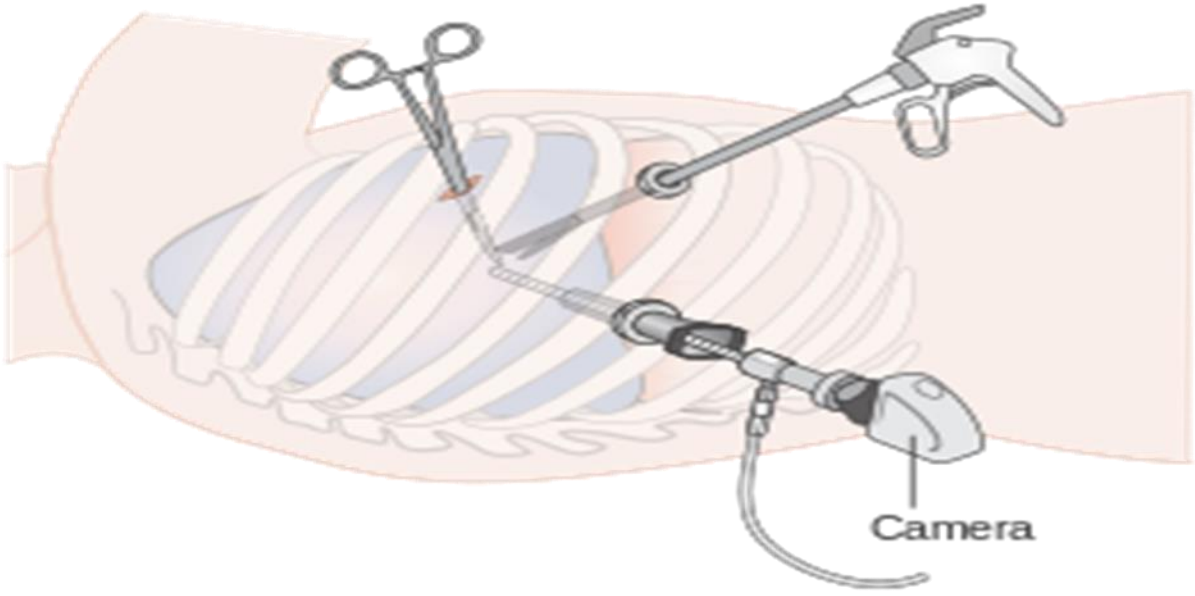
# Bronchoscopy



**Video-assisted thoracoscopic surgery (VATS).**






Camera

## Robotic surgery

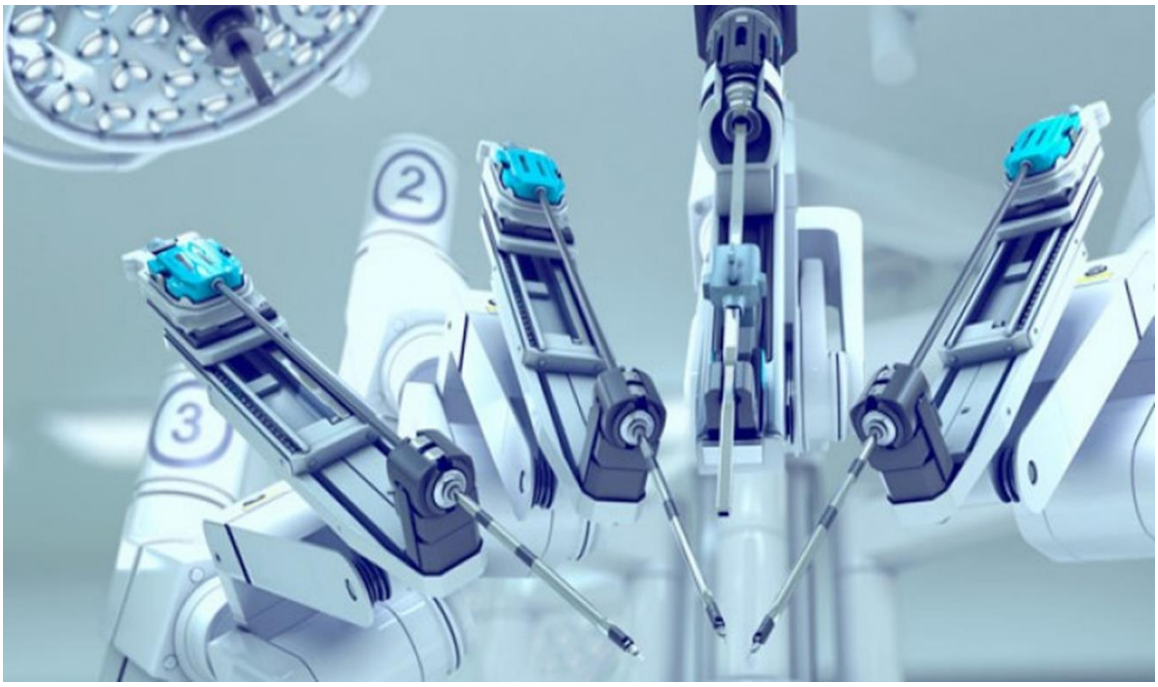



**Table 1: Advantages and disadvantages of VATS versus traditional thoracotomy approach**

| Advantages | Disadvantages |
|---|---|
| Better spinal visualization | Steep learning curve |
| Decreased incisional pain | Required double lumen intubation |
| Decreased blood loss | Limitations in dealing with intra-operative complications |
| Decreased ICU & hospital stay | Lack of stereoscopic appreciation |
| Decreased shoulder dysfunction | Required specialized equipment |
| Decreased pulmonary dysfunction | Required fluoroscopy |
| Cosmetically acceptable scars | Costly |

# Chest trauma

## Etiology of chest trauma:

A- Blunt trauma: non-penetrating, such as motor car accidents, fall from height.

B- Penetrating trauma: (pleura is injured) due to stab wounds and firearms.

Primarily peripheral lung, Hemothorax, Pneumothorax, Cardiac, great vessel or esophageal injury

C- Blasts: (part of chest wall may be lost): Stress waves, which disrupt the alveolo-capillary membrane resulting in hemorrhage and leakage of interstitial fluids into the alveoli (C/O dyspnea and cough with frothy bloody sputum).

D- Iatrogenic:

**Clinical picture:** (Varies according to the nature of trauma)

History:

1. Time & nature of the accident.

2. Dyspnea and chest pain.

**Examination**:

1. General examination:

a- Signs of shock may be present: pallor, hypotension, weak pulse etc...

b- Signs of respiratory distress may be present: cyanosis, working ala nasi.

c- Associated injuries: hepatic or splenic rupture.

2. Local examination: bruises & ecchymosis + one of the followings

a- Pneumothorax lead to mediastinal shift, Hyper-resonant note, I air entry.

b- Hemothorax:  shifted mediastinum, dullness, I air entry.

c- Rib fracture: localized tenderness & crepitus at the site of fracture.

d- Flail chest: flail segment will move in a paradoxical way to the rest of the chest wall.

