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Drainage patterns of middle lobe vein of right lung: an anatomical study

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Abstract

Objective: The purpose of the present study was to determine the variations in the drainage patterns of middle lobe vein of the right lung. **Methods**: Right lungs of 30 formalin fixed cadavers, were dissected carefully to expose the variations in the venous drainage of their middle lobes. After identifying the pulmonary veins for each lobe, middle lobe vein (MLV) drainage patterns were followed to their openings. The diameters of the MLV and its lateral and medial parts were measured with a caliper. The length of the MLV trunk was also evaluated. **Results**: Five different types of venous drainage patterns were observed. Type-I: Union of medial and lateral parts to form MLV as a trunk and opening of this vein to the right superior pulmonary vein (RSPV) (53.3%). Type-II: Opening of medial and lateral parts to the RSPV separately (16.6%). Type-III: Union of medial and lateral parts to form the MLV trunk and opening of this vein into the left atrium (16.6%). Type-IV: Opening of medial and lateral parts into the left atrium separately (10%). Type-V: Union of medial and lateral parts to form MLV trunk and opening of this vein to the right inferior pulmonary vein (3.3%). **Conclusion**: The venous drainage patterns of right middle lobe reveals great number of variations. Knowing the frequency of different types of drainage patterns classified in this study is extremely important for the surgeons performing pulmonary surgery, atrial fibrillation and imaging techniques.

Keywords: Pulmonary vein; Middle lobe vein; Variation

1. Introduction

The pulmonary veins begin to develop by the appearance of a rich collection of angioblasts and vascular channels around the developing lung buds and a small endothelial evagination growing toward the lung bud from the superior margin of the left atrium as the primordium of the pulmonary vein. On days 28–30, the evagination becomes canalized and connects with the vascular plexus. During days 30–32, the common pulmonary vein drains the pulmonary plexus into the left atrium, just caudal to the entry of the sinus venosus. Then the common pulmonary vein is absorbed into the left atrium along with its tributary veins [1]. The pulmonary veins, originating from capillary networks in the alveolar walls, return oxygenated blood to the left atrium. By repeated junctions, tributary veins finally form a single trunk in each lobe (three in the right and two in the left). The right middle and superior pulmonary veins usually join so that two veins, superior and inferior, leave each lung. They perforate the fibrous pericardium and open separately into the posterosuperior aspect of the left atrium [2]. The venous drainage pattern of right middle lobe of the lung reveals great number of variations. Although the middle lobe vein (MLV) most often joins the right superior pulmonary vein (RSPV), various combinations for the connections of MLV have been reported in the literature and textbooks [3–5]. The purpose of this study was to define the frequency of variations in the venous drainage of middle lobe of right lung, which might be of clinical importance.

2. Materials and methods

The right lungs of 30 formalin fixed human cadavers, 11 females and 19 males, between ages of 30–78, were investigated in this study. All the lungs and the left atrial walls including the junctions of the pulmonary veins were removed from the thoracic cavity preserving drainage patterns. Then the courses of the pulmonary veins were dissected carefully starting from the hilum of the lungs to observe the drainage for each lobe. For the middle lobe,

