Original Research

Investigating Thickness of Intima-Media in Carotid Artery by Doppler Ultrasound in Type 2 Diabetics: A Marker for Cardiovascular Risk

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Received: 15/11/2024 Accepted: 17/12/2024 Published: 22/12/2024

ABSTRACT
Background: Cardiovascular disease ranks as the leading cause of morbidity and mortality among individuals with diabetes. The use of sonography has facilitated the evaluation of subclinical atherosclerosis by measuring the Carotid Intima-Media Thickness (CIMT). This study aimed to assess the role of CIMT in predicting cardiovascular risk among patients with Type 2 Diabetes Mellitus (T2DM).
Materials and Methods: The study included 145 T2DM patients aged over 30 years (mean age: 53.68 ± 10.77 years; 49.65% males). Data on demographics, diabetes history, glycemic control, anthropometric indices, lipid profiles, and blood pressure were collected. The presence of metabolic syndrome was determined using IDF criteria. Sonographic evaluation was conducted to measure CIMT, with a thickness exceeding 0.9 mm on either side considered abnormal. Statistical analyses were performed using Chi-square and Student's t-tests.
Results: The average CIMT was 0.83 ± 0.33 mm, with 42.07% (61 patients) exhibiting abnormal CIMT values. The prevalence of metabolic syndrome was 74.7%. Abnormal CIMT was significantly associated with older age, male gender, prolonged diabetes duration, combination therapy with insulin and oral hypoglycemic agents, fasting and postprandial glucose levels, elevated HbA1c, and poor glycemic control. Among traditional cardiovascular risk factors, significant associations were identified between abnormal CIMT and obesity, smoking, elevated blood pressure or hypertension, elevated lipid parameters, and metabolic syndrome.
Conclusion: A considerable proportion of T2DM patients exhibited abnormal CIMT, which was linked to demographic, disease-specific, and conventional cardiovascular risk factors. Further research including a control group is recommended to validate these findings.

Keywords: Carotid Intima-Media Thickness, Type 2 Diabetes Mellitus, Cardiovascular Risk

INTRODUCTION

Lifestyle disorders represent a significant and prevalent challenge to humanity, often posing the most common non-communicable threat to health. Among these conditions, diabetes stands out due to its extensive impact, both in terms of the number of individuals affected and its role in precipitating other health-related complications. According to estimates, approximately 6.28% of the global population is affected by diabetes [1,2].

The development of atherosclerosis and cardiovascular disease is frequently linked to comorbid factors observed in individuals with Type 2 Diabetes (T2D), such as hypertension, insulin resistance, hyperglycemia, obesity, and dyslipidemia. These metabolic disturbances substantially increase the comorbidity burden among diabetic patients. Given the heightened cardiovascular risk associated with diabetes, the primary focus of diabetes management is on the early detection and intervention of cardiovascular disease, ideally before clinical symptoms appear [3-5].

Sonographic techniques have facilitated the evaluation of subclinical atherosclerosis by measuring carotid intima-media thickness (CIMT). This parameter is recognized as a biomarker for atherosclerosis and is strongly correlated with overall cardiovascular disease risk, particularly in individuals with T2D. High-resolution, non-invasive B-mode ultrasonography is among the most effective methods for identifying the early stages of atherosclerotic conditions. Notably, a 0.1-mm increase in carotid IMT has been associated with a 15% rise in the relative risk of ischemic heart disease and an 18% rise in the risk of cerebrovascular disease [6-8].

Given the critical role of carotid intima-media thickness in evaluating and stratifying cardiovascular risk in diabetic patients, the current study was undertaken to explore its association with cardiovascular risk factors in individuals diagnosed with Type 2 Diabetes Mellitus (T2DM).

MATERIALS AND METHODS

This cross-sectional study included patients aged over 30 years, of any gender, diagnosed with T2DM and undergoing treatment with anti-diabetic medications, insulin, or both. Exclusion criteria comprised individuals with chronic kidney disease, thyroid disorders, liver diseases, rheumatoid conditions, coronary artery disease, hypertension, cerebrovascular events, or familial hypertriglyceridemia. A total of 145 participants met the inclusion and exclusion criteria and were enrolled.

Demographic information, the duration of diabetes, and treatment regimens were documented at the time of enrollment. Personal habits, such as smoking and alcohol consumption, were also recorded. Blood pressure values exceeding 130/85 mmHg were classified as indicating cardiovascular risk [9]. Glycemic control was categorized as follows [10]: <6.5%: Well-controlled; 6.5–8.0%: Fairly controlled; >8%: Poorly controlled. Cardiovascular risk related to lipid profiles was evaluated using the following parameters: Total cholesterol (TC) >210 mg/dL [11]; Triglycerides (TG) >150 mg/dL [8]; High-density lipoprotein (HDL): <50 mg/dL for females and <40 mg/dL for males [9]; Low-density lipoprotein (LDL) >130 mg/dL [11]. Central obesity was assessed using the waist-to-hip ratio (WHR) based on World Health Organization (WHO) recommendations, which define abnormal WHR as >0.85 for females and >0.90 for males [12].