**Investigations:**

a- Laboratory: ABG ($PO_2$, $PCO_2$), blood sugar, urea & creatinine.
b- Radiological: Plain CXR and CT chest.
c- Instrumental:
   1. Bronchoscopy (if tracheobronchial injury is suspected).
   2. Esophagoscopy (to exclude esophageal injuries)

**Complications of chest trauma:**

1. Chest wall: fracture rib and flail chest.
2. Pleura: pneumothorax and hemothorax.
3. Diaphragmatic injury.
4. Great vessel injury.
5. Cardiac injury.
6. Lung lacerations.
7. Esophageal injury

**Treatment:**

**Resuscitation for chest injuries:**

1. Airway: maintaining upper airways clear and patent.
2. Breathing: keeping normal breathing rate by assisted or mouth to mouth breathing with observation of chest movement, the following problems may be present:
a- Flail chest → immobilization by strapping.
b- Sucking wound → should be sealed.
c- Tension pneumothorax → decompression by insertion of a wide-bore cannula in the 2nd intercostal space in mid clavicular line.
d- Penetrating objects → should be fixed (do not remove).
3. Circulation: precordial thump (once), external compression (cardiac massage), control of bleeding by compression (better than tourniquet, which may lead to distal ischemia).
4. Disability: Damaged limb should be splinted.

**At hospital**

**1- Resuscitation & primary survey:**

a. Patient kept in semi-sitting (Fowler) position except if the patient is pulseless, he should be kept in Trendelenburg position.
b. Maintain lower airway patency by endotracheal tube if needed.
c. Intravenous line supplies the fluid according to patient's need.
d. Oxygen therapy if needed.
e. Drugs: antibiotics, analgesics.
f. X-ray: upright position if possible.

**2- Continuous monitoring of:**

a. Level of consciousness.
b. Vital signs (pulse, blood pressure, temperature, and respiratory rate).
c. Neck veins, CVP.
d. Urine output, fluid chart and amount of drained fluid.

**3- Secondary survey:**

After establishment of general condition of the patient 2ry survey must be done.

**Specific treatment: life threatening conditions:**

1. Pneumothorax: intercostal tube under water seal insertion
2. Hemothorax: intercostal tube insertion.
3. Flail chest: emergency stabbing followed by fixation.

- Emergency thoracotomy may be required if there is uncontrollable internal or external bleeding.
- In serious chest injuries, it is necessary to admit the patient to the ICU where an endotracheal tube is inserted → allow effective and repeated aspiration of the tracheobronchial tree. If the patient is hypoxic or has flail chest, the endotracheal tube should be combined with intermittent positive pressure respiration.
- Sudden death if occurs it means error of the responsible doctor.
- Upper abdominal rigidity may be present in thoracic injuries not only in abdominal lesions.
- There is frequent hepatic & splenic rupture in lower chest injuries.

## Post-operative complications of cardiothoracic surgeries

### Early Complications:

### A. Respiratory complications:

*1. Atelectasis and Pneumonia:*

- The most common complication after a thoracic operation is respiratory failure.
- Treatment: aggressive pulmonary toilet, postural drainage, incentive spirometry, nasotracheal suction, ambulation, and nebulized expectorant will help to clear the secretions.

*2. Prolonged Air Leak:*

- A prolonged air leak is defined as one that lasts longer than 5 postoperative days.

*3. Pulmonary Edema:*

- Pulmonary edema in lobectomy can usually be treated with diuresis.
- Postpneumonectomy pulmonary edema can be fatal.
- Aggressive respiratory care including intubation may be necessary to manage a patient with postpneumonectomy pulmonary edema, which has a mortality rate of greater than 50%.

*4. Acute Respiratory Distress Syndrome (ARDS):*

Acute lung injury (ALI) and ARDS are potentially fatal complications after thoracic surgery.

5.*Pulmonary aspiration*: Due to aspiration of oropharyngeal and gastric contents into the airways.

*6. Pleural effusion & pneumothorax.*

### B. Cardiac Complications:

*1. Myocardial Infarction:*

- Myocardial infarction should be managed expediently with oxygen therapy, ECG monitoring, morphine, and aspirin if bleeding is not a great concern.

- Inotropic support may be needed If the patient's BP cannot be supported adequately with medications, intra-aortic balloon pump placement should be considered.

*2. Postoperative arrhythmia:*

- Related to hypokalemia, hypoxemia, alkalosis, digitalis toxicity & stress.
- Patient complains of chest pain, palpitation or dyspnea:
- Supraventricular arrhythmias: Atrial fibrillation (AF).
- Ventricular premature beats: Precipitated by hypercapnia, hypoxemia, pain or fluid overload.
- Complete heart block: Due to serious cardiac disease & calls for the immediate insertion of a pacemaker.

**Atrial Fibrillation (AF):**

Electric cardioversion is the initial treatment with hypotension.

Chemical cardioversion is the initial treatment for hemodynamically stable AF with intolerable symptoms.

Postoperative AF without hypotension is rate control for 24 hours. If conversion to sinus rhythm does not occur or paroxysmal AF continues past 24 hours, then chemical cardioversion is then tried.

Anticoagulation is given based on a patient's risk of stroke if AF occurs for longer than 48 hours.

*3. Postoperative heart failure:*

Predisposing risk factors: fluid overload with myocardial infarction & arrhythmia.

Clinically, dyspnea, hypoxemia & diffuse congestion of chest X ray.

Diagnosis; decreased PaO2, abnormal chest X ray, or elevated pulmonary artery wedge pressure.

Treatment: diuretics, nitroglycerine, inotropes, digitalis therapy, mechanical respiration if there is respiratory insufficiency.

## C. Bleeding:

- Postoperative bleeding is monitored by chest tube output.
- Sudden occurrence of large-volume, bloody drainage requires immediate re-exploration to find and stop the source of bleeding. Less rapid bleeding of more than 100 mL/h for 2 consecutive hours is also excessive after thoracic surgery. If the patient has been taking aspirin or other antiplatelet agents such as clopidogrel and if surgery was emergent or required before the known washout period (5 to 10 days depending on the medication), then platelet dysfunction must be considered.
- If bleeding persists after correction of deficient factors, exploration for a bleeding source should be performed.
- If coagulopathy and bleeding have been controlled but hematoma causes significant mediastinal or lung compression, then re-exploration is necessary.
- Transfusion of packed red blood cells should be considered, depending on the patient's hemoglobin level and hemodynamic condition.

## D. Postoperative fever:

- Fever occurs in about 40 % of patients after major surgery.
- Fever within 48 hours after surgery is usually caused by atelectasis.
- Fever appearing after the 2nd postoperative day causes: urinary catheter, phlebitis, pneumonia, urinary tract infection, antibiotic induced.
- Fever after the 5th postoperative day suggests wound infection, anastomotic leakage and abscess.
- Measures to determine the cause: History, physical examination, laboratory investigations and/or radiological studies.

