Original Article

The relationship between Intima-Media Thickness and Carotid Plaque Characteristics with Incidence and Severity of Premature Coronary Artery Disease

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Abstract

Background: Carotid intima media thickness (CIMT) and carotid plaque can predict premature coronary heart disease (PCAD) in patients hospitalized due to coronary artery disease or undergoing therapeutic interventions. This study aimed to determine the relationship between intima media thickness and carotid plaque characteristics with the incidence and severity of premature coronary artery disease.

Materials and Methods: The current study was an analytical cross-sectional study conducted on patients referred to Imam Hossein Hospital in 2021-2022 who underwent coronary angiography. Patients were classified into two groups with coronary artery involvement and the group without evidence of significant coronary involvement. Then the data of patients, such as sex, age, risk factors of cardiovascular diseases, and clinical history of individuals, were collected through interviews and aspects related to carotid intima media thickness and plaque formation through a specialized review of reports.

Results: A total of 59 women (%59) and 41 men (%41) participated in this study. The mean age was 51.50±9.54. The results of this study showed that there was a direct (positive) and significant correlation between carotid intima media thickness factors, including right and left carotid intima-media thickness, right and left carotid intima media thickness scores, and the number of carotid plaques with increasing severity of coronary artery involvement (P-values<0.05). There was a statistically significant correlation between carotid plaque number and severity of coronary artery disease (P-value<0.05).

Conclusion: CIMT has a significant correlation with PCAD, and in patients at risk of PCAD, measurement of CIMT was a suitable method.

Keywords: Atherosclerosis, Carotid, Intima, Premature coronary heart disease

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Introduction

Early-onset atherosclerotic disease involving more than 50% of coronary artery stenosis is premature coronary artery disease (PCAD). PCAD increases the risk of myocardial infarction[1]. Common risk factors for

Intima-Media Thickness and PCAD are diabetes, hypertension, smoking, high body mass index, and high levels of low-density lipoprotein cholesterol[2]. Due to PCAD being associated with increased mortality and morbidity, timely diagnosis of PCAD is vital[3].

One diagnostic method recommended for PCAD is carotid artery intima-media thickness (CIMT)[4]. This method is a non-invasive, quick, and repeatable test for PCAD[5-7]. CIMT is the distance between the media-adventitia layer's echogenic part and the lumen-intima layer's echogenic part with ultrasound. This view was assessed by radiologists in B-mode. It is suggested that this method can predict early atherosclerosis stages and is related to vascular events and cardiovascular outcomes[8, 9]. CIMT could be associated with the CVD risk factors such as sex, smoking, hypertension, diabetes, and cholesterol[10-12].

CIMT refers to the measurement of the thickness of the inner two layers of the carotid artery, including the intima and the media, which is in the far wall of the common carotid artery, 1 cm proximal to the bifurcation of the artery in a place where there is no plaque and higher values than 1 cm, it is considered increased or abnormal. It has been found that the increase in the thickness of the carotid intima-media and the occurrence of carotid plaques (increase in the focal thickness of the vessel wall (≥50%) with the thickness of the intima-media>1.2 mm that protrudes into the vessel lumen) are also significantly predictive. It is considered a risk factor for cardiovascular diseases[12]. It has also been found that the increase in carotid intima-media thickness has a close relationship with the risk of acute coronary syndrome such as myocardial infarction[18, 1].

Considering that the prediction of the occurrence of coronary heart disease at a younger age (premature coronary artery disease is considered in which the stenosis is greater than 50% in at least one of the main coronary arteries at the age of less than 55 years in men and less than 65 years old in women) can cause adverse outcomes at this age, such a prediction using a variety of clinical parameters will be very important. In this regard, non-invasive imaging methods such as ultrasonography have been more welcomed. It seems that the use of carotid artery atherosclerosis evaluation and carotid intima media thickness evaluation using ultrasound method can advance predicting the risk of early coronary artery disease. This study evaluated the relationship between intima-media thickness and carotid plaque characteristics with the incidence and severity of premature coronary artery disease.

