Ministry of Higher Education and Scientific Research

College of Health and Medical Technology

Anesthesia Techniques Department

Subject: practical Anesthesia-2,

3rd stage.

2025 - 2026

LECTURE ONE (1)

Preoperative assessment

The goal of the preoperative evaluation is to made a doctor – patient relationship , **reduce patient anxiety** and identify preoperative morbidities that may lead to patient complications due to anesthesia or surgical procedures.

The ASA physical classification

ASA 1: Normal healthy patient.

ASA 2: Mild systemic disease - no impact on daily life.

ASA 3: Severe systemic disease - significant impact on daily life.

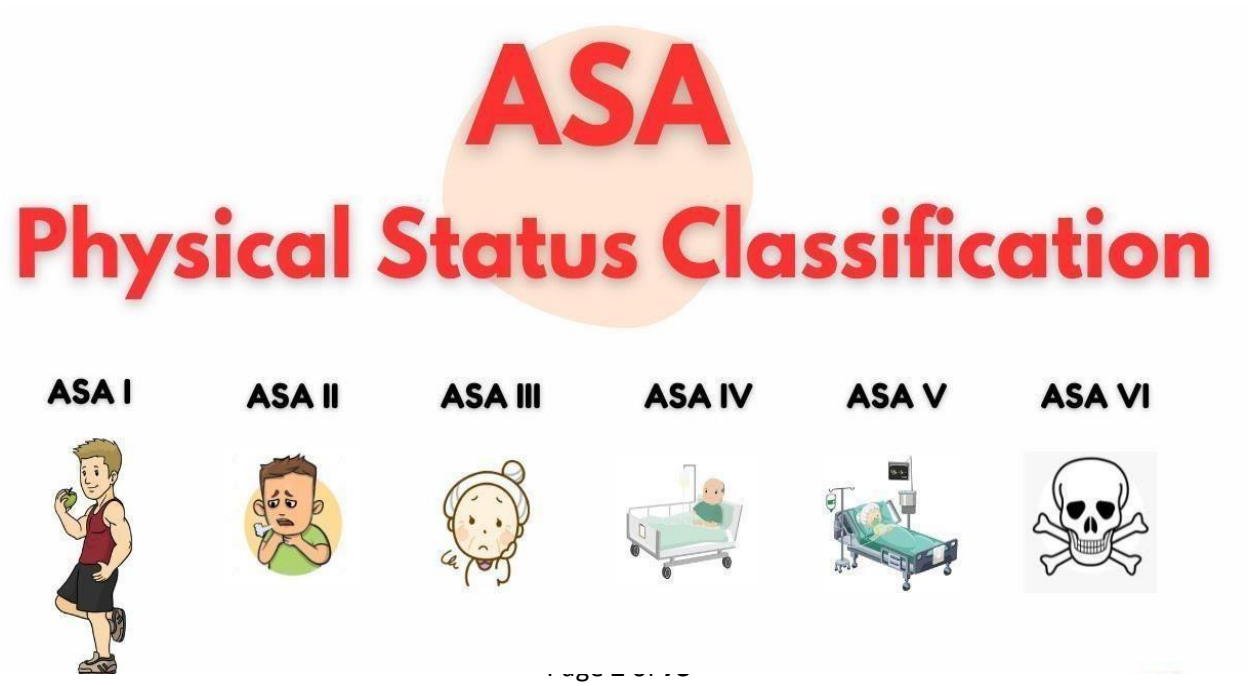
ASA 4: Severe systemic disease that is a constant threat to life.

ASA 5: Moribund, is not expected to survive without the operation.

ASA 6: Declared brain-dead patient - organ donor.

E : emergency surgery .

Note: **ASA = American Society for Anesthesiologists.**



Clinical Examinations

Phase 1: History taking & Laboratory investigation.

Phase 2: physical examination.

Phase 1: History taking & Laboratory investigation:

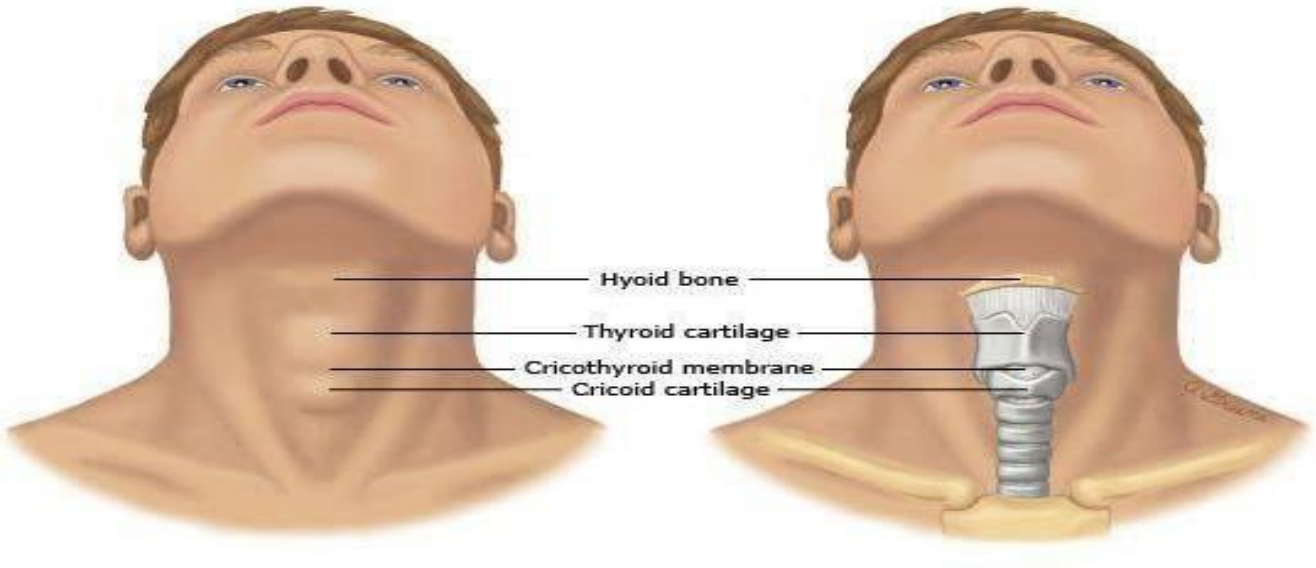
- **History taking** (Medical problems, previous anesthesia, family anesthesia history, allergies and drug intolerances, alcohol & smoking, last oral intake, etc.).
- **Laboratory investigation** (Hb , WBC count , coagulation studies , ECG , pregnancy test , chest x-ray , liver function test, etc.).

Phase 2 : physical examination :

1. Airway evaluation.
2. Respiratory system.
3. Cardiovascular system.
4. Vital signs including O2 saturation, BP, and Body temperature.
5. Height and weight (BMI).
6. Mental status.

Airway Evaluation (easy or difficult intubation)

Airway : the passage through which the air passes during respiration. The upper airways are made of the **nose**, **nasal cavity**, and **pharynx** while the lower airways are the **larynx**, **trachea**, **bronchial tree**, and **lungs**.



Mallampati Test

Used to predict the ease of endotracheal intubation , the score is assessed by asking the patient in a sitting posture, to open his or her mouth and to protrude the tongue as much as possible.

Class I: visualize the hard and soft palate , uvula , pillars .

Class II: visualize the hard and soft palate , uvula .

Class III: visualize the hard and soft palate , the base of the uvula.

Class IV: only hard palate visible .

» A high Mallampati score (class 3 or 4) is associated with more difficult intubation as well as a higher incidence of sleep apnea.

Cormack & Lehane grade

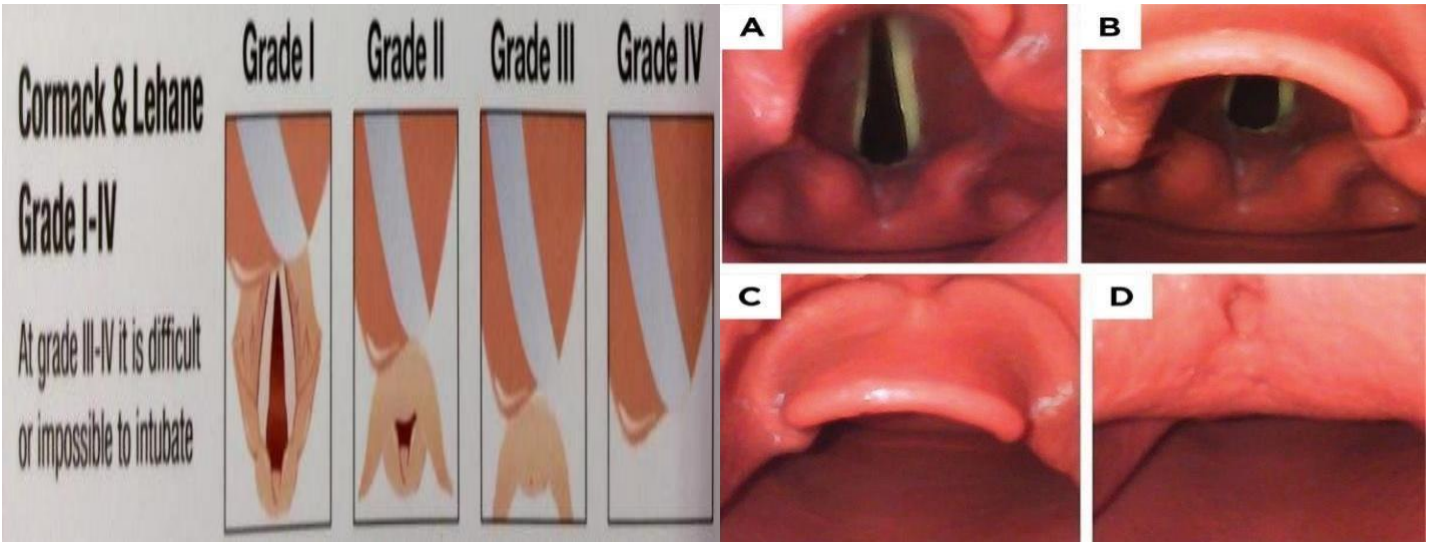
Cormack-Lehane grade : This classifies airway **views during direct laryngoscopy** based on the visible anatomical structures.

Grade 1: A full view of the glottis.

Grade 2: part of the cords are visible.

Grade 3: Only the epiglottis is visible.

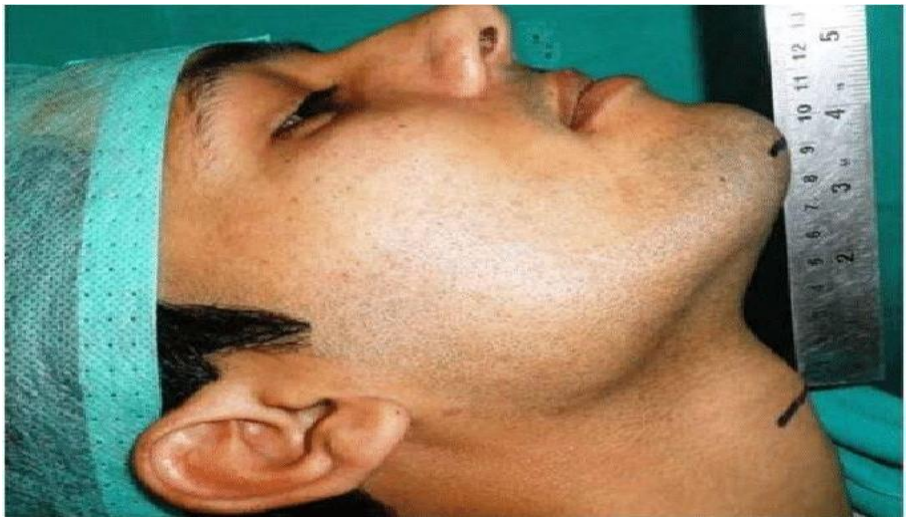
Grade 4: No glottis structure visible.



Thyromental distance

Thyromental distance (TMD) is defined as the distance from the chin to the top of the notch of the thyroid cartilage with the head fully extended .

» should be 7 cm or more .

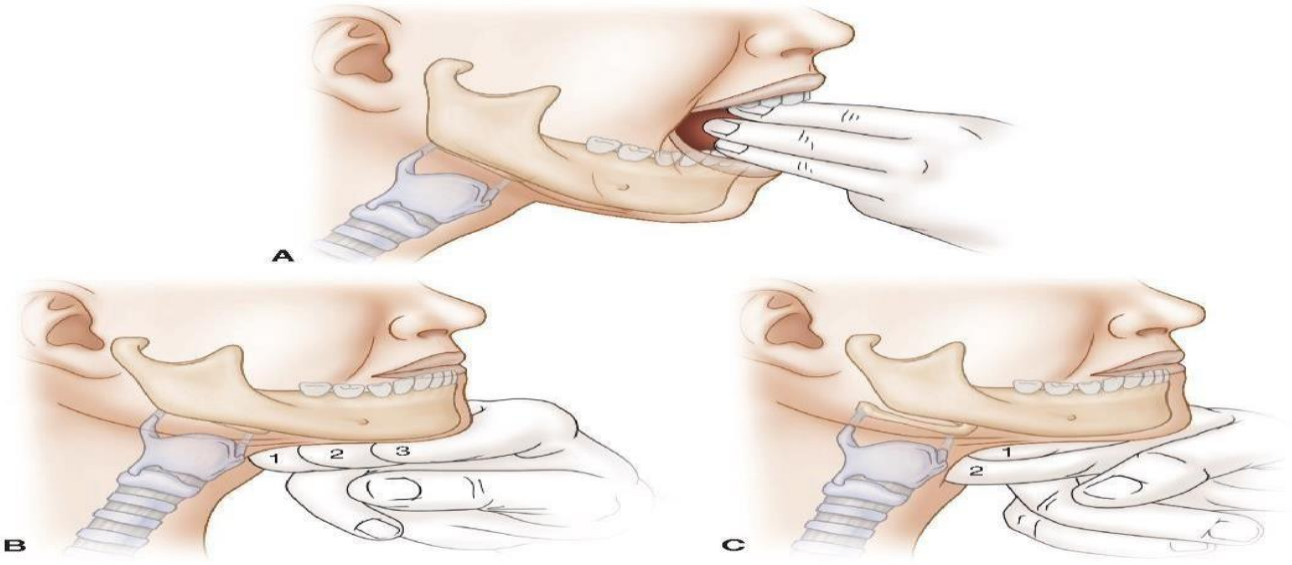


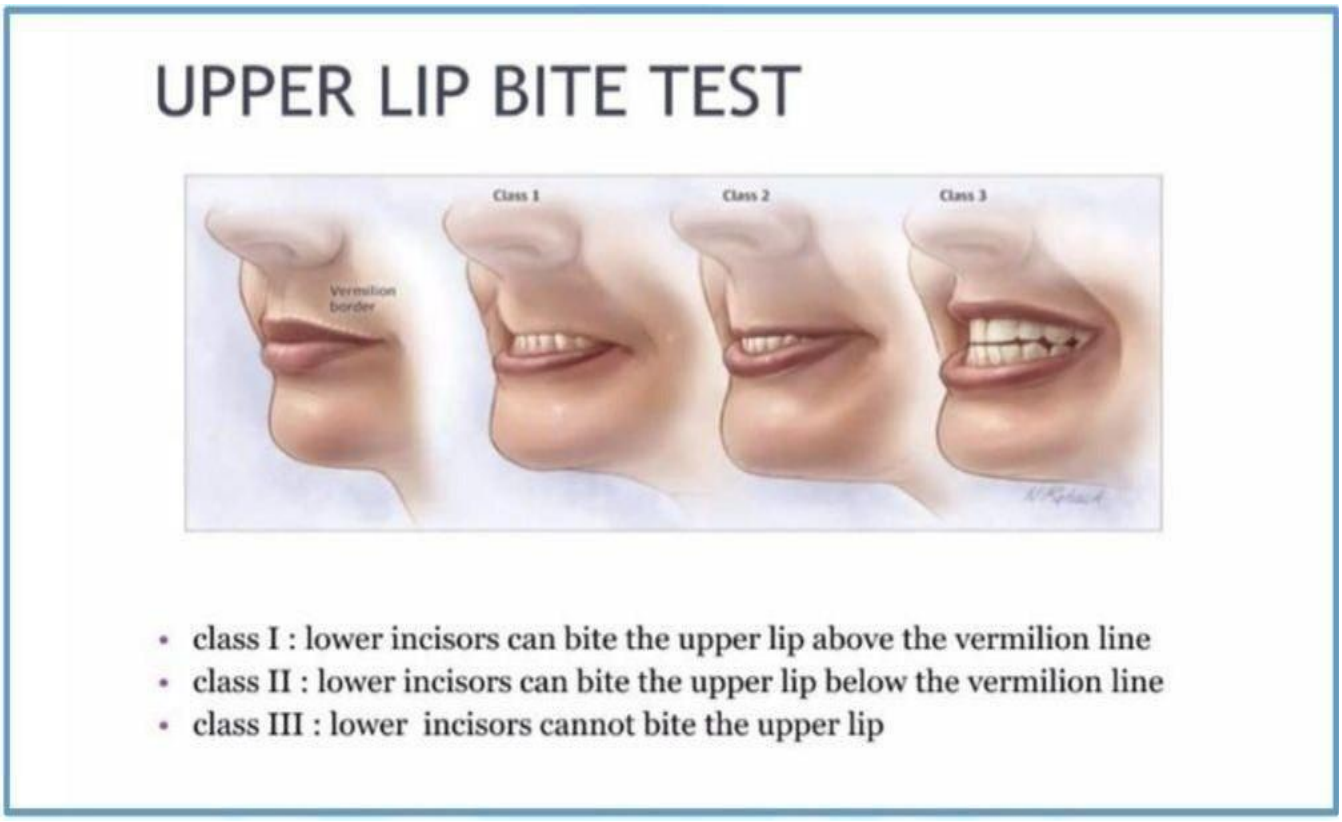
Evaluate 3-3-2 Rule

» **Mouth opening** ≥ 3 fingers.

