

Study of Anatomical Variations of Number of Pulmonary Veins and its Clinical Significance

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ABSTRACT

Introduction: The pulmonary veins play an important role in the pulmonary circulation by receiving oxygenated blood from the Lungs and delivering it to the left atrium. Pulmonary vein anatomy piqued curiosity of researchers off late after the discovery of its role in genesis of atrial arrhythmias and increased incidence of pulmonary hypertension in COPD. The congenital variations in number of pulmonary veins and their drainage patterns, encompass a wide spectrum of anomalies and are not uncommon in general population. The aim of the study was to observe the variations in the number of pulmonary veins and pulmonary ostia.

Material and Methods: The present study was done on 25 formalin fixed hearts aged 18-70 years, obtained from the department of anatomy, Sri Padmavathi Medical college for women, Tirupathi. These hearts were observed for the number of pulmonary veins, their drainage into left atrium, variations in pulmonary ostia on right and left sides and were compared with previous studies.

Results: Out of the 25 specimens studied, 23 hearts (92%) had normal pattern of four pulmonary veins, two from each lung extending to the left atrium and opening into it via two separate pulmonary ostia, on either side. In 2 (8%) out of 25 specimens, variations in the number of pulmonary veins and the pulmonary ostia were observed.

Conclusion: The awareness of the variant anatomy of pulmonary veins and their drainage is of paramount importance to Radiologists, Electrophysiologist and Cardio thoracic surgeons while performing surgical procedures on Heart.

Keywords: Pulmonary Veins, Pulmonary Ostia, Atrial Arrhythmias

INTRODUCTION

The pulmonary veins are phylogenetically recent structures that form independently, rather than taking over portions of the older cardinal vein systems. The pulmonary vein develops as an outgrowth of the dorsal atrial wall, just to the left of the septum primum.¹ From each lung, venous drainage channels converge until they ultimately form a single large common pulmonary vein, which drains into the left atrium of the heart. As the atrium expands, the common pulmonary vein becomes incorporated into its wall. Ultimately, the absorption passes the first and second branch points of the original pulmonary veins, with resulting entry of four independent pulmonary veins into the left atrium.^{1,2,3} Typical anatomy described above is found in 70-80% of patients.^{4,5,6} Variant configurations are described in literature which are more common on the right side and include a spectrum

ranging from presence of a common draining trunk of left superior and inferior pulmonary veins, presence of accessory (additional pulmonary veins) to rarely total anomalous pulmonary venous return (TAPVR) where they drain in to systemic veins or right atrium. Various studies revealed that variant anatomy of pulmonary veins is present in 10-20% of population.⁴⁻⁸ Anomalous pulmonary vein drainage is one of the treatable causes of pulmonary hypertension in adults.^{2,3} Despite popular notion that the anatomical variations of pulmonary veins and their ostia are rare, several recent studies have emphasized their role in higher incidence of atrial arrhythmia and are reported to be more common than anticipated. In existent literature limited data is available on variant anatomy of pulmonary veins, studies are mostly radiological, which warrants the further need for cadaveric studies.

The aim of the present study was to observe the number of pulmonary veins and its orifices on each side and to compare these findings with previous studies.

MATERIAL AND METHODS

The present study was done on 25 formalin fixed hearts aged 18-70 years, obtained from the Department of anatomy, Sri Padmavathi Medical college for women, Tirupathi.

Inclusion criteria

25 formalin fixed hearts aged 18-70 years

Exclusion criteria

1. Hearts with severe anatomical defects
2. Hearts which underwent surgery
3. Hearts of pediatric age group

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4. Hearts with previous traumatic sequelae, with grafts were excluded from the study.

The hearts with severe anatomical defects, hearts which underwent surgery of any sort, hearts with grafts, heart with traumatic sequelae and were excluded from the study. The hearts were observed insitu and then removed by routine dissection method and subjected to morphological analysis. The ethical committee approval from the institute and consent of the relatives were obtained. The left atrium of these hearts was studied from external aspect for the variations in the number of pulmonary veins, the orifices and the drainage in to left atrium was observed. A midline vertical incision was made along the whole length of the posterior wall of the left atrium and chamber is opened to observe the pulmonary ostia with respect to their number, and orientation/location and the observations were recorded and photographed. The number of pulmonary veins, the Percentage of variations on both sides Right & Left side was calculated. The most common variation observed was noted and the percentage was calculated and the data was compared with the earlier studies.

