Original Article

Impact of the Anatomical Factors of the Left Anterior Descending Coronary Artery in Patients With Single-Vessel Disease

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ABSTRACT

Background: Despite the recognition of the common risk factors for coronary artery disease (CAD), it appears that there is a wider range of risk factors. The purpose of the present study was to evaluate the association between the anatomical factors and the increased risk of CAD occurrence and its clinical consequences.

Methods: in this study, 50 cases with a single coronary artery stenosis of the left anterior descending artery (LAD) and 50 controls with a normal coronary angiography or non-obstructive CAD were enrolled, and the objective of the study was compared between the 2 groups.

Results: The number of the branches before the LAD stenosis significantly increased in the patients with LAD disease, and there was a meaningful increase in the number of both the diagonal and septal branches originating before the stenosis ($P<0.001$). The average number of the diagonal branches was the same in both groups, which was statistically insignificant. ($P=0.986$) The mean value of the angle between the largest diagonal branch or septal branch and the LAD in the cases with CAD and the controls showed no significant difference. A family history of the early-onset cardiovascular disease in the control group with non-obstructive CAD was 6% versus 20% in the CAD group, and this difference was statistically significant ($P\leq0.03$).

Conclusions: According to our study, it appears that the sum of the septal and diagonal branches of the LAD can be a statistically significant risk factor for the progression of atherosclerosis in the LAD as well. The LAD involvement is significantly associated with the familial type of CAD.
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KEYWORDS: Coronary artery disease, Left anterior descending artery (LAD), Anatomical factors

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The left main coronary artery originates from the left Valsalva sinus of the aortic root. Its shaft has a length of between 3 mm and 20 mm. After this small path, the left main coronary artery separates into its 2 branches: the left anterior descending artery or anterior interventricular branch (LAD) and the left circumflex artery.

The LAD track is in the anterior interventricular groove, which separates the right and the left ventricles, in the anterior aspect of the heart. The diagonal is a branch of the LAD that runs diagonally away from the anterior interventricular channel and toward the anterolateral aspect of the heart. The septal branches run into the septum and provide its blood source.[1,2,3]

Gender, age, blood levels of total and high-density lipoprotein (HDL) and total cholesterol, hypertension, smoking, and diabetes mellitus comprise the conventional risk factors for the increasing prevalence of coronary artery disease (CAD). [4,5,6,7,8] Apolipoproteins A-I and B are deemed newer lipid measures, and they exert a slight influence in calculating the CAD prospect hazard. Fibrinogen and homocysteine blood levels are associated with CAD. [9] Among the geographical factors, food regime, inactivity, and smoking, only smoking has documented effects. [10,11,12] These risk factors are regarded as the culprit for up to half of the cases of atherosclerosis or CAD. [13,14,15,16] Consequently, we should search for other risk factors and their influences on atherosclerosis and CAD. The effect of the vascular flow and its shear stress on the formation and advancement of atherosclerotic plaques is an undeniable fact. [17,18] Friedman and Ding [19] suggested that differences in the vascular structure may play a role in some of the unsolved questions in the CAD pathway. In fact, most of the instances of atheroma localize particularly at the coronary artery bifurcation, frequently at the ostium of the LAD.

Gazetopoulos and Ioannidis [20] found that in patients with coronary stenosis, the dimension of the main left coronary artery was meaningfully smaller than that in cases without angiographic evidence of CAD.

In light of these findings, it is anticipated that a smaller main left coronary artery should be considered an inherited factor prompting the formation of a plaque and causing CAD in the future.

On the other hand, the cause of involvement in only 1 vessel despite similar risk factors in the same patient is one of the unresolved questions in CAD. [21,22,23] It may, therefore, be postulated that the coronary structure could have an influence on the atheromatous plaque formation.

