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Original Research

Assessment of Carotid Intima-Media Thickness in Patients with Type 2 Diabetes Mellitus Using Carotid Doppler Ultrasonography

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Abstract

Background: Type 2 diabetes mellitus (T2DM) is associated with an increased risk of atherosclerosis and cardiovascular events. Carotid intima-media thickness (CIMT), measured by carotid Doppler ultrasonography, serves as a non-invasive marker for early detection of subclinical atherosclerosis. The main aim of the present study was to evaluate CIMT in patients with T2DM and investigate its association with clinical and metabolic risk factors.

Methods: This cross-sectional study included 65 T2DM patients who underwent carotid Doppler ultrasonography. Demographic data, duration of diabetes, glycemic control (HbA1c), blood pressure, and lipid profile were recorded. CIMT was measured at the distal common carotid artery bilaterally, and the average value was calculated. CIMT >0.9 mm was considered increased. Statistical analyses included correlation and comparative tests with significance set at $p < 0.05$.

Results: The mean age of the participants was 56.8 ± 9.4 years; 58.5% were male. The average CIMT was 0.86 ± 0.14 mm. Increased CIMT (>0.9 mm) was found in 36.9% of patients. Higher CIMT values were significantly associated with longer duration of diabetes (>10 years), poor glycemic control (HbA1c >8%), hypertension, and dyslipidemia. CIMT showed positive correlations with age ($r = 0.41$, $p < 0.01$), duration of diabetes ($r = 0.35$, $p < 0.05$), and systolic blood pressure ($r = 0.39$, $p < 0.01$).

Conclusion: A substantial proportion of T2DM patients exhibited increased CIMT, particularly those with poor metabolic control and cardiovascular risk factors. CIMT measurement via carotid Doppler may serve as a valuable tool for early detection of subclinical atherosclerosis in this high-risk population.

Keywords: Carotid intima-media thickness, Type 2 diabetes mellitus, Carotid Doppler, Atherosclerosis, Cardiovascular risk

Introduction

Insulin resistance and relative insulin insufficiency are hallmarks of type 2 diabetes mellitus (T2DM), a chronic metabolic disease that results in persistent hyperglycaemia. Microvascular and macrovascular complications—the latter being a major source of morbidity and mortality among diabetic patients globally—are exacerbated over time by inadequate glycaemic control (American Diabetes Association, 2023).Chronic inflammation, endothelial dysfunction, and lipid abnormalities increase atherosclerosis, the main pathological process causing cardiovascular and cerebrovascular disorders, in people with type 2 diabetes (T2DM) (Beckman et al., 2002). Implementing prompt therapies to lower the risk of cardiovascular events in this high-risk population requires early diagnosis of subclinical atherosclerosis. According to Stein et al. (2008), carotid intima-media thickness (CIMT), which may be assessed non-invasively using B-mode ultrasonography (carotid Doppler), is a trustworthy proxy for early atherosclerosis and cardiovascular risk. It has been demonstrated that coronary artery disease severity and presence, as well as the risk of myocardial infarction and stroke in the future, are correlated with CIMT, which represents structural alterations in the carotid artery wall (Lorenz et al., 2007).

According to Temelkova-Kurktschiev et al. (2000), a number of studies have shown that individuals with type 2 diabetes had higher CIMT than non-diabetic

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controls. This suggests that CIMT may be useful for risk assessment and disease monitoring. However, glycemic management, the length of diabetes, blood pressure, lipid profile, and the existence of additional cardiovascular risk factors can all affect how much CIMT progresses. Using carotid Doppler ultrasonography, this study intends to evaluate the CIMT in a cohort of T2DM patients and investigate its relationship to clinical factors such age, diabetes duration, glycemic management, and comorbidities. Comprehending these correlations can shed light on the vascular condition of individuals with diabetes and emphasize the significance of early detection of subclinical atherosclerosis.

Materials and Methods

This was a cross-sectional observational study conducted at GMC, Amritsar over a period of 6 months from [01st October 2024 to 31st March 2025]. The study was approved by the institutional ethics committee, and informed consent was obtained from all participants prior to enrolment.

