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Venous drainage of the middle lobe of the right lung in man

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The shape of the middle lobe of the right lung may vary greatly because of the varying extent of its surfaces in different specimens and the profuse branching of the two segmental bronchi, arteries and veins. The architecture of the middle lobe is therefore especially difficult to understand. For these reasons, attention must be paid to the arrangements of the veins which separate its segments. Thus, the aim of this study was to investigate the ways in which venous drainage of the middle lobe segments may take place. The studies were performed on 40 organs taken from adult human cadavers of both sexes. The pulmonary vessels and bronchi were filled with Plastogen G, after which corrosion casts were made and skeletonised. The lateral segment (SIV) and the medial segment (SV) of the middle lobe were drained in 55% of specimens by one vein and in 35% of specimens by two separately terminated veins. Considerably less frequently there were 3 veins (7.5% of specimens) and only in 2.5% of specimens — 4 veins. In specimens where the middle lobe was drained by one vein (55%) it was formed by joining the lateral (V4) and the medial (V5) segmental veins. In 32.5% of specimens these two segmental veins were formed by a junction of their typical sub-segmental tributaries, where the posterior sub-segmental vein V4a and the superior sub-segmental vein V5a were intra-segmental veins, whereas the anterior sub-segmental vein V4b and the inferior sub-segmental vein V5b were inter-segmental veins. In the remaining 22.5% of specimens with one vein of the middle lobe we noticed modifications in the course of the bronchi, arteries and veins. In the middle lobes drained by two separate veins (35% of specimens) there were independently running segmental veins, V4 and V5. These were formed by their typical tributaries (15%), whereas in the remaining 20% of specimens there were unusual patterns. Three individual veins of the middle lobe (7.5% of specimens) accompanied the lateral-medial type of bronchial arrangement in 5% of specimens, while in 2.5% of specimens the bronchial pattern was of the superior-inferior type. These veins run so as to form more often two superior and one inferior vein. The venous pattern of the middle lobe was consistent with the bronchial and arterial patterns in 35% of specimens. However, this conformation was present in those organs (32.5% of specimens) where the middle lobe was drained by one vein and only in 2.5% of specimens if there were two veins. If 3 or 4 individually emptied veins were present, we could not find any organ in which the bronchial, arterial and venous pattern would be fully compatible. Thus, the research revealed that convenient conditions for the separation of the segments of the middle lobe of the right lung were present in approximately 1/3 of the middle lobes.

Key words: right human lung, middle lobe, venous drainage

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INTRODUCTION

The middle lobe of the right lung is a wedge-shaped mass compressed between the upper and lower lobes and thus bounded principally by the horizontal and oblique fissures. Its shape varies greatly; its upper surface is (about 60% of specimens or more) often partially or wholly fused to the upper lobe [1, 9]. The peculiar shape of the lobe is doubtless due to the fact that the stem of the lobar middle bronchus descends for some distance before it branches. Because of its length, the middle lobe bronchus is vulnerable to compression by the surrounding lymph nodes and this leads to atelectasis and infection, known as "middle lobe syndrome" [8]. When the shape of the lobe is examined more closely it is seen to vary greatly because of the varying extent of its surfaces in different specimens and the profuse branching of the two segmental bronchi, arteries and veins. The architecture of the middle lobe is therefore especially difficult to understand. For these reasons, attention must be paid to the arrangements of veins which separate its segments. This is important in surgery of the lungs, especially in segmentectomy [8, 10].

Thus the aim of the study was to investigate the ways in which venous drainage of the middle lobe segments may take place, taking into consideration the possibility of their individual removal.

MATERIAL AND METHODS

The studies were performed on 40 organs taken from human adult cadavers varying in age and of both sexes. The pulmonary vessels and bronchi were filled with Plastogen G. Corrosion casts were then made and these were skeletonised.

RESULTS

The segments of the middle lobe of the right lung, namely the lateral segment (SIV) and the medial segment (SV), were drained in 55% of specimens by one vein (Fig. 1) and in 35% of specimens by two separately terminated veins (Fig. 2). Considerably less frequently there were 3 veins (7.5% of specimens; Fig. 3) and only in 2.5% of specimens — 4 veins.

