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LIPIDS, DIABETES AND CORONARY ARTERY DISEASE IN INDIANS

Sidhartha Das

ABSTRACT

Diabetes mellitus (DM) is a protean metabolic disorder that adversely affects the vascular channels of the body leading to occlusive vascular events like coronary artery disease (CAD) and peripheral vascular disease (PVD).Besides the diabetic state, higher levels of triglycerides, lower HDL cholesterol and more of glycated Apo B100 contributes to the excess of atherogenesis in these subjects. In Indian subjects with DM the lipid profile and pattern is greatly influenced by the ethnic origin, food habits, nutritional status and lifestyle influences. There has been a quantum increase in the incidence of CAD amongst urbanites while the picture in rural India has changed very little, suggesting the major impact of lifestyle modifications on lipid profiles and the deleterious effect of the latter in causing accelerated and more extensive CAD as evident angiographically. These alterations in lipid profiles precede the events much in advance and are also prevalent in the adolescent siblings of patients with CAD. In our social setup, it is the nurture which has been the main determining factor than the nature per se. Conventional dyslipidemia of hypercholesterolemia with high LDLc may not be the commonly found abnormalities in our subjects and due attention should be given to Type IV and Type IIb hyperlipidemias as cause of excessive CAD in our population groups besides tight glycemic control to avert increased glycation of functional proteins and apoproteins. Raised triglyceride levels can be used as surrogate lipid markers for CAD in the susceptible population and families.

KEY WORDS: Lipids; Coronary artery disease; Indian scenario.

INTRODUCTION

Lipids are a group of heterogeneous, metabolically active substances constantly moving in the circulation and existing in a state of dynamic equilibrium between peripheral tissues, gastrointestinal tract and liver. Triglycerides, cholesterol (both free and esterified), free fatty acids (FFA) and phospholipids (PL) constitute the plasma lipids (Table-1). Lipids are classified as polar or non-polar depending on their solubility in aqueous environment. All such lipids circulate in blood by being incorporated into a very complex combination where non-polar lipids like triglycerides and cholesterol esters form the core while phospholipids and free cholesterol along with certain specific proteins, called apoproteins (Apo) constitute the surface layer of these molecules called lipoproteins (1).

Cholesterol and PL constitute about two thirds of the total plasma lipids whereas FFA are metabolically most active. Distribution and levels of different lipids in the plasma are dependent upon the state of lipid traffic and factors modifying the production, passage, clearance and utilization of the lipoprotein molecules. These molecules have been classified into four major classes depending upon their specific gravity, electrophoretic mobility, type of lipid and phospholipid constitution, source of origin and apoprotein content. At any point of time, the plasma is flooded with a variety of lipoprotein molecules out of which the major lipoproteins are low density lipoprotein (LDL) and high density lipoprotein (HDL). While HDL is smallest in size and most dense in constitution, the chylomicron

Table 1: Lipid Distribution in Plasma

Total Plasma Lipids: 400 to 800 mg/dl	
Cholesterol and Phospholipids:	2/3rd of lipid pool
Free Fatty Acids and Triglycerides:	Metabolically most active
Phospholipids:	110 - 250 mg/dl Biological detergents
Free Fatty Acids:	8 to 20 mg/dl but daily transport in circulation is about 25gms. Principal source of energy in post-absorptive state. Synthesized in the liver and liberated from adipose tissue and lipoproteins at the endothelium-tissue interface by lipolysis.

Professor, Postgraduate Department of Medicine S.C.B. Medical College & Hospital, Cuttack.

Table 2: Plasma Lipoproteins

Class	Specific Gravity	Major Lipids	Apo-Proteins	Electrophoresis
Chylomicron	0.95	Exogenous Dietary Tg	AI, II, B48, E CI, II, III	Origin
Chylomicron Remnants		B48, E		
VLDL 3 subtypes	0.95-1.006	Endogenous Tg	B100, CI, II, III, E	Pre-beta
VLDL Remnants IDL and cholesterol		Endogeneous Tg	B100, C, E	Broad beta
LDL sub types Lp(a) –Apo B100	1.006-1.063	Cholesterol	B100	Beta
HDL 5 sub types	1.063-1.21	Phospholipids Cholesterol	AI, II, C, E	Alpha

is the largest and can be detected under a light microscope. The relative size and constituents of the four major lipoprotein are depicted in Table-2. Amidst the four major classes of lipoprotein chylomicron and VLDL have high triglyceride content. Cholesterol constitutes 50% of the weight of LDL and HDL carries up to 20% of cholesterol but is rich in phospholipids and Apoproteins (2).