» **Tip of the chin to hyoid bone** ≥ 3 fingers.

» **Hyoid bone to the top of the thyroid cartilage** ≥ 2 fingers.





Fasting guidelines

Time before anesthesia	Food or fluid intake
Up to 8 hours	Unrestricted (heavy meal)
Up to 6 hours	Light meal , formula milk
Up to 4 hours	Milk and fatty liquids
Up to 2 hours	Clear liquids only (no solids, no fat)
2 hours pre-anesthesia	Nothing permitted

Predictors of difficulty to face-mask ventilate (BONES)

1. The Bearded.
2. The Obese (body mass index > 30 kg /m^2).
3. Neck circumference > 60 cm .
4. The Elderly (older than 55 y) and the Edentulous .
5. The Snorers.

LECTURE TWO (2)

Anesthesia for Obstetric & Gynecology

Physiological Changes During Pregnancy

Parturients undergo remarkable changes during pregnancy, labor, and the immediate postpartum period that can directly affect anesthetic techniques.
Introduction of a good anesthetic management depend on understanding of **physiological** and **pharmacological changes** occurs during pregnancy.

Respiratory Effects

- ✓ Increase **O2 consumption** by 20% .. leading to » Increase tidal volume.. lead to » (uptake inhalational agents is faster) .
- ✓ Decrease functional residual capacity .. leading to » Decrease O2 reserves .. lead to » (increased risk of hypoxia and apnea) .
- ✓ Increase arterial PaO2 slight and decrease arterial PaCO2 .

NOTE : Preoxygenation before GA is mandatory **but less effective.**

NOTE : Increased incidence of difficult / failed intubation x10, and require smaller ETT .

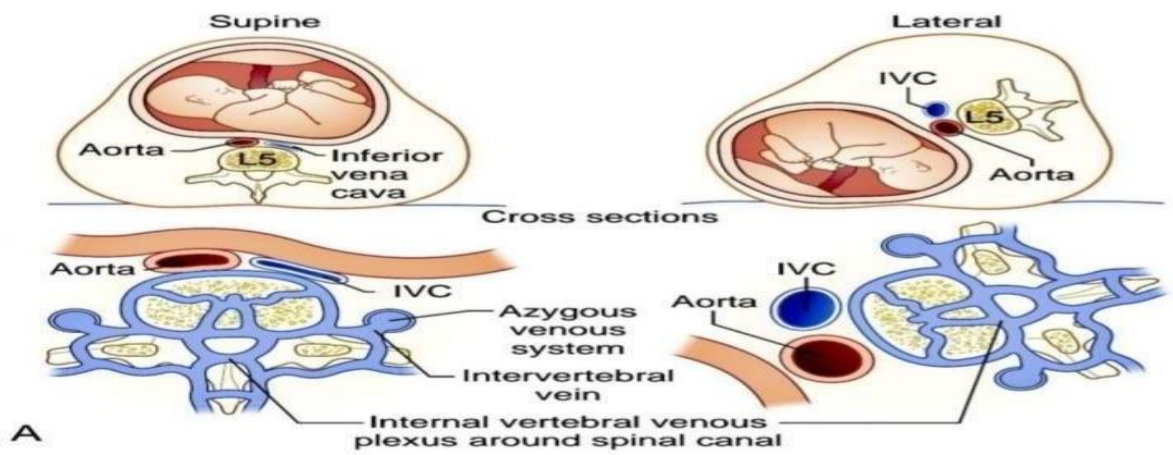
NOTE : Gentle laryngoscopy and smaller endotracheal tubes (6–6.5 mm) should be employed during general anesthesia.

Cardiovascular Effects

- ✓ Increase 35% Total blood volume.
- ✓ Increase 20% –50% Stroke volume.
- ✓ Increase 40% –50% Cardiac output by the third trimester.
- ✓ Increase 20% –30% Heart rate.
- ✓ Decrease 20% Systemic vascular resistance.
- ✓ Decrease Systolic and Diastolic blood pressure.

Note: Average blood loss during vaginal delivery is 400–500 mL , compared with 800– 1000 mL for a cesarean section.

Note: Approximately 5% of women at term develop supine hypotension syndrome **(Aortocaval compression)** . Always place a wedge or roll under the right hip so the patient is " tipped " to the left .



Hematological Effects

- ❖ Pregnancy is associated with a hypercoagulable state that may be beneficial in limiting blood loss at delivery.
- ❖ Fibrinogen and concentrations of factors VII, VIII, IX, X, and XII all increase.

Gastrointestinal Effects

All women in labor must be treated **as having a full stomach** and an increased **risk for pulmonary aspiration** of gastric contents for several causes :

- ✓ Increased progesterone levels cause smooth muscle relaxation.
- ✓ A reduction in lower esophageal sphincter pressure.

Enlarging the uterus causes increased intra-gastric pressure and this increases

gastroesophageal reflux during pregnancy .

Hepatic Effects

A 25–30% decrease in **serum pseudocholinesterase** activity is also present at term but rarely produces significant prolongation of succinylcholine's action.

Anesthesia for Labor & Vaginal Delivery

- **Meperidine** (Pethidine): a commonly used opioid , can be given in doses of 10–25 mg intravenously or Intravenous fentanyl , 25–100 mcg/h , has also been used for labor.
- **Morphine** is **not** used because it appears to cause greater respiratory depression in the fetus than meperidine
- Low-dose intravenous **ketamine** is a powerful analgesic.

Regional Anesthetic Techniques

- **Epidural** or intrathecal techniques (**spinal**) , alone or in combination, are currently the most popular methods of pain relief during labor and delivery. They can provide excellent analgesia while allowing the mother to be awake and cooperative during labor.

Anesthesia for Caesarean section

Regional anesthesia for Caesarean section was initially driven by maternal preference. It was subsequently found that regional anesthesia is also safer than GA.

Advantages :

- ✓ Mother being awake at the time of delivery .
- ✓ Minimal risk of aspiration and lower risk of anaphylaxis.
- ✓ Fewer drugs are administered , with less hangover than after GA.
- ✓ Better post-operative analgesia and earlier mobilization.

Note: Spinal is the most commonly used technique for elective Caesarean sections. It is **rapid in onset** , produces a dense block and with intrathecal opioids can produce long- acting postoperative analgesia.

General Anesthesia

Indication :

- ✓ Maternal request.
- ✓ Regional anesthesia contraindicated.
- ✓ Failed regional anesthesia.
- ✓ Urgent surgery
- ✓ Additional surgery planned at the same time as a Caesarean section.

Note: Elective GA is now uncommon, the majority of complications relate to the airway. Failed intubation is much more frequent in obstetric than non-obstetric anesthesia.

LECTURE THREE (3)

Anesthesia for pediatrics

It is often said that **pediatric** patients are '**not simply small adults**. The truth is that from the premature neonate to the near- adult adolescent, children are very diverse.

Involve the following age groups :

- Newborn » from birth to the first 24 hours .
- Neonates » (1 – 1 month) .
- Infants » (1 – 12 months) .
- Young children » (2 – 12 years of age) .

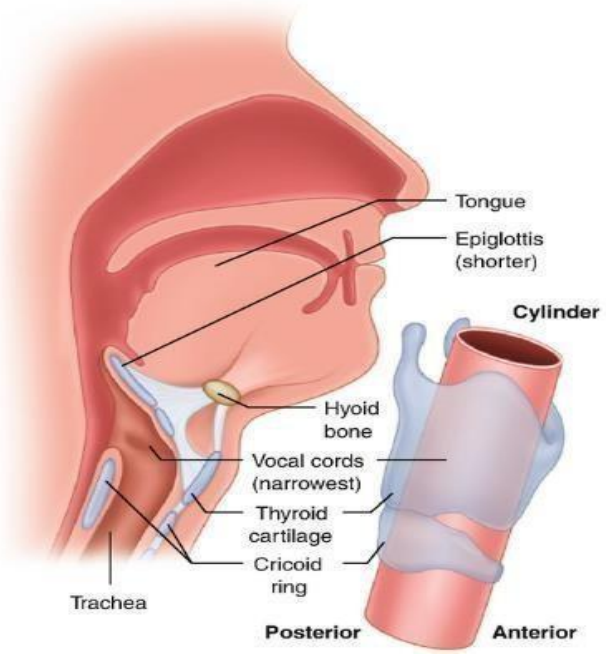
Anatomical changes:

- Larger head (prominent occiput) with a shorter neck and shorter trachea.
- Large tongue.
- High larynx **(level of C3 - C4) .**
- The narrowest part of the airway is at the **cricoid cartilage.**
- Difficult venous and arterial cannulation .
- Low-fat content and a greater surface area relative to weight **(rapid heat loss) .**
- Regulation of body temp is impaired (impaired shivering) .

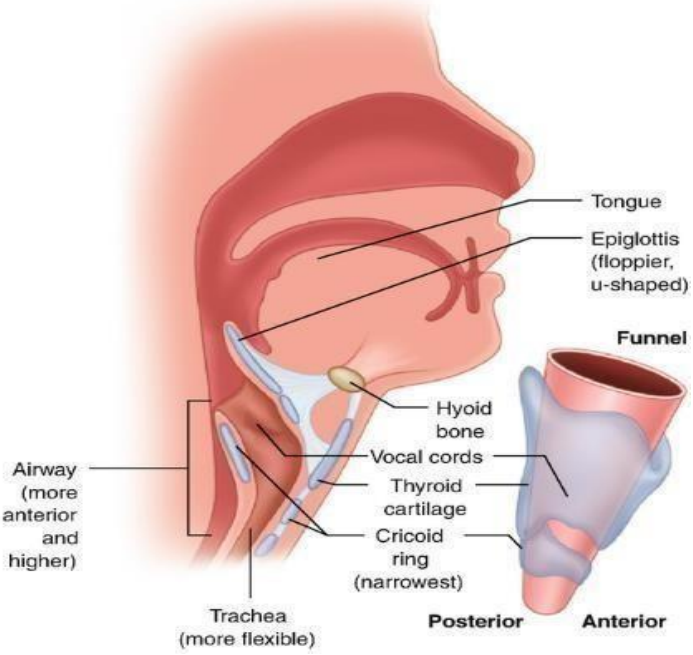
Note: Faster respiratory rate in pediatrics because of high metabolic rate leads to high oxygen consumption .

Note : children tidal volume is relatively fixed (5-7 ml/kg) and lower functional residual capacity .

Anatomy of adult airway



Anatomy of pediatric airway

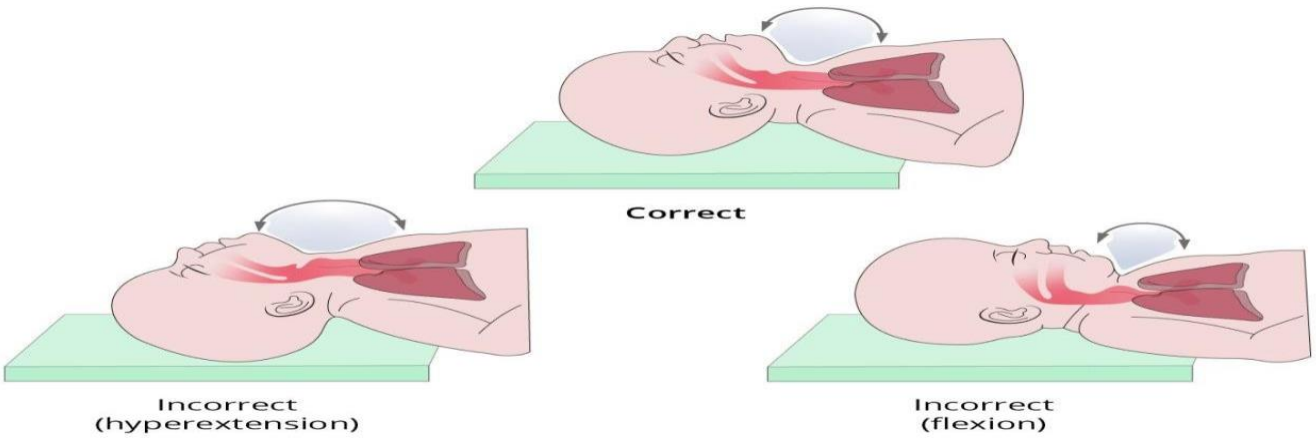


Cardiovascular considerations

Noncompliant left ventricle : so increase in **cardiac output** is achieved through an increase in **heart rate** (Heart-rate-dependent cardiac output).

- **Faster** heart rate : It is important to **avoid bradycardia** , This should be treated rapidly if it occur : the most **common cause** is **hypoxia .**
- Lower blood pressure . . (CO = SV × HR)

These changes predispose to **airway obstruction** , particularly if the child's head is placed in incorrect position **(flexion or hyperextended)** . **ideally** , maintain the child's head in neutral position or slightly extended .



Equipment's :

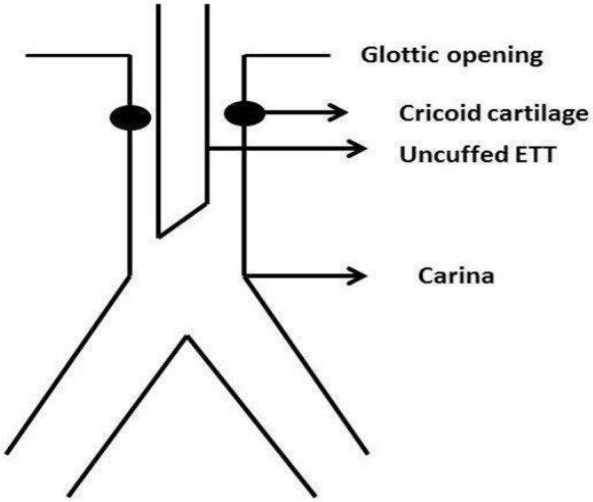
1. **A Miller blade (straight)** is better to use than **a curved blade (Macintosh)** for children because of the following : U-shaped epiglottis (may be large and floppy and difficult to pull out of view) and the Larynx is higher in the neck.

Infant

Toddler

Adult

2. **Uncuffed tubes** are commonly used for long - term ventilation in children.



