Anatomy Sheet #5

In the previous lecture, we finished discussion about the larynx; now we continue with trachea, lungs and pleura.

Trachea and lungs

The knowledge about the pleura and lungs is very important clinically; the doctor uses the stethoscope and puts it on the chest from front and back in order to hear the breathing sounds, and these sounds are related to trachea and lungs.

Trachea

- It extends below the larynx, that's why it begins at the lower border of the cricoid cartilage, and it ends at the level of the sternal angle or between T4 and T5 thoracic vertebrae.
- Its length is between 4-5 inches (about 11-13 cm). Its diameter is the same diameter of your index. The diameter is different in children; its diameter is the diameter of a pencil; it is very narrow making it a bit hard to do tracheostomy for them and needs fixation.
- It is characterized by the presence of C-shaped hyaline cartilage, and they are from 16-20 in number. The C-shaped cartilage is absent posteriorly and is replaced by trachealis muscle, a smooth muscle innervated by sympathetic and parasympathetic nerves. The muscle is found posteriorly because the esophagus lies posteriorly, so it helps in descending of bolus through the esophagus.
- The trachea is divided at the sternal angle into right and left main bronchi, also called primary bronchi, and they are extrapulmonary.
As you recall from the histology lab, the trachea has four layers:

1. **Mucosa**: respiratory epithelium with goblet cells and glands in it. The lamina propria is very thin and can’t be easily seen
2. **Submucosa**: can be easily seen and contains the glands, tracheal glands, which are seromucous glands.
3. **Supportive layer**: made of hyaline cartilage
4. **Adventitia**

**Relations of trachea**

*relations are frequently asked in exams*

**Anteriorly:**

- **Aortic arch**: Anteriorly is the aortic arch and posterior to it is the esophagus, in between is the recurrent laryngeal nerve.
  - The recurrent laryngeal nerve, on the left side, is found in thorax and then ascends in the neck, but on the right is found only in the neck below the subclavian artery. When we look at the arch of the aorta, we focus on the **left** recurrent laryngeal nerve which ascends between the trachea and esophagus.
  - In X-rays, trachea is deviated to the right and appears as a dark column because it contains air, thus, the longer left bronchus crosses below the arch of aorta and anterior to the esophagus.

- **Thymus**: rudimentary in adults and is behind the sternum
- **Thyroid gland**: especially its isthmus, which is found in front of its 2nd, 3rd, and 4th tracheal rings.
- **Origin of brachiocephalic artery**
- **Manubrium sterni**: almost all of the anterior relations, especially the aortic arch, are found behind it
Left side:

- **Arch of aorta**: first it lies anteriorly then goes posteriorly and to the left because it lies obliquely
- **Left subclavian artery**
- **Left common carotid artery**
- **Left phrenic**
- **Left vagus**
- **Left bronchus**

Right side:

- **Azygous arch**: the end of vena azygous makes an arch and ends in the superior vena cava.
- **Brachiocephalic artery** after being anterior goes to the right side
- **Right vagus**
- **Right phrenic**
- **Right main bronchus**

Posteriorly:

- **Esophagus** (most important posterior relation)
- **Thoracic duct** starts from cisterna chyli on the aortic orifice below the diaphragm, and then ascends upwards on the right side; when it reaches T4, it deviates to the left and then goes to the root of the neck.
- **Left recurrent laryngeal nerve** is posterior to the trachea because it ascends between the esophagus and trachea.

When the trachea reaches the lower part, it bifurcates. At the end of trachea, there is a mucous membrane that is very sensitive, called **carina**; it is the most sensitive area at the end of the trachea. Clinically, when you insert a bronchoscope, you don't touch the carina and stay above it to not cause sensation and result in contraction of the smooth muscle. When you see the carina, you either go left or right to the main bronchus.
In deep inspiration, the trachea descends downwards and after that it ascends back to its position. The trachea ends between T4 and T5; when it descends, it reaches T6.

