Journal of
Cardio - Thoracic Medicine

http://jctm.mums.ac.ir

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

Ahmad Separham[1], Masoud Nouri-Vaskeh[2], Mehdi Maleki[3*]

[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 depended 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.

►*Please cite this paper as:*
Separham A, Nouri-Vaskeh M, Maleki M. Association between left anterior descending artery lengths with coronary artery dominance: An angiographic study. J Cardiothorac Med. 2019; 7(3):484-490

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 depended on the length of the LAD (3, 4). This vessel has three anatomical types,

**Corresponding author: Separham A, Cardiologist, Cardiovascular Research Center, Madani Heart Hospital, Tabriz University of Medical Sciences, Tabriz, Iran. Tel: +989141885574 Fax: +984133372928; Email: medhimaleki.cardio@gmail.com*

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.

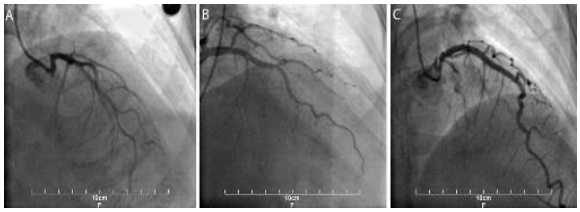

Figure 1. Left anterior descending artery angiograms. Type A. Type B. Type C

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

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

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).

Unstable angina was the most cause of admission among patients (51.6%). Unstable angina with 51.6% was the most frequency between admission settings. Other causes were positive exercise tolerance test, positive angiography; old, recent or acute myocardial infarction. We also excluded myocardial perfusion imaging, valvular heart disease and heart failure, respectively. The patients were divided into two groups according to the ejection fraction of left ventricle, and there was no significant difference between the

groups regarding ejection fraction higher and lower than 40% (P= 0.892). Regarding coronary arterial dominance, 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). 54.8% and 45.2% of patients were right and left dominant, respectively. Furthermore, the results revealed a

Table 2. Clinical and Paraclinical findings of patients

LAD Type	A	B	C	Total	P-value
Slow Flow	1(3)	15(45.5)	17(51.5)	33	0.015*
Muscle Bridge	0	6(60)	4(40)	10	0.099**
Ectasia	1(6.2)	6(37.5)	9(56.3)	16	0.810**
Admission Setting					
Unstable Angina	7(5.6)	46(36.8)	72(57.6)	125	
Stable Angina	9(18.4)	11(22.4)	29(59.2)	49	
Positive Exercise Tolerance Test	1(6.2)	6(37.5)	9(56.3)	16	0.041**
Positive Myocardial Perfusion Imaging	1(5.9)	4(23.5)	12(70.6)	17	
Heart Failure	0	2(25)	6(75)	8	
Ejection Fraction					
>40	15(7.3)	60(29.6)	128(63.1)	203	0.892*
≤40	3(9.3)	10(31.3)	19(59.4)	32	
Dominancy					
Right	19(13.9)	43(31.4)	75(54.7)	137	<0.001*
Left	0	32(29.1)	78(70.9)	110	

LAD, Left Anterior Descending; VHD, Valvular Heart Disease;
* Chi-square test
** Fisher's exact test

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 mechanism 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

1. Shaikh SSA, Munde K, Patil V, Phutane M, Singla R, Khan Z, et al. "Superdominant" Left Anterior Descending Artery Continuing as Posterior Descending Artery: Extremely Rare Coronary Artery Anomaly. Cardiol Res. 2018;9(4):253-7.

