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Original Research Article

Correlation of Atherogenic Index of Plasma with Coronary Artery Disease in Myocardial Infarction Patients: An Observational Study from North-India

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Abstract:

Background: Atherogenic Index of Plasma (AIP) is a newer marker of dyslipidemia that includes both atherogenic and anti-atherogenic lipid factors, i.e. triglycerides and high-density lipoprotein, and is recently studied for various cardio-vascular disease risk evaluations. However, its correlation with coronary artery disease (CAD) is scarcely described in the current literature.

Aim: To study the correlation of AIP with CAD in myocardial infarction (MI) patients.

Material and Methods: This was a single-centered observational study for a period of six months. Patients of age ≥18 years with a diagnosis of acute MI were included in this study, and lipid analysis was performed to identify the AIP. Then the patients underwent conventional CAG, and the GENSINI severity score was calculated on the basis of angiographic results. Both of these parameters were then correlated with Pearson's 'r' correlation analysis and, a p-value <0.05 was considered statistically significant.

Results: A total of 114 patients fulfilled the eligibility criteria and were included in this study. The mean age of the study group was 60.7 years, and male participants were more in numbers than female individuals (88 vs. 26). The average AIP and GENSINI scores were 0.15 and 35.8 respectively, and correlation analysis between the two parameters demonstrated a positive r-value (0.4405) with a statistically significant p-value.

Conclusion: The study concluded that AIP has a positive correlation with CAD severity in the MI population.

Keywords: Atherogenic index of plasma; Coronary angiography; Coronary artery disease; Dyslipidemia; Myocardial infarction

Introduction

One of the leading causes of cardiac morbidity and mortality is coronary artery disease (CAD), leading to myocardial infarction (MI). [1] The MI is the tissue necrosis of viable myocardium due to improper blood supply to cardiac myocytes. The most common cause of this tissue oxygen demand supply mismatch is CAD, which is coronary occlusion due to atherosclerosis. It is a multifactorial process that includes various genetic and environment factors, and recent studies have shown that low high-density lipoprotein (HDL) cholesterol and high total cholesterol (TC), low-density lipoprotein (LDL), and triglyceride (TG) levels are the major drivers of dyslipidemia. [2,3] This complex process, along with the inflammation of the vessel wall, is the triggering factor for plaque formation. With the addition of fatty tissue into the core structure, these plaques continue to grow, which subsequently leads to coronary blockade and MI. Thus, dyslipidemia is one of the key factors in the development of CAD.

The traditional risk factor modification guidelines include lipid-lowering strategies, which focus mainly on a decrease in LDL cholesterol. However, studies have demonstrated that after reducing the LDL cholesterol to the desired value, about 50% of cardiovascular risk still remains. [4] Also, researchers have recently started focusing on different markers of dyslipidemia, which include more than one parameter to reduce the fallacy of a single parameter. Thus, various new markers of incipient dyslipidemia have emerged for early detection of the ongoing atherosclerosis process. Among these, the atherogenic index of plasma (AIP) is one such marker, recently developed to reflect the balance between atherogenic and anti-atherogenic factors.

The current research has shown a positive correlation between AIP and the risk of CAD development.[5-6] In an Iranian study, AIP had a positive association with obesity-defining parameters like waist circumference and body mass index.[5] A study from Turkey also depicted AIP as a positive predictor of CAD.[7] But the direct

association between AIP and CAD severity in MI patients has been scarcely described in the current literature. Thus, this study focused on AIP to demonstrate a correlation with CAD severity and coronary angiographic outcomes in diagnosed MI patients.

Objective

To study the correlation of the atherogenic index of plasma with coronary artery disease in myocardial infarction patients.