## E. Wound complications:

- Hematoma: Collection of blood & clot in the wound.
- Seroma: Fluid collection in the wound other than blood & pus.
- Wound dehiscence: Partial or total disruption of any or all layers of the wound.

## F. Complications of IV fluids & hemodynamic monitoring:

- Air embolism: Air embolism may occur during or after insertion of a venous catheter. Embolized air lodges in the right atrium.
- Phlebitis: Phlebitis occur when needle or catheter inserted into a vein & left in a place will in time cause inflammation at the entry site.
- Cardiopulmonary complications: Perforation of the right atrium with cardiac tamponade associated with use of central & venous line.

## G. Central nervous system complications:

1. Cerebrovascular accidents:

Ischemic neural damage due to poor perfusion, occur due to atherosclerosis, hypotension, postoperative sepsis, bleeding or cardiac arrest. Irreversible brain damage occurs after 4 minutes of total ischemia.

Strokes occur for patients undergoing carotid & cardiac surgery.

Cardiac surgery as open-heart surgery and deep cooling coronary bypass & AF due to hypoxia or poor perfusion.

2. Convulsions.

3. Psychiatric complications.

## Late Complications

### A. Pulmonary Complications:

1. Bronchopleural Fistula. If air is leaking from the bronchial stump, adequate chest tube drainage to prevent or drain empyema is necessary.

2. Postpneumonectomy Syndrome. It is torsion or compression of the trachea, bronchus, esophagus, or pulmonary vasculature caused by mediastinal shift after pneumonectomy.

3. Empyema: If the patient also has an empyema tube drainage of the pleural cavity can be attempted.

If the infection extends into the pleural space, it is better to take the patient back to the operating room for a thorough drainage, irrigation, débridement, and decortication if the space is not well drained by chest tube.

Wound vacuum dressings have been successful in pleural spaces even.

### B. Post-thoracotomy Pain:

It remains a debilitating result after thoracotomy. It is pain that occurs along a thoracotomy scar at least 2 months after surgery, and its incidence is 45% to 67%.

Minimally invasive thoracic surgery has been shown to cause less pain than thoracotomy, some patients still suffer from chronic pain.

Treatment can involve several modalities:- Combinations of medication: nonsteroidal anti-inflammatory drugs, tricyclic antidepressants, anticonvulsants such as gabapentin, and opioids.

Behavioral techniques such as relaxation techniques.

Procedural treatments include intercostal nerve block, intrapleural local anesthetic, radiofrequency ablation, and transcutaneous electrical nerve stimulation.

### C. Others:

1. Joint stiffness: Thoracic spine, Costo-vertebral joints.
2. Muscle weakness: LD, Serratus anterior
3. Postural deformity: forward or sideward bending.

## Surgical management of rheumatic valvular heart diseases

**Introduction:**

- Valvular heart disease (VHD) is the commonest type of heart diseases in developing countries. RHD is the commonest AE.
- MV is the most common valve involved followed by AV and TV.

**Surgical options for heart valve diseases:**

- Opening the Stenosed valve by closed or open-heart techniques: Mitral valve.
- Repair of valves by open heart techniques: MV and TV repair are common.
- Valve replacement: when valve is badly deformed and damaged or calcified it is replaced by prosthetic valve which may be mechanical or bioprosthetic valves.

**Prosthetic heart valves:**

- Two types:
  - ✓ Mechanical valve.
  - ✓ Bioprosthetic valve.
- The major differences are related to the risk of thromboembolism (higher with mechanical valves) and the risk of structural deterioration of the bioprosthesis.

***1.Mechanical valves:***

• Longer lasting

• Need lifelong anticoagulation – Warfarin therapy.

***2.Bioprosthetic valves:***

• Heterogeneous grafts made from animal tissue.

• Low thrombogenic potential.

• Do not need systemic anticoagulation.

**Mechanical Prosthesis:**

- Three types:
    A. Bileaflet: most used St Jude
    B. Tilting disc: Medtronic Hall value
    C. Caged ball: discontinued now
- All mechanical prosthetic valves have an excellent durability over 25 years.
- Thrombosis and thromboembolic risks are greater with any mechanical valve in the mitral than in the aortic position.
- INR values: 2 - 3 for Aortic valve and 2.5 - 3.5 for Mitral valve.

**Bioprosthesis:**

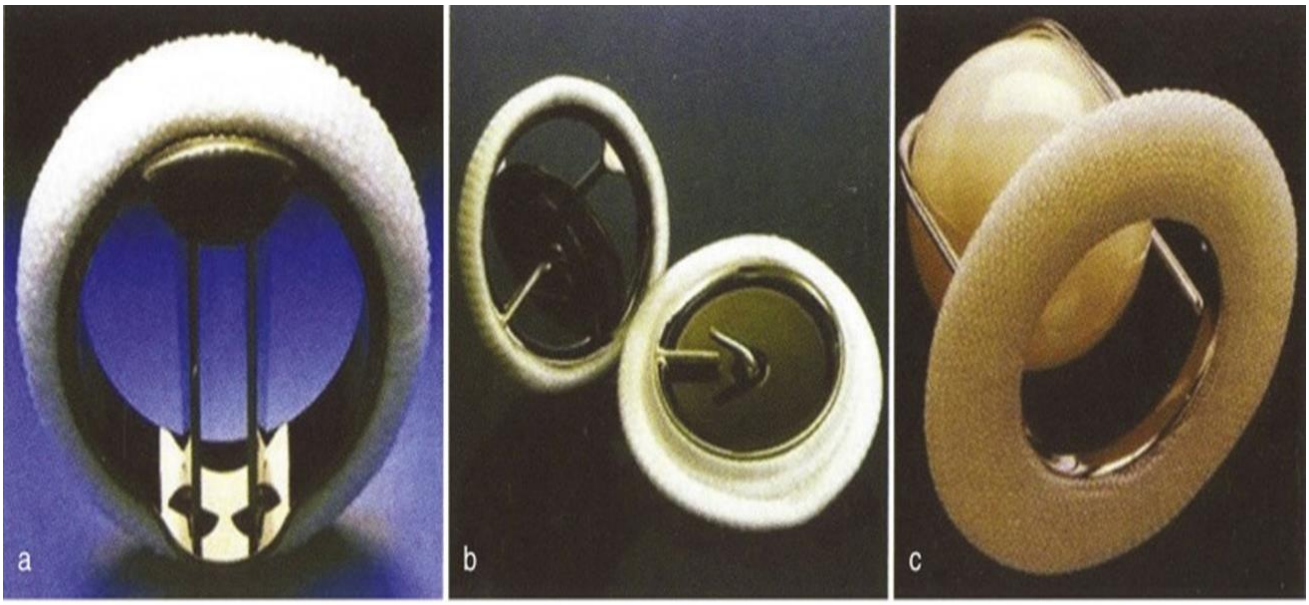
- Xenografts {porcine}: Stented or Stentless
- Homograft Aortic valves: These are harvested from cadavers.
- Pulmonary Autografts: Ross procedure, the patient's own pulmonary valve and main pulmonary artery are removed and used to replace the diseased aortic valve and often the aorta.
- All bioprosthetic valves have limited durability.

