ORIGINAL ARTICLE

Anatomic Study of Number of Pulmonary Veins Draining into the Left Atrium and Their Variations

Archana Narasipuram[1], Mrudula Chandraputula[2], Hajira Fatima[3]

ABSTRACT

Introduction: Pulmonary veins originate from the alveolar capillary plexus and carry oxygenated blood to the left atrium. The fibrous pericardium is perforated by the pulmonary veins and they drain separately in the posterosuperior aspect of the left atrium as the right and left pulmonary veins. From the dorsal atrial wall, primordial vein arises as an outgrowth just to the left of the septum primum. The primordial pulmonary vein and its main branches are incorporated into the wall of the left atrium as the atrium expands and results in the formation of four pulmonary veins. The knowledge of the variations in the pulmonary veins is helpful for endoscopists and also for the surgeons operating for arrhythmias. The aim of the study was to assess the number of pulmonary veins opening into the left atrium and their variations. **Materials and Methods:** The present study was conducted in the Department of Anatomy, Apollo Medical College, Hyderabad. Study design: This study is an observational study; the study material comprised 30 embalmed cadaveric heart specimens of unknown sex. Old and damaged cadaveric heart specimens were excluded from the study. The number of pulmonary veins opening into the left atrium and their variations was observed. The percentage of variations on the right and left side was calculated. **Results:** In the present study, out of 30 heart specimens which were used for the study, four pulmonary veins draining into the left atrium were observed in 26 heart specimens which are a normal pattern. A variation in the number of pulmonary veins opening into the left atrium was observed in only four heart specimens which were of a different pattern. The variation in the number of pulmonary veins in all the four heart specimens was on the right side. **Conclusion**: Knowledge about the variations in number of pulmonary veins is helpful as pulmonary veins are an important source of ectopic atrial electrical activity and can be useful for cardiologists, radiologists, and cardiothoracic surgeons in radiofrequency ablation surgeries.

KEY WORDS: pulmonary veins, ectopic electric activity, ablation surgeries

Introduction

Pulmonary veins originate from the alveolar capillary plexus and carry oxygenated blood to the left atrium. The fibrous pericardium is perforated by the pulmonary veins and they drain separately in the posterosuperior aspect of the left atrium as the right and left pulmonary veins.[1] The number of pulmonary veins may differ due to variable incorporation of the primitive pulmonary vein into the left atrium.[1] The terminal parts of the pulmonary veins are surrounded by atrial myocardium; these areas represent potential accessory reentrant circuits responsible for the initiation or maintenance of supraventricular tachycardia or atrial fibrillation and may be percutaneously ablated.[1] The smoothness of the left atrial wall is attributed to the primordial vein incorporation into the left atrium. From the dorsal atrial wall, primordial vein arises as an outgrowth just to the left of the septum primum.[2] The primordial pulmonary vein and its main branches are incorporated into the wall of the left atrium as the atrium expands and results in the formation of four pulmonary veins.[2] Previously, the variations in the number of the pulmonary veins were considered as rare and they were reported in few case reports.[3] Variations in pulmonary venous anatomy were noticed in 36% of the patients in recent studies.[4] The knowledge of the variations in the pulmonary veins is helpful for endoscopists

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and also for the surgeons operating for arrhythmias. The present study was done to assess the number of pulmonary veins opening into the left atrium and their variations.

Materials and Methods

The present study was conducted in the Department of Anatomy, Apollo Medical College, Hyderabad.

Study design

This study is an observational study. The study material comprised 30 embalmed cadaveric heart specimens of unknown sex. Old and damaged cadaveric heart specimens were excluded from the study. The number of pulmonary veins opening into the left atrium and their variations was observed. The percentage of variations on the right and left sides was calculated.

Results

In the present study, out of 30 heart specimens which were used for the study, four pulmonary veins draining into the left atrium were observed in 26 heart specimens which are a normal pattern. A variation in the number of pulmonary veins opening into the left atrium was observed in only four heart specimens which were of a different pattern. The variation in the number of pulmonary veins in all the four heart specimens was on the right side. There is only one pulmonary vein on the right side of the left atrium in three specimens [Figure 1a and b]. In one specimen, it appeared as if the two pulmonary veins fused to form a single opening [Figure 2]. One specimen showed four openings on the right side and two openings on the left side [Figure 3].

It was observed that the variations in the number of pulmonary veins were more common on the right side than on the left side.