Methods

In this cross-sectional-analytical study, patients referred to Imam Hossein Hospital in October 2021 who underwent coronary angiography were included. Then, the patients were divided into two groups based on the age criteria (women under 65 years and men under 55 years) and based on the results of coronary angiography so that the group with coronary vascular involvement in the affected group (in the form of a stenosis of at least 50% in at least one of coronary arteries) and the group without evidence of significant coronary artery involvement were classified in the non-affected group.

The sample size based on Oliveira et al. and Sanchis-Gomar et al.[13, 14] was calculated as 84 patients. Data collection in this study was done using a checklist that includes sex, age, risk factors of cardiovascular diseases, the clinical history of the individuals, and the results of the reports of angiography and ultrasound. Data collection was done by reviewing clinical records and face-to-face interviews with patients. Inclusion criteria were men under 55 and women under 65 with suspected symptoms of coronary artery involvement, including chest pain and DOE, who were candidates for coronary angiography. Exclusion criteria were a history of coronary artery bypass surgery (CABG) and percutaneous coronary intervention (PCI) or a history of carotid artery revascularization (angioplasty or carotid endarterectomy).

Patients were divided into two groups, as discussed earlier, and the ratio of selection of patients in the first group to the second one in this study was one-to-one. Patient information, including gender, age, cardiovascular disease risk factors, and clinical history, was extracted. Patients' clinical information was extracted through specialized examination of patients' angiography reports, which included 1. Some involved coronary arteries, 2. Location of coronary artery involvement (proximal, middle, or distal), 3. Determination of stenosis percentage. All patients underwent carotid artery evaluation using ultrasonography within a maximum of one week after coronary angiography.

The findings investigated in carotid ultrasound evaluation included: 1) the evidence of carotid calcification on both sides, 2) carotid stenosis and carotid plaques on both sides, 3) determining the thickness of the carotid intima-media in the involved areas and calculating its mean (mean IMT), 4) determining the IMT score based on the number of location involved in IMT, 5) determining the plaque score based on the mean thickness of the plaques, 6) determining the maximum length of the carotid plaque (max CPL). Finally, all data were compared between the two groups, and the severity of coronary artery involvement and prognostic value of CIMT in early diagnosis of PCAD were investigated.

Statistical analysis: At first, the normality of quantitative variables was evaluated using the Kolmogorov-Smirnov test and Q-Q chart. Mean, and standard deviation (SD) were used to report quantitative variables, and frequency and percentage (%) were used to describe grouped variables. The non-parametric Mann-Whitney U test was used to compare the averages of the quantitative variables between the two groups due to the non-normal distribution. Appropriate statistical tests such as the Chi-square test or Fisher's exact test were used to check the difference in the distribution of grouped variables. Spearman's rank correlation coefficient was used to investigate the correlation between the severity of coronary artery disease and other carotid artery ultrasound factors due to the variable's rank nature and the variables' non-normal distribution.

The logistic regression model was used to identify the association between independent factors and significant PCAD occurrence. Also, the Ordinal regression model was used for assessing related factors with the severity of PCAD in univariate and multivariable levels. The stepwise selection method with forward and backward approaches (with P_value ≤ 0.2) was used to select the best variables to enter the last multivariable models. Finally, the best multivariable logistic regression model was fitted based on the Area Under Curve (AUC, ROC curve) value, Akaike information criterion (AIC), and the Hosmer-Lemeshow test. The statistical analysis was conducted two-tailed at a significant level of less than 0.05. The results of the models were reported as Odds Ratio with 95% Confidence Interval (CI). The analysis was performed using STATA.14.

Ethical issue: The ethical committee of Shahid Beheshti University of Medical Science approved this study (IR.SBMU.MSP.REC.1401.173).