There is another group of lipoprotein termed as lipoprotein 'a' or Lp(a) (Table-2). Lipoprotein-a [Lp(a)] is a variant of LDL as both of them have apo B100 as the major apoprotein. Plasma levels of LP(a) is genetically determined and varies from one ethnic group to other. It has the capacity to suppress denovo cholesterol synthesis in peripheral tissues. Lp(a) acts as pseudoplasminogen and suppresses fibrinolysis, which can lead to increased thrombogenicity and is thus an independent risk factor for atherothrombosis. Its physiological activity is achieved through cross-binding with receptors for LDL. Its pathogenic role in atherosclerosis is not yet well defined. Indian have higher Lp(a) levels compared to other ethnic groups and this could be one of the reasons for premature CAD in Indians. In diabetics, Lp(a) levels are higher in those who are on insulin therapy.

The apoproteins are glycoproteins. They are classified as per the ABC nomenclature (Table-3). Besides being carrier proteins for lipoprotein molecules, they have widespread metabolic activity. The binding of a particular lipoprotein molecule to a particular cell type or tissue is dependent upon the apoprotein it contains, as the latter combines the receptor specific to it. LDL binds to endothelial cells and macrophage via the apoprotein B receptor while HDL and chylomicron remnants bind to hepatocytes through apoprotein E receptors. Further, these apoproteins have widespread enzymatic activities involving key enzymes of lipid metabolism like lipoprotein lipase (LPL) and lecithin cholesterol-acyl-transferase (L-CAT).

Table 3: Major Apoproteins and their Role in Lipid Metabolism

A1	HDL, CHYLOMICRON	L-CAT ACTIVATOR
A2		STRUCTURAL PROTEIN OF HDL
A4		TRANSFER OF APO BETWEEN HDL & CHYLO
APO(a)	LP (a)	INTERACTION WITH FIBRINOLYSIS
B48	CHYLOMICRON	STRUCTURAL APO OF CHYLOMICRON
B100	VLDL, IDL, LDL	LIGAND FOR BINDING TO
C1		LDL-RECEPTOR (LDL-R) ?LP BINDING TO LDL-R
C2	CHYLOMICRON, HDL, VLDL & I D L	ACTIVATOR OF LPL
C3		INHIBITOR OF LPL
E	CHYLOMICRON, VLDL, IDL & HDL	LIGAND FOR BINDING OF LP TO "E" RECEPTOR

There are three major lipid transport systems identified in the human body (1). One which handles dietary consumed fat is called exogenous lipid transport. Chylomicrons absorbed from the gut enter the systemic circulation through thoracic duct and then into the systemic venous system. They are rapidly hydrolyzed into FFA and glycerol at the tissue

endothelial interface. VLDL is synthesized in the liver and secreted into hepatic veins and constitutes the endogenous lipid transport. The VLDL are triglycerides rich lipoproteins, like chylomicrons they go on liberating triglycerides and FFA in the peripheral circulation to get converted into intermediate density lipoprotein (IDL) and ultimately cholesterol rich LDL. Thus LDL is the end product of endogenous lipid metabolism. The third transport system is called reverse cholesterol transport and involves the HDL molecule where cholesterol from peripheral tissues is carried back to the liver for utilization and degradation into bile salts.

As per PROCAM study, Lp(a) and TG are considered to be additional sensitive indicators of increased risk for major coronary events (3).