The study comprised 65 individuals between the ages of 40 and 75 who had been diagnosed with type 2 diabetic mellitus (T2DM). Patients who had carotid Doppler ultrasonography as part of a routine cardiovascular evaluation and who had been diagnosed with type 2 diabetes (as defined by the American Diabetes Association) for at least a year met the inclusion criteria.

Exclusion criteria

- History of cerebrovascular accident or transient ischemic attack
- Established coronary artery disease
- Known peripheral arterial disease
- Chronic kidney disease (stage 3 or above)
- Type 1 diabetes mellitus
- Active infection or inflammatory disease
- Patients on statin therapy for less than 6 months

Clinical and Laboratory Assessment

Age, sex, smoking status, length of diabetes, and history of dyslipidemia or hypertension were among the demographic information that was documented. An ordinary sphygmomanometer was used to test blood pressure. Using common enzymatic techniques, laboratory data such as serum creatinine, lipid profile, HbA1c, and fasting blood glucose were evaluated.

Carotid Doppler Ultrasonography

B-mode carotid Doppler ultrasonography was performed on each patient utilizing a high-resolution linear array transducer (7.5–10 MHz). Bilateral CIMT measurements were made at the far wall of the common carotid artery's (CCA) distal 1 cm section. Each side received three measurements, and the mean CIMT was determined by averaging the six results.

According to the American Society of Echocardiography recommendations, values >0.9 mm were determined to have an increased CIMT, whereas values ≤0.9 mm were deemed to be within the normal range (Stein et al., 2008).

Statistical Analysis

SPSS version 27 was used to analyze the data. Categorical data were represented as percentages, and continuous variables as mean ± standard deviation (SD). Continuous variables were compared using the Student's t-test, while categorical variables were compared using the Chi-square test. To evaluate the relationship between CIMT and clinical parameters, Pearson correlation coefficients were computed. Statistical significance was defined as a p-value of less than 0.05.

Results

A total of 65 patients diagnosed with type 2 diabetes mellitus (T2DM) underwent carotid Doppler ultrasonography to assess carotid intima-media thickness (CIMT). The study population consisted of 38 males (58.5%) and 27 females (41.5%), with a mean age of **56.8 ± 9.4 years**.

Table 1: Baseline Characteristics of the Study Population

Variable	Mean ± SD / n (%)
Age (years)	56.8 ± 9.4
Gender	-
Male	38 (58.5%)
Female	27 (41.5%)
Duration of Diabetes (years)	8.2 ± 4.6
HbA1c (%)	8.1 ± 1.2
Hypertension	34 (52.3%)
Dyslipidemia	29 (44.6%)
Smoking History	17 (26.2%)

Table 2:Carotid Intima-Media Thickness (CIMT) Distribution

CIMT Category	n (%)
Normal (≤ 0.9 mm)	41 (63.1%)
Increased (> 0.9 mm)	24 (36.9%)

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Overall Mean CIMT	0.86 ± 0.14 mm

Table 3: Mean CIMT According to Clinical Factors

Variable	Mean CIMT (mm) ± SD	p-value
Duration ≤ 10 years	0.81 ± 0.10	< 0.01
Duration > 10 years	0.94 ± 0.12	
HbA1c ≤ 8%	0.81 ± 0.10	< 0.05
HbA1c > 8%	0.91 ± 0.11	
With Hypertension	0.90 ± 0.13	< 0.05
Without Hypertension	0.82 ± 0.11	
With Dyslipidemia	0.92 ± 0.12	< 0.05
Without Dyslipidemia	0.83 ± 0.10	

Table 4: Correlation of CIMT with Clinical Parameters

Parameter	Correlation Coefficient (r)	p-value
Age	0.41	< 0.01
Duration of Diabetes	0.35	< 0.05
Systolic Blood Pressure	0.39	< 0.01
HbA1c	0.29	0.06

