A study on pulmonary venous ostia pattern in the left atrium and its clinical applications

1Rajesh S, 2Vijaya Kumar S, 3Manikanda Reddy V
1Assistant Professor, Department of Anatomy, Sree Gokulam Medical College & Research Institute, Trivandrum
2Assistant Professor, Department of Anatomy, Sri Ramachandra Medical College & Research Institute, Chennai
3Assistant Professor, Department of Anatomy, ACSR Government Medical College, Nellore

Abstract
Background & aims: Normally four pulmonary veins open into the left atrium. Frequently there are variations in the number of pulmonary veins opening in to the left atrium. Ectopic beats in atrial fibrillation commonly originates from the ostia of the pulmonary veins. The treatment of atrial fibrillation is by radio frequency ablation of the focus of origin and hence the knowledge of anatomical variation of pulmonary veins is necessary to find the ectopic focus in the origin of atrial fibrillation. Materials and Method: In this study the variation of pulmonary venous ostia pattern in the left atrium was studied in 80 formalin fixed adult cadaveric hearts. Results and Conclusion: 63 hearts showed no variation in the pulmonary venous ostia pattern which accounts for 78.75%, rest of the 17 hearts showed variation in the pulmonary venous ostia which accounts for 21.25%, the variation in the number of pulmonary veins was slightly higher for the left side [11.25%] when compared to the right sided variation [10%], the number of hearts which showed bilateral variation was noted in 2 hearts- both showed a single pulmonary vein opening on either side which accounts for 2.5%

Keywords: atrial fibrillation, ectopic beats, pulmonary venous ostia, pulmonary veins, left atrium

Introduction
The four pulmonary veins open in to the upper postero-lateral surfaces of the left atrium, two on each side. Their orifices are smooth and oval, the left pair frequently opening via a common channel1. Initially a single pulmonary vein opens in to the left half of primitive atrial chamber. Later, during development, the part of pulmonary vein nearest to the left atrium gets absorbed in to the left atrium. As a result four separate veins [two from each side] open in to the left atrium2.

Various anomalies can occur in the anatomy of pulmonary veins [mainly in number of pulmonary veins] depending on the degree of incomplete absorption of pulmonary veins in to the primitive left atrial chamber. With this knowledge, this study was designed to find out the variations in the pulmonary venous ostia pattern which may help in understanding the etiology of some of the diseases associated with such kind of variations.

Materials and Method
This study was conducted in formalin fixed adult cadaveric hearts of unknown sex in the department of Anatomy of Sree Gokulam Medical College, Sri Ramachandra Medical College & ACSR Government Medical College over a period of three years. The study design was a descriptive observational study. The sample size was 80. Only the hearts with intact left atrial chambers were considered in the study. Institutional research committee and ethical committee approval were obtained prior to the study. The number and pattern of pulmonary veins draining in to the left atrium was noted by the authors.

Results
Out of 80 hearts studied 63 hearts were found to be normal without any variation in the pulmonary venous ostia number which accounts for 78.75% of hearts, rest of the 17 hearts showed variation in the pulmonary venous ostia which accounts for 21.25%. The variation in the number of pulmonary veins opening in to the left atrium was slightly higher for the left side [11.25%] when compared to the right side variation [10%], the number of hearts which showed bilateral variation was noted in 2 hearts, both showed a single pulmonary vein opening which accounts for 2.5%.
Table 1: Right and left pulmonary vein distribution pattern

<table>
<thead>
<tr>
<th></th>
<th>Right</th>
<th>Left</th>
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<tbody>
<tr>
<td>Number of pulmonary veins</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Number of hearts</td>
<td>6</td>
<td>72</td>
</tr>
<tr>
<td>Percentage [%]</td>
<td>7.5%</td>
<td>90%</td>
</tr>
</tbody>
</table>

The variations that we have investigated were the number and pattern of the pulmonary venous ostia. We observed the normal 2 vein pattern on each side of pulmonary veins, and also single pulmonary vein [Fig. 1] and triple ostia [Fig. 2]. The pattern is shown in Table 1.

