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A Comparative Study of Lean, Obese and Non-Obese Type 2 Diabetes Mellitus with Special Reference to Renal Status and Lipid Profile in Jharkhand

Dr. Gita Bipin Chandra[1], Dr. Bindey Kumar[2], Dr. Swarnika Singh[3]
[1] *(Junior Resident, Department of Medicine, RIMS, Ranchi, Jharkhand, India)*
[2]*(Professor, Department of Medicine, RIMS, Ranchi, Jharkhand, India)*
[3]*(Junior Resident)*
Corresponding Author: Dr. Gita Bipin Chandra

Abstract: *Unfortunately type 2 diabetes mellitus has its limitation particularly in its focus on severity and phenotype rather than etiology and genotype. Two sub-groups of patients are currently distinguished by presence of obesity. A new kind of body habitus is found to have type 2 diabetes mellitus whose BMI is <20.25. 120 cases of type 2 diabetes mellitus (40 cases of lean; 40 cases of non-obese, 40 cases of obese) were selected from ambulatory patients attending Medicine outpatient department and admitted patients in the medicine wards from September 2017 to August 2018. 30 (75%) cases of lean, 34 (85%) cases of non-obese and 36 (90%) cases of obese responded in treatment with oral hypoglycemic agents, and 10 (25%) cases of lean, 4 (10%) cases of non-obese and 2(5%) case responded with insulin therapy, whereas only 2 (5%) case each of non-obese and obese responded with dietary restrictions at the initiation of present study. No lean patient responded with dietary restriction alone.*

Keywords: *Diabetes mellitus, lean type 2 diabetes mellitus, obese, non-obese.*

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I. Introduction

Unfortunately type 2 diabetes mellitus has its limitation particularly in its focus on severity and phenotype rather than etiology and genotype. Two sub-groups of patients are currently distinguished by presence of obesity. The degree and prevalence of obesity varies among different racial groups.

As far as diabetes in India is concerned, vast majority are found to be non-obese, in contrast to WHO prediction of 60-80 percent to obese, and almost one fourth has a habitus to be called as lean (BMI <20.25) (WHO study group on Diabetes Mellitus, 1985). They manifest with visibly different presentation, morbidity and mortality pattern as well as biochemical profile as compared with classical patients of type 2 diabetes mellitus. They continue to be lean even after years of good metabolic controls. Leanness is inherent characteristics of these individuals.

In multicentric study involving nine centers all over the country (1984-1990) the incidence of lean type 2 diabetes mellitus was observed to be 11 to 25 percent of all the diabetics' diagnosed type 2 diabetes mellitus. Good metabolic controls and affluence had little effect on their constitution, natural history or morbidity. These diabetes in due course of time become insulin requiring as compared to classical type 2 diabetes mellitus. Type 2 diabetes mellitus is the most prevalent form of diabetes seen worldwide. Epidemiological data over the past decades have shown that the pattern and profile of type 2 diabetes mellitus are very different in India compared to the West.[1] In Europe and America majority of type 2 diabetes are obese. In 1965 Tripathy and Kar highlighted that 27% of elderly diabetics were lean.[2] Following that various studies in India have reported a prevalence of low body weight/lean (Body mass index, BMI<20.25 kg/m^2) type 2 diabetes mellitus ranging from 1.6% to 26%.[3-7] The clinical and biochemical profile of these patients are different from classic type 2 diabetes mellitus.[5,6,8,9] These patients are neither related clinically or pathophysiologically to latent autoimmune diabetes of adults (LADA). Markers of autoimmune destruction of β-cells are absent in the vast majority of these patients.[5,10,11] Homeostatic model assessments by Das et al., suggest that they are typical cases of type 2 diabetes and the low body weight does not reflect poor beta cell function or loss of body weight due to long-standing uncontrolled diabetes.[11] However, more recent study by Bera et al., suggested poor β-cell function in such patients.[12]

Characteristics of lean (low body weight) type 2 diabetes mellitus –

All the patients of lean type 2 diabetes mellitus are designated as low body weight type 2 diabetes mellitus.

