Original Article

A Study of Correlation Between Anthropometric Measurements and Carotid Intima Media Thickness in Newly Diagnosed Type 2 Diabetes Mellitus Patients in a Tertiary Care Hospital in Eastern India

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The objective of the study was to find out correlation between Body Mass Index (BMI) and Waist Circumference (WC) with Carotid artery Intima Media Thickness (CIMT) in newly diagnosed Type 2 Diabetes Mellitus (DM) patients (within six month of initiation of antidiabetic drugs). This cross sectional observational study was conducted at Inpatient and Outpatient Department of Medicine and Diabetic Clinic of RG Kar Medical College, Kolkata, West Bengal, India from January, 2018 to June, 2019. Data were collected from 250 newly diagnosed Type 2 DM patients. CIMT was measured by Doppler ultrasound. Mean CIMT of 53.6 % overweight and 7.6% obese (as per BMI) participants was 0.90 and 1.26 respectively. Waist Circumference (WC) of 75 out of 140 male participant was >102 cm and WC of 88 out of 110 female participant was >88 cm. Among the participants of increased WC, 53.33% male and 36.66% female had increased CIMT. Higher HbA1C was associated with increased CIMT. This study showed significant correlation between BMI, WC with CIMT in newly diagnosed Type 2 DM patients. Our study demonstrated that Anthropometric Measurements (BMI and WC) are effective, noninvasive tools which can assist in identifying newly diagnosed Type 2 DM patients with increased CIMT predicting increased risk of micro and macro vascular complications.

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Key words **: BMI, WC, CIMT, Type 2 DM.**

Three major co-morbidities in Type 2 diabetes are Obesity, Dyslipidemia and Hypertension. Other associations are smoking, alcoholism, sedentary lifestyle, chronic kidney disease. In a study by Iglay *et al* (2016) showed that among 1389016 Type 2 DM patients, 97.5% of patients were found to have comorbidity for at least one basic diseases like Obesity, Dyslipidemia and Hypertension[1].

Indians are known to have a unique pattern of Dyslipidemia with Lower HDL cholesterol, increased triglyceride levels and a higher proportion of small dense LDL cholesterol. This type of dyslipidemia with diabetes is more prone to atherogenesis and thereafter cerebrovascular accidents[2].

Obesity is measured by many standardized indices. BMI (Body Mass Index) is widely used for measurement and categorization of obesity. Waist Circumference (WC) is used as an obesity (abdominal/ central) measure providing more sensitive approach in classification. BMI and WC can be measured with very simple and easily available instruments.

Diabetes and its associated complications such as dyslipidemia, atherosclerosis etc, lead to micro vascular and macro vascular complications. The best way to measure the extent and degree of atherosclerosis is by direct measurement of arterial wall thickness. This can be done by ultrasound guided measurement of thickness of two innermost layers of carotid artery. This is a noninvasive process. Studies have shown that carotid artery wall thickness matches proportionately with intracerebral artery wall conditions.

Thus in this study, a correlation between obesity indexes and carotid artery wall thickness is tried to be established and this correlation can give physicians a perception about the degree of atherosclerosis in

Editor's Comment :

- CIMT, an ultrasound biomarker of atherosclerosis is considered a marker of subclinical organ damage.
- Diabetic patients exhibit a greater CIMT value. CIMT should be prescribed in all diabetic patients during initial assessment for microvascular complications.

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Type 2 diabetes patients by some simple weight , height and Waist Circumference measurements.

Materials and Methods

This institution based cross sectional observational study was done in the Inpatient and Outpatient Department of General Medicine, Diabetic Outpatient Department of R.G.Kar Medical College, Kolkata, West Bengal from 1st January, 2018 to 30th June, 2019.

Patients diagnosed as Type 2 diabetes based on undermentioned criteria recommended by American Diabetic Association (ADA) and those having antidiabetic treatment duration of 6 months or less were included in our study. (attending Diabetic Clinic or admitted in Medicine Ward).

