The Bronchial Tree and Lobular Division of the Dog Lung

Shoichi NAKAKUKI

Department of Veterinary Anatomy, Faculty of Agriculture, Tokyo University of Agriculture and Technology, 3-5-8 Saiwai-cho, Fuchu-shi, Tokyo 183, Japan

(Received 5 August 1993/Accepted 16 December 1993)

ABSTRACT. The right lung of the dog consists of the cranial, middle, caudal and accessory lobes. The left lung consists of the bilobed middle and caudal lobes. These lobes are separated by interlobar fissures on either side. The dog lung has four bronchiole systems, dorsal, lateral, ventral and medial, on either side. The right cranial lobe is formed by the first bronchiole of the dorsal bronchiole system. The right middle lobe is formed by the first bronchiole of the lateral bronchiole system, and the right accessory lobe is formed by the first bronchiole of the ventral bronchiole system. The remaining bronchioles of the dorsal, lateral and ventral bronchiole systems and all the bronchioles of the medial bronchiole system constitute the right caudal lobe. In the left lung, the left middle lobe is formed by the first bronchiole of the lateral bronchiole system. The remaining bronchioles of the bilateral bronchiole system and all the bronchioles of the dorsal, ventral and medial bronchiole systems constitute the left caudal lobe. These findings are compared with those in other domestic animals and man.—KEY WORDS: bronchial tree, canine, lobular division of lung.


Aeby [1] examined the lungs of many mammals including man, and classified the bronchioles into the dorsal and ventral bronchiole systems. Furthermore, he classified the bronchioles into epiarterial and hypoarterial bronchioles according to the course of the pulmonary artery, and considered the left epiarterial bronchiole, i.e., the left upper lobe bronchiole, to be lacking in the human lung. Huntington [3] also examined many mammalian lungs and considered the left upper lobe bronchiole and the left middle lobe bronchiole to have a short common trunk originating from the left bronchus. On the other hand, Jackson and Huber [4] divided the human lung into ten pulmonary segments on either side for the convenience of surgery. They considered the left upper lobe to correspond to the right upper and middle lobes. Externally, however, the right lung consists of the upper, middle and lower lobes, and the left lung consists of the upper and lower lobes, the middle lobe being absent.

In veterinary anatomy, the lobular division of Ellenberger and Baum [2] was accepted for a long time. This discriminated the apical, cardiac, diaphragmatic and intermediate lobes in the right lung, and the apical, cardiac and diaphragmatic lobes in the left lung, except for the horse lung. However, Seiferle [8] pointed out that the left cardiac lobe by Ellenberger and Baum [2] is part of the apical lobe. At present, this is widely accepted in veterinary anatomy. In this way, the interpretations of the left lung have differed among authors.

Therefore, the present author examined many mammalian lungs to establish the fundamental structure of the bronchial ramifications. It was concluded that the dorsal, lateral, ventral and medial bronchiole systems arise from the dorsal, lateral, ventral and medial sides of both bronchi, respectively. Furthermore, two pairs of bronchioles arise from the lateral sides of the trachea. The cranial lobe bronchioles are the first bronchiole of the dorsal bronchiole system (cranial lobe bronchiole I) and the two bronchioles arising from the trachea (cranial lobe bronchioles II and III). In this way, three cranial lobe bronchioles can be enumerated. However, in general, the cranial lobe can be formed by any one of them. The middle lobe bronchiole is the first bronchiole of the lateral bronchiole system. The accessory lobe bronchiole is the first bronchiole of the ventral bronchiole system. The remaining bronchioles of the four bronchiole systems constitute the caudal lobe [5, 6].

In an earlier report, the present author described the main portion of the bronchial tree of domestic animals [6]. However, from a clinical standpoint, the peripheral portion of the bronchial tree is also necessary. Therefore, the present author has already reported detail of the whole bronchial tree of the horse [7]. In this paper, the author deals with the whole bronchial tree of the dog, including the peripheral portion.

MATERIALS AND METHODS

Lungs from thirty-three apparently healthy mongrel dogs were used. All of the dogs had been euthanitized by an injection of sodium pentobarbital. Thirteen of them were injected with variously colored celluoid solutions into the bronchial tree and blood vessels through the trachea and heart with the aid of a metal syringe. Nine other specimens were injected into the bronchial tree and pulmonary artery, and eleven into the bronchial tree only. After completion of the injections, these lungs were placed in water until the celluoid had completely coagulated. Then, the soft tissues were treated with hydrochloric acid (HCl). The cast models were obtained after washing in running water (Fig. 1).