Results

In the present study, 100 patients were enrolled into two groups with coronary artery involvement (n=50) and a group without evidence of significant coronary artery involvement (n=50), of which 59 were female, and 41 were male. The demographic, historical, and clinical data of all patients in the two groups are seen in Table 1. There were statistically significant differences between the two groups in terms of age, hip circumference (cm), opium addiction, diabetes mellitus, dyslipidemia, heart failure, HbA1c level, and Troponin I (all P-values <0.05). These parameters were higher in patients with PCAD.

Table 2 shows the clinical cardiac manifestation and angiography results in the two groups. The mean ejection fraction (EF) in the PCAD group was 44.68 ± 12.75 and 51.16 ± 7.09 in people without PCAD. There was a significant difference between the two groups in terms of EF. There were statistically significant differences between the two groups regarding chest pain, the occurrence of stable angina and ST-elevation myocardial infarction (STEMI), and coronary artery involvement (all P-values<0.05).

We evaluated CIMT in both groups, and it was observed that there were statistically significant differences between all parameters of CIMT between the two groups (P-values<0.05), except plaque location (P-values>0.05). The results showed in Table 3.

Investigation of the correlation between the severity of coronary artery disease and intima media thickness in patients showed that there was a direct (positive) and significant correlation between carotid ultrasound factors (including right and left carotid intima media thickness, right and left carotid intima media thickness score and the number of carotid plaques) with increasing the severity of coronary artery involvement. The data are seen in Table 4.

The assessment of factors related to significant coronary artery disease among patients based on univariate and multivariate logistic regression models is shown in Table 5. According to the results of univariate

Table 1. General and clinical characteristics of non-significant and significant PCAD patients.

Variables	Non-significant PCAD (n=50)	Significant PCAD (n=50)	Total (n=100)	P_value
General information				
Age (years)	49.45 ± 10.45	53.54 ± 8.15	51.50 ± 9.54	**0.018***
Gender				
Female	33 (66.00)	26 (52.00)	59 (59.00)	0.155
Male	17 (34.00)	24 (48.00)	41 (41.00)	
Anthropometric assessment				
Waist circumference (cm)	99.25 ± 19.41	100.56 ± 11.02	99.89 ± 15.80	0.984
Hip circumference (cm)	108.06 ± 14.75	102.97 ± 10.00	105.60 ± 12.86	**0.037***
Body Mass Index (BMI, kg/m^2)	30.23 ± 6.19	29.20 ± 4.96	29.73 ± 5.62	0.217
Habits and underlying diseases (Yes)				
Current smoker	8 (16.00)	14 (28.00)	22 (22.00)	0.148
Water pipe	3 (6.00)	3 (6.00)	6 (6.00)	1.000
Opium addiction	2 (4.00)	10 (20.00)	12 (12.00)	**0.028***
Diabetes Mellitus	9 (18.00)	23 (46.00)	32 (32.00)	**0.003***
Hypertension	22 (42.00)	29 (58.00)	50 (50.00)	0.110
Dyslipidemia	18 (36.00)	33 (66.00)	51 (51.00)	**0.003***
Thyroid function				
Normal	40 (80.00)	42 (84.00)	82 (82.00)	
Hypothyroidism	10 (20.00)	7 (14.00)	17 (17.00)	0.454
Hyperthyroidism	0 (0.00)	1 (2.00)	1 (1.00)	
Ischemic Heart Disease (IHD)	4 (8.00)	12 (24.00)	16 (16.00)	0.054
Myocardial Infarction (MI)	1 (2.00)	1 (2.00)	2 (2.00)	1.000
Heart Failure	2 (4.35)	9 (20.00)	11 (11.00)	**0.027***
Cerebral Vascular Accident / Transient Ischemic Attack(CVA/TIA)	1 (2.00)	5 (10.00)	6 (6.00)	0.204
Chronic Kidney Disease (CKD)	1 (2.00)	4 (8.00)	5 (5.00)	0.362
Family history of CVA/TIA	15 (28.00)	17 (34.00)	31 (31.00)	0.517
Family history of IHD /MI	34 (68.00)	37 (74.00)	71 (71.00)	0.509

