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Original Research Article.

A Study of Lipid Profile and Carotid Intimal Medial Thickness in Type 2 Diabetes Mellitus

Shetty Mallikarjun[1], Liritha C[1], Kamal Hassan[2], Basawaraj R Puranik[3], B. Prahalad[4]

[1]Post Graduate Resident, [2]Associate Professor, [3]Professor, [4]Professor and Head,
Department of General Medicine, Shadan Institute of Medical Sciences, Hyderabad, Telangana, India.

ABSTRACT

Diabetes Mellitus refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. Depending on the etiology of Diabetes Mellitus factors contributing to hyperglycemia include reduced Insulin secretion, decreased utilization and increased glucose production. Diabetes is frequently associated with the development of premature atherosclerotic vascular disease.This increased risk has been attributed to high prevalence of multiple atherosclerotic risk factors among diabetic patients. A Hospital based Prospective Analytical Study was conducted in 100 Patients with Type II Diabetes Mellitus who have given consent and fulfilling inclusion and exclusion criteria at Shadan Institute of Medical Sciences, Telangana. Fasting samples of the patients enrolled in the study are collected for blood sugar, HB A1c and Lipid profile (Total Cholesterol, LDL Cholesterol, HDL Cholesterol, Triglycerides and VLDL), followed by 2-hour Post Prandial Blood Sugars are estimated. Vascular Doppler is done to rule out Peripheral Vascular Disease. B- Mode two dimensional Carotid Doppler was done to measure Carotid Intima-Media Thickness (CIMT). Among the patients with abnormal CIMT, 20 males have HDL Cholesterol of <40mg/dl and 26 females have HDL Cholesterol of <50mg/dl, with a total of 46 subjects with low HDL (69.6%).19 male subjects have HDL Cholesterol >40mg/dl and 1 female subject with HDL Cholesterol >50mg/dl.

Keywords: Carotid Intima-Media Thickness, HDL Cholesterol, Post Prandial Blood Sugars, Triglycerides and VLDL.

***Correspondence to:**

Dr. Shetty Mallikarjun,
Post Graduate Resident,
Department of General Medicine,
Shadan Institute of Medical Sciences,
Hyderabad, Telangana, India.

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INTRODUCTION

Diabetes Mellitus refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. Depending on the etiology of Diabetes Mellitus factors contributing to hyperglycemia include reduced Insulin secretion, decreased utilization and increased glucose production. The metabolic dysregulation associated with Diabetes mellitus causes secondary pathophysiologic changes in multiple organ systems that impose a tremendous burden on the individual with diabetes and on health care system. With an increasing incidence worldwide, diabetes mellitus will be a leading cause of morbidity and mortality for the foreseeable future.[1] Diabetes is frequently associated with the development of premature atherosclerotic vascular disease. This increased risk has been attributed to high prevalence of multiple atherosclerotic risk factors among diabetic patients.[2,3]

Vascular complications due to atherosclerosis are a major cause of morbidity and mortality in type 2 diabetic patients, more so in India where the number of diabetics is approaching very high levels.

Atherosclerosis is which is the major risk factor is accelerated in diabetes mellitus. It has been suggested by the atherosclerotic risk project that the atherosclerotic process occurs at the same time in carotid, cerebral and coronary arteries. The intima media thickness (IMT) of the carotid artery (CIMT) can be measured with a high degree of accuracy and reproducibility by B mode ultrasonography which provides a reliable and valid estimate of the arterial wall thickness. Of the various non-invasive imaging methods available, arteria intima media thickness measurement obtained by B mode ultrasound is currently recommended by the American Heart Association as being relatively safe, non-invasive and inexpensive method of assessing sub clinical atherosclerosis, and being an independent predictor of atherosclerotic events.

Individuals with Diabetes Mellitus may have several forms of dyslipidaemias. The most common form of dyslipidaemia is hypertriglyceridemia and reduced HDL cholesterol levels. The dyslipidaemia that accompanies type 2 Diabetes plays an important role in the pathogenesis of accelerated atherosclerosis.

The most important components of this dyslipidaemia are an elevated very low-density lipoproteins (VLDL), total triglycerides (TG's) and a decreased high-density lipoproteins (HDL) concentration in the serum.[4,5]

METABOLIC SYNDROME

It is characterized by constellation of metabolic risk factors. These are

1. Abdominal obesity
2. Atherogenic dyslipidaemia
3. Raised blood pressure
4. Insulin resistance + glucose intolerance
5. Prothrombotic state
6. Proinflammatory state.

LIPOPROTEINS

The major large lipid molecules of plasma triglycerides & cholesterol, esters and phospholipids are predominantly transported by stable complex water-soluble macromolecules designated as lipoproteins.

The main classes of lipoprotein which can be identified by ultracentrifugation are chylomicrons, very low-density lipoproteins, low density lipoproteins and High-density lipoproteins.[10]

Table 1: Major Lipoprotein Classes: Composition and physical characteristics.