**Choice of the valve:**

- The major task when selecting an artificial valve is to weight the advantage of durability and the disadvantages of the risks of TE and anticoagulant treatment inherent in mechanical prostheses on the one hand with the advantage of low thrombogenicity and the disadvantage of abbreviated durability of bio prostheses on the other.
- Therefore, mechanical prostheses, usually of the bileaflet variety, are the valves of choice for most patients younger than 65 years.

***Bioprosthetic valve is preferred in:***

- ❑ Hemorrhagic tendency.
- ❑ Noncompliance with anti-coagulants.
- ❑ Patients age > 65 years.
- ❑ Young women, requiring valve replacement and wishing to bear children.




A

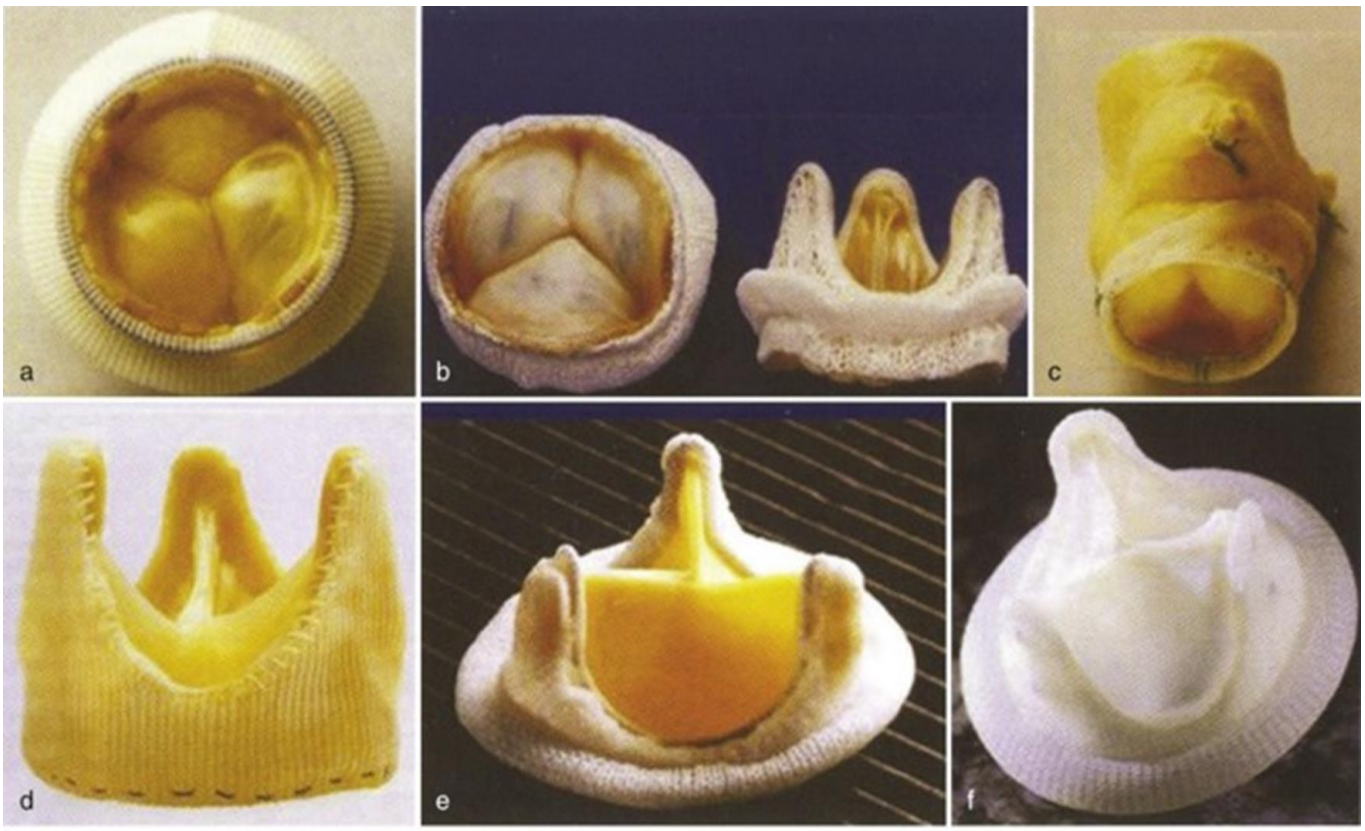
a, a bileaflet St. Jude Medical valve.

b, a Medtronic-Hall tilting disc valve;

c, a Starr-Edwards ball cage valve (no longer manufactured).

**Common mechanical valves**

## Different types of bioprosthetic valves




B

## Complications of prosthetic valves.

A. Structural valve failure.

B. Paravalvular leak.

C. Thrombosis and TE

D. Prosthetic valve endocarditis

E. Postoperative management:

- Antithrombotic therapy
- Antibiotic prophylaxis

## Comparing options for heart valve surgery

| | Advantages | Disadvantages |
|---|---|---|
| **Valve repair** | Preservation of structure<br>Improved hemodynamics<br>Avoid long term anticoagulation | Technically difficult<br>Varible failure rate |
| **Valve replacement** | | |
| Mechanical valves | Readily available , Life long durability, Can be used in any age group, Extensive experience and follow up | Needs life long anticoagulation,<br>Susceptibility to infection |
| Biological valves | | |
| Stented | Readily avilable, Short period of anticoagulents | Limited life span |
| Stentless | Readily available, Good hemodynamics,Short period of anticoagulents | Difficult to implant<br>Limited life span |
| Homograft | No anticoagulation , Good hemodynamics, | Technically difficult,<br>Not readily available |

## Aortic stenosis

Obstruction to LV outflow is localized most at the AV.

