Intubation and Anatomy of the Airway
And
Anesthesia apparatus
Anatomy and Airway assessment

• Why we need to know the anatomy of Respiratory tract?
• Parts of the tract? Which components?
• Innervation? Nerve injuries
• Airway assessment and 1-2-3 Rule
ANATOMY OF RESPIRATORY TRACT

• Anatomically Respiratory tract is divided into upper and lower tract in relation to vocal cord.

Upper: nose, mouth, pharynx, larynx, trachea, and mainstem bronchi.
Lower: bronchioles, terminal bronchioles, Respiratory bronchioles, alveolar ducts, alveolar sacs, alveoli.

• Or according to its function into conducting zone and respiratory zone.
  • Conducting zone:
    • Function: filter, warm and moisten air and conduct air to and from the respiratory zone
  • Respiratory zone: (p.s in RED)
    • Function: gas exchange

• And there are two openings to the human airway: the nose, which leads to the nasopharynx, and the mouth, which leads to the oropharynx. These passages are separated anteriorly by the palate, but they join posteriorly in the pharynx.
Oral cavity
Pharynx

The pharynx is a U-shaped fibromuscular structure that extends from the base of the skull to the cricoid cartilage at the entrance to the esophagus. It opens anteriorly into the nasal cavity, the mouth, the larynx, and the nasopharynx, oropharynx, and laryngopharynx, respectively.

**The nasopharynx is separated from the oropharynx by an imaginary plane that extends posteriorly.**

**The oropharynx is separated from the laryngopharynx by epiglottis at the base of the tongue.**
**The larynx is a cartilaginous skeleton** held together by ligaments and muscle. Located below the tongue and hyoid bone, between the great vessels of neck.

- Level of C4-C6
- 44mm in males and 36mm in females

**The larynx is composed of nine cartilages:**
- Thyroid
- Cricoid
- Epiglottis
- & (in pairs) arytenoid, corniculate, and cuneiform.

***The thyroid cartilage shields the conus elasticus, which forms the vocal cords.***
• LARYNGEAL FOLDS
  • Vestibular fold
  • Vocal fold
  • glottis: gap between the vocal folds, the narrowest part of the larynx (Entrance)
EXTRINSIC MUSCLES OF LARYNX

- Sternothyroid muscles depress the larynx.
- Omohyoid muscles depress the larynx.
- Sternohyoid muscles depress the larynx.
- Inferior constrictor muscles
- Thyrohyoid muscles elevates the larynx.
- Digastric elevates the larynx.
- Stylohyoid elevates the larynx.
- Mylohyoid elevates the larynx.
- Geniohyoid elevates the larynx.
- Hyoglossus elevates the larynx.
- Genioglossus elevates the larynx.
## INTRINSIC MUSCLES OF LARYNX

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Attachments</th>
<th>Innervation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cricothyroid</td>
<td>anterior lateral surface of the cricoid cartilage to the inferior margin of the thyroid cartilage</td>
<td>superior laryngeal nerve, external branch</td>
<td>tenses vocal cord</td>
</tr>
<tr>
<td>Posterior Cricoarytenoid</td>
<td>posterior lamina of cricoid cartilage to the muscular process of arytenoid</td>
<td>inferior (recurrent) nerve</td>
<td>abducts vocal cord</td>
</tr>
<tr>
<td>Lateral Cricoarytenoid</td>
<td>lateral surface of cricoid cartilage to the muscular process of the arytenoid cartilage</td>
<td>inferior (recurrent) nerve</td>
<td>adducts vocal cord</td>
</tr>
<tr>
<td>Thyroarytenoid (Vocalis)</td>
<td>posterior surface of the thyroid cartilage to the muscular process of the arytenoid cartilage</td>
<td>inferior (recurrent) nerve</td>
<td>adducts vocal cord and relaxes the voal cord</td>
</tr>
<tr>
<td>Arytenoid transverse</td>
<td>arytenoid cartilage to arytenoid cartilage</td>
<td>inferior (recurrent) nerve</td>
<td>adducts vocal cord</td>
</tr>
<tr>
<td>Oblique</td>
<td>arytenoid cartilage to arytenoid cartilage</td>
<td>inferior (recurrent) nerve</td>
<td>adducts vocal cord</td>
</tr>
</tbody>
</table>
INNERVATION OF LARYNX

• The **vagus nerve** (cranial nerve X) provides sensation to the airway below the epiglottis.

• Above the vocal cords **The superior laryngeal branch** divides into an external (motor) nerve for the cricothyroid muscle and an internal (sensory) laryngeal nerve – damage to this nerve will abolish the cough reflex.

• Below the vocal cords the **recurrent laryngeal nerve** which innervates all sensation & all Intrinsic muscles except the cricothyroid muscle.

