Angiology: Open Access
ISSN: 2329-9495

Baba et al., Angiol 2018, 6:2
DOI: 10.4172/2329-9495.1000210

Research Article Open Access

Carotid Intima-Media Thickness in Patients with Diabetes Mellitus Attending Tertiary Care Hospital in Nigeria

Musa Mohammed Baba[1,2*], **Mohammed Abdullahi Talle**[1], **Philip Oluleke Ibinaiye**[3], **Habu Abdul**[2] **and Faruk Buba**[1]

[1]*Cardiology Unit, Department of Medicine, College of Medical Sciences, University of Maiduguri, Nigeria*

[2]*Department of Medicine, Federal Medical Centre Nguru, Nigeria*

[3]*Department of Radiology, Faculty of Medicine, Ahmadu Bello University, Zaria, Nigeria*

***Corresponding author:** Musa Mohammed Baba, Department of Medicine, Federal Medical Centre, Nguru, Nigeria, Tel: +2348083437997; E-mail: drbaba01@gmail.com

Received date: February 28, 2018; **Accepted date:** April 16, 2018; **Published date:** April 30, 2018

Abstract

Objective: Carotid intima-media thickness is a significant and independent predictor of coronary artery disease in patients with diabetes. The aim of our study was to determine carotid intima-media thickness in Nigerians with diabetes.

Methods: This was an observational cross-sectional study involving consecutively presenting patients with type 2 diabetes mellitus and healthy age-matched adults. Anthropometric variables were measured, and blood samples collected for fasting blood sugar, cholesterol, and HbA1c. Carotid intima-media thickness was measured using a 2-D scanner. Association of carotid intima-media thickness with other variable was assessed using correlation and multivariable linear regression models.

Results: One hundred and fifty two subjects (87 diabetics and 65 healthy adults) were studied. Carotid intima-media thickness was significantly higher among diabetics. Seventy nine (90.8%) and seventy two (82.8%) patients with diabetes had carotid intima-media thickness greater than 0.9 mm and 1.0 mm respectively. Carotid intima-media thickness was higher in patients with higher HbA1c, fasting blood sugar, body mass index, total cholesterol and LDL cholesterol, and significantly correlated with HbA1c, age, fasting blood sugar, systolic blood pressure, total cholesterol, LDL-c and HDL-c. Age, HbA1c and duration of hypertension predicted increased carotid intima-media thickness.

Conclusion: The prevalence of increased carotid intima-media thickness is extremely high among Nigerians with diabetes, and this significantly correlated with other risk factors for cardiovascular diseases. Assessment of carotid intima-media thickness should be routinely included in evaluation of subjects with diabetes, and assessment of total cardiovascular risk.

Keywords: Diabetes mellitus; Carotid intima-media thickness; Cardiovascular risks

Introduction

Diabetes mellitus is one of the leading predisposing factors for atherosclerotic cardiovascular diseases, with upward of 50% of patients with diabetes dying from cardiovascular complications [1]. The risk of clinical atherosclerotic diseases is increased by as much as two to three fold in the presence of diabetes mellitus [2,3].

The number of people with diabetes is increasing globally, rising from 108 million in 1980 to 422 million in 2014, with a corresponding prevalence of 4.7% and 8.5% respectively [4]. Low- and middle-income countries experienced a more rapid rise in prevalence of diabetes over the period reviewed, and it is projected to become the seventh leading cause of mortality in 2030 [5]. The prevalence of diabetes in Nigeria varies from region to region. Although a national prevalence of 2.2% was reported in the 90s, current guestimates puts the prevalence at between 8% and 10% [6,7].

Ultrasound-measured carotid intima media thickness (CIMT) has been variously shown to be potent surrogate of generalized atherosclerotic vascular disease. Carotid intima-media thickness has been demonstrated to be a significant and independent predictor of coronary artery disease (CAD), the leading cause of death in patients with diabetes [8]. Diabetes have been associated with increased CIMT, and this has been linked to increased cardiovascular events in Caucasians and Asians with type 2 diabetes mellitus (T2DM) [9-11]. Among the patients studied in Jos (central Nigeria), CIMT was found to be higher among diabetics than the non-diabetics [12].

