

# Variations in the number of pulmonary veins draining into left atrium and its clinical significance

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## ABSTRACT

**Background:** Pulmonary veins, normally two on each side bring oxygenated blood from lungs to left atrium. During early embryonic life, absorption of pulmonary venous network by the left primitive atrial chamber results in opening of four pulmonary veins which drain independently into its chamber. The extent of absorption and hence, the number of pulmonary veins which open into left atrium may vary.

**Objective:** The study was done to observe the variation in the number of pulmonary veins opening in the left atrium.

**Materials and method:** The present study was done on 30 formalin fixed hearts of unknown age and sex which were obtained from the department of anatomy, Government medical college, Chandigarh. These hearts were observed for the variations in pulmonary ostia on right and left sides and were compared on both sides and also with the earlier data.

**Results:** In 8 (26.67%) out of these 30 hearts, variations were observed in the number of pulmonary veins and ostia either on one side or on both sides of the left atrium. 22 hearts (73.33%) out of 30 hearts had normal pulmonary veins which opened into left atrium via two separate pulmonary ostia, on either side.

**Conclusion:** Knowledge of number of pulmonary veins and their ostia locations is important to ensure that all ostia are ablated, as ectopic foci may go untreated in variant veins.

**Keywords:** pulmonary veins, pulmonary ostia, cardiac arrhythmias, atrial fibrillation, ectopic beats

## Introduction

Pulmonary veins are responsible for bringing the oxygenated blood from lungs to left atrium. Usually four pulmonary veins, two from each lung return oxygenated blood to the left atrium and opens into it via two separate pulmonary ostia on either side. [1] The pulmonary vein develops around the embryonic day 24, at the sinoatrial region which is left to the septum primum. [2] Significant anatomic variability in the number of ostia opening into left atrium has been documented. [3] Earlier, it was considered that the variations in the number and course of pulmonary veins were rare and they were confined only to few reports. [4] Recently, however, it has been found that variations in pulmonary venous anatomy were seen in 36% of patients [5] and they were one of the etiologies for ectopic heart beats. [6] The major sources of these ectopic beats appear to be the myocardial sleeves

of the distal pulmonary veins which are simple extensions of the left atrial myocardium over the outer surface of pulmonary veins. [7,8] This is the reason why they became a target of interventional cardiology procedures such as catheter radiofrequency pulmonary vein isolation. [9,10] Hence, anatomy and morphology of pulmonary veins are crucial for planning and performing invasive procedures by electrophysiologists and surgeons. [11] The present study was planned to observe the variation in the number of pulmonary veins opening in the left atrium because these may help in interventional procedures done by the clinicians.

## Materials and methods

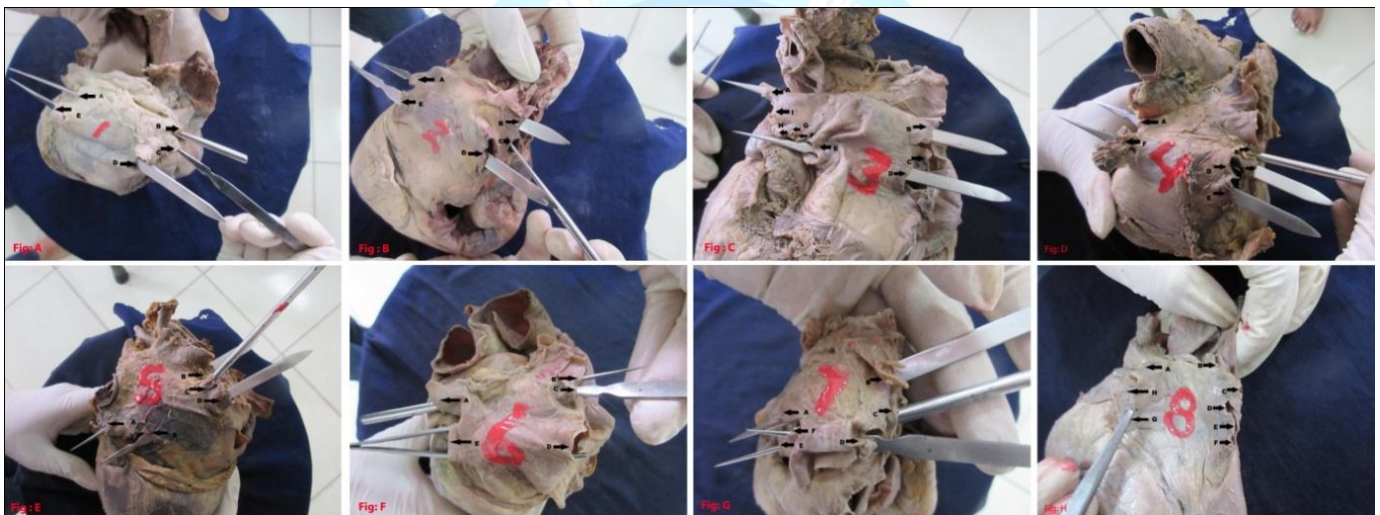
The present study was done on 30 formalin fixed normal size adult hearts of unknown sex which