LIPID PROFILE IN INDIAN POPULATION

Population based studies on lipid profiles, done at our center are depicted in figure 1 and 2 (4). The Tg levels revealed U shaped distribution in upper, middle and lower socio economic (SE) groups respectively. While higher Tg levels in the upper SE group is very likely to be due to higher fat intake compounded with slower VLDL clearance, relatively higher levels in the lower SE group is mostly due to very high carbohydrate diet. Interestingly, analysis of lipid profile done in persons living in a geographical area of 10 kilometers radius but belonging to different ethnic groups, lifestyle and food habits revealed significant difference as shown in Table 4 (5). The fishermen (Naulia) had the most ideal lipid profile to be followed by tribals where the cholesterol profile was ideal but Tg levels were similar to urban elite population. This further confirms that high carbohydrate diet has a great influence in modulating Tg levels. The National lipid normogram has been presented in Table–5 again reflects the influence of

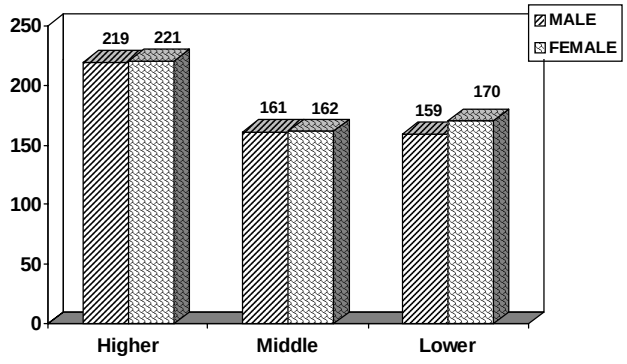

Fig 1: Mean Cholesterol Levels in Different Socio-Economic Groups, Cuttack (mg%) (7).

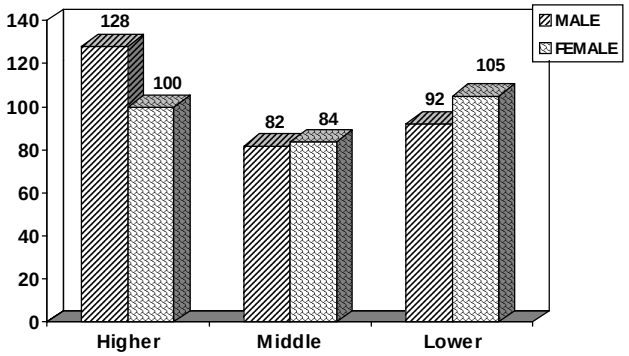

Fig 2: Mean Triglyceride Levels in Different Socio-Economic Groups, Cuttack (mg%) (7).

inherent dietary peculiarities on the lipid profile of people from east, west, north and south zones of India (1).

Table 4: Lipid Profile in Tribals, Fishermen and Urban Elite Population in mg/dl. (5)

Sub	HDLc	LDLc	VLDLc	Tc	Tg
Urban	41.8	114.8	28.8	185.4	144.4
Fishermen	43.5	71.4	24.8	139.8	124.2
Tribals	33.6	70.9	28.9	133.5	144.9

Tc: Total Cholesterol; Tg; Triglycerides

Table 5: Lipids and Lipoprotein Cholesterol Normogram in Indians (mg%). (1)

Zone		Triglycerides	Total Cholesterol	HDLc	LDLc
East		115	185	42	115
South	(a)	155	180	38	107
	(b)	119	172	40	108
West		107	188	38	129
North		132	150	43	101

Based on population studies as reported from different parts of India.

LIPIDS AND LIPOPROTEINS IN DIABETES MELLITUS

Insulin is an anabolic hormone having widespread influence on various processes which are growth enhancing and beneficial to the organism. Insulin exerts profound influence on expression and activity of genes regulating various key enzymes involved in lipid metabolism as well as synthesis and expression of apolipoproteins both in the liver and peripheral tissues. (adipocytes, skeletal muscle, endothelial cell, fibrocyte etc). At the endothelial tissue interphase it

primes the lipolytic enzymes and enhances the clearance of VLDL and chylomicron levels, composition, size and metabolism of plasma lipoproteins. Subjects with diabetes mellitus are influenced by factors such as:

- Type of diabetes mellitus
- Habitus i.e. lean, standard weight and obese.
- Nutritional status: under nourished or well nourished.
- Insulin sensitive or resistant stage
- Glycemic status and type of treatment
- FFA influx to the liver vis. a vis. insulin level in porto-hepatic bed.
- Presence of complications like nephropathy.

