CASE REPORT

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Anatomical variation of pulmonary veins opening into the left atrium: a case report

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SUMMARY

During a routine cadaveric dissection of the heart, an anomaly was noted while removing the pulmonary veins from the hilum of the lungs. There was a singular pulmonary vein found on the left side draining into the left atrium and three pulmonary veins, a superior, middle, and inferior, on the right side draining into the left atrium. This was confirmed by examination of the hilum of the lungs. Understanding the formation, termination, and relationships of the pulmonary veins is crucial for cardiologists, because they tend to be the major trigger in atrial fibrillation (Tsao et al., 2001). The anatomical variations in pulmonary veins also have the capability of producing associated ectopic beats, leading to the formation of, and possibly a higher incidence of, cardiac arrhythmias, most commonly, atrial fibrillation (Marom et al., 2004). The anomaly could therefore be identified as an isolated source for a patient presenting with such arrhythmia. An indication of treatment for arrhythmias is cardiac ablation therapy (Thorning et al., 2010). Knowledge of any anatomical variants would be essential to successful treatment.

Key words: Pulmonary vein – Pulmonary vein anomaly – Atrial fibrillation – Cardiac ablation

INTRODUCTION

During the fifth week after conception, the embryonic period begins. The mesoderm will give rise to the primitive circulatory system. The formation of the pulmonary veins takes place during this time, around day 24 (Prasanna et al., 2014). The smooth surface of the wall of the left atrium is formed by the incorporation of the primordial pulmonary 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 pulmonary vein and its main branches are incorporated into the wall and, as a result, four pulmonary veins are formed (Moore et al., 2012).

The histology of the pulmonary venous vasculature is separated into three layers. The innermost layer is comprised of a thin endothelium. The intermediate layer is an extension from the myocardial sleeve composed of blood vessels, collagen, and elastic fibers (Cabrera et al., 2002). The medial layer of these vessels contain layers of connective tissue and smooth muscle cells. This specialized conduction tissue, derived from the heart tube and destined to have pacemaker activity, is located within the myocardial sleeves of the pulmonary veins. The circular orientation of these layers allow for the contraction and relaxation of the vessels, changing the diameter of the lumen (Calkins et al., 2007). Furthermore, 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 (Calkins et al., 2007).

Significant anatomic variability in the number of ostia opening into the left atrium has been documented (Karim et al., 2009). However, through research, it was determined that the finding of a

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singular pulmonary vein on the left and three on the right has not been previously reported. Exact formation, location, and electrical activity of these anomalies are therefore significant in the cardiothoracic surgery field when arrhythmias are present and ablation therapy is initiated.

MATERIALS AND METHODS

A routine cadaveric dissection of a sixty-five-year-old, eighty-kilogram Caucasian male was performed following *Gray's Dissection Guide for Human Anatomy* (Tank and Boileau Grant, 2009). During dissection of the thorax and removal of the attachments of the great vessels, it was noted that there was only one pulmonary vein on the left side and three noted on the right. Further inspection and dissection of the lungs confirmed the pulmonary vein anomaly.

RESULTS

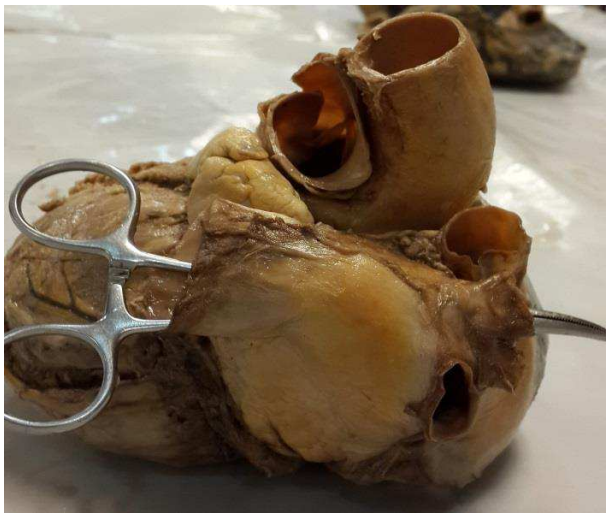

Fig. 1. Posterior view. Single left (L) pulmonary vein. Three right (R) pulmonary veins: inferior, middle, and superior.