In this report, the author mainly describes the dominant type of bronchial ramification in the dog, on the basis of the above proposed system of nomenclature [5, 6], from the viewpoint of comparative anatomy.
RESULTS

Bronchial ramification and lobular division (Figs. 1–4): The trachea divides into the right and left bronchi, which extend in a caudal direction in the right and left lungs. Both bronchi give off many bronchioles stereotaxically. These bronchioles can be classified into the dorsal (D), lateral (L), ventral (V) and medial (M) bronchiole systems.

![Image of bronchial tree](image)

Fig. 1. Ventral aspect. Celluloid cast model of the bronchial tree of the dog lung.

![Image of bronchial tree](image)

Fig. 2. Ventral aspect of the bronchial tree of the dog lung.

Figs. 2–4:
- D - dorsal bronchiole system
- L - lateral bronchiole system
- V - ventral bronchiole system
- M - medial bronchiole system
- D₁ - cranial lobe bronchiole (cranial lobe bronchiole 1)
- L₁ - middle lobe bronchiole
- V₁ - accessory lobe bronchiole
The remaining bronchioles of the four bronchiole systems constitute the caudal lobe.
- R.P.A. - right pulmonary artery
- L.P.A. - left pulmonary artery

![Image of bronchial tree](image)

Fig. 3. Lateral aspect of the right lung.

![Image of bronchial tree](image)

Fig. 4. Lateral aspect of the left lung.
on either side. Furthermore, these bronchioles give off many side branches (Figs. 1–4).

The right cranial lobe bronchiolo of the dog corresponds to the first bronchiolo (D_1) of the dorsal bronchiolo system, i.e. the cranial lobe bronchiolo I, and the cranial lobe bronchiolo II and III are absent. The right cranial lobe bronchiolo I arises from the dorsolateral side of the right bronchus and divides into two branches, cranial (a) and caudal (b). The cranial branch (a) is more developed than the caudal branch (b), and gives off side branches in both dorsal and ventral directions, among which the first side branch arising from the dorsal side of the main trunk of the cranial branch (a) is well developed (Figs. 2, 3). The caudal branch (b) divides into two branches, dorsal and ventral. This bronchiolo constitutes the right cranial lobe. The right middle lobe bronchiolo arises from the ventrolateral side of the right bronchus. This bronchiolo corresponds to the first bronchiolo (L_1) of the lateral bronchiolo system and extends in a ventrolateral direction, giving off side branches on both the cranial and caudal sides. The first side branch arising from the caudal lateral side of the main trunk is often well developed compared with the other side branches. This bronchiolo forms the right middle lobe. The right accessary lobe bronchiolo is the first bronchiolo (V_1) of the ventral bronchiolo system and arises from the ventromedial side of the right bronchus, dividing into two branches, lateral and medial (Fig. 2). This bronchiolo constitutes the right accessory lobe. The remaining bronchioles of the dorsal, lateral, and ventral bronchiolo systems and all the bronchioles of the medial bronchiolo system constitute the right caudal lobe. In the right caudal lobe, the lateral bronchiolo system is the most developed and has the second (L_2) to fifth (L_5) bronchioles, continuously. The branches arising from the cranial side of the second bronchiolo (L_2) of the lateral bronchiolo system are well developed. The third bronchiolo (L_3) divides into two branches in its distal portion. The fourth (L_4) and fifth (L_5) bronchioles do not divide, and the former is sometimes small or lacking. The dorsal bronchiolo system has the second (D_2) to sixth (D_6) bronchioles. The ventral and medial bronchiolo systems are poorly developed and variable, with bronchioles lacking here and there. The ventral bronchiolo system has only the fourth bronchiolo (V_4). The medial bronchiolo system has the third (M_3) and fourth (M_4) bronchioles (Fig. 2). Accordingly, the right lung consists of the cranial, middle, caudal and accessory lobes. These lobes are separated by interlobular fissures (Fig. 3).

