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RESEARCH ARTICLE

LIPID PROFILE AND ITS RELATIONSHIP WITH BLOOD GLUCOSE LEVELS IN METABOLIC SYNDROME

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Key Words
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Background: Metabolic syndrome (MetS) and its associated factors such as dyslipidemia and hyperglycemia are associated with increased risk of cardiovascular disease (CVD).
Aims and Objective: To assess lipid profile and its relation with blood glucose levels in patients with MetS.
Materials and Methods: This cross-sectional study included 72 male patients with MetS. Anthropometry, lipid profile, blood glucose, and presence of MetS (JIS criteria) were determined.
Results: High triglyceride (TG) level (>200 mg/dL, 44.4%) was the most common dyslipidemia followed by low levels of high-density lipoprotein cholesterol (<40 mg/dL, 19.4%). High total cholesterol levels (>240 mg/dL, 13.8%) and high low-density lipoprotein cholesterol levels (>160 mg/dL, 9.7%) were observed. On comparison, no significant differences in lipid levels of MetS patients with normal fasting glucose, impaired fasting glucose, and type 2 diabetes mellitus were observed.
Conclusions: Dyslipidemia was frequent in patients with MetS. High TG was the most common lipid abnormality, and a large number of patients had more than one abnormal lipid parameter. Based on their respective blood glucose levels, an identical pattern of dyslipidemia was observed in the study population.

INTRODUCTION

Metabolic syndrome (MetS) is comprised of endocrine/metabolic disturbances characterized by type 2 diabetes mellitus (T2DM) due to insulin resistance and impaired glucose regulation, hypertension, obesity, and altered lipid profile consisting of elevated levels of triglyceride (TG) and low levels of high-density lipoprotein cholesterol (HDL-C).[1] MetS commonly precedes the development of T2DM by many years, and the risk factors that constitute this syndrome also contribute to cardiovascular disease (CVD).[2]

Dyslipidemia contributes to the progression of atherosclerosis, the underlying pathology of CVD. Individuals with MetS or T2DM exhibit a characteristic pattern of abnormalities in serum lipid levels consisting of low levels of HDL-C and elevated levels of TG. This dyslipidemia is also characterized by increased concentration of small, dense low-density lipoprotein cholesterol (LDL-C) particles.[3] Such lipid pattern is termed atherogenic dyslipidemia. Evidence from epidemiologic studies suggests that the co-occurrence of low levels of HDL-C and elevated levels of TG is a strong risk factor for CVD.[4,5]

Many studies available in literature show the association between lipid profile and MetS-associated variables.[6,7] But there is paucity of data regarding relationship of blood glucose levels and lipid profile in MetS. In this study, lipid pattern and its relation to blood glucose levels in patients with MetS was investigated.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Postgraduate Department of Physiology, Government Medical College, Jammu, India, from September 1, 2011 to April 30, 2012. Informed written consent was obtained after explaining the nature of the study to the patients, and ethical clearance was obtained from Institutional Ethics Committee (IEC/pharma/thesis/research/project/06/2011/2060, dated 20-10-2011).

This study included 72 male patients with MetS, whereas those with history of CVD, thyroid disorders, or currently on lipid-lowering agents were excluded. Detailed history was noted and clinical examination was carried out. Body mass index (BMI), waist circumference (WC), and systolic

and diastolic blood pressure were measured using standard methods. Laboratory assessment included venous blood samples in a fasted state for the determination of components of the lipid profile [total cholesterol (TC), HDL-C, and TG] and blood glucose levels. The serum glucose was measured using the glucose oxidase/peroxidase method and the lipid profile by the enzymatic colorimetric method. LDL-C was calculated from the formula of Friedewald et al.[8]

MetS was defined as per JIS (Joint Interim Statement) criteria.[9] Accordingly, MetS was attributed in patients if three or more risk determinants were present: increased WC (>90 cm), elevated TG (≥150 mg/dL), low HDL-C (<40 mg/dL), hypertension (≥130/≥85 mmHg), and impaired fasting glucose (IFG; ≥100 mg/dL). Dyslipidemia was defined according to ATP-III guidelines.[10]

Patients were categorized into three groups depending on their fasting blood glucose levels.[11] Group I comprised patients with normal fasting glucose (NFG; <100 mg/dL), Group II had patients with IFG status (100–125 mg/dL), and Group III had patients with T2DM (≥126 mg/dL).