1. Lean type 2 diabetes mellitus are diabetics with body mass index less than 10%of the median value (20.25).

2. Age around 30-40 years.
3. Markers of autoimmunity like islet cell surface antibodies is absent.
4. Moderately severe basal hyperglycemia.
5. Glycosylated hemoglobin values higher than the classical type 2 diabetes mellitus (BMI >25).
6. Higher triglyceride values.
7. Lower cholesterol and higher HDL-C even in fasted state.
8. Low body weight type 2 diabetes mellitus subjects shows C-peptide response between that of type 1 and 2 normal weight type 2 diabetes mellitus subjects. So greater loss of β-cell mass and insulin reserve.
9. Lack of poverty, patients is mostly from middle socio-economic class.
10. Higher prevalence of neuropathy and infection and lower prevalence of hypertension and coronary artery disease.

Aims & Objectives:

1. To find out special characters regarding clinical parameters and complications of lean type 2 diabetes mellitus.
2. To study biochemical characteristic in there group of patients.
3. To study onset and progress of complications.
4. To study therapeutic response by oral hypoglycemic agents and insulin in these groups of patients.

II. Materials & Methods

The study was undertaken in Rajendra Institute of Medical Sciences, Ranchi in Department of Medicine. After written informed consent, 120 cases of type 2 diabetes mellitus (40 cases of lean; 40 cases of non-obese, 40 cases of obese) were selected from ambulatory patients attending Medicine outpatient department and admitted patients in the medicine wards from September 2017 to August 2018. The approval of institutional ethics committee was taken prior to the commencement of this study.

Inclusion criteria:

1. All patients with type 2 diabetes mellitus irrespective of age, sex
2. Diagnosis of diabetes mellitus was based on American Diabetes Association (ADA) criteria.
3. Those given written consent.

Exclusion criteria:

1. Patients suffering from hepatic, cardiorespiratory, endocrine and other systemic disease.
2. Pregnant female patients.
3. Known cases of type 1 diabetes mellitus.
4. Patients receiving drugs causing hyperglycemia.

After diagnosing the patients as type 2 diabetes mellitus, detailed interrogation and clinical examination using questionnaire.

The following points were highlighted in the general examination.

1. Height (in meter) and weight in (kg) were taken in each patient.
2. Blood pressure – Measured in supine and standing position.
3. Ophthalmoscopy – Routine ophthalmoscopy was performed in all cases through dilated pupil with ulcer opthalmoscope to detect retinopathic lesion.
4. The following laboratory investing were carried out-

a. Total and differential blood count, ESR, haemoglobin.
b. Routine urine examination with special importance on presence of sugar, protein, ketone, pus cells and RBC.

The following biochemical analysis was carried out using autoanalyser.

a. Fasting blood glucose
b. Post prandial blood glucose
c. Total cholesterol
d. LDL-Cholesterol
e. HDL-Cholesterol
f. VLDL-Cholesterol
g. Triglyceride
h. Blood urea
i. Serum Creatinine
j. Glycosylated haemoglobin

Statistical Method

The following methods were used in statistical analysis of result the present study.

1. Descriptive statistics.
2. Contingency coefficient for categorical variables like sex, socioeconomic status, family history and mode of presentation.
3. General linear model – Multivariate with controlling for age for a set of dependent variables e.g. all the biochemical parameters across three fixed factor lean, non-obese and obese.
4. Post-Hoc L.S.D. statistic applied to examine group difference between lean, non-obese and obese.

Methodology

1. Decreases the type 1 error.
2. Controlled any affect of age on biochemical parameters.

III. Results

In the following section the result and their subsequent analysis of relevant clinical and other investigations features have been detailed. 40 cases of Lean type 2 diabetes mellitus, 40 cases of non-obese type 2 diabetes mellitus BMI (>20.25 - <25) and 40 cases of obese type 2 diabetes mellitus (BMI >25) are selected for present study.

Table – I : Distribution of subjects

Type of type 2 DM	No. of cases	Male		Female	
		No.	%	No.	%
Lean	40	26	65	14	35
Non-obese	40	28	70	12	30
Obese	40	18	45	22	55
Total	120	72	60	48	40

Table – IIA: Age distribution in type 2 diabetes mellitus

Type of subject	≤ 30 years	> 30yrs -≤ 40yrs	> 40yrs - ≤ 50 yrs	> 50yrs - ≤ 60 yrs	> 60 yrs
Lean	2 (5%)	12 (30%)	14 (35%)	6 (15%)	6 (15%)
Non-obese	0	14 (35%)	12 (30%)	6 (15%)	8 (20%)
Obese	0	6 (15%)	8 (20%)	14 (35%)	12 (30%)

