Introduction

Pulmonary Embolism (PE) is considered as an important cause of patient morbidity and mortality as it is responsible for as many as 15% of all hospital deaths ***(Smith, 2000)***. It is also the 3rd cause of acute cardio-vascular disease after myocardial infarction and stroke. It is responsible for thousands of deaths allover the world because it often goes undetected as the clinical symptoms & signs are non specific & may be absent ***(Anderson et al., 1998)***.

The sequel of the misdiagnosis of pulmonary thrombo-embolism is well known to clinicians: the risks of unnecessary anticoagulants treatment are as undesirable as the danger of a missed diagnosis of pulmonary thrombo-embolism. The clinical manifestation of pulmonary embolism are extremely variable and depend primarily on the size of the embolus. Small emboli are often sub-clinical, whereas larger emboli may give transient symptoms, which can mimic other conditions. Massive embolism in a previously symptomless individual can be fatal, with the diagnosis only made at autopsy ***(Tocino et al., 1998)***.

Thus, accurate diagnosis is life saving for many patients, considering that the mortality rate in patients with untreated pulmonary embolism is as high as 30% ***(Blachere et al., 2000)***.

Pulmonary embolism can be accurately diagnosed with the interventional pulmonary arteriography, which is recognized as the diagnostic standard of reference, with sensitivity and specificity both greater than 95%. Because it's more invasive, arteriography is not routinely performed.

Ventilation-perfusion (V/Q) radionuclide lung scanning is the most frequently performed non-invasive imaging study for the diagnosis of pulmonary embolism, yet, the sensitivity of V/Q scanning is high, the specificity is low; therefore, a more accurate non-invasive diagnostic study is urgently needed ***(Druker et al., 1998)***. An imaging modality that combines the non-invasive nature of V/Q scanning with a high sensitivity and specificity and that enable direct visualization of pulmonary embolism is desirable ***(Garg et al., 1999)***.

The introduction of multi-detector scanner has substantially improved C.T. angiography by offering increased volume coverage, decreased dose of contrast media, decreased acquisition time and improved spatial resolution for assessment of smaller arterial branches ***(Rubin and Schmidt, 2007).*** In addition, scan time drops to a reasonable 6 -8 Sec., this brief scan time reduce the chance of arrhythmia or the patient releasing his breath and produce clearer image ***(Lisa Fratt, 2007).***

AIM OF WORK

To emphathize the role of multi-detector C.T. in the diagnosis of Pulmonary Embolism which is considered a real challenge to both the clinician & the radiologist; as the clinical signs and symptoms of such a disease are vague and non-specific.

PULMONARY VASCULATURE

The lungs are divided up by fissures into a predictable arrangement of lobes: (Fig. 1)

Right lung: Superior lobe, Middle lobe, Inferior lobe.

Left lung: Superior lobe, Inferior lobe.

The lobes are characterized by a discrete connection with the first subdivision of the bronchial tree after the level of the principal bronchi to both lungs; these are the lobar bronchi. In a similar manner, the vascular, nerve and lymphatic supply from the hila to each lobe has minimal connection with other lobes. This makes the lobes relatively independent functional units within the lung. Indeed, pathology may be confined to one lobe and corrective surgery may be facilitated by the clear demarcation between lobes produced by the fissures ***(Frazier et al., 2000).***

