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The Types of Forming of the Superior Pulmonary Veins

Zmienność żył płucnych górnych

The ever-increasing environmental pollution is causing a constant increase in pulmonary cancer incidence (15, 17). At the same time, owing to the introduction of new examination techniques in radiology, the rate of relatively early detected pulmonary focal tumours is also increasing (6, 13, 14). It can therefore be expected that by the end of this century there will have been an increase in detectability of early operational forms of lung diseases, in whose treatment segmentectomy and lobectomy can be used more often than pneumonectomy.

The knowledge of methods of vascularization of lung segments is important not only for the surgeon (2, 10, 15) but also for correct interpretation of radiological examination (6, 13). All of this led us to embark on scientific research into the superior pulmonary veins, particularly as this subject is not covered very broadly in the accessible literature (9, 12, 19).

MATERIALS AND METHODS

Fifty lungs taken from the dead of both sexes (30 males, 20 females), whose ages ranged from 16 to 81 years, were studied. Tests were carried out only on lungs from persons who had not died of respiratory or vascular diseases. The autopsies were carried

out in the Department of Forensic Medicine of the Medical Academy in Lublin, between 1st and 3rd day after death. The corpses and the test materials were kept refrigerated in accordance with forensic medicine standards. When the lungs had been defrosted, both the bronchi and the pulmonary vessels were rinsed under pressure of 20 cm H_2O. The rinsing continued until there was clear water flow without blood clots. If the specimen consisted of both lungs, the bronchi and the left atrium were injected together with the right and left pulmonary veins. In instances where the specimen only comprised the one lung, the main bronchus and the half of the atrium were injected, while the part of the atrium was hermetically stitched. The above-mentioned part of the lungs were injected under pressure of 10 cm H_2O with a 65% solution of methyl methacryl (Duracryl; Spofa-Dental Firm) as described by Tompsett (18). The pressure of 10 cm H_2O of the solution is equivalent to the average pressure in the left atrium. The preparation was then carried to a chest-shaped container filled with warm water (40°C), and during the Duracryl polymerisation process in the container, no changes occurred in the topographic relations between the elements of the hilum of the lungs. The shrinkage factor of Duracryl is nil. After 24 h, specimens were digested in sulphuric acid and washed in hot water. The specimens obtained were examined to determine the types of forming of the pulmonary veins. The names used are those found in *Nomina Anatomica* (16) and in Boyden (2).

RESULTS

Vein branches outflowing from segments of the right superior lobe connected in many different ways. According to this point of view three types of forming the right superior pulmonary vein were separated. These types were presented in Figure 1. The names of vein branches were designated according to *Nomina Anatomica* as follows:

SPV — superior pulmonary vein
- V^1 — apical branch
  - V^1a, V^1b — subsegmental parts
- V^2 — posterior branch
  - V^2a, V^2b — subsegmental parts
- V^3 — anterior branch
  - V^3a, V^3b — subsegmental parts
- V^{4+5} — middle lobe branch
- V^4 — lateral branch
  - V^4a, V^4b — subsegmental parts
- V^5 — medial branch

Symbols which were placed in brackets denote the possibility of appearing two vessels instead of one, which was shown in the illustration. The sign " ' " signified the additional vein, which was situated on the mediastinal surface of the definite segment. The venous branches leaving the segments of the upper lobe connected in various ways to create types and variants which were shown in Figure 1.

