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CASE REPORT

Anatomical Variation in the Number of Pulmonary Vein Ostia Draining into the Left Atrium: A Case Report

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ABSTRACT

Background: Presence of an extra pulmonary ostium found in the left atrium during routine cadaveric dissection. Normally, four pulmonary veins (PV), two from each lung, return oxygenated blood to the left atrium (LA) and open into it through two pulmonary ostia, one on either side, since during embryonic development the primordial pulmonary vein and its principal branches merge with the atrial wall as the left atrium grows, giving rise to the four pulmonary veins. Structural variations can be observed by the degree of incorporation of the branches, thus affecting the number of openings in the left atrium. Clinically, pulmonary veins can trigger foci of electrical activity in atrial fibrillation, occasionally cause disorders like Total Anomalous Pulmonary Venous Return (TAPVR), cause abnormalities in electrical activity of the heart depending upon the number of pulmonary veins draining into the left atrium, and lead to perioperative bleeding during surgical and endoscopic procedures if the patient presents with unknown venous anatomy. Recent research has shown that about 36% of patients may have changes in pulmonary venous architecture, which could be the cause of ectopic cardiac activity.

Method: Regular dissection was performed on an 80-year-old formalin-fixed female cadaver. The left atrium of the heart was studied externally to observe variation in pulmonary drainage pattern. The presence of an extra pulmonary ostium was seen on the left aspect of the left atrium. Tracing it towards the lung architecture showed the remnant structure in the root of the left lung, along with other openings, thus exhibiting one of the five different drainage variations explained in previous studies.

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Discussion: The number of pulmonary veins draining into the left atrium may range from one to five. In this cadaveric heart, one extra pulmonary vein was found between the left superior and inferior pulmonary veins. A common ostium is most frequently observed among the left-side, whereas an additional pulmonary vein is more commonly identified on the right side. In the cadaver though additional vein was found on the left side rather than the right.

Conclusion: Knowledge of variations in the number and arrangement of pulmonary veins is clinically important, as the pulmonary veins are a major source of ectopic atrial electric activity thus of importance to cardiologists, radiologists and surgeons.

KEYWORDS

• Heart • Pulmonary Veins • Pulmonary Ostia • Drainage Pattern • Left Atrium • Atrial Fibrillation

INTRODUCTION

Normally, pair of two pulmonary veins return oxygenated blood to the left atrium via the pulmonary ostia on each side.[1] Pulmonary veins can act as triggering foci of electrical activity in causing atrial fibrillation. Variations in the quantity and direction of pulmonary veins were previously thought to be uncommon and were mostly documented in isolated case reports. Recent research has shown that about 36% of patients may have changes in pulmonary venous architecture, which could be the cause of ectopic cardiac activity.[2] Ectopic foci which produce atrial fibrillation have been discovered in various locations in the heart – the superior vena cava walls, right and left atria along with their septa, coronary sinus ostium, crista terminalis and extension of muscle sleeve in the pulmonary veins. As a result, the posterior atrial wall with the pulmonary veins have become crucial targets for the intervention.[3]

The mesoderm helps construct the primitive circulatory system throughout the fifth week of embryonic development, with the creation of the pulmonary vein starting on day 24. The primordial pulmonary vein takes its origin from the dorsal wall of the primitive atrium situated lateral to the septum primum in the sinoatrial area.[4] The vein and its principal branches merge with the atrial wall as the left atrium grows, giving rise to the four pulmonary veins.[5] There is an embryological explanation for variations in the number of pulmonary veins. The observed structural variances may be explained by the degree of incorporation of these branches, which may affect the number of pulmonary venous apertures into the left atrium.[6]

The inferior veins are located further posteriorly than their superior counterparts in the superior posterolateral side of the left atrium, where the pulmonary veins empty.[7] The right pulmonary veins commonly travel posterior to their respective venae cavae, and their orifices are smooth and oval.[7] There is often a shared channel through which the left pulmonary veins open.[8] About 10–20% of people have been found to have pulmonary venous anatomical variations[9]; one study found that 36% of individuals had such abnormalities.[7] An anatomical study of 35 heart specimens revealed that only 74% of them had the four pulmonary veins that normally enter the superior posterolateral surfaces of the left atrium. Of the remaining specimens, 17% had five venous orifices and 9% had a long or short common left or right pulmonary venous trunk.[7]

The disposition and variation of the pulmonary veins and their ostia are particularly important during surgical and endoscopic procedures because unexpected venous anatomy may increase the risk of complications such as perioperative bleeding.[7] Clinically important disorders such as total anomalous pulmonary venous return (TAPVR), can occasionally be caused by anomalous pulmonary venous drainage which are also the cause of pulmonary hypertension in adults, a condition which is completely treatable.[9] Abnormalities in the initiation of ectopic atrial electrical activity may result from changes in the number of pulmonary

veins flowing into the left atrium.[10] Cardiac tomography is used to estimate the left atrium wall thickness (LAWT), which is dependent on the observer. The LAWT is thought to be influenced by the quantity and relative location of the pulmonary veins.[11]

MATERIALS AND METHODS

During regular dissection of an 80 year old formalin-fixed female cadaver at the Department of Anatomy, BPSGMC(W), Khanpur Kalan, Sonipat using a regular dissection kit and following instructions written in Cunningham's Manual of Practical Anatomy variations of the pulmonary veins ostia draining into the left atrium and its presence in the root of left lung along with other structures was observed.

