

VARIATION IN NUMBER AND DRAINAGE PATTERN OF PULMONARY VEINS DRAINING INTO THE LEFT ATRIUM

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ABSTRACT

Pulmonary veins carry oxygenated blood from the lungs to the left atrium of the heart. The variation in the number and drainage pattern of pulmonary veins is frequent and this knowledge is valuable for various procedures involving the pulmonary veins. The present study is done on 29 hearts obtained from formalin fixed cadavers from the dissecting room of department of anatomy, MAMC, Agroha, Hisar. The left atrium of these hearts was studied from external aspect for the number of pulmonary veins draining into left atrium and from internal aspect for the drainage pattern. In 13 out of 29 hearts (44.8%), variation in number of pulmonary vein was observed. In the present study the most common variation of right pulmonary veins is three veins with two ostia (10.3%) and the most common variation of left pulmonary veins is a single vein with a single ostium (17.2%). The variations of pulmonary veins are quite common with an equivocal variability in right-sided and left-sided drainage patterns. A classification is proposed to describe these variations to facilitate communication with referring clinicians.

Key words: Pulmonary veins, Pulmonary ostia, Drainage pattern, Left atrium

INTRODUCTION

Usually four pulmonary veins (PV), two from each lung return oxygenated blood to the left atrium and open into it via 2 separate pulmonary ostia (PO), on either side¹. Variations in number and drainage pattern are often observed but have gained a little attention. Though knowledge of these variations is valuable in cardio-thoracic surgeries and radiological procedures such as radiofrequency ablations in atrial fibrillation, cardiac valve replacements, pulmonary lobectomy and others, but literature regarding these variations is scarce, although a few radiological studies are available. Postmortem is arguably the best standard for such type of study, but such data are rarely available². Therefore, the present study is done on the cadavers with the following aims:

1. To find the number of hearts with variation in number of PV, irrespective of side, draining into the left atrium.
2. To find the variations in number of right and left PV draining into the left atrium.

MATERIAL AND METHOD

The present study is done on 29 hearts obtained from the formalin fixed cadavers of the dissecting room of

the department of Anatomy, MAMC, Agroha. The number of right PV and left PV were seen, close to the heart, from the external aspect. Left atrium of these hearts was opened by giving a midline incision along the whole length of its posterior wall, to study the drainage pattern of PV.

RESULTS

In 13 out of 29 hearts (44.8%) variation in number of PV was observed. These variations were either on the right side or on the left side of left atrium and none of the hearts showed variation in both right PV and left PV simultaneously.

On the right side the most common variation in the number of PV observed is 3 PV (17.2%), followed by 1 and 4 (3.4% each); while on the left side it is 1PV (17.2%), followed by 3PV (3.4%) (Table I).

The most common variation in the drainage pattern of the right PV is 3 PV with 2 PO (10.4%), followed by 3 PV with 3 PO (6.9%), 4 PV with 4 PO and 1 PV with 1 PO (3.4% each) (Fig 1). The most common variation in drainage pattern of the left PV is 1 PV with 1 PO (17.2%), followed by 3 PV with 2 PO (3.4%) (Fig 2).

The normal pattern of 2 PV with 2 PO is reported only in 75.9% and 79.2% of hearts, on the right and left side respectively.

DISCUSSION

Variation in the number of pulmonary vein ostia in the left atrium was thought to be rare³, and until recently was a subject of only case reports^{4,8}. Recently,

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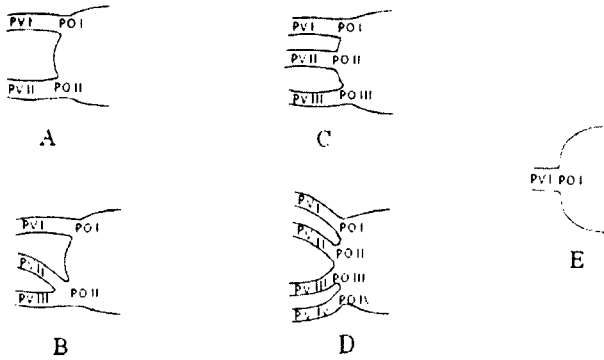


Figure 1- Drainage pattern of right pulmonary veins
Figure 1 shows schematic drainage patterns of the right PV

- A- Shows two PV with two separate ostia (75.9%)
- B- Shows three PV with two separate ostia (10.3%)
- C- Shows three PV with three separate ostia (6.9%)
- D- Shows four PV with four separate ostia (3.4%)
- E- Shows single PV with single ostia (3.4%)

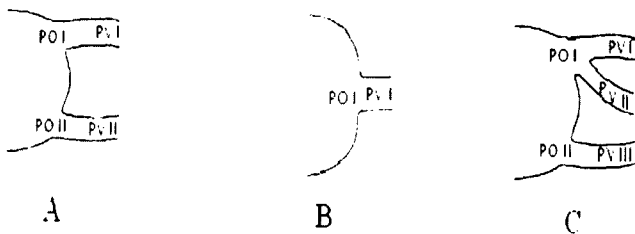


Figure 2- Drainage patterns of left pulmonary veins
Figure 2 shows schematic drainage patterns of the left PV:

- A- Shows two PV with two separate ostia (79.2%)
- B- Shows three PV with two separate ostia (3.4%)
- C- Shows single PV with single ostium (17.2%)