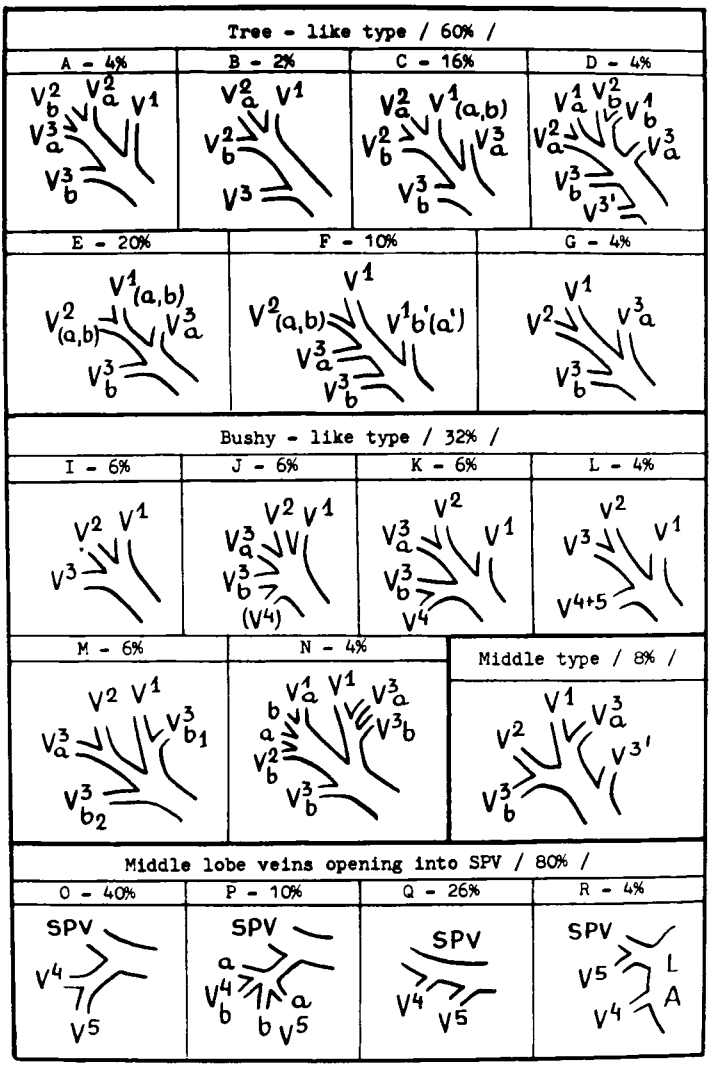

Fig. 1. Types and variants of the creating of the right superior pulmonary vein. LA — left atrium

In the tree-like type (60%) vein branches connected on different levels and they created a lot of variants. The most numerous of them was variant E (20%) — Figure 1, variant C (16%) — Figure 2, and variant F (10%) — Figure 3.

The bushy-like type (32%) included the cases in which not less than three big branches connected on the same level. It was interesting that only in 6% of all the cases three big segmental branches connected in one place.

The middle type (8%) was associated with the presence of two vein roots. The first one was created by V^1 and V^3a and the second one by V^2, V^3b (Fig. 4). The additional vein from the anterior segment ($V^{3'}$) was often in this type.

Veins of the middle lobe opened into the superior pulmonary vein in 80%, and in 20% they opened directly to the left atrium (Fig. 4). The variants of the opening of medial lobe veins into the right superior pulmonary vein were presented in Figure 2. The single venous vessel — middle lobe vein (V^{4+5}) opening into the right superior pulmonary vein on its lateral surface was observed in 50% of the cases. Its length ranged from 4 to 50 mm in males and from 8 to 26 mm in females. Its diameter ranged from 6 to 9 mm in males (7.5 mm on the average), and from 5 to 8 mm in females (6.8 mm on the average). In the majority of cases, V^{4+5} (40%) was made from the connection of the two segmental roots (V^4 and V^5) — Figure 2 and in the remaining 10% of the cases from the connection of three or four roots.

Veins originating in the following segments of the medial lobe: lateral (V^4) and medial (V^5) and opening independently into the right superior pulmonary vein were observed in 30% of the cases (Fig. 3). The length of the latter ranged from 5 to 35 mm, and its diameter ranged from 2.5 to 7 mm.

