Variations in origin, course and termination of anterior interventricular artery

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Abstract

Background and aims: Coronary arteries are known for their wide variations which are not readily covered in the standard Anatomy textbooks. Unpreparedness about these variations can lead to diagnostic misinterpretations and therapeutic catastrophes. Therefore a thorough knowledge of the coronary anatomy with demographic variations is highly essential. The Anterior interventricular artery or Left Anterior Descending artery is one of the most common site of coronary infarction and has been named as 'the artery of coronary occlusion' and 'the artery of sudden death'. Therefore, this study is focused on the variations of this artery with special reference to its origin, course and termination. Materials and methods: One hundred hearts were studied, using standard methods of dissection. The anterior interventricular artery was dissected out and its origin, course and termination were noted. Results: The anterior interventricular artery originated as a terminal branch from the left coronary artery, descended along the anterior interventricular sulcus and terminated near the apex or up the posterior interventricular sulcus. It terminated anterior to the apex in 12%, 2-5 cm up the posterior interventricular sulcus in 57% and >5cm up the sulcus in 31% cases. Conclusion: The present study contributes to the increasing database of coronary artery variations and would help clinicians in better understanding of coronary anatomy and in better patient management.

Keywords: Left anterior descending artery, LAD, ramus recurvus, myocardial bridges, sinus of Valsalva, anterior coronary artery of Vieuussens

Introduction

The anterior interventricular artery is a terminal branch of the left coronary artery (LCA). It has also been regarded as a continuation of the main trunk of LCA. It emerges behind the left atrial appendage in the anterior interventricular sulcus. It is also known as the 'left anterior descending artery' (LAD), 'anterior coronary artery of Vieuussens', 'descending anterior coronary artery', or the 'anterior division of the left coronary artery'. The term 'anomaly' refers to variations that are seen in less than 1% of the general population. Coronary artery abnormalities are found in 0.2% - 1.2% of the population. Anomalous origins of coronary arteries are found in 1-2% of the population undergoing cardiac catheterization. Failure to recognize these abnormalities may prolong angiography or result in repeat catheterization. Some abnormalities are associated with sudden death, myocardial infarction and angina. With advances in diagnostic and therapeutic procedures, a thorough knowledge of the coronary anatomy and its variations has become essential. Study of the LAD assumes even more importance as it is one of the most common site of coronary infarction and has been named as 'the artery of coronary occlusion' and 'the artery of sudden death'. Hence a detailed analysis of the LAD with regards to its origin, course and termination has been taken up in this particular study which will help clinicians in having a better understanding of the regional variations of this important artery for better management of coronary artery diseases.

Materials & Methods

A total of 100 hearts without any obvious pathology were collected from the departments of Anatomy and Forensic Medicine, Gauhati Medical College after obtaining the necessary ethical clearance. The hearts were collected during the period 2006 to 2009 and studied in the Department of Anatomy, Gauhati Medical College.
and Assam Medical College, Assam. The hearts were preserved in 10% Formalin. Visceral pericardium and subepicardial fat were removed. The coronary arteries and their branches were carefully dissected out and were followed till their termination. Some of the arteries were painted with red fabric colour to enhance contrast and photographed. Relevant data was recorded and compared with similar findings in the literature.

Results and observations

The LAD was found to arise as a terminal branch of the LCA. (Fig.1). No anomalous origin of the LAD was noted in the present study.

The LAD passed downward and left within the epicardial fat of the anterior interventricular sulcus accompanied by the great cardiac vein to reach the acute border near the apex of the heart. In many cases, the LAD was covered by myocardial bridge over part of its course. (Fig.2). Myocardial bridges were more common over the LAD than over other arteries. As the LAD descended along the anterior interventricular sulcus, it gave off branches to the ventricular walls and the interventricular septum.

Reaching the acute border of the heart, the LAD curved around the apical cardiac notch, about 1-3 cm to the right of the cardiac apex and reached the posterior interventricular sulcus.

In majority of cases (57 hearts), the LAD divided into smaller branches just after curving around the acute border and anastomosed with the posterior interventricular artery (PIVA) and the right marginal artery which also reached the apex. (Fig.3). In 31 hearts, the artery proceeded backward along the posterior interventricular sulcus for variable distances before anastomosing with the PIVA. In a lesser percentage of cases (12 hearts), it divided into branches just before reaching the cardiac notch and anastomosed with the terminal ramifications of the PIVA and the right marginal artery. (Fig.4).

Discussion

As described by other authors, the LAD was found to arise as a terminal branch of the LCA. Johnson states that the LAD is a continuation of the LCA. Various anomalies of the LAD origin have been reported including anomalous origins of the LAD from the right sinus of Valsalva (RSV), the right coronary artery (RCA), the pulmonary trunk or directly from the left sinus of Valsalva (LSV).

