



## High Resolution Carotid Ultrasound in Diabetics and Hypertensive Patients

### KEYWORDS

Hypertension; Insulin resistance; Metabolic syndrome; Obesity; Uric acid

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**ABSTRACT** **Background :-** Previous studies have indicated an association between Diabetes Mellitus (DM), Hypertension (HTN) and increased risk of atherosclerotic disease in adults with or without clinical cardiovascular disease (IHD) and cerebrovascular disease (CVE, stroke). Previous studies have also shown that Carotid Intima Media Thickness (CIMT) reliably gives a fair idea of presence or absence of atherosclerosis in carotid artery itself and coronary arteries and cerebral arteries and arteries elsewhere in the body.

**Aim:-** The aim of this study is to describe the mean values of CIMT, evidence of carotid plaques in Diabetics & Hypertensive patients and compare them in subjects who were nondiabetics and nonhypertensives.

**Results:-** Mean CIMT was significantly higher (0.8258mm +/- 0.200mm) in diabetics than in nondiabetics (0.7966mm +/- 0.231mm) and (0.8257mm +/- 0.224mm) in hypertensive patients than nonhypertensive patients (0.7860mm +/- 0.215mm). Evidence of carotid plaques was observed significantly more in diabetics and hypertensive patients than nondiabetics and nonhypertensive patients after adjusting for increasing age.

**Conclusion:-** The data of present study of local Indian population of low income group in and around Pune confirms the findings of previous studies done in general population in Spain. Hence it has been found in the present study that CIMT values in Diabetics & Hypertensive patients in local Indian population of low income group are higher than nondiabetics and nonhypertensive patients. Also the incidence of those having carotid plaques is higher in Diabetics & Hypertensive patients than nondiabetics and nonhypertensive patients which indicates that risk of atherosclerosis is more in Diabetics & Hypertensive patients after adjusting for increasing age.

### Introduction :-

The high incidence of CVE and IHD in individuals with atherosclerosis is a well documented fact<sup>(1)(2)</sup>. Diabetes and hypertension are known to be associated with higher risk of atherosclerosis which are independent risk factors of CVE or IHD<sup>(3)</sup>. Atherosclerosis generally occurs all over the arterial tree in the body and more or less equally in coronary, cerebral and carotid arteries. Hence Carotid Intima Media Thickness (CIMT) measurement can give a fair idea of atherosclerosis in carotid artery themselves and coronary arteries and cerebral arteries. Hence evaluation of CIMT is a reliable method of assessing atherosclerosis<sup>(4), (5)</sup>. Carotid B Mode ultrasound imaging is an accurate, non-invasive, cost effective, easy, widely available, easily reproducible method for assessing CIMT<sup>(6)</sup>. CIMT on B Mode ultrasound of carotid arteries corresponds very well to histologic intima and media. It can roughly quantify atherosclerotic burden in the body. Increasing age is also an independent risk factor for atherosclerosis and increased CIMT<sup>(7)(8)</sup>.

CIMT is defined as the area of tissue starting at the luminal-intimal interface and media-adventitia interface of CCA; or more precisely defined as the double line pattern visualized by B Mode vascular ultrasound formed by two parallel echogenic lines representing junction of the vessel lumen with the intima; and media-adventitia interface. Thickening of the intima-media complex implies occult plaque formation, but plaque is seen directly with ultrasound when it achieves sufficient size to protrude into the

carotid artery lumen. CIMT varies widely across different age groups. It increases with increasing age<sup>(7, 8)</sup>. Presence or absence of carotid atherosclerotic plaques was recorded. The CIMT measurements in this study were done in areas excluding visible plaques.

### Materials and Methods :-

A descriptive study was conducted. Prospective data was collected over a period of one year from December 2014 to November 2015. All individuals reporting consecutively to Radiology department of our institution, Smt Kashibai Navale Medical College and General Hospital, Pune were considered for this study. Their demographic features (age, sex), diagnosis and a documented history of cerebrovascular disease, ischaemic heart disease or the presence of vascular risk factors, Diabetes, hypertension were collected. American Diabetes Association (ADA) criteria were used to label a subject as diabetic. All the subjects labeled as diabetic in this study had at least one of the following criteria; i) A1C  $\geq$  6.5%, ii) Fasting Plasma Glucose level (FPG)  $\geq$  126mg/dL iii) 2 hr Plasma Glucose (PG) level  $\geq$  200 mg/dL iv) Random PG  $\geq$  200 mg/dL. As per JNC8 guidelines for hypertension<sup>(10)</sup> all patients  $\geq$  age of 60 years having blood pressure  $\geq$  150/90 mm of Hg and all adults less than 60 years having blood pressure  $\geq$  140/90 mm of Hg were considered to be hypertensive for this study. The patients were divided in two groups for analysis; Group A (Diabetic group):- All the subjects having diabetes were

included in this group. Group B (Hypertensive group):- All subjects with hypertension were included in this group. Subjects in the age group of 22 to 86 years were included in the study. Carotid artery ultrasonography was performed on all these subjects. Total number of subjects included in this study was 415. Out of them 263 were males, 151 were females and one belonged to other sex. Group A had 151 subjects. Group B had 222 subjects. Presence or absence of cardiovascular or cerebrovascular disease was not considered for this analysis. Institute's permission to carry out the study was taken and a consent from the subjects was obtained.