Family history of sudden death	13 (26.00)	15 (30.00)	28 (28.00)	0.656
Laboratory results				
HbA1c	5.98 ± 0.42	8.62 ± 2.81	7.55 ± 2.53	**<0.0001***
Triglyceride	104.64 ± 34.79	177.88 ± 175.94	148.23 ± 141.13	0.120
Cholesterol	164 ± 34.52	161.5 ± 45.005	162.52 ± 40.62	0.820
LDL	105.11 ± 27.29	113 ± 35.65	109.45 ± 32.01	0.624
HDL	42.27 ± 7.63	39.60 ± 8.43	40.78 ± 8.10	0.215
Troponin I	0.43 ± 1.25	1.67 ± 3.82	1.16 ± 3.09	**0.030***
CRP	7.76 ± 8.40	14.56 ± 25.40	12.39 ± 21.60	0.553
ESR	18.94 ± 17.11	23.49 ± 20.93	22.005 ± 19.71	0.564
Pro-BNP	469.8 ± 891.31	946.77 ± 1238.82	774.53 ± 1136.23	0.419

Data describes as n (%) or mean ± standard deviation, * statistically significant, P_value < 0.05

Table 2. Description of clinical and angiography results between non-significant and significant PCAD patients.

Variables	**Non-significant PCAD (n=50)**	**Significant PCAD (n=50)**	**Total (n=100)**	**P_value**
LVEF (%)	51.16 ± 7.09	44.68 ± 12.75	47.92 ± 10.77	**0.003***
Chief complaints				
Non-anginal chest pain	3 (6.00)	3 (6.00)	6 (6.00)	1.000
Atypical chest pain	10 (20.00)	2 (4.00)	12 (12.00)	**0.028***
Typical chest pain	26 (52.00)	38 (76.00)	64 (64.00)	**0.012***
Dyspnea	29 (58.00)	25 (50.00)	54 (54.00)	0.422
Weakness	2 (4.00)	1 (2.00)	3 (3.00)	0.558
Palpitation	7 (14.00)	2 (4.00)	9 (9.00)	0.160
Syncope	0 (0.00)	1 (2.00)	1 (1.00)	1.000
Faint	0 (0.00)	1 (2.00)	1 (1.00)	1.000
Without symptoms	2 (4.00)	1 (2.00)	3 (3.00)	1.000
PCAD presentation				
Stable angina	16 (32.00)	2 (4.00)	18 (18.00)	**<0.001***
Unstable angina	31 (62.00)	32 (64.00)	63 (63.00)	0.836
Non-STEMI	2 (4.00)	1 (2.00)	3 (3.00)	1.000
STEMI	0 (0.00)	14 (28.00)	14 (14.00)	**<0.001***
Clinical implementation for patients with STEMI				
Thrombolytic	0 (0.00)	7 (50.00)	7 (50.00)	N/A
Primary-PCI	0 (0.00)	7 (50.00)	7 (50.00)	
Heart failure	0 (0.00)	1 (2.00)	1 (1.00)	1.000
Without PCAD presentation	1 (2.00)	0 (0.00)	1 (1.00)	1.000

Coronary artery involvement				
Normal /Mild	44 (86.27)	0 (0.00)	44 (44.00)	**<0.001***
Ectasia	5 (9.80)	3 (6.12)	8 (8.00)	0.715
Muscle bridge	0 (0.00)	1 (2.04)	1 (1.00)	0.490
Slow flow	6 (11.76)	0 (0.00)	6 (6.00)	**0.027***
SVD	0 (0.00)	22 (44.90)	22 (22.00)	**<0.001***
2VD	0 (0.00)	10 (20.41)	10 (10.00)	**<0.001***
3VD	0 (0.00)	18 (36.00)	18 (18.00)	**<0.001***

Data describes as n (%) or mean ± standard deviation, * statistically significant, P_value < 0.05. N/A means not applicable

Table 3. Description of Carotid intima-media thickness ultrasound's results between non-significant and significant PCAD patients.

