Caspian Journal of Internal Medicine 2026 (Winter); 17(1): 97-105
DOI: 10.22088/cjim.17.1.97

Original Article

Investigating subclinical myocardial ischemia by measuring carotid intima-media thickness using Doppler Ultrasound in patients with acute cardiac ischemia

Yasaman Zeid Shafiei (MD) [1]
Mahsa Akhavan Sabagh (MD) [2]
Habib Haybar (MD) [1*]
Shirin Azizidoost (PhD) [1]

1. Atherosclerosis Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
2. Department of Radiology, School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

*** Correspondence:**
Habib Haybar, Atherosclerosis Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

E-mail: haybarhabib@gmail.com
Tel: +98 6133204501

Received: 28 Nov 2024
Revised: 28 Feb 2025
Accepted: 12 April 2025
Published: 21 Jan 2026

Abstract

Background: The present study aimed to evaluate the relationship between Carotid intima-media thickening (CIMT) with subclinical myocardial ischemia in acute cardiac ischemia (ACI) patients.

Methods: This prospective, observational study was conducted on 75 ACI patients referred to Golestan and Imam Khomeini hospitals of Ahvaz in 2023. The patients in healthy (CIMT≤0.8mm) and at risk of cardiac ischemia (CIMT>0.8mm) groups underwent carotid Doppler ultrasound to check CIMT and the presence of carotid plaque.

Results: CIMT mean was 1.07±0.12 mm in healthy ACI patients and 1.4±0.19 mm in those at risk of cardiac ischemia. Among patients at risk of CIMT and carotid plaque, 85.1% and 80.8% had at least one cardiovascular risk factor, respectively. However, no significant differences were found between CIMT, carotid plaque, and patients' risk factor profiles (P = 0.129 vs. P = 0.515). The adjusted odds ratio (OR) for CIMT was 1.50 (95% CI: 0.58–3.94, P = 0.400), indicating no significant association with the outcome. No significant associations were observed for age, sex, diabetes, hypertension, LDL, or HDL. While the prevalence of vessel disease was higher in at-risk group than healthy CIMT group, no dramatic differences were observed between CIMT and vessel involvement (P = 0.136).

Conclusion: The presence of one or more cardiovascular risk factors combined with increased CIMT may increase heart attack susceptibility, highlighting the potential of CIMT as an effective screening tool for predicting coronary artery disease. Further large-scale studies are needed to define its role in clinical practice more definitively.

Keywords: Myocardial ischemia, Carotid intima-media Thickness, Cardiovascular diseases, Ultrasonography, Doppler.

Citation:
Zeid Shafiei Y, Akhavan Sabagh M, Haybar H, Azizidoost Sh. Investigating subclinical myocardial ischemia by measuring carotid intima-media thickness using Doppler Ultrasound in patients with acute cardiac ischemia. Caspian J Intern Med 2026; 17(1): 97-105.

As one of the most important types of cardiovascular diseases (CVD), ischemic heart disease (IHD) is a condition in which the blood flow in the heart decreases and insufficient oxygen reaches the myocardium (1). Acute cardiac ischemia reduces the ability of cardiac muscle to pump blood (2). In the early stages of atherosclerosis, endothelial disruption along with increasing intima-media thickness is often observed in all vascular beds. Therefore, non-invasive ultrasound measurement of Carotid Intima-Media Thickness (CIMT) as a general marker for atherosclerosis predicts the risk of myocardial infarction (MI) and stroke (3, 4). Changes in CIMT and arterial stiffness can be detected early and are therefore considered important markers of upcoming severe atherosclerosis (3, 5). In addition, carotid atherosclerotic plaques indicate later stages of the disease compared to CIMT and arterial stiffness. Several longitudinal studies have also confirmed the relationship between abnormal CIMT and risk of stroke (6, 7).

Publisher: Babol University of Medical Sciences

Although the relationship between CIMT and the presence of carotid plaque with the risk of stroke and ischemic heart disease has been reported in some studies, there is still controversy regarding the utility of CIMT in risk stratification due to the variety of methodologies that are used to measure CIMT (8-10). Nowadays, various methods are utilized to measure CIMT and arterial stiffness. Carotid ultrasound is a widely employed non-invasive technique for assessing primary structural changes in carotid artery such as CIMT and arterial stiffness (8, 11). Studies indicated that ultrasound imaging of the carotid artery as a safe and relatively inexpensive approach enables the evaluation of subclinical carotid atherosclerosis and can improve CVD risk classification (10, 12). CIMT and arterial stiffness measurement can be useful in improving cardiovascular risk prediction models given that CIMT is a primary biomarker for subclinical carotid atherosclerosis as well as for CVD risk prediction. This is particularly important in those classified as "moderate cardiovascular risk" by traditional risk factor assessments because they may be classified as "high-risk" by CIMT measurement. Therefore, the present study was performed for retrogradely investigating the presence of subclinical ischemia in patients presenting with acute cardiac ischemia by measuring the carotid intima-media thickness using Doppler ultrasound.