The right pulmonary vein was a complete vessel from the place where it united V^{4+5} and from this place its length and diameter were measured. The length ranged in males from 3 to 25 mm (13 mm on the average) and the diameter ranged from 8 to 18 mm (13.5 mm on the average). In females the length ranged from 6 to 24 mm (12 mm on the average), and the diameter ranged from 12 to 16.6 mm (14 mm on the average).

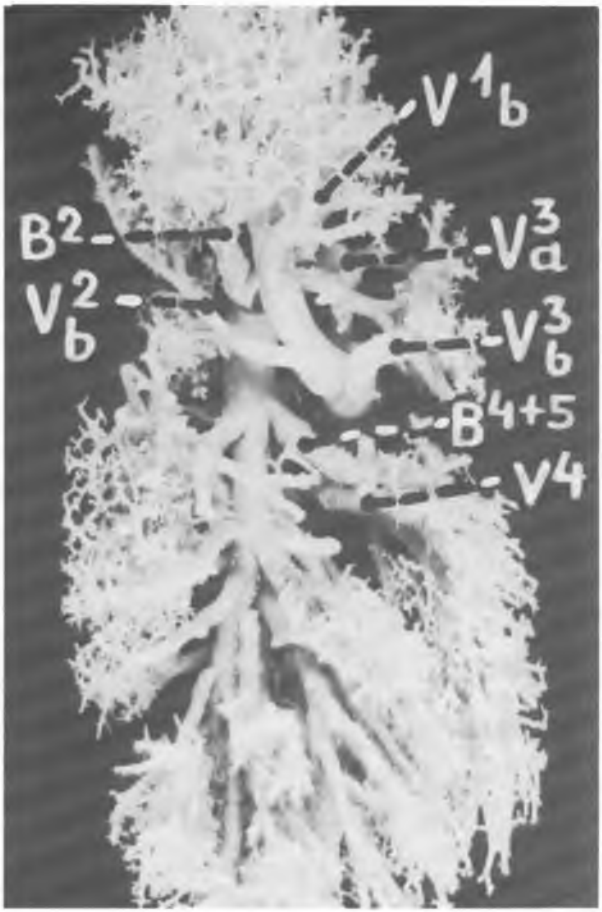

Fig. 2. Bronchi and veins of the right lung. Lateral view

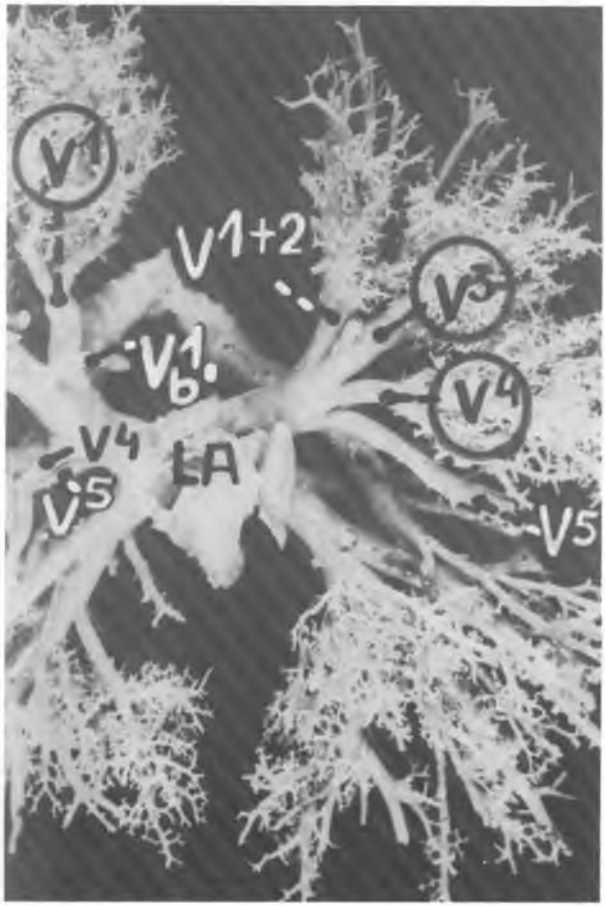

Fig. 3. Bronchial and venous ramifications of both lungs. Anterior view

Fig. 4. Bronchi and veins of the right lung. Anterior view

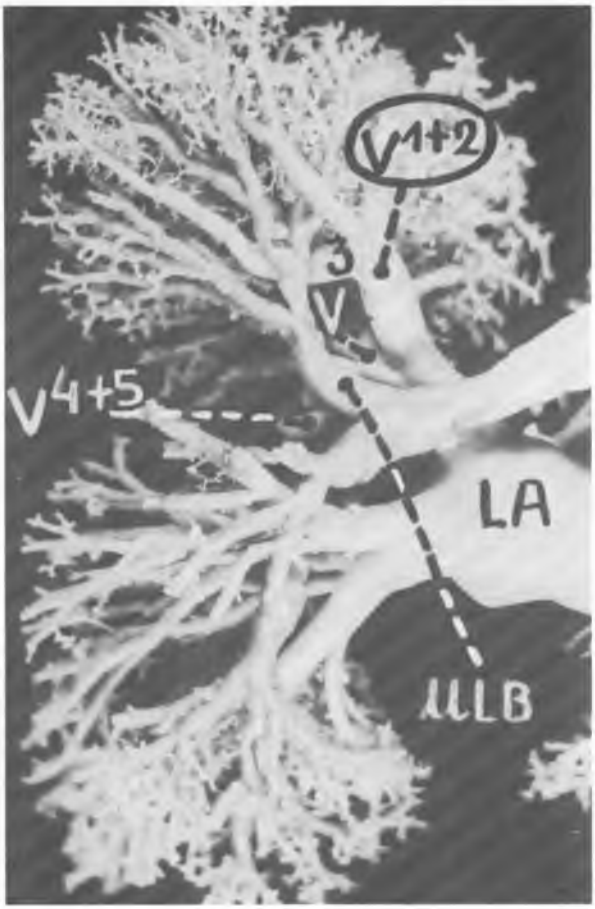

Fig. 6. Bronchi and veins of the left lung. Posterior view

Different ways of connecting of the left superior pulmonary veins can be the basis for distinguishing three main types of forming the left superior pulmonary vein with its fifteen varieties, they were shown in Figure 5. The names of veins branches and its parts were designed according to *Nomina Anatomica* as follows:

SPV — superior pulmonary vein
- V^{1+2} — apicoposterior branch
  - V^{1+2}**(a)** — intersegmental part
  - V^{1+2}**(b)** — intersegmental part
- V^3 — anterior branch
  - V^3**a**, V^3**b** — subsegmental parts