Carotid intima-media thickness ultrasound's results	**Non-significant PCAD (n=50)**	**Significant PCAD (n=50)**	**Total (n=100)**	**P_value**
Right carotid thickness	0.66 ± 0.10	0.71 ± 0.10	0.69 ± 0.10	**0.017***
Left carotid thickness	0.67 ± 0.11	0.72 ± 0.16	0.70 ± 0.14	**0.033***
Right IMT score				
0	46 (92.00)	39 (78.00)	85 (85.00)	
1	3 (6.00)	11 (22.00)	14 (14.00)	**0.041***
2	1 (2.00)	0 (0.00)	1 (1.00)	
Left IMT score				
0	44 (88.00)	33 (66.00)	77 (77.00)	
1	5 (10.00)	16 (32.00)	21 (21.00)	**0.010***
2	0 (0.00)	1 (2.00)	1 (1.00)	
3	1 (2.00)	0 (0.00)	1 (1.00)	
Right IMT segment thickness				
Right segment 1 (RS1)	0.64 ± 0.15	0.65 ± 0.11	0.64 ± 0.13	0.369
Right segment 2 (RS2)	0.80 ± 0.16	0.88 ± 0.19	0.84 ± 0.18	0.070
Right segment 3 (RS3)	0.63 ± 0.15	0.71 ± 0.15	0.67 ± 0.16	**0.009***
Right segment 4 (RS4)	0.59 ± 0.09	0.63 ± 0.13	0.61 ± 0.11	0.211
Left IMT segment thickness				
Left segment 1 (LS1)	0.65 ± 0.13	0.70 ± 0.17	0.67 ± 0.15	0.169
Left segment 2 (LS2)	0.82 ± 0.16	0.87 ± 0.20	0.85 ± 0.18	0.235
Left segment 3 (LS3)	0.66 ± 0.15	0.75 ± 0.18	0.71 ± 0.17	**0.005***
Left segment 4 (LS4)	0.59 ± 0.12	0.66 ± 0.17	0.63 ± 0.15	**0.012***
Plaque				
No	42 (84.00)	24 (48.00)	66 (66.00)	**<0.001***
Yes	8 (16.00)	26 (52.00)	34 (34.00)	
Plaque number				
0	42 (84.00)	24 (48.00)	66 (66.00)	
1	3 (6.00)	9 (18.00)	12 (12.00)	**0.002***
2	3 (6.00)	9 (18.00)	12 (12.00)	
≥ 3	2 (4.00)	8 (16.00)	10 (10.00)	

Plaque location (Yes)				
Right segment 1 (RS1)	3 (50.00)	10 (47.62)	13 (48.15)	1.000
Right segment 2 (RS2)	5 (83.33)	16 (76.19)	21 (77.78)	0.711
Right segment 3 (RS3)	0 (0.00)	5 (23.81)	5 (18.52)	0.555
Right segment 4 (RS4)	0 (0.00)	1 (4.76)	1 (3.70)	1.000
Left segment 1 (LS1)	2 (28.57)	8 (38.10)	10 (35.71)	1.000
Left segment 2 (LS2)	7 (100.00)	13 (61.90)	20 (71.43)	0.075
Left segment 3 (LS3)	0 (0.00)	8 (38.10)	8 (28.57)	0.075
Left segment 4 (LS4)	0 (0.00)	1 (4.76)	1 (3.57)	1.000
Max carotid plaque length	8.70 ± 3.16	9.01 ± 4.74	8.94 ± 4.37	0.684
Plaque score	3.83 ± 3.04	4.58 ± 3.17	4.40 ± 3.11	0.477

Data describes as n (%) or mean ± standard deviation, * statistically significant, P_value < 0.05

Table 4. Correlation of PCAD severity with carotid intima-media thickness ultrasound results.