Lipoprotein	Major lipid Components
1. Chylomicrons	Exogenous Triglyceride
2. VLDL	a. Triglyceride b. Cholesterol esters c. Phospholipids
3. LDL	a. Cholesterol esters b. Phospholipids
4. HDL	a. Cholesterol esters b. Phospholipids

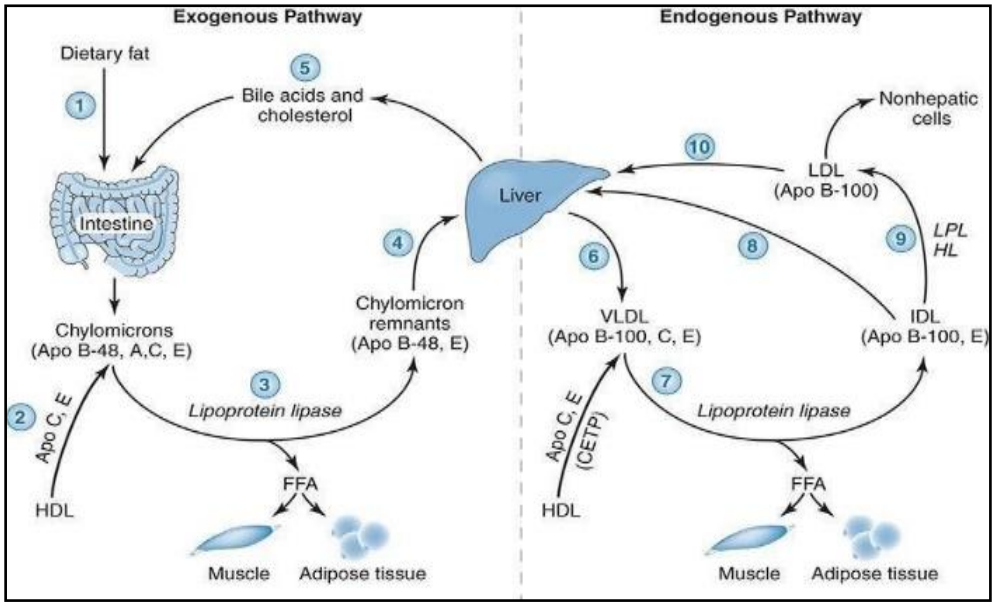


Figure 1: Pathways of lipoprotein metabolism.

LIPOPROTEIN METABOLISM

Lipoproteinmetabolismiscomplex.Virtuallyalloftheapolipoproteinmolecules exchange between the various lipoprotein classes at different stages in the metabolic process. Lipoprotein metabolism is best subdivided into three main areas; the exogenous pathway, the endogenous pathway and reverse cholesterol transport.

LIPID ABNORMALITIES ASSOCIATED WITH DIABETES

Lipid and lipoprotein abnormalities are common in diabetic patients because both insulin deficiency and resistance affect key enzymes and pathways in lipid metabolism; furthermore, posttranslational modification of apoproteins by glycation may also interfere with their activity. The lipid abnormalities seen in type 1 diabetes are generally related to insulin deficiency and level of glycaemic control and may respond to insulin therapy and improved metabolic control. In type 2 diabetes, abnormalities related to Hyperglycemia are present, but the dyslipidaemia may also be related to the metabolic defect underlying the impairment in glucose tolerance; these abnormalities may be resistant to changes in blood glucose control. The prevalence of lipid abnormalities in both type 1 and 2 diabetes also depend upon the coexistence of obesity, primary hyperlipidemias and secondary causes of hyperlipidemia (e.g., renal failure.).

It is found that over 60% of new patients with type 2 diabetes have a body mass index greater than 29 kg/m2. Lipid abnormalities are common in these patients and may reflect an increase in insulin resistance. In a large proportion of the patients, weight reduction achieved by dietary means normalizes glucose tolerance and reduces the level of hyperlipidemia. Primary hyperlipidemias are as common in diabetic patients as they are inthegeneralpopulation.[8]

Atherogenic Dyslipidaemia in Diabetes

Patients with diabetes are characteristically insulin resistant and often demonstrate atherogenic dyslipidaemia characterized by an elevated level of total triglyceride, reduced level of HDL-C, and an increased proportion of small, dense LDL-C particles. Insulin appears to play a central role in controlling triglyceride (TG)metabolism, and elevated insulin levels are associated with elevated triglyceride levels.

MAJOR DEFECTS IN TRIGLYCERIDE METABOLISM FOUND IN DIABETES

1. Increased endogenous triglyceride and VLDL production.
2. Decreased VLDL clearance
3. C-apolipoprotein defects.

Elevated triglyceride rich lipoprotein has a profound effect on LDL and HDL metabolism making them triglyceride enriched and smaller denser particles which are known to be highly atherogenic. These TRL's are toxic to endothelial Cells and are taken by macrophages resulting in foam cell formation. The high TRLs associated with alimentary lipemia lead to activation of factor VII and increased levels of PAI-1. Though it does not lead to any thrombus formation in itself, the procoagulant state augments the potential for thrombus formation in the event of plaque rupture.

CAUSES OF ELEVATED SERUM TRIGLYCERIDES21:

1. Overweight and obesity
2. Physical inactivity
3. Cigarette smoking
   Excess alcohol intake
4. Very high-carbohydrate diets (>60 percent of total energy)
5. Diseases (type 2 diabetes, chronic renal failure, nephrotic syndrome)
6. Drugs (corticosteroids, protease inhibitors, beta-adrenergic blocking agents, estrogens)
7. Genetic factors.