- V^{4+5} — lingular branch
- V^4 — superior lingular branch
  - V^4**a**, V^4**b** — subsegmental parts
- V^5 — inferior lingular branch
  - V^5**a**, V^5**b** — subsegmental parts

All the cases in which on one level were connected not less than three big veins, were included in the bushy-like type (40%). It was a simple connection V^{1+2}, V^3 and V^{4+5} only in 12% of the cases (variant A — Fig. 6). In the remaining variants (B, C and D), we found 4, 5 or 6 roots of this vein (Fig. 3).

In the tree-like type (16%) vein branches connected gradually giving variants: E (10%) and F, G, H (everyone presented in 2% of the cases).

The middle type presented in 40% of the cases was associated with two vein branches: V^{1+2} and V^{4+5}. The anterior branch (V^3) or its parts (V^3a and V^3b) opened in various ways into V^{1+2} or into V^{4+5} or even into both of them, creating the basis for distinguishing seven variants. The most numerous — I and J are no more than 10% of the cases.

All the three above-described types of the forming of the left superior pulmonary vein were associated with 96% of vein systems of the left upper lobe. In the remaining 4% of the cases, V^{4+5} were opened directly into the left atrium, and other branches (V^{1+2} and V^3) had a common trunk, which was not the superior pulmonary vein (Fig. 5, variant X).