ADA Criteria for the Diagnosis of Diabetes:

• HbA1C ≥ 6.5% — The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.*

OR

• FPG ≥ 126mg/dL (7mmol/L).Fasting is defined as no caloric intake for at least 8 h.*

OR

• Two-hour plasma glucose ≥200 mg/dL (11.1 mmol/L) during an OGTT.

The test should be performed as described by the WHO, using a glucose load containing the equivalent of 75g anhydrous glucose dissolved in water.*

OR

• In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥ 200mg/dL (11.1mmol/L).

*In the absence of unequivocal hyperglycemia, criteria 1-3 should be confirmed by repeat testing.

Type 1 Diabetes Mellitus, Gestational Diabetes Mellitus, Drug induced hyperglycemia, those with disease of exocrine pancreas, known endocrinopathies like Cushing Syndrome, Acromegaly were excluded from our study.

BMI calculated from their weight (kg) and height (meter) by this formula[3].

$$BMI = \frac{\text{weight (kg)}}{\text{height (m}^2\text{)}}$$

BMI Weight Status (age >20 years) —

Below 18.5	Underweight
18.5 – 24.9	Normal or HealthyWeight
25.0 – 29.9	Overweight (pre-obese)
30.0 and Above	Obese
30.0-34.9	Obesity I
35.0 - 39.9	Obesity II
Above 40	Obesity III (extreme)

Sugar (FBS, PPBS) was measured by Glucose Oxidase Peroxidase method (GOD-POD) HbAIC was measured by immunoturbidimetry method by Transasia EM 360 machine in Biochemistry laboratory of our institution.

Waist Circumference (WC) was measured at a level midway between lowest rib margin and uppermost part of iliac crest (C in the figure) with the tape all around the body in horizontal position (B in the figure). Participants were asked to stand with their feet fairly close together and their weight evenly distributed to each leg (A - umbilical line) (Fig 1).

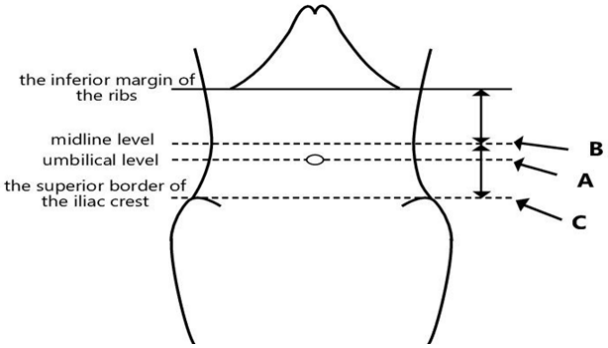

Fig 1 — Measurement of waist circumference

Men and women who have Waist Circumferences greater than 40 inches (102 cm) and 35 inches (88 cm), respectively, are considered to be at increased risk for Cardio Metabolic Disease[4].

Assessment of WC provides a measure of central fat distribution that cannot be obtained by measuring BMI. Large population studies have found Waist Circumference to be a strong correlate of clinical outcome, particularly diabetes and to be independent of BMI[5].

CIMT is defined as a double-line pattern visualized by echo 2D on both walls of the Common Carotid Artery (CCA) in a longitudinal view. Two parallel lines (leading edges of two anatomical boundaries)form it: lumen-intima and media-adventitia interfaces (in the Fig 2 distance between yellow and pink line is the IMT).