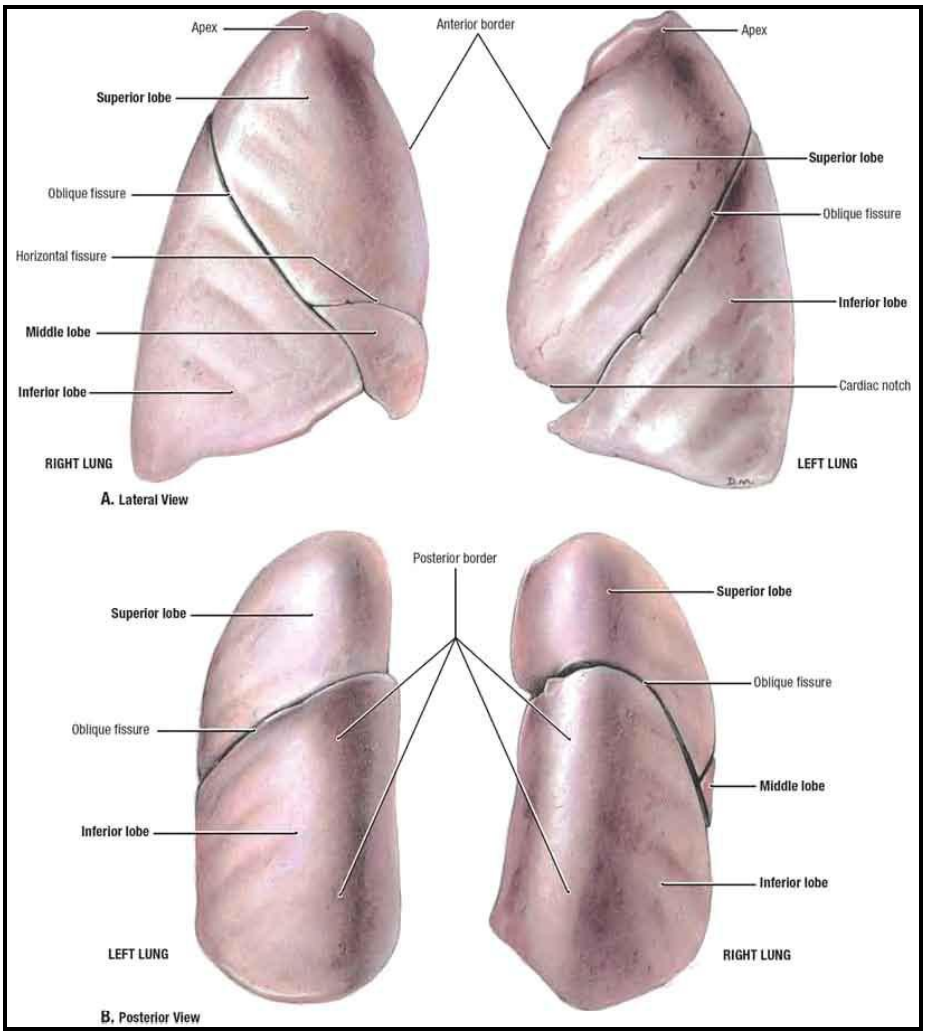


Fig. (1): Lobar anatomy of the lungs (***Quoted from Grant's Atlas, 2008)***.

Further, the lobes are subdivided into bronchopulmonary segments which are volumes of lung with an organized arrangement relative to each other within a lobe and similar functional independence as the lobes.

With further subdivision of bronchi, each segment is divided into secondary lobules. The lobar fissures are often incomplete, making a connection between two apposed lobes. Conversely, more than the expected number of lobes may be produced by new fissures e.g. the azygos lobe of the lung, the additional lobes are termed accessory lobes. The equivalent of the right middle lobe on the left side is termed the lingula. It is occasionally considered as a lobe but it is small in comparison and rarely separated from the left superior lobe by a fissure ***(Ryan et al., 2004).***

Anatomy of the Dual Pulmonary Circulation

Two separate but vital vascular networks, often forming rich anastomoses, support the complex anatomy and physiology of the lung parenchyma. The primary pulmonary circulation comprises the entire venous return of the body, flowing forward from the main pulmonary artery, ramifying throughout the pulmonary interstitium and airways, and reconstituting itself into pulmonary veins before entering the left atrium. A second, "bronchial" circulation draws approximately 1% of the systemic cardiac output and transmits blood at six times the pressure of the pulmonary circulation. The pulmonary and bronchial circulations communicate with one another by several microvascular interconnections. *(Frazier et al., 2000)*