Table – IIB: Mean age in type 2 diabetes mellitus

Type of type 2 diabetes mellitus	Years	Range
Lean	45.6 ± 10.71	28-65 years
Non obese	47.7 ± 1084	35-66 years
Obese	53.85 ± 10.16	35-69 years

Table – IIIA: Baseline data depicting mean weight (Wt), Height (Ht) Body mass index (BMI) and waist Hip ratio in type 2 diabetes mellitus cases

	Weight (Mean) in kg	Height (Mean) in cm	BMI	WHR (Mean)
Lean	43.9±5.97	155.2±6.937	17.91±1.463	O.83±0.03
Non obese	56.60±6.15	156.9±7.49	23.01±1.17	0.84±0.03
Obese	65.6±8.22	155.2±10.58	27.44±1.786	0.90±0.05

Table – III B: Baseline data depicting mean weight, height, Body mass index (BMI) and waist hip Ratio (WHR) in type 2 diabetes mellitus in male and female cases

	Weight (in kg)	Height (in cm)	BMI	WHR
Lean				
Male	46.25	159.75	18.30	0.84
Female	39.57	150.75	17.20	0.83
Non-obese				
Male	59.78	162.07	22.70	0.84
Female	53.5	151.66	23.33	0.83
Obese				
Male	68.66	161.6	26.12	0.89
Female	62.54	148.72	28.30	0.89

Table – IV: Family History

	Positive		Paternal		Maternal		Both	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Lean	10	25	8	29	2	5	--	--
Non obese	14	35	8	20	4	10	1	5
Obese	18	45	10	25	6	15	1	5
Total	42	35	26	21.66	12	10	2	3.33

Table – V: Baseline data – Socioeconomic status

Type of Type 2 DM	**Socioeconomic status**								
	Low			**Middle**			**High**		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
Lean	12 (30%)	8 (20%)	20 (50%)	10 (25%)	6 (15%)	16 (40%)	4 (5%)	--	4 (10%)
Non-obese	12 (30%)	4 (10%)	16 (40%)	10 (25%)	6 (15%)	16 (40%)	6 (15%)	2 (5%)	8 (20%)
Obese	6 (15%)	4 (10%)	10 (25%)	8 (20%)	10 (25%)	18 (45%)	4 (10%)	8 (20%)	12 (30%)

Table – VI: Baseline showing residence (Rural Vs urban) of type 2 diabetes Mellitus

Type of type 2 DM	Rural			**Urban**
	No.	**%**	**No.**	**%**
Lean	26	65	14	35
Non obese	22	55	18	45
Obese	16	40	24	60

Table – VII: Base line data showing mean duration of diabetes in years, mean fasting blood glucose (FBG), mean post prandial blood glucose (PPBG) and mean glycosylated HB% values

Data	**Lean**	**Non obese**	**Obese**
Mean duration of diabetes in years	5.5 ± 3.45	5.75 ± 3.13	6.1 ± 2.19
Fasting blood glucose mg/dl	226.5 ± 17.78	193.1 ± 29.00	206.65 ± 29.18
Post prandial blood glucose mg/dl	282.5 ± 20.74	248.65 ±36.13	262.7 ± 33.01
Glycosylated hemoglobin HbA1C	9.15 ± 1.01	7.81 ± 0.64	8.44 ± 0.952

Table – VIII: Mean values of lipid profile in lean, non-obese and obese Type 2 diabetes mellitus

Lipid profile mg/dl	**Lean**	**Non-obese**	**Obese**
Total cholesterol	207.90± 18.45	227.5 ± 22.03	229.20 ± 19.90
LDL cholesterol	122.85 ± 16.84	149.40 ± 25.01	150.70 ± 21.58
VLDL cholesterol	38.1 ± 4.70	35.35 ± 5.99	33.85 ± 3.97
HDL cholesterol	46.05 ± 6.87	42.15 ± 5.68	44.15 ± 8.68
Triglyceride	186.15 ± 20.54	170.90 ±24.77	168.50 ± 18.28

Table – IX A: HDL– C level in type 2 diabetes mellitus

Type of Type 2 diabetes mellitus	**< 35 mg/dl**		**35-50 mg/dl**		**> 50 mg/dl**	
	No.	**%**	**No.**	**%**	**No.**	**%**
Lean	4	10	26	65	10	25
Non obese	6	15	28	70	6	15
Obese	8	20	22	55	10	25