In those specimens, where the middle lobe was drained by one vein (55% of specimens), the vein was formed by joining the lateral segmental vein V4 and the medial segmental vein V5. These two segmental veins were formed in 32.5% of specimens by conjunction of their typical sub-segmen-

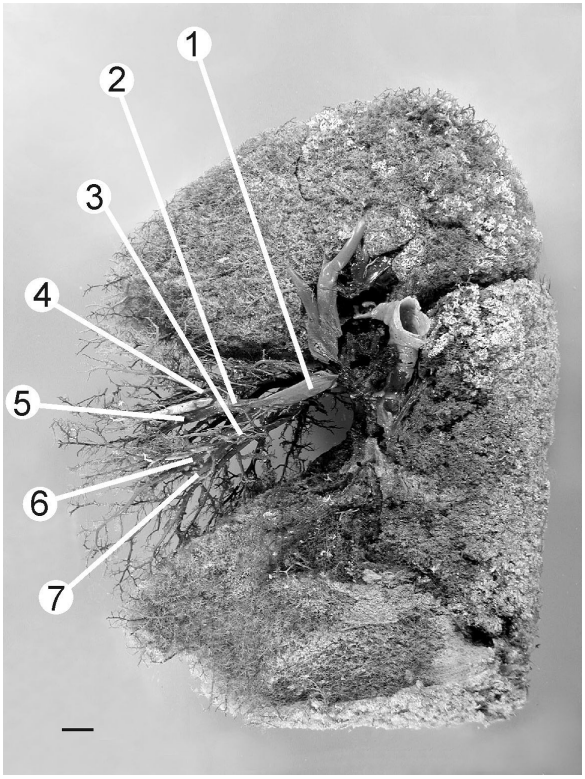

Figure 1. The segments of the middle lobe of the right lung are drained by one vein emptying into the right superior pulmonary vein. Vessels filled with Plastogen. Corrosion cast. Medial view. Scale bar: 10 mm; 1 — middle lobe vein, 2 — lateral segmental vein V4, 3 — medial segmental vein V5, 4 — posterior sub-segmental vein V4a, 5 — anterior sub-segmental vein V4b, 6 — superior sub-segmental vein V5a, 7 — inferior sub-segmental vein V5b.

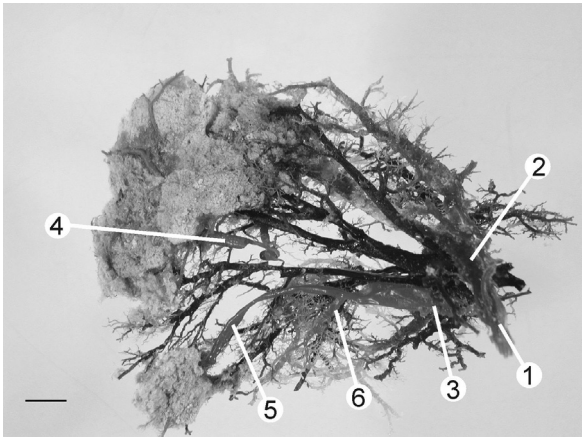

Figure 2. The vessels of the middle lobe of the right lung. The lateral segmental vein V4 is formed by V4a, while the medial segmental vein V5 is composed of V5a+V5b+V4b. Vessels filled with Plastogen. Corrosion cast. Medial view. Scale bar: 10 mm; 1 — middle lobe vein, 2 — lateral segmental vein V4 formed by posterior sub-segmental vein V4a, 3 — medial segmental vein V5, 4 — anterior sub-segmental vein V4b, 5 — superior sub-segmental vein V5a, 6 — inferior sub-segmental vein V5b.

Figure 3. Three separately-emptied veins of the middle lobe: superior (the posterior sub-segmental vein V4a), middle (the medial segmental vein V5) and inferior (the anterior sub-segmental vein V4b). Vessels and bronchi filled with Plastogen. Corrosion cast. Posterior view. Scale bar: 10 mm; 1 — middle vein (the medial segmental vein V5), 2 — inferior vein (the anterior sub-segmental vein V4b), 3 — superior vein (the posterior sub-segmental vein V4a), 4 — right superior pulmonary vein, 5 — common basal vein of the right inferior pulmonary vein, 6 — superior segmental vein V6 of the right inferior lobe.