The formula for estimating children's weight :

- < 1 month = 3 kg.
- 12 months = (0.5 x age in months) + 4.
- 1 - 5 years = (2 x age in years) + 8.
- 6 - 12 years = (3 x age in years) + 7

Endotracheal tube (ETT) :

Oral endotracheal tub size (ID) in mm :

Infants under 1 year :

- < 1500 g = 2.5 mm .
- 1500 - 3000 g = 3 mm .
- Over 3000 g = 3.5 mm .

Children over 1 year:

- Uncuffed ETT size = (age / 4 + 4) mm.

Note : Cuffed ETT size = (Uncuffed ETT – 0.5) .

Oral endotracheal tube length (depth) in cm :

- Infants under 1 year : 6 + weight in kg.
- Children over 1 year : age / 2 + 12.

Laryngeal mask airway (LMA)

Useful in short procedures with spontaneous ventilation.

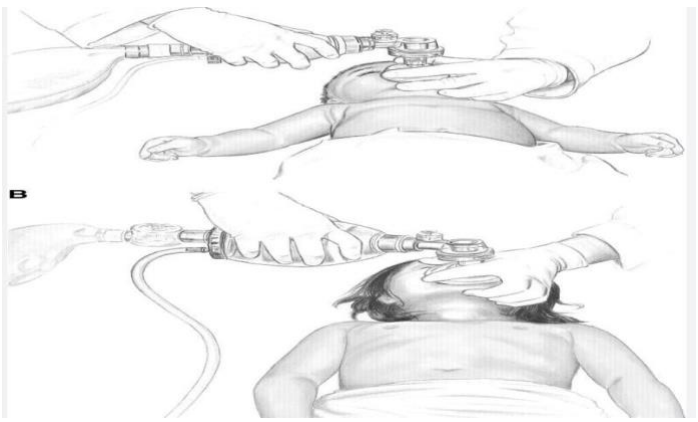
The size of LMA is estimated by the following formula.

LMA size = Weight kg / 20 + 1.

Anesthetic management

- The minimum alveolar concentration (MAC) values are decreased in neonates but increased in infants and children , **Sevoflurane is considered the agent of choice for inhalation induction.**
- Children are particularly sensitive to sedative and hypnotic drugs due to the immature hepatic biotransformation and decreased protein binding , **Ketamine is a common agent to be used for pediatrics.**
- Muscle relaxants neonates and infants are more sensitive to non-depolarizing neuromuscular blocking drugs because of the immature neuromuscular junction.

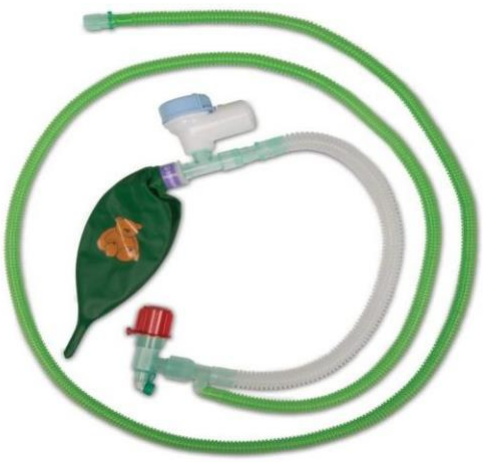
NOTE : Trachea narrow and **is much less rigid** . (the anesthetist's fingers should rest only on the mandible not on the soft tissue) .



Breathing systems

Common breathing systems (be lightweight with minimal dead space) used in pediatric practice include :

- Ayre's T-piece (Mapleson E).
- Jackson - Rees modification (Mapleson F).



LECTURE FOUR (4)

Anaesthesia for Geriatrics

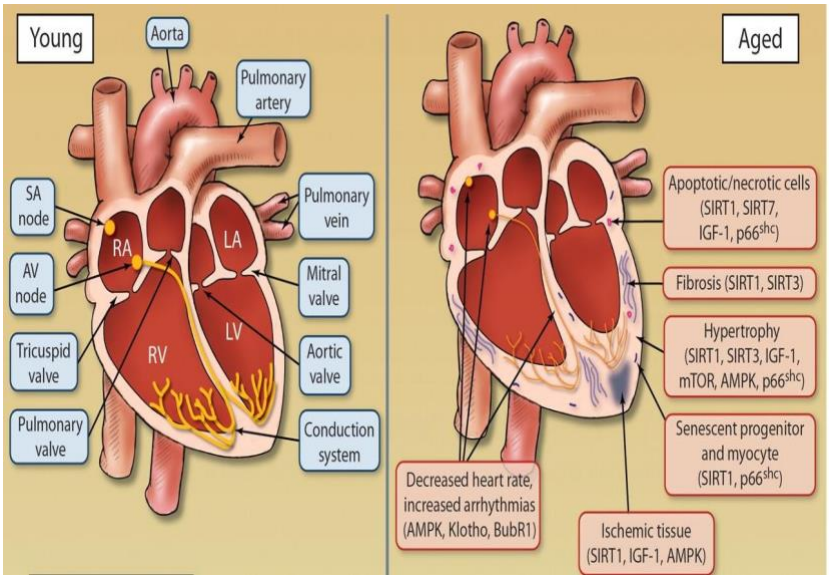
Is defined as providing anesthetic care for patients older than 65 years old in which perioperative morbidity and mortality are greater in the elderly than younger surgical patients .

Reduction in **cardiovascular**, **pulmonary**, **renal** and **central nervous system** function may be the most important determinants of outcome from surgical procedures under general or regional anesthesia.

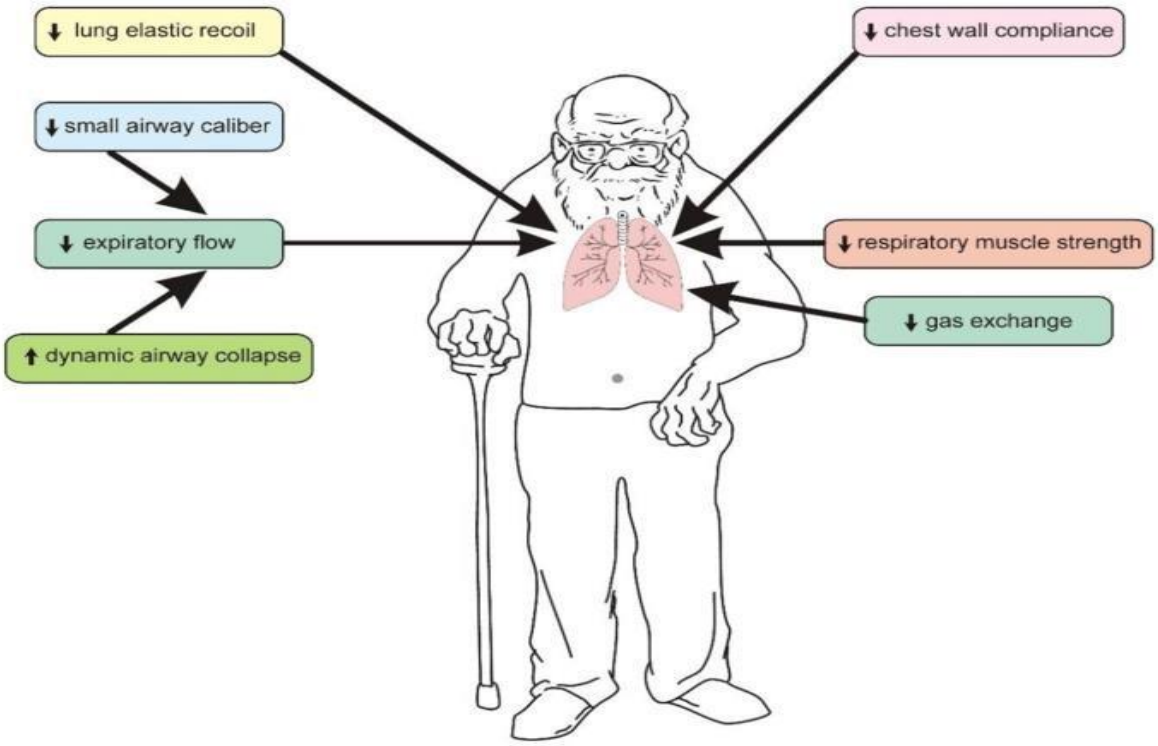
Geriatric Anatomical & Physiological changes

1. Age-related changes to the CVS

- Arteriosclerosis (increased BP and afterload on the heart).
- Increased afterload (e.g. from hypertension) produces ventricular hypertrophy, leading to increased myocardial oxygen demand.
- Decreased cardiac output and HR.
- Decreased baroreceptor reflex.



Age-related changes to the Respiratory system



↓ **Pulmonary elasticity**, → alveolar overdistention , airway collapse .

- ↓ **lung compliance**
- ↓ **chest wall compliance**,
- ↓ **total lung capacity** (**TLC**)
- ↑ **functional residual capacity** (**FRC**)
- ↑ closing capacity (**CC**) with age, and may become greater than the FRC - this occurs in the supine position at 44 years of age and in the upright position at 66 years.
- ↑ RV, FRC .

➢ The result of these changes is airway collapse, V/Q mismatch, and hypoxemia.

➢ Decreased cough reflex and ciliary clearance (risk of infection and aspiration).

Note: Oxygen - Oxygen - Oxygen therapy in Pre - Intra - Post anesthesia period for elderly patients.

Note: Plasma proteins are often reduced (Albumin) , so increasing free drug levels and possible toxic effects .

Prevention :

- Longer preoxygenation.
- Higher FiO , use of PEEP.
- Pulmonary toilet & early mobilization .

- ↓ MAC, ↑ neuraxial spread/duration.
- Delirium & Postoperative Cognitive Dysfunction (POCD).

⊘ Avoid : Benzodiazepines , meperidine , anticholinergics .

Metabolic & Endocrine

- ↓ Basal metabolic.
- ↓ Heat production , ↑ loss → hypothermia risk .

PREOPERATIVE PREPARATION

- **Assessment**
  - ✓ **A full history** and thorough **clinical assessment** are required.
  - ✓ An **ECG** is required for all patients.
  - ✓ A **chest X-ray** .
  - ✓ Note the level of cognitive function.
  - ✓ Assessment of **exercise tolerance** and functional ability is important.
  - ✓ The American Society of Anaesthesiologists (**ASA**) score should be recorded - it remains a good predictor of outcome in the elderly .

Resuscitation / optimization pre - operatively

- ✓ Dehydration is common.
- ✓ Preoptimisation enhance the oxygen delivery to the tissues during the perioperative period . by using fluid therapy, oxygen and possibly inotropic agents.

PERIOPERATIVE CARE

Induction of anaesthesia

Arm-brain circulation time is **increased**, and induction agent **dose requirements** are **reduced** .

- ✓ Titrate drugs slowly against effect, and inject into a running intravenous **infusion**.
- ✓ Thiopentone or propofol are both useful but should be given slowly to avoid overdose.
- ✓ An induction dose of propofol may result in hypotension and require a vasopressor.
- ✓ Avoid **ketamine** in the presence of cardiac disease as the tachycardia and hypertension that may result can

Maintenance of anaesthesia

- **Maintenance of anaesthesia** with **inhalational agents** is a suitable technique for elderly patients .
- **Fluid management**

Careful peri-operative fluid balance is mandatory in the elderly. Always consider measuring the **CVP** with large fluid shifts.

POSTOPERATIVE CARE

Oxygen therapy

- It is good practice to prescribe post-operative oxygen therapy for all elderly patients, and especially following abdominal or thoracic surgery.
- **Nasal cannulae** are often better tolerated than **facemasks** .

Analgesia

Consider prescribing a regular simple analgesic such as paracetamol , and use **NSAID's** with caution.

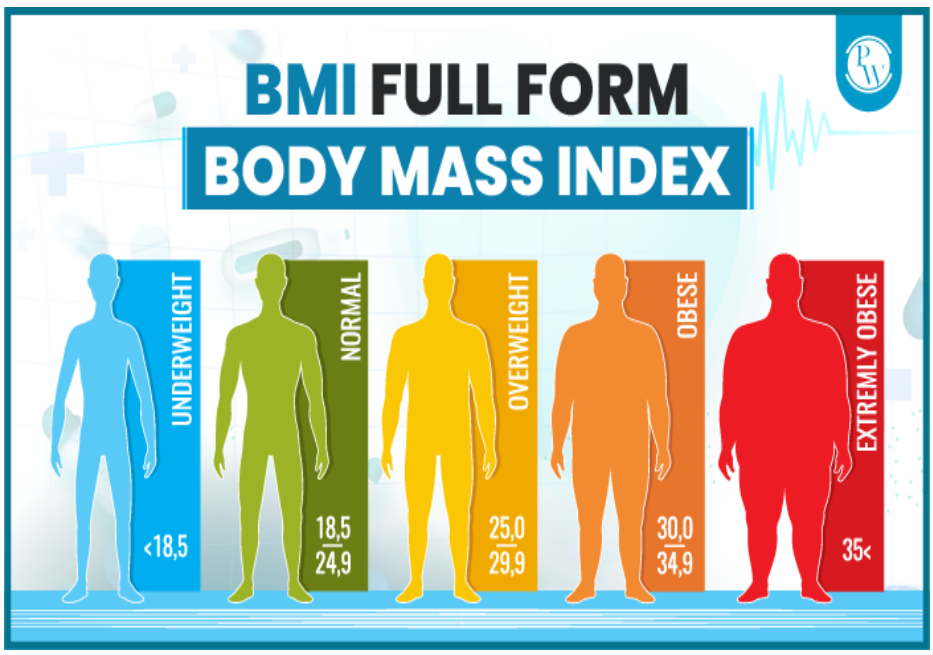
Regional techniques or an IV opioid infusion .

LECTURE FIVE (5)

Anesthesia for obese patient

Morbid obesity is defined in terms of body mass index (BMI).

- BMI is calculated by establishing a ratio between the patient's **weight** and **height** as follows: **Body mass index (BMI) = weight in kg/height in m2.**
- BMI values are classified as follows :
  - **BMI of 18.5–24.9 = normal**
  - **BMI of 25.0–29.9 = overweight**
  - **BMI of 30.0–34.9 = class I obesity**
  - **BMI of 35.0–39.9 = class II obesity**
  - **BMI of 40.0 or greater = class III obesity (sever or morbid obesity).**



Cardiovascular Disorders

A. Systemic Hypertension. Obesity-induced hypertension is related to the effects of hyperinsulinemia on the sympathetic nervous system and extracellular fluid volume.

B. Coronary Artery Disease.

C. Congestive Heart Failure .

Respiratory disorders

Since **obesity** is a **multisystem disease** affecting all organs, there are a number of implications relevant to the conduct of anesthesia :

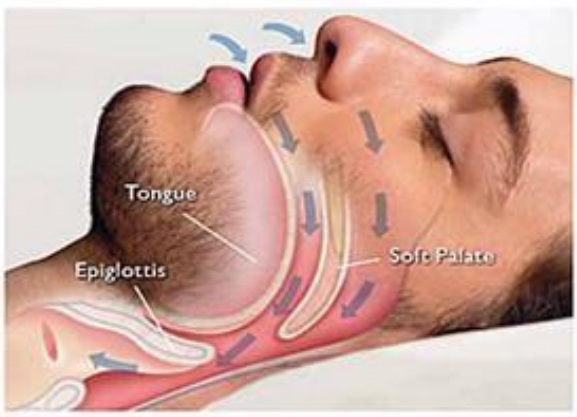
A. Lung Volumes. Obesity imposes a restrictive ventilatory defect because the weight of the thoracic cage and abdomen impedes the motion of the diaphragm and decreases functional residual capacity (FRC), especially in the supine position.

B. Gas Exchange and Work of Breathing. Paco2 and ventilatory response to carbon dioxide remain within a normal range in obese patients.

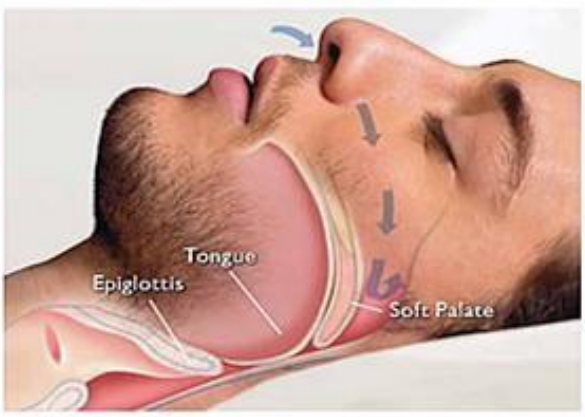
C. Lung Compliance and Resistance. Obesity is associated with a decrease in lung compliance and an increase in airway resistance .