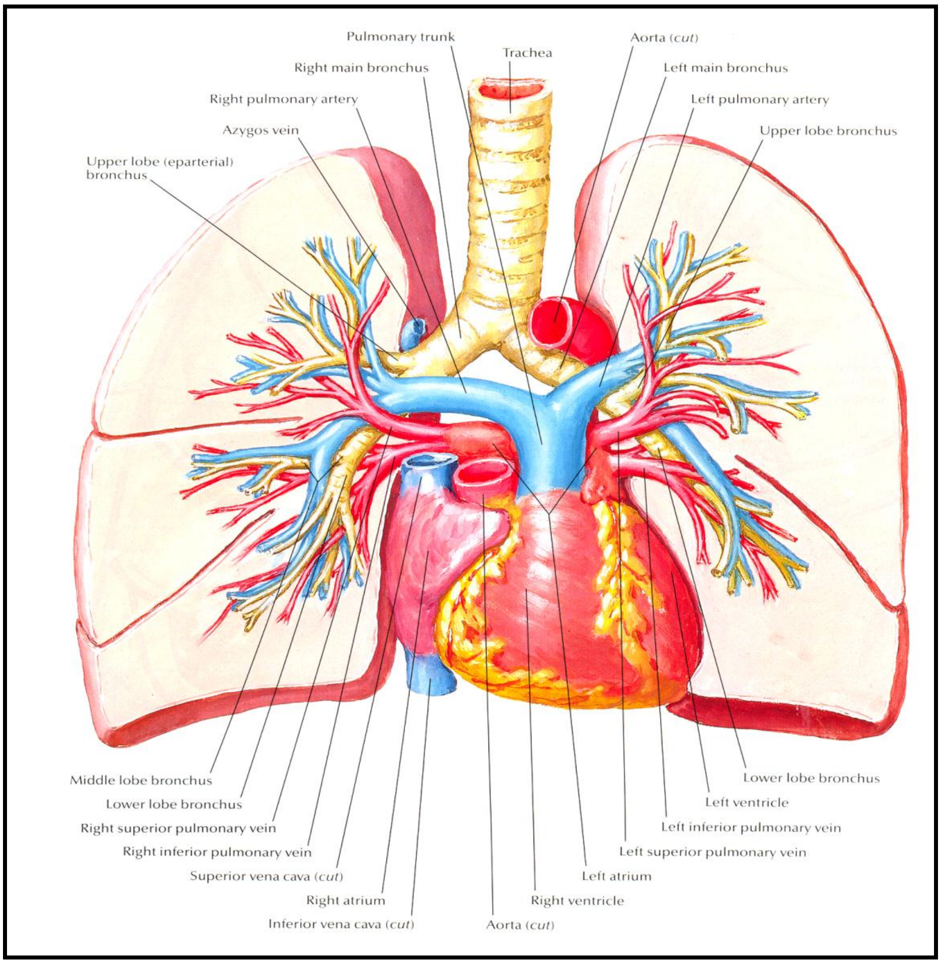


Fig. (2): Pulmonary vasculature *(Human Atlas Anatomy, 1991)*.

Lung segments:

The main segments of both lungs are named as follows (Fig. 3) *(Bannister, 1999):*

Right lung:

- *Superior lobe*: Apical, posterior and anterior.
- *Middle lobe*: Lateral and medial.
- *Inferior lobe:* Superior (apical), medial basal, anterior basal, lateral basal and posterior basal.

Left lung:

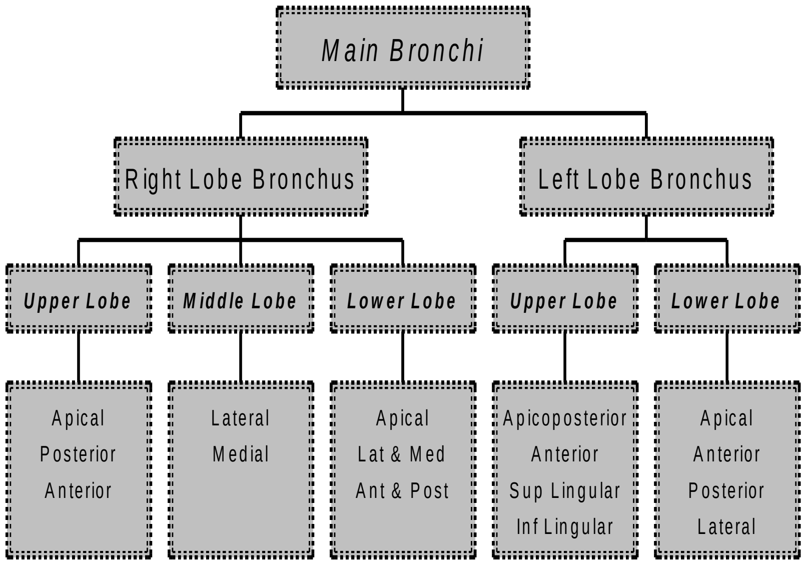
- *Superior lobe:* apical, posterior, anterior, superior lingular and inferior lingular.
- *Inferior lobe:* superior (apical), anterior basal, lateral basal and posterior basal.