Broadly, the lipid abnormalities (dyslipidemia) seen in type 1 and type 2 diabetes are presented in Table-6. Hypertriglyceridemia is the common dyslipidemia seen in uncontrolled diabetic stage, insulin resistant stage and presence of nephropathy in type 2 diabetics (6). Fig-3 and Table-7 depict the influence of nutritional status and glycemic control in patients with type 2 diabetes. Again, in Indian diabetics hypertriglyceridemia with increased VLDL is the more common dyslipidemia than low HDL cholesterol levels.

Table 6: Types of Lipid Abnormalities in DM

Type 1 DM		
Usual level of glycemia (Euglycemia)	:	Similar to non-diabetics
Poor glycemic control	:	↑Tg level and ↑LDLc oxidation
Diabetic nephropathy	:	↑LDLc & Lp(a), ↓HDLc
Type 2 DM		
Usual levels of glycemia (Euglycemic)	:	↑Tg, ↓HDLc, prevalence of small dense LDL, ↑LDL susceptibility to oxidation
Poor glycemic control	:	Worsening of hypertriglyceridemia
Diabetic nephropathy	:	↑Tg, ↑Lp(a) , ↓HDL

Table 7: Lipid profile in Controls, Untreated (Untr.) and Treated (Trt.) Undernourished (UND) and Well nourished (WND). Type 2 diabetics (mg%). (6)

Sub	Tg	Tc	HDLc	LDLc	VLDLc
Untr. UND	157.1	283.4	63.6	158.8	64
Trt.UND	107.8	199	70.4	104.6	24
Cont.	95.3	216.4	68.7	131.2	16.5
Untr.WND	168.4	300.2	52.8	182.2	65.2
Trt.WND	123.2	230.2	67.3	136.2	26.7

The Tg is endogenous in origin with rise in VLDL levels i.e. Type IV hyperlipoproteinemia. The hypertriglyceridemia is consequent to over production by liver and poor clearance of VLDL in the peripheral tissues. With adequate glycemic control and maintenance of euglycemia, it reverts to near normal levels. Therefore presence of hypertriglyceridemia is a good indicator of the state of poor metabolic control in patients with DM. Alternations in cholesterol levels are not uniform in patients with DM. In the diabetics seen in the West as well as affluent populations of our country, a rise in cholesterol levels along with Tg is seen, so the type of hyperlipoproteinemia is Type IIb. However diet, nutritional status and anthropometry play a vital role and the picture is different in most of our diabetics (7). Even in an uncontrolled state, only about one fourth of diabetics revealed hypercholesterolemia.

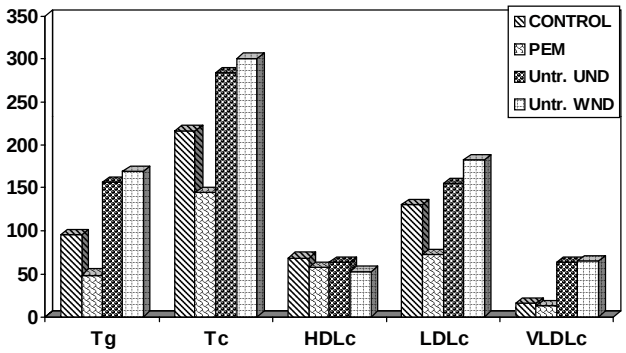

Fig 3: Lipid Profile in Controls, Adult-PEM, Untreated (Untr.) - Undernourished (UND) and Well nourished (WND) Type 2 Diabetics.(mg%) (6).

LIPID LEVELS AND THEIR INTERPRETATIONS IN DIFFERENT TYPE OF DM

Type-1 DM: This is a typical situation where insulin production is minimal to nil and therefore levels are low both in the porto-hepatic circulation and peripheral blood. The lipoprotein composition is accordingly affected with low HDLc, poor esterification of cholesterol, more of Tg with less VLDL clearance. This is more so in inadequately treated patients with poor glycemic control. The activity of enzymes like L-CAT and lipases are suppressed due to low circulating insulin levels which adversely affects HDL metabolism. Besides, higher concentration of free cholesterol in LDL and IDL makes them more atherogenic. However, institution of insulin treatment and maintenance of euglycemia rapidly reverses lipid metabolism to normal.