Materials and Methods

Study Design and sample process

The study was a single-centered, tertiary hospital-based cross-sectional study with a duration of 6 months. Patients aged 18 years or older with a typical history of chest pain, electrocardiographic changes, and elevated cardiac bio-markers were included. Patients with age <18 years, preexisting confirmed diagnosis of coronary artery disease, history of previous coronary artery bypass grafting or percutaneous coronary intervention, and individuals' already on lipid-lowering drugs and concomitant other cardiac diseases were excluded. The presence of malignant tumors, severe liver or kidney diseases, hereditary hyperlipidemia, or congenital cardiovascular disease, and individuals with an incomplete medical history or incomplete clinical data were also not included in this study.

Data collection

MI was confirmed by history, electrocardiography (ECG) characteristics, and elevation of Troponin T/I enzymes. The patients were then enrolled with verbal and written consent. They were explained regarding the nature and objective of the study. Only patients who gave positive consent were evaluated further. As per routine in-hospital management, patients were stabilized and then underwent biochemical analysis, including a complete blood count and lipid profile.

Ethical approval and consent to participate

This study was approved by the institutional review board. Written consent was obtained from the patients or their first-degree relatives (in the case of the patients' inability). No intrusions or changes were made in the routine management of the patient. Participants (or first-degree relatives) were assured that the confidentiality of personal data would be maintained at every possible level.

Measurement of AIP

After diagnosing the MI, lipid profiles containing TC, TG, LDL, and HDL levels were evaluated in all the participants. AIP was calculated according to the formula AIP = log (TG/HDL).

Coronary Angiography

All studied patients underwent coronary artery angiography by the Judkin technique via the femoral/radial approach with a 6-Fr catheter. CAD was defined in accordance with the 1979 WHO diagnostic Criteria.[8] The GENSINI scoring system was used to determine the severity of CAD [9]. This method defines narrowing of the lumen of the coronary arteries as 1 for 1% to 25% stenosis, 2 for 26% to 50%, 4 for 51% to 75%, 8 for 76% to 90%, 16 for 91% to 99%, and 32 for total occlusion. The score is then multiplied by a factor representing the importance of the lesion's location in the coronary artery system. For the location scores, 5 points were given for the left main lesion; 2.5 for the proximal left anterior descending (LAD) or left circumflex (LCX) artery; 1.5 for the mid-segment LAD and LCX; 1 for the distal segment of LAD and LCX, first diagonal branch, first obtuse marginal branch, right coronary artery, posterior descending artery, and intermediate artery; and 0.5 for the second diagonal and second obtuse marginal branches. All coronary segments were interpreted visually by two experienced cardiologists blinded to participant details, and the final score was calculated. The patient then underwent further revascularization procedures, i.e angioplasty or bypass grafting, as per the requirement.

Statistical Analysis

All of the collected data was first entered into a Microsoft Excel 2019 sheet. This was further evaluated for statistical analysis by using the SPSS version 28 software. Data was expressed as Mean ± Standard Deviation (SD) and variables were compared using Student t-test. The correlation association was identified using Pearson 'r' correlation analysis and a p-value <0.05 was considered statistically significant.

Results

Description of study population

A total of 128 patients from a tertiary health care facility were selected for this study after fulfilling the eligibility criteria, of whom, 120 underwent CAG. Among these, 114 patients had full CAG and biochemistry results and were included in this study. NSTEMI was the most prevalent MI in this cohort (35.0%), followed by AWMI (28.9%) and IWMI (8.7%) (Figure 1).

