



# The Relation between Left Coronary Dominancy and Atherosclerotic Involvement of Left Anterior Descending Artery Origin

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## ABSTRACT

**Introduction:** Limited information is available regarding the relationship between coronary vessel dominance and atherosclerotic involvement. Rheological factors have been implicated in the pathogenesis of coronary lesions. More than 90% of the coronary blood flow enters the left coronary if it is the dominant artery. The main purpose of this study was to determine the relation between left coronary dominance and atherosclerotic involvement of left anterior descending artery (LAD) origin. In addition, the prevalence and degree of associated ischemic mitral regurgitation (MR) in these patients were assessed. **Methods:** The study included 678 consecutive patients with an indication for coronary angiography. One hundred and twenty two patients with right dominant and 61 patients with left dominant arteries were randomly selected for analysis. All demographics, risk factors, coronary dominance and involvement, left ventricular ejection fraction (LVEF), and MR were recorded. **Results:** One hundred and eighty three patients (mean age of 57.7 years) were studied. The types of coronary circulation included right, left, and balanced in 78.6%, 8.9%, and 12.5%, of the patients respectively. In 64 patient with significant LAD lesions, 22 (34.9%) had ostial while the remainder had non-ostial involvement. Ischemic MR was present in 5 (2.7%) patients. There was no difference in demographics, risk factors, LVEF, MR, extent of coronary artery disease, and LAD ostial involvement between left and right dominant circulations. **Conclusion:** In this study, left coronary dominance was not associated with atherosclerotic involvement of LAD ostium and ischemic MR.

## Introduction

The coronary circulation was first described by Banchi in 1904.<sup>1</sup> Later on, Hettler, provided very detailed criteria for the type classification based on the course of the anterior and posterior interventricular branches and defined the following types: left coronary artery dominance, right coronary artery dominance, and co-dominant or balanced.<sup>1</sup> There are 3 types of circulation dominance: right, left, and balanced. When the arteries supplying the posterior interventricular septum originate from posterior descending artery and posterior lateral right coronary artery, it is called "right dominant (RD)" circulation. The dominance of right circulation is common in about 87-89% of the general population. The term "left dominance (LD)" refers to origination of the arteries supplying the posterior interventricular septum from left circumflex artery (LCX). The rate of the dominance of left circulation for the general population is about 7-8%. In co-dominance (balanced) circulation, however, the branches that run to the interventricular septum originate both from the

RCA and LCX. The rate of co-dominance in the general population is around 4%.<sup>2</sup>

Understanding of the anatomy of the major epicardial coronary arteries and their major branches is clinically important in the management of cardiovascular diseases and accompanying complications such as myocardial ischemia and sudden cardiac death.<sup>3-5</sup>

Rheological factors have been implicated in the pathogenesis of coronary artery disease (CAD). Locally disturbed flow could induce alterations that promote the steps of early atherogenesis. Intimal damage appears to be related to shear stresses as endothelial cell damage occurs at high shear rates. More than 90% of the coronary blood flow enters the left coronary if it is the dominant artery, producing high shear stress at its bifurcation.

The main purpose of this study was to determine the relation between left coronary dominance and atherosclerotic involvement of the origin of left anterior descending artery (LAD). In addition, the prevalence and

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degree of associated ischemic mitral regurgitation (MR) in these patients were assessed.