**Tracheotomy (tracheostomy) and intubations (endotracheal intubation)**

- In high tracheostomy, there are 2 sites used which are above the isthmus of the thyroid gland and below the true vocal cords:
  1) *Cricothyroid membrane*, between thyroid and cricoid cartilages
  2) *Cricotracheal membrane*, between cricoid cartilage and first tracheal ring
- It is commonly done at the lower level, in the cricotracheal membrane because it is further from the true vocal cords than cricothyroid membrane.

**NOTE:** in the record, the doctor mixed up here about the cricotraheal and cricothyroid membranes; both are above the isthmus of thyroid

- Low tracheostomy is suprasternal tracheostomy that is below the isthmus of thyroid.
- Suprasternal tracheostomy is done in emergencies. Tracheostomy in cricothyroid or cricotraheal membranes (high tracheostomy) is done during operation, for example, during thyroidection operation; if recurrent laryngeal nerve is cut causing adduction of the true vocal cords, tracheostomy is done in cricothyroid membrane or cricotraheal membrane, since they are clearly seen. A sharp object is used to make the incision.
- In intubation, a plastic tube is inserted below true vocal cords.
  - In operations, anesthesiologists always insert an endotracheal tube from the oral cavity or nose through the pharynx then inlet of larynx until the tube passes the true vocal cords then they leave the tube. Through this tube, they perform respiration by machine. They leave the tube throughout the operation and when the patient is under anesthesia, after that,
they remove the tube and everything returns back to normal. In many cases after the operation, the patient is bothered by his larynx and trachea and has coughing and production of sputum. Sometimes an antibiotic is given because intubation makes a slight trauma to the mucosa.

The diagram below illustrates the sites of tracheostomy:

![Diagram of tracheostomy sites]

**Bronchi**

We have right main bronchus and left main bronchus (the diagram in the slide shows the right and left main bronchi as viewed by the bronchoscope); they are extrapulmonary and are also called primary bronchi.

If a foreign body enters the respiratory tract, it is usually found in the right main bronchus because it is wider, shorter and more vertical with trachea and is about 1 inch long; but the left main bronchus is narrower, more horizontal and is about 2 inches long (in some books, they say 2-3 inches long).

- This is important in cases of emergency, for example, a child comes with a foreign body and has difficulty in breathing; the doctor immediately puts the bronchoscope in the right bronchus. The differences between the right and left main bronchi are important. The right and left main bronchi are extrapulmonary; they are also called primary bronchi.
The primary bronchi divide into secondary bronchi. In anatomy, the secondary bronchi are called *lobar* because on the right side divide into 3 parts, each going to a lobe: upper, middle, and lower lobes. The right lung is made of 3 lobes and divided by 2 fissures: oblique and transverse (horizontal). However, the left lung has only 2 lobes: upper and lower.

Then each secondary bronchus divides and gives bronchopulmonary segments which are the tertiary bronchi.

The divisions of tertiary bronchi are as follows:

**In the right lung:**

In upper lobe
- \( \text{Apical} \): in the direction of the apex
- \( \text{Anterior} \): in the direction of the anterior border
- \( \text{Posterior} \): goes posteriorly

In middle lobe
- \( \text{Medial} \)
- \( \text{Lateral} \)

In lower lobe
- \( \text{Apicobasal} \) (or apical of the lower lobe): highest one
- \( \text{Anterior} \)
- \( \text{Medial} \)
- \( \text{Lateral} \)
- \( \text{Posterior} \)

**In the left lung:**

The upper lobe segments are the same as in the right lung.

The lower lobe segments are the same as in the right lung in *ADULTS*. There is no middle lobe, but there is lingula that has *superior* and *inferior lingular* segments.
The bronchopulmonary segments further divide into terminal bronchioles. These bronchioles are accompanied by artery, vein, lymphatic, and nerve, and are called **lobular segment** or **lobule**. This lobule is the one removed during surgery. As we already mentioned, each lobule has its own bronchiole, artery, vein, lymphatic and innervation. This segment is important in surgery and is called surgical segment.

Bronchi ➔ terminal bronchiole (conducting bronchiole) ➔ respiratory bronchiole ➔ alveolar duct ➔ alveolar sac ➔ alveoli

The lung contains millions of alveoli.