**Classification of AS severity in adults**

| | Mild | Moderate | Severe |
|---|---|---|---|
| Peak velocity (m/s) | 2–2.9 | 3–4 | >4 |
| Mean gradient (mmHg) | <20 | 20–40 | >40 |
| Valve area ($cm^2$) | >1.5 | 1–1.5 | <1 |
| Indexed valve area ($cm^2/m^2$) | >0.85 | 0.60–0.85 | <0.60 |
| Velocity ratio | >0.50 | 0.25–0.5 | <0.25 |

Adapted from Nishimura *et al.*[1]

**Indications for surgery:**

1. The presence of symptoms (angina, CHF, syncope) with severe AS is a class I indication for surgery.

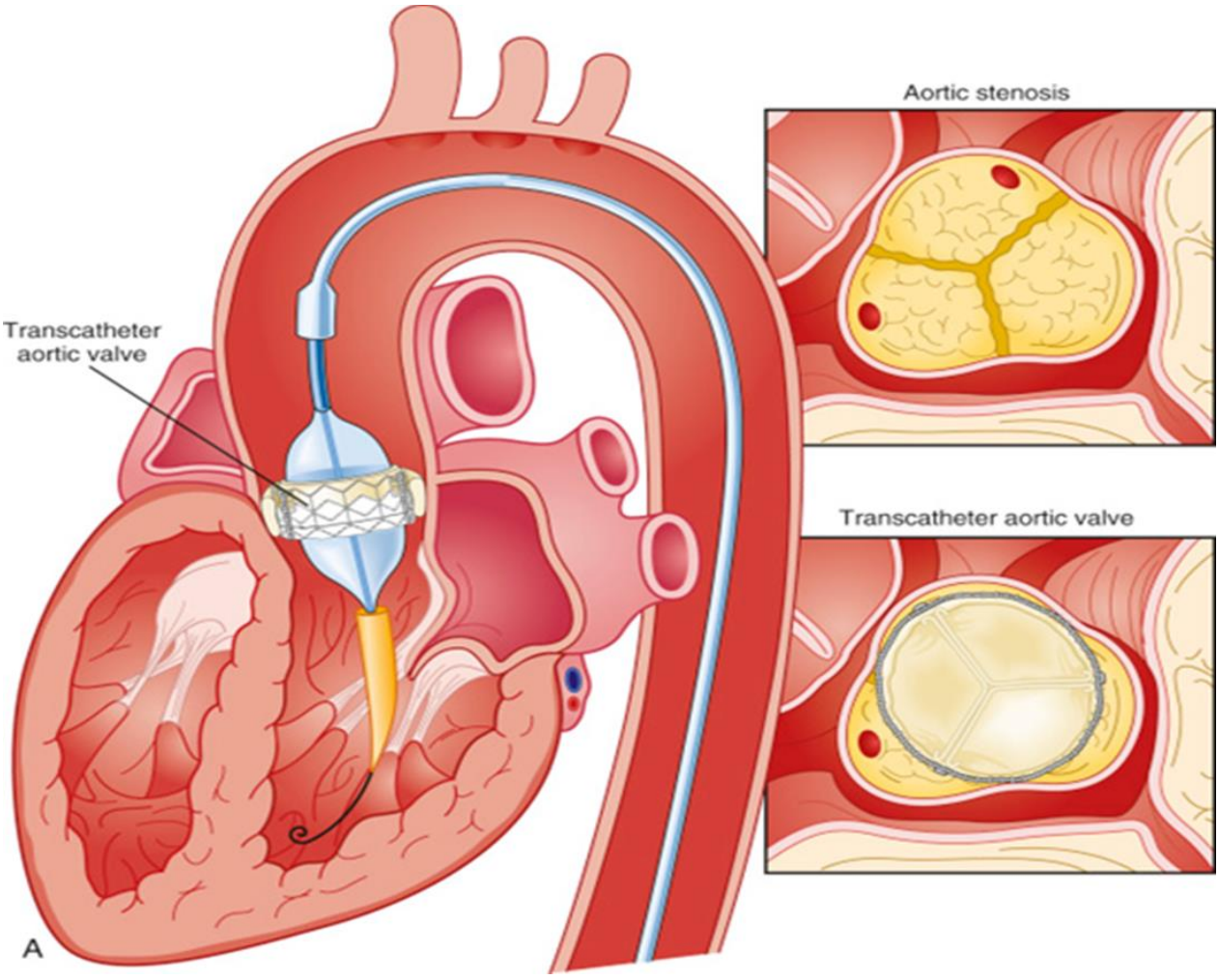
2. In contrast, surgery has traditionally not been considered for the asymptomatic patient, no matter how severe the degree of stenosis. However, patients with severe AS need to be followed carefully for the development of symptoms or rapidly progressive valve stenosis.

**Operative interventions:**

A. Aortic valve replacement.

B. Transcatheter aortic valve implantation (TAVI) by a percutaneous or transapical approach for seriously ill patients who are not candidates for conventional surgery.

**TAVI**



## Aortic regurgitation

**Causes:**

A. Primary disease of the aortic valve leaflets:

1. Rheumatic fever
2. Infective endocarditis

B. Aortic root disease {secondary to marked dilation of the ascending aorta}: Marfan syndrome; aortic dissection and systemic hypertension.

### Degrees of aortic regurgitation

| Parameters | Mild | Severe |
|---|---|---|
| PHT, ms | > 500 | < 200 |
| Vena contracta, mm | < 3 | > 6 |
| Jet diameter/LVOT, % | < 25 | > 65 |
| EROA, $cm^2$ | < 0.1 | > 0.3 |
| Regurgitation volume, mL | < 30 | > 60 |
| Regurgitation fraction, % | < 30 | > 60 |

**Indications for operation:**

1. Symptomatic patients with severe AR.

2. Endocarditis with hemodynamic compromise, persistent bacteremia or sepsis, conduction abnormalities, recurrent systemic embolization, large mobile vegetations, or annular abscess formation should undergo urgent surgery.

3. Asymptomatic patients must be followed closely for the development of symptoms or evidence of ventricular decompensation.

A. The standard surgical approach for chronic AR is aortic valve replacement (AVR).

B. However, there is growing experience with surgical aortic valve repair, which is a viable option for selected patients in experienced centers.

C. When AR is caused by leaflet perforation resulting due to infective endocarditis, a pericardial patch can be used for repair.

D. Aneurysmal dilation of the ascending aorta requires excision, replacement with a graft that includes a prosthetic valve, and reimplantation of the coronary arteries.

## Mitral stenosis

A. The predominant cause of MS is RHD.

B. About 25% of all patients with RHD have isolated MS, and about 40% have combined MS and MR.

C. Multivalve involvement is seen in 38% of MS patients, with the AV affected in about 35% and the TV in about 6%.

D. Two thirds of all patients with rheumatic MS are female.

E. Echocardiography is the gold standard for diagnosis and quantification of the severity of MS.

F. Evaluation of the morphology of the valve is helpful for predicting the hemodynamic results and outcome of percutaneous balloon mitral valvuloplasty (PBMV).

G. When Transthoracic Echo images are suboptimal, transesophageal echo (TEE) is appropriate. TEE is also necessary to exclude left atrial thrombus and evaluate MR severity when PBMV is considered.