We sought to determine CIMT among patients with diabetes presenting to a tertiary hospital in north eastern Nigeria, and to also determine the effect of other cardiovascular risk factors and indices of glycaemic control on CIMT.

Methods

Patients with diabetes mellitus presenting at the medical out-patient department of Federal Medical Centre Nguru were consecutively recruited from July 2013 to March 2014. Age matched healthy adults were enrolled to serve as controls. Anthropometric variables were measured using standard protocols, and fasting blood samples collected for determination of fasting blood sugar (FBS), cholesterol and blood urea nitrogen (BUN). Diabetes was defined according to WHO criteria [13]. Body mass index (BMI) was classified using the WHO guideline, and cholesterol levels classified according to the NCTP III guideline [14,15].

Blood pressure was measured and classified in accordance with JNC 7 guideline [16]. Only patients diagnosed with T2DM were included in this study.

Carotid intima-media thickness was measured by a radiologist with expertise in vascular ultrasound, using a high-resolution 2-D ultrasound scanner. The subjects were made to lie down supine with the neck slightly extended, and the head directed away from the side of interest. Images were systematically obtained at the common carotid, carotid bifurcation, and proximal internal carotid artery levels in longitudinal and short axis planes, and the far wall of carotid artery used in assessing CIMT. Zoomed images were used in identifying the intima-media interface, and CIMT determined using the leading-edge to leading edge convention. Carotid plaques where present were classified using modified Gray-Weale classification [17].

Data was analysed using SPSS software (22.0). Continuous variables were expressed as means (SD) and median (interquartile range) as appropriate. Means of continuous variables were compared using Student t-test or Mann-Whitney U test as appropriate. Paired-sample t-test was used in comparing CIMT of the right and le t side. Association of CIMT with other continuous variable was assessed using bivariate correlation and multivariable linear regression models. Proportions were compared using Chi-square test. A p value of <0.05 was considered significant for all statistical analysis.

Results

We enrolled 152 subjects, made of 87 diabetics and 65 healthy adults to serve as controls. There were 45 (51.7%) and 32 (47.7%) males in the diabetic and control groups respectively. The diabetic and control group had a comparable mean age of 45 (14.84) years and 45 (13.62) years respectively (p=0.992). Clinical characteristics of the groups are illustrated in Table 1.

	Diabetics (n=87)	Controls (n=65)	p
Male (%)	45 (51.7)	31 (47.7)	-
Age, years	45 (14.84)	45 (13.62)	0.992
BMI, kg/m^2	25.1 (5.31)	22.9 (1.68)	<0.001*
SBP, mm Hg	124.9 (17.18)	118.9 (10.17)	0.008*
DBP, mm Hg	79 (12.67)	77.9 (8.81)	0.521
Duration of diabetes, years	5.6 (4.12)	-	-
Hypertension (%)	22 (25.29)	-	-
Duration of hypertension	7 (5.45)	-	-
FBS, mmol/L	9.1 (3.01)	4.3 (0.50)	<0.001*
HbA1c (%)	7.6 (1.10)	5 (0.72)	<0.001*
Total cholesterol, mmol/L	4.3 (1.23)	4.8 (0.97)	0.006
LDL-c, mmol/L	2.9 (0.87)	3.3 (0.84)	0.010*
HDL-c, mmol/L	1.8 (0.47)	1.5 (0.38)	<0.001*
Triglyceride, mmol/L	2.5 (0.90)	2.1 (0.31)	0.004*

BMI=Body mass index; SBP=Systolic blood pressure; DBP=Diastolic blood pressure; FBS=Fasting blood sugar; LDL-c=Low density lipoprotein cholesterol; HDL-c=High density lipoprotein cholesterol; *Significant p value.

Table 1: Clinical and demographic characteristics of subjects.