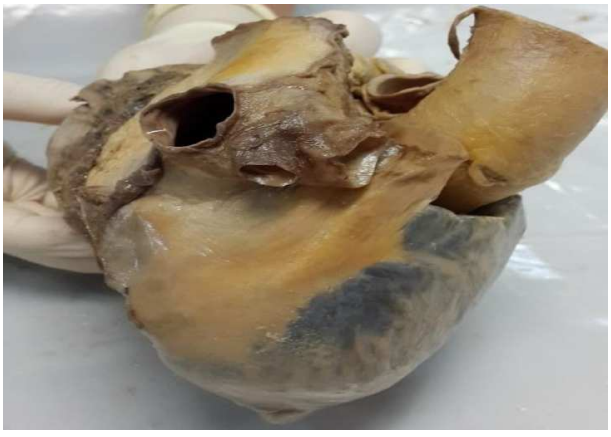

Fig. 2. Right/Posterior view. Single left (L) pulmonary vein. Right (R) inferior, right (R) middle, and right (R) superior pulmonary veins.

The variability discovered on dissection was a single pulmonary vein on the left side with a patent ostium leading to the left atrium. On the right side, a middle pulmonary vein was noted. Therefore, three, right inferior, middle, and superior, pulmonary vein patent ostia opened into the left atrium. (Figs. 1, 2).

DISCUSSION

The anatomical variant of three pulmonary veins on the right, being a superior, middle and inferior, and one pulmonary vein on the left is a rare variation that has not yet been reported. Therefore, this case report serves to show the undocumented anomaly for its clinical importance.

Clinically, several issues can arise with this type of pulmonary vein anomaly. Firstly, the presence of a middle pulmonary vein has been found to produce an increased frequency of cardiac arrhythmias, atrial fibrillation being the most common (Wannasopha et al., 2012). This arrhythmia is a cause of significant morbidity and mortality, with the highest risk being sudden cardiac death through heart failure (Tsao et al., 2001). In addition, research looking at the distribution of musculature between the three-and-one pulmonary vein anomaly could affect reentry arrhythmias (Calkins et al., 2007). Secondly, 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 (Calkins et al., 2007).

Atrial fibrillation, along with anomalous pulmonary vein drainage, is sufficient to produce left ventricular overload and dysfunction. This also leads to atrial remodeling. If chronic, it can lead to impaired myocardial function (Rajeshwari and Ranganath, 2012).

Lastly, variability in pulmonary venous anatomy could substantially alter the success rate of a common cardiac treatment, radiofrequency cardiac ablation (Wellens, 2015). This treatment ablates tissues at the veno-atrial junctions by using radiofrequency energy.

Untreated variants result in a high recurrence of arrhythmic activity (Marom et al., 2004). Therefore, a thorough pre-ablation assessment using contrast MRI or CT cross- sectional imaging, with the size of the section being 2.5mm or less, is necessary to define the pulmonary venous anatomy (Thorning et al., 2010). Knowledge of how many pulmonary veins are present and their ostia locations is important to ensure that all ostia are ablated, as ectopic foci may go untreated in variant veins. Going forward, this knowledge of variant pulmonary vein anatomy could also play a role in new balloon-based ablation technology research and development (Calkins et al., 2007).

In summary, in-depth knowledge of the variations

in pulmonary vein formation and drainage is clinically significant in the field of surgery and cardiology. Continued research into the rare anomaly found with a singular pulmonary vein on the left and three on the right will help improve success rates in the treatment of aberrant conditions involving these structures.

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