Table – IXB: Lipid abnormalities

Type of type 2 diabetes mellitus	Hypercholesterolemia (≥ 240 mg/dl)		Hypertriglyceridemia (≥ 200 mg/dl)		**LDL (≥ 160 mg/dl)**	
	No.	**%**	**No.**	**%**	**No.**	**%**
Lean	4	10	14	35	2	5
Non obese	10	25	6	15	10	25
Obese	10	25	4	10	12	30

Table – X: Incidence of hypertension in type 2 diabetes mellitus

Type diabetes mellitus	**Hypertension**		**Stage I hypertension**		**Stage II hypertension**	
	No.	**%**	No.	**%**	No.	**%**
Lean	6	15	4	10	2	5
Non-obese	6	15	4	10	2	5
Obese	12	30	8	15	4	15

[Hypertension is graded as follows according to JNC VIII report]

Blood pressure classification	Systolic blood pressure (mm Hg)		Diastolic blood pressure (mm Hg)
Normal	< 120	and	< 80
Pre-hypertension	120-139	and	80-89
Stage I	140-159	and	90-99
Stage II	≥ 160	and	≥ 110

Table – XI: Urinary changes in type 2 diabetes mellitus

Data	Lean		Non obese		Obese	
	No.	%	No.	%	No.	%
Sugar	40	100	36	90	38	95
Microproteinuria	6	15	6	15	6	15
Overt proteinuria	2	5	4	10	8	20
Pus cells	2	5	--	--	2	5
RBC	-		1	5	--	--

Table - XII A: Renal status (mean values) for blood urea and serum creatinine

Type 2 diabetes mellitus	Blood urea	Serum creatinine
Lean	30.20 ± 17.04	1.18 ± 0.55
Non-obese	25.40 ± 8.47	1.12 ± 0.30
Obese	25.20 ± 14.39	1.13 ± 0.66

Table – XII B: Renal status for blood urea and serum creatinine

Type of Type 2 diabetes mellitus	Blood urea				Serum Creatinine			
	Normal		Raised		Normal		Raised	
	No.	%	No.	%	No.	%	No.	%
Lean	34	85	6	15	32	80	8	20
Non obese	38	95	2	5	38	95	2	5
Obese	38	95	2	5	38	95	2	5

Table – XIII: Ophthalmoscopic finding in type 2 diabetes mellitus

Type of type 2 diabetes mellitus	Normal		Background Retinopathy		Proliferative Retinopathy	
	No.	%	No.	%	No.	%
Lean	36	90	4	10	--	--
Non obese	34	85	4	10	2	5
Obese	32	80	4	10	4	10

Table – XIV: Mode of presentation of type 2 diabetes mellitus

Mode of presentation	Lean		Non obese			Obese
	No.	%	No.	%	No.	%
Common symptoms of diabetes	26	65	28	70	24	60
Incidental	12	30	10	25	12	30
Infection	--	--	--	--	2	5
Complications like nephropathy	2	5	2	5	2	5

Table – XV: Response to anti-diabetic therapy

Type of Type 2 diabetes mellitus	Diet		Oral hypoglycemic agent		Insulin	
	No.	%	No.	%	No.	%
Lean	--	--	30	75	10	25
Non obese	2	5	34	85	4	10
Obese	2	5	36	90	2	5

Table – XVI: Contingency coefficient for categorical variable

Categorical variable	Lean (n=40)	Non-Obese (n=40)	Obese (n=40)	Contingency coefficient	Approx. Signi-ficance	Remarks
Sex						
● Male	26(65%)	28(70%)	18(45%)	0.215	0.233	Non-Significant
● Female	14(65%)	12(30%)	22(55%)			
SE status						
● Low	20(50%)	16(40%)	10(25%)			Non-Significant
● Middle	16(40%)	16(40%)	18(45%)	0.242	0.443	
● High	4(10%)	8(20%)	12(30%)			
Mode of presentation						Non-Significant
● Common symptoms of D.M.	26(65%)	28(70%)	24(60%)			
● Nephropathy				0.191	0.893	
● Incidental	2(5%)	2(5%)	2(5%)			
● Infection	12(30%)	10(25%)	12(30%)			
	--	--	2(5%)			
Family history						Non-Significant
● +ve for one parent	10(25%)	12(30%)	18(45%)			
● +ve for both parents	--	2(5%)	2(5%)	0.228	0.509	
● -ve	30(75%	26(65%)	20(50%)			

