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ORIGINAL ARTICLE

Sonographic Comparison of Atherosclerotic Changes in Carotid Arteries of Diabetic and Non-Diabetic Individuals

ZARTASH GUL[1], ANJUM TAZEEN[1], SYED MUHAMMAD YOUSAF FAROOQ[1], IRFAN SHABBIR[2], MISHAL ASIF[1], SYED AMIR GILANI[3], MUHAMMAD KAMRAN[4], KHALIL UR REHMAN[5], IRFAN ULLAH[6]

[1]*University institute of Radiological Sciences and MIT, The University of Lahore.*
[2]*Consultant Radiologist, Allied Hospital Faisalabad.*
[3]*Dean, Faculty of Allied Health Sciences, The University of Lahore.*
[4]*Department of Medical Laboratory Technology, Islamabad Medical and Dental College, Islamabad.*
[5]*Department of Biochemistry, Riphah International University, Faisalabad*
[6]*Department of Life Sciences, School of Science, University of Management and Technology (UMT), Lahore, Pakistan*
Correspondence author: Muhammad Kamran, Irfan Ullah, Email: kamranahmdani@gmail.com, irfan_btn@hotmail.com

ABSTRACT

Objective: To compare the sonographic findings of atherosclerotic changes in carotid arteries of diabetic and non-diabetic individuals.

Material & Methods: A cross-sectional study of 62 diabetic and non-diabetic individuals was conducted from 11 November 2021 to 20 March 2022 at the Radiology Department of District Head Quarter Hospital, Faisalabad, Pakistan. The ultrasound of carotid arteries with a TOSHIBA MX Doppler ultrasound machine, using a linear probe with transducer frequency of 5-12.5MHz was performed in both diabetic and non-diabetic participants.

Results: The mean value of CIMT in diabetic patients was 0.6839 ± 0.29178mm while the mean value of CIMT in Non- diabetic patients was 0.8000 ± 0.08563mm. The mean value of peak systolic velocity (PSV) of CCA in diabetic patients was 41.4194 ± 6.60189mm and the mean value of PSV of CCA in Non- diabetic patients was 41.7742 ± 6.52538mm. The mean value of PSV of ICA in diabetic patients was 58.4839 ± 12.03293mm and in Non- diabetic patients was 59.0323 ±10.03489mm. Similarly, the mean value of ICA/CCA ratio in diabetic patients was 1.4097 ± 0.39442 while in non-diabetic patients was 1.4323 ± 0.30374.

Conclusion: The diagnostic accuracy of ultrasonography of common carotid artery, and internal carotid artery is very high for atherosclerosis. The use of sonography for measurement of IMT and plaque area act as a vital tool for the detection of atherosclerosis changes due to diabetes.

Keywords: carotid artery, diabetes mellitus, intima-media thickness

INTRODUCTION

Diabetes mellitus (DM) is multifaceted medical trouble that has a worldwide prevalence. Type 2 diabetes mellitus (T2DM) has emerged as a growing health challenge, as its miles full-size within the United States. Out of 17 million diabetic individuals, 10 million people are recognized with T2DM and the other 6 million sufferers are undiagnosed in the US.[1] However, there may be an average asymptomatic duration of 5 years, many people with type 2 diabetes present clinically with complications, and ischemic stroke risk triples with diabetes ≥ 10 years.[2] Atherosclerotic lesions appear earlier in diabetics than in the general population; are more extensive; and are more often associated with complicated plaques such as ulceration, calcification, and thrombosis. Atherosclerotic complication of DM leading to stenosis with its attendant blood flow changes commonly affects carotid arteries, which can be assessed by imaging modalities. Recent studies proved that diabetes is related to carotid artery stenosis and ischemic stroke, which developed three instances more as examined in Non-diabetic individuals. [2] Atherosclerosis, a cause of carotid artery blood flow velocity changes and stenosis, has a predilection for extracranial carotid artery.[3] Duplex Doppler ultrasound (DUS) examination, which assesses blood flow velocity, is basic for the diagnosis of extracranial carotid artery stenosis. End-diastolic velocity, common carotid artery, peak systolic velocity as well as internal carotid artery, and PSV ratio are important blood flow velocity parameters (Doppler indices) assessed on DUS, and blood flow velocity is used to evaluate the sternness of carotid stenosis. DUS is the maximum used of all imaging modalities available for carotid arterial stenosis diagnosis because it requires no radiation or intravenous contrast and is inexpensive when compared with magnetic resonance angiography, and computed tomography angiography. PSV and EDV are important variables for the valuation of carotid artery stenosis, and they can be assessed with the aid of Doppler waveform analysis. [4,5]