Each segment is surrounded by connective tissue that is continuous with the visceral pleura, and is a separate respiratory unit ***(Drake et al., 2007)***.

Bronchopulmonary segments

Each lobe is subdivided into several bronchopulmonary segments, each of which is supplied by a segmental bronchus, artery and vein. Each segment takes its title from that of its supplying bronchus.

The anatomy of segmental bronchi is subject to variation, the most common being the origin of apical segmental bronchi, especially the right, from the trachea. ***(Ryan et al., 2004)***



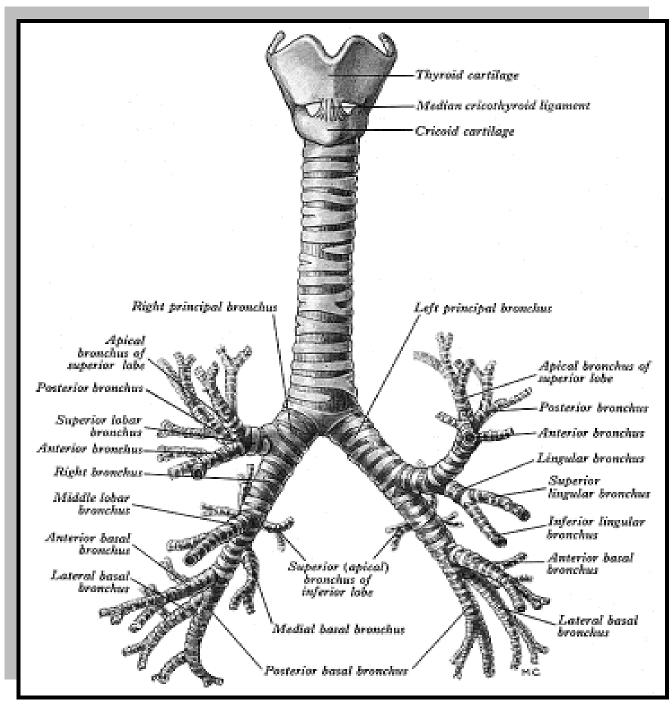


Fig. (3): Bronchial tree distribution ***(Ryan et al., 2004)***

The pulmonary artery

The pulmonary trunk or pulmonary artery conveys deoxygenated blood from the right ventricle to the lungs. About 5cm in length and 3 cm in diameter, it is the most anterior of the cardiac vessels and arises from the base of the right ventricle (from the pulmonary annulus) above and to the left of the supraventricular crest. It slopes up and back, at first in front of the ascending aorta, then to its left.

Below the aortic arch it divides, level with the fifth thoracic vertebra and to the left of the midline, into right and left pulmonary arteries of almost equal size. The pulmonary trunk bifurcation lies below, in front and to the left of the tracheal bifurcation. ***(Stranding et al., 2005)***