Factors	Mean ± SD	Min –Max	Spearman's correlation coefficient	P_value
Right carotid thickness	0.69 ± 0.10	0.39 – 1	0.23	**0.019***
Left carotid thickness	0.70 ± 0.14	0.09 – 1	0.21	**0.029***
Right IMT score	0.16 ± 0.39	0 – 2	0.22	**0.027***
Left IMT score	0.26 ± 0.52	0 – 3	0.29	**0.002***
Plaque number	0.76 ± 1.31	0 – 6	0.41	**<0.001***

* Statistically significant, P_value < 0.05.

Table 5. Factors associated with significant PCAD among patients based on univariate and multivariable logistic regression models.

Variables	Crude OR[1], 95% CI	P_value	Adjusted OR, 95% CI	P_value
Age (years)	1.04 (1.003 – 1.09)	0.036*	1.03 (0.96 – 1.11)	0.315
Gender				
Female	Reference	0.156	Reference	0.153
Male	1.79 (0.80 – 4.01)		2.98 (0.66 – 13.36)	
Opium addiction				
No	Reference	0.026*	Reference	0.031*
Yes	6.00 (1.24 – 28.98)		7.72 (1.21 – 49.26)	
History of dyslipidemia				
No	Reference	0.003*	Reference	0.012*

Yes	3.45 (1.51 – 7.85)		4.12 (1.37 – 12.42)	
History of Ischemic Heart Disease				
No	Reference	0.037*	Reference	0.107
Yes	3.63 (1.08 – 12.18)		3.20 (0.77 – 13.24)	
LVEF (%)	0.93 (0.89 – 0.98)	0.005*	0.94 (0.89 – 0.99)	0.036*
Carotid plaque	1.96 (1.26 – 3.05)	0.003*	1.54 (0.93 – 2.55)	0.088
Left IMT score	2.27 (0.94 – 5.48)	0.066	1.60 (0.53 – 4.84)	0.403

*Statistically significant, P_value < 0.05. [1]Odds Ratio, 95% Confidence Interval. P_value of Hosmer–Lemeshow test= 0.848. Area Under the Receiver Operating Characteristics Curve (AUC_ROC curve) =0.257.

Table 6. Factors associated with the severity of PCAD among patients based on univariate and multivariable ordinal regression models

Variables	Crude OR[1], 95% CI	P_value	Adjusted OR, 95% CI	P_value
Age (years)	1.04 (1.001 – 1.08)	0.044*	1.03 (0.96 – 1.11)	0.271
Gender				
Female	Reference	0.096	Reference	0.017*
Male	1.88 (0.89 – 3.99)		5.29 (1.34 – 20.76)	
Opium addiction				
No	Reference	0.033*	Reference	0.082
Yes	3.17 (1.09 – 9.20)		3.21 (0.86 – 12.006)	
History of diabetes				
No	Reference	<0.001*	Reference	0.002*
Yes	7.18 (3.008 – 17.15)		4.85 (1.77 – 13.27)	
History of dyslipidemia				
No	Reference	0.004*	Reference	0.039*
Yes	3.07 (1.42 – 6.64)		2.88 (1.05 – 7.91)	
History of Ischemic Heart Disease				
No	Reference	0.050	Reference	0.144
Yes	2.57 (0.99 – 6.62)		2.33 (0.74 – 7.29)	
LVEF (%)	0.92 (0.88 – 0.95)	<0.001*	0.94 (0.90 – 0.98)	0.005*
Carotid plaque				
No	Reference	<0.001*	Reference	0.013*
Yes	5.76 (2.54 – 13.05)		3.89 (1.33 – 11.35)	
Left IMT score	2.70 (1.21 – 6.02)	0.015*	2.48 (0.89 – 6.89)	0.080

*Statistically significant, P_value < 0.05. [1]Odds Ratio, 95% Confidence Interval.