METHODS

Given the importance of the LAD involvement in the prognosis of CAD, we designed the current study. [24,25] The aim of this study was to examine the association between the LAD and the structure of its subdivisions (as evaluated with coronary angiography) and the existence of stenosis. The bifurcation angles between the LAD trunk and the largest diagonal and largest septal portions, the total number of the septal and diagonal branches, and the number of the branches before and after the stenosis were assessed. This study was done as a cross-sectional evaluation of available elective cases in our catheterization laboratory. We enrolled 50 patients with a single coronary artery stenosis of the LAD and 50 controls with a normal coronary angiography or non-obstructive CAD. The study population consisted of all patients with suspected CAD based on new-onset symptoms and paraclinical findings who were candidates for coronary angiography according to the latest CAD guidelines.

The exclusion criteria were comprised of previous bypass surgery, a history of stable or unstable CAD (known cases), congenital heart diseases, multiple stenoses of the left LAD, poor-quality angiography, and a complete occlusion of the LAD.

Single-vessel disease in the LAD was defined as a lesion with 70% stenosis or more and when the other vessels were normal or had lesions less than 30%.

In order to eliminate interobserver and intraobserver variabilities, we utilized quantitative angiography software for the assessment of stenosis. Our controls were patients with patent coronary arteries or no lesions more than 30% (nonobstructive CAD).

All the patients' demographic characteristics were recorded, and the bifurcation angles between the LAD trunk and the largest diagonal and largest septal portions, the total number of the visible septal and diagonal branches, and the number of the branches before and after the stenosis were measured in a similar deep anteroposterior cranial view (cranial angulation>40°) with quantitative angiography software (SYNGO; Siemens; Erlangen; Germany).

The data were analyzed by using the IMD SPSS software, version 21. Nonparametric statistical analysis with the Mann–Whitney–Wilcoxon test was used to obtain the mean difference between the quantitative and qualitative variables of the 2 groups. Statistical significance was set at a *P* value of less than 0.05.

Ethical Considerations

All the data from the files were encoded and utilized anonymously. All the patients were informed about the procedure, and the consent forms were comprehensively explained. None of the data, data entry, and the preparation method of the final report disclosed any personal information to any individual or entity.

RESULTS

The present study consisted of 2 groups of 50 individuals. The study population comprised 51 men and 49 women. The mean age of the patients was 51.58 years in the control group and 62.61 years in the case group; this difference, however, was not statistically significant (P=0.197).

Eight percent of the controls and 16% of the patients in the case group suffered from diabetes, with the difference not constituting statistical significance (P≤0.221). Hypertension was reported in 28% of the members of the control group and 36% of the patients in the case group; the difference was not meaningful (P≤0.394). Dyslipidemia of any kind was reported in 28% of the patients in the control group and 36% of the patients in the case group, and the difference was not significant (P≤0.394). Six percent of the patients in the control group and 20% of the patients in the case group had a history of premature CAD in their first-degree relatives; the difference was statistically significant (P≤0.03).

The baseline clinical features and characteristics of the study population are depicted in Table 1. The average number of the septal branches of the LAD in the cases was 4.80, as opposed to 3.96 in the controls, and this difference was statistically significant according to the Mann–Whitney–Wilcoxon test (P=0.01). The average number of the diagonal branches of the LAD in both groups was 2.5, which was statistically insignificant (P=0.986). The average number of the branches originating after a stenosis compared with that before a stenosis in the cases rose by nearly 3 points, and the mean difference was highly significant according to the nonparametric paired Wilcoxon test (P<0.0001). The average number of the septal branches after a stenosis compared with that before a stenosis in the cases rose by nearly 2 points, and the mean difference was highly significant according to the nonparametric paired Wilcoxon test (P≤0.0001). The average number of the diagonal branches after a stenosis compared with that before a stenosis in the cases increased by almost 1 point; the mean difference was highly significant by the nonparametric paired Wilcoxon test (P≤0.0002). The mean bifurcation angles

between the LAD trunk and the largest diagonal were 47.08° in the cases and 45.80° in controls, with the mean difference constituting statistical insignificance (*P*=0.704). The mean bifurcation angles between the LAD trunk and the largest septal branch were 57.62° in the cases and 50.24° in the controls, and the mean difference was statistically insignificant (*P*=0.33).

These objectives of the anatomical variables are depicted in Table 2 and Table 3.