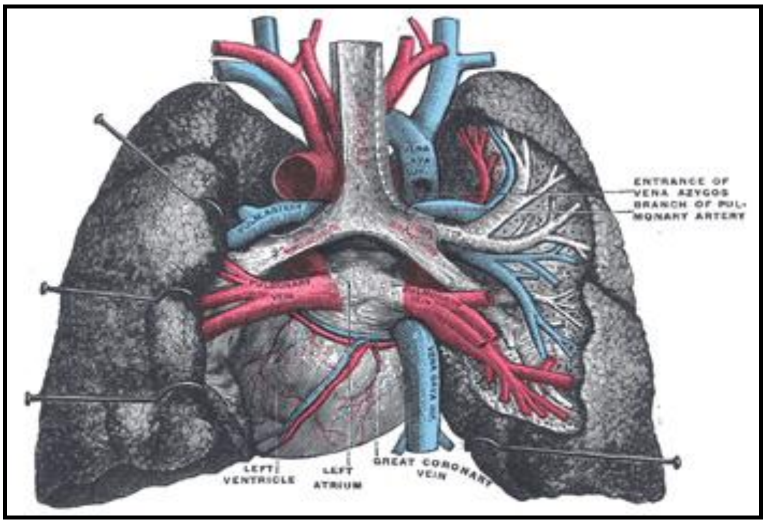


Fig. (4): Pulmonary Arteries ***(Stranding et al., 2006)***

Relations:

The pulmonary artery is entirely within the pericardium, enclosed with the ascending aorta in a common tube of visceral pericardium. The fibrous pericardium gradually disappears within the adventitia of the pulmonary arteries.

- Anteriorly: It is separated from the sternal end of the left second intercostal space by the pleura, left lung and pericardium.
- Posteriorly: There are the ascending aorta and left coronary artery initially, then the left atrium. The ascending aorta ultimately lies on its right. An auricle and coronary artery lies on each side of its origin. The superficial cardiac plexus is between the pulmonary bifurcation and the aortic arch. The tracheal bifurcation, lymph nodes and nerves are above, bilateral and to the right.

(Stranding et al., 2005)

The right pulmonary artery is longer than the left. It passes across the midline below the carina and comes to lie anterior to the right main bronchus. It bifurcates while still in the hilum of the right lung. An artery for the right upper lobe passes anterior to the right upper-lobe bronchus. The interlobar artery to the right middle and lower lobes passes with the bronchus intermedius ***(Ryan et al., 2004)***.

The left pulmonary artery spirals over the superior aspect of the left main bronchus to reach its posterior surface. It is attached to the concavity of the aortic arch by the ligamentum arteriosum.

The pulmonary arteries further subdivide into segmental arteries that travel with the segmental bronchi ***(Ryan et al., 2004).***

The segmental arteries are seen near the accompanying branches of the bronchial tree and are situated either medially (in the upper lobes) or laterally (in the lower lobes, lingula, and right middle lobe) ***(Garg, 2005)***. The pulmonary arteries supply only the alveoli *(cf.* the bronchial arteries, which supply the bronchi). **(Ry*an et al., 2004)***