Statistical Analysis: Intergroup comparisons were done using Pearson's χ^2-test, and mean values were compared using analysis of variance. Statistically significant differences were reported at $p < 0.05$.

RESULTS

The baseline characteristics of 72 patients with MetS show that their mean age (years) was 50.18 ± 9.63, BMI (kg/m^2) 26.71 ± 3.16, and WC (cm) 98.61 ± 7.64. Biochemical analysis showed that mean fasting blood sugar was 121.33 ± 37.39 mg/dL whereas HDL, TG, TC, and LDL-C were 45.36 ± 6.34, 195.11 ± 68.10, 194.48 ± 38.44, and 109.75 ± 34.70 mg/dL, respectively (Table 1).

Table 1: Baseline characteristics of subjects (*n* = 72)

Parameters	Mean ± SD
Age (year)	50.18 ± 9.63
BMI (kg/m^2)	26.71 ± 3.16
Waist circumference (cm)	98.61 ± 7.64
SBP (mmHg)	135.12 ± 15.80
DBP (mmHg)	88.22 ± 10.16
Fasting blood sugar (mg/dL)	121.33 ± 37.39
Serum HDL-C (mg/dL)	45.36 ± 6.34
Serum triglycerides (mg/dL)	195.11 ± 68.10
Total serum cholesterol (mg/dL)	194.48 ± 38.44
Serum LDL-C (mg/dL)	109.75 ± 34.70

HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

Table 2: Prevalence of optimal, suboptimal, and high lipid levels in metabolic syndrome (*n* = 72)

Lipid profile	Optimal	Suboptimal	High
TG*	19 (26.38%)	21 (29.16%)	32 (44.44%)
LDL-C**	31 (43.05%)	34 (47.22%)	7 (9.72%)
TC***	43 (59.72%)	19 (26.39%)	10 (13.89%)

TG, serum triglycerides; LDL-C, low-density lipoprotein cholesterol; TC, serum total cholesterol.
** TG: Optimal - <150 mg/dL; Suboptimal - 150–199 mg/dL; High: ≥200 mg/dL.*
*** LDL-C: Optimal - <100 mg/dL; Suboptimal - 100–159 mg/dL; High: ≥160 mg/dL.*
**** TC: Optimal - <200 mg/dL; Suboptimal - 200–239 mg/dL; High: ≥240 mg/dL.*

Table 3: Prevalence of HDL-C in MetS (*n* = 72)

HDL-C	Normal, ≥40 mg/dL	Low, <40 mg/dL	Total
Subjects (%)	58 (80.5%)	14 (19.4%)	72 (100%)

Table 4: Distribution of dyslipidemia in relation to blood glucose levels

Lipid parameter	NFG (*n* = 17) No. (%)	IFG (*n* = 26) No. (%)	T2DM (*n* = 29) No. (%)	*p*-Value (Yates')
TG ≥ 200 mg/dL	9 (52.9%)	13 (26.50%)	10 (34.5%)	0.563
LDL-C ≥ 160 mg/dL	0	3 (11.5%)	4 (13.8%)	0.584
TC ≥ 240 mg/dL	0	6 (23.1%)	4 (13.8%)	0.232
HDL-C < 40 mg/dL	6 (35.3%)	1 (3.8%)	7 (24.1%)	0.079

TG, serum triglycerides; LDL-C, low-density lipoprotein cholesterol; TC, serum total cholesterol, NFG, normal fasting glucose; IFG, impaired fasting glucose; T2DM, type 2 diabetes mellitus.

Table 5: Mean values of serum lipids (mg/dL) among three groups

Lipid profile	NFG (*n* = 17), mean ± SD (Group 1)	IFG (*n* = 26), mean ± SD (Group 2)	T2DM (*n* = 29), mean ± SD (Group 3)	*p*-Value
TG	211.82 ± 57.92	201.88 ± 64.33	179.24 ± 75.34	0.243
LDL-C	102.2 ± 28.46	113.74 ± 39.56	110.61 ± 33.82	0.565
TC	189.06 ± 27.61	201 ± 43.21	191.83 ± 39.76	0.549
HDL-C	43.35 ± 6.40	46.81 ± 6.01	45.24 ± 6.48	0.217

TG, serum triglycerides; LDL-C, low-density lipoprotein cholesterol; TC, serum total cholesterol, NFG, normal fasting glucose; IFG, impaired fasting glucose; T2DM, type 2 diabetes mellitus.