Table – XVII: General linear model multivariate controlling for age for a set of dependent variables across three fixed factors (lean, non-obese and obese)

	Mean value of lean	Mean value of non-obese	Mean value of obese	F value	Signi-ficance	Remark
FBG	226.50±17.78	193.10±29.00	206.65±29.18	8.53	0.001	Significant
PPBG	282.85±20.74	248.65±36.13	262.70±33.01	6.77	0.002	Significant
TC	207.90±18.45	227.50±22.03	229.20±19.90	5.66	0.006	Significant
LDL-C	122.85±16.84	149.40±25.01	150.70±21.58	9.16	0.001	Significant
HDL-C	46.05±6.87	42.15±5.68	44.15±8.68	1.39	0.256	Non-Significant
VLDL	38.10±4.70	35.35±5.99	33.85±3.97	3.43	0.066	Non-Significant
TG	186.15±20.54	170.90±24.77	168.50±18.28	4.01	0.023	Significant
G. Hb	9.15±1.01	7.81±0.64	8.44±0.95	11.45	0.001	Significant
Urea	30.20±17.04	25.40±8.47	25.20±14.39	0.83	0.441	Non-Significant
Creat.	1.18±0.55	1.12±0.30	1.13±0.66	0.115	0.891	Non-Significant

Table–XVIII: Post-HOC L.S.D. statistic applied to examine group difference between lean and non-obese

Dependent variables	Weight type (I)	Weight type (J)	Mean difference (I-J)	Std. Error	Signi-ficance	Remark
FBG	Lean	Non-obese	33.40	8.18	0.001	Significant
PPBG	Lean	Non-obese	34.20	9.70	0.001	Significant
TC	Lean	Non-obese	-19.60	6.38	0.003	Significant
LDL-C	Lean	Non-obese	-26.55	6.77	0.001	Significant
TG	Lean	Non-obese	15.25	6.75	0.028	Significant
G. Hb	Lean	Non-obese	1.34	0.28	0.001	Significant

Table–XIX: Post-HOC L.S.D. statistic applied to examine group difference between lean and obese

Dependent variables	Weight type (I)	Weight type (J)	Mean difference (I-J)	Std. Error	Signi-ficance	Remark
FBG	Lean	Obese	19.85	8.18	0.018	Significant
PPBG	Lean	Obese	20.15	9.70	0.042	Significant
TC	Lean	Obese	-21.30	6.38	0.001	Significant
LDL-C	Lean	Obese	-27.85	6.77	0.001	Significant
TG	Lean	Obese	17.65	6.75	0.011	Significant
G. Hb	Lean	Obese	0.715	0.280	0.014	Significant

IV. Discussion

All the patients of lean type 2 diabetes mellitus designated as low body weight type 2 diabetes mellitus. Low body weight type 2 diabetes mellitus, phenotypically a separate subtype of type 2 diabetes mellitus is of interest in tropical region characterized by its typical age predilection with altered lipid pattern along with some controversial renal involvement. More elevated fasting and post prandial blood glucose at the time of presentation of low body weight type 2 diabetes mellitus in comparison to obese and non-obese type distinguishes it further.

Corroboration and comparison of available data of type 2 diabetes mellitus in present set up is the mode of study.

K. Kannan and C.S Yagnik et al depicted in their studies the male preponderance in lean type 2 diabetes mellitus, which is comparative with the sexual distribution in the present study. The present study showed (65%) male and (35%) female distribution among lean type 2 diabetes mellitus population.[13,14]

The western literatures as well as Indian literature are in favour of this sexual distribution. Male preponderance is not only characteristic of low body weight type 2 diabetes mellitus but also a distinguished feature of low body weight type 2 diabetes mellitus supported 65% of male cases in this total series of patients but no statistical significance was observed in this study between the other groups.

In view of different literatures low body weight type 2 diabetes mellitus usually present around late fifth decade. This series of patient although showed variable age of presentation (28-65 years) but their mean age of presentation is 45.6 years, in comparison to previous reference by V. Seshaiah[15] (47.26 years), C.S. Yagnik et al[14] (43 years), S. Das et al[7] (48 year) and K. Kannan et al[13] (44.3 years). Mean age of presentation of non-obse and obese cases are 47.7 years and 54 years respectively. Low body weight type 2 diabetes mellitus patients in present study depicted a little earlier age of onset than obese and obese type 2 diabetes mellitus.