High-resolution B-mode system (B-mode imaging is preferred over M-mode imaging), equipped with a linear array transducer >7 MHz with minimal

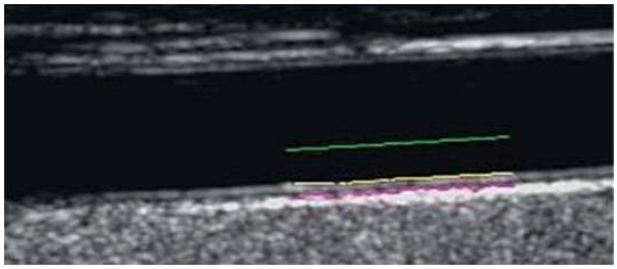

Fig 2 — Ultrasound image of carotid intima media

compression (<10:1) and footprint of at least 3 cm;

In this study maximum cut-off value for normal CIMT is taken as 0.9 mm

With the help of Microsoft word and excel data analysis was done using the statistical Software namely SPSS 11.0 and Systat 8.0. Chi-square and Fisher Exact Test was used to analyze patient demographics and outcome scores. Association between CIMT and BMI was analysed with a multivariable binary logistic regression model.

Results

250 patients participated in the study, 140 were males (56%) and 110 were females (44%). Age of the patients in study population ranged from 20 to 73 years. Mean age 44.36 years. Most of the participants were between 30 to 60 years.

Height of the patients in study population ranged from 1.36 m to 1.92 meters. Mean height 1.63 meters. Weight of the patients in study population ranged from 48Kg to 99 kilograms. Mean weight-70.35 kilograms. 82 were normal BMI (18.5 – 24.9), 142 were preobese (BMI 25 – 29.9) and 26 were obese (BMI >30). Mean BMI in all age group were approximately 26. That means, most subjects were in pre-obese group.

Fasting Blood Sugar of the participants ranged from 134 to 292, Mean FBS 191.45. Postprandial Blood Sugar of the participants ranged from 176 to 430 mg/dl. Mean PPBS 280.7 Among 250 participants, majority (173) were non-smokers, and 77 were smoker and most (200)were non-alcoholics and only 50 were alcoholics.

Out of 250 patients,117 had HbA1c between 6.5-8%, 96 had HbA1c between 8-10% irrespective of age and sex.

Distribution of Mean HBA1c (%) in BMI Group :

Mean HbA1c were around 8 in all BMI group (Table 1).

Difference of mean HBA1c according to BMI group was not statistically significant.

39.3% cases have CIMT >0.9% having HbA1c level 6.5 – 8% and 42.26% cases have CIMT >0.9% with HbA1c 8-10%. Mean CIMT in normal BMI group was 0.7299 Mean CIMT in over weight group was 0.9003 and Mean CIMT in obese group was 1.2619

Prevalence of higher CIMT (0.9 mm) was found more among higher HbA1c level & higher BMI group (Table 2).

Waist Circumference was higher in obese and overweight BMI group.

Among the 140 male subjects,75 had WC>102 cm of which 40(53.33%) had increased CIMT and 88 (among 110 female subjects) had WC>88cm of which 32(36.36%) had increased CIMT. We found that CIMT was positively correlated with Waist Circumference (Table 3) and this correlation was statistically significant.

Among 250 participants, 37.57 % non-smoker and 50% smoker participants had increased CIMT and 37.18% of all non-alcoholic subjects and 58.82% of all alcoholic subjects had increased CIMT.

Table 1 — *Distribution of HBA1c(%) among different BMI group*

BMI group	Number	Mean	SD	Minimum	Maximum	Median	p-value
Normal	97	8.1902	1.0982	5.9000	11.0000	8.1000	0.1684
Over weight	134	8.5331	1.4979	5.9000	14.0000	8.1000	
Obese	19	8.5577	1.3063	6.5000	11.0000	8.6000	

Table 2 — *Distribution of mean CIMT (mm) among different age group*

Age group	Number	Mean	SD	Minimum	Maximum	Median	p-value
N≤40	97	0.8120	0.2294	0.46	1.50	0.7800	0.0012
41-60	134	0.9312	0.2423	0.38	1.60	0.8850	
61-80	19	0.8926	0.2918	0.54	1.60	0.8700	

