International Journal of Biomedicine 12(1) (2022) 104-108
http://dx.doi.org/10.21103/Article12(1)_OA9

ORIGINAL ARTICLE

Cardiology

INTERNATIONAL JOURNAL OF BIOMEDICINE

Comparison of the Impacts of Insulin and Oral Treatment, with or without Dietary Control and Physical Activity Management, on the Carotid Intima-Media Thickness of Patients with Type 2 Diabetes

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Abstract

The aim of this study was to assess carotid intima-media thickness (CIMT) changes in relation to the treatment options of type 2 diabetes (T2D).

***Methods and Results*:** This cross-sectional descriptive study included 92 adults (57.61% female and 42.39% male) diagnosed with T2D with the mean age of 48.59±8.24 years and mean disease duration of 6.0±3.03 years. All patients were categorized into three groups according to the treatment types: Croup A included patients (n=21) treated with insulin injections; Group B included patients (n=33) treated with pills; and Group C included patients (n=38) treated with pills, dietary control, and regular exercise. The control group included 83 healthy people. High-resolution B-mode sonographic evaluations of common carotid arteries (CCAs) were performed. CIMT was measured at a point 1cm distal from the bulb of the carotid artery. The random blood glucose (RBG) test was performed at the time of the sonographic investigation.

In T2D patients, the CIMT was significantly higher than in the healthy participants (P<0.001).The CIMT of the left CCA in Group C was significantly lower than in Groups A and B (P=0.033). The age of participants and the duration of T2D were significantly associated with increased CIMT (P=0.021 and P=0.015, respectively).

Conclusion: Dietary control and physical activity should be considered significant factors in controlling CIMT in T2D. (**International Journal of Biomedicine. 2022;12(1):104-108.**)

Key Words: carotid intima-media thickness • type 2 diabetes • dietary control • physical activity • insulin injection

For citation: Hamad HA, Gameraddin M, Alshoabi S, Adam M, Aloub S, Abdelmalik BA. Comparison of the Impacts of Insulin and Oral Treatment, with or without Dietary Control and Physical Activity Management, on the Carotid Intima-Media Thickness of Patients with Type 2 Diabetes International Journal of Biomedicine. 2022;12(1):104-108. doi:10.21103/Article12(1)_OA9

Abbreviations

CCAs, common carotid arteries; **CVD**; cardiovascular disease; **CIMT,** carotid intima-media thickness; **DM,** diabetes mellitus; **RBG**, random blood glucose; **T2D**, type 2 diabetes.

Introduction

Diabetes mellitus (DM) is a significant health problem and a key risk factor for atherosclerosis and several cardiovascular issues, such as myocardial infarction, stroke, and vascular death. Compared to people without DM, those with diabetes have a higher risk of CVD events and cardiovascular death.[1,2]

Carotid intima-media thickness (CIMT) is an important ultrasound biomarker for the evaluation of atherosclerosis and is considered a predictor of organ damage. People with DM exhibit a higher CIMT than those without DM.[3-5]

The control of DM has a significant role in the prevention of CVDs. Uncontrolled DM can damage various organs, such as the eyes, nerves, kidneys, and cardiovascular system.[6] A large number of prospective and retrospective studies have reported significant associations between control of T2D and reduction of the progressive effect of CIMT.[7] For T2D, a diet rich in fiber has been found to have a beneficial effect on cardiovascular risk factors.[8] Regular physical activity has also been shown to reduce CIMT.[9]

The aim of this study was to assess CIMT changes in relation to the treatment options of T2D.

Materials and Methods

This cross-sectional descriptive study was conducted at Ribat University Hospital and Military Hospital in Khartoum State from January 2015 to November 2017. A total of 92 adults (57.61% female and 42.39% male) diagnosed with T2D with the mean age of 48.59±8.24 years and mean disease duration of 6.0±3.03 years were categorized into three groups according to the treatment types (Table 1): Croup A included patients (n=21) treated with insulin injections; Group B included patients (n=33) treated with pills; and Group C included patients (n=38) treated with pills, dietary control, and regular exercise. The participants were asked for regular exercise and dietary control using a designed data collection sheet.

Table 1.
Demographic characteristics of patients with T2D

Variable	Mean ± SD
CIMT (Male; n=53)	1.675±0.088 mm
CIMT (Female; n =39)	1.907±0.168 mm
Age	48.59±8.25 years
Duration of the disease	6±3.03 years
RBG Group C Group A Group B	 125±8 mg/dL 150±11 mg/dL 170±9 mg/dL

The dietary control was implemented through medical nutrition therapy utilized for improving diabetes management. RBG was taken at the time of the sonographic investigation.