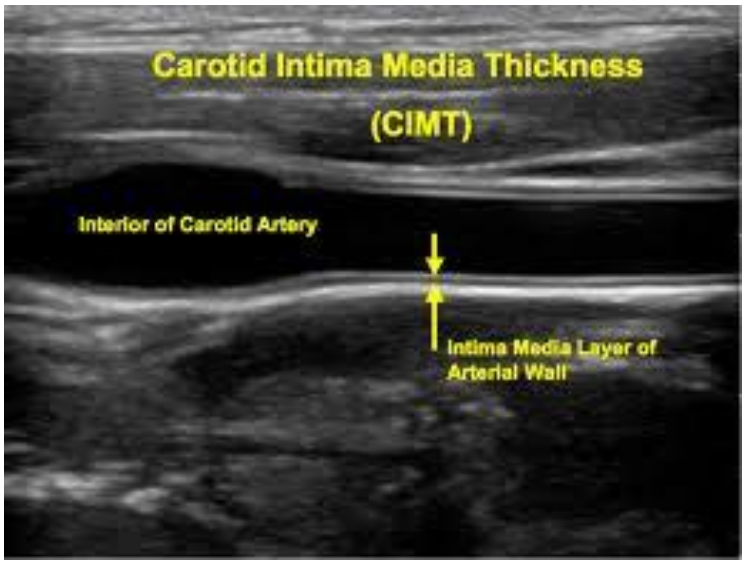

Figure 1: showing Carotid Intima Media Thickness

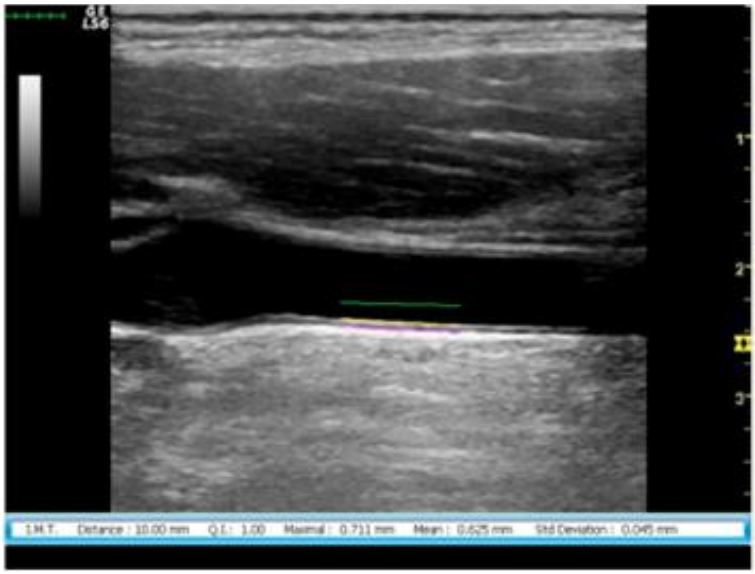

Figure 2: Carotid media thickness and plaque risk

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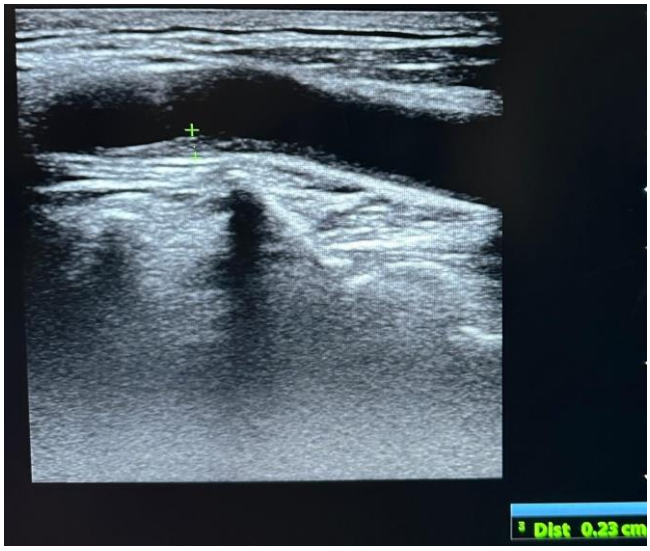