Analysis of variance (ANOVA) was used to compare continuous variables. Regression analysis was conducted to estimate the effect of diabetes, hypertension on CIMT and carotid plaques. 95% Confidence Interval was calculated wherever applicable. IBM SPSS 20 was used for statistical analysis.

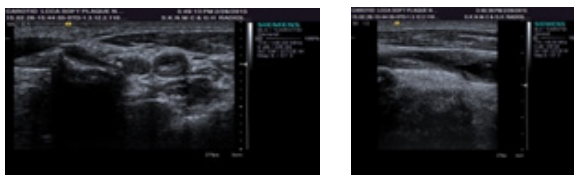
**Ultrasound Protocol:-**

All the carotid ultrasound examinations were done on Siemens Acuson X 300 and Siemens Acuson S 2000 ultrasound machines with high frequency probes of more than 7.5MHz frequency. Both ultrasound operators were the above mentioned first two investigators in this study; both Radiologists having 20 years of experience in conducting B Mode ultrasound and colour Doppler studies of carotid arteries. Interobserver and intraobserver errors were eliminated by strict adherence to examination protocol as follows.

Each patient (subject) was explained the procedure and ensured that the patient was comfortable and cooperative during the procedure. As CIMT of CCA ( common carotid artery) has better reproducibility than that of ICA( internal carotid artery) or carotid bifurcation due to ease of access and proximity to the surface and CCA being relatively parallel to skin, measurement of CIMT was done at this site on far wall of CCA in all patients. Presence or absence of atherosclerotic plaques were also noted. CIMT was measured in areas excluding the plaque. Both sonologist and patient were positioned properly to obtain high quality images. CIMT measurement was done in supine position with head of patient resting comfortably and neck slightly hyperextended and rotated in direction opposite to the probe. A wedge pillow at an angle of 45 degrees was used to standardize the lateral rotation. Images were optimized by adjusting patient's neck position and rolled towels were given under neck for comfort.

The six values of mean CIMT ( three on each side) were obtained and averaged to get mean CIMT <sup>(9)</sup>. Thus a single mean CIMT value was obtained in each subject. Presence or absence of plaques in carotid arteries was recorded in all the patients.

**Images:-**



B Mode Ultrasound Images showing transverse and longitudinal section of CCA with plaque

**Results:-**

Total cases studied 415. (n=415). Age in years					
Mean	N	Std. Deviation	Median	Minimum	Maximum
56.7614	415	13.42679	59.0000	22.00	86.00

**Table 1:- showing age distribution in the sample**

		Frequency	Percent
Valid	Female	151	36.4
	Male	263	63.4
	Other	1	.2
	Total	415	100.0

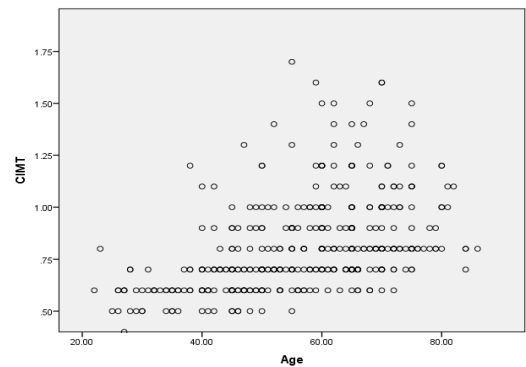
**Table 2:- showing distribution of sex in the sample.**

CIMT in mm					
Mean	N	Std. Deviation	Median	Minimum	Maximum
.8072	415	.22088	.7000	.40	1.70

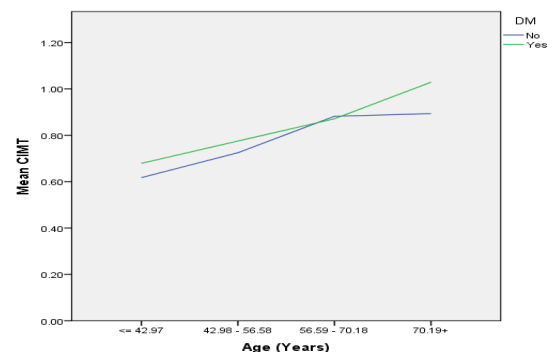
**Table 3:- showing CIMT of the entire sample irrespective of age and sex**

Age Group	Age range yrs	Mean CIMT mm	N	Std. Deviation	Median
1	<=43.33	.6414	70	.13987	.6000
2	43.34-56.76	.7483	120	.19272	.7000
3	56.77- 70.19	.8777	166	.22411	.8000
4	70.20+	.9254	59	.19262	.8000
Total		.8072	415	.22088	.7000