Sixty four (73.6%) of the patients with diabetes had FBS of 7 mmol/l and above, while seventy three (83.9%) had HbA1c of 7% and above. Twenty two (25.3%) of the patients with diabetes were also hypertensive, whereas thirteen (14.9%) had a BMI of 30 kg/m^2 and above. Elevated total and low density lipoprotein cholesterol (LDL-c) were documented in 20 (23%) and 22 (25.3%) of the patients with diabetes respectively.

Carotid intima media thickness measured at various levels and plaque types are illustrated in Table 2. The diabetic group had a significantly higher mean CIMT compared to control at all levels. Seventy nine (90.8%) of the patients with diabetes had CIMT greater than 0.9 mm, while sixty nine (79.3%) had CIMT greater than 1.0 mm compared to 30 (46.2%) and 26 (40%) respectively for the controls (p<0.001 for both comparisons).

Citation: Baba MM, Talle MA, Ibinaiye PO, Abdul H, Buba F (2018) Carotid Intima-Media Thickness in Patients with Diabetes Mellitus Attending Tertiary Care Hospital in Nigeria. Angiol 6: 210. doi:10.4172/2329-9495.1000210

	Diabetics (n=87)	Controls (n=65)	p
RCCIMT, mm	1.16 (0.17)	0.90 (0.28)	<0.001*
LCCIMT, mm	1.18 (0.18)	0.90 (0.28)	<0.001*
RCBIMT, mm	1.23 (0.20)	0.99 (0.29)	<0.001*
LCBIMT, mm	1.23 (0.18)	0.98 (0.26)	<0.001*
RICIMT, mm	1.16 (0.16)	0.90 (0.26)	<0.001*
LICIMT, mm	1.17 (0.17)	0.90 (0.27)	<0.001*
Plaque type			
1	4 (4.6%)	0 (0%)	-
2	5 (5.7%)	1 (1.5%)	0.102¶
3	2 (2.3%)	1 (1.5%)	0.564¶
4	0 (0%)	0 (0%)	-
5	0 (0%)	0 (0%)	-
6	76 (87.4%)	42 (64.6%)	0.002*¶
No plaque	0 (%)	21 (32.3%)	-

RCCIMT=Right common carotid intima-media thickness; LCCIMT=Left common carotid intima-media thickness; RCBIMT=Right carotid bifurcation intima-media thickness; LCBIMT=Left carotid bifurcation intima-media thickness; RICIMT=Right internal carotid intima-media thickness; LICIMT; Left internal carotid intima-media thickness; *Significant p value; test of proportion used for comparison

Table 2: Carotid intima media thickness and plaque types.

Mean CIMT measured at the bifurcation was significantly higher than those measured at the common carotid and internal carotid levels ($p<0.001$ for all comparisons). However, CIMT measured at corresponding levels of the two sides did not differ. Similarly, CIMT was similar in males and females. Patients with diabetes with higher levels of HbA1c, FBS, BMI, total cholesterol and LDL-c had a significantly higher CIMT (Table 3).

Variable	CIMT† (mm)	P
HbA1c, %		
<7	1.0 (0.2)	<0.001*
≥ 7	1.2 (0.2)	
FBS, mmol/L		
<7	1.0 (0.3)	<0.001*
≥ 7	1.2 (0.1)	
BMI, Kg/m^2		
<30	1.2 (0.1)	0.006*
≥ 30	1.25 (0.1)	
SBP, mm Hg		
<140	1.2 (0.1)	0.09
≥ 140	1.2 (0.3)	
Total cholesterol, mmol/L		

>5.2	1.2 (0.1)	0.01*
≤ 5.2	1.2 (0.1)	
LDL-c, mmol/L		
<4	1.2 (0.1)	0.001*
≥ 4	1.3 (0.2)	
CIMT=Carotid intima-media thickness; HbA1c=Glycated haemoglobin; FBS=Fasting blood sugar; BMI=Body mass index; SBP=Systolic blood pressure; LDL-c=Low density lipoprotein cholesterol; *Significant p value; †CIMT expressed as median (interquartile range) and compared using Mann-Whitney U test		

Table 3: Comparison of left carotid intima media thickness based on cardiovascular risks.

