An Outline of Bronchial Anatomy

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As long ago as the seventeenth century anatomists were preparing casts of the pulmonary air passages by filling the bronchi with fusible metal and removing the lung tissue by corrosion. These early anatomists were chiefly interested in the nature of the cellular structure of the lung, the distribution and mode of branching of the larger bronchi had no importance for them and were not studied in detail until the latter part of the nineteenth century. Indeed some modern textbooks of anatomy still reproduce archaic and inaccurate woodcuts illustrating the trachea and its main branches. Aeby in 1882 was the first to give a detailed description of the human bronchial tree and this was followed in 1889 by the even more minute account of William Ewart, who was physician and pathologist to the Hospital for Consumption, Brompton. Ewart went so far as to name the bronchi down to those of the sixth order and his description was based largely on the study of solid casts of both the bronchi and the pulmonary blood-vessels which he made with fusible metal. But, as so often happens, the work of Aeby and Ewart was forgotten and it was not until little more than ten years ago that interest in the bronchial tree revived. This revival was due to the development of chest radiography, particularly bronchography, and also to the increasing use of bronchoscopy and the advance of thoracic surgery. In 1932 Kramer and Glass pointed out that the lung could be subdivided into a number of segments, each supplied by a well-defined bronchus having an orifice which was visible on bronchoscopy. But perhaps the best known contribution to the subject is a brief description of the bronchial tree, with diagrams, published by H. P. Nelson in 1934 and often reproduced subsequently. Nelson himself stated that this account was incomplete and was not final but unfortunately the full publication of his anatomical researches was prevented by his tragic death.

The following description of the bronchi in man is based on an investigation which started with an attempt to make corrosion casts of the bronchial tree using celloidin instead of fusible metal. Details of this method have already been published (Foster-Carter, 1942). A study of these casts brought to light certain points which were at variance with previous accounts and a further investigation of dissections and bronchograms was therefore undertaken in order to supply the omissions and clarify the obscurities of former descriptions.

Fundamentally the bronchial system in each lung consists of a stem with a series of dorsal and ventral branches. Each pulmonary artery, arising in the gap between the two main bronchi, must cross the stem bronchus to reach the lung. In the reptiles the first branch bronchi arise from the stem below the point at which it is crossed by the pulmonary artery, but in most mammals a branch develops above this point on the right side. This is the eparterial bronchus and it supplies the right upper lobe. The mammalian left lung still resembles that of the reptiles because the first branch of the left stem bronchus, supplying the upper lobe, arises below the left pulmonary artery.

Let us consider first the bronchi of the right upper lobe (fig. 1). The eparterial bronchus divides into three branches, posterolateral or dorsal, anterolateral or ventral and apical. Many previous accounts have mentioned a fourth or "axillary" branch but this does not normally exist in the human lung. The axillary area of the right upper lobe is supplied by lateral twigs from the anterior, posterior and apical branches and not by a separate "axillary" branch. Continuing down the right stem bronchus, the next branch, the middle bronchus, is directed forwards and supplies the middle lobe; it has two main divisions, anterior and lateral.

In the left lung the branch to the upper lobe arises below the pulmonary artery and combines the functions of the eparterial and middle bronchi on the right. The left upper lobe is equivalent to the right upper and middle lobes and is rarely subdivided by a fissure. The bronchus to the left upper lobe therefore has, as would be expected, two main divisions; the left ascending bronchus and the left middle bronchus. The ascending branch is equivalent to the eparterial bronchus on the right and has similar branches —anterolateral, apical and posterolateral—the last two arising by a common stem. The left middle bronchus supplies that area of the left upper lobe which corresponds with the right middle lobe, sometimes called the lingula or lingual process; it has anterior and lateral divisions as on the right side.