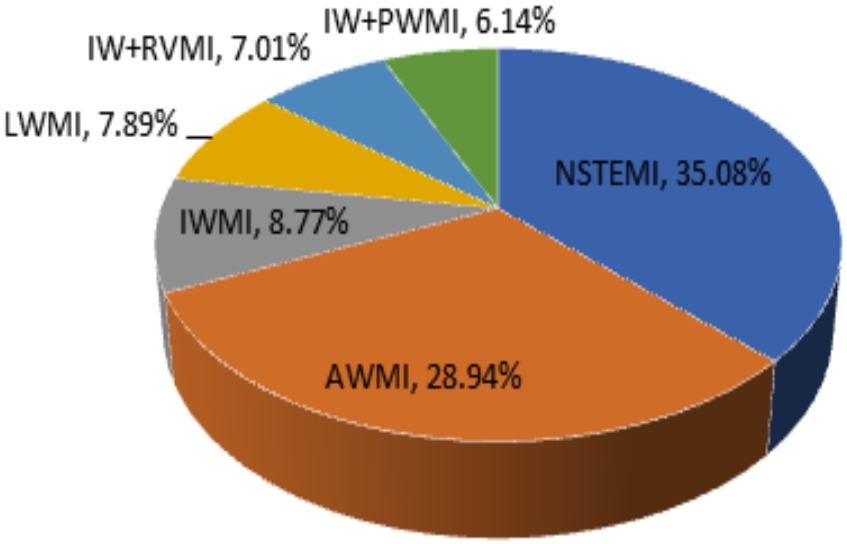

Figure 1: Pie-chart of total population demonstrating the prevalence of various MI types.

Male patients outnumbered female participants (88 vs. 26), and the mean age of the study population was 60.7 (±10.6) years. The female group had higher mean age, total cholesterol and triglyceride levels, AIP, and the GENSINI score as compared to their male counterparts (Table 1).

Table 1: Basic characteristics of the study population

Parameters	Total population (N= 114)	Male population (N= 88)	Female population (N=26)	p-value*
Age (years)	60.7 (±10.6)	59.4 (±9.5)	65.1 (±12.8)	< 0.01 (S)
Hemoglobin (gm/L)	13.1 (±2.0)	13.5 (±1.7)	11.6 (±2.2)	< 0.01 (S)
Platelet count (× 10^9/L)	241.6 (±136.7)	231.2 (±148.4)	276.7 (±78.4)	0.06
Total leukocyte count (× 10^9/L)	9.6 (±3.3)	9.6 (±3.3)	9.5 (±3.4)	0.44
Total Cholesterol (mg/dl)	148.1 (±37.6)	145.5 (±32.9)	157.0 (±50.4)	0.08
Triglyceride (mg/dl)	131.3 (±31.4)	127.4 (±29.8)	144.7 (±33.5)	< 0.01 (S)
High density lipoprotein (mg/dl)	39.3 (±5.1)	39.3 (±5.1)	39.5 (5.20)	0.43
Low density lipoprotein (mg/dl)	91.2 (±27.3)	91.23 (±27.9)	91.3 (±25.7)	0.49
Atherogenic Index of Plasma (AIP)	0.15 (±0.10)	0.14 (±0.10)	0.19 (±0.09)	0. 01 (S)
Ejection Fraction (%)	44.0 (±9.7)	44.2 (±9.7)	43.4 (±9.58)	0.28
GENSINI Score	35.8 (±20.6)	34.3 (±19.8)	41.2 (±22.6)	0.06
*Student t-test; (S): Significant				

Triple vessel involvement was more prevalent in the male population, and a total of 61 (53.5%) patients had all three vessels diseased (Figure 3). Left main vessel involvement was observed in 4.38% of individuals.