2. Tahir H, Ahmad S, Awan MU, Omar B, Glass J, Cole J. Anomalous Origin of Left Anterior Descending Artery and Left Circumflex Artery from Right Coronary Sinus with Malignant Left Anterior Descending Artery Course: Role of Coronary CT Angiography Derived Fractional Flow Reserve in Decision Making. Cureus. 2018;10(8):e3220.
3. Brener SJ, Witzenbichler B, Maehara A, Dizon J, Fahy M, El-Omar M, et al. Infarct size and mortality in patients with proximal versus mid left anterior descending artery occlusion: the Intracoronary Abciximab and Aspiration Thrombectomy in Patients With Large Anterior Myocardial Infarction (INFUSE-AMI) trial. Am Heart J. 2013;166(1):64-70.
4. Cerci RJ, Arbab-Zadeh A, George RT, Miller JM, Vavere AL, Mehra V, et al. Aligning coronary anatomy and myocardial perfusion territories: an algorithm for the CORE320 multicenter study. Circ Cardiovasc Imaging. 2012;5(5):587-95.
5. Ilia R, Rosenshtein G, Weinstein J, Cafri C, Abu-Ful A, Gueron M. Left anterior descending artery length in left and right coronary artery dominance. Coron Artery Dis. 2001;12(1):77-8.
6. Sharif-Barfeh Z, Beigoli S, Marouzi S, Rad AS, Asoodeh A, Chamani J. Multi-spectroscopic and HPLC studies of the interaction between estradiol and cyclophosphamide with human serum albumin: binary and ternary systems. Journal of Solution Chemistry. 2017 Feb 1;46(2):488-504.
7. Alidoosti M, Salarifar M, Zeinali AM, Kassaian SE, Dehkordi MR. Comparison of outcomes of percutaneous coronary intervention on proximal versus non-proximal left anterior descending coronary artery, proximal left circumflex, and proximal right coronary artery: a cross-sectional study. BMC Cardiovasc Disord. 2007;7:7.
8. Perlmutt LM, Jay ME, Levin DC. Variations in the blood supply of the left ventricular apex. Invest Radiol. 1983;18(2):138-40.
9. Kobayashi N, Maehara A, Brener SJ, Genereux P, Witzenbichler B, Guagliumi G, et al. Usefulness of the Left Anterior Descending Coronary Artery Wrapping Around the Left Ventricular Apex to Predict Adverse Clinical Outcomes in Patients With Anterior Wall ST-Segment Elevation Myocardial Infarction (from the Harmonizing Outcomes With Revascularization and Stents in Acute Myocardial Infarction Trial). Am J Cardiol. 2015;116(11):1658-65.
10. Stone GW, Dixon SR, Grines CL, Cox DA, Webb JG, Brodie BR, et al. Predictors of infarct size after primary coronary angioplasty in acute myocardial infarction from pooled analysis from four contemporary trials. Am J Cardiol. 2007;100(9):1370-5.
11. Sasaki K, Yotsukura M, Sakata K, Yoshino H, Ishikawa K. Relation of ST-segment changes in inferior leads during anterior wall acute myocardial infarction to length and occlusion site of the left anterior descending coronary artery. Am J Cardiol. 2001;87(12):1340-5.
12. Umei TC, Awaya T, Okazaki O, Hara H, Hiroi Y. Pacemaker malfunction after acute myocardial infarction in a patient with wrap-around left anterior descending artery supplying the right ventricular apex. J Cardiol Cases. 2018;18(1):9-12.
13. Wahaab ITA, Gamra SA, Salama FMM, Hadi KA. Length of Left Anterior Descending (LAD) Coronary Artery in Relation to Right & Left Dominancy: A Retrospective Computed Tomographic (CT) Coronary Angiographic Study. The Egyptian Journal of Hospital Medicine (April 2018). 2018;71(4):2944-9.
14. Zimmerman FH, Cameron A, Fisher LD, Ng G. Myocardial infarction in young adults: angiographic characterization, risk factors and prognosis (Coronary Artery Surgery Study Registry). J Am Coll Cardiol. 1995;26(3):654-61.
15. Ilia R. Proximal left anterior descending artery stenosis: dangerous or not? Cathet Cardiovasc Diagn. 1994;33(2):101-2.
16. Kim BG, Kim KH, Nah JC, Cho SW. Simultaneous left and right ventricular apical thrombi after occlusion of the wrapped left anterior descending artery. J Cardiol Cases. 2019;19(5):153-6.
17. Gibson CM, Cannon CP, Murphy SA, Marble SJ, Barron HV, Braunwald E. Relationship of the TIMI myocardial perfusion grades, flow grades, frame count, and percutaneous coronary intervention to long-term outcomes after thrombolytic administration in acute myocardial infarction. Circulation. 2002;105(16):1909-13.
18. Sanei H, Asoodeh A, Hamedakbari-Tusi S, Chamani J. Multi-spectroscopic investigations of aspirin and colchicine interactions with human hemoglobin: binary and ternary systems. Journal of Solution Chemistry. 2011 Nov 1;40(11):1905-31.
19. Montecucco F, Carbone F, Schindler TH. Pathophysiology of ST-segment elevation myocardial infarction: novel mechanisms and treatments. Eur Heart J. 2016;37(16):1268-83.
20. Shukri IG, Hawas JM, Karim SH, Ali IKM. Angiographic study of the normal coronary artery in patients attending Ulaimani Center for Heart Diseases. European Scientific Journal, ESJ. 2014;10(24).
21. Kucher N, Lipp E, Schwerzmann M, Zimmerli M, Allemann Y, Seiler C. Gender

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.
22. Ilia R, Weinstein JM, Wolak A, Gilutz H, Cafri C. Length of left anterior descending coronary artery determines prognosis in acute anterior wall myocardial infarction. Catheter Cardiovasc Interv. 2014;84(2):316-20.
23. Omerbasic E, Hasanovic A, Omerbasic A, Pandur S. Prognostic value of anatomical dominance of coronary circulation in patients with surgical myocardial revascularization. Med Arch. 2015;69(1):6-9.
24. Parikh NI, Honeycutt EF, Roe MT, Neely M, Rosenthal EJ, Mittleman MA, et al. Left and codominant coronary artery circulations are associated with higher in-hospital mortality among patients undergoing percutaneous coronary intervention for acute coronary syndromes: report From the National Cardiovascular Database Cath Percutaneous Coronary Intervention (CathPCI) Registry. Circ Cardiovasc Qual Outcomes. 2012;5(6):775-82.