The bronchi of the lower lobes are similar on the two sides and may be considered together. Continuing our journey down the stem bronchus—after it enters the lower lobe the first branch to be encountered is a large bronchus directed backwards. This is the first dorsal branch of the stem and it supplies the apex of the lower lobe. Branches of this bronchus can also extend as far outwards as the posterior axillary line and downwards to the level of the 10th dorsal vertebra. The next branch, the cardiac bronchus, is peculiar to the right lung, it arises from the medial aspect of the stem and supplies the medial part of the right lower lobe adjacent to the heart. A short distance farther down, another large branch, the anterior basic, arises from the anterior aspect of the stem to supply the anterior part of the lower lobe. Almost immediately after this the stem bronchus appears to bifurcate into two terminal branches, the middle basic and

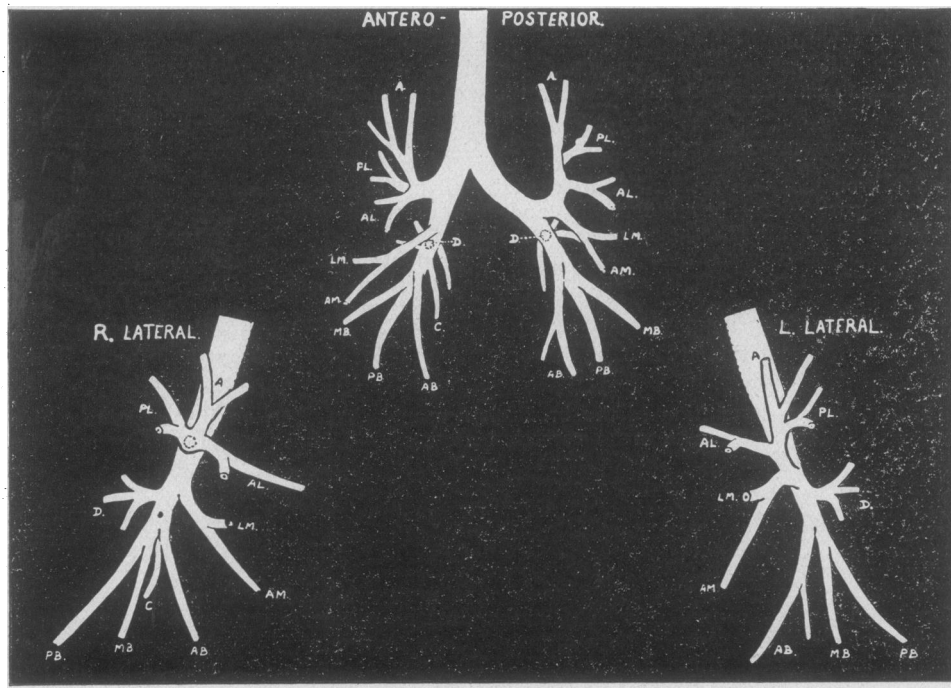

FIG. 1.—Schematic diagram of the human bronchial tree.

A. Apical. AL. Anterolateral. PL. Posterolateral. AM. Anterior middle. LM. Lateral middle. D. Dorsal. C. Cardiac. AB. Anterior basic. MB. Middle basic. PB. Posterior basic.

the posterior basic. These supply the middle and posterior parts of the lower lobe respectively and the posterior basic branch is actually the direct continuation of the stem bronchus itself.

A knowledge of bronchial anatomy can be applied in many ways. It is essential for the proper production and interpretation of bronchograms. To produce a good bronchogram it is best to fill only one lung at a time and while the iodized oil is being injected, the patient should be placed in a series of carefully planned positions in order that all the bronchi of the lung may be filled. In the semi-recumbent position the oil flows into the posterior parts of the lower lobe (fig. 2). With the patient leaning forward the middle and anterior parts of the lower lobe and, on the right side, the middle lobe are filled (fig. 3). The patient then lies on his side and the oil fills the upper lobe (fig. 4); rolling on to the face and on to the back at this stage helps to distribute the oil throughout the lung. It must be remembered that the bronchial tree is a three-dimensional object and in order to depict any three-dimensioned object in two dimensions it is best to show two views of it, taken at right angles to each other. For this reason the antero-