Out of the 80 hearts studied it was found that single pulmonary venous ostia pattern variation was more common than triple pulmonary venous ostia pattern which was noted in 12 hearts [15%] out of which 2 hearts showed bilateral single pulmonary venous ostia. Bilateral variation in the pulmonary venous ostia pattern was rare when compared to unilateral variation. In bilateral variation of pulmonary venous ostia the single pulmonary venous ostia variation was more common. In our study there were two hearts with bilateral pulmonary venous ostia variations, both were found to be having single pulmonary vein bilaterally. None of the hearts showed four pulmonary venous ostia and hence four pulmonary veins opening in one side of left atrium is very rare. While comparing right and left pulmonary veins there is not much difference in the variation pattern and percentage.

Discussion

The variation in the pulmonary venous ostia pattern in the left atrium was found to be quite a common phenomenon which accounts for 21.25% in our study. The knowledge of such variation in the anatomy of pulmonary venous ostia is very important since various pathologies of heart are associated with such variations.

It was found that the pulmonary venous ostium is one of the important sites of origin of ectopic beats in atrial fibrillation. There can be multiple foci of ectopic beats located on the walls of the same pulmonary vein or it can originate from more than one vein, which may be difficult to identify. The ectopic beats in atrial fibrillation may arise from anomalous veins. In a study conducted by Kato et al [2003] it was found that the patients who had atrial fibrillation had larger diameter pulmonary veins than the normal control subjects.

The atrial fibrillation can be treated by medications, pacemaker, surgical procedure, and percutaneous ablation. Radiofrequency ablation procedure is more commonly used for treating atrial fibrillation, due to this reason MRI or CT imaging prior to radiofrequency ablation is required to find the site of origin of ectopic

Fig. 1: Single pulmonary vein ostium - Left side

Fig. 2: Triple pulmonary venous ostia - Right side
beats which may more commonly arise from anomalous pulmonary veins. The ectopic beats originating from the superior pulmonary veins are more common than the inferior pulmonary veins, this is because of the greater extension of myocardial sleeve in to the superior pulmonary veins than the inferior pulmonary veins. This phenomenon helps us to identify the most common and probable location of origin of ectopic beats in case of atrial fibrillation.

Pulmonary venous stenosis is one of the etiologies for hemoptysis, the knowledge of pulmonary venous variations such as single narrow pulmonary vein which may cause hemoptysis should be considered.

In most of the studies it was noted that approximately 70% of the general population has normal anatomy in the pulmonary venous ostia pattern and the rest [approximately 30%] of the individuals have variations in the pulmonary venous ostia pattern. Multi-detector computed tomography [MDCT] is an imaging technique which can be done with or without injecting contrast agent in a live individual for finding anatomical variation of the pulmonary venous ostia pattern.

In some studies it was noted that the right sided variation was more frequent than the left sided variation. In our study there was only a slight difference between the right and left sided variations, left side variations being slightly higher. In the different types of variations single pulmonary venous ostia variation was more common than the triple or more number of pulmonary venous ostia variations.

Conclusion

In this descriptive observational study conducted in 80 formalin fixed adult cadaveric hearts to study the pulmonary venous ostia pattern, it was found that 21.25% of hearts showed variations in the pulmonary venous ostia pattern. The variations are found both unilaterally and bilaterally. Unilateral variations are more commonly found than the bilateral variations. Among the variations single vein variations are more common than triple vein variations. Bilateral variations are found only as single pulmonary venous ostia variant.

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References


Corresponding Author
Dr. Rajesh. S
Assistant Professor, Department of Anatomy
Sree Gokulam Medical College & Research Institute
Venjaramoodu, Trivandrum - 695 607, India.
Mobile : +91 90422 29402
e-mail ID : drrajeshselvaraj@gmail.com