This article can be cited as: Ahrar Yazdi MH, Razavi-Ratki SK, Arabi Aliabad A, et al. Cardiovascular events in patients referred to computerized tomography angiography with moderate coronary artery stenosis. Cardiovasc Biomed J. 2022; 2(1): 36-41.

Original Article

Cardiovascular events in patients referred to computerized tomography angiography with moderate coronary artery stenosis

Mohammad Hosein Ahrar Yazdi [1], Seid Kazem Razavi-Ratki [2], Abbas Arabi Aliabad [3], Amir Hossein Kheirkhah [4], Kimia Monshizadeh Ashkezari [4], Reza Nafisi Moghadam [1], Ali Pedarzadeh [5], Nasim Namiranian [6], Fatemeh Yaghoubi [7,*]

[1] Department of Radiology, School of Medicine, Shahid Sadoughi General Hospital, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[2] Department of Nuclear Medicine, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[3] Department of Radiology, Shohadaye Kargar Hospital, Yazd, Iran
[4] Department of Medical Genetics, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[5] Yazd Cardiovascular Research Center, Non-communicable Diseases Research Institute, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[6] Diabetes Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran
[7] Department of Clinical Biochemistry, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

*** Corresponding Author:**
Address: Yazd, Musa Ibn Jafar Street, 3rd Square of Azadshahr, Yazd, Iran. **Postal code:** 8917156197; **Tel:** +989151679598; **Email:** f.yaghobi67@gmail.com

Article Information:
Received: 19 Oct 2021; Revised: 31 Jan 2022; Accepted: 4 Feb 2022 DOI: 10.18502/cbj.v1i2.10591

Abstract

Objectives: Cardiovascular diseases are the most critical causes of mortality in the modern world. Additionally, most acute coronary events result from sudden thrombosis leading to atherosclerotic plaque rupture. Computerized tomography (CT) angiography can identify the characteristics and quantity of plaques. This study investigated the relationship between plaque and moderate coronary stenosis.

Methods: This study was a retrospective diagnostic study comprising 91 patients who had been referred to CT angiography at Afshar Hospital in Yazd City, Iran, from 2017 to 2018 and undergone coronary angiography CT while bearing moderate coronary artery stenosis. Using the CT report, location, plaque density, the extent of stenosis, and vein involved were all extracted and recorded. The patients were followed up for one year from the time of the CT scan using the MACE questionnaire. Ultimately, data was analyzed using SPSS software version 22 through Chi-square, Fisher's exact test, and t-test.

Results: The results revealed the mean age of the patients to be 62.76±1.08 years; 39 (42.9%) women and 52 (57.1%) men. Based on the obtained results, the most common involved vessel, location of stenosis in CT angiography, and plate density included the left anterior descending artery with 75.8%, the middle part of the left anterior descending artery with 29.7%, mixed density with 54.9% and one segment with 62.6% frequency. Also, according to the significant adverse cardiac event (MACE) questionnaire results, the frequency distribution of cardiovascular events in the studied patients did not exhibit any evidence of cardiovascular events in the patients' one-year follow-up.

Conclusions: There was no evidence of cardiovascular events in the patients with moderate coronary artery stenosis during a 1-year follow-up.

Keywords: Angiography, Plaque, Cardiovascular Diseases, Coronary Artery Disease

Abbreviations
CAD: Coronary artery disease
CT-Scan: Computerized tomography Scan
ACS: Acute coronary syndrome
LAD: Left anterior descending artery
LCX: Left circumflex artery
RCA: Right coronary artery
MACE: Major adverse cardiac event
CCTA: Coronary CT angiography
CAD-RADS: Coronary Artery Disease Reporting and Data System