### Measurement of the severity of MS

| Indicator | Mild | Moderate | Severe |
|---|---|---|---|
| Mean gradient (mm Hg) | <5 | 5–10 | >10 |
| PA systolic pressure (mm Hg) | <30 | 30–50 | >50 |
| Mitral valve area ($cm^2$) | >1.5 | 1.0–1.5 | <1.0 |

**Indications for MS intervention:**

1. An interventional procedure is indicated for a patient in NYHA class III–IV with moderate or severe MS (MVA <1.5 cm2). It may also be considered for patients with class II symptoms when critical MS (MVA <1 cm2).
2. PBMV (percutaneous balloon mitral valvuloplasty) is the procedure of choice for patients with moderate-to-severe MS if valve morphology is favorable by echo score. The presence of left atrial thrombus or more MR usually contraindicates this procedure.
3. Surgery is indicated when PBMV is contraindicated or not feasible, LA thrombus, or 3-4 + MR.
    a. Class I:
        - Symptomatic class III–IV patients with MVA <1.5 cm2
        - Symptomatic patients with moderate-to-severe MS and moderate-to-severe MR

    b. Class IIa: symptomatic class I–II patients with severe MS and PA >60 mm Hg

    c. Class IIb: asymptomatic patients with MVA <1.5 cm2 with recurrent embolism on anticoagulation if valve repair can be performed.

## Surgical valvotomy

Three operative approaches are available for TTT of rheumatic MS:

A. Closed mitral valvotomy.

B. Open valvotomy with cardiopulmonary bypass (CPB), which may be combined with other repair techniques.

C. MVR

## Comparison between MS surgery options

| APPROACH | ADVANTAGES | DISADVANTAGES |
|---|---|---|
| Closed surgical valvotomy | Inexpensive<br>Relatively simple<br>Good hemodynamic results in selected patients<br>Good long-term outcome | No direct visualization of valve<br>Only feasible with flexible, noncalcified valves<br>Contraindicated if MR > 2+<br>Surgical procedure with general anesthesia |
| Open surgical valvotomy | Visualization of valve allows directed valvotomy<br>Concurrent annuloplasty for MR is feasible | Best results with flexible, noncalcified valves<br>Surgical procedure with general anesthesia |
| Valve replacement | Feasible in all patients regardless of extent of valve calcification or severity of MR | Surgical procedure with general anesthesia<br>Effect of loss of annular-papillary muscle continuity on LV function<br>Prosthetic valve<br>Chronic anticoagulation |
| Balloon mitral valvotomy | Percutaneous approach<br>Local anesthesia<br>Good hemodynamic results in selected patients<br>Good long-term outcome | No direct visualization of valve<br>Only feasible with flexible noncalcified valves<br>Contraindicated if MR > 2+ |

## Mitral Regurgitation

**The major causes of MR include:**

A. RHD

B. Infective endocarditis

C. Ischemic heart disease

D. Mitral valve prolapse (MVP)

**Indications for surgery:**

1. Class I:

- Symptomatic acute MR (usually CHF or cardiogenic shock).
- Symptomatic class II–IV patients with chronic severe MR.
- Acute endocarditis with hemodynamic compromise, persistent bacteremia or sepsis, annular abscess or recurrent systemic embolization.

2. Class IIa: Patients with advanced MR with class III–IV symptoms, EF <30%, and/or ESD >55 mm if repair is highly likely.

3. Class IIb: Asymptomatic patients with chronic severe MR and EF >60% with ESD <40 mm (if repair likely), new onset of atrial fibrillation, or pulmonary artery pressure >50 mm Hg.

## Tricuspid valve (TV)

- ❑ The most common cause of TR is not intrinsic involvement of the TV itself (i.e., 1ry TR) but rather dilation of the RV and of the tricuspid annulus causing 2ndry (functional) TR.
- ❑ This may be a complication of RV failure of any cause.
- ❑ It is observed in patients with RV hypertension secondary to any form of cardiac or pulmonary vascular disease, most commonly MV disease.
- ❑ RV systolic pressure greater than 55 mm Hg will cause functional TR.

**Indications for surgery:**

1. Tricuspid stenosis. Surgery is indicated for class III–IV symptoms, including hepatic congestion, ascites, and peripheral edema that are refractory to salt restriction and diuretics.
2. Tricuspid regurgitation:
   a. Class I: TV repair is indicated when severe TR is present with MV disease requiring MV surgery.
   b. Class IIa: TV repair (annuloplasty) or replacement (if leaflets not amenable to repair) is reasonable for symptomatic, severe 1ry TR.
   c. Persistent sepsis or recurrent pulmonary embolization from TV vegetations is an indication for surgery.

## Surgical management of ischemic heart diseases

- Coronary artery disease (CAD) is a major cause of death and disability in developed countries.
- CAD remains responsible for about one third or more of all deaths in individuals over the age of 35 years.
- CAD represents a spectrum of clinical syndromes caused by insufficient coronary blood flow to the myocardium.
- It is almost always due to subintimal atheroma deposition leading to arterial luminal stenosis or occlusion and wall thickening.

**Various methods of treatment have been proposed including: -**

1. Medical therapy
2. Catheter-based interventions,
3. Coronary artery bypass grafting (CABG).

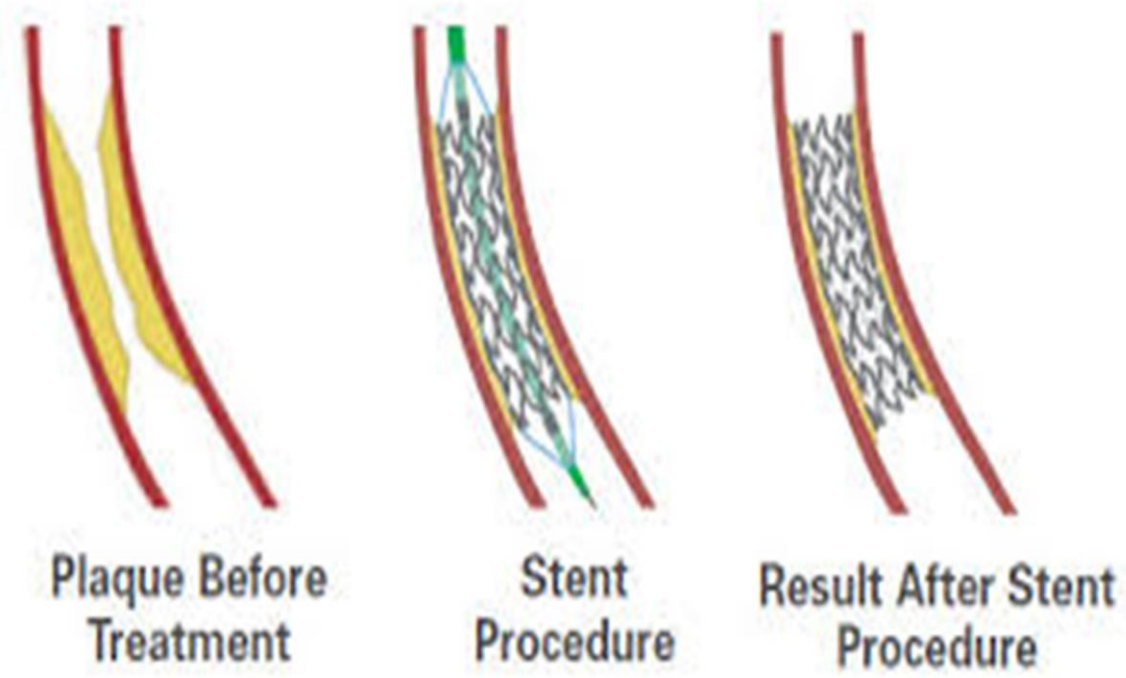
**Treatment goals of CAD: -**

- To decrease the frequency and severity of angina symptoms.
- To increase the duration of one's functional capacity (duration of angina-free exercise).
- To prolong life and reduce the incidence of acute coronary syndromes.