Methods

This prospective observational study was conducted on 75 patients diagnosed with acute cardiac ischemia who were referred to emergency department of Golestan and Imam Khomeini hospitals of Ahvaz in 2023. This study was done after approval by Research Ethics Committee of Jundishapur University of Medical Sciences, Ahvaz (Ethical code: IR.AJUMS.HGOLESTAN.REC.1402.074). Written informed consent was taken from all the patients. Besides, in all stages of this research, the provisions of ethics statement in Helsinki Declaration as well as principles of confidentiality of patient information were observed. Based on the findings of previous studies (13), the sample size was calculated at least 75 people who were chosen as available (non-random) sample using G-Power software at alpha level of 0.5, test power of 90% and effect size of 0.3. The inclusion criteria were as follows: presenting with chest pain and positive angiographic indication of coronary artery occlusion (≥75% stenosis of cross-section of a coronary artery), the ability and consent of the patient to undergo carotid Doppler Ultrasound. Furthermore, patients with no significant coronary artery stenosis or normal coronary arteries in angiography, those with cerebral hemorrhage and subarachnoid hemorrhage, and patients with a history of cerebrovascular accidents were excluded from the study.

Examination of patients: All patients were examined before the study, and a detailed history was taken from them. Demographic and clinical characteristics, as well as laboratory and angiography results were recorded in the data collection checklist. The risk factors of subclinical myocardial ischemia including age, gender, along with underlying diseases such as hypertension and diabetes mellitus were recorded. For this purpose, the results of laboratory parameters such as fasting blood sugar (FBS) and lipid profile, including total cholesterol (TC), triglyceride (TG), high-density lipoprotein (HDL-C) and low-density lipoprotein (LDL-C), were also reviewed.

After initial examinations, the patients underwent cardiac angiography, and the number of coronary vessels involved was checked. Review of clinical and angiography results for all patients was done by only one person (i.e., a cardiology fellowship). Hypertension was defined as a history of taking antihypertensive drugs or systolic blood pressure ≥140 mmHg and diastolic blood pressure ≥90 mmHg (14). Based on the criteria of American Diabetes Association (ADA), diabetes mellitus was described as the consumption of hypoglycemic drugs at the time of visit or FBS≥126 mg/dl, OGTT ≥200 mg/dL, HbA1C≥6.5%, classical symptoms of hyperglycemia along with random BS≥200 mg/dl (15). Hyperlipidemia was documented either on the basis of the history or when the serum triglyceride or cholesterol levels exceeded 150 or 200 mg/dL (16).

Carotid Doppler ultrasound: All patients with a positive angiography result were evaluated by carotid Doppler ultrasound, which was performed by a radiologist. For this purpose, the patient was placed on the scanning bed, so that the patient's head was at rest. To measure CIMT, an ultrasound device (GE Voluson E6 model) and a linear ultrasound probe with a minimum frequency of 7 MHz and a depth of 4 cm were utilized. The obtained data included transverse and longitudinal images of common carotid parameters throughout the observed vessels. Carotid plaque was defined as a focal area with CIMT>1.5 mm extended into the lumen and differentiated from the adjacent border (17). Median intima thickness up to 0.6 mm (average of one side) was considered as the absence of coronary plaque. Moreover, stenosis ≥50% of the studied vessels was considered as hemodynamically significant (18). The results related to the thickness of carotid arteries and the presence of plaque were subsequently recorded. Afterward, based on CIMT, patients were divided into two groups:

those at risk of ischemic heart disease (CIMT>0.8mm) and those without this risk (CIMT≤0.8mm) (19). Finally, the relationship between carotid Doppler ultrasound results and the risk of subclinical cardiac ischemia was investigated.

Identification of potential confounders: Potential confounders were selected according to prior knowledge, biological plausibility, and their association with the exposure and outcome variables. Variables such as CIMT (Carotid Intima-Media Thickness), age, and sex were identified as potential confounders due to their recognized or hypothesized influence on the outcome. These variables were included in the multivariable regression models to adjust for their potential confounding effects.