Table 3 — *Correlation of CIMT in all parameters*

	CIMT (mm)	Remarks
AGE(Years) :		
Pearson Correlation Coefficient (r)	0.204**	Positive Correlation
p-value	0.001	Statistically significant.
Number	250	
HEIGHT (meter) :		
Pearson Correlation Coefficient (r)	-0.304**	Negative Correlation
p-value	0.000	Statistically significant.
Number	250	
WEIGHT (Kilograms) :		
Pearson Correlation Coefficient (r)	0.237**	Positive Correlation
p-value	0.000	Statistically significant.
Number	250	
HbA1C (%) :		
Pearson Correlation Coefficient (r)	0.044	Positive Correlation
p-value	0.493	Statistically not significant.
Number	250	
BMI(kg/m2) :		
Pearson Correlation Coefficient (r)	0.635**	Positive Correlation
p-value	0.000	Statistically significant.
Number	250	
Waist Circumference :		
Pearson Correlation Coefficient (r)	0.199**	Positive Correlation
p-value	0.002	Statistically significant.
Number	250	

Discussion

Major cause of death among diabetes population is cardiovascular disease. Major co-morbidities in Type 2 Diabetes Mellitus are hypertension, dyslipidemia, obesity. Associations with smoking, alcoholism, less physical activity may accelerate the progression of micro- and macro-vascular complications of Type 2 Diabetes Mellitus. Major pathological process for these complications is widespread atherosclerotic changes in vessels which start in prediabetic states. By the time, the symptoms of diabetes manifest, the atherosclerotic changes have an extensive progress. This subclinical atherosclerotic changes need to be detected early to reduce the mortality and extend the life span of diabetics by preventing major cardiovascular events.

Many patients are diagnosed late when the osmotic symptoms of hyperglycemia becomes very much prominent. A study in South Korea by Kim CS *et al* suggested that the 2 hPG parameter among the various metabolic parameters exerts the greatest influence upon the prevention of carotid IMT progression in type 2 diabetic subjects[6]. The level of 2hPG is an independent risk factor for the progression of carotid IMT in Korean Type 2 Diabetic patients.

The prevalence of obesity in India is varying from rural to urban and State-wise as well due to various factors. The main factors for variation in obesity are geographical condition, life style and dietary pattern. In our study, higher CIMT was found in older subjects of above 40 yrs age (Table 2). A study by Bosevski M *et al* in Macedonia, found that older have a greater probability of detection of increased CIMT.[7]

Diabetic patients who smoke tend to have higher CIMT because smoking is a risk factor for atherosclerosis in diabetics. Alcoholic diabetics also have higher CIMT values as alcoholism is a risk factor for dyslipidemia which in turn causes more atherosclerosis.

When CIMT was plotted against BMI in scattered diagram, CIMT was found to be positively correlated with BMI and this correlation was statistically significant.

Among the different HbA1c ranges, it was found that higher the HbA1c value is associated with increased CIMT. Data from a study conducted in Paris by Tropeano AI *et al* suggest that hyperglycemia is a major independent determinant of CIMT in hypertensive hyperglycemic patients, not only in Type 2 DM patients, but also at the earlier stage of IFG, offsetting the mechanical role of local pulse pressure[8].

Conclusion

For assessment of macro vascular complications of Diabetes CIMT, is a well standardized surrogate marker for assessing cardiovascular risk and it is well accepted as a parameter of subclinical atherosclerosis. CIMT is a strong predictor of future cardiovascular events and is correlated with conventional markers of cardiovascular risk such as age; hypertension and dyslipidemia and also demonstrated that subclinical atherosclerosis increases with increasing degrees of glucose intolerance, abdominal obesity.

This study showed a significant correlation between HbA1c and BMI and Waist Circumference with Carotid Intima Medial Thickness (CIMT).The study also showed a correlation between CIMT and some coexisting modifiable risk factors like smoking, alcoholism, body weight and some non-modifiable risk factors like age, height.

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