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Original research article

A study on relationship between carotid intima-media thickness and coronary artery disease

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Abstract

Background: Cardiovascular disease, especially ischaemic heart disease, is a predominant cause of worldwide mortality, resulting in 9.14 million fatalities in 2019. The incidence of coronary artery disease (CAD) is increasing in India, particularly in metropolitan regions. Risk aspects for CAD, including diabetes, hypertension, and obesity, coincide with those for cardiovascular disease. The assessment of CIMT with Doppler ultrasonography is an effective method for the early identification of atherosclerosis and the classification of CAD risk.

Aim: This study aimed to investigate the relationship between CIMT and the severity of CAD, as well as to evaluate the efficacy of CIMT as a non-invasive technique for the early diagnosis of atherosclerosis and CAD risk stratification.

Methodology: A cross-sectional research was performed at South Eastern Railways Central Hospital in Kolkata from June 2019 to May 2021, including 100 patients having coronary angiography. CIMT was evaluated with high-resolution B-mode ultrasonography, whereas CAD severity was determined using the Gensini score. The Pearson correlation coefficient was employed for statistical analysis.

Results: No notable gender disparities in the prevalence of CAD or related risk aspects such as hypertension and diabetes were detected. Men had elevated LDL cholesterol levels ($p=0.021$) and a greater prevalence of smoking ($p=0.031$) compared to women. CIMT is

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connected with the severity of CAD, with elevated CIMT readings signifying more advanced CAD.

Conclusion: CIMT serves as a significant, non-invasive instrument for the early diagnosis of coronary artery disease (CAD). Notwithstanding gender disparities in lipid profiles and smoking behaviours, CIMT is proficient in detecting early CAD, which may improve outcomes. Additional research is required for gender-specific techniques in the therapy of CAD.

Keywords: Atherosclerosis, Cardiovascular illness, Carotid Intima-Media Thickness, Coronary artery disease, Doppler ultrasonography.

1. Introduction

Cardiovascular disease (CVD), especially ischaemic heart disease (IHD), continues to be a predominant cause of morbidity and death worldwide. In 2019, Ischaemic Heart Disease (IHD) was responsible for 182 million Disability-Adjusted Life Years (DALYs) and 9.14 million fatalities globally [1]. A myocardial infarction, a prevalent sign of ischaemic heart disease, transpires when blood flow to the myocardium is impeded, resulting in myocardial damage. The primary risk factors for heart attacks, including hypertension, diabetes, dyslipidaemia, smoking, obesity, and physical inactivity, substantially coincide with those for CVD. While the incidence of coronary artery disease (CAD) is diminishing in wealthy countries, it is escalating in emerging nations due to urbanisation, prolonged life expectancy, and alterations in lifestyle.

In India, coronary artery disease (CAD) impacts 21.4% of those with diabetes and 11% of those without, with urban populations exhibiting higher prevalence than rural counterparts. Traditional risk factors such as dyslipidaemia, hypertension, diabetes, and smoking significantly contribute to the elevated prevalence of coronary artery disease in India. The INTERHEART research found nine principal risk aspects, including psychological stress and inadequate nutrition, which account for nearly 90 percent of acute myocardial infarctions (AMIs) in South Asians [2]. Over fifty percent of CAD patients present their initial symptoms as myocardial infarction or other acute coronary syndromes, highlighting the necessity for early CAD identification to avert acute incidents and decrease death rates. Timely

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identification of people at elevated risk for coronary artery disease can provide preventative measures, enhancing long-term results [3].

Atherosclerosis, the fundamental aetiology of coronary artery disease (CAD), develops progressively, typically commencing in early adulthood and advancing with age. Although some extent of atherosclerosis is unavoidable, its advancement rate can be affected by controllable risk factors. Timely identification of subclinical atherosclerosis is essential to avert clinically severe coronary artery disease (CAD) [4]. Nonetheless, conventional diagnostic instruments, such as exercise electrocardiography, stress echocardiography, and coronary angiography, frequently identify atherosclerosis just in its advanced phases [5].

