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Research Article

SONOGRAPHIC ASSESSMENT OF COMMON AND INTERNAL CAROTID ARTERIES IN TYPE 1 DIABETIC PATIENTS

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ABSTRACT

Background: Diabetes Mellitus is one of risk factors that cause carotid arteries atherosclerosis which occurs when lipoprotein accumulates in the intima of the artery. As atherosclerosis progresses it may completely occlude the artery lumen or plaque may rupture sending thrombus more distal, resulting in Transient Ischemic Attack or stroke.
Aim: The aim of this study was to assess the Common Carotid Arteries and Internal Carotid Arteries in adult Sudanese patients with Type 1 Diabetes Mellitus.
Material and methods: 108 participants were enrolled in the study; they were scanned with linear probe of (7-10 MHz). Intima-Media-Thickness (IMT), Caliper, peak Systolic Velocity (PSV), pulsatility index (PI) and Resistive Index (RI) were measured.
Results: Intima-Media-ThicknessIMT in CCAs increased in Type 1 Diabetes; furthermore, it has been found to be significantly correlated to age and duration of diabetes. Pulsatility index (PI) also increased in diabetic patient. Other Doppler indices found to be within normal range.
Conclusion
Intima-Media-Thickness (IMT) and pulsatility index (PI) have been regarded as an early indicator of atherosclerosis in type 1 diabetes. IMT increases as the disease progresses, causing a range of macro and microvascular atherosclerosis-induced complications. Therefore ultrasound measurements can be considered as a noninvasive screening test and follow-up method in diabetic patients.

INTRODUCTION

Diabetes is one of risk factors that cause carotid arteries atherosclerosis which occurs when lipoprotein accumulates in the intima of the artery and is oxidatively modified and cytokine released which leads to monocyte deposition in the artery wall then transform into foam cells causing smooth muscle cells to migrate to intima and form the plaques. These plaques tend to occur at arterial branches points and bifurcations. As atherosclerosis progresses it may completely occlude the artery lumen or plaque may rupture sending thrombus more distal, resulting in Transient Ischemic Attack (TIA) or stroke(Sharrett et al., 1994). Ultrasound assessment of carotid arteries plaque and stenosis has become the first choice for carotid scanning; it is easily, a noninvasive, inexpensive, sensitive and permitting the evaluation of both the macroscopic appearance of plaques as well as flow characteristic in carotid arteries (Stein et al., 2008).

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High-resolution carotid ultrasonography can determine the presence or extent of atherosclerosis *in situ*. Carotid artery intima–media thickness (cIMT) independently predicts the risk of cardiac (myocardial infarction, angina pectoris, coronary intervention) and cerebrovascular events (stroke or transient ischemic attack)(Lorenz et al., 2006), the involvement of other arterial beds with atherosclerosis and is well suited for use in large-scale population studies as a marker of subclinical disease due to the relative simplicity and noninvasive nature of the technique(Naghavi et al., 2003). In this study Doppler ultrasound was used to assess Common and Internal Carotid Artery in both side of neck in patients with type 1 diabetes mellitus, considering age of patients and duration of diabetes, Intima-Media-Thickness (IMT), Caliper in mm, peak Systolic Velocity (PSV) and Resistive Indices (RI) were obtained as variables for assessment.

MATERIALS AND METHOD

Subjects

108 participants with type 1 diabetes mellitus (male = 61 and female =47) who admitted at National Ribat Hospital.

The sample selection and negligence depend on two criterions, the included subjects are patients with Type 1 Diabetes Mellitus and excluded are patients with Type 2 Diabetes Mellitus, Hypertension, Smokers and patients with previous history of carotid artery surgery.

Machine used

Ultrasound scanfor CCA was performed using a higher resolution Siemens Ultrasound medical system, Sonoline G 60S, equipped with a linear probe frequency 7-10 MHz Printing facility issued through the ultrasound digital graphic printer.