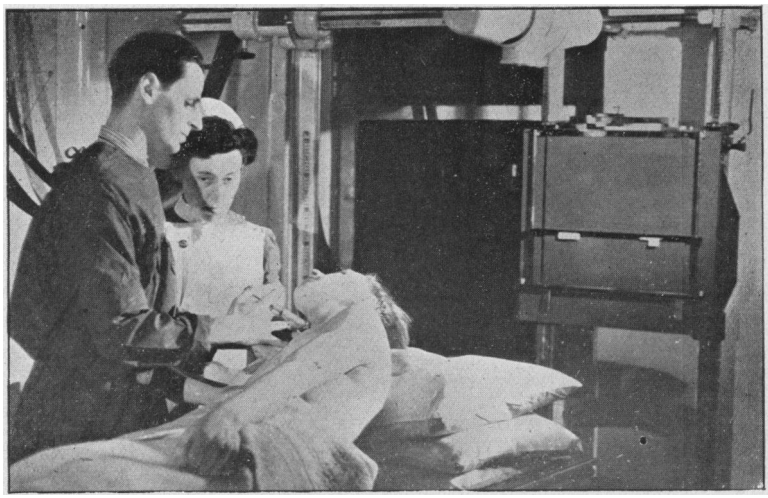

FIG. 2.—First position for bronchography of the right lung.

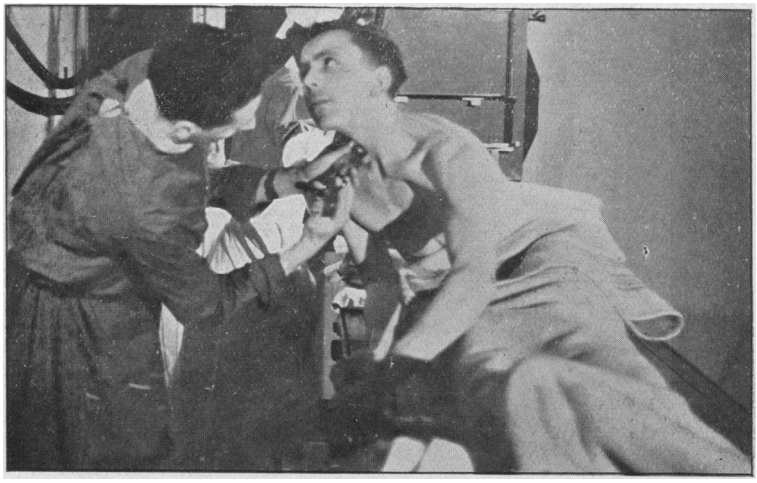

FIG. 3.—Second position.

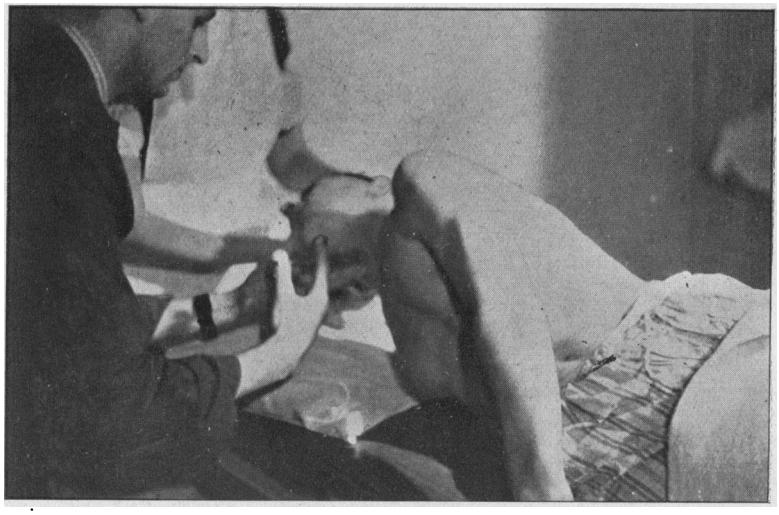

FIG. 4.—Third position.

posterior view alone is of little value in interpreting a bronchogram; only when it is viewed together with a lateral film can each bronchus be identified with certainty. If, by design or accident, the bronchi of both lungs have been outlined at the same time, the lateral film becomes confused owing to superimposition and an oblique film is necessary to separate the bronchi of the two sides. Such separation occurs when the chest is at an angle of 45 degrees to the X-ray plate, but the resulting picture is rather more difficult to interpret than the lateral view.