The assessment of 'Carotid Intima-Media Thickness' (CIMT) with non-invasive Doppler ultrasonography has become a valuable method for identifying early atherosclerotic alterations [6]. Intima-media layer thickening in the carotid arteries is an early indicator of atherosclerosis and is linked with the presence and severity of CAD [7, 8]. CIMT provides a precise technique for identifying atherosclerosis in its pre-occlusive stage, facilitating early intervention [9-12]. This study examines the relationship between CIMT and the amount of CAD, evaluating its potential as an early diagnostic instrument and for risk stratification, which may enhance the prevention and management of CAD.

2. Methodology

2.1 Study Area

This cross-sectional observational study was performed in the Department of Medicine and Cardiology, South Eastern Railways Central Hospital, Kolkata, over a two-year duration from June 2019 to May 2021. The institutional ethics committee authorised the study, confirming compliance with ethical norms in all operations.

2.2 Sample Size

The research had a total sample size of 100 patients.

2.3 Inclusion and Exclusion Criteria

The research population consisted of patients admitted to the wards of the Department of Medicine and the Department of Cardiology at South Eastern Central Railway Hospital in Kolkata. The inclusion criteria were individuals diagnosed with stable angina, STEMI,

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NSTEMI, unstable angina, or cardiomyopathy, all of whom were clinically recommended for coronary angiography. Exclusion criteria were imposed on people having a history of prolonged antiplatelet or statin medication, coronary angioplasty, carotid surgery, previous coronary artery bypass graft surgery, or cerebrovascular incidents.

2.4 Procedure

This cross-sectional observational research encompassed patients receiving cardiac catheterisation at South Eastern Central Railway Hospital in Kolkata. Before the surgery, participants filled out a questionnaire evaluating symptoms, risk factors, and current medicines. Exclusion criteria were patients with significant past cardiac operations (angioplasty, bypass surgery), symptomatic cerebrovascular illness, and peripheral vascular disease. Clinical tests encompassed height, weight, blood pressure, cardiovascular condition, and biochemical evaluations, including fasting and postprandial blood glucose, as well as lipid profiles. Risk variables including hypertension, diabetes, dyslipidaemia, a familial history of early coronary artery disease, and smoking were assessed.

Carotid intima-media thickness (IMT) was assessed at three locations on each side of the carotid artery via longitudinal imaging. The maximum and average IMT levels from six designated locations were examined. All patients received coronary angiography, conducted by two examiners who were blinded to the IMT results. The Gensini score was employed to evaluate the severity of CAD, with CIMT values over 1 mm signifying an elevated risk. The revised Gensini score evaluated the degree of stenosis and allocated a multiplier according to the functional importance of the impacted arterial segments. This method highlighted both the magnitude and intensity of CAD.

2.5 Parameter outcomes

The research encompassed comprehensive evaluations, including a medical history addressing current and prior diseases, as well as risk factors for diabetes, hypertension, and chest discomfort. Clinical and anthropometric assessments quantified weight, height, waist, and hip circumferences. Biochemical assessments comprised fasting and postprandial blood glucose, HbA1c, lipid profile, creatine kinase MB, serum LDH, and troponin T. Supplementary laboratory examinations comprised a full blood count, standard urine analysis, and a chest X-ray. Electrocardiography, two-dimensional and M-mode transthoracic echocardiography, and

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carotid intima-media thickness assessment using high-resolution B-mode ultrasonography were conducted. The severity of CAD was evaluated by invasive coronary angiography.

2.6 Statistical Analysis

"Statistical analysis was conducted with IBM SPSS version 20. Data were expressed as mean ± standard deviation for continuous variables and as counts and percentages for categorical variables". The 'Pearson Chi-square test was employed for the comparison of qualitative data, while an independent sample t-test was utilised for gender-based comparisons. The Pearson correlation evaluated the association between CIMT and the Gensini score. A p-value less than 0.05 was believed significant.

3. Results

Table 1 displays the age distribution of patients, contrasting men and females. In the 50-60 age demographic, ladies represented 50% and males 40.7%, together constituting 45% of the whole sample. The age group of 61-70 years included 34.8% females and 33.3% men, accounting for 34% of the overall population. The cohort aged over 70 years exhibited the lowest representation, with 15.2% females and 25.9% men, accounting for 21% of the overall population. A p-value of 0.398 signifies the absence of a significant gender difference in age distribution. In general, the lower age categories have a very even gender distribution, but males somewhat exceed females in the senior age category (above 70 years).