Type-2 DM: In patients with type-2 DM there is

global dysfunction of lipoprotein metabolism. The degree of dyslipidemia is more widespread (Table-6). There are increases in small dense LDL (LDL3) which is highly atherogenic. In patients with poor glycemic control, levels of Tg rich lipoproteins are higher. This rise is not only due to over production of VLDL but also poor peripheral clearance consequent to lesser expression of ApoB100 receptors on endothelial cell surface. In uncontrolled patients with type-2 DM the recycling of receptors is also slow, glycated ApoB100 have longer interaction with its receptors and so prolongs the half life of both LDL and VLDL molecules. The HDL levels may not be low in these type of diabetic subjects more so with fair glycemic control. Unlike type-1 DM, patients with type-2 DM have good insulin reserve and so much higher porto-hepatic insulin concentration which keeps the HDL cycle and hepatic enzyme system at an optimum. Patients with poor peripheral insulin levels may therefore have near normal HDLc levels while values of VLDLc, LDLc, IDLc and Tg may be higher. Such discordance is peculiar to type 2 DM. Type IV, Type IIb and Type III dyslipoproteinemias commonly met with in type 2 DM often reverses with diet and hypoglycemic drug therapy. (Fig. 4) (8, 9).

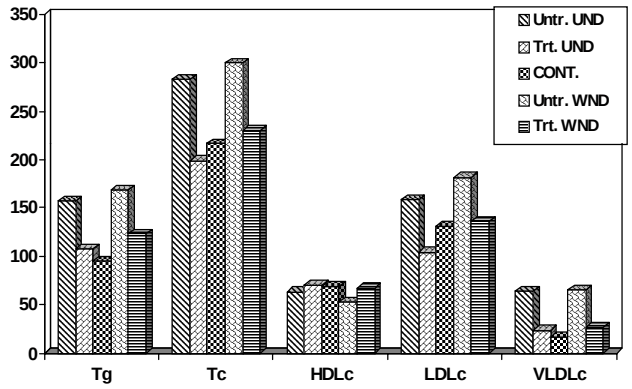

Fig 4: Lipid Profile in Controls, Untreated (Untr.) and Treated (Trt.) Undernourished (UND) and Well nourished (WND) Type 2 Diabetics. (mg%) (6).

Low Body Weight Type 2 DM (Lean Type-2 DM) (4, 6, 10): The diabetic state differentiates Lean type-2 DM from PEM in many respects including lipid profile. Cholesterol content in LDL and VLDL are higher as is Tg content, although the absolute values of these lipid levels are much lower than in well nourished diabetics (WND). Levels of mean HDLc are visibly higher in Lean type-2 DM irrespective of glycemic status. The Tg levels in Indian subjects with DM is higher both in Lean type-2 DM as well as in WND when compared with data from the west. This profile is likely to be the true reflection of the influence of nutritional status on lipid profile in developing societies, rather than a consequence of any specific biological alterations. A diabetic lives in his/her own SE group and is so bound to share similar nutritional habits. To further elucidate this apparent peculiarity, Tg levels were correlated with BMI in patients with diabetes.

Studies done by Seshiah et al from Chennai have also revealed similar lipid profile in obese, non-obese and lean diabetics in their population (11). While in the WND there was a positive correlation suggesting slower removal of Tg in the obese, there was no correlation in the Lean type-2 DM. Studies on Lean type-2 DM have shown that pre-existing dyslipidemia found in an uncontrolled state improves with establishment of glycemic control. Hypercholesterolemia is very unusual in such patients with DM.

CORONARY ARTERY DISEASE (CAD)

The prevalence of CAD in urban and rural population of India as observed by various investigators since 1960 are presented in Table-8. The diagnosis of CAD was done clinically in all these studies. In the urban population there has been a steady increase in prevalence of CAD from 1.05% to 7.3% on an average while the prevalence was as high as 11% in New Delhi and 12.6% in Trivandrum respectively, suggesting an epidemic like situation in these places. However, the change in profile in CAD in rural areas has not been that significant (Table-8). Study on mortality profile in patients with CAD from different Asian countries has revealed that the prevalence was highest amongst Indians as compared to people of Chinese origin, Indonesians and Malaysians (Table-9) (12). Premier study done by us had shown HDLc was lower and LDLc higher in non-diabetics with CAD, while such dyslipidemia was not obvious in diabetics with CAD (13). As reported by us, more than a decade ago, Tg levels were much higher in diabetics with CAD. Recent studies from Chennai "CUPS NO.5" revealed no difference in HDL values amongst subjects with or without CAD (Fig.5) (14). Hospital based studies from Patna also did not reveal any statistical difference in mean lipid levels in patients with CAD and controls (Fig.6) (15). The conventional dyslipidemia of low HDL and high LDL is probably not the significant cause behind higher prevalence of CAD in Indians.