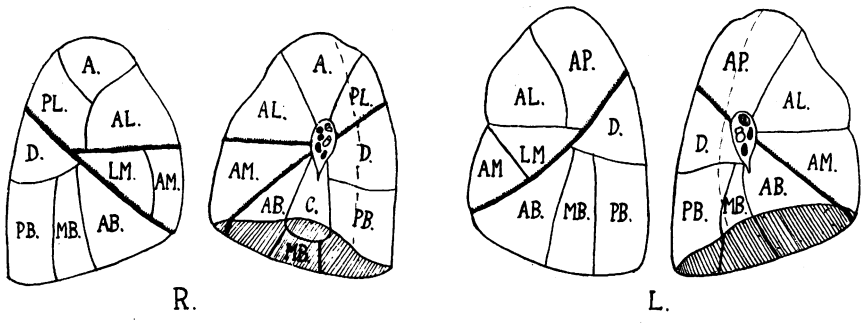

FIG. 5.—The bronchopulmonary segments.

A. Apical. AL. Anterolateral. PL. Posterolateral. AM. Anterior middle. LM. Lateral middle. D. Dorsal. C. Cardiac. AB. Anterior basic. MB. Middle basic. PB. Posterior basic. AP. Apico-posterior (combined left apical and posterolateral segments).

Finally, a knowledge of the anatomy of the bronchi brings with it a new clinico-anatomical conception of the lung as a functional organ composed not merely of lobes but of a number of smaller yet distinct segments each supplied by a well-defined bronchus. The areas of lung supplied by the bronchial divisions which we have described are shown in fig. 5; the sizes of the segments relative to each other vary slightly in different lungs. Disease processes, especially those caused by aspiration such as lung abscesses, are often confined to one or more broncho-pulmonary segments and an understanding of these subdivisions is of great value both in elucidating the X-rays of such conditions and in planning their treatment. For instance, if it is decided to treat an infective lesion in the lung by postural drainage it is necessary first to decide from the X-ray which segments are involved and then to plan the optimum position for drainage from a knowledge of the course of the bronchi draining these segments (figs. 5, 6, 7 and 8).

In this brief account of normal bronchial anatomy, variations have purposely been omitted for the sake of clarity. Certain important variations do occur and they are described elsewhere (Foster-Carter, 1942), but the very word variation presupposes the existence of a normal arrangement and the basic mode of branching of the bronchi is the same in the large majority of instances. It is this common pattern, the theme upon which any variations must be based, which I have endeavoured to describe.

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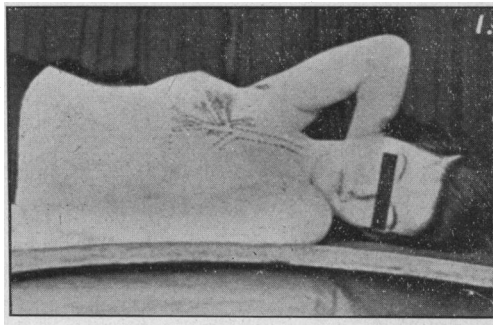
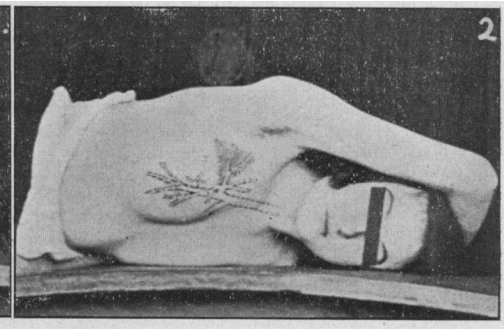
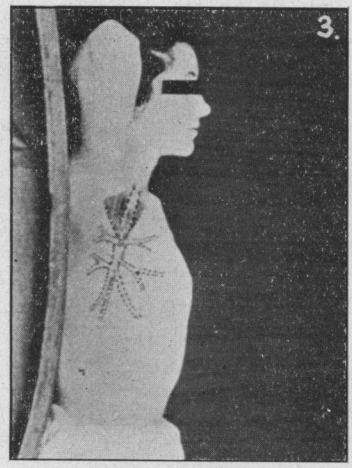
FIGS. 6, 7 and 8.—POSITIONS FOR POSTURAL DRAINAGE OF THE VARIOUS PULMONARY SEGMENTS.



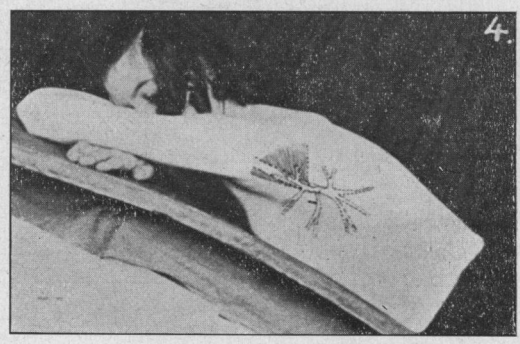
(1) Anterolateral (right upper lobe).