Table 1: Age Distribution of Patients and Gender Comparison

Age Group (years)	Female (n, %)	Male (n, %)	Total (n, %)	P Value
50-60	23 (50)	22 (40.7)	45 (45.0)	0.398
61-70	16 (34.8)	18 (33.3)	34 (34.0)	
>70	7 (15.2)	14 (25.9)	21 (21.0)	
Total	46 (100)	54 (100)	100 (100.0)	

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Table 2 illustrates the distribution of Angina on Exertion (AOE), Dyspnoea on Exertion (DOE), and familial history categorised by gender. Concerning AOE, 65.2% of females and 68.5% of men indicated feeling angina during exercise, with no statistically significant gender difference (p=0.726). In the instance of DOE, 58.7% of females and 68.5% of men experienced dyspnoea on exertion, with a p-value of 0.308, signifying no significant gender disparity. Regarding familial history, 45.7% of females and 59.3% of men exhibited a positive family history of CAD; however, the difference was not statistically significant (p=0.288). In summary, the sample exhibited no notable gender-based disparities in the frequency of AOE, DOE, or familial history.

Table 2: Presentation of Angina on Exertion, Dyspnea on Exertion, and Family History by Gender

Presentation/Family History	**Sex**	**Total (n, %)**	**P Value**
Angina on Exertion (AOE)			0.726
No	Female: 16 (34.8)	33 (33.0)	
	Male: 17 (31.5)		
Yes	Female: 30 (65.2)	67 (67.0)	
	Male: 37 (68.5)		
Total	Female: 46 (100)	100 (100.0)	
	Male: 54 (100)		
Dyspnea on Exertion (DOE)			0.308
No	Female: 19 (41.3)	36 (36.0)	
	Male: 17 (31.5)		
Yes	Female: 27 (58.7)	64 (64.0)	
	Male: 37 (68.5)		

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Total	Female: 46 (100)	100 (100.0)	
	Male: 54 (100)		
Family History			0.288
No	Female: 25 (54.3)	47 (47.0)	
	Male: 22 (40.7)		
Yes	Female: 21 (45.7)	53 (53.0)	
	Male: 32 (59.3)		
Total	Female: 46 (100)	100 (100.0)	
	Male: 54 (100)		

Table 3 examines the lipid profile, ejection fraction (EF), and renal profile among genders. Males had a substantially elevated mean LDL level (148.15 mg/dL) relative to females (136.98 mg/dL), with a p-value of 0.021. No notable gender disparity was seen in HDL levels (39.91 mg/dL for men and 38.96 mg/dL for females, p=0.951) or total cholesterol (203.63 mg/dL for males and 205.57 mg/dL for females, p=0.534). No significant difference in ejection fraction (EF%) was observed between males (60.39%) and females (60%), with a p-value of 0.187. In the renal profile, males exhibited a somewhat elevated mean urea level (21.65 mg/dL) relative to females (20.37 mg/dL), however, this disparity was not statistically significant (p=0.142). Nonetheless, men exhibited substantially lower creatinine levels (0.846 mg/dL) compared to females (0.902 mg/dL), with a p-value of 0.025.

Table 3: Comparison of Lipid Profile, Ejection Fraction, and Renal Profile Between Genders

Parameter	Sex	Mean	Std. Deviation	Std. Error Mean	P Value
Lipid Profile					

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LDL	M	148.15	10.095	1.374	0.021
	F	136.98	10.408	1.535	
HDL	M	39.91	6.156	0.838	0.951
	F	38.96	5.379	0.793	
Total Cholesterol	M	203.63	15.877	2.161	0.534
	F	205.57	14.979	2.209	
Ejection Fraction (EF%)					0.187
ECHO - EF%	M	60.39	1.406	0.191	0.187
	F	60	1.52	0.224	
Renal Profile					
Urea	M	21.65	4.598	0.626	0.142
	F	20.37	3.929	0.579	
Creatinine	M	0.846	0.1224	0.0167	0.025
	F	0.902	0.112	0.018	

Table 4 compares the prevalence of diabetes mellitus, hypertension, and smoking status across genders. The prevalence of diabetes mellitus was comparable between genders, with 54.3% of females and 55.6% of men afflicted, indicating no significant difference (p=0.419). Regarding hypertension, 50% of both females and males were diagnosed, with no statistically significant difference (p=0.39). Smoking status exhibited a notable gender disparity (p=0.031). A greater proportion of males (68.2%) were smokers in contrast to females (31.8%), with 42.86% of females and 56% of males indicating non-smoking status.