Statistical analysis: Descriptive statistics, including mean, standard deviation (SD), frequency, and percentage, were employed to summarize the data. The normality of data was assessed using the Kolmogorov-Smirnov test. To compare continuous variables between the two groups, an independent t-test was utilized along with chi-square test for comparison of categorical variables. Ordinal logistic regression was performed to assess the association between various variables and the outcome. Statistical analysis was conducted using SPSS Version 24 (SPSS Inc., Chicago, IL, U.S.A.), R software (Version 4.4.2) and a significance level of 0.05 was considered in all the tests. To evaluate the robustness of primary findings, sensitivity analyses were conducted using alternative model specifications. Specifically, logistic regression models were fitted with a reduced set of covariates (CIMT, age, and sex) to assess whether the associations observed in the primary analysis were consistent when adjusting for fewer variables. The results of these models were compared to the primary analysis to identify potential confounding or instability in the estimates. Additionally, the stability of the model was evaluated by examining the magnitude of coefficients, standard errors, and convergence behavior. All sensitivity analyses were performed using R software (Version 4.4.2), and a significance level of 0.05 was considered.

Results

A total of 75 patients with mean age of 63.43±11.25 years (range: 40-88 years) participated in this study. The patients included 53 (70.7%) men and 22 women (29.3%). There was a history of diabetes and hypertension in 34 (45.3%) and 23 (30.1%) people, respectively. CIMT measurement using Doppler ultrasound showed that 28(37.3%) people had CIMT≤0.8mm (no risk) and 47 (62.7%) people had CIMT>0.8mm (at risk). There was no significant difference between the two groups at risk and without risk of acute cardiac ischemia in terms of age, gender, diabetes and blood pressure, as well as mean serum levels of TG, total cholesterol, HDL-C, LDL-C and blood sugar (p>0.05) (table 1). According to the coronary angiography results, there was involvement of two vessels (2VD) in 8 people (10.7%), 3VD in 43 people (57.3%), LM2VD in 4 people (5.3%), LM3VD in 8 people (7.7 10%), and SVD in 12 people (16%) (figure 1)

Table 1. Comparison of basic characteristics of patients at risk with the healthy group

Variable	Group	Healthy (28 persons)	At risk of IHD (47 persons)	P-value
Age (year), mean±SD		61.82±10.29	64.44±11.80	0.32*
Sex, n (%)	Male	17 (60.7%)	36 (76.6%)	0.14**
	Female	11 (39.3%)	11 (23.4%)	
DM, n (%)		12 (42.9%)	22 (46.8%)	0.76**
HTN, n (%)		7 (25.0%)	16 (34.0%)	0.41**
TG (mg/dL), mean±SD		168.73±122.27	148.83±83.65	0.42*
TC (mg/dL), mean±SD		178±43.90	165.13±45.43	0.25*
HDL-C (mg/dL), mean±SD		39.84±10.05	38.25±7.89	0.49*
LDL-C (mg/dL), mean±SD		113.65±40.72	105.47±50.69	0.51*
FBS (mg/dl), mean±SD		217.08±150.36	198.09±113.89	0.56*

Abbreviations: IHF: Ischemic heart disease; DM: Diabetes mellitus; HTN: Hypertension; TG: Triglyceride; TC: total Cholesterol; HDL-C: High-density lipoprotein Cholesterol; LDL-C: Low-density lipoprotein Cholesterol; FBS: Fasting blood sugar. P-value< 0.05 was considered significant. *Independent t-test, ** Chi-square test.

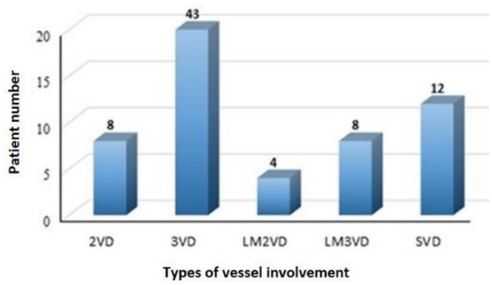

Figure 1. Frequency distribution of acute cardiac ischemia patients based on the types of vascular involvement in angiography. 2VD: two-vessel disease; 3VD: three-vessel disease; LM2VD: Left main, two-vessel disease; LM3VD: Left main, three -vessel disease; SVD: single vessel disease.

Carotid plaque was diagnosed in 52 patients (69.3%), and ≥50% carotid artery stenosis was observed in 5 cases (6.7%). The average age of patients with carotid plaque was significantly higher than that of patients without plaque (P=0.046), and HDL-C in the group with carotid plaque was significantly lower than that of patients without plaque (P=0.045). However, the gender of patients, diabetes and blood pressure, serum levels of TG, total cholesterol, LDL-C and blood sugar did not show any significant differences between the two groups of patients with and without carotid plaque (table 2).