logistic regression, it was observed that increased age, opium addiction, positive history of ischemic heart disease, positive history of blood lipid disorders, decrease in the percentage of ventricular ejection fraction upon entering the hospital, and increase in the number of carotid plaques had statistically significantly associated with the occurrence of coronary artery disease (P-value<0.05). According to the results of the multiple logistic regression model, in people with a history of opium addiction, compared to people who did not use drugs, the chance of having coronary artery disease was about seven times higher (P value=0.031, 95% CI=1.21-49.72, OR=7.72). Compared to people without a history of dyslipidemia, the chance of having coronary artery disease was about four times higher (P value = 0.012, 95%CI = 1.37-12.42, OR=4/12). With an increase of one unit in the EF (1%), the chance of having coronary artery disease has decreased to 6% (P value = 0.036, 95% CI = 0.89-0.99, OR=0.94) (Table 5).

The relationship between the severity of coronary artery disease among patients based on univariate and multivariate rank regression models is shown in Table 6. According to the results of univariate rank regression, it was observed that increased age, opium addiction, history of diabetes mellitus, history of blood lipid disorders, decrease in the percentage of ventricular ejection fraction upon entering the hospital, presence of carotid plaque and thickness score left carotid intima media was related to the severity of coronary artery disease (P-value <0.05).

According to the multivariate rank regression model results, severe coronary artery disease odds were 5.29 times higher in men than women (P-value=0.017, 95%CI=1.34-20.76, OR=5.29). In people with a history of addiction, compared to people who were not addicted, the severity of coronary artery disease (compared to having normal coronary arteries) was about three times higher (P-value = 0.033, 95%CI =1.09-9.2, OR = 3.17).

In people with a history of diabetes mellitus compared to people without a history of diabetes, the chance of severe coronary artery disease (compared to having normal coronary arteries) was 4.85 times higher (P-value=0.002, 95%CI=1.77-13.27, OR=4.85). In people with a history of dyslipidemia, compared to people without it, the chance of severe coronary artery disease (compared to having normal coronary arteries) was 2.88 times higher (P-value = 0.039, 95%CI=1.05-7.91, OR=2.88).

With an increase of one unit in the EF value (1%), the chance of having severe coronary artery disease decreases to 6% (P-value = 0.036, 95%CI = 0.89- 0.99, OR=0.94). In people with carotid plaque, compared to people without plaque, the chance of severe coronary artery disease (compared to having normal coronary arteries) was 3.89 times higher (P-value = 0.013, %95CI = 1.33-11.35, OR = 3.89). Regarding the relationship between the intima-media thickness score and the severity of coronary artery involvement, although for one-unit increase in the left carotid intima-media thickness score, the severity of coronary artery involvement increased almost 2.5 times, this relationship was not statistically significant (OR=2.48, 95%CI=0.89–6.89, P-value=0.08) (Table 6).

Discussion

This study aimed to determine the relationship between carotid intima media thickness and carotid plaque characteristics with the incidence and severity of premature coronary artery disease. One hundred patients were enrolled into two groups. Fifty patients had coronary artery involvement as a group with coronary artery involvement, and the other 50 patients were considered a group without significant coronary artery involvement. The present study showed significant differences between the group with coronary artery disease and the group without PCAD regarding the right and left carotid carotid thickness, carotid intima media thickness score in RS3, LS3, and LS4 sections, carotid plaque formation, and its number. In addition, a direct (positive) and significant correlation was observed between carotid ultrasound factors, including right and left carotid thickness, right and left carotid intima media thickness scores, and the number of carotid plaques, with increasing severity of coronary artery involvement.

Atherosclerosis is a generalized disorder that spread in whole body arteries. Atherosclerosis occurs in the early decades of life[15]. The commonest arteries involved with atherosclerosis are carotid and coronary arteries[16]. Carotid IMT assessment is recommended as a method to evaluate the risk of atherosclerosis of coronary arteries. Previous studies recommended that IMT may increase with diabetes mellitus, hypertension, age, hyperlipidemia, sex[17, 18]. There has been controversy about the diagnostic role of IMT in diagnosing PCAD until now[9].