In persons with none of these factors, serum triglyceride levels typically are less than 100 mg/dl. When some of these triglyceride-raising factors develop, levels commonly rise into the range of 150 to 199mg/dl.

ADULT TREATEMENT PANEL (III) GUIDELINES 21:

The finding of elevated serum triglycerides helps to identify persons who are at risk and who need intervention for risk reduction. In addition, when triglyceride levels are ≥200 mg/dl, the presence of increased quantities of atherogenic remnant lipoprotein scan heighten CHD risk. For these reason, ATP III modified the triglyceride classification to give more attention to moderate elevations.

NON-HDL CHOLESTEROL AND TRIGLYCERIDES:

Since VLDL cholesterol is highly correlated with atherogenic remnant lipoproteins, it can reasonably be combined with LDL cholesterol to enhance risk prediction when serum triglycerides are high. The sum of VLDL+LDL cholesterol in called non-HDL cholesterol. It is calculated routinely as total cholesterol minus HDL cholesterol. Non-HDL cholesterol includes all lipoproteins that contain apoB. In persons with high triglycerides (200-499 mg/dL) most cholesterol occurring in the VLDL fraction is contained in smaller (remnant) VLDL. Non-HDL cholesterol is highly correlated with total apolipoprotein B (apo B).

ATHEROSCLEROSIS

Atherosclerosis is the leading cause of death and disability in the developed world. Despite our familiarity with this disease, some of its fundamental characteristics remain poorly recognized and understood. Although many generalized or systemic risk factors predispose to its development, atherosclerosis affects various regions of the circulation preferentially and yields distinct clinical manifestations depending on the particular circulatory bed affected. Atherosclerosis of the coronary arteries commonly causes myocardial infarction and angina pectoris. Atherosclerosis of the arteries supplying the central nervous system frequently provokes strokes and transient cerebral ischemia. In the peripheral circulation, atherosclerosis causes intermittent claudication and gangrene and can jeopardize limb viability. Involvement of the splanchnic circulation can cause mesenteric ischemia. Atherosclerosis can affect the kidneys either directly (e.g., renal artery stenosis) or as a frequent site of atheroembolic disease.[11]

Table 2: Categories of serum Triglyceride:

Triglyceride Category	ATP III Levels
Normal Triglycerides	<150 mg/dl
Borderline-high triglycerides	150-199 mg/dl
High triglycerides	200-499 mg/dl
Very high triglycerides	≥500 mg/dl

Table 3: Categories of Total Cholesterol:

Total Cholesterol Category	ATP III Levels (mg/dl)
Desirable	<200
Borderline High	200-239
High	≥240

Table 4: Categories of LDL cholesterol:

LDL Cholesterol Category	ATP III Levels (mg/dl)
Optimal	<100
Near optimal/above optimal	100-129
Borderline High	130-159
High	160-189
Very High	≥190

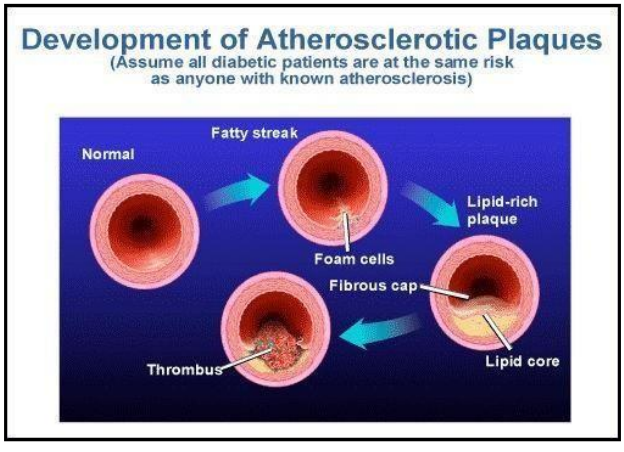


Figure 2: Stages of Atherosclerosis.

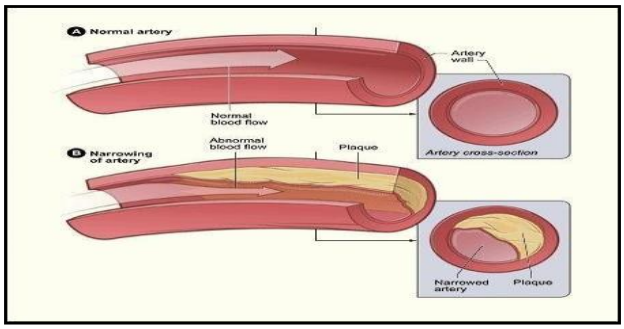


Figure 3: Stages of atherosclerosis.