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Table 4: Comparison of Distribution of Diabetes Mellitus, Hypertension, and Smoking Status Between Genders			
Parameter	**Sex**	**Frequency (%)**	**P Value**
Diabetes Mellitus			0.419
No	Female: 21 (45.7)	45 (45.0)	
	Male: 24 (44.4)		
Yes	Female: 25 (54.3)	55 (55.0)	
	Male: 30 (55.6)		
Total	Female: 46 (100)	100 (100)	
	Male: 54 (100)		
Hypertension			0.39
No	Female: 23 (50)	51 (51.0)	
	Male: 28 (51.9)		
Yes	Female: 23 (50)	49 (49.0)	
	Male: 26 (48.1)		
Total	Female: 46 (100)	100 (100)	
	Male: 54 (100)		
Smoking Status			0.031

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No	Female: 32 (57.14)	56 (56.0)	
	Male: 24 (42.86)		
Yes	Female: 14 (31.8)	44 (44.0)	
	Male: 30 (68.2)		
Total	Female: 46 (100)	100 (100)	
	Male: 54 (100)		

Table 5 depicts the prevalence of regional wall motion abnormalities (RWMA) identified using echocardiogram (ECHO) in female versus male patients. The prevalent disorder, Global Hypokinesis/Hyperkinesis (H/K), was identified in 19.6% of females and 11.1% of men, with no statistically significant gender difference noted (p=0.430). Other conditions such as H/K ALW (Anterior Left Wall), H/K ASLW (Anterior Septal Left Wall), and H/K ASW (Anterior Septal Wall) were comparatively infrequent, exhibiting no significant gender disparities. H/K ILW (Inferior Left Wall) impacted a singular male patient, but H/K IW (Inferior Wall) was more prevalent in men (13%) compared to females (6.5%). A total of 65.2% of females and 61.1% of men exhibited no RWMA, indicating a greater incidence of RWMA among males; nevertheless, the differences were not statistically significant (p>0.05).

Table 5: Comparing ECHO - RWMA (regional wall motion abnormalities) between gender

ECHO - RWMA (regional wall motion Abnormalities)	**Sex**		**Total (%)**	**P value**
	Female	**Male**		
Global H/K	9 (19.6)	6 (11.1)	15	
H/K ALW	3 (6.5)	2 (3.7)	5	0.430

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H/K ASLW	0 (0)	2 (3.7)	2	
H/K ASW	1 (2.2)	3 (5.6)	4	
H/K ILW	0 (0)	1 (1.9)	1	
H/K IW	3 (6.5)	7 (13)	10	
No	30 (65.2)	33 (61.1)	63	
Total	46	54	100	

4. Discussion

In recent years, IMT of the common carotid artery has been proposed as a rapid, non-invasive, and repeatable indicator for CAD [13, 14]. CIMT, evaluated by B-mode ultrasonography to quantify the distance between the media-adventitia and lumen-intima layers of the carotid artery, serves as a prognostic indicator for early atherosclerosis alterations [15]. Research indicates that CIMT is associated with risk factors like smoking, diabetes, hypertension, and cholesterol levels [16], and it has been connected to the severity of CAD. Patients with advanced CAD exhibit elevated CIMT levels relative to healthy persons [17]. Notwithstanding substantial discoveries about the correlation between CIMT and CAD, its use in clinical screening, especially across genders, remains ambiguous.

The current study indicates that the prevalence of CAD is highest in persons aged 50-60 years (45%), followed by those aged 61-70 years (34%) and those beyond 70 years (21%), underscoring an elevated risk for CAD in the 50-60 age group. The survey revealed that women were more common in the 50-60 age bracket, whilst males were predominant in the over-70 age category. The gender distribution among age categories was not statistically significant ($p=0.398$). Research conducted by Coskun et al. on CIMT and coronary artery stenosis revealed no significant differences in age, gender, or smoking behaviours between individuals with and without serious coronary lesions [18]. Furthermore, Wegner's research highlighted the postponed manifestation of coronary artery disease (CAD) in women, who generally experience symptoms of acute myocardial infarction (MI) later than males, mostly attributable

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to preventive biological factors before menopause. Nonetheless, this gender disparity decreases with age, and women over 40 encounter a comparable risk of CHD as males [19].