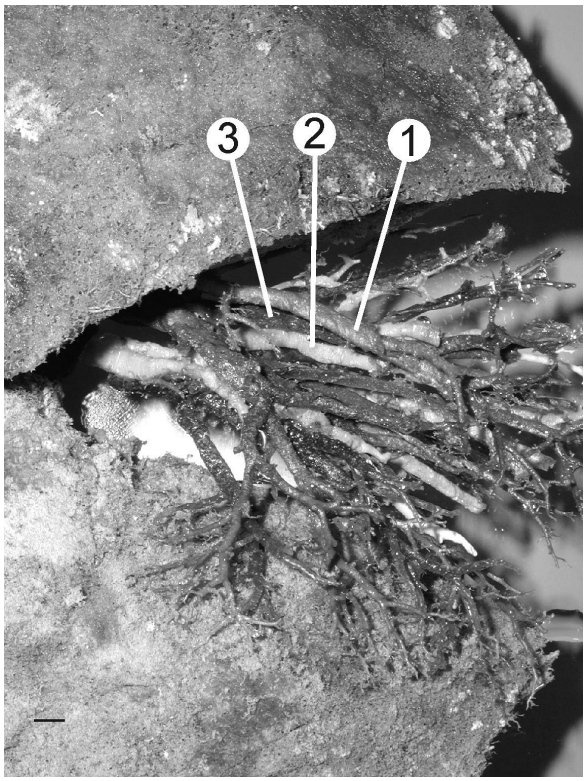

Figure 4. The posterior sub-segmental vein V4a runs atypically above the bronchi and empties into the middle lobe vein from the medial side of the superior surface. Vessels and bronchi filled with Plastogen. Corrosion cast. Posterior view. Scale bar: 10 mm; 1 — posterior sub-segmental vein V4a, 2 — lateral segmental bronchus B4, 3 — lateral segmental artery A4.

tal tributaries, i.e. V4 by the posterior sub-segmental vein V4a and the anterior sub-segmental vein V4b, and V5 by the superior sub-segmental vein V5a and the inferior sub-segmental vein V5b. The sub-segmental branches V4a and V5a were intra-segmental veins, whereas the sub-segmental branches V4b and V5b were inter-segmental veins (Fig. 1). In the remaining 22.5% of specimens (from 55%) we noticed modifications in the course of the bronchi, arteries and veins. In 15% of specimens (from the group of 22.5%) the lateral segmental vein V4 was only formed by the posterior sub-segmental vein V4a, while the medial segmental vein V5 was composed of sub-segmental veins V5a+V5b+V4b (Fig. 2). In 1/2 specimens of this group (from 15%) V4a ran atypically above the bronchi and also emptied atypically into the middle lobe vein from the medial side of superior surface (Fig. 4) and not from the medial surface, as in the other specimens (Fig. 1). In 7.5% of the remaining specimens (from the group of 22.5%) other untypical variants occurred, where V4 was formed by V4a+V4b+V5b and V5 by V5a.

In the organs where the middle lobe was supplied by one vein, it emptied in 52.5% of specimens into the right upper pulmonary vein (Fig. 1).

In the middle lobes, which were drained by two separate veins (35% of specimens), segmental veins V4 and V5 ran independently. These were formed by their typical tributaries but with some modifications in 15% of specimens (Fig. 5). They ran close by the medial surface of the middle lobe and so were classified as medial veins. Both medial veins emptied into the right superior pulmonary vein in 10% of specimens (Fig. 5) and one opened into the right inferior pulmonary vein in 5% of specimens. These veins accompanied the bronchi of the lateral-medial

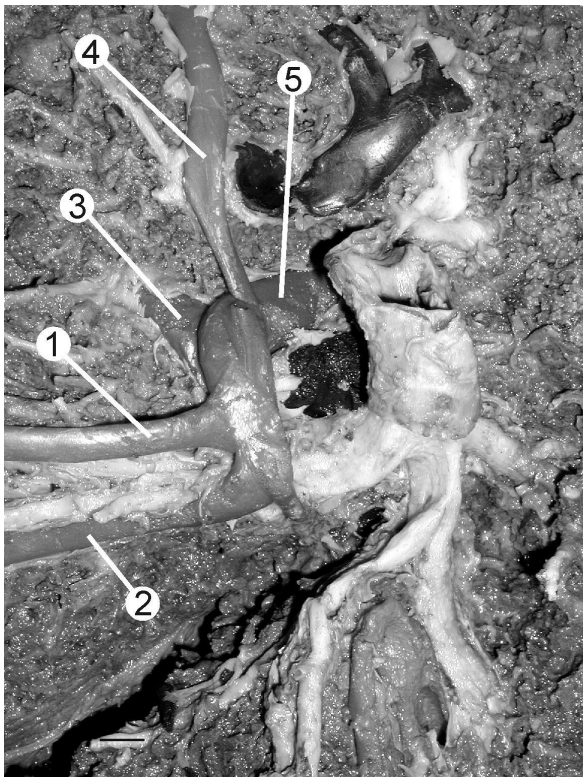

Figure 5. The middle lobe is drained by two, separately emptied into the right superior pulmonary vein, segmental veins, V4 and V5, which empty separately into the right superior pulmonary vein,. Vessels and bronchi filled with Plastogen. The lung is dissected traditionally. Medial view. Scale bar: 10 mm; 1 — lateral segmental vein V4, 2 — medial segmental vein V5, 3 — anterior segmental vein V3, 4 — superior segmental vein V1, 5 — posterior segmental vein V2.