Introduction

Coronary artery disease (CAD) is the most common cause of mortality in developed countries [1, 2]. CAD is one of the most common diseases in human societies, thus killing thousands of people annually. Therefore, treatment and control of the disease impose enormous costs on individuals and communities [3, 4]. Additionally, because of the high prevalence and morbidity associated with CAD, it is one of the most pressing health issues in Iran [5]. CAD refers to stenosis or whole/part of CAD following spasmodic atherosclerosis or the presence of the clot. As for this condition, the infected artery cannot provide the nutritional needs of the myocardial muscle to oxygen, resulting in angina and myocardial infarction [6]. In 2003, CAD was identified as the leading cause of death worldwide, affecting more than 7 million lives. The disease can affect people at any age; however, it is more prevalent at an early age hence tripling the risk by rising every decade.
CAD affects men more than women. It has been shown that 60% of cardiovascular diseases occur in south Asia, thereby involving some 20% of the world's population [7]. The incidence rate of acute myocardial infarction and sudden death has been epidemiologically investigated and varies based on the risk factors such as age, sex and race at individual levels, and based on the countries, geographic regions, and social classes at demographic levels and over time CAD triggers mortality, morbidity, and disability in the Iranian population, contributing to almost 50% of the problem annually. The mortality rate due to CAD is reducing in developed countries. However, there is evidence that the disease is increasing in Iran, so its rate has escalated between 20% and 45%. It seems that changes in lifestyle like high consumption of processed foods and saturated fats, low levels of physical activity, and increasing the prevalence of obesity and type 2 diabetes are the contributing factors leading to a progressive increment in the prevalence of risk factors for cardiovascular diseases in developed countries. Research conducted on the adult population of Tehran demonstrates a high prevalence of risk factors for cardiovascular diseases, especially hypertension and high levels of total cholesterol. In Iran, the Ministry of Health official statistics show that 33 to 39.3% of deaths occur annually due to cardiovascular diseases. Myocardial infarction characterizes 19.5% of the prevalence of cardiovascular diseases in Iran [8, 9].
CAD is a chronic process initiated from a young age and progresses gradually. Known risk factors for this disease include high blood pressure, smoking, diabetes, sedation, obesity, high blood cholesterol, high triglycerides, alcohol indulgence, genetic predisposition, age, and sex [10-12]. Chest pain is the most common symptom of CAD occurring due to the narrowing of the cardiovascular vessels. Other symptoms of CAD include shortness of breath, weakness, nausea, and increased heart rate [13].Echocardiography can be beneficial for CAD diagnosis. For people who do not project a particular sign, echocardiography, cardiac imaging, and advanced non-invasive imaging is recommended [14]. CT angiography is an imaging method used to image arterial and venous vessels in the body. CT angiography is used to detect the number of arteries. In this method, the contrast is injected at high speed into the vessel and then the CT-scan device scans from the desired imaging area [15]. Coronary CT angiography (CCTA) is used to evaluate cardiac vessels. In addition to studying coronary artery disease, studying the stent, reviewing the open state or package of stents, and studying atherosclerotic diseases are used [16]. Studies have shown that CCTA has a diagnostic value of angiography in diagnosing CAD and vessel involvement [17]. Therefore, this study investigates the relationship between plaque and moderate coronary stenosis and plaque characteristics with cardiovascular events using CT angiography in the patients referred to the CT angiography department of Afshar Hospital in Yazd, Iran.

Materials and Methods

This retrospective diagnostic research was conducted in Afshar Cardiovascular Hospital in Yazd City, Iran. The study included all patients with suspected CAD in 2017 to 2018 who had been

referred to the CT angiography of Afshar Hospital and had undertaken the CT angiography of coronary arteries and atherosclerotic plaque diagnosed with stenosis medium. In this study, the researchers referred to the reception of the CT angiography section and extracted the following information from the CT report: the place of stenosis, vessel involved left anterior descending artery (LAD), left circumflex artery (LCX), and right coronary artery (RCA), plaque density (calcified, non-calcified, mixed), number of segments involved (1,2,3), remodeling, family history of cardiovascular disease, diabetes, blood pressure, dyslipidemia, cigarette smoking, and angiography after CT angiography. All patients were followed up for a year. MACE questionnaire covered five areas of death, myocardial infarction, angioplasty, reagent surgery vascular transplantation, and hospitalization to cardiac contact.