Table 1 shows the number of pulmonary veins draining into the left atrium

	Right				Left			
	1	2	3	4	1	2	3	4
Number of PV	1	2	3	4	1	2	3	4
Number of hearts	1	22	5	1	5	23	1	-
Percentage	3.4	75.9	17.2	3.4	17.2	79.3	3.4	-

Table II Comparison of drainage pattern of right pulmonary veins

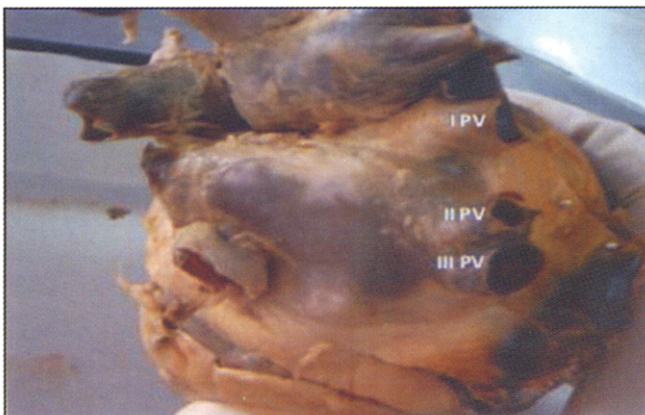
Number of PV	Number of Ostia	Marom et al ²	Present study
		Percentage	Percentage
2	2	50	75.9
3	2	21	10.3
3	3	24	6.9
1	1	2	3.4
4	4	3	3.4
6	5	1	-

Table III Comparison of drainage pattern of left pulmonary veins

Number of PV	Number of Ostia	Marom et al ²	Present study
		Percentage	Percentage
2	2	86	79.3
1	1	14	17.2
3	2	-	3.4

Table IV Suggested classification of drainage pattern of PV, based on number of PV and PO

Right/Left	Type
Type I	1 PV with 1 ostium
Type II A	2 PV with 2 ostia
Type II B	2 PV with 1 ostium
Type III A	3 PV with 3 ostia
Type III B	3 PV with less than 3 ostia
Type IV A	4 PV with 4 ostia
Type IV B	4 PV with less than 4 ostia
Type V A	5 PV with 5 ostia
Type V B	5 PV with less than 5 ostia



Photograph 1 : Three right pulmonary veins



Photograph 2 : Single left pulmonary vein

however, variations in pulmonary venous anatomy were reported in 36% of patients⁹ and ectopic beats could arise from these anomalous veins¹⁰. It was observed that this greater than expected variability in pulmonary venous anatomy could alter the success of procedures like radiofrequency ablation of arrhythmias/fibrillation, as ectopic foci may go untreated in variant veins².

Very few workers have studied the variations and drainage patterns of pulmonary veins in cadavers. Ho et al reported a single ostium for pulmonary veins in 6 out of 26 hearts, in a cadaveric study¹¹. Marom et al studied the anatomy of pulmonary veins in 201 patients by using Computer Tomography². They reported 3-5 ostia on the right side in 26% patients; and 14% patients had a single ostium on the left side. In the present study 3 ostia on right side were observed in 6.9% hearts, 4 ostia in 3.4% hearts and a single ostium in 3.4% hearts. On the left side, a single ostium was observed in 17.2% hearts. Thoracic surgeons should be aware of these variations and meticulous intraoperative confirmation of pulmonary venous anatomy is required when using endoscopic devices¹². According to Marom et al, the most common drainage pattern was 2 pulmonary veins each on right and left side with 2 separate ostia², coinciding with the present study (Table II and III). The second common pattern on the right side as reported by Marom et al is 3 pulmonary veins with 3 ostia (24%) 2, whereas, in our study it is 3 pulmonary veins with 2 ostia (10.3%) (Table II). The second most common pattern on the left side was a single pulmonary vein with a single ostium (14%) as reported by Marom et al². In the present study also the second most common pattern is a single pulmonary vein with a single ostium (17.2%) (Table III). The results of the present study show that 3 or more ostia are a more common variation on the right side (Picture 1), whereas on the left side, a single ostium is more common (Picture 2), this coincides with the findings of Marom et al².

A classification is suggested based on the number of PV and number of PO in the left atrium, on right and left side separately, which will be helpful for the clinicians to evaluate the anatomy of pulmonary veins prior to or during any procedures involving these veins and will also facilitate communication regarding the pulmonary veins with their co-workers. Depending upon number of PV it may be classified into Type I to Type V; and if the number of PO is equal to the number of PV it may be categorized into A subtype; and if the number of PO is less than the number of PV, then it may

be categorized into B subtype (Table IV).

These variations of the PV can be explained on the embryological basis. Initially, a single common PV develops as an outgrowth of the dorsal atrial wall. As the atrium expands the primordial PV and its main branches are gradually incorporated into the wall of the left atrium. As a result, four PV are formed¹³. Possibly, the number of PV opening into the left atrium can vary depending on the extent of incorporation of the branches of the common PV.

We conclude that there is substantial variation in number and drainage pattern of pulmonary veins and these variations should not be undermined by the radiologist and thoracic surgeon prior to or during various procedures which directly or indirectly involve the pulmonary veins (radiofrequency ablations, lobectomies, valve replacements, pulmonary vein catheterization and others).

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