To rule out the effect of pivotal cardiovascular risk factors on CIMT and carotid plaque presence, the risk factor profile of ACI patients was assessed, including diabetes, hypertension and hyperlipidemia. According to table 3, at least 40 out of a total of 47 patients at risk of CIMT (85.1%) have one risk factor. Moreover, in patients with carotid plaque cases, 42 (80.8%) patients showed at least one risk factor associated with cardiovascular disease. Overall, no significant difference was observed between CIMT and carotid plaque with cardiovascular risk factor profile in ACI patients (0.484 vs. 0.08 vs. 0.515).

Table 2. Comparison of characteristics of patients with and without carotid

Variable	Group	Without plaque (23 persons)	With plaque (52 persons)	P-value
Age (year), mean±S.D		59.73±12.70	65.14±10.20	0.046*
Sex, n (%)	Male	69 (69.6%)	37 (71.2%)	0.82*
	Female	7 (30.4%)	15 (28.8%)	
DM, n (%)		11 (47.8%)	23 (44.2%)	0.77*
HTN, n (%)		4 (17.4%)	19 (36.5%)	0.09*
TG (mg/dL), mean±S.D		158.80±72.27	155.32±109.42	0.89**
TC (mg/dL), mean±S.D		176.70±51.52	167.24±42.29	0.43**
HDL-C (mg/dL), mean±S.D		42.50±9.99	37.19±7.75	0.045**
LDL-C (mg/dL), mean±S.D		109.31±48.20	108.35±46.83	0.94**
FBS (mg/dl), mean±S.D		230.23±156.37	193.32±111.71	0.33**

Abbreviations: DM: Diabetes mellitus; HTN: Hypertension; TG: Triglyceride; TC: total Cholesterol; HDL-C: High-density lipoprotein Cholesterol; LDL-C: Low density lipoprotein Cholesterol; FBS: Fasting blood sugar. P-value< 0.05 was considered significant. *Independent t-test, ** Chi-square test

Table 3. Correlation of CIMT and presence of plaque with cardiovascular risk factor in patients with ACI

Risk Factor	CIMT		P-value	Carotid plaque		P-value
	No risk (N=28)	At risk (N=47)		Yes (N=52)	No (N=23)	
DM, n (%)	12 (42.9)	22 (46.8)	0.464	23 (44.2)	11 (47.8)	0.484
HTN, n (%)	7 (25)	16 (34)	0.289	19 (36.5)	4 (17.4)	0.08
HLD, n (%)	13 (46.4)	20 (42.6)	0.465	23 (44.2)	11 (47.8)	0.484
Presence of at least 1 RF	20 (71.4)	40 (85.1)	0.129	42 (80.8)	18 (78.3)	0.515

Abbreviations: DM: Diabetes mellitus; HTN: Hypertension; RF: Risk factor; HLD: Hyperlipidemia, CIMT: Carotid intima-media thickening. P-value< 0.05 was considered significant.

In the present study, the importance of five vessel diseases, including single-vessel disease (SVD), two-vessel disease (2VD), three-vessel disease (3VD), left main two-vessel disease (LM2VD) and left main three-vessel disease LM3VD was evaluated in patients with and without risk of CIMT. As reported in table 4, although 3VD was reported as the most common type of vessel disease in patients with and without risk of CIMT [22 (46.8%) vs. 21 (75%)], the prevalence of diseased vessel was higher in patients who were at risk of CIMT compared to healthy CIMT group. Based on chi-square test, there was no significant difference between vessel disease and CIMT in patients with ACI (P=0.136). The ordinal logistic regression analysis (table 5, figure 2) revealed that none of the examined variables had statistically significant associations with the outcome. The adjusted OR for CIMT was 1.50 (95% CI: 0.58–3.94, P= 0.400), indicating a non-significant correlation. Similarly, age (OR = 1.00, 95% CI: 0.95–1.06, P = 0.912) and sex (OR = 1.36, 95% CI: 0.44–4.19, P= 0.593) did not demonstrate significant effects. Additionally, DM (OR = 1.61, 95% CI: 0.62–4.26, P = 0.331) and HTN (OR = 0.94, 95% CI: 0.28–3.13, P= 0.920) were not significantly related to the outcome. Lipid profile components, including LDL (OR = 0.99, 95% CI: 0.99–1.01, P = 0.739) and HDL (OR = 0.97, 95% CI: 0.91–1.04, P= 0.441), also failed to reach statistical significance.