D. Obstructive Sleep Apnea (OSA). OSA is cessation of breathing for more than 10 seconds during sleep, and hypopnea is a reduction in the size and number of breaths compared with normal breathing .

treatment includes removal of precipitants, weight loss and nocturnal CPAP.



Normal breathing
During sleep, air can travel freely to and from your lungs through your airways.



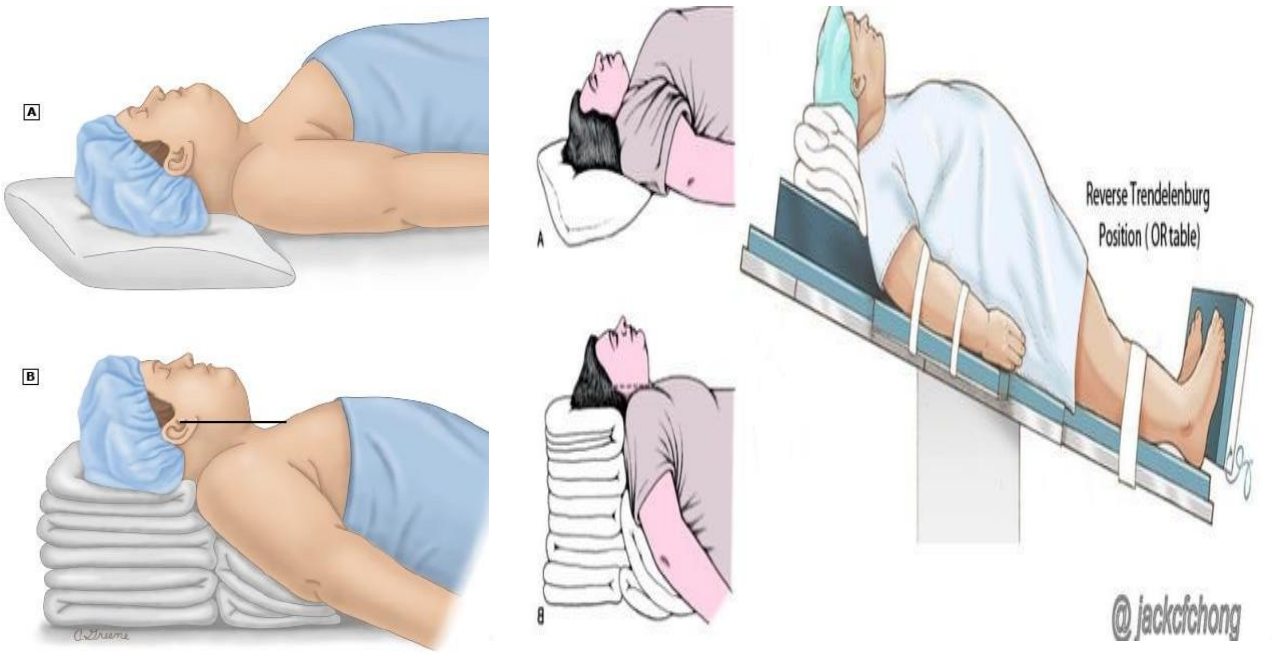
Obstructive Sleep Apnoea
Your airway collapses, stopping air from traveling freely to and from your lungs and disturbing your sleep.

Specific Anaesthetic considerations :

- ✓ Avoid sedative premedication (difficult to maintain airway)
- ✓ Airway obstruction is very likely to occur in the postoperative period (give oxygen and apply CPAP if required)
- ✓ Regional techniques and short acting anaesthetic agents are ideal to reduce postoperative drowsiness.
- ✓ Consider nocturnal oxygen for up to 5 days following major surgery if available.
- ✓ Regional anesthesia plus noninvasive mechanical ventilation represented the preferred techniques for obese patient with respiratory problems.

- ✓ Always assess the airway for prediction of difficult intubation.
- ✓ Difficult mask ventilation can sometimes be transformed by placement of an oral airway ; typically, laryngeal mask airways (LMA) are used for this purpose.
- ✓ Obese women are more likely to have large breasts, which can interfere with easy placement of the laryngoscope, therefore aim for a degree of head-up tilt, and if necessary, apply traction on the breasts to allow placement of the laryngoscope.

- ✓ For intubation , **ramps** are recommended to achieve optimal sniffing position. These ramps are created by placing folded blankets under the patient's shoulders, neck, and occiput. The idea is to bring the patient's **chin** to a **higher** point than the **chest**.



Anesthesia management

1.Preoperative Evaluation.

The focus is on cardiovascular and respiratory systems and airway evaluation .

Continuous Positive Airway Pressure (CPAP) or Bi-Level Positive Airway Pressure (BiPAP). If such treatment is used at home, the patient should bring the mask so that this therapy can be continued in the perioperative period.

2. Intraoperative Management

Positioning : Specially designed operating room tables may be needed, and special transfer devices (such as air transfer mattresses) can minimize the risk of injury to patient or staff. “Ramping” the patient may allow better ventilator mechanics. Pressure points require special attention. Neutral arm position is preferred when possible.

Choice of Anesthesia : **Local or regional anesthesia is preferable to general anesthesia if feasible.**

Regional Anesthesia: In obese patients' regional anesthesia may be technically difficult, as bony landmarks are obscured. Local anesthetic requirements for spinal and epidural anesthesia in **obese patients may be as much as 20% lower than in nonobese patients.**

Regional Anesthesia

Premedication : Use of benzodiazepines is controversial owing to risk of upper airway obstruction.

Management of Ventilation.

Controlled ventilation using large tidal volumes is often applied in an attempt to offset the decreased FRC. Positive end- expiratory pressure (PEEP) may improve ventilation/perfusion matching and arterial oxygenation in obese patients, but adverse effects on cardiac output and oxygen delivery may offset these benefits.

Note : Patients should be maintained in a semi-upright position during spontaneous ventilation during emergence.

Monitoring.

The technical difficulty of placing intravenous catheters and invasive monitors may be increased by the presence of obesity.

for those patients in whom a poor fit of the noninvasive blood pressure cuff is likely because of the severe conical shape of the upper arms or unavailability of appropriately sized cuffs.

For surgeries performed with the patient under local or regional anesthesia, capnography is recommended to decrease the risk of undetected airway obstruction.

Fluid Management.

Fluid management should be based on lean body weight. Urinary output during laparoscopic surgery does not necessarily reflect volume status.

Postoperative Management

Extubation:

When obese patients are fully recovered from the depressant effects of anesthetics, extubation is considered. Ideally, obese patients should recover in a head-up to sitting position.

Postoperative Analgesia.

Opioid depression of ventilation in obese patients is a concern, and Patient- controlled analgesia or neuraxial opioids are commonly used. Nonsteroidal anti-inflammatory agents may reduce narcotic requirements.
Ketamine and dexmedetomidine may be useful. Patients with OSA are at risk for development of postoperative hypoxemia. Adequacy of ventilation should be assessed for 24 to 48 hours postoperatively.

LECTURE SIX (6)

ANAESTHESIA FOR THORACIC SURGERY

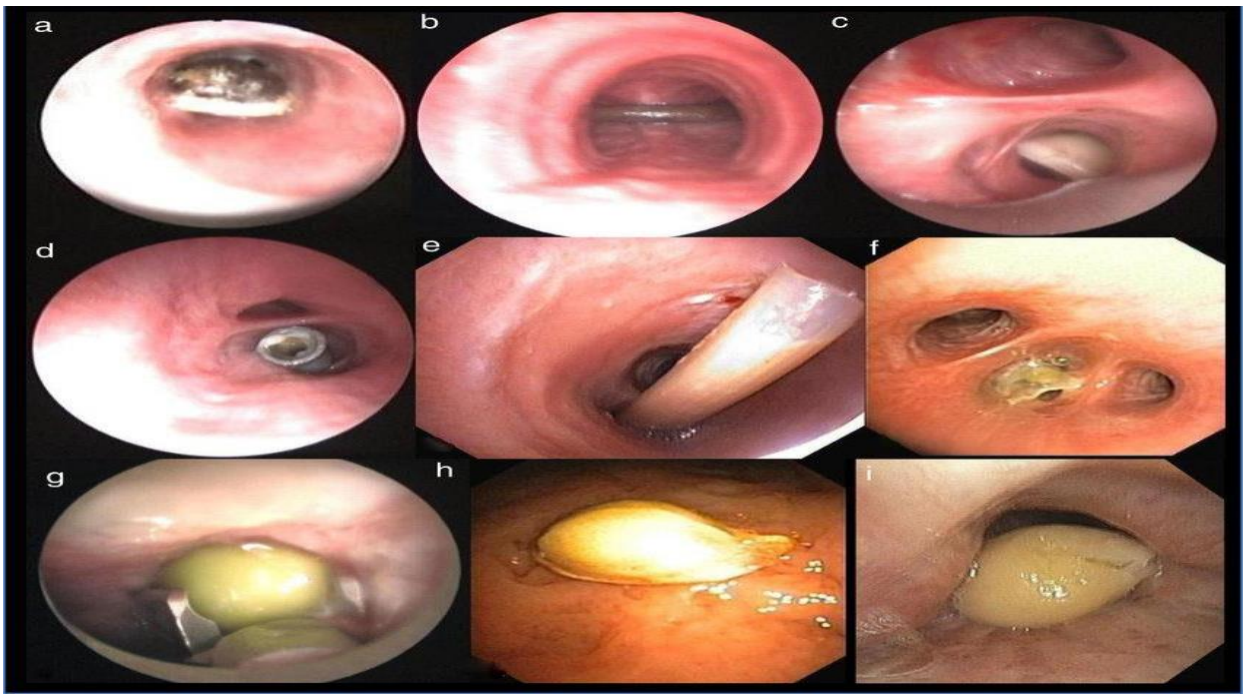
Common indications for thoracic surgery include

1. malignancies (mainly of the lungs and esophagus)
2. chest trauma
3. esophageal disease
4. and mediastinal tumors.

Note : Positioning a double-lumen tracheal tube to maintain anesthesia in the lateral position with the chest opened and one lung collapsed.

BRONCHOSCOPY

Rigid bronchoscopy may be for diagnostic or interventional procedures.
The latter include stenting, lasering and removal of foreign bodies.



Preparation, investigation and examination

To a large extent this will be dictated by the clinical condition of the child.
If the child is stable a chest radiograph may be helpful in localising the FB , although the majority of FBs will not be radio-opaque.
In the acute situation few other investigations are indicated. The patient should be starved according to the recommended guidelines , but this will clearly not be possible with acute respiratory distress .

Sedative premedication should not be used .

General anaesthesia will be required to perform bronchoscopy.

The anaesthetic machine and other equipment should be checked, especially suction equipment. A range of sizes of endotracheal tubes should be available, in case intubation is urgently required, bearing in mind that the presence of airway oedema reduces the tracheal diameter.

Inhalational induction is recommended using either sevoflurane or halothane in 100% oxygen.
Sevoflurane causes less airway irritation and is more cardiovascularly stable than halothane.

Intubation should not be performed prior to rigid bronchoscopy, due to the risk of **dislodging** or **fragmenting** the FB, with a **risk of complete airway obstruction**.

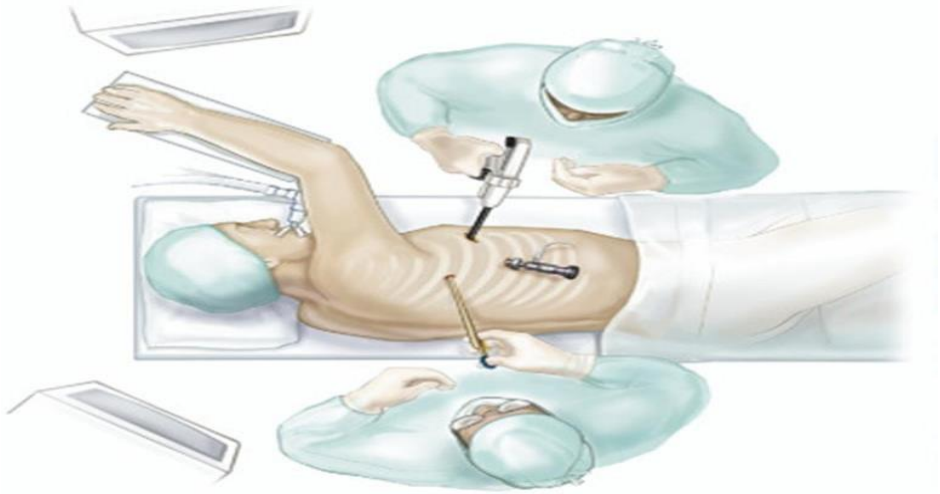
The anaesthetic is discontinued, 100% oxygen is administered, and the patient observed carefully until awake and extubated.
Postoperatively, the child must be monitored for signs of stridor and airway obstruction due to oedema.
Humidified oxygen is recommended for 24 hours

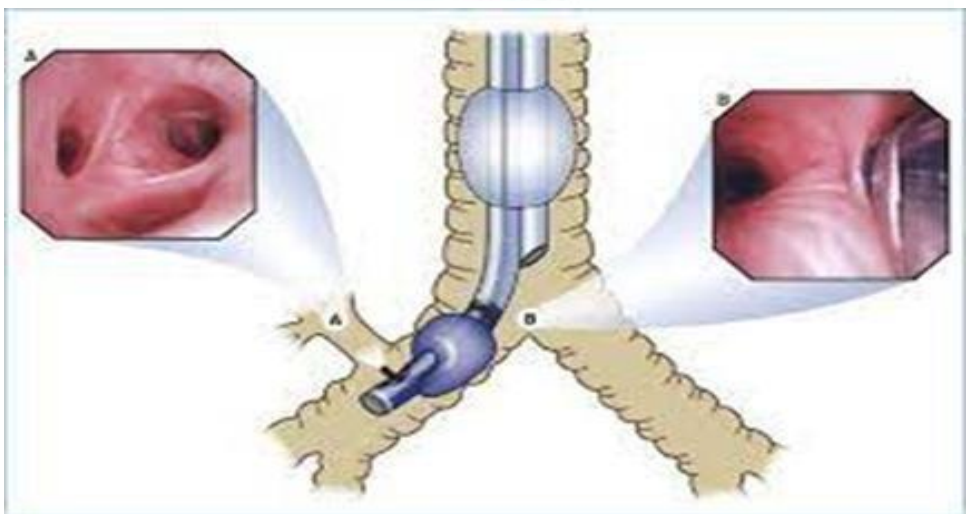
Fiber-optic bronchoscopy

Commonly, fiber-optic bronchoscopy is performed under **topical anesthesia** and **sedation** with midazolam or diazepam. **Opioids** may be used in addition, but apnea must be avoided. A flexible fiber-optic scope may be passed via an endotracheal tube or laryngeal mask airway under general anesthesia .

One-lung anesthesia:

In thoracic anesthesia, **One lung ventilation (OLV)** is the term used in thoracic anaesthesia to describe the ability to ventilate one of a patient's lungs, allowing the other one to collapse.