Discussion

The pulmonary veins are responsible for carrying oxygenated blood from the lungs to the left atrium of the heart. The pulmonary veins differ from the other veins in the body that usually carries deoxygenated blood from rest of the body to the heart. Humans have four pulmonary veins, right pulmonary veins as right superior and right inferior and left superior, and left inferior veins. Initially, the dorsal wall of the left atrium receives a single large pulmonary vein.[5] The right and left pulmonary veins are the branches from the main pulmonary vein and each branch further divides into upper and lower branches. Hence, dorsal

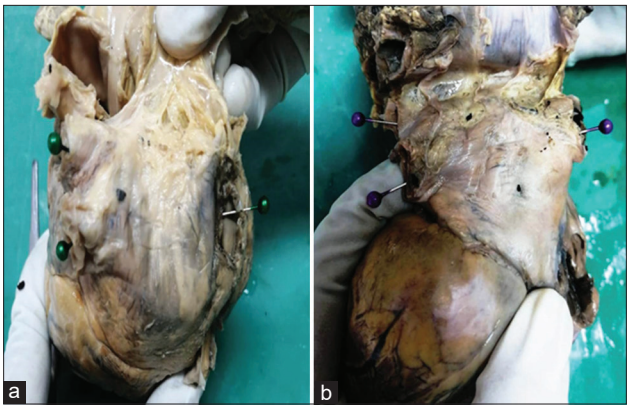

Figure 1: (a and b) A single pulmonary vein on the right side

Figure 2: Single pulmonary vein on the right

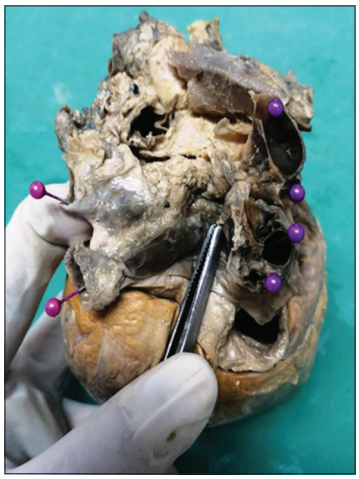

Figure 3: Four pulmonary veins on the right

wall of the left atrium is formed by the incorporation of four pulmonary veins into the atrium.[5] Incorporation of the pulmonary veins beyond their first division results in the development of supernumerary or

accessory pulmonary veins and such variations are usually found on the right side.[6] In the present study, 10% of specimens showed a single pulmonary vein on the right side and 3% of the specimens showed four pulmonary veins on the right side. Similarly, in a cadaveric study conducted by Parsana *et al*., single pulmonary vein on the right side was observed in 14% of the specimens and four pulmonary veins in 4%. In a study conducted by Kaur *et al*., three pulmonary veins were found in 13.3% specimens and four pulmonary veins in 6.67% and 5 pulmonary veins in 3.3%. In a study conducted by Simriti and Rekha,[7] single pattern of pulmonary veins was seen in 20% hearts, double pattern observed in 66.6% hearts, and triple pattern was seen in 13.3% hearts on the right side. About 10% showed variations in the right in a study by Mondal and Sengupta.[8] Most of the previous studies are similar to the present study.

Study	Variations in the right pulmonary veins (%)	Variations in the left pulmonary veins (%)
Simriti and Rekha	33.33	33.33
Kaur *et al*.	23.33	10
Mondal and Sengupta	10	10
Present study	13.3	-

The development of venous system is complex and it results in various congenital pulmonary venous abnormalities. Development of the common pulmonary vein begins around the 24th day of gestation, at the sinoatrial region which is to the left of the septum primum.[9] The common pulmonary vein becomes incorporated into the left atrium and connections to the systemic veins are lost. This is the reason for the usual arrangement of four pulmonary veins draining into the left atrium, due to separation of the systemic and pulmonary venous systems.[9] In anatomical terms, pulmonary venous anomalies are also known as anomalous connections, anomalous drainages, or abnormal numbers of pulmonary veins.[10]

The variations in the number of pulmonary veins opening in to the left atrium may have an influence on initiating ectopic atrial electrical activity. Identifying pulmonary venous anomalies are an important factor that helps the surgeons approach toward the therapeutic intervention. The study also emphasizes on pre-procedural imaging of the left atrium and pulmonary veins before performing any interventional endoscopic procedures.

Knowledge about these pulmonary vein variations is useful for researchers, cardiologists, radiologists, and surgeons involved in a variety of endovascular and surgical techniques for invasive therapy of patients with atrial fibrillation which can utilize the information related to variations in pulmonary vein opening into the left atrium.

Conclusion

Knowledge about the variations in number of pulmonary veins is helpful as pulmonary veins are an important source of ectopic atrial electrical activity and can be useful for cardiologists, radiologists, and cardiothoracic surgeons in radiofrequency ablation surgeries.

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