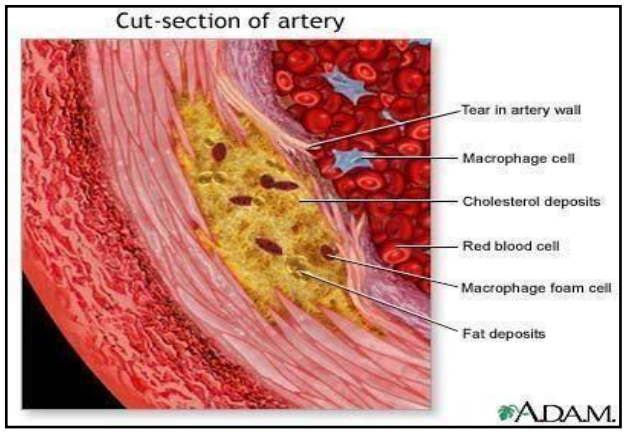


Figure 4: Cut Section of Artery Showing Atheroma

CAROTID ATHEROSCLEROSIS[28]:

Atherosclerosis within the carotid artery occurs most frequently within the common carotid bifurcation and proximal internal carotid artery. Additionally, the carotid siphon (portion within the cavernous sinus) is also vulnerable to atherosclerosis. Male gender, older age, smoking, hypertension, diabetes, and hypercholesterolemia are risk factors for carotid disease, as they are for stroke in general. Carotid atherosclerosis produces an estimated 5% of ischemic stroke, and the risk of stroke rises the higher the degree of carotid narrowing.

Evaluation of Carotid Artery Intima-Media Thickness by doppler ultrasound-an indication of atherosclerosis

Measurement of the intimal-medial thickness (IMT) of the common carotid artery (CCA) by B-mode ultrasound was found to be a suitable noninvasive method to visualize the arterial walls and to monitor the early stages of the atherosclerotic process.[8] The thickness of the Common carotid artery (CCA) was demonstrated to be related to cardiovascular risk factors and to the occurrence of coronary heart disease. An increase in carotid Intima media thickness (IMT) is associated with an increased risk of cerebrovascular disease (CVD) and ischemic heart disease (IHD).[13] Cerebral circulation mainly comprised of four major arteries; the left and right internal carotid arteries and vertebral arteries. B mode ultrasonography emerged during 1980s as an alternative to angiography to quantify atherosclerotic lesions of carotid artery and their progression.[14,15] Glagov and coworkers proved that with progression arterial atherosclerosis there is compensatory dilation of the artery. As the artery becomes more diseased, the artery expands or compensates to maintain lumen area. Infact in stenosis <40%, the lumen area is only marginally different than the non-diseased lumen. However, if stenosis >40% there is an acceleration of the decline in lumen area.

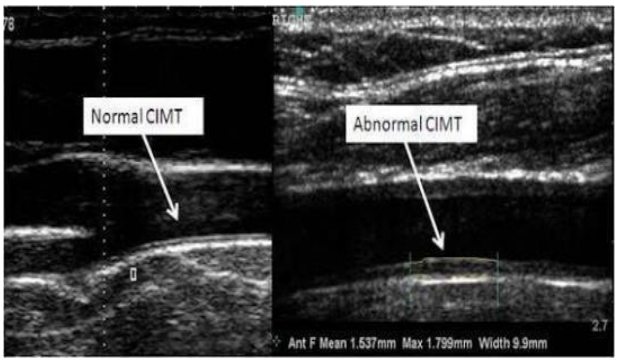


Fig 5: Carotid doppler Showing normal and abnormal CIMT.

AIMS AND OBJECTIVES

To estimate the levels of different types of lipids and carotid Intima-Media thickness in Type II Diabetes Mellitus.

OBJECTIVES

1. Estimation of lipid profile and carotid intima media thickness in type 2 diabetes mellitus
2. To correlate the levels of different types of lipids with carotid intima media thickness in type 2 Diabetes Mellitus.
3. To correlate HBA1c levels and BMI with carotid intima media thickness in type 2 Diabetes Mellitus.

MATERIALS AND METHODS

STUDY DESIGN: A Hospital based Prospective Analytical Study.

STUDY SUBJECTS: Patients with Type II Diabetes Mellitus who have given consent and fulfilling inclusion and exclusion criteria.

SAMPLE SIZE: 100 patients with Type II Diabetes Mellitus are enrolled during the study period in Shadan institute of medical sciences, Telangana.

STUDY SETTINGS: Patients attending Medical Outpatient units and admitting to medical wards of Shadan Institute of Medical Sciences, Telangana.

STUDY PERIOD: May 2019 – April 2020.

DATA COLLECTION: All enrolled patients are informed about the nature of the study and informed written consent is taken before including them in the study. A detailed history, physical examination, BMI and systemic examination is done. Blood samples for Fasting Blood sugars, 2-hour Post Prandial Blood Sugars, HB A1c, Fasting Lipid Profile, Blood Urea, Serum Creatinine are collected and other investigations like Electrocardiograph, Fundoscopy, Ultrasound Abdomen, Vascular Doppler and B-Mode two-dimensional ultrasound for Carotid Intima-Media Thickness are done.

Inclusion Criteria: Patients with Type II Diabetes Mellitus with duration of Diabetes more than or equal to 5 years.

Exclusion Criteria: Patients diagnosed to be having Ischaemic Heart Disease, Cerebrovascular disease, Peripheral Vascular Disease. Patients of Type 1 diabetes mellitus

METHODS

Fasting samples of the patients enrolled in the study are collected for blood sugar, HB A1c and Lipid profile (Total Cholesterol, LDL Cholesterol, HDL Cholesterol, Triglycerides and VLDL), followed by 2 hour Post Prandial Blood Sugars are estimated. Vascular Doppler is done to rule out Peripheral Vascular Disease. B-Mode two dimensional Carotid Doppler was done to measure Carotid Intima-Media Thickness (CIMT).