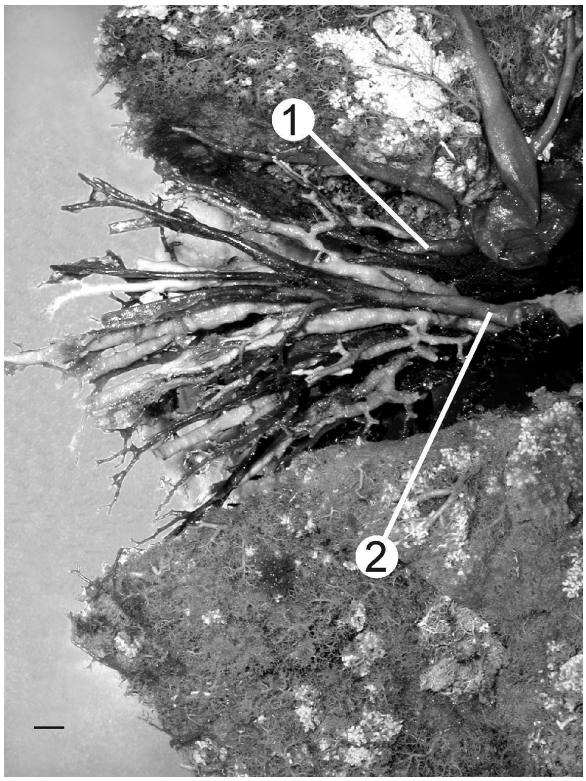

Figure 6. Two separately emptied veins of the middle lobe. The lateral segmental vein V4 runs on the superior surface of the middle lobe and opens into the right superior pulmonary vein. The medial segmental vein V5 runs on the medial surface of the lobe and opens into the right inferior pulmonary vein. Vessels and bronchi filled with Plastogen. Corrosion cast. Medial view. Scale bar: 10 mm; 1 — lateral segmental vein V4, 2 — medial segmental vein V5.

pattern. However, in the remaining 20% of specimens there were unusual patterns. In majority of them (17.5%) one of these veins was formed by the posterior sub-segmental vein V4a and the other by the medial segmental vein V5 and the anterior subsegmental vein V4b (Fig. 6). In the remaining cases (2.5%) one of the veins was formed by the anterior sub-segmental vein V4b whereas the second by the medial segmental vein V5 and posterior sub-segmental vein V4a. One of the veins usually ran near to the superior surface of the lobe and was termed the superior vein, while the other ran on its medial surface and was known as the median vein. The superior vein was formed by the lateral segmental vein V4 or one of its sub-segmental tributaries, posterior V4a or anterior V4b. Most frequently it was the anterior sub-segmental vein V4b (10% of specimens). Exceptionally (in 5% of specimens) the superior vein was formed by the superior sub-segmental vein V5a, separately or with the posterior sub-segmental vein V4a. The superior vein emptied into the right superior pulmonary vein in 15% of specimens (Fig. 6) or into the anterior segmental pulmonary vein V3 in 5% of specimens. The medial vein opened into the right superior pulmonary vein in 12.5% of specimens and into the right inferior pulmonary vein in 7.5% of specimens (Fig. 6). Where two independent veins were present in the middle lobe, the bronchial pattern was compatible with the venous pattern only in 2.5% of specimens.

Three individual veins of the middle lobe were found in 7.5% of specimens (Fig. 3) but in 5% of specimens they accompanied the lateral-medial type of bronchial arrangement, while in 2.5% of specimens it was the superior-inferior bronchial pattern. These 3 individual veins ran so as to form two superior and one inferior vein (5% of specimens). The superior veins were formed by sub-segmental branches V4a and V4b or V4a and V5a. The inferior vein was formed by segmental vein V5 or sub-seg-

mental branches V5b and V4b. In 2.5% of specimens (from the group of 7.5%) these 3 veins ran as the superior (V5a), medial (V5b+V4b) and inferior vein (V4a), which supplied the lower part of the middle lobe (Fig. 3). All superior veins (from the group of 7.5% of specimens) emptied into the right superior pulmonary vein. The medial veins opened into the right superior pulmonary vein in 5% of specimens and in 2.5% of specimens into the right inferior pulmonary vein. The inferior vein opened into the right inferior pulmonary vein (Fig. 3).