Patients were excluded from the study if they had any history of previous ischemic stroke, hypertension, familial hyperlipidemia, CVDs, carotid or peripheral vascular surgery, or renal insufficiency. The control group included 83 healthy participants.

Sonographic examination

The patients were investigated using an ultrasound machine (Sonoline G 60S) equipped with a linear probe with a frequency of 7–10MHz. High-resolution B-mode sonographic evaluations were performed. Patients were examined in a supine position with the sonographer seated beside the patient's head. The sonographic scanning of the neck was obtained by tilting and rotating the head away from the side being investigated. The CCAs were scanned in several transducer positions, such as long-axis (longitudinal) and short-axis (transverse) planes. The views of the CCAs were obtained from the anterior, lateral, and posterior-lateral approaches. CIMT was measured at a point 1cm distal from the bulb of the carotid artery.

Statistical analysis was performed using the standard Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp). Continuous variables were presented as mean±standard deviation (SD). For data with normal distribution, inter-group comparisons were performed using Student's t-test. Multiple comparisons were performed with one-way ANOVA. The linear regression test was applied. A probability value of $P<0.05$ was considered statistically significant.

The study was approved by the ethical committee of the College of Medical Radiologic Science at the Sudan University for Science and Technology (SUST). Written informed consent was obtained from all participants.

Results

The results of biochemical analysis were not significantly different between the groups; the range of the RBG was 125–170 mg/dl for the three groups (Table 1). In T2D patients, the CIMT was significantly higher than in the healthy participants ($P<0.001$) (Table 2).

Table 2.
CIMT in patients with T2D and Control group

Variables	Participants	n	Mean±SD	P-value	95% CI
Right CCA CIMT, mm	T2D	92	1.47±.268	< 0.001	.745─.86
	Control group	83	0.66±0.079		
Left CCA CIMT, mm	T2D	92	1.52±0.220	< 0.001	.869─.97
	Control group	83	0.59±0.098		

The CIMT of the left and right CCAs was not significantly different between Group A and Group B. In contrast, the CIMT of the left CCA in Group C was significantly lower than in Groups A and B ($P=0.033$) (Table 3).

The right CIMT was also lower in Group C than in Group A, but differences were not statistically significant (Table 4). Figure 1 summarizes the changes in the mean CIMT in the study groups.

We applied a linear regression test to determine the risk factors and predictors that may affect the carotid IMT. We found that the age of participants and the duration of T2D are significantly associated with increased CIMT ($P=0.021$ and $P=0.015$, respectively). Importantly, the treatment of T2D with dietary control and exercise has a significant association

with CIMT (*P*=0.022). After adjusting for age, duration of T2D, and gender, the mean CIMT maintained a significant difference depending on the type of treatment (Table 5).

Table 3.

CIMT in patients according to the type of treatment

Group	n	Right CCA CIMT, mm	Left CCA CIMT, mm	Duration of T2D, years
Group C	38	1.44±.27	1.46±.19	4.79±2.24
Group A	21	1.48±.31	1.61±.18	8.19±3.23
Group B	33	1.48±.23	1.52±.25	6.00±2.98
P-value (ANOVA test)		0.836	0.033	< 0.001

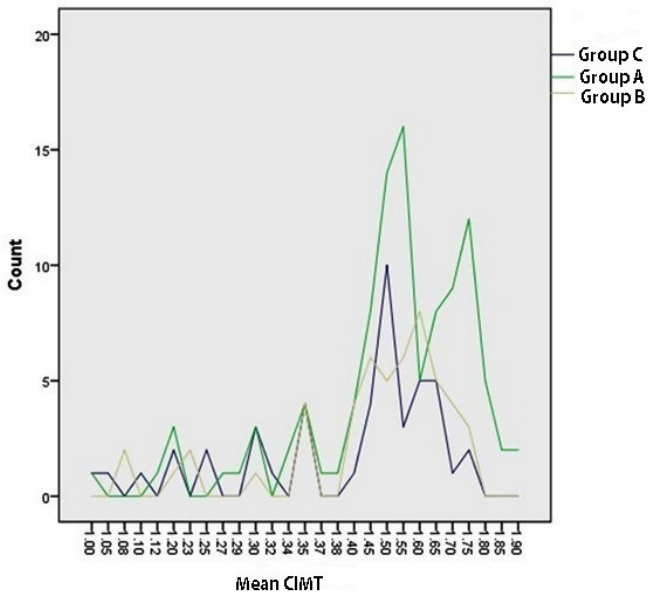

Fig.1. *CIMT in patients according to the type of treatment*

Table 4.