After receiving a branch from the lingula, the left superior pulmonary

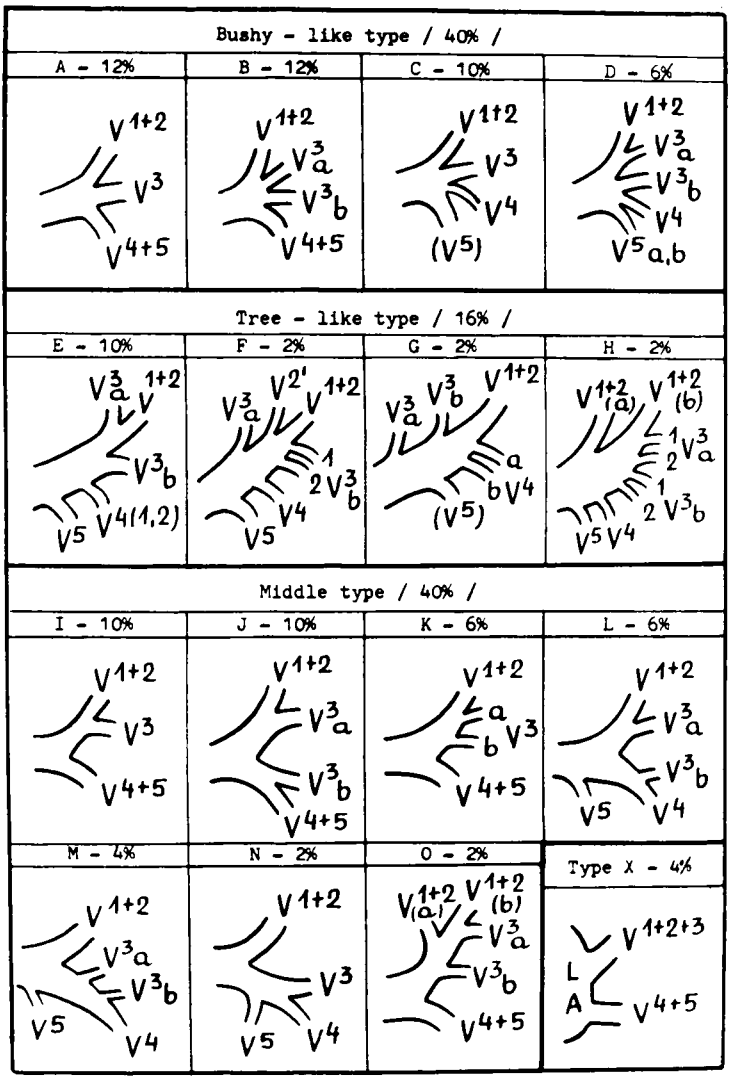

Fig. 5. Types and variants of the creating of the left superior pulmonary vein. LA — left atrium

vein went down and medial from the left lobe bronchus and it went out from the hilus as the most anterior element. Its length ranged in males from 5 to 30 mm (17 mm on the average) and its diameter from 10 to 17 mm (14 mm on the average). In females the length ranged from 10 to 26 mm (19 mm on the average), and diameter — from 12 to 16 mm (14.5 on the average).

DISCUSSION

The superior pulmonary veins were examined by many authors. Some of them were concentrated on describing the ways of forming segmental veins, the others studied the course of the interlobal veins because of using information on them during segmentectomy and still others were interested in abnormalities of the openings of the pulmonary veins to caval veins system. These cases were not observed in the examined material. In Boyden's elaboration [2] we have found the equivalent for medial type, which was confirmed by this author in 30% of the cases (own study — 8%).