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Effect of Nerve Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior laryngeal nerve</td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>Minimal effects</td>
</tr>
<tr>
<td>Bilateral</td>
<td>Hoarseness, tiring of voice</td>
</tr>
<tr>
<td>Recurrent laryngeal nerve</td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>Hoarseness</td>
</tr>
<tr>
<td>Bilateral</td>
<td>Stridor, respiratory distress</td>
</tr>
<tr>
<td>Acute</td>
<td>Aphonia</td>
</tr>
<tr>
<td>Chronic</td>
<td>WHY?</td>
</tr>
<tr>
<td>Vagus nerve</td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>Before it gave different branches, how it differs?</td>
</tr>
<tr>
<td>Bilateral</td>
<td>Hoarseness</td>
</tr>
<tr>
<td>Aphonia</td>
<td>WHY?</td>
</tr>
</tbody>
</table>
Innervation above glottis

• The sensory supply to the upper airway is derived from the cranial nerves.
• The mucous membranes of the nose are innervated by the ophthalmic division (V1) of the trigeminal nerve anteriorly (anterior ethmoidal nerve) and by the maxillary division (V2) posteriorly (sphenopalatine nerves).
• The palatine nerves provide sensory fibers from the trigeminal nerve (V2) to the superior and inferior surfaces of the hard and soft palate.
• The olfactory nerve (cranial nerve I) innervates the nasal mucosa to provide the sense of smell.
• The lingual nerve (a branch of the mandibular division [V3] of the trigeminal nerve) and the glossopharyngeal nerve (cranial nerve IX) provide general sensation to the anterior two-thirds and posterior one-third of the tongue, respectively.
• Branches of the facial nerve (VII) and glossopharyngeal nerve provide the sensation of taste to those areas, respectively.
• The glossopharyngeal nerve also innervates the roof of the pharynx, the tonsils, and the undersurface of the soft palate.
V₁ Ophthalmic division of trigeminal nerve (anterior ethmoidal nerve)
V₂ Maxillary division of trigeminal nerve (sphenopalatine nerves)
V₃ Mandibular division of trigeminal nerve (lingual nerve)
IX Glossopharyngeal nerve
X Vagus nerve
SL Superior laryngeal nerve
IL Internal laryngeal nerve
RL Recurrent laryngeal nerve
TRACHEA

• A cartilaginous (Anteriorly) and membranous (Posteriorly) tube which Begins as a continuation of the larynx at the lower border of cricoid cartilage at the level of C6, and terminates at the carina (the point at which the right and left mainstem bronchi divide), at the level of T5.

• Adults – 10-16 cm long and 2.5 cm in diameter.

• Infants – 4-5 cm long and may be as small as 3mm in diameter.

• Kept patent by the presence of C-shaped cartilaginous rings.
AIRWAY ASSESSMENT

• A preanesthetic airway assessment is mandatory before every anesthetic procedure.

• The goal of evaluating a patient's airway is to identify any possible problems with maintaining, protecting, and providing a patent airway during anesthesia.

• Several anatomical and functional maneuvers can be performed to estimate the difficulty of endotracheal intubation; successful ventilation (with or without intubation) must be achieved by the anesthetist if mortality and morbidity are to be avoided. Although the presence of these examination findings may not be particularly sensitive for detecting a difficult intubation, the absence of these findings is predictive for relative ease of intubation.

Assessments in general must include:

• History
• Physical examination in general (Face, teeth, neck, chest, deformities, Facial hair, Obesity, syndromatic?).

• Mouth opening: an incisor distance of 3 cm or greater is desirable in an adult.

• Mallampati classification: a frequently performed test that examines the size of the tongue in relation to the oral cavity. The more the tongue obstructs the view of the pharyngeal structures, the more difficult intubation may be.

• Thyromental distance: This is the distance between the mentum (chin) and the superior thyroid notch. A distance greater than 3 fingerbreadths is desirable.

• Neck circumference: A neck circumference of greater than 43 cm (17 inches) is associated with difficulties in visualization of the glottic opening.

• TMJ & neck movements.

• BMI (>30 may be a problem)

• Ultra sound examination, Ultrasound can be used as an adjunct to confirm ETT placement as well as to assist in identification of the cricothyroid membrane during emergent cricothyroidotomy.
1-2-3 Rule

One of the tests to assess the airway for intubation, what do the numbers in the name mean?

**RULES:**

- **1. TMJ MOBILITY**
- **2. MOUTH OPENING**
- **3. THYROMENTAL DISTANCE**
**First rule:**

**Temporomandibular Joint (TMJ) mobility**

- To find any restriction in mobility of the TemporoMandibular Joint, how important is this? What pathologies restrict it?

1. Ask the patient to sit up with his head in the neutral position.
2. open his mouth as wide as possible.
   - The condyle should rotate forward freely such that the space created between the tragus of the ear and the mandibular condyle is approximately **one fingerbreadth** in width.
Near tragus

Diagnosing TMJ
SECOND RULE : 2 TESTS

Mouth Opening (insicor distance) and tongue protrusion

1. Ask the patient to open his mouth as wide as he can.
   - The aperture of the patient's mouth should admit at least 2 fingers (3cm) between his teeth, on the other hand, it will be difficult to insert the laryngoscope blade on less than 2 fingers.
   - P.S don’t forget to look for any missing or dentally worked teeth (Caps, bridges .... Why?)