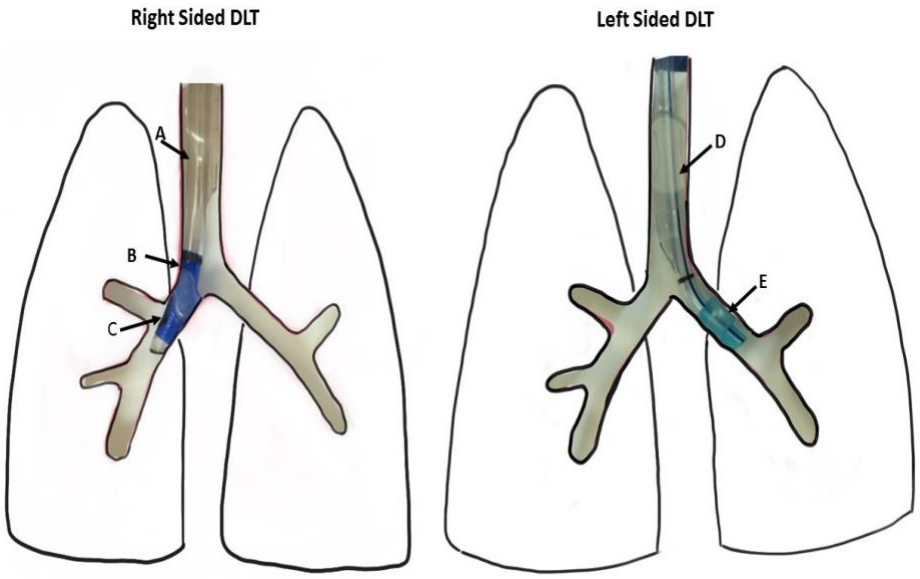


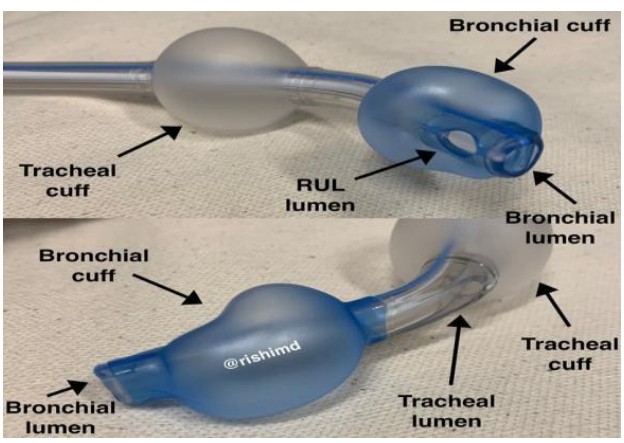
Techniques for OLV

There are 3 devices that can be inserted to achieve one lung ventilation:

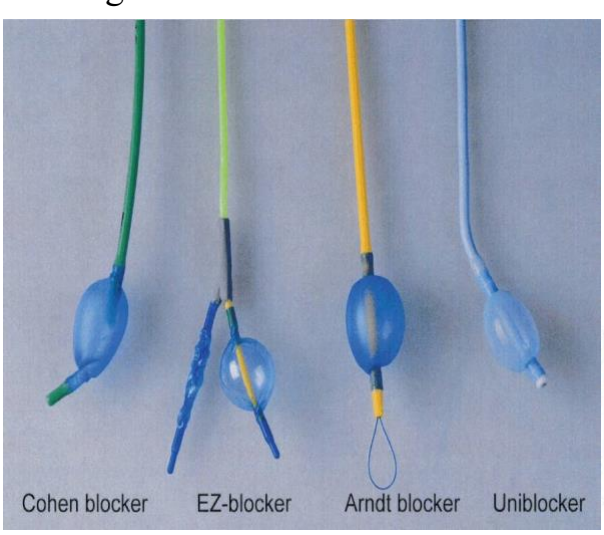
a double lumen tube, **a bronchial blocker**, or a **single lumen tube inserted beyond the carina**.

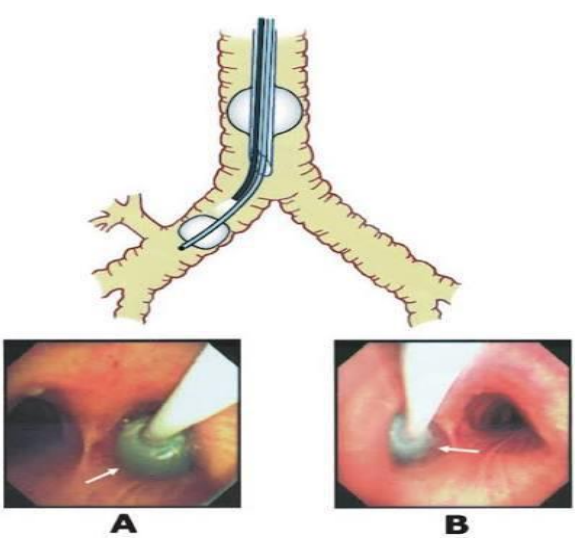
Double lumen tubes (Right and left sided tubes)

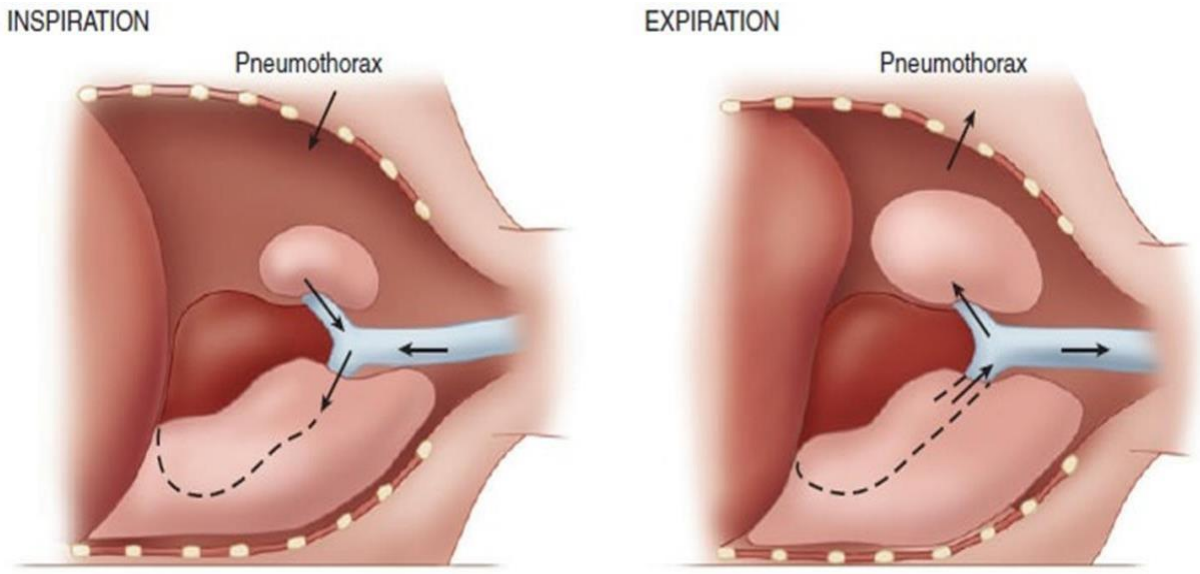




A bronchial blocker : is a device that is inserted into a conventially placed single lumen tube.







Overcoming hypoxia during OLV

Because of the above changes in lung physiology, it is not uncommon for a patient to desaturate during OLV.
If this happens:

For sudden or severe desaturation:

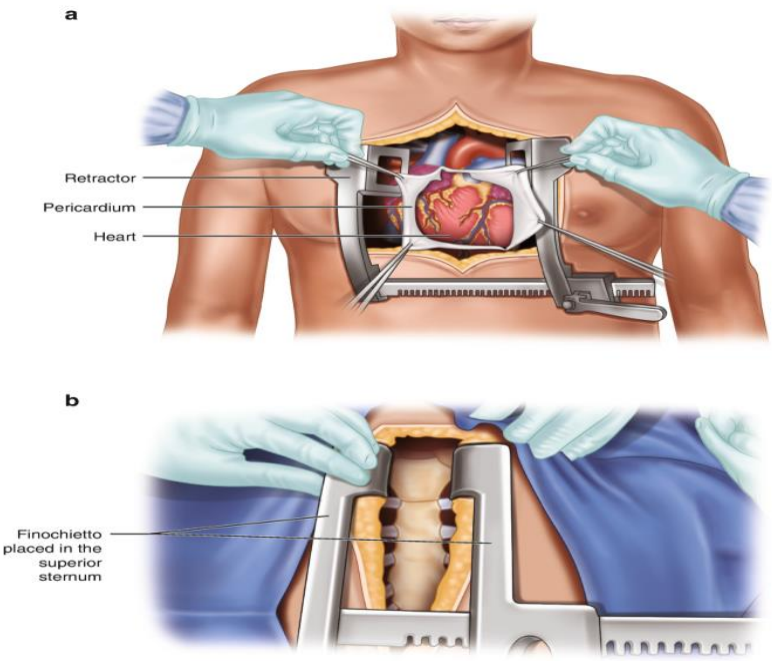
Convert to two-lung ventilation.

For gradual desaturation:

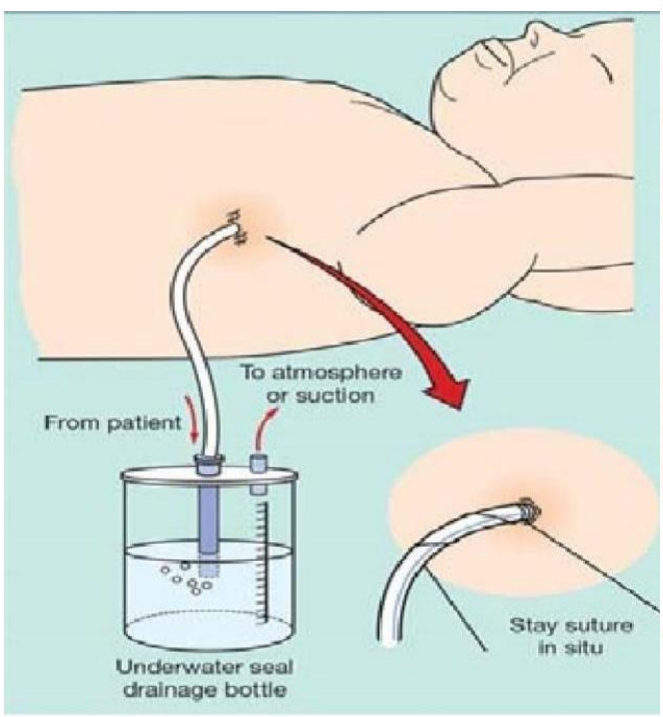
1. Tell the surgeon early rather than waiting for the saturations to plummet. It may be that you have to reinflate the lung temporarily.
2. Turn the inspired **oxygen up to 100%.**
3. Make sure that the patient's **blood pressure** has not dropped as this may be the cause of desaturation.
4. **Tube** patency and position should be checked.
5. **Secretions** may be blocking the tube lumen.
6. Look at the **capnograph** trace. If it has changed, as a general rule the tube has moved.
7. Applying positive end expiratory pressure (**PEEP**) to the ventilated lung
8. Application of continuous positive pressure (**CPAP**) to the non-ventilated lung may help
9. Intermittent two-lung ventilation.
10. If these methods all fail, the collapsed lung must be reinflated and the patient ventilated with 100% oxygen.

Thoracotomy

Median sternotomy in supine position is used for access to the thymus, retrosternal goiters and anterior mediastinum .



lateral thoracotomy is used for most-other thoracic operations..
Accidental pneumothorax during thoracotomy can be caused, it is a risk during any operation near the pleura or where local blocks are performed in the region of the thorax. It may be a cause of cardiovascular collapse and be difficult to diagnose.
Puncture of the lung itself will usually close spontaneously, but chest drains are usually required as a precaution.



Underwater seal drain

Heimlich flutter valve

Postoperative considerations:

1. **Postoperative hypoxemia:** Patients who have undergone a thoracotomy will require oxygen in the immediate postoperative period for 24 hours and chest physiotherapy, factor may contribute postoperative hypoxemia are:

A. Pneumothorax: which it should be excluded by routinely postoperative chest radiograph.
B. Atelectasis.
C. Sputum retention.
D. Poor pain relief.
E. Fluid overload.

2. **Cardiac arrhythmia:** The most common one after thoracotomy is atrial fibrillation.
3. **Torsion of remaining lobe :** It is may occur after lobectomy. The presentation may be up to 2 weeks postoperatively. Chest radiology shows engorgement and increased density of the affected lobe. Resection of the affected lobe is usual.
4. **Herniation of the heart:** Removal of pericardium together with lung resection, may allow the heart to be displaced from the mediastinum.

   Cardiovascular collapse is usually profound. Emergency reexploration is required.

LECTURE seven (7)

Anesthesia of Orthopedic Surgery

Common Anaesthetic Considerations

The common Anaesthetic considerations for Orthopedic surgery may be related to:

1. **Trauma association**: some of orthopedic patients' presence with other injuries due to trauma, and carry risks of **emergency surgery** (e.g., **aspiration of gastric contents**, **internal bleeding).**

2. **Musculoskeletal disease,** some patients have musculoskeletal disease need **Orthopaedic surgery** e.g., **rheumatoid arthritis RA**, **connective tissue diseases, muscular abnormalities.**

Patients with rheumatoid arthritis (RA) specifically require orthopedic surgery need special attention. because RA multisystem disease need special considerations include: -

A. **Pulmonary system e.g. pulmonary fibrosis**
B. **Cardiac system: - coronary artery disease. Myocarditis**
C. **Musculoskeletal systems: - atlentooccipital subluxation**
D. **Hematological system: -anemia, platelet dysfunction**
E. **Endocrine system adrenocortical impairment**

- **Airway management** in patients has **RA** can be challenging in these patients **because** RA involvement of the **cervical spine and temporomandibular joints** **results in limited neck range of motion and mouth opening.** Also, Patients with RA on **chronic steroid therapy** may require perioperative steroid replacement.

3 - MH (malignant hyperthermia) There is a higher-than-normal incidence of **MH** susceptibility in young patients with musculoskeletal abnormalities.

4 – Risk of congenital malformations: may be accompanied

by other system involvement, in **Orthopaedic surgery** and other injury e.g., cardiac lesions.

5 – Hyperkalemia: - there is a risk of massive **hyperkalemia** following **Suxamethonium** if neurological or muscle lesions are present. **Hyperkalemia may lead to cardiac arrest.**

6 - Tourniquets use

- ✓ Use of a pneumatic tourniquet on an extremity creates a bloodless field and decrease blood loss during surgery.
- ✓ The pressure in the arterial tourniquet should, in all cases, exceed arterial pressure. For the lower limb, this pressure is typically 300 mmHg (or 150 mmHg above systolic arterial pressure) and for the upper limb, 250 mmHg (or 100 mmHg above systolic arterial pressure)
- ✓ The maximum period of safe ischemia is not known precisely. Lasting damage is unlikely if a tourniquet time of 90 for upper limb and 120 minutes for lower limb is not exceeded.
- ✓ Tourniquet on more than one limb should never be deflated (or inflated) simultaneously.
- ✓ **tourniquets Inflation can produce potential clinical problems including: -**

A- Hemodynamic changes: - this is because of a rapid shift of blood volume into the central circulation. This is well tolerated in normal patients but in patients with noncompliant ventricles and diastolic dysfunction may be disaster.

B- Tourniquets pain, Tourniquet pain start gradually beginning approximately **1 h** after cuff inflation and becomes so severe over time which presented by Signs of progressive sympathetic activation include marked hypertension, tachycardia, and diaphoresis.

C- Arterial Thromboembolism, and pulmonary embolism. Tourniquet-by induced ischemia of a lower extremity may lead to the development of deep venous thrombosis.

D- Muscle dysfunction: - Prolonged inflation **(>2 h**) routinely leads to transient muscle dysfunction from ischemia and may produce rhabdomyolysis or permanent peripheral nerve damage. Tourniquet inflation has also been associated with

increases in body temperature in pediatric patients undergoing lower extremity surgery.

4- bone cement: **Cement implantation syndrome** due to Systemic absorption of residual methylmethacrylate monomer can produce vasodilation and trigger platelet aggregation, microthrombus formation in the lungs, and cardiovascular instability.

The clinical manifestations of bone cement implantation syndrome include

A- Hypoxia (increased pulmonary shunt),

B- Hypotension,

C- Arrhythmias (including heart block and sinus arrest),

D- Pulmonary hypertension (increased pulmonary vascular resistance), and decreased cardiac output.

Treatment strategies for this complication include

A- Increasing inspired oxygen concentration prior to cementing,

B- Maintain euvolemia,

C- Creating a vent hole in the distal femur to relieve intramedullary pressure,

D- Using a femoral component that does not require cement.