Methodology

Common Carotid (CC) and Internal Carotid (IC) arteries were scanned to visualize IMT, calipers, PSV and RI, which consider as dependent variables and correlation with age and duration of type 1 diabetes mellitus as independent variables. Patient lay in supine position with knee support and examiner seated toward the patient's head, the neck scanning was enhanced by tilting and rotating the head away from the side being examined. Several transducer positions were used in this research to examine CC IC arteries in long-axis (longitudinal) planes and short-axis (transverse), the views of the carotid arteries were obtained from anterior, lateral and posterior-lateral approach depending on which best shows the vessels. Image for CCA were obtained in longitudinal plane at the point along a 1cm distal from bulb of carotid artery to measure IMT which was proved to be a simple and reproducible method for assessing IMT of CCA for routine practice.

B-mode image of arterial wall composed of two parallel echogenic lines separated by a hypoechoics space, calculation of carotid IMT is arguably the most widely used noninvasive measure of atherosclerosis currently employed by clinicians and clinical investigators, both to quantify the extent of subclinical disease and to monitor change over times (Stein et al., 2004).For the far (posterior) wall of the carotid artery, this index can be easily measured by ultrasound as the distance between the leading edge of the luminal echo (first bright line) and the leading edge of the media-adventitia echo (second bright line).

For the near (anterior) wall, IMT is measured as the distance between the trailing edge of the first bright line and the trailing edge of the second bright line (del Sol et al., 2001).In CCA and ICA color Doppler ultrasound imaged the arteries as completely as possible with caudal angulation of transducer in supraclavicular area and cephalic angulation at the level of the mandible. Pulsed Wave Doppler ultrasound (PWD)is used to provide Doppler parameters of CCA and ICA after positioning the sample volume of the beam in the middle of the vessels using an insonation angle 60 degree, between ultrasound beam and longitudinal axis of the carotid segment, thus PSV was assessed and RI was automatically calculated by sonographic machine using the following formula (Laurent et al., 1990).

RI=PSV – EDV/PSV

Informed Consent

The research protocol was approval by both the College of Medical Radiologic Science (CMRS), Sudan University for Science and Technology (SUST) and Ultrasound Department in Ribat Hospital. Beside we obtained written informed consent from all patients prior to each Common Carotid Artery and Internal Carotid Artery ultrasound scan.

RESULTS

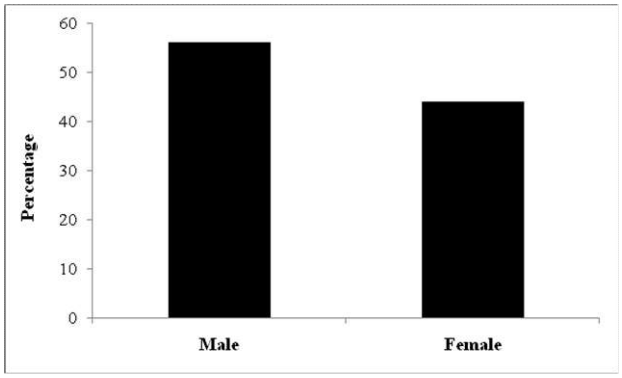

Figure 3.1. Gender distribution

Table 3.1. the Descriptive Statistics of Right Common Carotid Artery indices

	Mean	Std. Deviation	Std. Error Mean
RT CCA Caliper	7.648	1.12	0.108
RT CCA IMT	1.857	1.75	0.168
RT CCA PSV	74.68	18.20	1.750
RT CCA RI	0.685	0.063	0.006
RT CCA PI	1.973	0.276	0.026

Table 3.2. Descriptive Statistics of Left Common Carotid Artery indices

	Mean	Std. Deviation	Std. Error Mean
LT CCA PSV	73.525	14.6896	1.4135
LT CCA RI	.6659	.05956	.00573
LT CCA PI	2.0531	.25637	.02467
LT ICA Caliper	5.8206	.97417	.09418
LT CCA IMT	2.024	1.4142	.1361