It results from the above-described materials that in 20% of the cases medial lobe veins do not open into the right superior pulmonary vein. Other authors suppose that this situation is rather rare [2, 9, 12]. Brantigan [3] and Van der Spuy [19] have classified such a variety as an abnormality. Boyden [2] has found it only in 4% of cases. The same author has described the variants (8%) in which one of the two middle lobe veins was opened into the right inferior pulmonary vein, and the vein from the posterior part of the lateral segment V^4a was opened into the anterior or posterior branch of the upper lobe.

In the authors' own material in a few cases such vessels were observed but because of their small diameter (under 3 mm) and because of the fact that usage of mechanical suture eliminates any danger of damage, it has not been considered necessary to distinguish such forms. Of course it does not impair reliability of the previous reports. Percentage of number of noted veins was similar to our owen results; Boyden [2] reported single venous branch in 51%, Lindskog and others [9] in 64% (in our own studies 60%), two independent veins were found in 36% (own studies — 40%).

The relationship between the placing of the lung lesion and the possibility of its complete removing has been known for quite a long time [1]. However, it has recently been proved that the location of cancer in the left lung, according to statistics, decreases substantially the possibility of resection [7]. The difference between diagnosis of hilar lesion in the left and the right lung was that the left side was examined less accurate due to a more strict relationship between the left lung, the left main bronchus,

the pulmonary artery and aorta [4, 7]. These factors altogether in connection with a relatively frequent lesion in the hilus and a very close proximity of the left pulmonary veins and pericardium make that left lung operations (especially those of the superior lobe) are considered most difficult in lung surgery.

In lingulectomy as well as in resection of the apical segment of the inferior lobe the knowledge of vascular anatomy is essential (this fact has been emphasised by surgeons many times) [11]. Intersegmental part of the branch of the frontal wein (V3b) is an element which allows for the precise separation of the lingula from the remaining part of the superior lobe and helps to identify roots of the superior pulmonary vein. In the presented studies the vein appeared in 54% which is similar to the newest data collected by Lee and others [8] in the patient using computerized tomography (the vessel was detected in 50% of the examined persons).

In every 1 of 10 of the examined cases an untypical venous drainage was detected. The vein entered either into the left atrium by itself or the, superior branch of the vein entered into the superior pulmonary vein and inferior branch into the inferior pulmonary vein. The latter was observed in 6%/10% according to Boyden [2]. In few cases (6%) Boyden reported single veins from the basal, medial segment entering into the lingula vein. The authors have not found any; besides, the common usage of the safe method of separating unidentified elements in adhesion between the lobes using the mechanical suture makes this fact of no importance. It also applies to tiny veins from the upper of the apical segment of the inferior lobe discharging into the posterior branch, which were observed (also by other authors) in a few percent of cases both on the left and the right sides.

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STRESZCZENIE

Badaniu poddano 50 preparatów płuc ludzkich, które pobrano ze zwłok obu płci (30 męskich, 20 żeńskich) w wieku od 16 do 81 lat. Lewy przedsionek, żyły płucne i oskrzela główne nastrzykiwano 65% roztworem Duracrylu, a następnie wytrawiano w kwasie siarkowym. Otrzymane preparaty badano, oceniając typy powstawania żył płucnych górnych.

Wyróżniono 3 główne typy tworzenia żyły płucnej górnej prawej: typ drzewkowaty — 60%, typ krzaczkowaty — 32% oraz typ pośredni — 8%. W każdym z nich

wyodrębniono również liczne warianty. Żyły płata środkowego uchodzą w 80% przypadków do żyły płucnej górnej, natomiast w 20% odpływają bezpośrednio do lewego przedsionka. W przebiegu żyły płucnej górnej lewej wyróżniano 3 typy oraz 15 wariantów.

Obserwowano znacznie większą zmienność w powstawaniu żyły płucnej górnej lewej niż żyły płucnej górnej prawej. Zauważono również istotne statystycznie zróżnicowanie w częstości występowania poszczególnych wariantów w danym typie w płucu prawym i lewym.