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Normal Anatomy of the Human Lung and Associated Structures

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Introduction to Pulmonary Morphology: An Overview

Functional Morphology

The respiratory tract is part of a system that conducts oxygen from outside air to the mitochondria in the cells throughout the body. It is therefore the most common route of entry for toxic substances from the environment. The same thinness and delicacy of the air-blood barrier in the lung that facilitates the passage of oxygen also reduces its effectiveness as a barrier to toxic substances (Fig. 1.1). As they are transported through the airway system to the gas exchange region, toxic substances may be deposited anywhere on the epithelium, depending on a variety of factors, and enter the tissue.

Variabilities

Apparently there are scarcely any systematic structural variabilities of the human respiratory tract, for example due to body size, growth, age, sex, or ethnic origin that would fundamentally influence its function. In general there are differences between individuals, mainly genetically based, but they belong to a normal interindividual variability. Differences in organ size are usually proportional to the difference in body size. Even the growing human lung, after the age of 2 years, does not seem to deviate principally in its structure from the adult lung (1,2).

However, the effect of body size or growth has recently been found smaller for more distal than for more proximal airways of the conductive zone (trachea, bronchi, and bronchioli). From this it has been predicted that deposition of particulate inhalants would be highest in the newborn and decrease with increasing age to 21 years. This model prediction also indicates that, in general, smaller individuals will receive greater initial deposition within the conductive zone than larger individuals, at a given ventilatory state. It is therefore concluded that smaller individuals might be at greater risk from many types of airborne inhalants (3).

At greater age the wall structures of the airways experience some changes, particularly in the connective tissue compartments.

Occasionally the azygos vein is lower in the right upper lobe, causing a fissure. The portion of this lobe on the medial side of the fissure forms the so-called azygos lobe, which is easily detectable on an x-ray by the shadow caused by the four layers of the pleura.

There is very little information about gender-related differences. Up to the age of 14, boys apparently have larger lungs than girls (1). It is controversial whether women’s airways are smaller than men’s relative to lung size.

Differences between ethnic groups are probably mainly dimensional differences, that is, differences in body size that are reflected in proportional differences in lung size.

There exist considerable morphological variabilities in the airway system between species. The structure of the wall and the geometry of the conducting airways are very variable. There are also important structural differences at the level of the respiratory bronchioles. In some species they are absent; others, including man, have three to five generations (4,5). These differences are such that they might well influence the deposition and clearance pattern of particulate inhalants. The structure of the gas exchange parenchyma, however, is very similar among mammals, the structural diffusing capacity being directly proportional to body size over six orders of magnitude (6).

Anatomy of the Chest

This section deals with the topography of the chest organs (7–11).
FIGURE 1.1. Electron micrograph of interalveolar septum demonstrates air-blood barrier, consisting of three layers: endothelium, interstitial space, and epithelium (× 14,250).

Chest Wall and Thoracic Cavity

The skeletal boundaries of the thoracic cavity are anteriorly the sternum and the rib cartilages, and, laterally and posteriorly, the ribs, the intercostal spaces, and the vertebral column. Cranially an open communication exists to the neck region. Abdominally it is closed by the diaphragm, which bulges deeply into the thoracic cavity; hence the outer borders of the thorax do not coincide with those of the cavity. The diaphragm is flatter at the center than at the periphery, and higher on the right side than on the left. From the highest point on each side the diaphragm slopes suddenly downward to the costal and vertebral attachments; this slope is more marked and longer behind than in front, so that only a narrow space is left between the diaphragm and the posterior wall of the thorax (Figs. 1.2 and 1.3).

The chest capacity does not correspond with the skeletal thorax, because the lower part of the region enclosed by the ribs is encroached upon by the diaphragm and the upper abdominal viscera. The capacity varies with the phase of respiration, which also affects to some extent the positions and relations of the thoracic viscera. Its arbitrary upper limit is usually taken as the plane of the thoracic inlet, but the apices of the lungs extend above this into the neck.

The thoracic cavity is divided by the mediastinum, the region between the lungs that extends from the back of the sternum to the vertebral column and from the thoracic inlet above to the diaphragm below. It contains the heart enclosed within a fibroserous sac, the pericardium, and other organs that are embedded in loose connective tissue. The lungs occupy the right and left parts of the thoracic cavity. Each one is covered with a serous membrane, the pleura, which also lines the walls of the corresponding half of the chest, and forms the lateral boundary of the mediastinum.

The pleural cavities are airtight, closed serous spaces that are filled out to a capillary cleft from medial by the lungs. They are lined by the parietal pleura (costal, mediastinal, and diaphragmatic portions) on