Mortality and morbidity are the leading results of diabetes in patients with diabetes, and macrovascular disorder is the foremost contributor. Using carotid ultrasound (US) for the non-invasive assessment of arterial morphology in diabetic patients is a promising technique for tracking ailment development and finding the manner of remedy in diabetes patients. The intima-media thickness is a traditional endpoint.[6] Assessment of plaque quantity or plaque area is in all likelihood a greater influential measurement as compared to IMT because it predicts clinical occasions and estimates all plaques of the carotid system.[7,8] It is known that carotid atherosclerosis is also associated with coronary artery or cerebrovascular disease. The visualization of lumen surfaces and of the carotid wall is executed by the usage of carotid ultrasonography to measure the sternness of atherosclerosis. B-mode ultrasound dimension of intima-media thickness of carotid artery is a reproducible and quantitative measure of carotid arteriosclerosis that correlates nicely with that received with the aid of pathological measurements.[9] B-mode ultrasound measurement of intima-media thickness of carotid artery likewise correlates well with aortic intima-media thickness that supposed to imitate the severity of general atherosclerosis and measured with the aid of transesophageal echocardiography. Carotid ultrasonography could be a very useful approach for screening and diagnosis of atherosclerosis, as it is a cost-effective and convenient method.[10,11]

The maximum common complications of diabetic patients are atherosclerosis in coronary and carotid arteries. Ultrasonography is one of the methods that is used to locate histological variations and intima-media thickness of carotid arteries in sufferers with diabetes mellitus, as it is miles a correct imaging approach to evaluate carotid intima-media thickness. So, the assessment of Intima-media thickness accomplished by using this method is an alternative marker for early analysis of atherosclerotic. [12]

Compared with other methods, carotid ultrasonography has several benefits, as its procedure is simple, noninvasive, and inexpensive. Its equipment often easily available as well as it can detect atherosclerotic changes including plaque formation, and intima -media thickening.

MATERIAL AND METHODS

Data Collection Procedure: A cross-sectional study of 62 diabetic and non-diabetic individuals was conducted at the radiology department of District Head Quarter Hospital, Faisalabad. The

complete data regarding the history of the patient like age, family history, gender, body mass index (BMI), sonographic findings of the carotid arteries (Plaque volume, plaque area, echogenicity, echotexture, blood flow velocities, vascularization pattern, CIMT, EDV, PSV, and ICA/CCA PSV ratio) was collected in data collection procedure. The ultrasound of carotid arteries with a TOSHIBA MX Doppler ultrasound machine, using a linear probe with transducer frequency of 5-12.5MHz was performed in both diabetic and non-diabetic participants.

Inclusion & Exclusion Criteria: Both diabetic and non-diabetic individuals with ages between 18-80 years that were referred for Carotid Artery Ultrasound were included in the current study. Pregnant women, cigarette smokers, obese individuals, hypertensive, and individuals with clinical evidence of stroke and heart failure were excluded from the study.

Data / Statistical Analysis: Data was analyzed by using IBM-SPSS version 25. Percentages and frequencies were derived for qualitative variables and standard deviation and mean were derived for quantitative variables. Independent t-test was applied to compare variables in both groups. Graphs were also constructed where required.

Ethical Approval: Ethical approval was granted by hospital committee.

RESULTS

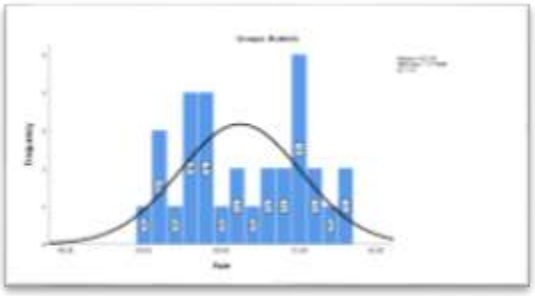
A total of 62 patients were included in which the age of 31 patients with diabetes was ranged from 50-75 years with the mean age 62.3871 ± 7.82593 years (Table 1, Graph 1). At the same time, the age of 31 Non-diabetic patients was ranged from 50-78 years with the mean age 63.2258 ± 7.76191 years (Table 1, Graph 2).

The body mass index (BMI) of the patients with diabetes was ranged from 14.30-37.90 with the mean value 25.4742 ± 6.38759 kg/m^2. While, the body mass index (BMI) of Non-diabetic patients was ranged from 14 -37 with the mean value 23.0903 ± 4.97704 kg/m^2 (Table 1). Out of 62 (100 %) patients, 36 (58.1 %) were male, whereas 26 (41.9 %) were female that participated in this study. Plaque location was assessed by ultrasonography using an ultrasound machine which reveal that 24 (38.7 %) patients have no plaque, 12 (19.4 %) patients have a plaque in the right carotid bulb, 16 (25.8 %) patients in the left carotid bulb, 6 (9.7 %) patients in Left carotid bulb extending in the internal carotid artery (ICA), and 4 (6.5 %) patients in Right carotid bulb extending in the internal carotid artery (ICA) in the neck (Table 2).