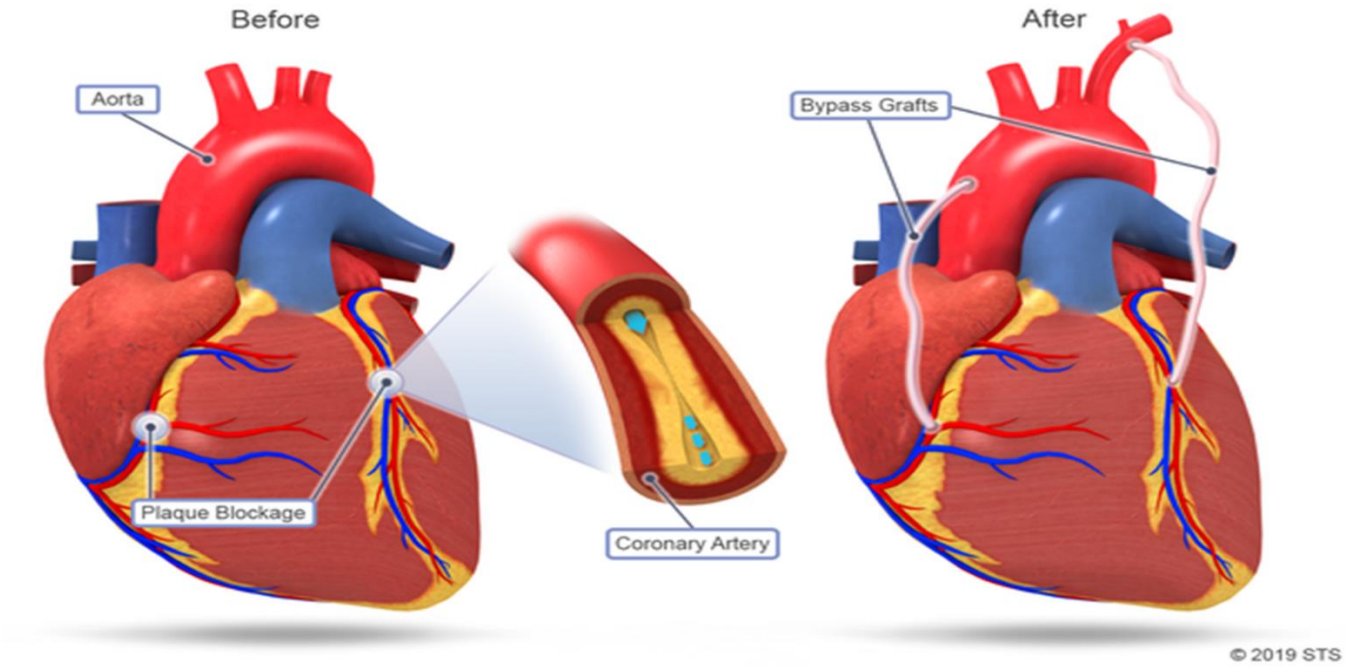
### 1. Medical management of CAD:

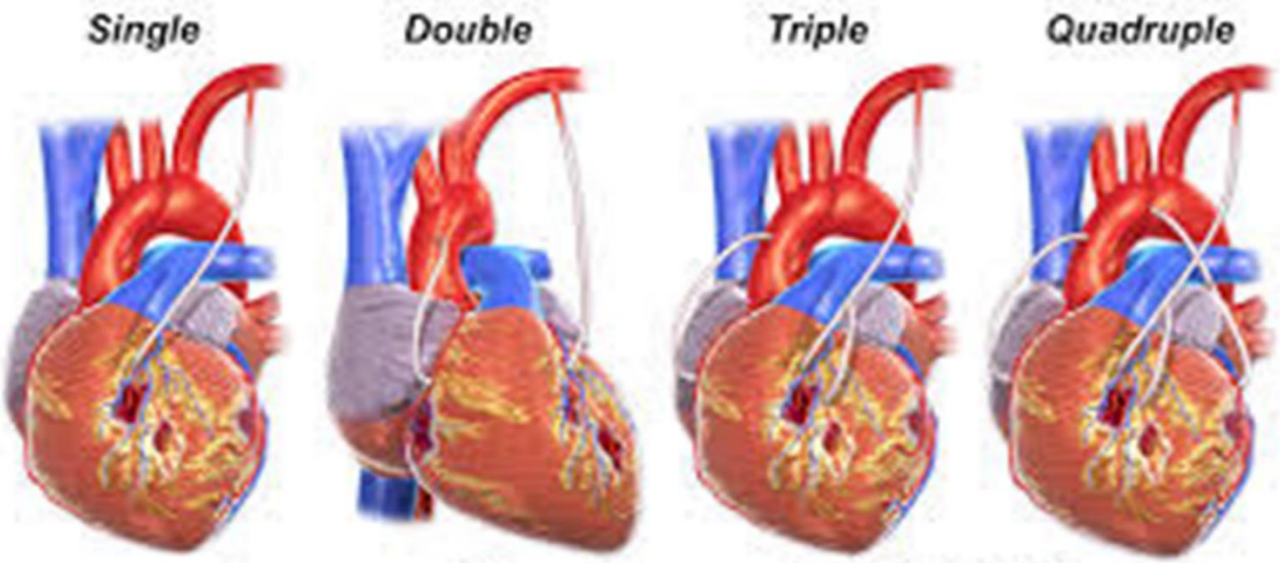
- Beta blockers
- Calcium channel blockers
- Nitrates
- Statins (lipid-lowering drugs)
- Daily use of aspirin
- Clopidogrel

2. **<u>Percutaneous coronary intervention (PCI):</u>**
    - PCI has become one of the most performed medical procedures
    - the use of drug-eluting stents (DESs) has supplanted the use of older stents, referred to as bare-metal stents (BMSs)



3. **<u>Coronary artery bypass grafting (CABG):</u>**
   - The decision for surgery is made based on the comprehensive evaluation of the patient.
   - Anatomic considerations that favor recommendation for CABG include presence of significant left main coronary artery or proximal left anterior descending artery disease, multivessel CAD, and presence of lesions not amenable to stenting.