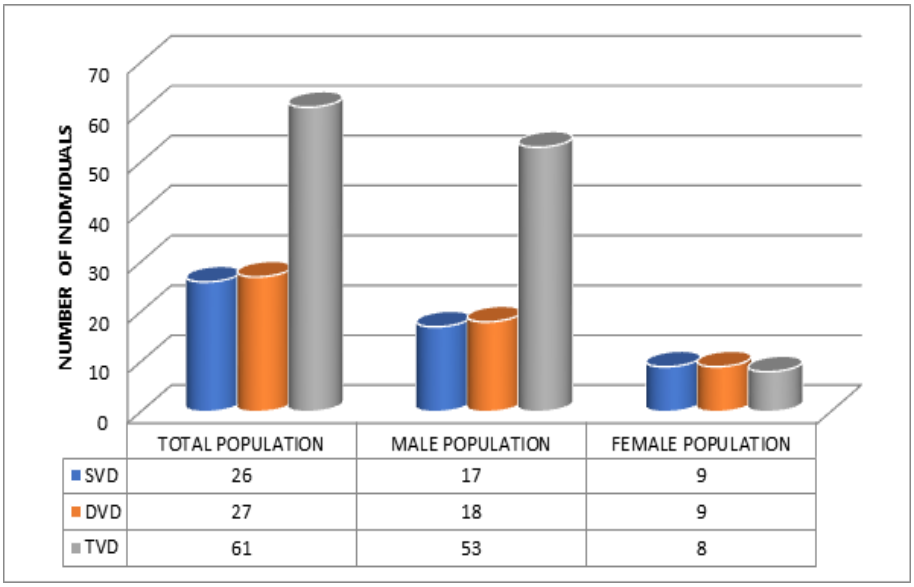

Figure 2: Bar-graph demonstrating the number of vessels involvement in the study cohort

AIP with GENSINI score

When AIP was correlated with the GENSINI score, a positive 'r' value (0.4405) was observed for the total population (p-value <0.05), and the female population had the highest value of the correlation coefficient (0.4905), demonstrating a stronger correlation between these two parameters with a statistically significant p-value (Table 2).

Table 2: Correlation of AIP with GENSINI score

	AIP with GENSINI Score	
	'r' value*	**p-value**
Total Population (N=114)	0.4405	< 0.01 (S)
Male (N=88)	0.4081	<0.01 (S)
Female (N=26)	0.4905	0.01 (S)
* Pearson's correlation; (S): Significant		

Discussion

In this observational study, the correlation between AIP and CAD severity was studied in the North Indian population. The study cohort had a higher number of male participants, and the mean age was in the older age group, depicting a higher incidence of MI in the older and male gender individuals. These findings were similar to a recent study by Cai et al on 5387 subjects, in which the mean age of the study cohort was 62.1 years and 60.18% of the subjects were male. [10] The research demonstrated that AIP was a strong independent risk factor for CAD in the Chinese Han population.

The mean AIP level in the study cohort was 0.15, which is at intermediate risk for cardio-vascular disease. [5] Previously, the levels of AIP have been associated with fatty liver, hidradenitis suppurativa, osteomyelitis in patients with diabetic foot, obesity, and diabetes. [11] All of these pathologies are linked with vascular oxidative stress and insulin resistance, leading to atherosclerosis development. Thus, AIP is an indirect assessment of atherosclerosis burden and related complications, including CAD. Having an average AIP of 0.15 in our study cohort, triple vessel disease in more than half of the study cohort also describes a positive association of this marker with CAD severity.

For the objective correlation of CAD severity with AIP, the GENSINI score was calculated. The mean GENSINI score was 35.8, which describes a severe CAD in our population (score >20).[9] When the score was correlated with AIP, the analysis demonstrated a positive correlation with a significant p-value in the total population and both gender groups. Our results were in accordance with those of Elyamani AS et al, which evaluated AIP in 150 diabetic individuals. [12] This finding was also consistent with a recent meta-analysis by Ulloque-Badaracco JR et al, which stated that a higher value of AIP increases the odds of developing CAD. [13] The indirect correlation between developing CAD

and high AIP is also described in various studies. Choudhary MK et al demonstrated an association between AIP and arterial stiffness in normotensive individuals, which is a marker of CAD. [14] Similarly, a study from Korea described a significant correlation between coronary calcium and AIP levels. [15]

In this study, one important limitation was that it was a single-centered study with small numbers of participants. So, further confirmation of the result is desirable in large multi-center studies. Also, the GENSINI score is an observer-dependent CAD severity score, which may have a score variation between observers. But to reduce this variation, two experienced cardiologists were designated to calculate the score for all the individuals.

Conclusion

The study demonstrated a positive correlation between AIP and the GENSINI score in the adult age group population, which describes that a raised value of AIP is associated with severe CAD and multiple vessel involvement. The easy calculability of this dyslipidemia-defining marker further adds in its importance for routine testing in high-risk individuals and provides a new parameter for targeted therapy.

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