SPSS software version 22 was used to analyze the data. Descriptive statistics provided the frequency, mean, and standard deviations of variables. Inferrential statistics included Chi-square, Fisher's exact test and t-test. In all cases, *p-value* <0.05 was considered as a meaningful level. Inclusion criteria included all patients referred to the CT angiography section from 2017 to 2018 about whom CT angiography involved coronary arteries; these patients suffered from moderate coronary artery stenosis. Patients identified with any history of cancer and malignancies, unsuccessful angiopolism, or diseases augmenting blood coagulation (antiphospholipid syndrome, hyperhomocysteinemia, lupus) were excluded from the study. This research was carried out by obtaining permission from the Ethics Committee of Shahid Sadoughi University of Medical Sciences with code 1400199263. The study was carried out with full and informed consent of patients by completing consent forms. In this study, except for the patient's secrets predicated on the Helsinki treaty, they were assured that their information would remain confidential.

Results

In this study, 91 patients with a mean age of 62.76 ± 1.08, i.e., the minimum age of 38 and the maximum of 84 years were studied. The results of our study on the distribution of sex in the patients indicated 39 patients (42.9%) as female and 52 (57.1%) as male. The results concerning the frequency distribution of cardiovascular events using the MACE questionnaire demonstrated no evidence of major cardiovascular events, including death, myocardial infarction, angioplasty, open-heart surgery/vascular transplantation, and hospitalization due to cardiac disease during one-year follow-up of the patients. The findings on the frequency distribution of the involved vessels also projected that in 69 (75.8%) patients, the involved vessel is LAD; in 13 (14.3%), it is LCX and in 9 (9.9%) it is RCA.

The results on the frequency distribution of stenosis in CT angiography represented conflict being at the middle part of the LAD in 27 (29.7%) patients. Detailed information about the frequency distribution of stenosis is shown in Table 1.

Regarding the distribution of plaque density in patients, the results revealed density of the mixture in 50 (54.9%) of the patients (Table2).

Table 1. Frequency distribution of stenosis in patients examined

Place of conflict	Abundance	Percentage
PROXIMAL PART LAD	25	27.5
DISTAL PART LCX	3	3.3
OM1 LCX	2	2.2
PROXIMAL PART RCA	5	5.5
MID PART RCA	4	4.4
DISTAL PART RCA	1	1.1
MID PART LAD	27	29.7
DISTAL PART LAD	5	5.5
RAMUS INTER LAD	2	2.2
D1 LAD	7	7.7
D2 LAD	3	3.3
PROXIMAL LCX	7	7.7
Total	91	100

* **LAD**: *Left anterior descending artery,* **LCX**: *Left circumflex artery,* **OM1**: *first obtuse marginal artery*

Table 2. Distribution of plaque density in patients examined

Plaque density	Abundance	Percentage
Calcified	26	28.6
Non- Calcified	15	16.5
Mixed	50	54.9
Total	91	100

The results of this study on the distribution of the frequency of the number of segments involved in the patients demonstrated 57 (62.9%) patients bearing the conflict of one segment, 24 (26.4%) showing the conflict of 2 segments and 10 (11%) patients conflicting three segments. The distribution of variables, i.e., the presence of remodeling, family history of heart disease, diabetes, blood pressure,

dyslipidemia, smoking, and angiography after CT angiography in patients, were also reviewed. According to the findings, 9 (9.9%) patients after CT angiography were identified with chest pain complaints and undertook angiography that did not reveal any significant stenosis to require blood supply (revascularization).

Discussion

The current study evaluated the relationship between plaque characteristics and cardiovascular events in CT angiography performed in moderate coronary artery stenosis patients.

Involved vessels in our study were LAD, LCX, and RCA, with the maximum and minimum frequency distribution devoted to LAD and RCA, respectively.

