Association between left anterior descending artery length with coronary artery dominance: An angiographic study

Ahmad Separham1, Masoud Nouri-Vaskeh2, Mehdi Maleki3*

1 Cardiologist, Cardiovascular Research Center, Madani Heart Hospital, Tabriz University of Medical Sciences, Tabriz, Iran
2 MD, Connective Tissue Diseases Research Center, Tabriz University of Medical Sciences, Tabriz, Iran
3 Fellowship of Interventional Cardiology, Cardiovascular Research Center, Madani Heart Hospital, Tabriz University of Medical Sciences, Tabriz, Iran

ARTICLE INFO

Article type: Original Article

Article history:
Received: 23 Jun 2019
Revised: 18 July 2019
Accepted: 29 July 2019

Keywords:
Coronary Circulation
Coronary Angiography
Left Anterior Descending Artery
Left Coronary Dominancy

ABSTRACT

Introduction: Although left anterior descending (LAD) artery supplies a large portion of the myocardium, the amount of blood supply provided by LAD is dependent on the length of the LAD. The aim of the current study was to evaluate the association between coronary artery dominance and LAD anatomic types in patients with normal epicardial coronary arteries.

Methods: This retrospective study was conducted at a tertiary teaching hospital on a total of 252 patients with normal coronary artery angiographic findings between April 2018 to March 2019. Patient's medical records were utilized to collect demographic and catheterization data, as well as their clinical characteristics. Qualitative and quantitative catheterization data, including the anatomical type of LAD, dominance, LAD slow flow phenomenon, LAD ectasia, and Muscle Bridge were obtained from the angiographic examination. The three anatomical LAD types, including type I (LAD terminating before the apex), type II (LAD reached the apex), and type III (LAD wrapping around the apex) were compared in the left and right dominant coronary artery patients.

Results: The mean age of patients was 58.06±10.89 years (age range: 27-79 years). The slow flow phenomenon was more significantly observed in patients with type C LAD (P=0.015); however, there was no significant difference between LAD types regarding LAD Muscle Bridge (P=0.099) and ectasia (P=0.810). In total, 54.8% and 45.2% of the patients had right and left dominant coronary artery systems, respectively. Moreover, there was a statistically significant association between wrap-around LAD and left coronary artery dominance (P<0.001).

Conclusion: The type C LAD is more prevalent in patients with left dominant coronary artery.

Introduction

Left ventricle myocardium is largely supplied by the left coronary artery branches including left anterior descending (LAD) artery and left circumflex artery. In general, 35% of the left ventricle blood supply provided by LAD (1, 2). Although LAD supplies a large portion of the myocardium, the amount of blood supply provided by LAD is dependent on the length of the LAD (3, 4). This vessel has three anatomical types,
including type I (LAD terminating before the apex), type II (LAD reached the apex), and type III (LAD wrapping around the apex). The type III LAD supplies the apical region; however, the type II LAD does not supply that region (5,6). The length of LAD is usually a predictor of patient prognosis in a different clinical setting (7).

One study showed that in 10.2% of patients, LAD did not pass around the apex and terminated before the apex; moreover, in 12.1% of the cases, the apex received dual supply from LAD and posterior descending artery. Nevertheless, LAD supplied the diaphragmatic surface of the left ventricle in the remaining patients (77.7%) (8). Kobayashi et al. (9) reported the adverse clinical outcomes in patients with LAD that wrapped around the apex after anterior ST-segment elevation myocardial infarction. The type III LAD supplies a large portion of the myocardium and its occlusion is associated with poor outcomes (10). Wrap-around LAD also supplies the inferior portion of the left ventricle; therefore, it is followed by the occlusion of the concomitant ST-segment elevation (11). Umei et al. (12) reported the pacemaker malfunction in acute myocardial infarction in patients with type III LAD.

Given the dearth of research investigating the association between LAD types and coronary dominance in patients with normal coronary arteries, this study aimed to evaluate the association between LAD anatomical types and coronary artery dominance.

Materials and Methods

This cross-sectional study was conducted at a tertiary teaching hospital on patients with no evidence of coronary artery stenosis from April 2018 to March 2019. The GPower version 3.0.10 (Heinrich Heine University, Düsseldorf, Germany) was used for sample size calculation (Power= 80%, α error: 5%) according to Abdul Wahaab et al. study (13). The patient’s medical records were utilized in order to collect demographic and catheterization data which covered such information as age, gender, left ventricular ejection fraction, admission setting, and coronary artery disease risk factors. Qualitative and quantitative catheterization data, including the anatomical type of LAD, dominance, LAD slow flow phenomenon, LAD ectasia, and Muscle Bridge were obtained from the review of angiographic movies and analyzed by an experienced interventionist. The LAD types were classified based on a classification in a coronary artery surgery study (13). Figure 1 depicts the LAD types which are classified into type A (I), B (II), and C (III) in the current study.