Body mass index is the single most important predictor for low body weight type 2 diabetes mellitus and other phenotypically different type of type 2 diabetes mellitus. According to Indian authorities and WHO if the body mass index in less than < 20.25, type 2 diabetes mellitus are considered as low body weight. In the present study 17.91 is the mean BMI of type 2 diabetes mellitus belonging to low body weight group. This is at par with the observation of other and was significantly lower than non-obese (23.01) and obese (27.44).

Waist Hip Ratio is another parameter considered in the study, it is of no remarkable characteristic to distinguish low body weight with other types of type 2 diabetes mellitus.

Apart from few literatures (e.g. K. Kannan study[13], 16% positive family history) positive family history is not much convincing in other studies. But this study showed positive family history of 25% in low body weight, 35% in obese and 45% in obese cases of type 2 diabetes mellitus. Prevalence of family history was higher than type 1 diabetes mellitus or malnutrition related diabetes mellitus as reported in international workshop on diabetes peculiar to tropics. Both parents having type 2 diabetes mellitus was 0% in lean, 5% in non-obese and 5% in obese. The contingency coefficient for family history in the three groups was not found to be significant in this study.

Low body weight type 2 diabetes mellitus is more rural origin than non-obese and obese cases. It may be incidental finding and more cases are required for making any comments about this finding.

These low body weight type 2 diabetes are not restricted to poor socio-economic status (50% in lean compared to 40% in non-obese and 25% in obese), but were more from rural areas as compared to non-obese and obese subjects (65% in lean compared to 55% in non-obese and 40% in obese). Such observation was near similar to the report given by Sadikot et al.[16] The contingency coefficient for socioeconomic status in the three groups was not found to be significant in this study.

Mean duration of diabetes was 5.5 years in lean, 5.7 years in non-obese and 6.1 years in obese.

One important observation is that fasting blood glucose (FBG) in low body weight type 2 diabetes mellitus is higher (226.5 mg/dl) in comparison to non obese (193.1mg/dl) and obese (206.65 mg/dl). It is consistent with previous large series of observation by S. Das et al[8]., B.K. Sahay[17] and V. Seshaish et al.[15]. Post prandial blood glucose level was also higher in case of lean type 2 diabetes mellitus as compared as to non obese (282.85 mg/dl vs 248.65 mg/dl vs 262.7 mg/dl). These observations are associated with significantly high mean glycosylated hemoglobin level in lean type 2 diabetes mellitus cases than non obese and obese cases (9.15 vs 7.81 vs 8.44). This data is consistent with studies of S Das and V. Sidhartha.[18]

In this study using general linear model multivariate with controlling for age and Post-Hoc L.S.D., FBG, PPBG and glycosylated haemoglobin was found to be significantly increased in lean compared to non-obese and obese.

All the above observation suggest that low body weight type 2 patients are having less insulin secretion either in fasting state or post prandial state and it is also evident that day to day regulation of insulin secretion is also defective.

Mean value of total cholesterol appears to be lower in low body weight type 2 diabetes mellitus group of patients as compared with the mean value of total cholesterol in non-obese and obese type 2 diabetes mellitus group of patients (207.9 mg/dl vs 227.5 mg/dl vs 229.2 mg/dl) and LDL cholesterol values are comparatively

lower in body weight patients than in the non obese and obese group of patients (122.85 mg/dl vs 149.4 mg/dl vs 150.7 mg/dl). In this study using general model multivariate with controlling for age and Post-Hoc L.S.D. statistic, total cholesterol and LDL-cholesterol was found to be significantly less than non-obese and obese subjects.

Mean value of triglyceride is higher in low body weight type 2 diabetes mellitus than other group of non-obese and obese (186.15 mg/dl vs 170.9 mg/dl vs168.5 mg/dl), and using general linear model multivariate with controlling for age and using Post-Hoc L.S.D., significantly raised triglyceride level was seen in lean compared to non-obese and obese. This is one of the most important observations among low body weight type 2 diabetes mellitus, as this observation is very much consistent with the most of the earlier studies.

Hypercholestrolemia i.e. cholesterol level ≥ 240 mg/dl (10%) in contrast to hypertriglyceridemia i.e. triglyceride ≥ 200 mg/dl (35%) is less common in low body weight type 2 diabetes patients. But HDL cholesterol values is not significantly variable in the different group of low body weight type 2 diabetes mellitus patients as compared to non-obese and obese (46.05 mg/dl vs 42.15 mg/dl vs 44.15 mg/dl). VLDL cholesterol was also not significantly variable between the three groups. Lower incidence of hypercholesterolemia and relatively higher incidence of hypertriglyceridemia is found in low body weight type 2 diabetes mellitus group of patients by different series of studies by K. Kannan, C.S. Yagnik et al.[13,14]

LDL cholesterol ≥ 160 mg/dl was present in 5% of lean compared to 25% in non-obese and 30% in obese.