8.DVT (deep venous thrombosis) and PE(pulmonary embolism) are common, especially after hip surgery; and can cause morbidity and mortality following orthopedic operations on the pelvis and lower extremities. Risk **factors of DVT and PE include**

A. **Obesity,**
B. **Age greater than 60 years,**

C. **Procedures lasting more than 30 min,**
D. **Use of a tourniquet,**
E. **Lower extremity fracture.**
F. **Immobilization for more than 4 days.**

Positioning

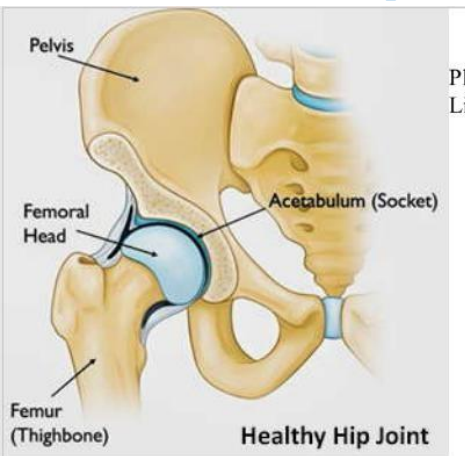
Orthopedic surgery often requires the use of unusual positions, some of which carry risks of *nerve damage, soft tissue ischemia, electrical and thermal injury and joint pain*. Care must be taken in protecting areas at risk of injury.
Forceful movement of the patient by the surgeon is often inevitable during orthopedic surgery. When such movement occurs, it is advisable to re-check the patient's position ensuring that soft tissues, nerves, eyes, airway connections and venous access are safe. Although some procedures may be performed under regional anesthesia alone, long operations may result in significant discomfort related to posture.
Some positions adopted during orthopedic surgery are associated with venous air embolism, which occurs when large veins are open to air, particularly, when venous pressure is low. These postures include the **lateral position for hip surgery**, the **sitting position** for shoulder surgery and the **prone position** for spinal surgery.

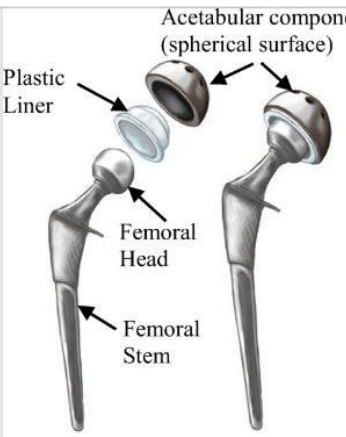
ANAESTHESIA FOR HIP REPLACEMENT

- **Hip replacement can be performed under general, spinal or epidural anaesthesia, and a combination of techniques is often used.**
- **The advantages of regional techniques include:**

· **Reduced blood loss, reducing the need for transfusion**
· **Avoids effects of general anaesthesia on pulmonary function**
· **Avoid intubation**
· **Good early postoperative analgesia**
· **Reduced incidence of postoperative venous thrombosis and pulmonary embolism**

- **The advantages of general anaesthesia include:**
  · **Easier for patients that cannot tolerate lying flat**
  · **Safer in patients with fixed output states like aortic stenosis, where maintenance of normal sinus rhythm, heart rate and intravascular volume is critical.**
  · **Patient preference**





Spinal anaesthesia

- A simple **THR** is particularly **amenable** to spinal anaesthesia and this can be supplemented with **sedation** or **general anesthesia**.
- **Target-Controlled-Infusion** (**TCI**) **propofol** is useful sedation for the lateral position, using facemask supplemental oxygen. Intermittent doses of **midazolam**, also can be used.
- For the **supine position** in a patient who wishes to be asleep during surgery, consider an **LMA** with a **light GA** to maintain the airway.
- The addition of **intrathecal opioid** helps cover the longer duration of surgery necessary for a more complex primary hip replacement.

- It is a **suitable technique** for up to **3 hours** of surgery. Alternatively, or for longer cases, a combined **spinal/epidural** technique can be used.
- **GA** (rather than sedation) may be combined with an epidural for any **complex primary operation** because of the prolonged surgical time. An **LMA**, or **endotracheal** tube and **IPPV**, may be considered.
- **Intraoperative**
- Inserting a urinary catheter will help to monitor fluid balance.
- Aim to **maintain blood pressure** at an adequate level based on preoperative readings. In **elderly** patients with **vascular disease** **hypotension** should be treated immediately.
- Intra-operative **antibiotic** prophylaxis will be required.
- Ensure **adequate** IV loading prior to cementing of femoral component.
- **Hypotension** can occur on **pressurisation** of the cement into the femur, **usually due to vasodilatation and direct myocardial depression from the monomer.**
- The **transient hypotension** does not correlate with the level of monomer in the circulation, but with deficit in blood volume.

Postoperative

- The **surgeon** usually **prefers** the patients to be placed on their bed in the **supine position** with the legs **abducted** using a pillow to prevent dislocation of the prosthesis.
- Patients are usually mobilized at **24-48 hours** and simple IM/ subcutaneous opioids with regular paracetamol or NSAIDs are usually sufficient for postoperative analgesia in a simple THR.
- If an epidural has been inserted, a postoperative infusion can be used but needs to **cease** prior to mobilization.
  PCA is a suitable alternative if pain relief is needed for an extended period.

LECTURE EIGHT (8)

Anesthesia for Ophthalmic surgery

Anesthesia for ophthalmic surgery dramatically changed recently, much cataract surgery is now performed under topical anesthesia only and much other surgeries under local anesthetic nerve block. When general anesthesia is used the laryngeal mask airway has generally replaced endotracheal tubes.

Intraocular pressure (IOP)

Normal intraocular pressure is 10-20 mmHg.

Increased IOP after some eye surgeries (particularly cataract) is typically due to retained ophthalmic viscosurgical device (the solution which used to maintaining the anterior chamber during surgical maneuvers) so, There are many factors that have to be taken into consideration that affect intraocular pressure.

It may be lowered by:

1. Intravenous anesthetics (except ketamine).
2. Inhalational anesthetics.
3. Hypotension.
4. Hypocapnia.
5. Reduction in venous pressure, including head-up tilt.
6. Mannitol and acetazolamide.
7. Mechanical pressure on the eye to increase absorption of aqueous humor.

It is may be raised by:

1. Hypertension.
2. Hypercapnia.
3. Raised venous pressure, including head-down tilt.

4. Suxamethonium (transient effect).
5. Local anesthetic block.
6. Ketamine (has a little effect).

The oculocardiac reflex:

Traction on extraocular muscles, pressure on the eyeball, administration of a retrobulbar block, and trauma to the eye can elicit a wide variety of cardiac dysrhythmias ranging from bradycardia and ventricular ectopy to sinus arrest or ventricular fibrillation.

- This reflex consists of a trigeminal (V1) afferent and a vagal efferent pathway.
- The oculocardiac reflex is most commonly encountered in pediatric patients undergoing strabismus surgery, although it can be evoked in all age groups and during a variety of ocular procedures, including cataract extraction, enucleation, and retinal detachment repair.
- In awake patients, the oculocardiac reflex may be accompanied by nausea. Routine prophylaxis for the oculocardiac reflex is controversial.
- Anticholinergic medication is often helpful in preventing the reflex, and intravenous atropine or glycopyrrolate immediately prior to surgery is more effective than intramuscular premedication.

Management of the oculocardiac reflex when it occurs includes:

(1) Immediate notification of the surgeon and temporary cessation of surgical stimulation until heart rate increases

(2) Confirmation of adequate ventilation, oxygenation, and

depth of anesthesia

(3) Administration of intravenous atropine (10 mcg/kg) if bradycardia persists

(4) In resistant episodes, infiltration of the rectus muscles with local anesthetic.

The reflex eventually fatigues (self-extinguishes) with repeated traction on the extraocular muscles.

General anesthesia

Indications for general anesthesia:

• Potential failure of cooperation by the patient, especially those with learning difficulties.

• Patient phobias, especially severe claustrophobia.

• Children.

• Long duration operation.

• Various technical surgical problems.

Premedication is not used routinely now for eye surgery, but a short-acting benzodiazepine may be given orally as premedication to anxious patients.

Anticholinergic agents cause a dry mouth and discomfort and do not need to be given with premedication. They are more likely to be needed in strabismus or retinal surgery, but may be given intravenously after induction if necessary.

Propofol used widely because of its short duration of action, pleasant induction and reduced post-operative nausea.

Etomidate is useful in elderly or unhealthy patients because of its cardiac stability, reduction in IOP and rapid recovery.

Moderate hyperventilation reduces PaCO2 and provides excellent operating conditions.

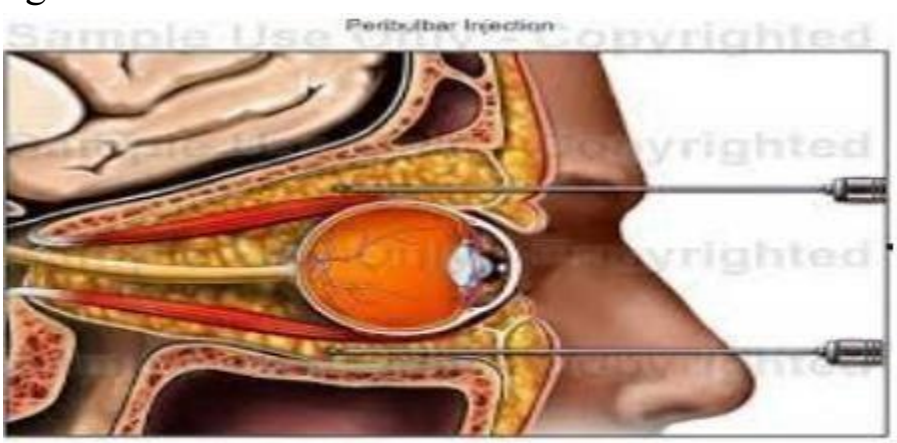
Use of Rae tube is preferred in eye surgery

Early on in the procedure, the surgeon should be encouraged to infiltrate a long acting local anesthetic by the sub-Tenon's

route. This should successfully eliminate various requirements in anesthetic from the surgical stimulus and provide a stable anesthetic with a reduction in the amounts of general anesthetic agent required.

Local anesthetic techniques

1. Topical: It is used for cataract surgery.
2. Sub-Tenon block: It is used for cataract surgery when immobile eye required. It is often unsatisfactory for vitreoretinal surgery. A blunt cannula is passed into the plane between Tenon's capsule and the sclera to inject the local anesthetic. It is often administrated by the surgeon without the help of the anesthetist.
3. Retrobulbar block: Injection of the local anesthetic into the muscle cone behind the eye. It is increasingly regarded as out of date and unsafe because the significant incidence of perforation of the globe, hemorrhage, and intradural injection.
4. Peribulbar block: It can be a true extradural injection, allowing the local anesthetic to diffuse into the muscle cone, or into the intraconal space. It is increasingly used vitreoretinal surgery and other forms where a greater level of akinesia and analgesia is needed



Peribulber block

LECTURE NINE (9)

ANESTHESIA FOR UROLOGICAL SURGERY

Urological procedures fall into a number of categories:

1) **Pediatric *reconstructive* surgery for congenital abnormalities.**

2) **Minor surgery on the *genitalia*, such as circumcision and vasectomy.**

3) **Minimally invasive surgery, including *cystoscopy* and *transurethral resection of the prostate (TURP).***

4) ***Major surgery*, such as cystectomy, nephrectomy and renal transplantation.**

Nephrectomy

- **The patient is placed in the *lateral position* with the *flank raised*** to open the space between the **ribs** and the **pelvis** for surgical access. This is referred to as '***breaking the table***' named as **kidney position**.

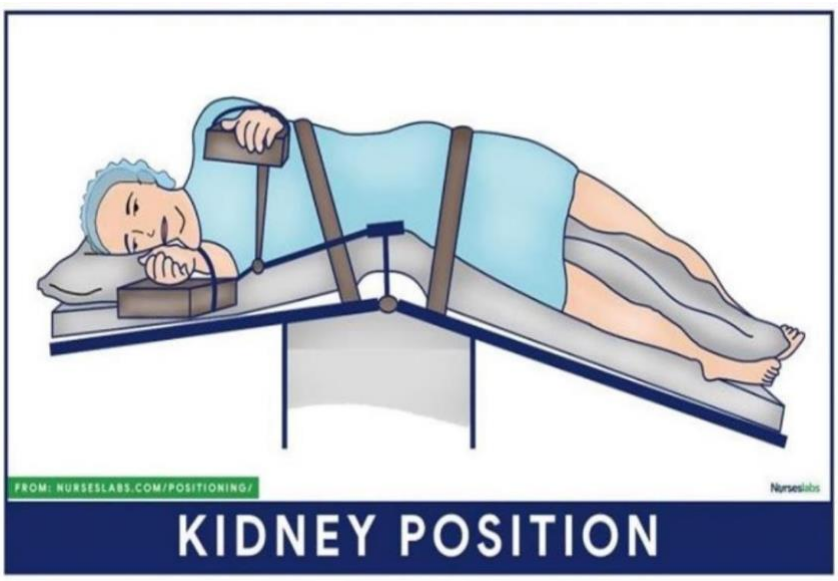
- At this point, **attention to the patient's head and airway is very important** as these may become unsupported as the table moves.

- ***The upper arm must not be abducted extensively* at the shoulder** and all areas of the body in contact with support ***should be well padded***.

- **There is a risk of pneumothorax from perforation of the pleura by the surgeon**, **The hole is generally small**, so the use of

- **positive-pressure ventilation and manually inflating the lungs before closure of the pleura help to prevent postoperative problems**.

- **A chest drain may be inserted before the end of surgery**



Bladder Tumors

- These are often removed repeatedly by **diathermy** or **loop excision.**

- Some **destruction by laser** may be carried out without a general anesthesia.

- **The lithotomy position is used.**

- These procedures may be carried out with **spinal anesthesia**. However, **they are frequently rapid** and unless there is a contraindication,

- **general anesthesia with a face mask or LMA is suitable**.

- Occasionally, **there is a rapid blood loss, so a large-gauge cannula should be used**.

- When **diathermy** used, the **obturator nerve** is often directly stimulated; this leads to excessive **jerking movements** of the **leg**, surgery is made more difficult and there is a risk of perforation of the bladder.

- **Paralysis** and **ventilation** may therefore be required to prevent perforation.

- Patients with **bladder cancer** may present for ‘repeated’ check **cystoscopies**. These are often performed under **topical anesthesia** and do not involve the anesthesiologist.

- If there is a need for **extensive examination or biopsy**, general anesthesia may be required.

Transurethral Resection of the Prostate gland (TURP)

It is a **common** operation, performed in the **lithotomy position**.

- **Continuous irrigation** with **glycine** is used to allow vision of operative site.
- **Chippings** are cut from the prostate gland with a wire loop.

Possible problems:

1) Hemorrhage: This is difficult to quantify as blood is mixed with irrigation fluid. Suggested methods include **Hematocrit estimation** by hemoglobinometer or measuring the hemoglobin concentration of the collected irrigation fluid, and from the known volume, calculating the quantity of hemoglobin lost.

Monitoring of heart rate and arterial pressure may help to identity bleeding, although they will be a **late sign.**

TURP syndrome (Transurethral resection of prostate syndrome): This is a complex syndrome which may involve (changes) **hypo**-osmolality, **hypo**natremia, **hyper**glycemia, **hyper**rammonemia and **intra vascular fluid shifts**.

These changes are caused by absorption of irrigating fluid (**glycine** is a hypotonic solution) through open **prostatic veins**, and later by its absorption from pooled irrigation fluid in the retroperitoneal and perivesiacal spaces.

Massive hemolysis may occur from hypo-osmolality. **Hemoglobinemia** from hemolysis, in combination with **hypotension**, may lead to **acute renal failure.**

Signs of TURP Syndrome may occur from as early as 15 minutes into the resection up to 12 hours after operation.

The signs include:

- hyper- or hypotension and
- pulmonary edema,
- confusion,
- bradycardia,
- convulsions, and

✓ Visual disturbance (all signs of cerebral edema).

Treatment depends on careful assessment and consists of mannitol, hypertonic saline or loop diuretics.