Significant correlation was observed between left common CIMT and HbA1c (r=0.539, p<0.001), age (r=0.567, p<0.001), FBS (r=0.426, p<0.001), systolic blood pressure (r=0.218, p=0.043), total cholesterol (r=0.301, p=0.005), LDL-c (r=0.230, p=0.032) and HDL-c (r= -0.354, p=0.001). Stepwise multivariable regression analysis identified age, HbA1c and duration of hypertension to be significant predictors of increased CIMT (r^2=0.399, F=18.35, p<0.001), with the best predictors being HbA1c (standardized beta=0.352, p<0.001) and age (standardized beta=0.304, p=0.004).

Discussion

Our study demonstrates that patients with diabetes have significantly higher CIMT compared to apparently healthy individuals. Although this finding conforms to reports from other parts of Nigeria and the world [12,18], measured CIMT among the diabetics in our study is much higher. Plausible explanation for this variation includes differences in sample sizes, duration of diabetes, differences in demographics, co morbidities, method of measuring CIMT and levels of glycaemic control.

The prevalence of increased CIMT among our diabetic subjects is staggering and portends a significantly increased risk for cardiovascular disease [10]. Comparison with other studies might be difficult owing to differences in co morbidities and level of glycaemic control, among others. More than two-third of the diabetic subjects in our study had uncontrolled blood sugar as reflected by the FBS (73.6%) and HbA1c (83.9%). This could partly explain the high burden of increased CIMT observed. Increased prevalence of high CIMT was reported in patients with diabetes with increased blood pressure, elevated HbA1c, elevated FBS and elevated cholesterol [19-21]. This association is not unexpected, given the role of the various individual risk factors in the pathogenesis of atherosclerosis. Their combinatorial effect in driving atherosclerosis is more than additive and could be responsible for the high burden of increased CIMT [3].

We found a significant correlation between CIMT and HbA1c, FBS, SBP, total cholesterol, LDL-c and HDL-c, similar to what was reported in other studies [22,23]. High blood pressure and elevated LDL-c are leading risk factors in pathogenesis of atherosclerotic vasculopathy. Diabetes is associated with reduced HDL-c, elevated triglyceride and high small dense lipoprotein cholesterol, findings dubbed as diabetic dyslipidaemia. However, our study did not find significant association between CIMT and triglyceride. It is intriguing that patients with diabetes had a better lipid profile than the healthy controls. Although detail of medication was not completely captured in our study, the likelihood of being on statins is quite high. Importantly, therapeutic lifestyle changes being an integral part of the management of patients with diabetes might have impacted positively on the lipid profile.

Age, HbA1c and duration of hypertension independently predicted increased carotid IMT in our patients with diabetes. Ageing is an important independent risk factor for atherosclerosis and patients with this vasculopathy have been shown to have evidence of cellular senescence [24]. In a study by Saha and his colleagues, significant association was observed between age and high CIMT among patients with stroke [25]. Contrary to studies from other centres, we did not find significant differences in CIMT between males and females.

Increased CIMT develops faster among diabetics compared to non-diabetics, and hard carotid plaques develop in parallel with increasing levels of HBA1c [26]. However, we did not find the duration of diabetes to significantly impact on CIMT, a finding similar to that reported by others [27]. An association between HBA1c and incident coronary heart disease, stroke and peripheral vascular disease had been established in earlier studies [28-30]. An HBA1c level of 6.5% to 7% is shown to be associated with increased risk of stroke independent of other risk factors.

Assessment of CIMT combines the unparalleled advantages of being a sensitive, non-invasive and a reproducible test for assessing atherosclerotic vascular diseases and risk of cardiovascular diseases; and has been included in the list of diagnostic tools for global cardiovascular risk assessment [31]. Its impact is mainly in individuals with intermediate 10-year risk for cardiovascular events, allowing for reclassification to either the low-risk or high-risk category [32]. This has an enormous implication for the implementation of cost effective preventive measures.