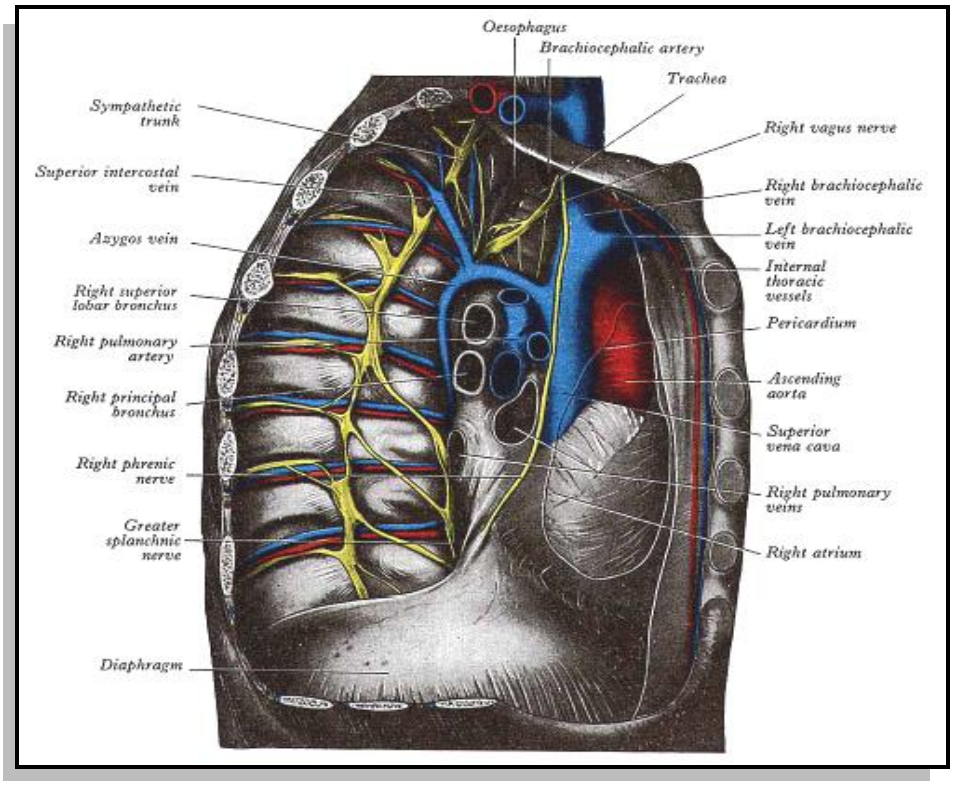


Fig. (5): Relation of the pulmonary artery *(Grays, 2000)*.

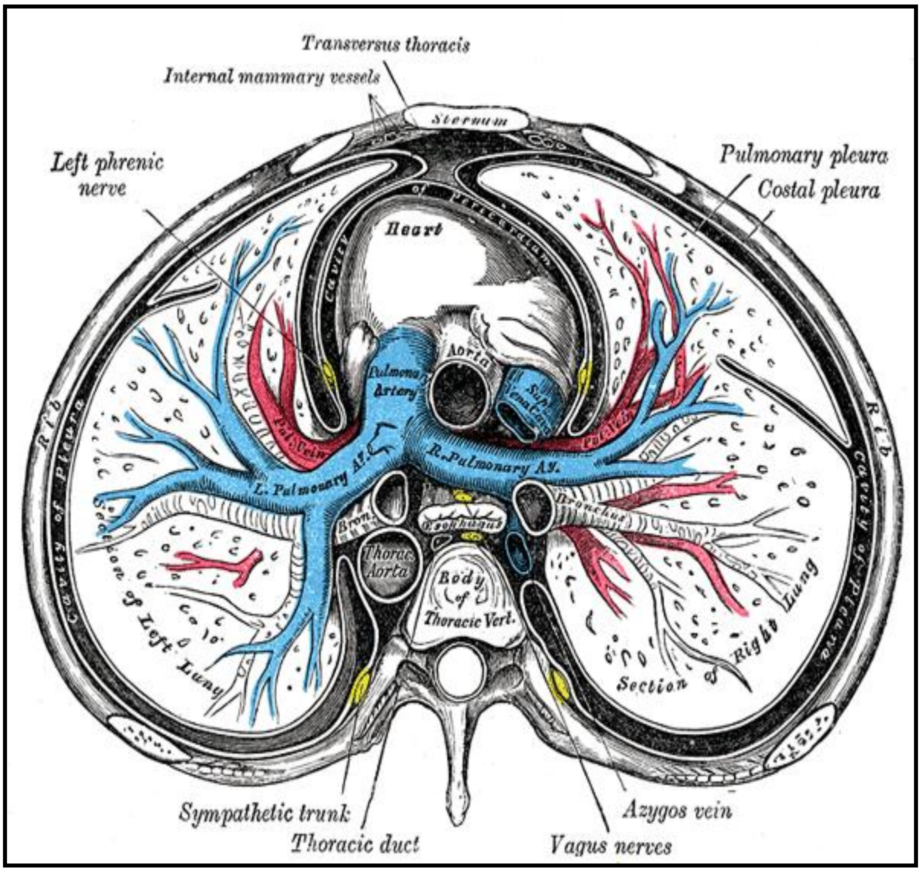


Fig. (6): Pulmonary Arteries relations *(Standring et al., 2006)*

The pulmonary veins

These do not follow the bronchial pattern but tend to run in intersegmental septa.

Two veins pass to each hilum - from lung tissue above and below each oblique fissure. These enter the mediastinum slightly below and anterior to the pulmonary arteries. On the right side, the veins from the lobes may remain separate, so that three veins