Anomalous origin of the LAD from the right sinus of Valsalva is a rare abnormality with an incidence of 0.02% to 0.03%. Vlodaver et al. have described two patients where the LAD artery arose from the right sinus or RCA and passed anterior to the right ventricular outflow tract. The functional significance of this rare abnormality is unknown but it was found to be commonly associated with Tetralogy of Fallot. It is important to recognize the course anterior to the right ventricular outflow to prevent its damage during ventriculostomy.

Anomalous origin of LAD from the Pulmonary artery has been identified in 0.04%. Survival past infancy of such cases was mostly related to the development of collaterals from the RCA and circumflex (Cx) to the LAD. Older patients with this abnormality may be asymptomatic but had risk of mitral regurgitation, angina pectoris, myocardial infarction and sudden death. Even asymptomatic patients should undergo ligation of LAD at the pulmonary trunk which may be combined with a saphenous vein bypass graft between the LAD and aorta.

The LAD and Cx arteries may arise from separate ostium in the left aortic sinus as noted in 1.8% Pakistanis and in 3% of Hungarians. This abnormality must be kept in mind before performing angiography and recognized before surgery. However, none of the above anomalous origin of the LAD was noted in the present study.

The LAD was seen to pass down in the anterior interventricular sulcus accompanied by the great cardiac
Table 1: Termination of LAD (compared with other authors)

<table>
<thead>
<tr>
<th></th>
<th>Anterior aspect of apex</th>
<th>Posterior aspect of apex</th>
<th>2-5 cm up the PIVS</th>
<th>&gt;5 cm up the PIVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>James (1961)</td>
<td>16%</td>
<td>24%</td>
<td>38%</td>
<td>22%</td>
</tr>
<tr>
<td>Kalpana R (2003)</td>
<td>8%</td>
<td>12%</td>
<td>80%</td>
<td>0%</td>
</tr>
<tr>
<td>Present Study</td>
<td>12%</td>
<td>57%</td>
<td>31%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Fig 1: Origin of LAD from Left Coronary artery

Fig 2: Myocardial bridges along the course of LAD

Fig 3: Termination of LAD at <2 cm up the posterior interventricular sulcus

Fig 4: Termination of LAD at anterior apex

Abbreviations: LAD - Left anterior descending artery; PIVA - Posterior interventricular artery; LCA - Left coronary artery; Cx - Circumflex artery; RV - Right ventricle; LV - Left ventricle

Vein to reach the acute border near the apex of the heart. Similar observations were also made by other authors2-6.

Myocardial bridges were more common finding here than in other arteries. However, the systolic luminal bridges caused by these myocardial bridges are probably benign in most people13. The prevalence of myocardial bridges is 0.5-1.6% in the general population while it is 28% in children and 30-50% in hypertrophic cardiomyopathy patients13.

James14 noted that the LAD artery curved around the apex cordis and continued for variable distance up the posterior interventricular sulcus. The artery lied 1-3 cm to the right of the apex cordis15. The portion of the

artery that is lodged in the interventricular posterior groove is known as the 'Mouchet's posterior recurrent interventricular artery' or 'ramus reccurens'. Johnson has noted that the anterior interventricular artery usually turns round the apex into the posterior interventricular sulcus, traversed a third to a half of its length, to meet the terminal twigs of the corresponding right coronary ramus. In one-third of specimens, the artery terminated at the apex itself. In the present study however, the LAD mostly curved around the apical cardiac notch and ended within two cm up the posterior interventricular sulcus in 57 % cases. It extended 2-5 cm up the posterior interventricular sulcus (PIVS) in 31% and anterior apex in 12 % specimen. Other authors have also described a similar termination but with wide variations, which have been compared with the finding of this study. (Table: 1)

Dual Anterior Descending coronary artery is an exceptionally rare abnormality with only a few cases been reported so far. Spindola-Franco et al reported dual anterior descending coronary artery bifurcation of the anterior interventricular artery in 1% of cases (a limit between anomalies and anatomic variations). However, Cohen observed a higher percentage (3.8-5 %) of such cases. This anomaly was classified into 4 types. In types I, II, and III, the anterior descending branch originated from the trunk of the major anterior descending coronary artery. In Type IV the long anterior descending branch originated in the right sinus of Valsalva or in the right coronary artery. Although this anomaly was initially considered benign, some authors associate it with stable angina, acute myocardial infarction, and post infarction angina. Angiographically, a duplicated LAD may be distinguished from a large diagonal artery by its straight septal branches, lesser kinking with myocardial contraction, being usually the only vessel which ran round the apex and characteristically terminated in an inverted Y.

Many rare abnormalities reported above were mainly angiographic studies where the sample size was huge. As this is a dissection based study, its limitations was the limited number of sample size as compared to angiographic studies of the coronary arteries. It however gives a hint that the prevalence of these abnormalities in this region is quite rare, may be below 1 %. Further studies with more number of specimens can be taken to find the rare variations.

**Conclusion**

The findings in the study throws light on the regional variations in LAD anatomy which are not available in standard textbooks. Knowledge of these regional and demographic variations will keep cardio surgeons and radiologists better prepared in their diagnostic and therapeutic skills.

**References**


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