Figure 3: Image showing plaque of 3.5 mm thickness

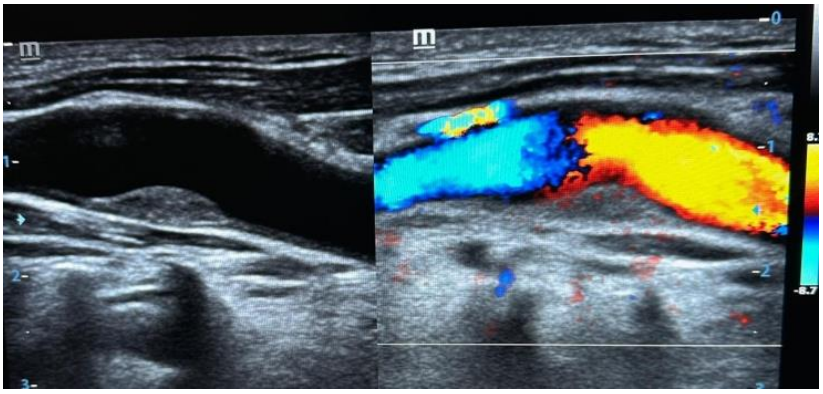

Figure 4: showing carotid intima media with thickness 2.3 mm

Discussion

In order to quantify subclinical atherosclerosis and investigate its relationship to clinical and metabolic markers, the current study used Doppler ultrasonography to measure carotid intima-media thickness (CIMT) in 65 patients with type 2 diabetes mellitus (T2DM). Our results demonstrated that even in the absence of obvious cardiovascular illness, a considerable percentage of patients (36.9%) had elevated CIMT (>0.9 mm), suggesting the existence of early atherosclerotic alterations.In this study, the mean CIMT was 0.86 ± 0.14 mm, which is in line with results from comparable populations. Temelkova-Kurktschiev et al. (2000), for example, found that newly diagnosed type 2 diabetics had higher CIMT than healthy controls, corroborating the idea that diabetes speeds up atherogenesis early in the course of the disease.

Patients with a longer history of diabetes (>10 years), poor glycemic control (HbA1c >8%), hypertension, and dyslipidemia had noticeably higher CIMT results. These results are consistent with earlier research showing that endothelial dysfunction, vascular smooth muscle proliferation, and increased arterial wall thickness are all facilitated by chronic hyperglycemia when combined with other metabolic disorders (Beckman et al., 2002; Geroulakos et al., 1994).

Furthermore, we discovered that CIMT was positively correlated with systolic blood pressure, age, and the length of diabetes—all of which are known risk factors for atherosclerosis. According to Lorenz et al. (2007), this supports the usefulness of CIMT as a sensitive, non-invasive indicator of cumulative cardiovascular risk in individuals with diabetes.

Interestingly, contrary to some previous research that suggested somewhat higher values in men, our study did not find significant gender differences in CIMT (Hodis et al., 1998). The sample size or the differences in the distribution of risk factors between the sexes in our cohort could be the cause of this disparity.

The ability of CIMT testing to identify subclinical vasculature alterations prior to the onset of clinical episodes is what makes it useful. Increased CIMT is predictive of future myocardial infarction and stroke, according to several longitudinal investigations (Bots et al., 1997). Thus, adding CIMT screening to the regular evaluation of T2DM patients—particularly those with other risk factors—may enhance early risk assessment and enable the timely start of preventive interventions.

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Limitations

The cross-sectional nature of the study restricts the capacity to draw conclusions about causality. The findings' generalizability may be impacted by the single-center design and comparatively small sample size. Furthermore, a non-diabetic control group for comparison was absent from the study, which would have improved the analysis.

Conclusion

In conclusion, a significant percentage of T2DM patients had elevated CIMT, especially those with poor glycemic control, a longer disease duration, and associated dyslipidemia or hypertension. These results provide credence to the inclusion of CIMT measurement in diabetic cardiovascular risk assessment procedures, which may help direct early intervention tactics.

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