Conclusion

We have demonstrated in this study that patients with diabetes have higher CIMT than healthy controls, and that the prevalence of increased CIMT is extremely high. Given the overwhelming evidence linking increased CIMT to incident cardiovascular diseases, the high prevalence of increased CIMT among our diabetic cohorts is of great concern. Assessment of CIMT should be routinely included in evaluation of subjects with diabetes, and concerted efforts made towards prevention of future CVDs. Given the small sample size from a single centre, larger multicentre study will be required to establish the prevalence of increased CIMT in Nigerian patients with diabetes.

Limitations

Our study has a number of limitations. The small sample size might have limited the power of the study. Medications and complications of diabetes that might directly impacts on atherosclerosis especially nephropathy were not captured as part of the study. The manual assessment of CIMT might have affected the accuracy of measurement compared to other studies in which semi-automated edge detection method was used. Finally, all measurements of CIMT were carried out by a single examiner with documentation of intra-observer variability.

Conflict of Interest

None

References

1. Gu K, Cowie CC, Harris MI (1998) Mortality in adults with and without diabetes in a national cohort of the US population, 1971-1973. Diabetes Care 21: 1138-1145.
2. Kannel WB, McGee DL (1979) Diabetes and glucose tolerance as risk factors for cardiovascular disease: The Framingham study. Diabetes Care 2: 120-126.
3. Stamler J, Vaccaro O, Neaton JD, Wentworth D (1993) Diabetes, other risk factors and 12yr cardiovascular mortality for men screened in the Multiple Risk Factor Intervention Trial. Diabetes Care 16: 434-444.
4. Global report on diabetes (2016) World Health Organization, Geneva.
5. Mathers CD, Loncar D (2006) Projection of global mortality and burden of disease from 2002 to 2030. PLoS Med 3: e442.
6. Akinkugbe OO (1997) The non-communicable diseases in Nigeria-Report of a national survey. Ibadan, Nigeria: intec printers limited.
7. Ogbera AO, Ekpebegh C (2014) Diabetes mellitus in Nigeria: The past, present and future. World J Diabetes 5: 905-911.
8. Ravikumar R, Deepa R, Shanthirani C, Mohan V (2002) Comparison of carotid intima media thickness, arterial stiffness and brachial artery flow mediated dilation in diabetic and nondiabetic subjects [The Chenai Urban Population Study (CUPS-9)]. Am J Cardiol 90: 702-707.
9. Temelkova-Kurktschiev TS, Koehler C, Leonhardt W, Schaper F, Henkel E, et al. (1999) Increased intimal-medial thickness in newly detected type 2 diabetes: Risk factors. Diabetes Care 22: 333-338.
10. O'Leary DH, Polak JF, Kronmal RA, Manolio TA, Burke GL, et al. (1999) Cardiovascular Health Study Collaborative Research Group: Carotid artery intima and media thickness as a risk factor for myocardial infarction and stroke in older adults. N Engl J Med 340: 14-22.
11. Kota SK, Mahapatra GB, Kota SK, Naveed S, Tripathy PR, et al. (2013) Carotid intima media thickness in type 2 diabetes mellitus with ischemic stroke. Indian J Endocrinol Metab 17: 716-722.
12. Okeahialam BN, Alonge BA, Pam SD, Puepet FH (2011) Carotid Intima Media Thickness as a measure of cardiovascular disease Burden in Nigerian Africans with Hypertension and Diabetes Mellitus. Int J Vasc Med 2011: 1-4.
13. Alberti KG, Zimmet PF (1998) Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus. Provisional report of a WHO consultation. Diabetic medicine 15: 539-53.
14. Anuurad E, Shiwaku K, Nogi A, Kitajima K, Enkhmaa B, et al. (2003) The new BMI criteria for asians by the regional office for the western pacific region of WHO are suitable for screening of overweight to prevent metabolic syndrome in elder Japanese workers. Journal of occupational health 45: 335-43.