were obtained from the department of anatomy, Government medical college, Chandigarh. Left atria of these hearts were studied from external aspect, for the variation in the number of pulmonary veins which drained into it. The hearts having severe anatomical defects, hearts on which surgery has been done were not included. The hearts with grafts, heart trauma and were also not included. The clearance for the study was obtained from the ethical committee of the institute. Variations in the pulmonary ostia on right side as well as on left side were observed, noted down and photographed. Percentage of variations found on right and left side was calculated. Percentage of most common variation on both the sides was also calculated. Then the present study was compared with the available data.

**Results**

22 hearts (73.33%) out of 30 hearts had normal pulmonary veins which opened into left atrium via two separate pulmonary ostia, on either side. In 8 (26.67%) out of these 30 hearts, variations were observed in the number of pulmonary veins and ostia either on one side or on both sides of the left atrium.

In the present study, 7 hearts (23.33%) showed variations in the number of pulmonary veins on right side, 3 hearts (10%) presented variations in the number of pulmonary veins on left side while 2 hearts (6.67%) presented variations in the number of pulmonary veins on right as well as left side simultaneously as seen in the figure 1.



**Fig. 1 Pulmonary veins on left side and right side**

The most common variation on right side in the number of pulmonary veins observed was 3 pulmonary veins (13.33%), followed by 4 pulmonary veins (6.67%) and 5 pulmonary veins (3.33%). In contrast to the right side, these

variations were less common on left side. In 3.33% of the hearts 3 pulmonary veins and in 3.33% of hearts 6 pulmonary veins were observed as shown in the table I.

**Table 1: Number of hearts showing variation and percentage**

No. of pulmonary veins	Right side				Left side				
	2	3	4	5	2	3	4	5	6
No. of hearts	1	4	2	1	5	1	0	0	1
Percentage	3.33%	13.3%	6.67%	3.33%	16.67%	3.33%	0	0	3.33%

The variation in the right side is found in 8/30(26%) cases while on left side variation was present in 7/30(23%) cases so the variation is more common on right side. Variation in number on both side were present in 3/30(10%). The maximum number of veins found on left side was 5 as compared to 6 found on right side.

### Discussion

The smooth surface of the wall of the left atrium is formed by the incorporation of the primordial vein, which develops as an outgrowth of the dorsal atrial wall just lateral of the septum primum in the sinoatrial region. As the left atrium expands, the primordial vein and its main branches are incorporated into the wall and, as a result, four pulmonary veins are formed.<sup>[12]</sup>

It has been demonstrated that the presence of p cells, transitional cells and purkinje cells present in pulmonary veins are specialized conduction cells that contribute to the observation of electrical activity within the musculature.<sup>[13]</sup> Approximately 70% of the general population has four pulmonary veins: right superior & inferior and left superior & inferior veins with four pulmonary independent ostia.<sup>[2]</sup> Super numery or accessory pulmonary veins with their own ostia occur by over incorporation of the pulmonary veins beyond their first division and such variations are usually found on the right side. Very few workers have studied the variations and drainage patterns of pulmonary veins in cadavers.

In a cadaveric study conducted, 16% of the hearts showed a single ostium for pulmonary veins.<sup>[14]</sup> The pulmonary vein and its drainage orifices were divided into 6 patterns on the right side & 2 patterns on the left side.<sup>[5]</sup> In a study conducted by Parsanna et al, 28% cases showed variable pulmonary vein on right side and only 6% showed variation on left side. There were 14% specimens with a single ostium on right side & 6% specimens had 1 venous ostium on the left side. A case of one pulmonary ostium on left side & three pulmonary ostia was reported.<sup>[15]</sup> It was found that present

study was comparable with the earlier studies. The presence of a middle pulmonary vein has been found to produce an increased frequency of cardiac arrhythmias, atrial fibrillation being the most common.<sup>[16]</sup> This arrhythmia is a cause of significant morbidity and mortality, with the highest risk being sudden cardiac death through heart failure.<sup>[6]</sup> The ectopic beats arising from the anomalous veins can give rise to thrombo-emboli and embolic stroke. Furthermore, atrial fibrillation has been shown to result in atrial remodeling by impacting atrial size.<sup>[13]</sup>

Knowledge of number of pulmonary veins and their ostia locations is important to ensure that all ostia are ablated, as ectopic foci may go untreated in variant veins. The knowledge of pulmonary vein anomaly could also play a role in new balloon based ablation technology research and development.

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