Table 3.3. Descriptive Statistics of Right Internal Carotid artery indices

	Mean	Std. Deviation	Std. Error Mean
RT ICA Caliper	5.83	0.85	.0819
RT ICA PSV	66.99	12.96	1.24
RT ICA EDV	22.62	4.89	0.47
RT ICA RI	0.67	0.05	0.005
RT ICA PI	1.96	0.35	0.034

Table 3.4. Descriptive Statistics of Left Internal Carotid artery indices

	Mean	Std. Deviation	Std. Error Mean
LT ICA Caliper	5.82	0.97	0.094
LT ICA PSV	65.43	12.16	1.17
LT ICA EDV	22.18	5.30	0.51
LT ICA RI	0.66	0.057	0.005
LT ICA PI	2.00	0.33	0.032

DISCUSSION

The study has been carried out in Ribat Hospital affiliated to National Ribat University with general aim to assess Common Carotid (CA) and Internal Carotid (IC) artery in both side of neck in patients with type 1 Diabetes using Doppler ultrasonography.

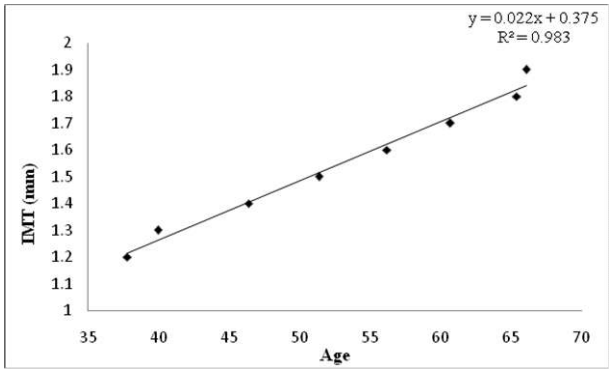

Figure 3.2 Correlation between IMT and Age in Rt CCA

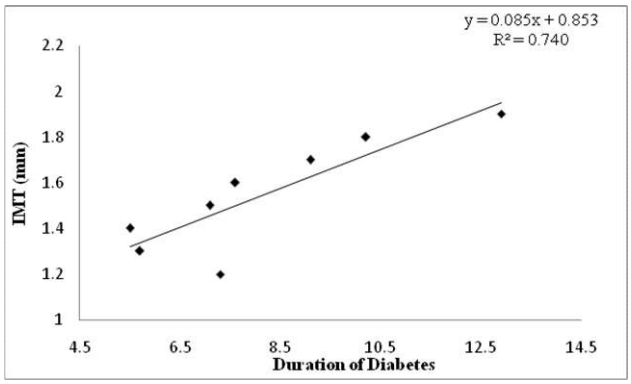

Figure 3.3. Correlation between IMT and Duration of Diabetes in Rt CCA

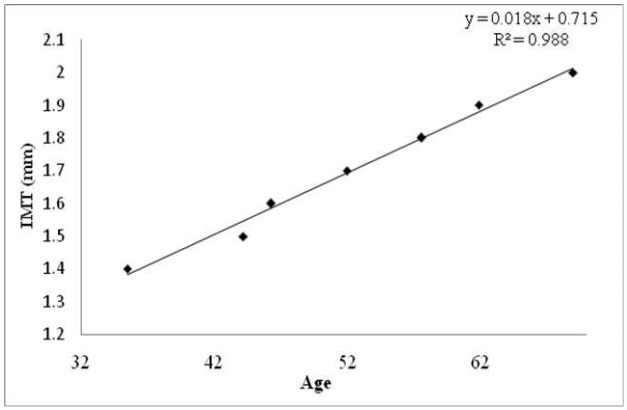

Figure 3.4. Correlation between IMT and Age in Lt CCA

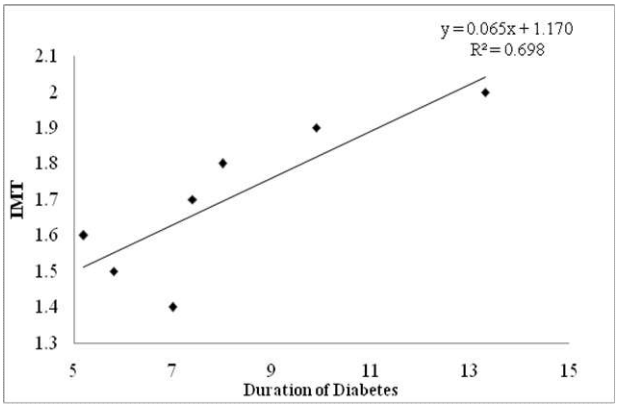

Figure 3.5 Correlation between IMT and Duration of Diabetes in Lt CCA

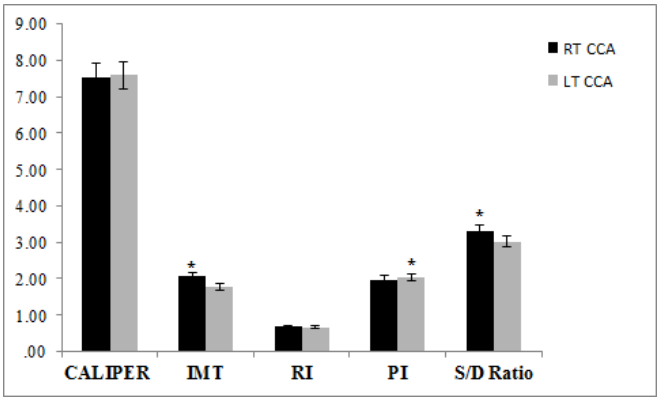

Figure 3.5 Comparison between Lt and Rt CCA indices (data presented as mean, (a strike indicates the significant difference at $p < 0.05$)

Changes in both structural and functional aspects of arteries have been a research interest for several years as they are considered risk factors for cardiovascular events. As diabetes is one of the most common causes of cardiovascular disease, IMT was changed due to impaired glucose level.Many published studies of normative IMT reported that the diagnostic values of carotid arteries ultrasound using B-mode in evaluating IMT in patients with type 1 DM(Lim et al., 2008), in this study IMT found to be increased than the normal range. Furthermore, IMT is significantly correlated to age and duration of diabetes. Aside from age as a variable that can influence IMT, the duration of