Carotid Doppler: High resolution B-Mode Ultrasonography is used for Doppler study of Carotid Arteries. Linear transducer of frequencies exceeding 7MHz are used for Doppler study. Common Carotid Artery, Bifurcation of Common Carotid Artery, Internal Carotid Artery and External Carotid Artery are visualized with anterior, posterior, lateral, transverse and circumferential scan at each level. Plaque thickness and luminal flow is estimated. Most often plaques are formed at bifurcation of Common Carotid Artery and Internal Carotid Artery.

Ethical Clearance: Patients are informed about the purpose of the study and written consent is taken. All investigations are done free of cost and no financial burden is imposed on patients. No ethical issues are involved. Ethical clearance is obtained from the Institutional Ethics Committee.

Statistical Analysis: Statistical analysis is done using SPSS software. Chi-square test is used, Correlation coefficient, P values were calculated. P values of <0.05 are considered to be statistically significant.

Figure 6: Age with Sex distribution:

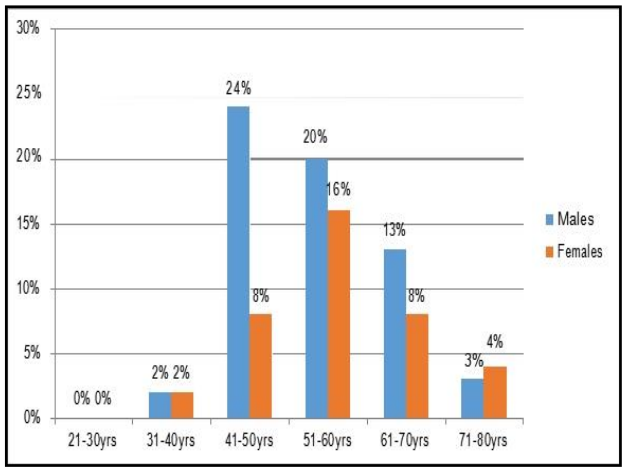


Figure 7: Lipid Profile according to Age distribution:

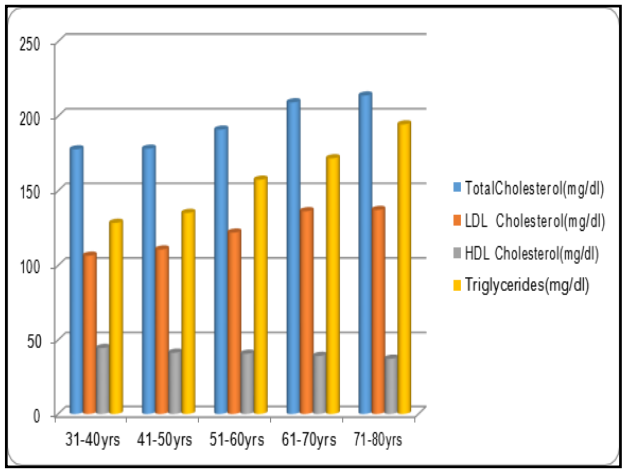


Table 5: Lipid Profile according to Sex distribution.

Sex	Mean Total C (mg/dl)	Mean LDL C (mg/dl)	Mean HDL C (mg/dl)	Mean TG (mg/dl)
Male	193.25	123.83	39.66	153.98
Female	188.65	117.71	41.92	155.07

C=Cholesterol; TG=Triglycerides

Figure 8: CIMT in Patients.

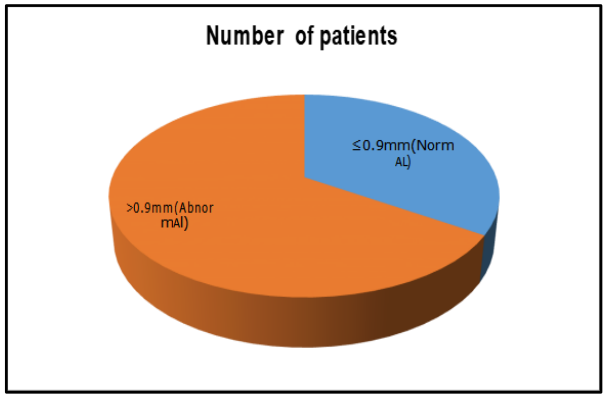


Figure 9: CIMT according to sex distribution.

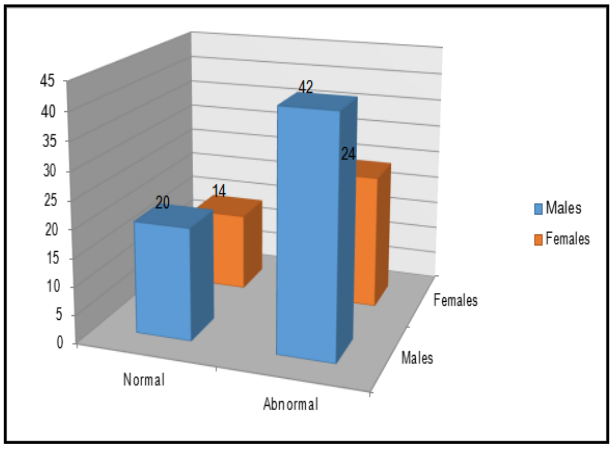


Figure 10: CIMT in relation to age Distribution.