Table 4. Evaluation the number of vessel diseases in patients with and without CIMT

Vessel disease	CIMT		P-value
	At risk (N=47)	No risk (N=28)	
SVD, n (%)	10 (21.3)	2 (7.1)	
2VD, n (%)	7 (14.9)	1 (3.6)	
3VD, n (%)	22 (46.8)	21 (75)	0.136
LM2VD, n (%)	3 (6.4)	1 (3.6)	
LM3VD, n (%)	5 (10.6)	3 (10.7)	

Abbreviations: 2VD: two-vessel disease; 3VD: three-vessel disease; LM2VD: Left main, two-vessel disease; LM3VD: Left main, three -vessel disease; SVD: single vessel disease. CIMT: Carotid intima-media thickening. P-value< 0.05 was considered significant.

Table 5. Adjusted odds ratios (OR) with 95% confidence intervals (CI) and p-values from the ordinal logistic regression model assessing the association

Variable	Adjusted OR	Lower 95% CI	Upper 95%CI	P_value
CIMT	1.504009	0.583993	3.941921	0.4
Age	1.002957	0.952217	1.058195	0.912
Sex	1.356463	0.440119	4.185471	0.593
DM2	1.608197	0.620448	4.264779	0.331
HTN2	0.940151	0.279919	3.134192	0.92
LDL	0.998165	0.986942	1.008779	0.739
HDL	0.974744	0.912872	1.040957	0.441

Abbreviations: CIMT: Carotid intima-media thickness; DM: Diabetes mellitus; HTN: Hypertension; HDL: High-density lipoprotein; LDL: Low-density lipoprotein. P-value< 0.05 was considered significant.

Sensitivity analysis: The results of sensitivity analysis using a logistic regression model indicated no statistically significant correlation between the predictors (CIMT, age, and sex) and the outcome (Angio). The coefficient estimates for CIMT and sex were extremely large in magnitude but accompanied by high standard errors, resulting in non-significant p-values (p ≈ 1.0). Similarly, the effect of age on Angio was small and non- significant (P = 0.428) (table 6).

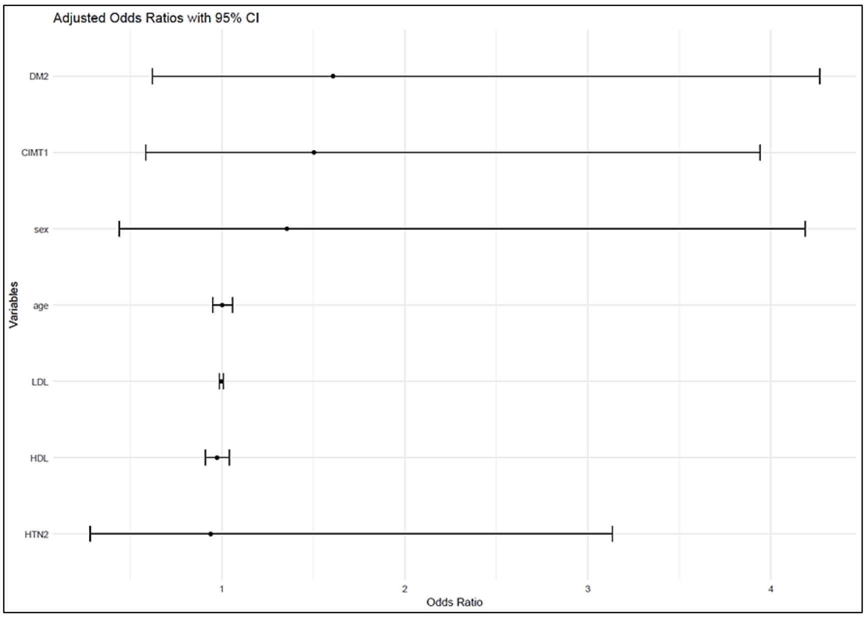

Figure 2. Adjusted odds ratios (OR) with 95% confidence intervals (CI) and p-values from the ordinal logistic regression model assessing the association between CIMT, demographic factors, and clinical variables with the outcome.

Table 6. Sensitivity analysis results of association between ischemia and confounder potentials (CIMT, age, and sex)

Variable	Estimate	Std. Error	z-value	p-value
(Intercept)	-0.200	6418.198	0.000	1.000
CIMT	-18.225	4322.308	-0.004	0.997
Age	0.038	0.047	0.793	0.428
Sex	17.695	4744.566	0.004	0.997

CIMT: Carotid intima-media thickness, P-value< 0.05 was considered significant.