CIMT was measured using a high-resolution B-mode ultrasound system with linear transducers operating at frequencies between 7 MHz and 12 MHz. CIMT was defined as the distance between the intimal-luminal and medial-adventitial interfaces of the carotid artery, which appears as a "double-line" on sonographic imaging [13]. The common carotid artery (CCA) near its bifurcation was the typical site for CIMT measurement on the far wall. Measurements were taken for both the right and left carotid arteries, with the average CIMT calculated from these values. A CIMT >0.9 mm was considered indicative of an abnormal or thickened artery [14]. If either side exceeded this cut-off, the CIMT was classified as abnormal.

RESULTS

The association of CIMT with various clinicodemographic and laboratory parameters was analyzed (Table 1). The abnormal CIMT group (n=61) had a significantly older age (58.18 ± 9.33 years vs 47.29 ± 8.06 years, $p < 0.01$), with a higher proportion of males (62.30% vs 40.48%, $p < 0.05$). The duration of diabetes was longer in the abnormal CIMT group (10.94 ± 5.55 years vs 5.91 ± 4.22 years, $p < 0.01$), along with higher HbA1c (7.70 ± 1.48% vs 6.33 ± 0.92%, $p < 0.01$), fasting blood sugar (183.84 ± 81.60 mg/dl vs 122.74 ± 25.95 mg/dl, $p < 0.01$), and postprandial blood sugar (272.09 ± 94.39 mg/dl vs 183.74 ± 39.84 mg/dl, $p < 0.01$). Glycemic control was poorer in the abnormal CIMT group, with more participants having fair (67.21% vs 40.48%, $p < 0.01$) and poor control (29.51% vs 8.33%, $p < 0.01$). Regarding diabetes medication, fewer patients in the abnormal CIMT group were on oral hypoglycemic agents (OHAs) (34.43% vs 92.86%, $p < 0.01$), and more were on both insulin and OHAs (55.74% vs 4.76%, $p < 0.01$).

Table 1: CIMT association with clinicodemographic and laboratory parameters

Characteristic	Abnormal CIMT (n=61)	Normal CIMT (n=84)	p Value
Age (years)	58.18 ± 9.33	47.29 ± 8.06	<0.01
Gender			

Male	38 (62.30)	34 (40.48)	<0.05
Female	22 (36.07)	51 (60.71)	
Duration of Diabetes (years)	10.94 ± 5.55	5.91 ± 4.22	<0.01
HbA1c (%)	7.70 ± 1.48	6.33 ± 0.92	<0.01
FBS (mg/dl)	183.84 ± 81.60	122.74 ± 25.95	<0.01
PPBS (mg/dl)	272.09 ± 94.39	183.74 ± 39.84	<0.01
Glycemic Control			
Good	1 (1.64)	44 (52.38)	<0.01
Fair	41 (67.21)	34 (40.48)	
Poor	18 (29.51)	7 (8.33)	
Diabetes Medication			
OHAs	21 (34.43)	78 (92.86)	<0.01
Insulin	5 (8.20)	3 (3.57)	
Both	34 (55.74)	4 (4.76)	

Table 2 shows that abdominal obesity and hypertension were significantly associated with abnormal CIMT. The abnormal CIMT group had higher waist circumference (92.42 ± 6.39 cm vs 86.54 ± 7.29 cm, p < 0.01), waist-to-hip ratio (0.94 ± 0.08 vs 0.82 ± 0.06, p < 0.01), systolic blood pressure (129.49 ± 12.71 mmHg vs 116.08 ± 11.66 mmHg, p < 0.01), and diastolic blood pressure (85.09 ± 7.49 mmHg vs 75.54 ± 9.78 mmHg, p < 0.01). Hypertension, as per IDF criteria, was more common in the abnormal CIMT group (35 vs 21, p < 0.01). The lipid profile also differed significantly, with higher total cholesterol (179.36 ± 39.42 mg/dL vs 147.43 ± 21.66 mg/dL, p < 0.01), triglycerides (196.21 ± 70.43 mg/dL vs 142.40 ± 40.48 mg/dL, p < 0.01), and LDL (99.73 ± 29.98 mg/dL vs 79.11 ± 16.51 mg/dL, p < 0.01), and lower HDL (40.23 ± 8.62 mg/dL vs 39.78 ± 7.80 mg/dL, p < 0.01) in the abnormal CIMT group. Smoking and alcohol consumption were also more prevalent in the abnormal CIMT group (22 vs 16, p < 0.05 for smoking; 18 vs 15, p < 0.05 for alcohol).