Table 1. Clinical features and characteristics of the study participants

Variable	Control		Case		Total	
	number	percentage	number	percentage	number	percentage
Gender						
Male	51%	51	62.00	31	38.00	20
Female	49%	49	38.00	19	60.00	30
Diabetes						
Yes	12%	12	16.00	8	8.00	4
No	88%	88	84.00	42	92.00	46
Hypertension						
Yes	32%	32	36.00	18	28.00	14
No	68%	68	64.00	32	72.00	36
History of premature CAD						
Yes	13%	13	20.00	10	6.00	3
No	87%	87	6.00	40	94.00	47
Dyslipidemia						
Yes	32%	32	36.00	18	28.00	14
No	68%	68	64.00	32	72.00	36

CAD, Coronary artery disease

Table 2. LAD anatomical variables in the 2 groups

Variable	Total Number	Mean	Mann–Whitney–Wilcoxon
Septal branches in the cases	2891.50	4.80	883.500
Septal branches in the controls	2158.50	3.96	
Diagonal branches in the cases	2527.50	2.5	1247.500
Diagonal branches in the controls	2522.50	2.5	
Bifurcation angle between the largest diagonal and the LAD in the cases	2580.00	47.08	1195.00
Bifurcation angle between the largest diagonal and the LAD in the controls	2470.00	45.80	
Bifurcation angle between the largest septal and the LAD in the cases	2835.00	57.62	940.00
Bifurcation angle between the largest septal and the LAD in the controls	2835.00	50.24	

LAD, Left anterior descending artery

Table 3. LAD anatomical variables in the case group

Variable / Stenosis location	Mean	Differences in the Number of Positive Ranks	Differences in the Number of Negative Ranks	Number of Ties	Wilcoxon Signed-Rank Test	*P*
Number of the branches originating before a stenosis	2	40	4	6	928	<0.001
Number of the branches originating after a stenosis	5.28					
Number of the septal branches before a stenosis	1.16	39	5	6	39	<0.001
Number of the septal branches after a stenosis	3.6					
Number of the diagonal branches before a stenosis	98	27	11	12	585	0.002
Number of the diagonal branches after a stenosis	68					

LAD, Left anterior descending

DISCUSSION

Cardiac diseases are among the leading causes of death and disability worldwide. [26,27,28] Despite the known effects of a turbulent flow on the formation and development of atherosclerosis such as increasing the plaque volume at the bifurcation of peripheral arteries, this hypothesis has not been evaluated sufficiently with respect to coronary arteries. Furthermore, previous studies have apportioned less blame to coronary anatomic factors. On the other hand, the cause of involvement in only 1 vessel despite similar risk factors in the same patient is one of the unresolved questions in CAD. [29,30,31] It could be proposed that the coronary structure could exert an influence on atheroma plaque formation. In the present study, we sought to examine this hypothesis for LAD single-vessel disease. The bifurcation angles between the LAD trunk and the largest diagonal and largest septal portions, the total number of the visible septal and diagonal branches, and the number of the branches before and after a stenosis were measured and compared. Based on the results, it appears that the sum of the septal and diagonal branches of the LAD may be a statistically significant risk factor for the progression of atherosclerosis in the LAD.

Moreover, the LAD involvement alone is significantly associated with a family history of premature CAD. It could be hypothesized that genetic factors affecting the anatomical coronary structure could be the primary cause of CAD. Given the extent of cardiac disease burden, we suggest further studies with larger sample sizes to confirm this relationship. It is clear that proving this theory could help screen patients with a genetic background of CAD who might develop the disorder in the future anyway.

There were several limitations to our study. First, our sample size was relatively small. Second, we tried to standardized coronary angiography views; nonetheless, due to obesity or concomitant lung disease, they were not quantitatively the same. Third, as a primary objective, we sought to evaluate the coronary anatomy in family members, but we failed due to ethical issues.

CONCLUSIONS

Evaluation of anatomical factors in CAD might one day be a part of patients' examination to screen patients who will develop CAD as the leading cause of death in the 21st century.

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