Discussion

Results of the present study showed that 62.7% of patients with acute cardiac ischemia had carotid involvement, as evidenced by an increased CIMT index. This finding supports the established link between coronary artery disease and carotid artery involvement. In the study of Fatema et al., the average CIMT in 85% of ischemic heart disease (IHD) patients was above the normal range (CIMT ≤ 0.8 mm) (19). This rate was higher than that in our study, which may be attributed to differences in the populations under investigation. Similarly, Gaman et al. reported that the average IMT of common carotid arteries was 0.96 mm (20), indicating thickening beyond normal levels. Evensen et al. also found that an increase in CIMT was associated with left ventricular dysfunction in patients with coronary artery disease (21). These results align with our study and emphasize the usefulness of CIMT measurements for predicting coronary heart disease risk. Many cardiovascular disease (CVD) risk factors affect the carotid artery wall. Polak et al. identified age as the strongest predictor of increased carotid artery IMT, showing an annual increase of 0.007 mm in common carotid arteries (CCA) and 0.037 mm in internal carotid arteries (ICA). In addition, factors like gender, HDL-C level, smoking, hypertension, and diabetes were significantly associated with the rise of IMT in both CCA and ICA (22). However, our study did not find a significant correlation between age, gender, HDL, or LDL cholesterol with CIMT. This discrepancy may be due to differences in patient demographics or sample size. The ordinal logistic regression analysis in our study revealed that none of the examined variables had a statistically significant association with CIMT. Specifically, the adjusted odds ratio (OR) for CIMT was 1.50 (95% CI: 0.58–3.94, P = 0.400), indicating a non-significant relationship with the outcome. Similarly, no significant effects were observed in terms of age (OR = 1.00, 95% CI: 0.95–1.06, P

= 0.912), sex (OR = 1.36, 95% CI: 0.44–4.19, P = 0.593), diabetes (OR = 1.61, 95% CI: 0.62–4.26, P = 0.331), hypertension (OR = 0.94, 95% CI: 0.28–3.13, P = 0.920), LDL (OR = 0.99, 95% CI: 0.99–1.01, P = 0.739), or HDL (OR = 0.97, 95% CI: 0.91–1.04, P = 0.441). A recent meta-analysis has reported the sensitivity, specificity, and diagnostic odds ratio of CCA IMT for CAD at 68%, 61.5%, and 3.2, respectively, with ICA IMT showing better diagnostic performance (79%, 74.4%, and 7.9) (9). The increase in CIMT reflects early atherosclerosis in carotid arteries before coronary arteries, which may explain its lower specificity for CAD. The thickening of arterial wall due to blood pressure and age means that increasing IMT might not always signify the atherosclerotic process, but rather the progression rate of cardiovascular events and stroke. Moreover, ICA IMT has been shown to be more closely linked to CAD, enhancing the predictive power of the Framingham Risk Score (FRS) for cardiovascular events and stroke (23, 24). However, further studies are needed to determine whether carotid ultrasound could be used for early CAD risk assessment and diagnosis (25).

Our study also revealed that 6.7% of patients with acute cardiac ischemia had ≥50% carotid artery stenosis, while 69.3% exhibited carotid plaque. The average age of patients with carotid plaque was significantly higher than those without plaque, and the presence of carotid plaque had an inverse relationship with HDL-C levels. A recent meta-analysis highlighted that carotid plaque presence offers superior diagnostic accuracy over CIMT for predicting future myocardial infarction, and that its negative predictive value for future events was higher than CIMT (9). This suggests that CIMT may reflect an age-related process or hypertrophic response to blood pressure or other risk factors, whereas carotid plaque indicates advanced atherosclerosis. In the later stages, carotid plaques may also develop in CCA. In our study, the presence of carotid plaque in more than 69% of patients may be an efficient predictive marker for acute myocardial infarction.