3) Sepsis: There is a risk of **septicemia** in those patients with urinary tract **infection**, **stones in the bladder** or an **indwelling catheter**. These patients should receive **intravenous antibiotics**, as should any patient with a joint prosthesis or valvular heart disease.

Preoperative period

- Preadmission counseling
- Smoking & alcohol cessation
- Nutritional therapy
- Thromboprophylaxis (e.g., LMWH, compression stockings)
- Clear liquids up to 2 h, Solid food up to 6 h before surgery
- Carbohydrate loading
- Antimicrobial prophylaxis for both aerobic and anaerobic pathogen
- Antiemetics

Intraoperative period

- Minimally invasive surgery
- Neuraxial anesthesia (e.g., epidural analgesia, rectus sheath catheter analgesia)
- Optimizing fluid therapy
- Active warming strategy (e.g., fluids warming, forced air warming)

Postoperative period

- Postoperative analgesia
  - Epidural analgesia
  - Transeverses abdominis plane block
  - Rectus sheath catheter analgesia
  - Oral paracetamol/non-steroidal anti-inflammatory drugs
- Early nasogastric tube removal
- Early oral nutrition
- Prevention of postoperative ileus (e.g., chewing gum, alvimopan)
- Early mobilization

LECTURE THIRTEEN (13)

Anesthesia for Neurosurgery

Cerebral Physiology

- The brain normally consumes 20% of total body oxygen.
- Most cerebral oxygen consumption (60%) is used to generate adenosine triphosphate (ATP) to support neuronal electrical activity
- Because of the rapid oxygen consumption and the absence of significant oxygen reserves, interruption of cerebral perfusion usually results in unconsciousness within 10 s.
- If blood flow is not reestablished within 3 to 8 min under most conditions, ATP stores are depleted, and irreversible cellular injury occurs.
- Cerebral perfusion pressure (CPP) is the difference between MAP and intracranial pressure (ICP) (or central venous pressure [CVP], if it is greater than ICP).
- **MAP – ICP (or CVP) = CPP**. CPP is normally 80 to 100 mm Hg. Moreover, because ICP is normally less than 10 mm Hg, CPP is primarily dependent on MAP
- **In normal individuals**, CBF remains nearly constant between MAPs of about 60 and 160mm Hg
- Pressures above 150 to 160 mm Hg can disrupt the blood–brain barrier and may result in cerebral edema and hemorrhage.

CEREBROSPINAL FLUID

- CSF is found in the cerebral ventricles and cisterns and in the subarachnoid space surrounding the brain and spinal cord.

- CSF cushions the central nervous system (CNS) against trauma and helps clear waste products
- In adults, normal total CSF production is about 21 mL/h (500 mL/d), yet total CSF volume is only about 150 mL
- Carbonic anhydrase inhibitors (acetazolamide), corticosteroids, spironolactone, furosemide, isoflurane, and vasoconstrictors decrease CSF production

INTRACRANIAL PRESSURE

The cranial vault is a rigid structure with a fixed total volume, containing brain (80%), blood (12%), and CSF (8%).
Any increase in one component must be offset by an equivalent decrease in another to prevent a rise in ICP.

ICP is normally 10 mm Hg or less.

Effect of Anesthetic Agents on Cerebral Physiology

Volatile Anesthetics

- **Halothane**, **desflurane**, **sevoflurane**, and isoflurane produce concentration-dependent **decreases** in **CMR**.
- **Isoflurane** produces the **greatest** maximal depression (up to 50% reduction)
- At **normocarbia**, volatile anesthetics **dilate** cerebral vessels and **impair** autoregulation (**increase** cerebral blood flow)
- **Sevoflurane** produces the **least** cerebral vasodilation.
- Expansion of cerebral blood volume can markedly elevate ICP in patients with reduced intracranial compliance.
- **Hypocapnia** can blunt the increase in cerebral blood volume associated with volatile anesthetic administration. Volatile anesthetics affect both formation and absorption of CSF.
- **Isoflurane**, facilitates absorption of CSF and is therefore an agent with favorable effects on CSF dynamics.

- When combined with intravenous agents, **nitrous oxide** has minimal effects on CBF, CMR, and ICP
- When given alone, **nitrous oxide** causes cerebral vasodilation and can potentially increase ICP.

INTRAVENOUS AGENTS

With the exception of **ketamine**, all intravenous agents either have little effect on or reduce CMR and CBF.

Cerebral autoregulation and CO_2 responsiveness are preserved with all agents.

- **Barbiturates** have **four** major actions on the CNS:
  (1) hypnosis, (2) depression of CMR, (3) reduction of CBF due to increased cerebral vascular resistance, and (4) anticonvulsant activity.
- **Barbiturates** produce dose-dependent **decreases** in CMR and CBF until the EEG becomes isoelectric.

The resultant reduction in **CSF** volume, combined with decreases in **CBF** and cerebral blood volume, makes **barbiturates** ***highly effective in lowering ICP.***

- **Opioids** generally have minimal effects on CBF, CMR, and ICP, unless $PaCO_2$ rises secondary to respiratory depression.
- **Propofol** reduces CBF and CMR, similar to barbiturates and etomidate.
- **propofol** seems to have significant anticonvulsant activity. Its short elimination half-life makes it a useful agent for neuroanesthesia.
- **Propofol** infusion is commonly used for maintenance of total intravenous anesthesia in patients with or at risk of intracranial hypertension.
- **Propofol** is by far the most common induction agent for neuroanesthesia.

Benzodiazepines lower CBF and CMR, but to a lesser extent than barbiturates,
etomidate, or propofol. Benzodiazepines also have useful anticonvulsant properties.
Midazolam *is the benzodiazepine of choice in neuroanesthesia because of its short half-life.*

- **Ketamine** is the only intravenous anesthetic that dilates the cerebral vasculature and increases CBF (50–60%).
- **ketamine** administration does not increase ICP in neurologically impaired patients under controlled ventilation with concomitant administration of propofol or a benzodiazepine.
- **Intravenous lidocaine** decreases CMR, CBF, and ICP, but to a lesser degree than other agents.

STRATEGIES FOR BRAIN PROTECTION

The brain is very vulnerable to ischemic injury because of its relatively **high oxygen consumption and near-total dependence on aerobic glucose metabolism**

- **Hypothermia** is a suggested method for protecting the brain during focal and global ischemia.
- **Ketamine** may also have a protective effect because of its ability to block the actions of glutamate at the NMDA receptor.
- **Xenon** is also suggested as a neuroprotective agent.
- Maintenance of a satisfactory CPP is critical.
- Hypotension, increases in venous pressure, and increases in ICP should be avoided.
- **Hyperglycemia** amplifies neurological injury following either focal or global ischemia, so blood glucose should be maintained at **less than 180 mg/dL.**

- **Normocarbia** should be maintained as both **hypercarbia** and **hypocarbia** have no beneficial effect on cerebral ischemia; hypocarbia induced cerebral vasoconstriction may aggravate the ischemia, whereas hypercarbia may induce a steal phenomenon with focal ischemia or worsen intracellular acidosis.

Anesthesia Management

Intracranial Hypertension

- Intracranial hypertension is defined as a sustained increase in intracranial pressure (**ICP**) ***above 15 mm Hg.***
- Intracranial hypertension may result from an expanding tissue or fluid mass, a depressed skull fracture if it compresses a venous sinus, inadequate absorption of cerebrospinal fluid (CSF), excessive cerebral blood volume (CBV), or systemic disturbances promoting brain edema.

Symptoms and signs, including headache, nausea, vomiting, papilledema, focal neurological deficits, and altered consciousness.

- When ICP exceeds 30 mm Hg, cerebral blood flow (CBF) progressively decreases, and a vicious circle is established: ischemia causes brain edema, which in turn increases ICP, resulting in more ischemia.

Treatment of intracranial hypertension, cerebral edema, or both is ideally directed at the underlying cause.

- **Blood glucose** should be monitored frequently and possibly controlled with insulin infusions when steroids are used.
- **Osmotic agents** are usually effective in temporarily decreasing brain edema and ICP until more definitive measures can be undertaken.

- **Diuresis** lowers ICP chiefly by removing intracellular water from normal brain tissue.
- **Moderate hyperventilation** ($PaCO_2$ of 30–33 mm Hg) reduces CBF, CBV, and ICP acutely but may produce cerebral ischemia from cerebral vasoconstriction.
- **Mannitol**, in doses of 0.25 to 1 g/kg, is particularly effective in rapidly decreasing intracranial fluid volume and ICP.
- **Mannitol** should generally not be used in patients with intracranial aneurysms, arteriovenous malformations (AVMs), or intracranial hemorrhage until the cranium is opened.
- **Hypertonic saline** (3% NaCl) is sometimes used to reduce cerebral edema and ICP
- Serum sodium concentration and osmolality should be frequently monitored.

In patients with traumatic brain injury, interventions in addition to mannitol to lower intracranial pressure include head elevation, CSF drainage via ventriculostomy, and metabolic suppression with barbiturates.

Anesthesia & Craniotomy for Patients with Mass Lesions

Intracranial masses may be congenital, neoplastic (benign or malignant), infectious (abscess or cyst), or vascular (hematoma or arteriovenous malformation).

PREOPERATIVE MANAGEMENT

The preoperative evaluation for patients undergoing craniotomy should attempt to establish the presence or absence of intracranial hypertension.

- Computed tomography (**CT**) and magnetic resonance imaging (**MRI**) scans should be reviewed for evidence of brain edema,

midline shift greater than 0.5 cm, or ventricular displacement or compression.

- Imaging studies typically will be performed before the patient receives ***dexamethasone***, so the mass effect may be less acute when patients who have already received dexamethasone present in the operating room.
- The neurological examination should document **mental status** and any **sensory** or **motor** deficits.
- **Medications** should be reviewed with special reference to ***corticosteroid***, ***diuretic***, and ***anticonvulsant*** therapy.
- Laboratory evaluation should rule out corticosteroid-induced hyperglycemia, electrolyte disturbances due to diuretics, or abnormal secretion of antidiuretic hormone.

Premedication

- **Sedative** or **opioid** premedication is best avoided, particularly when intracranial hypertension is suspected.
- Hypercapnia secondary to respiratory depression increases ICP.
- **Corticosteroids** and anticonvulsant therapy should be ***continued*** until the time of surgery.

INTRAOPERATIVE MANAGEMENT

Monitoring

In addition to **standard monitors**, **direct intraarterial pressure monitoring** and **bladder catheterization** are used for most patients undergoing craniotomy.

Rapid changes in blood pressure during anesthetic procedures, positioning, and surgical manipulation are best managed with guidance from **continuous invasive monitoring of blood pressure.**

Moreover**, arterial blood gas analyses** are necessary to closely regulate $PaCO_2$.

End-tidal CO_2 measurements alone cannot be relied upon for precise regulation of ventilation; the arterial to end-tidal CO_2 gradient must be determined.

Central venous access and pressure monitoring may be considered for patients requiring ***vasoactive drugs***.

A **bladder catheter** is necessary because of the use of ***diuretics***, the ***long duration*** of most neurosurgical procedures, and the utility of bladder catheterization in ***guiding fluid therapy*** and ***measuring core body temperature***

Induction

The goal of any technique should be to induce anesthesia and intubate the trachea without increasing ICP or compromising CBF

Arterial hypertension during induction increases CBV and promotes cerebral edema.

Sustained hypertension can lead to marked increases in ICP, decreasing CPP and risking herniation. Excessive decreases in arterial blood pressure can be equally detrimental by compromising CPP.

- The most common induction technique employs **propofol** or **etomidate**.
- All patients receive **controlled ventilation** once the induction agent has been injected.
- A **neuromuscular blocker (NMB**) is given to facilitate ventilation and prevent straining or coughing, both of which can abruptly increase ICP.

- An **intravenous opioid** given with **propofol** blunts the sympathetic response, particularly in young patients.
- **Esmolol** (0.5– 1.0 mcg/kg) is effective in preventing tachycardia associated with intubation in lightly anesthetized patients.
- **Succinylcholine** may theoretically increase ICP, particularly if intubation is attempted before deep anesthesia is established.
- **Succinylcholine**, however, remains the agent of choice for rapid sequence induction or when there are concerns about a potentially difficult airway as hypoxemia and hypercarbia are much more detrimental than any effect of succinylcholine to the patient with intracranial hypertension.
- **Hypertension** during induction can be treated with β1-blockers or by deepening the anesthetic with additional propofol.
- Modest concentrations of **volatile agents** (eg, **sevoflurane**) may also be used. Sevoflurane best preserves autoregulation of CBF and produces limited vasodilation; it may be the preferred volatile agent in patients with elevated ICP. Because of their potentially deleterious effect on CBV and ICP, vasodilators (eg, nicardipine, nitroprusside, nitroglycerin, hydralazine) are avoided until the dura is opened.
- Hypotension is generally treated with incremental doses of vasopressors (eg, phenylephrine).

Positioning

- Frontal, temporal, and parietooccipital craniotomies are performed in the supine position.
- The head is elevated 15° to 30° to facilitate venous and CSF drainage. The head may also be turned to the side to facilitate exposure.

- Before and after positioning, the position of the endotracheal tube should be verified with auscultation, and all breathing circuit connections checked. The risk of unrecognized disconnections is increased because the patient's airway cannot be easily assessed after surgical draping; moreover, the operating table is usually turned 90° or 180° away from the anesthesia provider.

Maintenance of Anesthesia

Anesthesia can be maintained with inhalation anesthesia, total intravenous anesthesia
techniques (**TIVA**), or a combination of an opioid and intravenous hypnotic (most often propofol) with a low-dose inhalation agent.

- Neuromuscular blockade is recommended to prevent straining, bucking, or other movement.
- TIVA with remifentanil and propofol facilitates rapid emergence and immediate neurological assessment.
- Normocarbia should be maintained intraoperatively. Lower $PaCO_2$
  tensions provide little benefit and may be associated with cerebral ischemia and
  impaired oxygen dissociation from hemoglobin. Ventilatory patterns resulting in high mean airway pressures (a low rate with large tidal volumes) should be avoided because of a potentially adverse effect on ICP by increasing central venous pressure and the potential for lung injury.
- Lung protective ventilation (tidal volume ≤6 mL/kg) is recommended.
- Intravenous fluid replacement should be limited to glucose-free isotonic crystalloid.

- Hyperglycemia is common in neurosurgical patients and has been implicated in
  amplifying ischemic brain injury.
- Hyperglycemia should be corrected preoperatively.
- Neurosurgical procedures are often associated with substantial occult blood loss (underneath surgical drapes or on the floor). Hypotension and hypertension should both be expeditiously corrected. Euvolemia should be maintained, which is often tricky in the setting of osmotic diuresis.

Emergence

- Most patients undergoing elective craniotomy can be extubated at the end of the procedure.
- Patients who will remain intubated should be sedated to prevent agitation.
- Extubation in the operating room requires special handling during emergence. Straining or "bucking" on the endotracheal tube may precipitate intracranial hemorrhage or worsen cerebral edema.

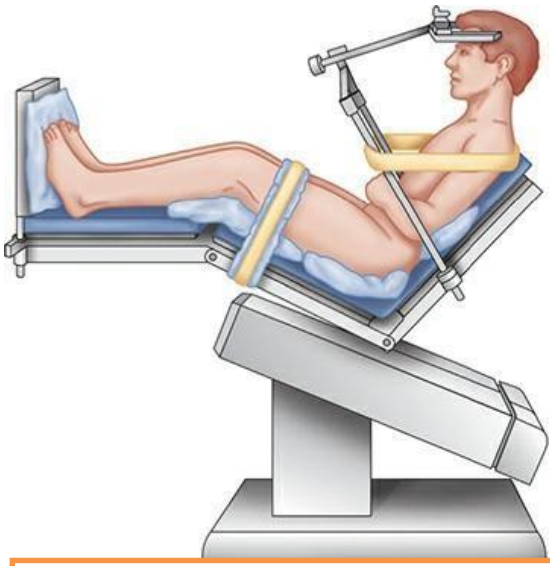
As the skin is being closed, the patient may resume breathing spontaneously.

- Care must be taken to avoid any patient motions (eg, bucking on the tube), which could promote neck or cranial injuries.
- Delayed awakening may be seen following an opioid or sedative overdose
- Most patients are taken to the intensive care unit postoperatively for close monitoring.