A transverse incision was made into the manubrium, inferior to its union with the first costal cartilage to access the thoracic cavity. The parietal pleura was sliced across both intercostal spaces to divide the ribs and the intercostal gaps. The inferior sternum and anterior aspect of the ribs along with their costal cartilages were elevated. The lungs were made to withdraw laterally in order to divide the structures forming their roots in a sequential manner. Next, an incision was made through pleura on each side parallel to the route of the phrenic nerve to reveal the pericardium, superior vena cava on the right, and aortic arch on the left. The manubrium was raised and clavicle separated from its articulation with the acromion process to access the upper mediastinal compartment.[12]

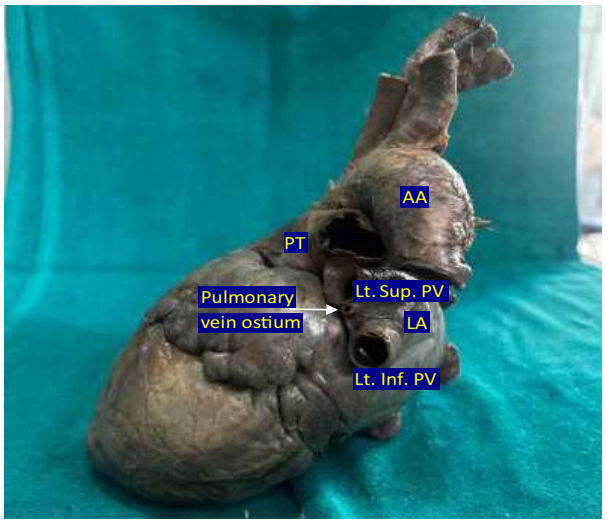


Figure 1A: shows presence of a middle pulmonary vein ostium between left superior and inferior pulmonary veins of the left atrium

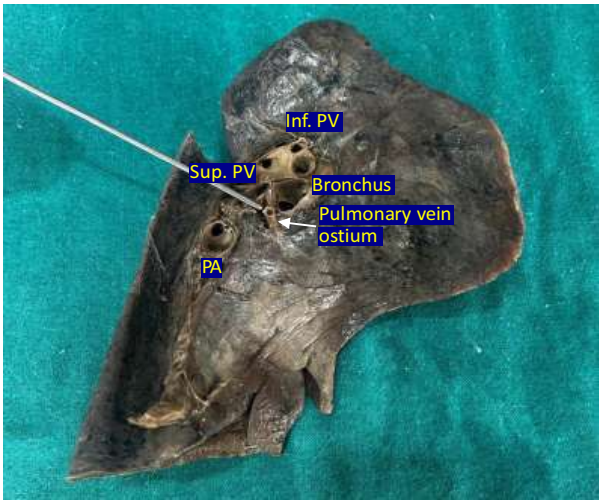


Figure 1B: showing root of left lung with all the anatomically normal structures along with presence of the opening of the extra pulmonary vein.

(AA – Aortic Arch, **PT** – Pulmonary Trunk, **Lt. Sup. PV** – Left Superior Pulmonary Vein, **Lt. Inf. PV** – Left Inferior Pulmonary Vein, **LA** – Left Atrium)

The left atrium was examined for presence of any variations in the number of pulmonary veins, the orifices and the drainage pattern. Presence of an extra pulmonary ostium lying between two left pulmonary veins apart from the normal four ostia was seen entering the left atrium.

Presence of an extra ostium was seen in the root of the left lung of the cadaver which correlated with the opening of a pulmonary ostium of the left atrium located between left superior and inferior pulmonary veins, thus confirming presence of a pulmonary vein variation.

DISCUSSION

Majority of people have two pulmonary veins that empty into the left atrium on either side, which is the normal anatomical configuration observed in 82% people.[2] Variation in the number of pulmonary vein ostia in the left atrium was thought to be rare.[1] Though recent studies exhibited that 36% of patients had abnormalities in pulmonary venous architecture which may be the cause of the ectopic beats.[1] Anomalous connections, anomalous drainages and variances in the number of pulmonary veins – these are the three main categories of pulmonary vein abnormalities.[13] Number of these pulmonary vein ostia draining in the left atrium can range from one to five.[2]

Previous studies conducted on the anatomy of left atrium showed significant variation.[3]

Left sided pulmonary veins are more likely to have a shared ostium while the right side is more likely to have an extra pulmonary vein.[3] In the dissected cadaver the anatomical variation of three left pulmonary veins (superior, middle, inferior) and two right pulmonary veins draining in the left atrium[14] was observed which doesn't coincide with the previous studies.

Two pulmonary veins with two distinct ostia on both the sides were the most prevalent drainage pattern in a study conducted by Marom EM *et al*[15] [71% on the right side & 86% on the left]. One pulmonary vein and one ostium were found in 2% of cases on the right side and 14% of cases on the left.[9,15] In contrast to the variation found in the left atrium of the current study, he found that alterations in the right pulmonary vein drainage were more frequent than those on the left.[10]

A middle pulmonary vein may be linked to a higher incidence of cardiac arrhythmias, the most prevalent of which is atrial fibrillation.[16,17]

CONCLUSION

Since pulmonary veins are a primary source of ectopic atrial electrical activity (especially in individuals with atrial fibrillation) understanding such anatomical variations in number and patterns is therapeutically significant. Therefore cardiologists, radiologists and cardiothoracic surgeons should be aware of these while performing procedures such as radiofrequency catheter ablations and pre-procedural diagnostic imaging.

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