In support of our findings, Seo et al. reported a strong association between echogenic carotid plaques and acute coronary syndromes, suggesting that carotid plaque may serve as a surrogate marker for high-risk patients (26). Similarly, Zaidi et al. observed plaque formation in 14.5% of CAD patients, with strong correlations found between Doppler sonography findings and atherosclerosis (18). Darabian et al. also noted that the presence and volume of carotid plaques are more reliable predictors of CAD and stroke risk compared to IMT (27), a finding consistent with ours. In another study, it was reported that the presence of carotid plaque is an independent and important predictor for the risk of major cardiovascular events (28). Other studies have similarly concluded that carotid plaque is a stronger predictor for risk stratification than CIMT (23, 24). Thus, carotid plaque might offer significant value for CAD risk assessment and diagnosis, though further research is needed in this respect. Additionally, our study examined whether routine ultrasound should be conducted for every patient. We conclude that ultrasound should be performed primarily in high-risk individuals those without current heart problems but with risk factors such as diabetes, hypertension, and hyperlipidemia. Our data showed that 85.1% of patients at risk of CIMT had at least one cardiovascular risk factor. Furthermore, 80.8% of patients with carotid plaque also presented with at least one cardiovascular risk factor. Given that atherosclerosis often develops silently over decades before clinical manifestations emerge, it is suggested that patients with cardiovascular risk factors should undergo carotid ultrasound to detect subclinical ischemia and identify those at risk of myocardial infarction.

Regarding vessel disease, our study revealed that 3-vessel disease (3VD) was the most common in both groups, with 46.8% of patients with CIMT risk and 75% of patients without CIMT risk reporting it. However, patients with CIMT risk had a higher prevalence of diseased vessels than those in the healthy CIMT group. Like other studies, this investigation had a number of limitations, including its relatively small sample size, which may not have represented the entire population of acute cardiac ischemia patients. Moreover, the lack of follow-up prevented the assessment of CIMT changes over time. Future prospective longitudinal studies with larger sample sizes will provide more comprehensive insights.

Based on CIMT index, the findings of this study demonstrated that 85.1% of patients at risk of CIMT (40 out of 47) had at least one cardiovascular risk factor. Additionally, 80.8% of patients with carotid plaque also presented with at least one risk factor. Our results further show that CIMT is associated with the progression of coronary artery disease. Given its multiple advantages ease of application, accessibility, reproducibility, and low cost—carotid Doppler ultrasonography proves to be a valuable screening tool for assessing carotid arteries and determining CIMT in patients presenting with at least one risk factor, even in the absence of typical heart symptoms. A combination of cardiovascular risk factors and increased CIMT intensifies the risk of heart attack, underscoring the importance of CIMT as a screening method for predicting coronary artery disease. Our ordinal logistic regression analysis revealed that despite being associated with risk factors, CIMT did not show a significant correlation with the outcome; however, the data still highlight the potential of CIMT as a non-invasive predictor of coronary artery disease. In conclusion, our study emphasizes the potential of CIMT in detecting subclinical myocardial ischemia. However, further large-scale studies with longer follow-up periods are needed to define its role in clinical practice more definitively.

Acknowledgments

We wish to thank all our colleagues in angiography and radiology departments of Golestan Hospital of Ahvaz Jundishapur University of Medical Sciences.

Funding: The present study was financially supported by Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran (Grant number: CVRC-0205).

Ethics approval: This study was conducted after approval by the Research Ethics Committee of Jundishapur University of Medical Sciences, Ahvaz (Ethical code: IR.AJUMS.HGOLESTAN.REC.1402.074). Written informed consent was taken from all patients

Conflict of interests: All authors declare no conflict of interest.

Authors' contribution: H.H, Study design, H.H. and Sh.A Data acquisition, data analysis, and drafting the manuscript, H.H, Sh.A and M.A.S critical reviewing; M.A.S and Y.Z.Sh: Analysis and interpretation of data for the work, Y.Z.Sh data analysis and drafting the manuscript.