The current study revealed no significant variations in gender distribution or family history among CAD patients, with a p-value of 0.288. The research conducted by Gheisari et al. [20] examined lipid profiles by gender, demonstrating that males had substantially elevated levels of low-density lipoprotein (LDL) cholesterol (148.15±10.09 mg/dL) in contrast to women (136.98±10.40 mg/dL), with a p-value of 0.021. This data aligns with current evidence indicating that post-menopause, women's LDL levels increase, rendering them more vulnerable to CHD [21]. No significant variations were detected in high-density lipoprotein (HDL) cholesterol and total cholesterol levels across genders. Research indicates that women consistently exhibit greater HDL cholesterol levels than males across all age groups; nonetheless, low HDL presents a more pronounced risk factor for CAD in women, particularly after menopause [22]. Research by Eastwood and Doering indicated that elevated triglyceride levels and reduced HDL substantially increase the risk of CAD in women [23]. Oikonomou et al. examined the correlation between diabetes and coronary heart disease (CHD), highlighting that the mechanisms of insulin resistance and its impact on CHD risk vary by gender, so confounding the comprehension of the matter [24].

The study evaluated ejection fraction (EF), indicating no significant difference between genders (males: 60.39±1.406%, females: 60.00±1.520%, p=0.187). No gender differences were seen in urea levels (males: 21.65±4.598%, females: 20.37±3.929%, p=0.142). Creatinine levels were substantially elevated in females (0.902±0.1220) relative to males (0.846±0.1124), with a p-value of 0.025. This indicates a potential gender disparity in renal function among CAD patients, which may influence treatment methods.

No significant difference was noted in the incidence of diabetes mellitus (p=0.419) or hypertension (p=0.390) between genders concerning comorbidities. Smoking was notably more common in men (68.2%) compared to women (31.8%), with a p-value of 0.031. Smoking is a recognised risk aspect for CAD, underscoring its substantial contribution to the onset of cardiovascular illnesses, especially in males. Coskun et al. found that individuals with at least one major coronary lesion (over 50% blockage) were more predisposed to comorbidities such as hypertension, diabetes, and hyperlipidaemia, highlighting the necessity of controlling these

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risk factors to avert the advancement of CAD [18]. Numerous research has investigated the impact of diabetes and hypertension on gender disparities in the risk of coronary artery disease (CAD). Research conducted by Gheisari et al. revealed that women with a history of myocardial infarction (MI) had a much higher propensity to develop ischaemic heart disease (IHD) than those without a prior MI [20].

Diabetes and hypertension became recognised as substantial risk factors for ischaemic heart disease in both sexes. Madonna et al. examined the influence of sex differences and diabetes on coronary artery disease (CAD), highlighting that individuals with diabetes have a two to threefold elevated risk of cardiovascular disease, with women exhibiting heightened risk attributable to hormonal fluctuations and metabolic variables [25]. This underscores the necessity for gender-specific strategies in the prevention and treatment of CAD. This study highlights the important function of carotid IMT as a prognostic instrument for CAD, particularly in its initial phases. The results indicate that although some gender disparities are present in lipid profiles and renal function, other variables such as smoking and comorbidities, including diabetes and hypertension, are pivotal in assessing CAD risk.

Although no notable variations were found in the frequency of diabetes, hypertension, or familial history across genders, the study emphasises that lifestyle factors, notably smoking, are a predominant risk aspect for CAD, especially in males. Additional study is required to formulate more explicit gender-specific protocols for the management and prevention of CAD, particularly in light of the distinct processes and risk profiles associated with men and women.

Conclusion

This research underscores the essential function of CIMT as a prognostic instrument for the early identification of CAD. No notable gender differences were seen in the incidence of CAD, family history, or comorbidities such as diabetes and hypertension; however, lifestyle variables, notably smoking, were identified as a substantial risk factor, especially in men. Furthermore, disparities in lipid profiles and renal function were seen across women, highlighting the necessity for gender-specific approaches in the management of CAD. CIMT is an effective, non-invasive technique for detecting early atherosclerosis and allowing prompt therapies to mitigate CAD-related morbidity and death.

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