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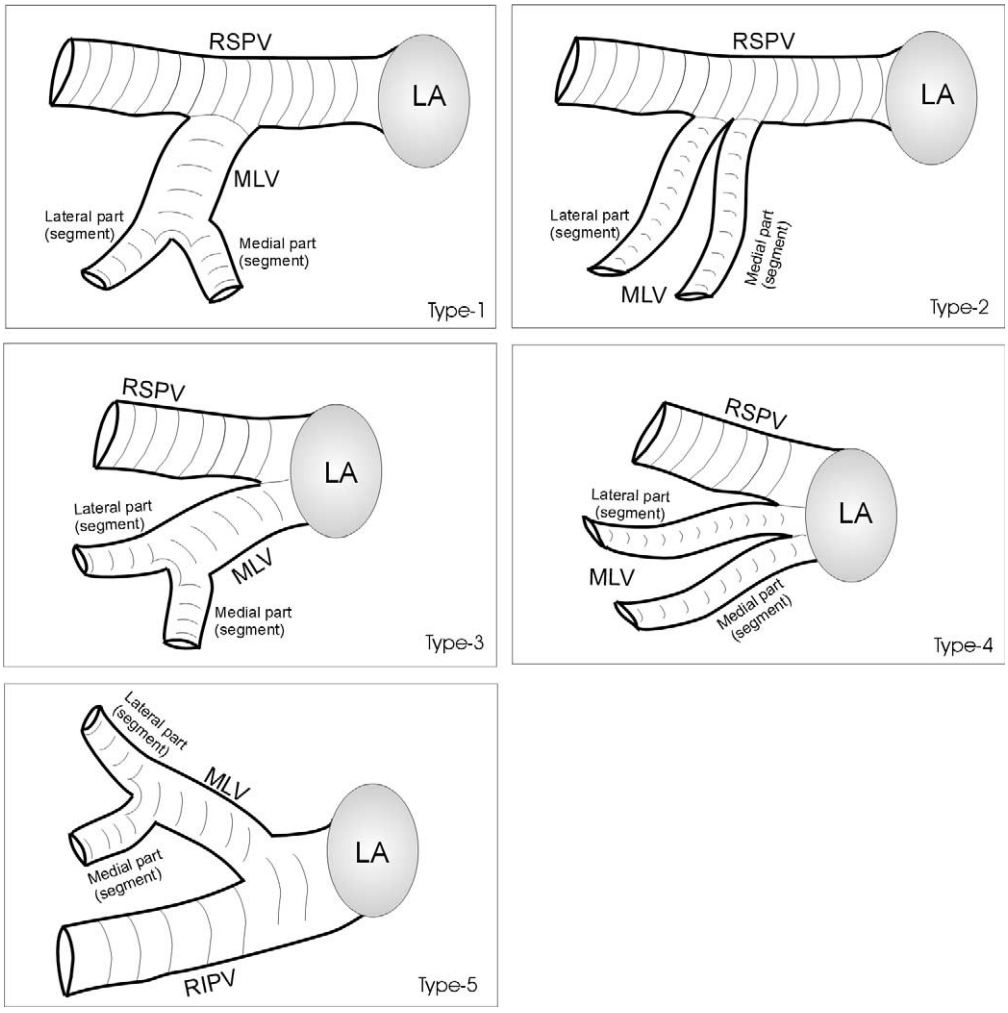

Fig. 1. Five types of drainage of the MLV of right lung: Type-1: the opening of the MLV as a single trunk to RSPV; Type-2: the opening of the MLV to RSPV as medial and lateral parts; Type-3: the opening of the MLV as a single trunk to LA; Type-4: the opening of the MLV to LA as medial and lateral parts; and Type-5: the opening of the MLV as a single trunk to RIPV.

medial and lateral parts of the MLV were identified and their various drainage patterns were classified.

The length and the diameter of the MLV trunk and the diameters of its lateral and medial parts were measured with a caliper proximal to their openings. Data were presented as mean ± SD. Wilcoxon Signed Ranks and Mann–Whitney *U*-test were used for the statistical analyzes.

3. Results

Five different types of venous drainage patterns were observed (Fig. 1). In 16 right middle lobes (53.3%), the lateral and medial parts of the MLV were joining together to form the MLV as a trunk and this trunk was opening to the RSPV. This drainage pattern was defined as Type-I. In five right middle lobes (16.6%), the lateral and medial parts were opening to the RSPV separately and this pattern was defined as Type-II. In five right middle lobes (16.6%), MLV, formed as a trunk by the union of its lateral and medial parts, was draining into the left atrium directly. This pattern was defined as Type-III. In three right middle lobes (10%), the lateral and medial parts were draining into the left atrium separately and this group was defined as Type-IV. In only one right middle lobe (3.3%), MLV, formed as a trunk by the union of its lateral and medial parts, was draining to the right inferior pulmonary vein. This pattern was defined as Type-V.

In 70% (Type-I, II), RSPV was receiving the venous blood from the right middle lobe. In 26.7% (Type-III, IV), venous blood from the right middle lobe was draining into the left atrium directly. In 73.3% (Type-I, III, V), the lateral and medial parts were uniting to form the MLV trunk and in 26.7% (Type-II, IV), these two parts were opening to the RSPV or left atrium without forming a trunk.

The measurements related to the diameters and the lengths of MLV and the diameters of its lateral and medial parts are shown in Table 1. The mean diameters of the medial and lateral parts of MLV were not statistically different between each of the drainage pattern types as well as in

Table 1
Measurement of MLV and their parts[a]

MLV	Mean ± SD (mm)	Median (mm)	Min-max (mm)
Diameter of medial part	4.11 ± 1.09	3.9	2.4–6.7
Diameter of lateral part	4.02 ± 0.85	3.85	2.0–5.7
Length of MLV trunk	17.05 ± 7.30	18.3	4.7–32.7
Diameter of MLV trunk	6.30 ± 1.44	5.95	4.2–9.7

[a] MLV: middle lobe vein.

the whole group (Wilcoxon Signed Ranks Test, $P > 0.05$). However, the mean diameters of the MLV trunk were found to be higher in the Type-I than in the Type-III. (Mann–Whitney U-test, $P < 0.01$). When the mean trunk lengths of the MLV were compared, that of Type-III was found to be significantly longer than Type-I (Mann–Whitney U-test, $P < 0.001$).