Coronary artery dominance is a condition in which the vessel leads to the posterior descending artery. Slow flow phenomenon is referred to as a delay to the progression of the contrast media into the coronary arteries in the absence of significant coronary stenosis. In the present study, the TIMI frame count greater than 27 frames in LAD was considered as coronary slow flow.

The inclusion criteria were patients with normal coronary angiographic findings in the age range of 20-80 years old. On the other hand, the patients younger than 20 and older than 80 years old with a history of previous coronary angiography, and the elders who had recent or acute myocardial infarction were excluded from the study. Moreover,
dominant coronary circulation was regarded as an exclusion criteria were, history of previous coronary codominant coronary circulation as confounding factor.

Statistical Analysis

The data were analyzed in SPSS software (version 16.0, SPSS, Chicago, IL, USA) through the chi square and Fisher’s exact test to compare the frequency and percentages of the categorical variables. Moreover, continuous variables were summarized as mean±SD and were analyzed using the ANOVA t-test. P-value less than 0.05 were considered statistically significant.

Results

According to the results obtained from this study, out of 252 patients, 98 (38.9%) cases were male. The number of patients in the type A, B, and C LAD were 19, 75, and 153, respectively. The mean age of patients in type A, B, and C LAD were 61.95±9.57 years, 58.41±11.78 years, and 57.2±10.55 years (P= 0.186), respectively. Table 1 summarizes the demographic characteristics of patients. As shown in Table 1, there was no significant difference between LAD types in terms of gender (P=0.100), family history (P=0.231), and underlying diseases, such as diabetes mellitus (P=0.103), hypertension (P=0.852), and hyperlipidemia (P=0.056). But smoking was more prevalent in type C LAD (P=0.010).

Table 1. Demographic characteristics of patients

<table>
<thead>
<tr>
<th>LAD type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7(7.2)</td>
<td>37(38.1)</td>
<td>53(54.6)</td>
<td>0.100*</td>
</tr>
<tr>
<td>Female</td>
<td>12(8)</td>
<td>38(25.3)</td>
<td>100(66.7)</td>
<td></td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>5(11.9)</td>
<td>17(40.5)</td>
<td>20(47.6)</td>
<td>0.103*</td>
</tr>
<tr>
<td>Hypertension</td>
<td>9(8.2)</td>
<td>35(31.8)</td>
<td>66(60)</td>
<td>0.852*</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>2(20)</td>
<td>0</td>
<td>8(80)</td>
<td>0.056**</td>
</tr>
<tr>
<td>Smoking</td>
<td>2(2.7)</td>
<td>16(21.6)</td>
<td>56(75.7)</td>
<td>0.010*</td>
</tr>
<tr>
<td>Positive Family History</td>
<td>1(25)</td>
<td>0</td>
<td>3(75)</td>
<td>0.231**</td>
</tr>
</tbody>
</table>

LAD: Left Anterior Descending
* Chi-square test
** Fisher’s exact test

Table 2 depicts the clinical and angiographic findings among the patients. As indicated in Table 2, a significant difference is observed between LAD types regarding the slow flow phenomenon (P=0.015). However, no significant difference was observed between LAD types regarding LAD Muscle Bridge (P=0.099) and ectasia (P=0.810).
An angiographic study

Significant statistical association between anatomical types of LAD and coronary artery dominance. In other words, left coronary artery dominance was more prevalent in patients with type C LAD (P<0.001).

Table 2. Clinical and Paraclinical findings of patients

<table>
<thead>
<tr>
<th>LAD Type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Total</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow Flow</td>
<td>1(3)</td>
<td>15(45.5)</td>
<td>17(51.5)</td>
<td>33</td>
<td>0.015*</td>
</tr>
<tr>
<td>Muscle Bridge</td>
<td>0</td>
<td>6(60)</td>
<td>4(40)</td>
<td>10</td>
<td>0.099**</td>
</tr>
<tr>
<td>Ectasia</td>
<td>1(6.2)</td>
<td>6(37.5)</td>
<td>9(56.3)</td>
<td>16</td>
<td>0.810**</td>
</tr>
</tbody>
</table>

Admission Setting

<table>
<thead>
<tr>
<th>Setting</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Total</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstable Angina</td>
<td>7(5.6)</td>
<td>46(36.8)</td>
<td>72(57.6)</td>
<td>125</td>
<td>0.041**</td>
</tr>
<tr>
<td>Stable Angina</td>
<td>9(18.4)</td>
<td>11(22.4)</td>
<td>29(59.2)</td>
<td>49</td>
<td>0.810**</td>
</tr>
<tr>
<td>Positive Exercise Tolerance Test</td>
<td>1(6.2)</td>
<td>6(37.5)</td>
<td>9(56.3)</td>
<td>16</td>
<td>0.041**</td>
</tr>
<tr>
<td>Positive Myocardial Perfusion Imaging</td>
<td>1(5.9)</td>
<td>4(23.5)</td>
<td>12(70.6)</td>
<td>17</td>
<td>0.810**</td>
</tr>
<tr>
<td>Heart Failure</td>
<td>0</td>
<td>2(25)</td>
<td>6(75)</td>
<td>8</td>
<td>0.810**</td>
</tr>
</tbody>
</table>