References

1. Lancellotti P, Petitjean H, Nchimi A, Cosyns B. Special Issue on ischemic heart disease. Acta Cardiol 2023; 78: 1-4.
2. Adamson PD, Newby DE. Non-invasive imaging of the coronary arteries. Eur Heart J 2019; 40: 2444-54.
3. Addis DR, Townsley MM. Implications of carotid arterial plaque assessment by ultrasound for the cardiothoracic anesthesiologist: an overview of the 2020 American society of echocardiography recommendations for the assessment of carotid arterial plaque by ultrasound for the characterization of atherosclerosis and evaluation of cardiovascular risk. J Cardiothorac Vasc Anesth 2021; 35: 987-90.
4. Nezu T, Hosomi N. Usefulness of carotid ultrasonography for risk stratification of cerebral and cardiovascular disease. J Atheroscler Thromb 2020; 27: 1023-35.
5. Flore R, Ponziani FR, Tinelli G, et al. New modalities of ultrasound-based intima-media thickness, arterial stiffness and non-coronary vascular calcifications detection to assess cardiovascular risk. Eur Rev Med Pharmacol Sci 2015; 19: 1430-41.
6. Kumar P, Sharma R, Misra S, et al. CIMT as a risk factor for stroke subtype: a systematic review. Eur J Clin Invest 2020; 50: e13348.
7. Sun P, Liu L, Liu C, et al. Carotid intima-media thickness and the risk of first stroke in patients with hypertension. Stroke 2020; 51: 379-86.
8. Fernández-Alvarez V, Linares Sánchez M, López Alvarez F, et al. Evaluation of intima-media thickness and arterial stiffness as early ultrasound biomarkers of carotid artery atherosclerosis. Cardiol Ther 2022; 11: 231-47.
9. Inaba Y, Chen JA, Bergmann SR. Carotid plaque, compared with carotid intima-media thickness, more accurately predicts coronary artery disease events: a meta-analysis. Atheroscler 2012; 220: 128-33.
10. Zhao YC, Zhang J, Wang F, et al. Value of carotid intima thickness in assessing advanced carotid plaque vulnerability: a study based on carotid artery ultrasonography and carotid plaque histology. Quant Imaging Med Surg 2024; 14: 1994-2007.
11. Zyriax BC, Dransfeld K, Windler E. Carotid intima–media thickness and cardiovascular risk factors in healthy volunteers. Ultrasound J 2021; 13: 1-7.
12. Olinic M, Lazar FL, Onea HL, et al. Peripheral artery disease ultrasound assessment in predicting the severity of coronary artery disease. Life 2024; 14: 333.
13. Hekmatnia A, Pourmoghaddas A. Prevalence of increased intima-media thickness ratio of carotid arteries in patients with coronary artery disease. J Inflamm Dis 2003; 7: 105-10.
14. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/AS PC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Hypertension 2018; 71: 1269-1324.
15. Care D. Classification and diagnosis of diabetes. Diabetes Care 2017; 40: S11-24.
16. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection,

Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002; 106: 3143-421.

17. Singh AS, Atam V, Jain N, et al. Association of carotid plaque echogenicity with recurrence of ischemic stroke. N Am J Med Sci 2013; 5: 371-6.
18. Zaidi N, Gilani S, Mehboob R, et al. Diagnostic accuracy of carotid intima media thickness by B-mode ultrasonography in coronary artery disease patients. Arch Med Sci Atheroscler Dis 2020; 5: e79-84.
19. Fatema N, Haque M, Siddique M, et al. Noninvasive carotid duplex study may be used as predictor test for ischaemic heart disease. Mymensingh Med J 2014; 23: 730-6.
20. Gaman SA, Balakhonova TV, Sinitsyn VE, At'kov OIu, Ternovoĭ SK. Structural and functional changes of coronary and carotid arteries in patients with ischemic heart disease. Ter Arkh 2005; 77: 15-21. [in Russian]
21. Evensen K, Sarvari SI, Rønning OM, Edvardsen T, Russell D. Carotid artery intima-media thickness is closely related to impaired left ventricular function in patients with coronary artery disease: a single-centre, blinded, non-randomized study. Cardiovasc Ultrasound 2014; 12: 39.
22. Polak JF, Pencina MJ, Meisner A, et al. Associations of carotid artery intima-media thickness (IMT) with risk factors and prevalent cardiovascular disease: comparison of mean common carotid artery IMT with maximum internal carotid artery IMT. J Ultrasound Med 2010; 29: 1759-68.
23. Takasu J, Budoff MJ, Katz R, et al. Relationship between common carotid intima-media thickness and thoracic aortic calcification: the Multi-Ethnic Study of Atherosclerosis. Atheroscler 2010; 209: 142-6.
24. Budoff M. Atherosclerosis: Should we use CIMT testing? New insights from Framingham. Nat Rev Cardiol 2011; 8: 615-6.
25. Yang CW, Guo YC, Li CI, et al. Subclinical atherosclerosis markers of carotid intima-media thickness, carotid plaques, carotid stenosis, and mortality in community-dwelling adults. Int J Environ Res Public Health 2020; 17: 4745.
26. Yoshihiro S, Shigeyuki W, Tomoko I, et al. Echolucent carotid plaques as a feature in patients with acute coronary syndrome. Circ J 2006; 70: 1629-34.
27. Darabian S, Hormuz M, Latif MA, Pahlevan S, Budoff MJ. The role of carotid intimal thickness testing and risk prediction in the development of coronary atherosclerosis. Curr Atheroscler Rep 2013; 15: 306.
28. Tada H, Nakagawa T, Okada H, et al. Clinical impact of carotid plaque score rather than carotid intima-media thickness on recurrence of atherosclerotic cardiovascular disease events. J Atheroscler Thromb 2020; 27: 38-4.