Table 8: Prevalence of CAD in Urban and Rural India

Author	Year	Place	CAD (%±SD)
		URBAN POPULATION	
Mathur KS	1960	Agra	1.05 ± 0.3
Padmavathi	1962	Delhi	1.04 ± 0.3
Sarvotham SG	1968	Chandigarh	6.60 ± 0.6
Gupta SP	1975	Rohtak	3.63 ± 0.5
Chaddha SL	1990	Delhi	9.67 ± 0.3
Shety KS	1994	New Delhi	10.9
Gupta R	1995	Jaipur	7.59 ± 0.6
Singh RB	1995	Morababad	8.55 ± 2.3
Begom TR	1995	Trivandrum	12.65 ± 1.5
Ramchandran	2001	Chennai	3.9
Mohan V	2001	Chennai	11
Gupta R	2002	Jaipur	7.30
		RURAL POPULATION	
Dewan BD	1974	Haryana	2.06 ± 0.4
Jajoo UN	1988	Vidarbha	1.69 ± 0.3
Kutty VR	1993	Kerala	7.43 ± 0.8
Wander GS	1994	Punjab	3.09 ± 0.5
Gupta R	1994	Rajasthan	3.53 ± 0.3
Singh RB	1995	U.P	3.09 ± 1.4

Table 9: CAD Mortality in Asian countries (100,000 Population)

Country	1992
China	
Urban (M, F)	90,61
Rural (M, F)	45,31
Hong Kong (M, F)	55,33
India (Bombay)	158
Indonesia	60
Malaysia(West)	60
Philippines	32
Singapore (M, F)	154, 84
Taiwan (M, F)	35
Thailand	56

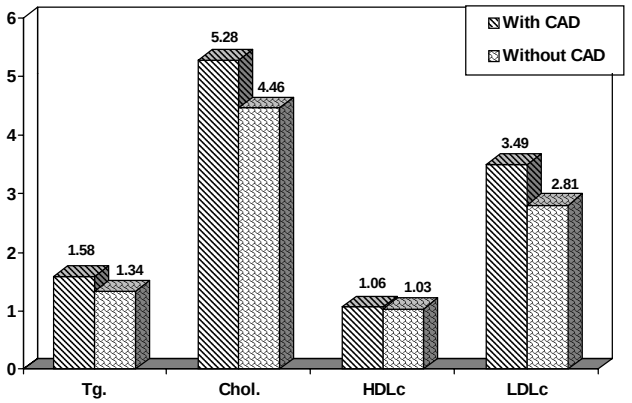

Fig 5: Lipid Profile in Subjects With and Without CAD, Chennai "CUPS No.5" (mMol/L) (14).

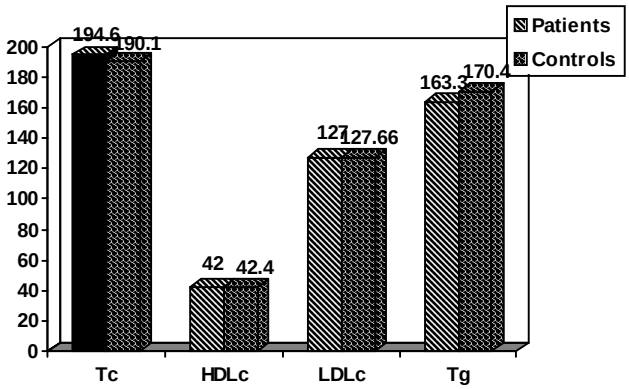

Fig 6: Mean Lipid Levels in Patients with CAD and Controls, Patna (in mg/dl) (15).

Further data from studies using coronary angiography as a tool to diagnose CAD done at different centers revealed that higher triglycerides with marginally raised LDLc associated dyslipidemia in patients from South India, whereas increase in total cholesterol and LDLc was common in those from North India (Table-10) (16, 17). Such dyslipidemia casts its shadow much before the event manifests and so can be used as a marker for both detection and prevention of CAD in vulnerable population.