Inconsistent with our results, in a study conducted by Hashemi, among 98 lesions found in coronary arteries, LAD artery with 46% frequency was the most common. After that, the involvement prevalence of LCX and RCA arteries appeared to be 23% [18]. In the US National Cardiovascular Plan, Dixon and his colleagues identified LAD with 38% frequency as the most common involved vessel. In comparison, the following degrees of involvement were related to RCA (34%) and LCX (28%) [19]. Also, in other studies based on cardiac autopsy, LAD was the most common artery with atherosclerosis among coronary arteries [20, 21]. Our research emanated from the frequency distribution of the stenosis site based on CT angiographic findings and identified the most common site of stenosis being the medial part of the LAD with a frequency of 29.7%, followed by the proximal part of LAD with 27.5% frequency. Also, the distal portion of RCA with 1.1% frequency is projected as the lowest. In a study conducted in 2008, the most common site of involvement was the proximal part of LAD [19]. In addition, based on Wada and Iwasaki's studies, the most common site of stenosis was the proximal part of LAD [22, 23]. However, in our study, the most common site of involvement was the medial part of the LAD. In spite of this, the proximity of its frequency to the proximal portion of LAD is similar to Wada and Iwasaki's studies.Investigating the frequency distribution of cardiovascular events in patients using the MACE questionnaire did not show any significant cardiovascular incidence, including death, cardiac stroke, angioplasty, open-heart surgery/vascular transplantation, and hospitalization for one-year cardiac follow-up patients. Jacobson's study was performed on 162 patients with primary acute coronary syndrome (ACS); during a 5-year follow-up, and about 25% experienced a second heart attack. In CT angiography, patients with a higher plaque burden or obstructive non-culprit plaques represented a significant risk of cardiovascular events [24]. Hashemi's study revealed that 32% of patients showed at least one of the complications of MACE after undertaking angiography [18]. In a survey conducted in 2014, it was revealed that regardless of obstructive or nonobstructive diseases, plaque and segment size >4 are associated with CAD complications. Also, the rate of cardiovascular events in patients with nonobstructive CAD with more than four segments of involvement was similar to that of people with more than 50% obstructive CAD and less than four-segment cases. This study revealed that if observed plaques during CT angiography are extensive, patients can be considered appropriate for invasive procedures [25]. In Sun's study conducted in 2012 on 800 patients, abnormal findings were observed in CT angiography in 549 cases (68.6%). Among the abnormal CT findings, there was no statistically significant relationship between sex and duration of symptoms, but abnormal findings escalated significantly with the increase in age ($P < 0.001$) [26].

The present study involved some strenghts and limitations. The samples were selected from the same clinic and were matched in terms of age and sex. However, the small number of samples, and the difference in the number of samples studied represent some limitations leading to disparity in the follow-up time, brought about different results compared to other studies, resulting in the lack of complications based on MACE criteria.

Conclusion

According to the obtained results, the most common age for CAD was the 1st and seventh decades of life. According to CT angiographic findings, the most common involved vessel was LAD, and the most common site of stenosis was the middle part of LAD. Also, the results revealed a low incidence of cardiovascular events in patients with moderate coronary artery stenosis during a 1-year follow-up. It implies that the incidence of major cardiovascular events such as death, myocardial infarction, angioplasty, and open-heart surgery/vascular transplant appears to be rare in Yazd.

Conflicts of Interest

All the authors declare no conflict of interest.

Acknowledgments
We are grateful to all those who helped us in this project, including Dr. Reza Nafisi Moghadam, Dr. Mohammad Hossein Ahrar, Dr. Seyed Kazem Razavi Rataki, and Dr. Paderzadeh, Dr. Nasim Namiranian and Dr. Abbas Arabi Alia.