15. Farrand ME (1988) National Cholesterol Education Program guidelines: New opportunities and challenges for dietitians. Topics in Clinical Nutrition 3: 9-20.
16. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, et al. (2003) The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: The JNC 7 report. Jama 289: 2560-2571.
17. Gray-Weale AC, Graham JC, Burnett JR, Byrne K, Lusby RJ (1988) Carotid artery atheroma: Comparison of preoperative B-mode ultrasound appearance with carotid endarterectomy specimen pathology. J Cardiovasc Surg 29: 676-681.
18. Brohall G, Oden A, Fagerberg B (2006) Carotid artery intima media thickness in patients with Type 2 diabetes mellitus and impaired glucose tolerance: a systematic review. Diabetic medicine 23: 609-616.
19. Yamasaki Y, Kodama M, Nishizawa H, Sakamoto K, Matsuhisa M, et al. (2000) Carotid intima-media thickness in Japanese type 2 diabetic subjects: predictors of progression and relationship with incident coronary heart disease. Diabetes care 23: 1310-1315.
20. Salonen R, Salonen JT (1990) Progression of carotid atherosclerosis and its determinants: a population-based ultrasonography study. Atherosclerosis 81: 33-40.
21. Lakka TA, Salonen R, Kaplan GA, Salonen JT (1999) Blood pressure and the progression of carotid atherosclerosis in middle-aged men. Hypertension 34: 51-56.
22. Matsumoto K, Sera Y, Nakamura H, Ueki Y, Miyake S (2002) Correlation between common carotid arterial wall thickness and ischemic stroke in patients with type 2 diabetes mellitus. Metabolism-Clinical and Experimental 51: 244-247.
23. Temelkova-Kurktschiev T, Koehler C, Schaper F, Henkel E, Hahnefeld A, et al. (1998) Relationship between fasting plasma glucose, atherosclerosis risk factors and carotid intima media thickness in non-diabetic individuals. Diabetologia 41: 706-712.
24. Costopoulos C, Liew TV, Bennett M (2008) Ageing and atherosclerosis: Mechanisms and therapeutic options. Biochemical pharmacology 75: 1251-1261.
25. Saha A, Sinha PK, Paul R, Bandyopadhyay R, Biswas K, et al. (2011) Study of carotid intima media thickness and its correlation with novel risk factors in ischemic stroke. Neurology asia 16: 25-31.
26. Jørgensen L, Jenssen T, Joakimsen O, Heuch I, Ingebretsen OC, et al. (2004) Glycated hemoglobin level is strongly related to the prevalence of carotid artery plaques with high echogenicity in nondiabetic individuals. Circulation 110: 466-470.
27. Kota SK, Mahapatra GB, Kota SK, Naveed S, Tripathy PR, et al. (2013). Carotid intima media thickness in type 2 diabetes mellitus with ischemic stroke. Indian J Endocrinol Metab 17: 716.
28. Selvin E, Marinopoulos S, Berkenblit G, Rami T, Brancati FL, et al. (2004) Meta-analysis: glycosylated hemoglobin and cardiovascular disease in diabetes mellitus. Annals of internal medicine 141: 421-431.
29. Stratton IM, Adler AI, Neil HAW, Matthews DR, Manley SE, et al. (2000) Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. Bmj 321: 405-412.
30. Selvin E, Coresh J, Golden SH, Brancati FL, Folsom AR, et al. (2005) Glycemic control and coronary heart disease risk in persons with and without diabetes: the atherosclerosis risk in communities study. Archives of internal medicine 165: 1910-1916.
31. Mancia G, De Backer G, Dominiczak A, Cifkova R, Fagarde R, et al. (2007) ESH/ESC practice guidelines for the management of arterial hypertension-ESH/ESC task force on the management of arterial hypertension. Journal of Hypertension 25: 1751-1762.
32. Peters SAE, den Ruijter HM, Bots ML, Moons KGM (2012) Improvements in risk stratification for the occurrence of cardiovascular disease by imaging subclinical atherosclerosis: A systematic review. Heart 98: 177-184.