RESULTS

Out of 25 specimens studied, 23 specimens specimens (92%) had normal presentation of four pulmonary veins, two from each lung which extended to the left atrium and drained into it on either side via two separate pulmonary ostia. In 2 (8%) out of 25 specimens, variations in the number of pulmonary veins and the pulmonary ostia were observed on left side. In the present study all the heart specimens on Right side showed normal number of pulmonary veins & their ostia and had a normal drainage pattern into left atrium. All the hearts studied showed normal orientation of pulmonary ostia, superior ostia being directed upwards and laterally and the



Figure-1: Photograph showing absent Left superior pulmonary vein



Figure-2: Photograph showing absent Left inferior pulmonary vein
 Rt SPv: Right Superior Pulmonary vein
 Rt IPv: Right Inferior Pulmonary vein
 Lt SPv: Left Superior Pulmonary vein
 Lt IPv: Left Inferior Pulmonary vein

No. of pulmonary veins	No. of pulmonary Ostia	Right side		Left side	
		No of cases	Percentage	No of cases	percentage
2	2	25	100%	23	92%
1	1	0	0	2	8%

Table-1: Observations of number of Pulmonary veins

Cadaver number	Right side	Left side	Remarks
Cadaver number 1	Normal pattern of 2 pulmonary veins and ostia draining into left atrium	Single inferior pulmonary vein with a single ostium on the left. Absent superior pulmonary vein noted.	The ostia of the pulmonary veins had normal orientation directed backwards and laterally
Cadaver number 2	Normal pattern of 2 pulmonary veins and ostia draining into left atrium	Single superior pulmonary vein with a single ostium on the left. Absent inferior pulmonary vein noted.	

Table-2: observations of variant anatomy of pulmonary veins

No.of Pulmonary Veins	No.of Pulmonary Ostia	Marom et al ⁴	Lovesh Shukla et al ⁵	Daksha dixit et al ⁶	Sabah et al ⁷	Present study
2	2	86	79.3	63.3	82.9	92%
1	1	14	17.2	21.6	12.1	8%

Table-3: Comparison of drainage pattern of Left Pulmonary Veins (percentage of cases observed)

inferior pulmonary ostia oriented to backwards and laterally (table-1).

Following variations were recorded in our study: Two specimens (8%) had a single pulmonary vein with a single ostium on the left side and two pulmonary veins on Right side of the left atrium (table-2).

Overall, in our study, 92% of hearts had a normal number and drainage pattern of pulmonary veins, the most common variation observed was in the number of pulmonary veins on left side was a single pulmonary vein (8%) as depicted in Figure 1 & 2.

Figure 1 depicts heart specimen with normal pattern of 2 pulmonary veins and 2 ostia draining into left atrium on Right side and on the left side Single inferior pulmonary vein connected to the left atrium via single ostium directed laterally and backwards, the superior pulmonary vein was conspicuously absent.

Figure 2 demonstrated heart specimen which on the left side Single superior pulmonary vein draining in to left atrium via single large ostium directed laterally and downwards, with absent inferior pulmonary vein. On Right side all the specimens showed normal number & drainage into left atrium.

DISCUSSION

Usually four pulmonary veins drain into the left atrium through separate openings i.e. the left superior and inferior and the right superior and the inferior pulmonary ostia and this is seen in about 70-80% of general population.

Marom EM et al in 2004⁴, categorised the pulmonary veins and its ostia into 6 patterns on the right side and 2 patterns on the left side. In his study, the most common drainage pattern was two pulmonary veins, each on right and left side, with two separate ostia [71% on right side & 86% on left side]. The presence of one pulmonary vein and one ostium was noted in 2% on right side and 14% on Left side. In his study variations in the right pulmonary vein drainage were more common than those on the left side, which differed from the findings of in the present study in which, 8% showed variations in the left pulmonary veins and all the on the right side had normal number and drainage pattern. No Accessory pulmonary veins or ostia were observed in the present study (table-3).

The variational anatomy observed in the present study was single pulmonary vein and single ostium on left side which was reported in earlier studies as, 17.2% by Lovesh Shukla et al⁵ with variant anatomy on left side, daksha dixit et al⁶ had 21.6%, 23.5% by Rajguru⁸, 11% by Prasanna et al⁹ and 12.1% by Sabah et al⁷ had one pulmonary vein and one ostium which were in concordance with the present study.

CONCLUSION

Variant anatomy of pulmonary veins and its ostia is considered as one of the harbingers of atrial arrhythmogenic pacemakers which require Radiofrequency ablation. Detailed knowledge of pulmonary venous anatomy and their relationship to the left atrial wall is of cardinal significance for mapping

and ablation of these foci. However, the differences in the variations in number & drainage pattern with respect to previous studies may be attributed to the genetic factors, ethnicity, geographical conditions and large scale studies are needed to appraise the prevalence of variant anatomy in general population. The awareness of the variant anatomy of pulmonary veins and their drainage is of fundamental importance to radiologists, electrophysiologist and cardio thoracic surgeons while performing surgical procedures on heart.

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