Table 2: Association of CIMT and obesity, hypertension, lipid profile and personal history

Characteristic	Abnormal CIMT (n=61)	Normal CIMT (n=84)	p Value
WC (cm)	92.42 ± 6.39	86.54 ± 7.29	<0.01
WHR	0.94 ± 0.08	0.82 ± 0.06	<0.01
SBP (mmHg)	129.49 ± 12.71	116.08 ± 11.66	<0.01
DBP (mmHg)	85.09 ± 7.49	75.54 ± 9.78	<0.01
HTN (IDF criteria)	35	21	<0.01
TC (mg/dL)	179.36 ± 39.42	147.43 ± 21.66	<0.01
TG (mg/dL)	196.21 ± 70.43	142.40 ± 40.48	<0.01
HDL (mg/dL)	40.23 ± 8.62	39.78 ± 7.80	<0.01
LDL (mg/dL)	99.73 ± 29.98	79.11 ± 16.51	<0.01
Smoking	22	16	<0.05
Alcohol	18	15	<0.05

Multivariate analysis (Table 3) identified age, waist circumference, and systolic blood pressure as significant predictors of abnormal CIMT. Age (β = 0.49, p < 0.01) and waist circumference (β = 0.233, p < 0.01) were positively associated with abnormal CIMT, while the waist-to-hip ratio, triglycerides, LDL, HDL, total cholesterol, and blood pressure parameters showed no significant predictive value (all p > 0.05).

Table 3: Multivariate analysis for predictors of CIMT

Parameter	Beta	Significance	Lower CI	Upper CI
Age (yrs)	0.49	<0.01	0.008	0.013
WC (cm)	0.233	<0.01	0.003	0.01
WHR	-0.036	0.596	-0.5	0.287
TG (mg/dL)	-0.128	0.867	-0.005	0.005
PPBS (mg/dL)	-0.033	0.813	-0.001	0.001
LDL (mg/dL)	-0.38	0.801	-0.027	0.021
TC (mg/dL)	0.604	0.773	-0.02	0.027

HDL (mg/dL)	-0.211	0.655	-0.029	0.018
SBP (mmHg)	-0.043	0.654	-0.004	0.002
HbA1c	0.084	0.323	-0.013	0.038
DBP (mmHg)	0.168	0.06	0	0.007
FBS (mg/dL)	0.241	0.055	0	0.002

DISCUSSION

Cardiovascular disease remains a leading cause of morbidity and mortality among individuals with diabetes. This study aimed to evaluate CIMT using sonography in diabetic patients and to analyze its relationship with traditional cardiovascular risk factors in those with T2DM.

In a study by Momeni et al. [15], the mean age of participants was reported as 59.65 ± 9.37 years, which is slightly higher than the mean age in this study, calculated as 54.57 ± 10.66 years. While Momeni et al.'s study had a female predominance (64.3% females vs. 35.7% males), the current study included an equal proportion of male and female participants. Additionally, various studies have investigated the association of CIMT with traditional cardiovascular risk factors across diverse age and sex distributions among Type 2 Diabetes Mellitus patients [14,16,17]. The age range in the present study encompassed both mature adults and the elderly, making it particularly relevant for analyzing cardiovascular risk in a balanced, gender-inclusive diabetic population.

Dakre et al. [18] reported that 67% of participants had a diabetic history exceeding five years but did not provide data on glycemic control (HbA1c levels) or treatment type. In contrast, Omar et al. [19] reported mean HbA1c levels of 9.2% and 8% in two groups within their study, without discussing diabetes duration or specific treatments. In this study, the mean HbA1c was 7.37 ± 1.54%, and detailed information on diabetes duration and treatment types was documented.

Dakre et al. [18] also reported that 88% of their participants were overweight or obese according to BMI criteria. In this study, 86.7% of participants were classified as obese based on waist circumference, and 34.4% were obese according to waist-to-hip ratio criteria. While Dakre et al. observed hypertriglyceridemia and low HDL levels in 85% and 75% of participants, respectively, this study reported lower proportions, with hypertriglyceridemia and low HDL levels observed in 60.2% and 61.01% of participants, respectively. Unlike Dakre et al. [18], this study also evaluated additional cardiovascular risk factors, such as mean blood pressure and behavioral risks like smoking and alcohol use. The obesity profile in both studies was comparable.

The mean CIMT in this study was 0.83 ± 0.33 mm, with values of 0.81 ± 0.22 mm and 0.84 ± 0.33 mm for the right and left carotid arteries, respectively. CIMT >0.9 mm was observed in 42.06% of participants, aligning with findings by Momeni et al. [15], who reported a mean CIMT of 0.84 ± 0.18 mm but did not categorize it. In another study, Bhinder and Kamble [20] reported a mean CIMT of 0.78 ± 0.06 mm among prediabetic patients, slightly different than in this study, likely due to differences in diabetic status. Dakre et al. [18] found that 53% of their participants had CIMT >0.9 mm, a finding consistent with this study.

A limitation of this study was the absence of a control group, which restricts the ability to compare the relative risk of abnormal CIMT in Type 2 Diabetes Mellitus patients against a non-diabetic population.

CONCLUSION

Abnormal CIMT was significantly associated with various cardiovascular risk factors, including advanced age, male gender, prolonged diabetes duration, use of combined insulin and oral hypoglycemic agents, inadequate glycemic control, increased waist-to-hip ratio, central obesity as indicated by waist circumference, smoking, hypertension, elevated mean systolic and diastolic blood pressures, and dyslipidemia. Detecting abnormal CIMT in populations with low cardiovascular risk can serve as an early warning, enabling clinicians to implement timely interventions to prevent severe cardiovascular or cerebrovascular events.

Source of funding: None

Conflicts of interest: None

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