References

1. Link N, Slater W. Coronary artery disease. West J Med.. 2001;174(5):330.
2. Keil U. The Worldwide WHO MONICA Project: results and perspectives. Gesundheitswesen. 2005;67 Suppl 1:S38-45.
3. Delemos J, Omland T. Chronic coronary artery disease: a companion to Braunwald's heart disease E-book: elsevier Health Sciences; 2017.
4. Mancini MC. Coronary artery bypass surgery: are outcomes influenced by demographics or ability to pay?. Ann Surg. 2001;233(5):617-22.
5. Ebrahimi M, Kazemi-Bajestani S, Ghayour-Mobarhan M, Ferns G. Coronary artery disease and its risk factors status in Iran: a review. Iran Red Crescent Med J. 2011; 13(9):610-623.
6. Jeremias A, Brown DL. Cardiac Intensive Care E-Book: Elsevier Health Sciences; 2010.
7. Rudisch B, Nemeroff CB. Epidemiology of comorbid coronary artery disease and depression. Biol Psychiatry. 2003;54(3):227-40.
8. Hatmi Z, Tahvildari S, Motlag AG, Kashani AS. Prevalence of coronary artery disease risk factors in Iran: a population based survey. BMC Cardiovasc Disord. 2007;7:32.
9. Sarraf-Zadegan N, Sayed-Tabatabaei F, Bashardoost N, et al. The prevalence of coronary artery disease in an urban population in Isfahan, Iran. Acta Cardiol. 1999; 54(5):257-63.
10. Torpy JM, Burke AE, Glass RM. Coronary heart disease risk factors. Jama. 2009; 302(21):2388.
11. Kivimäki M, Nyberg ST, Batty GD, et al. Job strain as a risk factor for coronary heart disease: a collaborative meta-analysis of individual participant data. Lancet. 2012; 380(9852):1491-7.
12. Khera AV, Kathiresan S. Genetics of coronary artery disease: discovery, biology and clinical translation. Nat Rev Genet. 2017;18(6):331-344.
13. Bax JJ, Poldermans D, Elhendy A, et al. Improvement of left ventricular ejection fraction, heart failure symptoms and prognosis after revascularization in patients with chronic coronary artery disease and viable myocardium detected by dobutamine stress echocardiography. J Am Coll Cardiol. 1999; 34(1):163-9.
14. Loder E, Weizenbaum E, Frishberg B, Silberstein S, Force AHSCWT. Choosing Wisely in Headache Medicine: The A merican Headache Society's List of Five Things Physicians and Patients Should Question. Headache. 2013; 53(10):1651-9.
15. Baliyan V, Shaqdan K, Hedgire S, Ghoshhajra B. Vascular computed tomography angiography technique and indications. Cardiovasc Diagn Ther. 2019;9(Suppl 1):S14-S27.
16. Sun Z, Lin C, Davidson R, Dong C, Liao Y. Diagnostic value of 64-slice CT angiography in coronary artery disease: a systematic review. Eur J Radiol. 2008; 67(1):78-84.
17. Miller JM, Rochitte CE, Dewey M, et al. Diagnostic performance of coronary angiography by 64-row CT. N Engl J Med. 2008; 359(22):2324-36.
18. Hashemi SM, Firouzfar A, Hajheidari P, Yadegarfar G, Danesh M, Shoureshi P. Anatomic distribution of coronary culprit lesion and five-year follow-up for major adverse cardiac events (MACE) in patients with acute coronary syndrome. J 2017; 35(444):1074-1079.Isfahan Med School.
19. Dixon WC, Wang TY, Dai D, et al. Anatomic distribution of the culprit lesion in patients with non–ST-segment elevation myocardial infarction undergoing percutaneous coronary intervention: findings from the National Cardiovascular Data Registry. J Am Coll Cardiol. 2008; 52(16):1347-8.
20. Kajinami K, Seki H, Takekoshi N, Mabuchi H. Coronary calcification and coronary atherosclerosis: site by site comparative morphologic study of electron beam computed tomography and coronary angiography. J Am Coll Cardiol. 1997; 29(7):1549-56.
21. Wasilewski J, Roleder M, Niedziela J, et al. The Role of septal perforators and “myocardial bridging effect” in atherosclerotic plaque distribution in the coronary artery disease.Pol J Radiol. 2015; 80(1):195-201.
22. Wada K, Fujii K, Horitani K, et al. Influence of different physiological hemodynamics on fractional flow reserve values in the left coronary artery and right coronary artery. Heart Vessels. 2021; 36(8):1125-1131.
23. Murasato Y, Hikichi Y, Nakamura S, et al. Recent perspective on coronary bifurcation intervention: statement of the “Bifurcation Club in KOKURA”. J Interv Cardiol. 2010; 23(4):295-304.
24. Jacobson AF, Senior R, Cerqueira MD, et al. Myocardial iodine-123 meta-iodobenzylguanidine imaging and cardiac events in heart failure: results of the prospective ADMIRE-HF (AdreView Myocardial Imaging for Risk Evaluation in Heart Failure) study. J Am Coll Cardiol. 2010; 55(20):2212-21.
25. Bittencourt MS, Hulten E, Ghoshhajra B, et al. Prognostic value of nonobstructive and obstructive coronary artery disease detected by coronary computed tomography angiography to identify cardiovascular events. Circ Cardiovasc Imaging. 2014; 7(2):282-91.

26. Sun Z-H, Liu Y-P, Zhou D-J, Qi Y. Use of coronary CT angiography in the diagnosis of patients with suspected coronary artery disease: findings and clinical indications. J Geriatr Cardiol. 2012; 9(2):115-22.