Hypertension is less as compared to the other diabetic population. This is at par with Das S.[19] At this juncture it is worthwhile recollecting hyperinsulinemia-hypertension connection and absence of hyperinsulinemia in low body weight type 2 diabetes mellitus subjects.

Urinary changes in type 2 diabetes mellitus patients showed that presence of sugar in 100%, 90% and 95% cases of low body weight, non-obese and obese cases of type 2 diabetes mellitus respectively. The presence of microproteinuria, is similar (15%) in each group of patients. Overt proteinuria is slightly higher in obese group (20%) as compared to low body weight 5% and non-obese (10%). It is consistent with previous studies by K. Kannan.[13]

Raised blood urea is found in 15% cases of low body weight type 2 diabetes mellitus, 5% in case of obese type 2 diabetes mellitus and 5% case of non showed raised blood urea at the starting of the study.

Similarly it is found that raised serum creatinine is found in 20% case of low body weight type 2 diabetes mellitus, 5% cases of non-obese and 5% cases of obese type 2 diabetes mellitus.

The increased incidence of raised blood urea and creatinine in low body weight type 2 diabetes mellitus. It is consistent with finding by Das S and Sidhartha V.[18] But mean value of urea was 30.20, 25.4 and 25.2 mg/dl in lean, non-obese and obese respectively, which is not significant. Similarly mean value of serum creatinine was 1.18, 1.12 and 1.13 in lean, non-obese and obese respectively, which is non-significant.

Ophthalmoscopy revealed retinopathy in 16% of cases of low body weight type 2 diabetes mellitus. It is consistent with finding by Sidhartha Das[18] and more or less similar incidence of retinopathy in non-obese and obese type 2 diabetes mellitus is comparative with the other studies.

U.K. Prospective diabetic study 1988 revealed mode of presentations of patients of type 2 diabetes mellitus as 53% with diabetic symptoms, 29% incidental finding, 16% with infection and 2% with complication is consistent with different modes of presentation of low body weight, obese, non-obese group of patients in the present series. In this series the mode of presentation was similar in all the three groups and using contingency coefficient, there was no significance found.

Therapeutic goal was achieved with insulin in 25% cases of low body weight type 2 diabetes mellitus at the onset of the study in comparison to 10% of non-obese and 5% of obese cases.

Higher doses of oral hypoglycemic agent were needed to control blood sugar in low body weight type 2 diabetes mellitus and more oral hypoglycemic agent therapy failure was observed in this study needs further attention.

The most characteristic criteria in low body weight type 2 diabetes i.e. type 2 diabetes mellitus with lower body mass index has got increased fasting and post prandial blood sugar values in comparison with non-obese and obese type 2 diabetes mellitus which reflects decreased Beta cell reserve having lesser amount of endogenous insulin secretion.

Hypertriglyceridemia, reflecting lower blood insulin status is characteristic of low body weight type 2 diabetes mellitus.

So far as renal pathology is concerned no significant difference in renal function was observed.

Insulin requirement at the onset of low body weight type 2 diabetes mellitus is to extent of 25% which is much higher in incidence than insulin requirement among non-obese and obese type 2 diabetes mellitus population, raises the question whether low body weight type 2 diabetes mellitus should be considered as a separate subgroup among type 2 diabetes mellitus, where Beta cell secretory capacity and hepatic metabolism is definitely different from rest of type 2 diabetes mellitus patients.

V. Conclusion

Insulin was necessary to achieve therapeutic goal in more cases of low body weight type 2 diabetes mellitus than non-obese and obese group.

Higher doses of oral hypoglycemic agents were required control blood sugar in low body weight type 2 diabetes mellitus. More incidence of oral hypoglycemic failure was in low body weight type 2 diabetes mellitus reflecting poorer insulin status.

So the present study showed that low body weight (lean) type 2 diabetes mellitus are definitely different subset of population of type 2 diabetes mellitus with clinical characteristic different from those of other subtypes of type 2 diabetes mellitus i.e. non-obese and obese.

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