4. Discussion

Pulmonary blood vessels arise as early as the 5th week of gestation. Pulmonary arteries and veins develop together. Before birth, their development is closely related to growth of the bronchial tree [6]. The wall of the left atrium is smooth and is formed by incorporation of the primitive pulmonary vein. This vein develops as an outgrowth of the dorsal atrial wall, just to the left of the septum primum. As the atrium expands, the primitive pulmonary vein and its main branches are gradually incorporated into the wall of the left atrium; as a result, four pulmonary veins are formed that have separated openings [7]. The usual two major venous trunks from both lungs are the superior and inferior pulmonary veins. Although the middle lob vein most often joins the superior pulmonary vein, on occasion, it may enter the pericardium and drain into the atrium as a separate vessel. Rarely, it becomes a tributary of the inferior pulmonary vein [4].

Different types of drainage patterns of the middle lobe of the right lung have been reported in the literature [4,5,8]. In our study the most common drainage type was the forming of MLV by the union of the lateral and medial parts of the MLV and drainage of MLV as a trunk to the RSPV (Type-I) which was observed in 53.3% of 30 specimens. Sugimoto et al. showed the anatomic variation of a MLV emptying into the right inferior pulmonary vein (RIPV) in two patients who had right lower lobectomy. They concluded that physicians should diagnose drainage of the MLV in each case, and surgeons must expose the tributaries of the right or left inferior pulmonary veins and identify their origins when performing right or left lower lobectomies to avoid the postoperative complications [3]. Yamashita reported that MLV was emptying into the right inferior pulmonary vein in 4.8% of their cases [5]. In our study, MLV formed by the union of lateral and medial segmental pulmonary veins was emptying into the right inferior pulmonary vein in 3.3% of 30 specimens (Type-V) and this result was close to the findings of Yamashita. Alfke reported another case of an anomalous pulmonary vein of the right middle lobe. In his case the anomalous vein was draining into the apical pulmonary vein [9]. This type of a pattern was not seen in our study.

Tsao studied diameter of pulmonary vein (PV) ostium with three-dimensional magnetic resonance angiography. It was stated in his study that three different drainage patterns of MLV were present and the opening location we presented in our study, are close to the values found in his study [10]. However our study has indicated that MLV drains in five different types shown in Fig. 1. The pulmonary veins and surrounding ostial areas frequently may lead to atrial fibrillation (AF) [11,12]. These studies show that MLV opening into left atrium (LA) is clinically significant and should be defined in patients with AF.

Cavalcanti stated that the extremities of the pulmonary veins and their junctions with the atrium have a morphological substract which may be of physiological importance in the control of the pulmonary venous pressure and blood flow [13]. In this respect, our study is of importance as lateral and medial parts of MLV either open separately or with one trunk in different locations.

The new device for circumferential balloon isolation of the PV ostia using radiofrequency or ultrasound energy blocks the conduction between the PVs and LA and prevents AF initiated by ectopic beats from the PVs. Thus, the diameters of the PVs become very important for selecting the optimal size of the balloon for the ablation of the PVs [14]. We believe that MLV values given in Table 1 are especially of importance in similar studies. A total of 26.7% cases in our study and similar ratio in literature, MLV was directly opening into the left atrium. Therefore, in cases where MLV opens into LA, the diameter of this vein and its ostia gains clinical importance.

Angiography is often diagnostic of pulmonary vein abnormalities but is invasive and usually requires multiple wedge injections into the pulmonary arteries. Echocardiography may not optimally show the entry site of all four pulmonary veins. Magnetic resonance (MR) imaging is a valuable technique to image pulmonary vein anomalies and is particularly useful when definition of the variant anatomy is suboptimal by angiography or echocardiography [15,16]. The values found in our study which was presented as a cadaver work, will aid in such practices made to demonstrate pulmonary veins.

In conclusion, the venous drainage patterns of right middle lobe reveals great number of variations, knowing the frequency of different types of drainage patterns classified in this study is extremely important for the surgeons performing pulmonary surgery, atrial fibrillation and imaging techniques.

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