**Bronchopulmonary segments**

- They are important surgically. In the past, they used to remove the whole lobe, but nowadays, they remove only units which are lobules. The lobule consists of bronchopulmonary segment: terminal bronchiole, respiratory bronchiole, alveolar duct, alveolar sac, alveoli, pulmonary artery, pulmonary veins, lymphatic vessels, and autonomic nerves (sympathetic and parasympathetic).
- It is pyramidal in shape which means it has an apex directed towards the hilum and a base on the surface.
- It is surrounded by connective tissue which separates the segment. What helps the surgeon in determining the unit is finding connective tissue with vein. Therefore, the vein with the connective tissue is a **landmark** for the boundary of the segment, but the artery and bronchiole are found inside the segment.
- If the segment is diseased, it can be removed surgically
- As we mentioned earlier the right side has 10 segments, and the left has also 10 segments in ADULTS.
- When the left lung develops, it is made of 8 segments because in the upper lobe there is an **apicoposterior segment** that later divides in adult into **apical** and **posterior** segments, and in the lower lobe there is **anteromedial segment** that later divides in
adult into anterior and medial segments. *It takes time for the segments to divide after birth.

- The segment is important clinically because the unit gets infected first before the infection spreads to other segments. Surgical removal of a segment or unit is done depending on the fact that the infection inside the unit and is surrounded by connective tissue before it spreads. Also in drainage, it is important to know which segment is affected; a tube is inserted into the affected segment and is drained.

**Lungs**

- There are 2 lungs: right and left.
- The left lung is composed of two lobes with an oblique fissure between them. The right lung is made of 3 lobes: upper, middle, and lower and between them is the horizontal and oblique fissures.

- They are grey dark in color and spongy
  - In smokers, the entire surface has dark black spots because of accumulation of nicotine.
  - The pulmonary arteries, they first start as pulmonary trunk from the right ventricle, which then divides into right and left pulmonary arteries.
• They are the only arteries in the body that carry deoxygenated blood and goes to the lungs
  ▪ Opposite to them are the veins; they carry the oxygenated blood coming from the capillaries of the lung that continue as venules and then end as 4 pulmonary veins that open into the left atrium
  ▪ The lung is normally pink in color and sometimes becomes grey after fixation.
  ▪ Blood vessels are composed of pulmonary veins and pulmonary arteries.
  ▪ The lung has an apex and a base; the base is also called diaphragmatic surface because it lies over the diaphragm.
    • Connecting the GI with respiratory: below the right cupula of the diaphragm is the liver and below the left are fundus of the stomach and spleen. Therefore, these are the lower relations for the base or diaphragmatic surface.
    ▪ The apex of the lung lies in the root of the neck, and it ascends about 1 inch above the medial 1/3 of the clavicle, or 3-4 cm above the first rib.
      • This is clinically very important because the subclavian artery and vein make a groove on the upper surface of the first rib and above it is the clavicle, e.g. insertion of a canula for a patient to measure the fluid he takes; we call it CVB line (subclavian line). If the physician doesn't know the anatomy well, he could hit the apex of the lung causing its collapse. Thus, it is routine for a patient with CVB line to take an x-ray to check if the lung is collapsed or not.
      ▪ It also has an anterior border and a posterior border; the difference between them is that the anterior is sharper but posterior is rounded.
        • The anterior border has a groove for the first rib, and the costal surface also has a groove for the first rib.
- It has 3 surfaces
  1) Mediastinal surface having the hilum
  2) Costal surface: the outer surface related to the costal cartilages and ribs
  3) Diaphragmatic surface: also base
    - Mediastinum is a space between the 2 lungs dividing into superior, middle, anterior and posterior; the most important one is the middle containing the heart and pericardium.