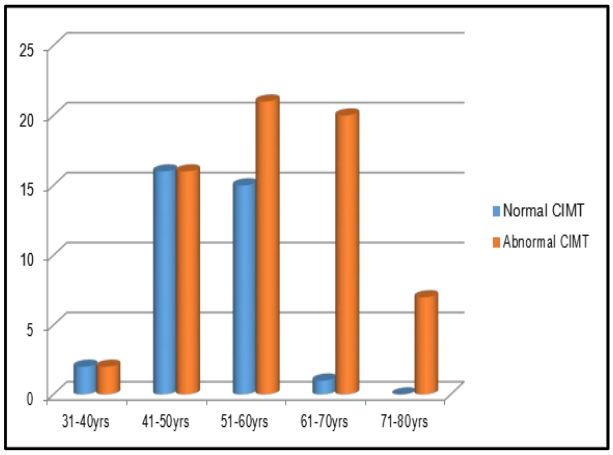


Figure 11: CIMT with Duration of Diabetes.

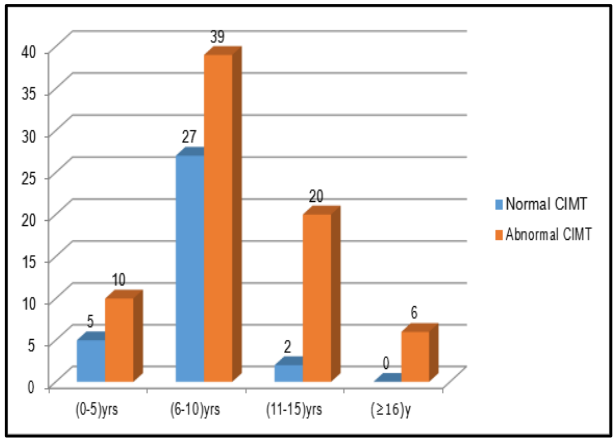


Figure 12: CIMT in relation to Total Cholesterol.

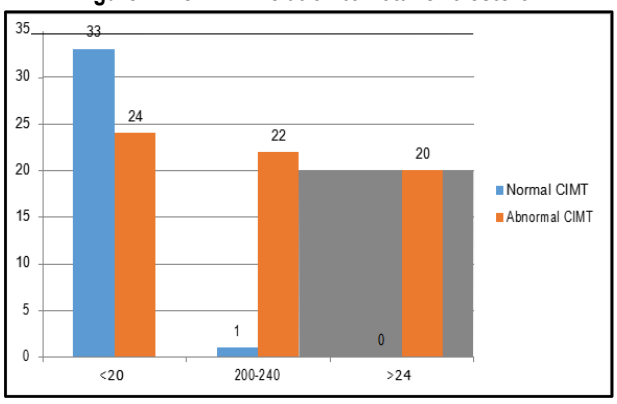


Figure 13: CIMT in relation to LDL Cholesterol.

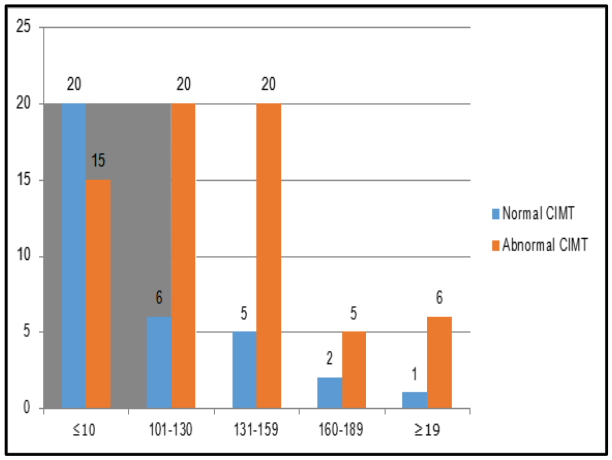


Figure 14: CIMT in relation to HDL Cholesterol.

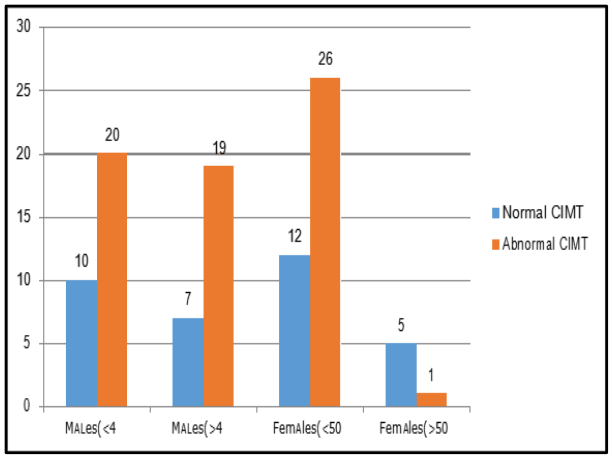


Figure 15: CIMT in relation to Triglycerides.