In the left lung, all the cranial lobe bronchioles are absent. The left middle lobe bronchiolo arises from the ventrolateral side of the left bronchus and is well developed. This bronchiolo corresponds to the first bronchiolo (L_1) of the lateral bronchiolo system and divides into cranial (a) and caudal (b) branches. The cranial branch (a) gives off side branches both dorsally and ventrally. The first side branch arising from the dorsal side of the main trunk of the cranial branch (a) is well developed (Fig. 4). The caudal branch (b) also gives off side branches in both cranial and caudal directions. The cranial (a) and caudal (b) branches form one lobule each. The dorsal portions of these lobules are united with each other, and the two constitute the left middle lobe. The origin of the left middle lobe bronchiolo is more cranial than that of the right middle lobe bronchiolo (Fig. 2). The left accessory lobe bronchiolo, i.e. the first bronchiolo (V_1) of the ventral bronchiolo system, is absent. The remaining bronchioles of the lateral bronchiolo system and all the bronchioles of the dorsal, ventral and medial bronchiolo systems constitute the left caudal lobe. In the left caudal lobe, the lateral bronchiolo system is the most developed and has the second (L_2) to sixth (L_6) bronchioles, continuously. The branches arising from the cranial side of the second bronchiolo (L_2) of the lateral bronchiolo system are well developed. The third bronchiolo (L_3) of the lateral bronchiolo system divides into two branches in its distal portion. The fourth bronchiolo (L_4) usually does not divide into two branches in its distal portion, and sometimes it is small or lacking. The fifth (L_5) and sixth (L_6) bronchioles usually do not divide into two branches. The dorsal bronchiolo system has the second (D_2) to seventh (D_7) bronchioles. The ventral bronchiolo system has the second (V_2), third (V_3) and fifth (V_5) bronchioles. The medial bronchiolo system has the third (M_3), fifth (M_5) and sixth (M_6) bronchioles (Fig. 2). Accordingly, the left lung consists of the bilobed middle and caudal lobes, both of which are separated by an interlobular fissure (Fig. 4).

**DISCUSSION**

The anatomical terms used in this report, i.e. the cranial lobe, middle lobe, caudal lobe and right accessory lobe, correspond to the upper lobe, middle lobe, lower lobe and right medial basal segment (S') of the human lung, respectively. However, in the human left lung, the upper lobe and medial basal segment (S') are absent from the viewpoint of comparative anatomy [5, 6]. The term bronchiolo corresponds to a lobular bronchus arising from the right and left bronchi, or a segmental bronchus arising from the caudal lobe bronchi in veterinary anatomy.

There is a numerical variation as to bronchioles arising from the right and left bronchi, especially in the ventral (V) and medial (M) bronchiolo systems. Furthermore, the bronchiolo ramifications and their extensions in the lung are also variable. However, if we know the fundamental type of bronchial ramifications, then the bronchioles can be easily identified. Therefore, in this report, the author described mainly the dominant type of bronchial ramifications.

The left middle lobe bronchiolo, as designated by the present author, corresponds to the common trunk of the bronchiolo (bronchi) forming the left apical and cardiac lobes of Ellenberger and Baum [2] in the cow, pig or dog. Furthermore, each of them corresponds to the left apical lobe bronchiolo (bronchus) of Seiferle [8]. At present, in veterinary anatomy, these bronchioles are called the left
cranial lobe bronchiole (bronchus).

However, the right cranial lobe bronchiole of the dog is the first bronchiole (D₁) of the dorsal bronchiole system and arises from the dorsolateral side of the right bronchus. It is an epiarterial bronchiole because it is located on the cranial side of the right pulmonary artery. The right middle lobe bronchiole is the first bronchiole (L₂) of the lateral bronchiole system and arises from the ventrolateral side of the right bronchus. It is one of the hypoarterial bronchioles because it is located on the caudal side of the right pulmonary artery. In this way, the cranial lobe bronchiole and the middle lobe bronchiole are completely different from each other in their bronchiole systems, the origin of their bronchioles and their relationship to the pulmonary artery.

The left middle lobe bronchiole, as designated by the present author, arises from the ventrolateral side of the left bronchus and corresponds to the first bronchiole (L₁) of the lateral bronchiole system, although the origin of this bronchiole is more cranial than that of the right middle lobe bronchiole. Furthermore, it is a hypoarterial bronchiole. Therefore, from these features, this bronchiole does not correspond to the right cranial lobe bronchiole, but to the right middle lobe bronchiole. Therefore, the left cranial lobe bronchiole of the dog, as currently accepted in veterinary anatomy, should be called the left middle lobe bronchiole (bronchus). Furthermore, this bronchiole also corresponds to the left cranial lobe bronchioles of the cow and pig, or to the left upper (cranial) lobe bronchiole (bronchus) of man. Therefore, the left cranial (upper) lobe bronchiole of these animals and man also should be called the left middle lobe bronchiole from the viewpoint of the comparative anatomy [5, 6].

In order to identify the lung lobes, it is important to take into consideration not only their external features but also their bronchial ramifications and relationship to the pulmonary artery.

REFERENCES