- The hilum has:
  - **Bronchus**. The right main bronchus divides into 2: eparterial bronchus (above artery) and hyparterial bronchus (below artery), however the left remains one bronchus in the hilum of the lung.
  - **Pulmonary artery and vein**. The veins are 2 on the right and 2 on the left, one superior and one inferior. The pulmonary artery is only one artery in the hilum, which then branches in the lung.
  - The hilum also has **lymph nodes, lymphatic vessels** and **autonomic nerves** (sympathetic and parasympathetic)

  - ✓ To differentiate the bronchus, you feel the cartilage.
  - ✓ The veins are 2: one superior and one inferior and are usually found anteriorly and lower.
  - ✓ The artery is usually found above the veins; it is the highest one.

- There is an inferior border and is formed as a result of pressing of cupula of the diaphragm on the base; it surrounds the cupula of the diaphragm or base.
  - Clinically important, when you take an angle between the mediastinal surface and base, it is found on the inferior border; this angle is filled by lung tissue when there is inspiration.
  - The most important angle is the **costodiaphragmatic angle/recess**; this recess is occupied by the lung during inflation. There is also mediastinodiaphragmatic angle.
Surface anatomy of the lung

You have to know the surface anatomy of lung, pleura and fissures; the most important of these are the ones for the lungs and pleura because when fluid accumulates and needs aspiration, you need to know the termination of the lung and termination of pleura and enter between them.

Surface anatomy of the lung

✓ First mark the apex (1 inch above the medial 1/3 of clavicle), the surface anatomy of the apex of the pleura is the same as the lung, meaning that the pleura is adherent to the lung, whether parietal or visceral pleura.

✓ The anterior border of the lung is marked from:
  • the sternoclavicular joint till the sternal angle (angle of Lewis) at the 2nd rib and connect them with a straight line
  • continue the line till the 4th costal cartilage
  • between 4th and 6th costal cartilages draw 1/2 a circle 1/2 inch (about 1cm) to the inside due to the presence of the cardiac notch on the left side
  • go back to the 6th costal cartilage
  • On the right side, the anterior border is continuous; a straight line is drawn from the 4th to the 6th costal cartilages, no deviation.

✓ The base is marked from:
  • the 6th costal cartilage at midclavicular line, the same as the anterior border, to the 8th costal cartilage at midaxillary.
  • Posteriorly, inferior angle of scapula or scapular line, which is the paraspinal line: 4cm from the dorsal spine, and reaches till 10th dorsal thoracic spine.

✓ To mark the posterior border, you connect the apex to the base posteriorly by drawing a line from the apex till the 10th thoracic spine.
- Rector spinae muscle that looks like 3 finger, descends on the sides of the dorsal spine; its edge is the posterior border.

The following diagrams illustrate how to draw the surface anatomy of the lungs.
Surface anatomy of the pleura

- Its apex is the same as that of the lung: 1 inch above medial 1/3 of clavicle.
- Its anterior border is the same as that of lung: sternoclavicular, then to sternal angle and reaches till 4th; it also deviates along with cardiac notch but returns back to 7th costal cartilage instead of 6th.
- Base:
  - midclavicular: 8th instead of 6th
  - midaxillary: 10th
  - posteriorly 12th.
  - So it increased 2 spaces, and these 2 spaces are filled by the inflated lung during inspiration. The space in anterior, posterior and apex is potential, very small. Therefore, expansion of lungs is downwards.
  - This is important clinically because fluid accumulates in lower part. Now if you want to insert a canula in the midaxillary line, it is inserted in the 9th between the lung (8th) and pleura (10th); if you use midcalvicular, you insert the canula in the 7th, between 6th and 8th.

The following diagrams illustrate how to draw the surface anatomy of the pleura.
Root and hilum

The pleura, especially the visceral pleura, that is adhered to the mediastinal surface of the lung surrounds the hilum, and in the lower part, it fuses and becomes a ligament called pulmonary ligament. The pulmonary ligament descends downwards and gives space for the pulmonary vessels in the hilum.

As we have already mentioned earlier, it contains pulmonary artery, 2 pulmonary veins, main bronchus (on the right divides into ep- and hyparterial, but on the left stays one bronchus), bronchial vessels (supplies the lung tissue with nutrients), nerves and lymphatics.

I'm sorry for any mistakes; I tried my best 😊

Wishing you the best of luck

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