### Materials and methods

This prospective study included 678 consecutive patients with an indication for coronary angiography referred to Madani Heart Center in 2011. Patients with non-ischemic MR were excluded. One hundred and twenty two patients with RD and 61 patients with LD circulations were randomly selected for analysis. All demographics, risk factors, left ventricular ejection fraction (LVEF), and MR were recorded. Familial CAD was defined as the presence of coronary artery disease in first-degree family members at <55 years in men and <65 years in women. Hypertension was defined as the current use of antihypertensive medication or an average blood pressure >140/90 mmHg on two different occasions. Hyperlipidemia was defined by serum cholesterol levels > 250 mg/dl, serum triglyceride levels > 200 mg/dl, or use of anti-lipid drugs. A diagnosis of diabetes mellitus was made if the patient needed insulin, oral agents or had fasting blood glucose  $\geq$  126 mg/dl. Angiography of the right coronary artery was performed in at least 2 projections and the branches of the left coronary artery in at least 3. Coronary angiograms were digitally saved and each angiogram was analyzed by 2 experienced cardiologists blinded to clinical data; coronary dominance and the extent and location of coronary involvement were determined. In the few cases where assessment differed, the film was reviewed again in the presence of the complete angiography assessment committee until a consensus was achieved. CAD was defined as more than 50% diameter stenosis in one or more of the three major coronary arteries (LAD, LCX, and RCA) or their major branches. Subcritical stenosis of less than 50% was characterized as minimal CAD. The extent of coronary artery disease was noted as 1-, 2- or 3-vessel disease. LVEF was semi-quantitatively analyzed by transthoracic echocardiography before discharge by an operator who was blinded to the patient data and the location of infarction.

All patients gave written informed consents and the study was approved by our local Ethics Committee.

### Statistical analysis

Variables were expressed as mean  $\pm$  SD and percentage. Differences in the frequency of characteristics were assessed by independent sample Student's t-test for continuous variables. Chi-squared test (or Fisher exact test if applicable) was used for categorical variables. Two-tailed  $P < 0.05$  was considered significant. SPSS 13.0 software (SPSS Inc., Chicago, IL, USA) was used for data storage and analysis.

### Results

One hundred and eighty three patients were studied. The mean age of the patients was  $57.96 \pm 1.12$  (27-90) years

while 67.6% were male (Table 1). There was no significant difference in demographics, CAD risk factors, LVEF, diagnosis during admission, and the extent of coronary involvement (Table 1). The types of coronary circulation were right, left, and balanced in 78.6%, 8.9%, and 12.5%, respectively. In 64 patient with significant LAD lesions, 22 (34.9%) had ostial while the remainder (65.1%) had non-ostial involvement. When we considered coronary dominance, no significant difference in the involvement of LAD ostium was observed between groups (33.3% vs. 37.5%;  $P = 0.73$ ). Although ischemic MR seemed to occur more commonly in the LD group, the difference was not statistically significant. There was a trend for more involvement of proximal LAD in the LD group ( $P = 0.09$ ) which did not reach to a statistical significance (Table 1).

### Discussion

Our study indicated that, although RD circulation is more common in the general population, there may be no association between left coronary dominance and atherosclerotic involvement of LAD ostium and prevalence of ischemic MR. Understanding coronary artery variations and pathologies is important in planning the treatment and in the interpretation of findings of cardiovascular diseases.<sup>3-4</sup> Coronary artery dominance and its clinical importance should be known by cardiovascular specialists and be included in their interpretations. Such anatomical variations have been involved in pathophysiology of cardiac arrhythmias, MI, and even in sudden death.<sup>5-8</sup>

The coronary circulation was first described by Banchi in 1904.<sup>1</sup> Later on, Hettler, provided very detailed criteria for the type classification based on the course of the anterior and posterior interventricular branches and defined the following types: left coronary artery dominance, right coronary artery dominance, and co-dominant or balanced.<sup>1</sup> There are limited and conflicting results on the prognostic and therapeutic implications of coronary variations and dominance. Dodge et al.<sup>9</sup> and Kaimkhani et al.<sup>10</sup> both found that the diameter of the left main coronary artery (LMCA) and LAD were unaffected by dominance. In the study conducted on 541 patients by Balci,<sup>11</sup> it was shown that the dominance in the coronary circulation does not predispose to coronary atherosclerosis. This result was in contrast to the findings of another study by Vasheghani-Farahani,<sup>12</sup> which stated a significantly higher predisposition to 3-vessel involvement in RD patients even after adjusting the data for age, sex, and coronary risk factors. RCA and LCX were more involved in RD patients, but dominance had no effect on LAD disease. Goldberg et al.<sup>13</sup> demonstrated that LD is a significant and independent predictor of increased long-term mortality in patients with acute coronary syndrome (ACS). Although the association between coronary dominance and mortality was similar across the whole spectrum of ACS, it was more pronounced in patients with MI.