TG < 150 mg/dL, LDL < 100 mg/dL, TC < 200 mg/dL), and HDL-C > 40mg/dL were observed in 26.38%, 43.05%, 59.72%, and 80.55% patients, respectively. TG ≥ 200 mg/dL, TC ≥ 240 mg/dL, and LDL-C ≥ 160 mg/dL were observed in 44.44%, 13.89%, and 9.72% patients, respectively, suggesting that many patients had more than one lipid abnormality (Tables 2 and 3).

Analysis of distribution of dyslipidemia showed that hypertriglyceridemia (TG ≥ 200 mg/dL) was present in 52.9%, 26.50%, and 34.5% patients with NFG, IFG, and T2DM, respectively. Low HDL-C was observed in

NFG (35.3%), IFG (3.8%) and T2DM (24.1%) of patients. High LDL-C was observed in 11.5% and 13.8% patients with IFG and T2DM, respectively. High TC was observed in 23.1% and 13.8% of patients with IFG and T2DM, respectively. On intergroup comparison, differences were not found to be statistically significant (Table 4).

Comparison of mean values of lipid parameters in MetS patients with NFG, IFG, and T2DM showed no statistical differences (Table 5).

DISCUSSION

In this study, the relationship between glucose levels and lipid pattern in patients with MetS was examined. Hypertriglyceridemia was the most common lipid abnormality observed in these patients. Suboptimal and high TG levels were observed in 73.6% and 44.4% patients, whereas low levels of HDL-C were observed in only 19.4%. Similar observation was made in a study conducted in north Indian population with MetS wherein TG was the most prevalent lipid abnormality.[12] In our study, analysis of the baseline characteristics of the patients showed that mean WC was increased (98.61 ± 7.64 cm). WC is an indicator of visceral adipose tissue, which is a source of free fatty acids converted into TG by the liver.[13]

High levels of TG and low levels of HDL-C in patients with MetS result from decreased clearance of these lipoproteins from the circulation. Lipoprotein lipase (LPL) is a major enzyme responsible for clearing TG-containing lipoproteins from the circulation, and insulin resistance is associated with impaired LPL activity.[14] Hepatic lipase, which is responsible for clearing HDL particles from the circulation, shows increased activity in the presence of insulin resistance and causes HDL-C levels to decline.[15] A low level of HDL-C is an important risk factor for CVD. The cardioprotective effects of HDL-C have been attributed to its role in reverse cholesterol transport, its effects on endothelial cells, and its antioxidant activity.[16]

Elevated levels of LDL-C are a major risk factor for CVD and its reduction is prime target of pharmacotherapy. The positive relationship between first or subsequent attacks of coronary heart disease is observed over a broad range of LDL-C levels. The higher the level of LDL-C, the greater the risk is. In this trial, 41 patients had levels of LDL-C more than 100 mg/dL; of which, 7 were having more than 160 mg/dL.

In a study carried out on Indian population with T2DM, hypertriglyceridemia and high serum LDL-C levels (≥100 mg/dL) were recorded as major components of dyslipidemia, and most of these patients had mixed dyslipidemia. These findings are in concurrence with the results of this study,[17] whereas others have recorded normal levels of LDL-C.[18,19]

On intergroup comparison of NFG, IFG, and T2DM among patients with MetS, no statistically significant difference in lipid levels was observed. Insulin-resistant individuals not having diabetes mellitus are likely to have lipid profiles that are nearly identical to those seen in the large majority of patients with T2DM as observed in this study.[20] Although differences between individual lipids were not statistically significant in this study, yet interestingly the patients in the IFG group had higher numerical mean values of TC, LDL-C, and TG when compared to the T2DM patient group. This could be because most of the patients with diabetes mellitus were established cases. Hence, they were well informed about their condition and were following more intensive lifestyle intervention.

CONCLUSION

From results of this study, we conclude that dyslipidemia is a common feature of MetS, and a large number of patients had more than one individual lipid abnormality. Most common dyslipidemia was high TG and least was high LDL. Pattern of the dyslipidemia was similar in all three groups based on blood glucose levels.

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