Table 10: Lipid and Lipoprotein Levels in Angiographically Proved CAD and Controls, Delhi and Vellore (16, 17).

Sub	Tc		LDLc		HDLc		LDL/HDLc		VLDLc		Tg	
	Del.	Vell.	Del.	Vell.	Del.	Vell.	Del.	Vell.	Del.	Vell.	Del.	Vell.
Patients	211	206.72	117	124.14	43.5	36.43	2.6	X	49.7	X	155	193.3
Controls	186	180.47	88	107.5	42.1	37.98	2.2	X	56.1	X	167	155.19

Del.-Delhi, Vell.-Vellore,

CAD amongst Patients with DM

Focusing on prevalence of CAD amongst diabetics in India, starting with the data of the multi-centric study conducted by ICMR (1984-87) to recent publication from Ahmedabad, there has been visible rise of prevalence from 5-8% to 20-30% amongst diabetics over the period of time (Table-11). This is an alarming situation and needs introspection with reference to the quantum increase in prevalence as well as risk factors.

Table 11: Prevalence of CAD amongst Diabetics, In India

Author	Year	Place	Prevalence of CAD (%)	
ICMR	1984-87	Multicentric	8.1%	Males
			4.7%	Female
Mohan V.	2001	Chennai	21.4%	
Gupta PB	2001	Surat	19%	
Gupta S	2001	Nagpur	33.5%	Males
			21.5%	Females
Phatak SR	2002	Ahmedabad	20.2%	Males
			26.1%	Females

Studies done by us in patients with established acute myocardial infarction (AMI) with or without diabetes and a publication from Bangalore on diabetics with CAD showed serum Tg levels to be higher in the diabetic group whereas other lipid fractions were nearly similar and not significantly elevated as would have been expected Table-12 (18). However studies done on siblings of patients with CAD showed existing dyslipidemia in the siblings as compared to healthy controls (Fig-7) (19).

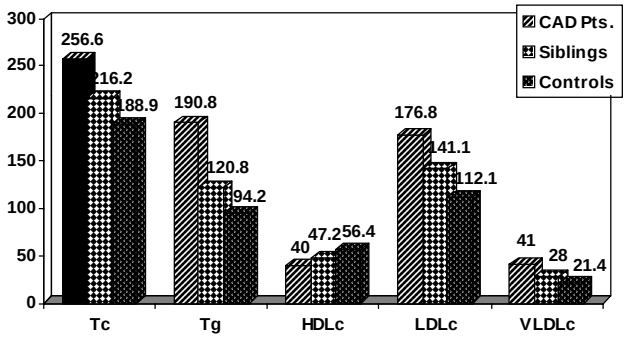

Fig 7: Mean Lipid Pattern in CAD Patients, Siblings and Controls, Cuttack (mg%) (19).

Coronary angiography is one of the most reliable procedures adopted to diagnose CAD. Angiographic data on Indian patients with suspected CAD had revealed that triple vessel disease (TVD) was much higher in diabetics as compared to non-diabetics, to be followed by double vessel disease (DVD) and single vessel disease (SVD) (Fig.8) (20). This is corroborative of western observations that diabetics have more extensive involvement of coronary artery (CA) as compared to non-diabetics (21). To further elucidate the extensiveness of atherosclerotic involvement of CAD in diabetics and non-diabetics in the same cohort and the existing dyslipidemia, a prospective study was undertaken at our centre. The coronary angiogram was analyzed as per the criteria laid down by American Heart Association with regards to segments (fifteen in Toto) and severity of occlusion (Grade 0-4). The gross angiographic profile is given in Table-13 where it is obvious that occlusion of left main coronary artery, DVD and TVD were more in

Table 12: Lipid profile in Patients with CAD–Diabetics and Non-Diabetics, Cuttack and Bangalore (mg%) (18).