2. Ask the patient to protrude his tongue maximally.

   The structures visualized should include:
   1) The pharyngeal arches.
   2) Uvula.
   3) Soft palate.
   4) Hard palate.
   5) Tonsillar beds.
   6) Posterior pharyngeal wall.

In intubation we care only when the tongue and soft palate are seen. (Mallampati 3&4)
Mallampati classification:

• Class I: The entire palatal arch, including the bilateral faucial pillars, is visible down to the bases of the pillars.
• Class II: The upper part of the faucial pillars and most of the uvula are visible.
• Class III: Only the soft and hard palates are visible.
• Class IV: Only the hard palate is visible.
**Third rule:**

**The thyromental distance**

This is the distance between the mentum (chin) and the superior thyroid notch.

A distance **greater than 3 fingerbreadths** is desirable, adults who have less than 3 fingerbreadths may have either an anterior larynx or a small mandible, which will make intubation difficult.
Thyromental distance
Tip of thyroid cartilage to the tip of the chin (mentum)
Laryngeal view.

Grade 1: Most of glottis seen
Grade 2: Posterior commissure seen
Grade 3: Only epiglottis seen
Grade 4: Not even epiglottis seen
laryngoscope
laryngoscope: is an instrument used to examine the larynx and to facilitate intubation of the trachea.

**The handle** usually contains **batteries** to light a **bulb** on the blade tip or, alternately, to power a fiberoptic bundle that terminates at the tip of the blade.

**The blade:**

The **Macintosh** and **Miller** blades are the most popular. But also we have **Wisconsin**

**The choice of blade depends on personal preference and patient anatomy. Because no blade is perfect for all situations, the clinician should become familiar and proficient with a variety of blade designs.**

**Macintosh**: is designed so that the tip lies anterior to the epiglottis

**Miller**: is favored for children and are designed to pass posterior to the epiglottis.

**Incorrect usage can cause trauma to the front incisors.**
Both Miller and Macintosh laryngoscope blades are available in sizes 0 (neonatal) through 4 (large adult).

The Miller blades are commonly used for infants. It is easier to visualize the glottis using these blades than the Macintosh blade in infants, due to the larger size of the epiglottis relative to that of the glottis

Various maneuvers, such as the “sniffing” position and external movement of the larynx with cricoid pressure during direct laryngoscopy, are used to improve the view.
Endotracheal Tubes (ETTs)
Endotracheal intubation is employed both for the conduct of general anesthesia and to facilitate the ventilator management of the critically ill.

** Most of endotracheal tubes made of either rubber or PVC (polymerized vinyl chloride), which is a plastic (soft), to prevent irritation to the mucosa.

**The patient end of the tube is beveled to aid visualization and insertion through the vocal cords. Murphy tubes have a hole (the Murphy eye) to decrease the risk of occlusion, should the distal tube opening abut the carina or trachea.

**Most adult ETTs have a cuff inflation system consisting of a valve, pilot balloon, inflating tube, and cuff. The valve prevents air loss after cuff inflation. The pilot balloon provides a gross indication of cuff inflation. The ETT cuffs, creating a tracheal seal, permit positive-pressure ventilation and reduce the likelihood of aspiration.

**Disadvantages: higher cost, potential tracheal injury by cuff pressure,
Types of tubes

1- **cuffed tubes**
2- **uncuffed tubes**: often used in infants and young children; however, in recent years, cuffed pediatric tubes have
According to the type of the cuff: There are two types:

There are two major types of cuffs:
1- high pressure (low volume)
High-pressure cuffs are associated with more ischemic damage to the tracheal mucosa and are less suitable for intubations of long duration.

2- Low-pressure (High volume) cuffs
may increase the likelihood of sore throat (larger mucosal contact area), aspiration, spontaneous extubation, and difficult insertion (because of the floppy cuff). Nonetheless, because of their lower incidence of mucosal damage, low-pressure cuffs are most frequently employed.
Size of tube:

**Resistance** to airflow depends primarily on **tube diameter**, but is also affected by **tube length and curvature**.

ETT size is usually designated in millimeters of internal diameter, or, less commonly, in the French scale (external diameter in millimeters multiplied by 3).

The choice of tube diameter is always a **compromise** between maximizing flow with a larger size and minimizing airway trauma with a smaller size. Female 6.5-7, male 7.5-8

<table>
<thead>
<tr>
<th>Age</th>
<th>Internal Diameter (mm)</th>
<th>Cut Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-term infant</td>
<td>3.5</td>
<td>12</td>
</tr>
<tr>
<td>Child</td>
<td>$4 + \frac{\text{Age}}{4}$</td>
<td>$4 + \frac{\text{Age}}{2}$</td>
</tr>
<tr>
<td>Adult</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>7.0–7.5</td>
<td>24</td>
</tr>
<tr>
<td>Male</td>
<td>7.5–9.0</td>
<td>24</td>
</tr>
</tbody>
</table>
Shape of tube

1-Reinforced tubes
with nylon or steel spiral in such cases, to prevent kinking

2-RAE tubes
are curved tubes, for difficult intubations (e.g., children)

3-Double-lumen tube
to ventilate the lungs in thoracic surgery
if necessary independently