**Table 4:- indicating CIMT in different age groups in the entire sample**



**Graph 1 showing distribution of CIMT of the entire sample**



**Graph 2 showing CIMT in diabetic and nondiabetic patients**

Female		Sex			Total
		Male	Other		
DM	.00	102	162	0	264
	1.00	49	101	1	151
Total		151	263	1	415

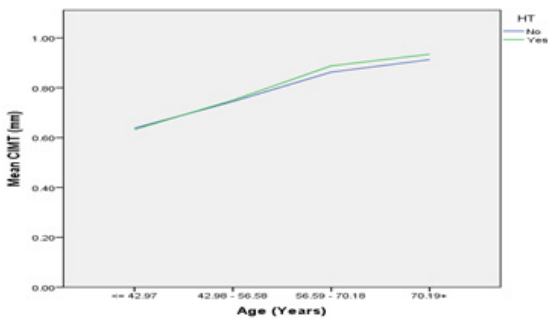
Table 5 :- showing frequency of diabetics and nondiabetics with sex crosstabulation in the sample

Age group	DM	Mean	N	Std. Deviation	Median
1	.00	.6174	46	.14500	.6000
	1.00	.6789	19	.13157	.7000
	Total	.6354	65	.14299	.6000
2	.00	.7246	69	.20466	.7000
	1.00	.7750	56	.16542	.7000
	Total	.7472	125	.18905	.7000
3	.00	.8817	104	.24166	.8000
	1.00	.8710	62	.19281	.8000
	Total	.8777	166	.22411	.8000
4	.00	.8933	45	.16842	.8000
	1.00	1.0286	14	.23346	1.0500
	Total	.9254	59	.19262	.8000
Total	.00	.7966	264	.23127	.7000
	1.00	.8258	151	.20082	.8000
	Total	.8072	415	.22088	.7000

Table 6:- showing agewise distribution and CIMT of diabetic and nondiabetic subjects in the entire sample

Female		Sex			Total
		Male	Other		
HT	.00	62	130	1	193
	1.00	89	133	0	222
Total		151	263	1	415

Table 7:- showing frequency of hypertensive and nonhypertensive patients with sex crosstabulation in the sample



Graph 3:- showing hypertensive and nonhypertensive patients in relation to different age groups in the sample

Age-group	HTN	Mean	N	Std. Deviation	Median
1	.00	.6378	37	.14211	.6000
	1.00	.6321	28	.14670	.6000
	Total	.6354	65	.14299	.6000
2	.00	.7446	65	.18117	.7000
	1.00	.7500	60	.19872	.7000
	Total	.7472	125	.18905	.7000
3	.00	.8627	67	.22619	.8000
	1.00	.8879	99	.22327	.8000
	Total	.8777	166	.22411	.8000
4	.00	.9125	24	.21123	.8000
	1.00	.9343	35	.18140	.9000
	Total	.9254	59	.19262	.8000
Total	.00	.7860	193	.21569	.7000
	1.00	.8257	222	.22415	.8000
	Total	.8072	415	.22088	.7000

Table 8:- showing hypertensive and nonhypertensive patients and CIMT in relation to different age groups in the sample Evidence of carotid plaques was found as follows:

- in entire sample 121 out of 415 29.2%
- in patients with DM :- 46 out of 151 30.5%
- In patients with HTN (Hypertension):- 70 out of 222 31.5%
- In patients without DM/HTN:- 31 out of 114 27.2%

After adjusting for age presence of carotid plaque was significantly higher in diabetics and hypertensive groups.

**Conclusion and discussion:-**

The data of present study of local Indian population mainly comprising of low income group in and around Pune confirms the findings of previous studies in general population<sup>(11)</sup>. Hence it has been found in the present study that CIMT values in diabetic and hypertensive subjects in local Indian population of low income group are significantly higher than nondiabetics and nonhypertensives in the same income group. Also the incidence of those having carotid plaques is significantly higher in diabetic and hypertensive subjects in local Indian population of low income group than nondiabetics and nonhypertensives in the same income group after adjusting for increasing age. Hence it appears from the present study that those individuals having history of diabetes and hypertension in local Indian population of low income group are at significantly higher risk of atherosclerosis and eventually of cardiovascular or cerebrovascular accidents than nondiabetics and nonhypertensives in the same income group. Carotid B Mode ultrasound Imaging is an accurate, non-invasive, cost effective, easy, widely available, easily reproducible method for assessing CIMT and hence can reliably assess atherosclerotic burden in diabetics and hypertensive patients. So it may be worthwhile screening all diabetic and hypertensive patients by B Mode carotid ultrasound so that a preventive therapy may be initiated in those found to have evidence of atherosclerosis to prevent risk of stroke or ischemic heart disease<sup>(6)</sup>.

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