Rheological factors have been implicated in the

**Table 1.** Demographic, echocardiographic, and angiographic findings in both groups

	Right dominant coronary circulation	Left dominant coronary circulation	P Value
Age (yrs)	58.42±10.77	57.03±12.30	0.43
Male (%)	69.7	65.6	0.57
Familial CAD* (%)	4.1	3.3	0.78
Hyperlipidemia (%)	27.0	21.3	0.39
Hypertensive (%)	47.5	41.0	0.40
Diabetic (%)	23.8	21.3	0.70
Active smoker (%)	29.5	36.1	0.36
LVEF <sup>¶</sup> (%)	47.66±9.86	48.77±10.02	0.48
<b>Diagnosis during admission</b>			0.09
STEMI <sup>§</sup> (%)	32.8	25.4	
NSTEMI/UA <sup>†</sup> (%)	46.6	37.3	
Stable angina (%)	14.7	30.5	
Others (%)	6.0	6.8	
<b>Coronary involvement</b>			0.21
Single vessel disease (%)	25.4	36.1	
Two vessel disease (%)	26.2	19.7	
Three vessel disease (%)	27.9	18.0	
Minimal CAD*	20.5	26.2	
Proximal LAD lesion (%)	40.2	54.1	0.07
Ostial LAD lesion (%)	33.3	37.5	0.73
<b>Ischemic MR<sup>‡</sup> (%)</b>	1.60	4.90	0.44
Mild (%)	2.5	1.6	
Moderate (%)	1.6	3.3	
Severe (%)	0.0	1.6	
Coronary artery disease; ¶ left ventricular ejection fraction; § ST elevation myocardial infarction; † unstable angina; ‡ myocardial regurgitation.			

pathogenesis of CAD. Locally disturbed flow could induce alterations that promote the steps of early atherogenesis. Intimal damage appears to be related to shear stresses because endothelial cell damage occurs at high shear rates. More than 90% of the coronary blood flow enters the left coronary if it is the dominant artery, producing high shear stress at its bifurcation. A short LMCA trunk would maximize this high shear stress at its bifurcation and actually a study has considered this anatomic variation as a risk factor in developing coronary atherosclerosis.<sup>14</sup> Eren et al.<sup>15</sup> included 325 consecutive patients who underwent computed tomography coronary angiography (CTA) and showed that although the number of patients with CAD was higher among RD subjects, the rate of atherosclerotic CAD was significantly higher among the LD patients. In a recent study by Veltman et al.<sup>16</sup> on 1425 patients referred for CTA the presence of a LD circulation was identified as an independent predictor of non-fatal MI and all-cause

mortality, especially in patients with significant CAD on CTA.

We could not confirm our hypothesis on the relation between left dominance and LAD involvement and occurrence of ischemic MR, most probably because of insufficient sample size. Although there was a trend for more involvement of proximal LAD in the LD group, this did not reach to a statistical significance ( $P=0.09$ ). On the other hand, ischemic MR seemed to occur more commonly in the LD group, the difference was not statistically significant ( $P=0.44$ ; Table 1).

#### Limitation

Probably the most important limitation of this study was its relatively small patient population, which results in a comparatively small group of patients with a LD coronary artery circulation. Of note, the prevalence of RD, LD, and balanced coronary artery circulation in the present

study population was comparable to that described in the previous studies.<sup>10,12-15</sup> Because of the small patient groups among patients with significant CAD, statistically significant difference between the risk estimates for having a significant stenosis in LAD in patients with a RD and LD coronary circulations was not observed, presumably due to insufficient power. Larger studies are needed to elucidate the relationship between significant stenosis of LAD and the dominancy of the coronary circulation.

### Conclusion

Left coronary dominance might not be associated with atherosclerotic involvement of LAD ostium and ischemic MR.

**Competing interests:** The authors declare that they have no competing interests, and did not receive funding for this article.

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