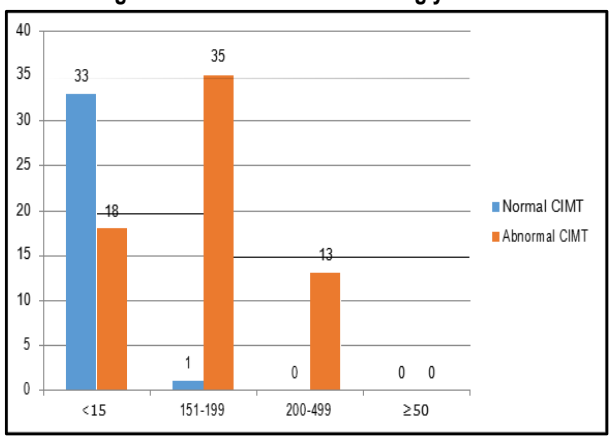


Figure 16: CIMT in relation to HBA1c.

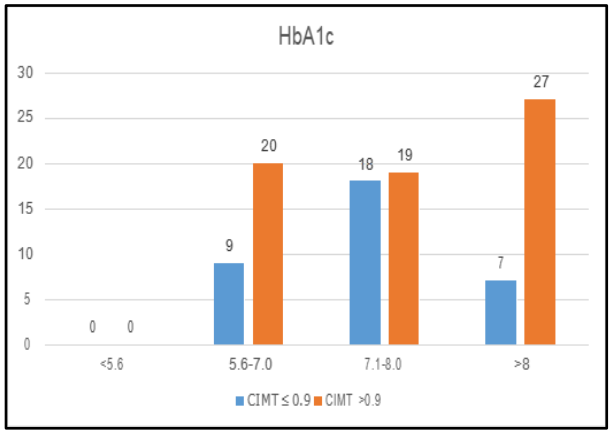
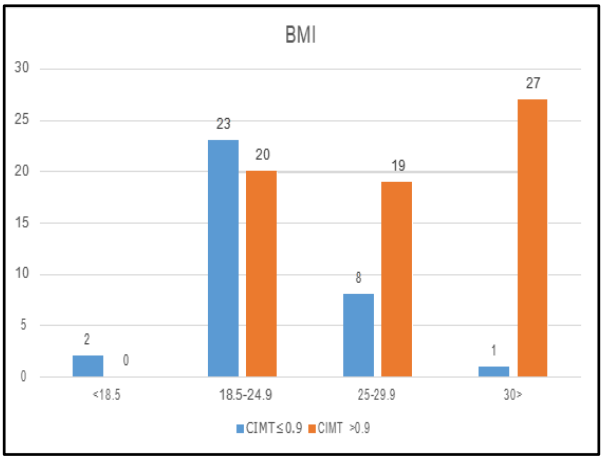


Figure 20: CIMT in relation to BMI.



RESULTS AND DISCUSSION

100 subjects with Type II Diabetes Mellitus of age 21-80 years are enrolled into the present study. The Lipid profile and Carotid Intima Media Thickness are measured, and the data is analysed and discussed. Based on CIMT thickness the patients are divided into two groups, one with normal and the other with abnormal CIMT.

Age Distribution of patients: Age is non-modifiable risk factor for Atherosclerosis. With advancing age there is physiologic thickening of carotid artery Intima-Media. In the present study highest number of patients are between the age group 51-60 years and the least number of patients are between age group 31-40 years. The mean age is 55.6±9.2 years. In the study by Salla SPR et al[56] and R. Gayathri et al[57], the mean age was 56.26±11.23 years and 55.79 years respectively which correlates with the present study. The mean age observed in the study by A. K. Agarwal et al[59] (59.79±8.81years) and Davidson et al[19] (58.9±7.8 years) was higher compared to present study.

Sex Distribution of patients: Carotid Intima-Media Thickness differs with the sex, which can be attributed to other risk factors. In the present study 62% are males and 38% are females with male to female ratio 1.6:1. In the study by Salla SPR et al[16], 62% were males and 38% were females which is comparable with the present study. Kraml et al[20] also reported similar results. In the study by Sunil Kumar Kota et al[21] similar male preponderance was observed.

Table 6: Comparison of Sex distribution with other studies.

Study	Male:Female
Present Study	1.6:1
Salla SPR et al[56]	1.6:1

Age Distribution in relation to CIMT: Normal mean carotid Intima-Media Thickness values of 0.5mm to 0.9mm have been reported for the young (20-30 years) and >0.9mm for older (>60years) age group respectively. While values between 0.9mm-1.4mm are considered as thickening, values higher than 1.4mm are indicative of atheromatous plaque. As age advances there is increase in CIMT, which is a non-modifiable risk factor for atherosclerosis.

In the present study, majority of the patients with normal CIMT were in 5th and 6thdecade with mean age of 50.85±6.22 years and majority of the patients with abnormal CIMT were in 6th and 7th decade with mean age of 58.16±9.67years.

In the study conducted by Salla SPR et al[16] similar results were observed, with mean age of 51.95±11.38 years and 59.64±10.14 years in patients with normal and abnormal CIMT respectively.

Sex Distribution in relation to CIMT:

Sex difference is observed in Carotid Intima –Media Thickness with male preponderance in which other risk factors have role in thickening of Carotid Intima-Media. In the present study 42 male patients and 24 female patients have abnormal CIMT. On comparing males and females higher values of CIMT are found in males than in females, possibly due to protective effect of female hormones. Similar results have been reported by Salla SPR et al[16], Kraml et al[20] and Sunil Kumar Kota et al.[21]

CIMT in relation to duration of Diabetes:

Diabetes and it's duration play a significant role in carotid atherosclerosis. As the disease duration increases there is increases Insulin resistance leading to Dyslipidaemia and atherosclerosis. In the present study the mean duration of Diabetes in patients with normal and abnormal CIMT is 7.14±1.82 and 9.9±3.65 respectively, which is statistically significant (P<0.005). It is similar to Salla SPR et al[16] study, AK Agarwal et al[18] (P<0.002), V Mohan et al[7] and Butt MU et al[62] (P<0.05) which showed a significant association of duration of Diabetes and CIMT.