Ejection Fraction

<table>
<thead>
<tr>
<th>Fraction</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Total</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;40</td>
<td>15(7.3)</td>
<td>60(29.6)</td>
<td>128(63.1)</td>
<td>203</td>
<td>0.892*</td>
</tr>
<tr>
<td>≤40</td>
<td>3(9.3)</td>
<td>10(31.3)</td>
<td>19(59.4)</td>
<td>32</td>
<td>0.892*</td>
</tr>
</tbody>
</table>

Dominancy

<table>
<thead>
<tr>
<th>Dominance</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Total</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>19(13.9)</td>
<td>43(31.4)</td>
<td>75(54.7)</td>
<td>137</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Left</td>
<td>0</td>
<td>32(29.1)</td>
<td>78(70.9)</td>
<td>110</td>
<td>0.810**</td>
</tr>
</tbody>
</table>

Discussion

The anterior wall of the left ventricle and an anterior section of the interventricular septum are supplied by LAD that contains about 35% of the left ventricular myocardium. Therefore, LAD has a critical role in myocardial blood supply and its stenosis leads to poor cardiac outcomes. Moreover, type C LAD is of utmost importance since the LAD wraps around the apex in this type (14, 16). Consequently, in the LAD lesions, especially when LAD wraps around the apex, it is anticipated to observe increased myonecrosis area, impaired left ventricular function, and subsequent higher mortality rate (17, 19).

In the current study, anatomical types of LAD correlated significantly with dominance, smoking, slow flow, and coronary circulation. However, there was no significant difference between LAD types in terms of the Muscle Bridge, Ejection fraction, and ectasia. In addition,
no prevalence was observed in a specific type of LAD in terms of hypertension, hyperlipidemia, and diabetes mellitus.

In a similar study with a different method, Abdul Wahaab et al. (13) showed a significant relationship between LAD length and coronary artery dominance. In their study, coronary computed tomography angiography was employed for the evaluation of LAD types, unlike an invasive method which was utilized in this study. Although conventional coronary angiography is an invasive procedure with its own complications, all patients had at least one indication for this type of angiography. Both studies reported a high frequency of type C LAD in individuals with left dominant coronary artery, compared to those who are right dominant.

There are several studies on the evaluation of coronary arteries length and diameter. Differences between genders regarding coronary artery diameters were reported by Shukri et al. (20). Moreover, Kucher et al. (21) revealed a larger coronary artery in males than females.

In the same line, Ilia et al. (22) showed extensive myocardial necrosis in patients with type C LAD treated with primary percutaneous coronary intervention. Consequently, the length of LAD may affect a patient’s prognosis in anterior myocardial wall infarction. It should be noted that the type A and B LADs have an excellent prognosis in anterior myocardial wall infarction. A significant difference was also found between LAD types in terms of a slow flow phenomenon. On the other hand, increased LAD length was associated with higher slow flow phenomenon. This finding has not been reported previously and needs large studies with long term follow-ups.

Previous studies have shown higher mortality and poor prognosis in patients with acute coronary syndrome who had left coronary artery dominance (23,24). One of the possible mechanisms responsible for this unfavorable outcome may be the length of LAD. The present study showed that wrap-around LAD (type C) was more common in the left dominant coronary artery. This may lead to larger infarct size and more jeopardized myocardium if the left dominant coronary artery system is affected.

**Limitations**

The current study suffers from some limitations, among which is the lack of evaluation of the association between LAD types and patients prognosis. Since this study aimed to investigate the association between LAD type and coronary dominance, it is recommended that further and larger study conduct research in this regard. Furthermore, the role of the slow flow in the patient’s outcome should be considered in further studies.

**Conclusion**

In conclusion, type C LAD is associated with left coronary artery dominance. In addition, the slow flow phenomenon was more observed in patients with longer LAD which needs further evaluation.

**Acknowledgment**

The authors wish thanks to Intervention Ward’s staffs of Madani Hospital of Tabriz University of Medical Sciences for their cooperation.

**Conflict of interests**

The authors declare that they have no conflict of interest.

**Funding**

The authors received no financial support for this study.

**References**


differences in coronary artery size per 100 g of left ventricular mass in a population without cardiac disease. Swiss Med Wkly. 2001;131(41-42):610-5.