Studies on evaluating carotid plaque and carotid intima media thickness and its relationship with associated factors in patients with coronary artery disease are limited. For example, based on the study of Zaidi et al. in 2020, 100 patients and the same number of control groups were assessed. It was found that 14.5% of people had carotid plaque, and 12% had arterial calcification. In this study, the sensitivity of ultrasound in carotid plaque detection in predicting coronary artery involvement was 78%, specificity was 75%, positive predictive value was 75.7%, and negative predictive value was 77.3%[19]. In the current study, we didn't assess the diagnostic accuracy of CIMT but found that 52% of patients with PCAD had carotid plaque, but 16% of patients without PCAD had carotid plaque. We discovered that CIMT positively correlated with PCAD and its risk factors, such as diabetes mellitus and smoking. Based on our study and Zaidi et al.'s study, it can be said that CIMT was a good method for diagnosing and predicting PCAD. We can set programs for preventive actions based on the findings CIMT.

Based on Jordanova et al.'s study that was conducted as a cohort study on 1031 patients with coronary heart disease, all patients underwent ultrasound evaluation of CIMT. Patients were followed for 24 months for cardiovascular events. Carotid artery stenosis was determined in 1009 cases. Cardiovascular events were recorded in 2.5% of patients. The results of this study showed that the presence of carotid plaque could significantly increase the risk of cardiovascular events by 1.9 times[20]. The current study found that cardiovascular events occurred in 31% of patients. We found that carotid plaque increases the chance of severe coronary artery disease 3.89 times. This finding was higher than Jordanova et al.'s study. This difference may come from the difference in sample size of the two studies. Our sample size was lower than Jordanova et al.'s study and was of our study's limitations.

In the 2015 Oliveira et al study, 89 patients under the age of 45 (55 patients with a history of PCAD and 34 patients without a history of CAD) were selected and evaluated by carotid ultrasonography. It was found that 20% of patients in the group with PCAD and 6% of patients without PCAD had carotid plaque, and it was concluded that carotid plaque is a strong predictor for presence of PCAD (14). The finding of our study about the correlation of CIMT with PCAD was similar to Oliveira et al.'s study. The current study found a significant correlation between CIMT and PCAD. We also found out that an increase of one unit in the EF decreases the chance of severe coronary artery disease by about 6%. A decrease in EF can occur due to PCAD (21). Based on these two studies, CIMT significantly correlated with PCAD and decreased EF. It was observed that the correlation coefficient between the left and right carotid intima media thickness and the severity of coronary artery involvement were 0.29 and 0.22, respectively.

In Zhu et al.'s study, the presence of carotid plaques in the two groups of patients with and without ischemic heart disease was 80% and 49%, respectively. Carotid intima-media thickness in the two groups was 0.21 ± 0.84 and 0.18 ± 0.76 mm, respectively, and a significant difference was observed between the two groups. According to the regression model, carotid plaque was a strong predictor for the diagnosis of coronary heart disease (22). In our study, we found that the number of carotid plaques in the two groups of patients with and without PCAD was 52% and 16%, respectively, and this finding differed from Zhu et al.'s study. In the current study, we found that the right and left carotid artery thickness in patients with PCAD were 0.71 ± 0.10 and 0.72 ± 0.16, and in patients without PCAD, these values were 0.66 ± 0.10 and 0.67 ± 0.11 respectively, and there were significant differences between these values in the current study. We found a correlation between the carotid plaque and PCAD, similar to Zhu et al.'s study.

Further studies should be performed with a greater sample size and evaluation of CIMT in patients with PCAD over time.

Conclusion

This study's results showed a significant correlation between the presence of carotid plaque and its number in patients with premature coronary artery disease with an increase in the severity of coronary artery involvement. Based on our findings, CIMT can be used as a predictive factor for premature coronary heart disease. CIMT correlated with PCAD-associated factors such as diabetes mellitus. Our results showed that CIMT measurement should be a noninvasive method with a high cost-benefit value in patients at risk of PCAD.

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Conflict of interest

The authors further declare that they have no conflict of interest.

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