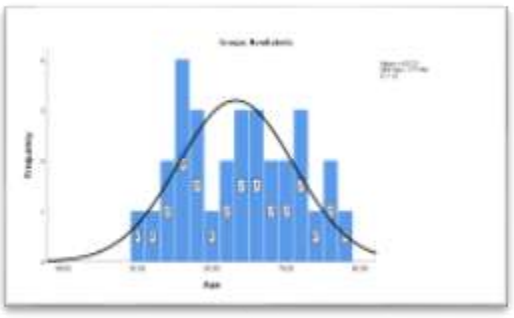
The scanning of carotid intima-media thickness (CIMT), peak systolic velocity (PSV) of common carotid artery (CCA), and internal carotid artery (ICA), and ICA/CCA ratio was performed which showed that the mean value of CIMT in diabetic patients was 0.6839 ± 0.29178mm while the mean value of CIMT in Non-diabetic patients was 0.8000 ± 0.08563mm. The mean value of peak systolic velocity (PSV) of CCA in diabetic patients was 41.4194 ± 6.60189cm/sec and the mean value of PSV of CCA in Non- diabetic patients was 41.7742 ± 6.52538 cm/sec. The mean value of PSV of ICA in diabetic patients was 58.4839 ± 12.03293mm and the mean value of PSV of ICA in Non- diabetic patients was 59.0323 ±10.03489mm. Similarly, the mean value of ICA/CCA ratio in diabetic patients was 1.4097 ± 0.39442 and the mean value of ICA/CCA ratio in non-diabetic patients was 1.4323 ± 0.30374 (Table 3).

Table 1: Frequency Distribution of patients (n=62).

		N	Mean	Std. Deviation	Minimum	Maximum
Age	Diabetic	31	62.38	7.82	50.00	75.00
	Non-diabetic	31	63.22	7.76	50.00	78.00
	Total	62	62.80	7.74	50.00	78.00
BMI	Diabetic	31	25.47	6.38	14.30	37.90
	Non-diabetic	31	23.09	4.97	14.00	37.00
	Total	62	24.28	5.80	14.00	37.90



Graph 1: Frequency distribution of Diabetic patients with age.



Graph 2: Frequency distribution of non-Diabetic patients with age.

Table 2: Distribution of patients according to Plaque location (n=62).

Plaque location		Frequency (n)	Percentage (%)
Valid	No plaque	24	38.7
	Right carotid bulb	12	19.4
	Left carotid bulb	16	25.8
	Left carotid bulb extending in ICA	6	9.7
	Right carotid bulb extending in ICA	4	6.5
	Total	62	100.0

Table 3:

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
CIMT	Diabetic	31	.68	.29	.05
	Nondiabetic	31	.80	.085	.01
CCA	Diabetic	31	41.41	6.60	1.18
	Nondiabetic	31	41.77	6.52	1.17
ICA	Diabetic	31	58.48	12.03	2.16
	Nondiabetic	31	59.03	10.03	1.80
Ratio	Diabetic	31	1.40	.39	.07
	Nondiabetic	31	1.43	.30	.05

Table 4: Independent Samples Test.

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
CIMT	Equal variances assumed	18.27	.000	-2.12	60	0.038	-0.116	0.054	-0.22	-0.006
	Equal variances not assumed			-2.12	35.13	0.041	-0.116	0.054	-0.22	-0.005
CCA	Equal variances assumed	0.007	0.931	-0.21	60	0.832	-0.354	1.667	-3.68	2.98
	Equal variances not assumed			-0.21	59.99	0.832	-0.354	1.667	-3.68	2.98

ICA	Equal variances assumed	1.137	0.291	-0.19	60	0.846	-0.548	2.814	-6.17	5.08
	Equal variances not assumed			-0.19	58.12	0.846	-0.548	2.814	-6.18	5.08
Ratio	Equal variances assumed	1.547	0.218	-0.25	60	0.801	-0.022	0.089	-0.201	0.15
	Equal variances not assumed			-0.25	56.32	0.802	-0.022	0.089	-0.20	0.15

The patients were categorized into 5 groups according to the typed of Echogenicity. Out of 62 (100 %) patients, 8 (12.9 %) patients were categorized in Type 3, 19 (30.6 %) patients in Type 4, 11 (17.7 %) patients in Type 5, and 24 (38.7 %) patients have missed echogenicity evaluation in our study

Table 3: Group Statistics for carotid intima-media thickness, internal carotid artery, common carotid artery, and their ratio, the mean as well as the standard deviation of values in diabetic and non-diabetic patients (n=62).