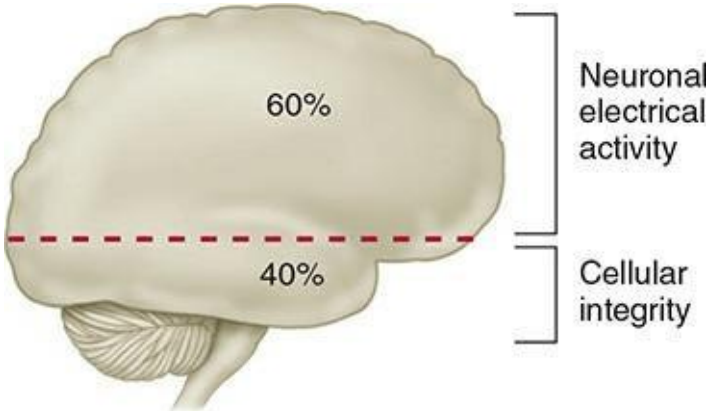
Venous Air Embolism

- Venous air embolism can occur when the pressure within an open vein is **subatmospheric**.
- These conditions may exist in any position and during any procedure whenever the wound is above the level of the heart.

- The incidence of venous air embolism is greater during **sitting craniotomies** (20–40%) than in craniotomies in any other position.
- The physiological consequences of venous air embolism depend on the **volume** and the **rate** of air entry and whether the patient has a right-to-left intracardiac shunt.
- Modest quantities of air bubbles entering the venous system ordinarily lodge in the pulmonary circulation, where they are eventually absorbed.
- Small quantities of embolized air are well tolerated by most patients.
- When the amount entrained exceeds the rate of pulmonary clearance, pulmonary artery pressure rises progressively. Eventually, cardiac output decreases in response to increases in right ventricular afterload.
- Nitrous oxide can markedly accentuate the effects of even small amounts of entrained air by diffusing into air bubbles and increasing their volume.



The sitting position for craniotomy



Normal brain oxygen requirements

LECTURE TWELFTH (12)

Anesthesia for Ear, Nose and Throat (ENT)

Introduction

- The practice of anesthesia for the **Ear**, **Nose**, and **Throat** (ENT) patient is challenging and surgery required high degree cooperation and communication between **surgeon** and **anesthesiologist**.

§The anesthesia practitioner is often required to be qualified regarding difficult airway management and must have the knowledge and skills to abnormal and difficult anatomy.

§ As a specialty, ENT presents specific Considerations to the anesthetist in regard to the preparation and management of ENT surgical procedures.

Special Considerations for ENT Procedures

- **Shared airway and Positioning.**
- **Surgical field avoidance.**
- **Restricted use of nitrous oxide.**
- **Use of specialized equipment.**
- **Laser.**
- **Prevention of endotracheal tube fire.**
- **High percentage of pediatric patients.**

- **Minimizing blood loss.**

Anesthetic Considerations for ENT Surgeries:

- **A true sharing of the airway between the surgeon and the anesthetist.** i.e. the surgical ENT field is the same field of anesthesia (airway)

Management includes:

- ✓ The **endotracheal tube** should be secured with tape or suture to prevent removal during surgery.
- ✓ **Good monitoring** of adequacy of ventilation by assessed the: -
  - Observing chest movement,
  - Chest auscultation,
  - Pulse oximetry,
  - End-tidal CO2,
  - Inspiratory airway pressure monitoring.

- **Use of specialized equipment (specially ETT).**

Variety of ETT designs are used:

- ❖ to prevent kinking of the ETT
- ❖ to prevent obstruction of the ETT when severe angles are necessary
- ❖ to prevent fires in the airway during laser therapy
- ❖ to provide maximal patient ventilation and safety

these types include: -

- **Standard endotracheal tubes (**acceptable for many ENT procedures**)**
- **Preformed right-angled ETTs**
- **Oxford ETT tube (**less liable to kink**)**
- **RAE tube;** designed to be even more 'anatomically' shaped than the Oxford tube.
- **Cole ETTs tube:** used in **neonates**. Shouldered, with thickened walls to prevent kinking
- **Armored Reinforced ETTs tubes**: resemble standard tubes but contain a spiral of metal or nylon in the tube wall.
- **Laser-protected ETTs tubes** include tubes made totally out of metal and those coated with 'laser proof' substances.

Laser-protected ETTs tubes

• Cole ETTs tube

Red rubber type of ETTs

Oxford ETT tube

Standard endotracheal tubes

Oral RAE tube in-situ

Oral RAE tube

Preformed right-angled ETTs

Tonsillectomy and Adenoidectomy

- Adenotonsillectomy in the United States is remains the most **common pediatric** surgery.
- Routine tonsillectomy is generally performed as an **outpatient procedure**.

- Untreated tonsillar and adenoidal hyperplasia may lead to nasopharyngeal obstruction, causing failure to thrive, speech disorders, obligate mouth breathing, sleep disturbances

A-In child: Excision of lymphoid tissue from oropharynx (tonsils) or nasopharynx (adenoids)

- ✓ **Time**: 20–30min
- ✓ **Pain** +++
- ✓ **Position**: Supine, pad under shoulders
- ✓ **Blood loss**: Usually small, can bleed post-op
- ✓ **Practical techniques**: South-facing uncuffed Rae tube or reinforced LMA, placed in groove of split blade of Boyle–Davis gag; SV or IPPV

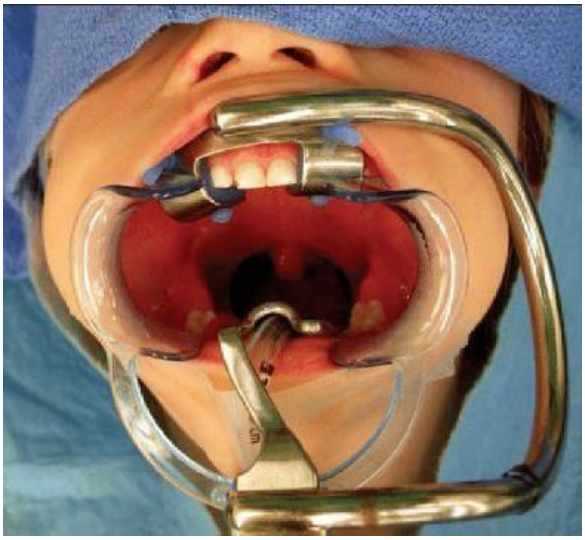
Preoperative:

- ✓ Careful history to exclude OSA or active infection.
- ✓ Topical LA on hands (mark sites of veins).
- ✓ Paracetamol/NSAID PO. Or rectally

Perioperative

•IV or inhalational induction (sevoflurane)—Guedel airway useful if nasopharynx blocked by large adenoids.
• Intubate (uncuffed RAE) using relaxant or deep inhalational anesthesia, or insert LMA using propofol/opioid or deep inhalational anesthesia.
• Secure in midline, no pack (obscures surgical field).
• Beware surgeon displacing/obstructing tube intraoperatively, particularly after insertion or opening of Boyle–Davis gag.
• T-piece ideal for SV, but ensure reservoir bag always visible.

• Reliable IV access essential, though IV fluids not routine.



• **analgesia** with morphine or fentanyl titrated IV plus paracetamol/ NSAID PR if not given preoperatively.

• **antiemetic**: at least one recommended—dexamethasone or ondansetron.

• Careful suction of oropharynx and nasopharynx at end under direct vision (generally done by surgeon).
• **Extubate** left lateral/head-down (tonsil position), with Guedel airway.

Post-operative

- Keep patient in tonsil position until airway reflexes return.
- highquality recovery care essential.
- analgesia with IV morphine/fentanyl initially, then oral paracetamol/ NSAID/morphine. Dexmedetomidine has been used.
- Leave IV cannula (flushed) in place in case of bleeding.
- In small children, a pillow under the chest can be used to provide the necessary tilt.
- avoid blind pharyngeal suction with a rigid sucker, as this may start bleeding from the tonsil bed.
- NSAIDs increase bleeding slightly (especially if given preoperatively).
- LA infiltration of the tonsil bed is not recommended.
- Beware continual swallowing in recovery, a sign of bleeding from the tonsil/adenoid bed.

❖ Bleeding after adenotonsillectomy

- May be detected in recovery or many hours later.
- Loss may be much greater than readily apparent (swallowed blood).
- Senior anesthetist must be involved.

Problems include:
• hypovolemia
• Risk of aspiration (fresh bleeding and blood in stomach)
• Difficult laryngoscopy because of blood in the airway or edema
• Residual anesthetic effect.
• Resuscitate preoperatively; check Hb cross-match, and give blood, as needed.

Note: Hb will fall as IV fluids administered (dilution).

Options:

• **RSI**: enables rapid airway protection, but laryngoscopy may be difficult (blood, swelling)—generally preferred
• Inhalational induction left lateral/head-down: allows time for laryngoscopy but takes longer, and unfamiliar technique to many.
• **Use wide-bore gastric tube** to empty stomach after bleeding stopped.
• extubate fully awake.
• **extended stay in recovery** for close monitoring.
• **Nasopharyngeal pack** occasionally needed (secured via tapes through nose) if bleeding from adenoids cannot be controlled. Usually very uncomfortable—patient may need midazolam/morphine to tolerate.
• **Check post-operative Hb**

B- in adult

As for child, except:

• Usually more painful post-operatively in adult—give morphine in theatre
• IPPV–relaxant technique used more commonly. Mivacurium useful with quick surgeon
• Preoperative oral NSAID avoids suppository use, though may increase bleeding risk.
• Occasionally, patients present with peritonsillar abscess (quinsy). Now normally treated with antibiotics, and tonsillectomy performed later. If drainage essential because of airway swelling, pus usually aspirated with syringe and large needle under **LA** infiltration.

Nasal operations

- Hypotensive techniques (induced hypotension) required to reduce bleeding;
- The patient is positioned 10º head-up.

- Anesthesia may be maintained using either spontaneous or controlled ventilation, depending on the duration of surgery.
- The pharynx should be packed with 2-inch ribbon gauze so that blood, pus or debris does not contaminate the larynx or pass into the stomach.
- When surgery has been completed, the pack is removed, the pharynx is
  cleared and the patient is turned into a lateral position.
- Surgical nasal packing, which used in such surgeries, cause a difficulty in maintaining a patent airway, so, a Guedel airway should be placed in position before the tracheal tube is removed to provide a patent airway, using of LMA, instead of tracheal tube, almost eliminates these difficulties, by leaving the LMA in place postoperatively until the patient rejects it in the recovery room.

Induced hypotension

- It is the deliberate reduction of systemic arterial blood pressure in order to reduce bleeding and facilitating surgery.
- It should be remembered that blood flow to the brain is maintained by autoregulatory vasodilation.
- In the coronary and cerebral circulations, maximum vasodilation is reached when the mean arterial pressure decreases to 50 – 60 mmHg {mean arterial pressure ≈ (2 diastolic pressure + systolic pressure) /3}, and further reductions in pressure result
  in parallel decrease in organs blood flow.
- Induced hypotension may be achieved by a reduction in either systemic vascular resistance or cardiac output.

A decrease in systemic vascular resistance may occur as a result of:

1) Anesthetic agent (e.g., propofol)

2) Drug interferes with the sympathetic reflex arc (e.g., phentolamine).

3) Drug acts on the vessel wall (e.g., sodium nitroprusside). A reduction of cardiac output is less desirable as oxygen delivery may be reduced, but

may be achieved using a beta blocker (e.g., esmolol).

Indications for induced hypotension:

1) Expected major blood loss. (Nasal surgeries)
2) Complex neurosurgery.
3) Microsurgery.
4) Intraocular surgery.

Induced hypotension should be avoided in patients with:

1) ischemic heart disease.
2) Fixed cardiac output (e.g., aortic stenosis).
3) Carotid artery stenosis.
4) Previous cerebrovascular accident.

LASER surgery

It is used to strip polyps or tumors from the vocal cords accurately and with immediate control of bleeding. There are two major anesthetic **problems:**

1) Damage to the tracheal tube: the introduction of cuffed flexible stainless-steel tubes for nasal or oral use has essentially solved this problem. For added safety, the cuff should be filled with water.
2) Retinal damage: To avoid this, all personnel must wear protective spectacles to prevent retinal damage. Anesthetists are particularly at risk as they are unable to retire behind the operating microscope during the laser procedure. Sometime a fire on tissue or tube occurs due to laser so there is **Airway fire protocol**.

1. Stop ventilation and remove tracheal tube.
2. Turn off oxygen and disconnect circuit from machine.
3. Submerge tube in water.
4. Ventilate with face mask and reintubate.
5. Assess airway damage with bronchoscopy, serial chest x-rays, and arterial blood gases.
6. Consider bronchial lavage and steroids.

LECTURE FIFTEENTH (15)

Controlled HypotensiveAnesthesia

is a State of induced controlled hypotension during anaesthesia to reduce bleeding and improve the surgical field adjusted to the patient's age pre-operative blood pressure and past medical history.

❖ **First used by Cushing in 1917**

ADVANTAGES

❖ Decreases blood loss during surgery

❖ Decreases operative time

❖ Provides bloodless operative field

PRINCIPLE

❖ Reduction in systolic blood pressure to 80-90 mmHg ..

❖ Decrease in MAP to 50-60 mmHg in normotensive patients .

❖ Reduction in MAP by 30% of the baseline values .

VITAL ORGAN PHYSIOLOGY

❖ Controlled hypotension rarely results in damage because organ blood flow is normally well maintained .

❖ Three main organs whose proper functioning is vital which autoregulate their blood pressures include:

- Brain
- Kidney
- Heart

CEREBRAL CIRCULATION

❖ Many feel that it is the perfusion of the cerebral circulation that is the critical factor that limits MAP reduction.

Auto regulation - MAP range of 50-150mmHg .

VARIOUS FACTORS UNDER CONTROL OF ANAESTHETISTS TO MAINTAIN MAP ARE :

1. paCO2 (partial pressure of Arterial CO_2) → increase in PaCO , there is an increase in cerebral blood flow .

2. Pao2 ⟶ High 02 mainly in hyperbaric range can lead to cerebral damage and thus brain compensates by Vasoconsriction.

- If O_2 below normal then Vasodilation

3. Volatile anaesthetics

Volatile anesthetics attenuate or abolish the auto regulation of cerebral blood flow in a Dose dependent manner in the following order :

halothane > **enflurane** > **isoflurane.**

4. Vasodilators

CORONARY CIRCULATION

Coronary blood flow is dependent upon the aortic diastolic blood pressure and the coronary vascular resistance.

RENAL BLOOD FLOW

Renal blood flow is controlled in two ways: Extrinsic autonomic and Hormonal mechanisms and Intrinsic auto regulation .

BLOOD PRESSURE GOAL

- The aim of Hypotensive anaesthesia is to reduce blood loss and provide a "dry" operating field. Hence, the degree of hypotension should be individualized.

- The hypotension should be considered satisfactory when bleeding appears to be minimal and organ perfusion adequate.
- Inducing hypotension to a MAP of 30% below a patient's usual MAP, with a minimum of 50mmHg in young patients and 80mmHg in the elderly is clinically acceptable.

PATIENT LIMITATIONS

- Cardiac disease
- Diabetes mellitus
- Anaemia, haemoglobinopathies, polycythaemia.
- Hepatic disease
- Ischaemic cerebrovascular disease
- Renal disease
- Respiratory insufficiency
- Severe systemic hypertension
- Intolerance to drugs available to produce hypotension .

ANAESTHETIST LIMITATIONS

- Lack of understanding of the technique.
- Lack of technical experience.
- Inability to monitor the patient adequately.

TECHNIQUE

MAP = CARDIAC OUTPUT X SYSTEMIC VASCULAR RESISTANCE

= (Stroke volume x Heart rate) X SVR

- Arterial bleed directly prop to MAP beta blockers reduce Stroke volume and Alpha Blockers reduce Peripheral vascular resistance .
- Capillary bleed by local adrenaline and hyperventilation to reduce arterial and venous PCO2 .
- Venous Tone reduced by intravenous nitrates and positioning .