Four independent veins of the middle lobe were present in only 2.5% of specimens. There was one organ where the lateral segmental bronchus B4 and medial segmental bronchus B5 arose individually from the inferior bronchial stem. These 4 veins formed the superior vein V4b, the inferior vein V4a and two medial veins (V5a and V5b running independently). All the veins referred to opened into the right inferior pulmonary vein.

The venous pattern of the middle lobe was consistent with the bronchial and arterial patterns in 35% of specimens. However, this conformation was present in those organs where the middle lobe was drained by one vein (32.5% of specimens) and only in 2.5% of specimens where two veins drained the middle lobe. When 3 or 4 individually emptied veins were present we could find no organ in which the bronchial, arterial and venous pattern would be fully compatible. A point of note was the fact that the more veins drained the middle lobe separately, the smaller the proportion of conformity between bronchial, arterial and venous patterns and thus the smaller the percentage of the two segments of the middle lobe that were easily dissectible. Convenient conditions for individual separation of the segments of the middle lobe of the right lung were found in 35% of specimens.

DISCUSSION

All the authors who have researched the venous supply of the middle lobe of the right lung have noticed that the venous pattern is more varied and complicated in comparison with the bronchial or arterial patterns [1–5, 11]. This results not only from the fact that there can be a single vein or 2, 3 or even 4 independently emptied veins, but also from the possibility of different sites for their outlets. Boyden [2] noticed one vein in 52% of specimens, two veins in 36% of specimens and three veins in 12% of specimens. Cordier and Cabrol [4] found one vein of the middle lobe in 55% of specimens and two veins in the remaining 45% of specimens. Lindskog et al. [5] noticed a single vein in 64% of specimens, with two veins in 36% of specimens. Other authors have also noticed the different possibilities for the openings of these veins. In our research 55% of specimens had a single vein for the middle lobe, which always opened into the right superior pulmonary vein, which is similar to the result in Boyden's research (52% of specimens). Maciejewski [6] found in 60% of specimens one vein for the middle lobe. In 10% this opened into the left atrium of the heart and in the remaining 50% of specimens emptied into the right superior pulmonary vein.

If two or more veins were present, Boyden [3] noticed that only in 8% of specimens the veins emptied into the right inferior pulmonary vein and in two specimens — into the left atrium of the heart. Maciejewski [6] observed two veins in 40% of specimens; in 26% of specimens these emptied into the right superior pulmonary vein, whereas in 10% of specimens — directly into the left atrium of the heart. In the remaining 4% of specimens one of the veins opened into the right superior pulmonary vein and the second directly into the left atrium. Yazar et al. [11] found the single trunk of the middle lobe vein in 73% of specimens and this opened into the right superior pulmonary vein in 53%, into the left atrium in 16.6% and into the right inferior pulmonary vein in 3.3%. The authors noticed two veins in 26.6% of specimens, which joined the right superior pulmonary vein in 16.6% of cases and the left atrium separately in 10%. Thus according to Yazar et al. [11] one of the veins of the middle lobe opens into the left atrium in 26.6% of specimens and according to Maciejewski [6] in 20% of specimens, whereas Boyden [3] found this in 4% of specimens. In our research we found 12.5% of specimens where one of the veins of the middle lobe did not open into the right superior or inferior pulmonary vein and probably joined the left atrium, but as we only used isolated lungs, we could not test this. However, we found among the 45% of specimens with two or more veins that in 12.5% of specimens one or more of these veins opened into the right inferior pulmonary vein. This pattern was noticed in all the specimens where 3 or 4 veins were present.

Boyden's [3] research revealed that the venous pattern was not consistent with the bronchial pattern in 44% of specimens and he noticed full conformation of the bronchial pattern to the arterial and venous patterns only in 32% of specimens. Maciejewski and Sawa [7] found associations between the

patterns of bronchial division and that of venous drainage of the middle lobe in slightly more than half the cases examined.

In our research the bronchial and arterial pattern was compatible with the venous pattern in only 35% of specimens. Thus the research revealed that convenient conditions for the separation of the segments of the middle lobe of the right lung were present in approximately 1/3 of the middle lobes.

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