(2) Posterolateral (right upper lobe).

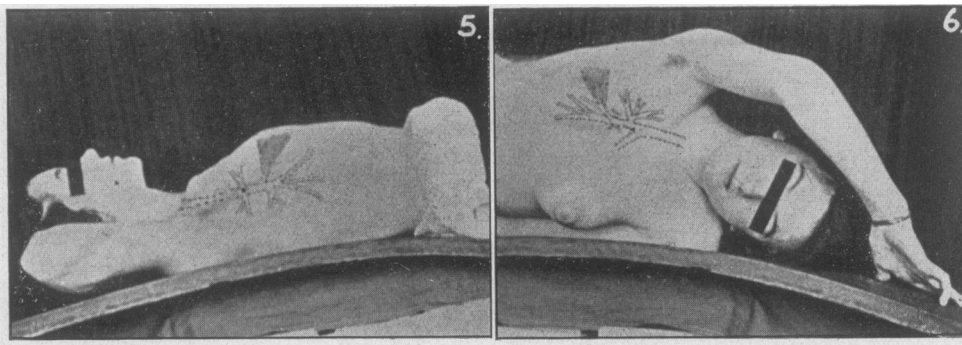


(3) Apical (right upper lobe).

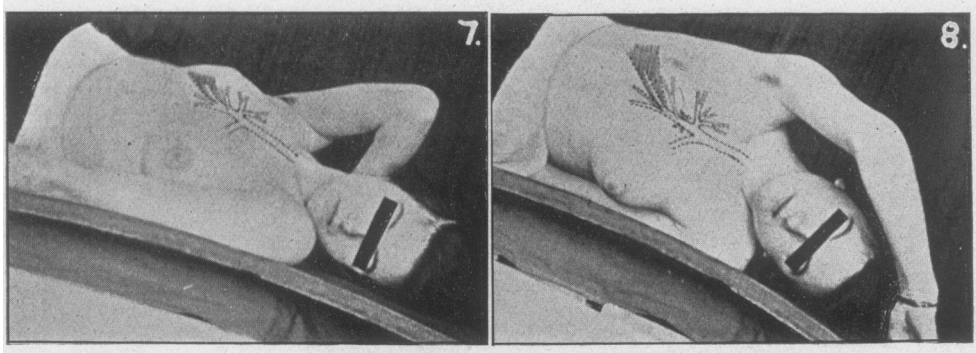


(4) Combined apical and posterolateral (left upper lobe).

FIG. 6.

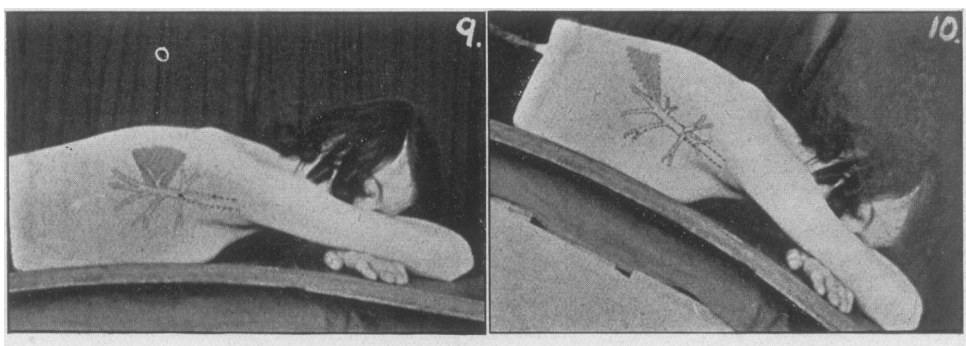


(5) Anterior middle (right middle lobe). (6) Lateral middle (right middle lobe).



(7) Anterior basic (right lower lobe). (8) Middle basic (right lower lobe).

FIG. 7.



(9) Dorsal (right lower lobe). (10) Posterior basic and cardiac (right lower lobe).

FIG. 8.

The remaining segments of the left lung are drained in positions similar to those shown for the right lung.