diabetes is a relevant factor for IMT increase, this result totally consistent with Kamile, study which reveal that in patients with type 1 DM CIMT is higher than in the control group and each increment in its value is related with diabetes microvascular complications and duration of diabetes (Gul et al., 2010), and due to adherence of circulating monocytes to the endothelium then immigration into the sub-endothelium and subsequent formation of foam cells which are principle initial events in an increase IMT value in type 1DM patients (Eigenbrodt et al., 2007).Longer disease duration of diabetes might enhance its metabolic effects on the vascular system and result in earlier onset and accelerated progression of atherosclerosis. However, with increasing age other classical cardiovascular risk factors may play an additional role in diabetic(Pezeshki Rad et al., 2014).

This study revealed that IMT for the Lt CCA is greater than in the Rt CCA which is based on the basic thickness of Lt CCA that usually thicker than the Rt CCA and this is approved by previous study which showed that the value of IMT for Lt CCA has been greater than the Rt CCA (Vicenzini et al., 2007). This study demonstrated that the PI of CCA and ICA increased in diabetic patients. This may result from either luminal narrowing of the ICA or reduced resistance of the distal vessels.Thus, the increased PI observed in this study presumably represents enhanced cerebrovascular resistance in the cerebral circulation.These results were quite consistent with those of Lee et al; they demonstrated significantly increased pulsatility of the ICA in diabetic patients(Lee et al., 2000). IMT and PI have been regarded as an early indicator of atherosclerosis in type 1 diabetes. IMT increases as the disease progresses, causing a range of macro and microvascular atherosclerosis-induced complications. Therefore ultrasound measurements can be considered as a noninvasive screening test and follow-up method in diabetic patients.

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