CIMT in relation to Total Cholesterol:

Increased Total Cholesterol levels along with that of LDL Cholesterol leads to atherosclerosis in various arteries, causing luminal narrowing and vascular events. In the present study the mean total cholesterol in patients with normal CIMT is 159.17±27mg/dl and inpatients with abnormal CIMT is 208.16±31.55mg/dl (P<0.001) which is statistically significant. In Salla SPR et al[56] the mean total cholesterol in patients with normal CIMT is 195.33±44.87mg/dl and in patients with abnormal CIMT is 222±40.57 mg/dl (P<0.01)

CIMT in relation to LDL Cholesterol:

LDL Cholesterol levels increase with age because the LDL receptors that remove bad cholesterol from the blood become less active with the age. In Type II Diabetes patients the Insulin resistance in adipose tissue is responsible for dyslipidaemia, increase in LDL Cholesterol. In the present study the mean LDL Cholesterol in patients with normal and abnormal CIMT is 98.35±31.34mg/dl and133.43±31.89mg/dl respectively which is statistically significant (P<0.001).

In Salla SPR et al[16] study the mean LDL cholesterol in normal and abnormal CMIT patients were 118.6±33.83mg/dl and 138.5±30.94 respectively, which were statistically significant (P=0.0028).

CIMT in relation to HDL Cholesterol:

HDL transports cholesterol to liver, adrenals, ovary and testes by both direct and indirect pathways. The cholesterol delivered to the liver is excreted. In Diabetes Mellitus due to Insulin resistance there is decrease in HDL cholesterol leading to dyslipidaemia and atherosclerosis. In the present study the mean HDL Cholesterol in patients with normal and abnormal CIMT is 40.67±7.73mg/dl and 40.47±5.54mg/dl respectively which is statistically significant (P<0.005).

In Salla SPR et al[56] study the mean HDL Cholesterol in patients with normal and abnormal CIMT is 47.9±7.75mg/dl and 41.59±8.69mg/dl respectively which was statistically significant (P<0.0003).

CIMT in relation to Triglycerides:

High Triglyceride levels have increased risk of atherosclerosis, In diabetes mellitus the dyslipidaemia (elevated triglycerides) leads to atheroma formation.

In the present study the mean Triglycerides in patients with normal and abnormal CIMT is 125±18.15mg/dl and 169.54±28.25mg/dl respectively which is statistically significant (P<0.001).

In Salla SPR et al[56] the mean Triglycerides in patients with normal and abnormal CIMT was 149.4±66.82mg/dl and184.6±98.48mg/dl respectively which was statistically significant(P=0.0452).

CIMT in relation to HBA1c:

In the present study the CIMT is abnormal in subjects with fair and poor control of Diabetes. Saima Nazish et al in their study concluded that HbA1c levels may be useful as an indirect marker of the initial stages of carotid artery atherosclerosis[22]. In the study by Amit Shankar Singh et al they have observed a correlation between CIMT and raised HBA1c.[23] Reza Pramayudha et al also observed a moderate correlation between CIMT and HBA1c in newly diagnosed diabetic subjects.[24]

CIMT in relation to BMI:

Body mass index is an indirect measure of obesity in general population.[25] In the present study overweight and obese subject have abnormal CIMT compared to subjects with normal BMI. There is a statistically significant correlation between obesity and CIMT. Amit Shankar Singh et al showed a significant correction between obesity and CIMT in patients with ischemic stroke.[25] Similar positive correlation was shown by S. Fennira et.al.[26]

SUMMARYANDCONCLUSION

100 patients who have satisfied inclusion and exclusion criteria are included in the study and results are statistically analysed and discussed.

- The commonest age group observed in the present study is 51-60 years
- Male preponderance is observed in the present study with male to female ratio of 1.6:1.
- As the age advances there is increasing Total Cholesterol, LDL-c, triglycerides and decrease in HDL-C is observed in the in the present study.
- Mean Total Cholesterol, LDL-C, HDL-C and Triglycerides are equally distributed in both sexes.
- Abnormal CIMT is observed in majority of patients (66%).
- There is no sex predilection in relation with abnormal CIMT in the present study.
- With advancing age the incidence of abnormal CIMT is increased in the present study.
- CIMT is increased with increasing duration of Diabetes.
- In the present study there is statistical significance is observed between CIMT and Total Cholesterol, LDL–C and Triglycerides.
- There is Statistically inverse relation observed between CIMT and HDL-C.

- Abnormal CIMT is observed in overweight and obese subjects in the present study which is statistically significant.
- CIMT is abnormal in those with fair and poor control of Diabetes asmeasuredbyHbA1c.

LIMITATIONS

There are many risk factors for Atherosclerosis like Age, Sex, Hypertension, Diabetes, BMI, Smoking, Lipid abnormalities. Risk factors like Hypertension and Smoking are not analyzed in study.

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