Sub	Tc		HDLc		LDLc		VLDLc		Tg	
	Ctc.	Bang.	Ctc.	Bang.	Ctc.	Bang.	Ctc.	Bang	Ctc.	Bang.
CAD -Diabetics	192.2	194.1	39.2	40.2	118.3	105.9	34.7	48.4	150.6	209.4
CAD-Non-diabetics	197.1	200.4	41.5	44.9	116.2	128	39.3	27.5	120.3	137.6

Ctc.-Cuttack, Bang.-Bangalore

diabetics whereas SVD was higher in non-diabetics respectively. The extensiveness of involvement and degree of occlusion was categorized as per Ledru et al as described below (22):

Coronary score: No. of coronary arteries exhibiting stenosis > 75%.
Extent score: No. of segments exhibiting lesions > Grade – 1 (adjusted to 15 coronary segments)
Severity score: Average grade of stenosed coronary segments
Atherosclerotic score: Calculated as average severity of all analyzable segments.

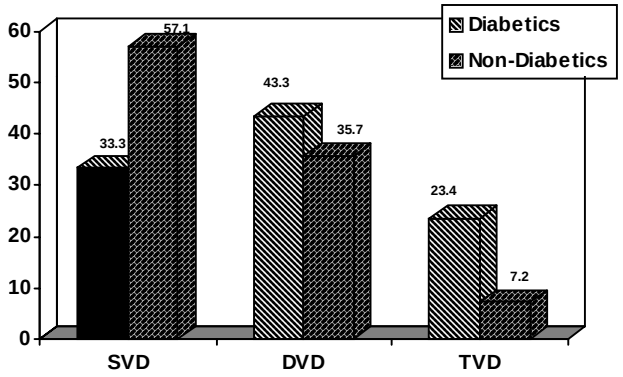

Fig 8: Quantum of Coronary Vessel Involvement by Angiography, Cuttack (%) (20).

Table 13: Coronary Angiographic Profile in Diabetics and Non Diabetics (n=147 in each group) in %.

Sub	Left Main	SVD	DVD	TVD
Diabetics	6.1	11.6	42.9	39.4
Non-diabetics	1.3	33.4	34.6	30.7

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Table 14: Degree of Atherosclerotic Involvement of CA and Corresponding Lipid levels (Mean & S.D.)

		Diabetics	Non-Diabetics	P Value
Coronary Score	:	0.91 (0.63)	0.43 (0.39)	<0.001
Extent Score	:	4.91 (3.1)	2.3 (1.81)	<0.001
Severity Score	:	1.85 (0.41)	1.2 (0.32)	<0.001
Atherosclerotic Score	:	0.52 (0.31)	0.21 (0.26)	<0.001
Lipid Values in mMol/L				
Total Cholesterol	:	4.81 (0.31)	4.70 (0.29)	N.S.
HDL cholesterol	:	0.84 (0.13)	1.12 (0.15)	<0.001
LDL cholesterol	:	3.29 (0.19)	3.23 (0.22)	N.S.
Triglycerides	:	2.98 (0.07)	2.41 (0.06)	<0.001

Mishra, Routray, Das, Behera, Satpathy & Patnaik , Cuttack, 2003

The degree of atherosclerosis of CA and corresponding mean lipid levels are presented in Table 14. The diabetics had statistically significant higher values for all the above four scores suggesting both extensive and higher grade of occlusive CAD. The associated dyslipidemia was lower HDL cholesterol with higher levels of serum triglycerides.

The crux of the issue is now well known that majority of diabetics have dyslipidemia. Central characteristics of such dyslipidemia are increase in triglyceride levels, more of triglyceride rich VLDL and lower HDL levels in those with overt CAD. LDL cholesterol levels may not be raised as compared to non-diabetics but could have more of small dense LDL with glycated ApoB100 which is highly atherogenic. This lipid triad confers a risk for cardiovascular disease that equals or exceeds the risk conferred by LDLc leads of 150 – 220mg/dl. Therefore, diabetic dyslipidemia even without established CAD should be treated as aggressively as non-diabetics with CAD. Hypertriglyceridemia and lower HDLc levels may proceed development of overt type 2 DM/Insulin resistant state and so can be used as markers.

Diabetes mellitus, type 2 in particular, is a progressive macrovascular disease, with universally established excessive predilection for CAD irrespective of race, ethnicity, gender or geography. Salient biochemical markers for this vasculopathy are chronic hyperglycemia and non-HDL dyslipidemia.

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