CIMT of the left and right CCAs in groups of patients according to the type of treatment

CIMT	Group	Mean ± SD, mm	*P*-value	95% CI
Left CCA CIMT, mm	Group C	1.46±0.19	.005	-.25957 — -.04896
	Group A	1.61 ±0.18		
Right CCA CIMT, mm	Group C	1.44±0.28	.66	-.19145 — .12333
	Group A	1.48±0.31		
LT CCA CIMT, mm	Group A	1.61±0.18	.183	-.04122— -.03344
	Group B	1.52±.25		
RT CCA CIMT, mm	Group A	1.48±.31	.996	-.14934 — .14856
	Group B	1.48±.23		

Table 5.

CIMT in the linear regression test

Model	Unstandardized coefficient		Standardized coefficient	t	*P*	95.0% CI for B
	B	Std. Error	Beta			
Age	.035	.015	.275	2.357	.021	.005–.064
Gender	.492	.209	.233	2.356	.021	.077–.908
Dietary and exercise control	.523	.224	.247	2.335	.022	.078–.968
Duration of T2D	-.101-	.041	-.293-	-2.480-	.015	-.183–-.020
(Constant)	-.734-	.759	--	-.968-	.336	-2.242–.774

Discussion

Atherosclerosis is a major cause of death and disability in patients with T2D.[10] The CIMT is a risk marker for CVD.[11-13] The present study explored the expected change in the CIMT of T2D patients undergoing three types of treatment.

We found that the CIMT was significantly higher in the T2D group than in the control group. A previous study also reported that the average common CIMT was 0.13mm greater in patients with DM,[14] and several other studies have found a significant relationship between CIMT and DM.[15,16]

The present study revealed that age and duration of DM were significantly associated with increased CIMT. This finding consistently agreed with previous studies, which reported a significant impact of age and DM duration on CIMT.[17,18] Despite the significant relationship between gender and CIMT, as reported in previous studies,[19,20] the current study found an insignificant correlation.

In our study, oral treatment with dietary control and exercise had a more significant impact on reducing the CIMT than oral treatment without exercise and dietary control. A previous study reported the beneficial effect of dietary control on T2D and glucose metabolism in general, reducing the risk of microvascular complications.[21] Epidemiological data have shown that a higher intake of some foods, such as whole grains, fruit, and soluble fibers, and lower consumption of saturated fat are associated with a decrease in CIMT. Lower CIMT has been reported with consumption of more than 0.79 servings/day of whole grains and more than 25g/day of fiber, predominately in a soluble form, and dietary control has thus been correlated with a significant decrease in CIMT.[22]

In the current study, the pills, diet, and exercise group had significantly lower CIMT. In the literature, it has been reported that regular exercise has a beneficial effect in reducing CIMT, which in turn helps to prevent carotid plaques. Byrkjeland et al.[23] reported that there was a significant effect of exercise on the presence of carotid plaques (*P*=0.013), with significantly lower CIMT in their exercise group than in the control group in patients without identified carotid plaques. Long-term physical activity may also have a positive effect

against atherosclerosis in healthy asymptomatic individuals.[24,25] These studies support our finding that dietary control and physical activity are related to significantly lower CIMT than insulin injections alone for T2D.

The current recommendations for the treatment of patients with T2D highlight the importance of diet and exercise.[26-30] Dietary knowledge and exercise for the treatment of T2D lead to better control of the disease and prevent carotid atherosclerosis, which is a key factor in cardiovascular events.

Limitations

The findings of this study should be interpreted in the context of some specific limitations. The diabetic treatments may not have been controlled perfectly in accordance with clinician instructions, and some patients may not have optimally implemented physical activity and dietary control. Secondly, the sample size is not large enough, and this may influence the statistical or clinical conclusion. These situations may affect the current results.

In conclusion, both insulin and oral treatment without other forms of management had no significant impact on reducing the progressive effect of CIMT. In contrast, oral treatment with dietary control and exercise saw significant differences. Therefore, dietary control and physical activity should be considered significant factors in controlling CIMT in T2D. Further studies are required to understand the correlation between diet, physical activity, and changes in CIMT.

Competing Interests

The authors declare that they have no competing interests.

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