Coronary Artery Bypass Graft (CABG)

## Surgical management of congenital heart diseases

### Classification of CHD:

According to arterial oxygen saturation CHD are classified into two main categories:

1- A cyanotic CHD: Normal arterial oxygen saturation, Examples:

- ❑ Ventricular septal defect (VSD),
- ❑ Atrial septal defect (ASD),
- ❑ Patent ductus arteriosus (PDA),
- ❑ Coarctation of aorta,
- ❑ Pulmonary stenosis

2- Cyanotic CHD: Reduced arterial oxygen saturation, Examples:

- ❑ Tetralogy of Fallot (TOF)
- ❑ Transposition of great arteries (TGA)
- ❑ Tricuspid atresia
- ❑ Truncus arteriosus
- ❑ Total anomalies pulmonary venous drainage (TAPVR)
- ❑ Hypoplastic left or right heart, etc

**Basics of Surgery for CHD:** 2 main categories:

1.Palliative Procedures

2.Complete repair

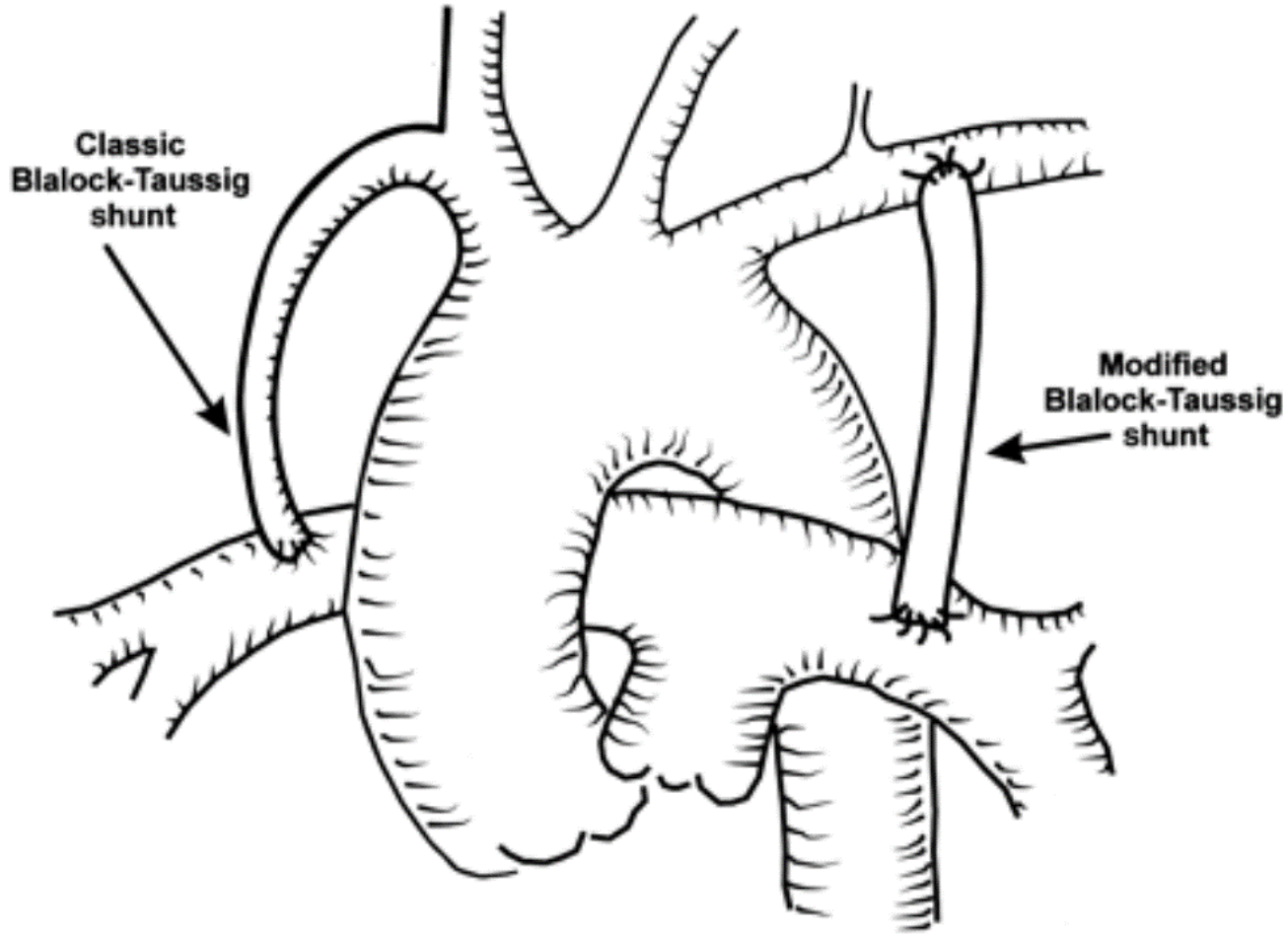
***Palliative Procedures:***

Goals of palliative procedures:

- To provide symptomatic relief making:
- The cardiac malformation more tolerable,
- Providing an improvement in the patient's condition and
- Permitting growth until the child has complete correction.

**2 classic palliative procedures:**

- ❑ Aortopulmonary shunt: Aiming to increase pulmonary blood flow.
- ❑ Pulmonary artery banding: it reduces pulmonary blood flow and pressure protecting the pulmonary vasculature, aiming to avoid progression to irreversible pulmonary vascular disease.
- ❑ More complex palliative procedures include the Norwood operation for hypoplastic left heart syndrome and the Glenn operation.



**Complete repair:**

It is feasible in many extra-cardiac as well as intra-cardiac congenital anomalies

A- Repair of extra cardiac anomalies:

Usually no need for cardiopulmonary bypass.

The commonest examples are PDA, and coarctation of aorta.

B- Repair of intra cardiac anomalies:

Usually carried out using cardiopulmonary bypass.

The commonest anomalies are VSD, ASD, and tetralogy of Fallot.

**Student activities**

**Course title: Cardiothoracic surgery. level : ……. Academic year: 2024/2025 - first semester**

**Student name: …….. ID #:……Lab section #:…….**

1. **Attendance**

| **Lectures** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
| **Practical sections** | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

2. **Quizzes :**

| **Quiz 1** | **Quiz 2** | **Quiz 3** | **Quiz 4** | **Quiz 5** | **Quiz 6** | **Quiz 7** | **Quiz 8** | **Quiz 9** | **Quiz 10** |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | | | | | | | |
| **Student average mark** | | | | | | | | | |

**2. Practical assignment:**

**…….**

**3. Teamwork research assignment**

**……..**

| **Student total mark** | |
|---|---|

**Lab section demonstrator** **lecturer of the course**

**……** **…….**