DISCUSSION

Atherosclerotic changes in carotid arteries of diabetic and non-diabetic individuals were diagnosed by sonographic evaluation. In our study, total age ranged from 50-78 years with mean age of 62.8065 ± 7.74139 years (Table 1) in which 31 (50 %) patients with diabetes have mean age of 62.3871 ± 7.82593 years which is greater than 40.3 ± 1.8 years reported by Pollex et al [7] and less than 65.9 ± 8.0 years reported by Irie et al. [8] similarly, the age 31 (50 %) Non-diabetic patients has mean age of 63.2258 ± 7.76191 that is greater than 40.4 ± 1.8 years reported by Pollex et al[7] and less than 65.1 ± 7.2 years reported by Irie et al. [13]

Total body mass index (BMI) ranged from 14.0-37.9 with the mean value 24.2823 ± 5.80454 kg/m^2 (Table 2). In our study, the body mass index (BMI) of diabetic patients is less than 29.1 ± 5.1 kg/m^2 while the body mass index (BMI) of Non-diabetic patients is also less than 29.3 ± 5.6 kg/m^2 reported by Onmez et al. [14]

All the patients included in this study have been speculated to go through color Doppler Ultrasonography of common carotid artery (CCA), and internal carotid artery (ICA). The peak systolic velocity (PSV) of ICA/CCA ratio was also noted. There is no significant difference for ICA PSV, CCA PSV, and ICA/CCA ratio between diabetic and non-diabetic individuals. In our study, the mean value of ICA PSV is less than 69.88 ± 5.1mm, and the mean value of CCA PSV is also less than 81.73 ± 2.3mm for diabetic individuals. Similarly for Non- diabetic individuals, the mean value of ICA PSV is less than 73.94 ± 1.2mm and the mean value of CCA PSV is also less than 82.75 ± 2.3mm reported by Nwokorie et al. [15]

Our study shows the diagnostic accuracy of carotid artery Doppler findings in diabetic patients. The carotid intima-media thickness (CIMT) in diabetic patients is greater than Non- diabetic patients that shows that the Ultrasonography is a significant marker for the diagnoses of diabetes. Similarly, a study conducted by Okafor et al. [16] evaluate that diabetes mellitus enhance the hazard of cardiovascular diseases as it causes atherosclerosis by changing the intima-media thickness of carotid arteries. They mentioned that mortality and morbidity are the most important consequences of cardiovascular diseases that arise in individuals with diabetes mellitus. The degree of atherosclerosis is contemplated via the carotid artery inside the numerous vessels particularly in coronary arteries. They monitored the development of atherosclerotic ailment and response to remedy by way of the usage of an exceedingly non-invasive and reasonably-priced ultrasonography approach that measures the thickness of the carotid artery with real-time. They concluded that ultrasonography is a useful technique for the assessment of carotid intima-media thickness (CIMT) through evaluating the atherosclerotic changes in diabetic and non-diabetic patients.

In their study, Al-Nimer and Hussein [17] reported that diabetic patients are at expanded hazard of atherosclerosis disorder due to the fact they have got extra intima media thickness of the carotid artery. They differentiate the diabetes patients with nonblood pressure aspect from individuals who are free from the blood pressure aspect, metabolic syndrome on basis of intima media thickness of carotid artery. They conclude that there is an association between extra carotid IMT values and metabolic syndrome in patients with diabetes mellitus even if the blood pressure aspect is not present. To demonstrate the regression of carotid IMT, further prospective studies are advised with the enterprise of metabolic syndrome in patients with diabetes mellitus.

In their observation, Alizadeh et al. [18] reported that diabetes mellitus has a global prevalence. The formation of arteriosclerosis in carotid arteries exhibits its vascular complications. The screening of patients with diabetes is mandatory at early level because complications might also increase due to overdue analysis. They concluded that even sonography is a useful device in the measurement of carotid IMT for screening of diabetic patients but in addition, research is counseled for outlining a way to use these strategies for the advertising of affected person's outcomes.

Although the patients with diabetes mellitus have a greater value of intima-media thickness of carotid arteries as compared to Non-diabetic patients in our study however a tremendous distinction became now not been determined for CIMT amongst diabetic and non-diabetic individuals. No doubt, the motive for this loss of distinction is a small sample size but it also appears that it may be because of the relative insensitivity of CIMT that is used as an alternative marker for the prognosis of atherosclerosis in diabetic patients.

CONCLUSION

The diagnostic accuracy of ultrasonography of internal carotid artery, and common carotid artery is very high for atherosclerosis. Our study suggests that the mean value of carotid intima-media thickness (CIMT) in diabetic patients was greater than CIMT in Non- diabetic patients, which shows that the use of sonography for measurement of IMT and plaque area act as a vital tool for the detection of atherosclerosis changes due to diabetes.

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