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Abnormal Complete Blood Counts and Lipid Profiles as the Predictor for Complications in Type 2 Diabetes Mellitus: A Hospital Based Analysis.

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KEYWORDS

Type 2 Diabetes Mellitus; Complete Blood Counts; Lipid Profile; Complication

ABSTRACT:

Introduction: Patients with type 2 diabetes mellitus (DM) show a significant derangement in complete blood count parameters influencing the clinical severity. However, there was no information on these associations from the southern Odisha, India.

Objectives: This study was undertaken to analyze the possible association of complete blood counts parameters and lipid profile in type 2 DM with respect to their complications.

Methods: This cross-sectional study was undertook in 138 type 2 DM patients by collecting 5 mL of blood samples along with clinical data. Laboratory parameters such as CBC, lipid profile and blood sugar were investigated. The recruited patients were categorized into two groups i.e. patients with complications and patients without complications (uncomplicated). The comparison of generated data was carried out using SPSS version 16.

Results: Out of 138 patients, 50 (36.2%) were uncomplicated and rest were presented with various complications. On analysis, sugar profile (FBS, PPBS and HbA1c) and platelet indices (PDW, MPV and PLCR) were significantly low in uncomplicated group compared to complicated group. Further, triglyceride level was positively associated with HbA1c only in un-complicated group; while in complicated group, PLT count was negatively correlated with PPBS and HbA1c; and triglyceride level was positively correlated with FBS, PPBS and HbA1c respectively.

Conclusions: The abnormal hematological and lipid profile in type 2 DM patients may be used as a predictors for increased risk of complications and may be included as a routine analysis for the management of diabetes and its complications

1. Introduction

Diabetes mellitus (DM) can be defined as a group of metabolic disorders that are characterized by several defects in the regulation of carbohydrate, fat or protein metabolism, or all of the above [1]. Diabetes has reached epidemic proportions in many developing nation including India [2]. It is estimated that in 2019 about 77 million people have DM in India and by 2045 it would have increased to 134 million [3]. The Global Burden of Disease data from 1990-2021 estimated that, the incidence of DM increased from 162.74 to 264.53 per 0.1 million population from 1990 to 2021 with an annual incidence change of 0.63% [4]. As per International Diabetes federation, 2017, prevalence of DM is 8.3% and males have higher prevalence (9.1%) as compared to females (8.47%) [5].

Diabetes and its complications are significantly related to hyperglycemia, hyperinsulinemia, dyslipid-emia, thrombophilia, oxidative stress, inflammation, endothelial dysfunction, hemostatic and hematological

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abnormalities and generations of atherogenic lipo-proteins. Patients with poorly controlled diabetes may have a significant alteration in various parameters including metabolic, cellular and hematologic disturbances that lead to vascular complications.

In recent years, there has been renewed interest in hematological parameters in patients with DM. Hematological alterations include structure, function and metabolism of red blood cells (RBC), white blood cells (WBC) and platelets indices. Several studies have shown WBC such as basophil, eosinophil, neutrophils increases in number in patients with DM as well as linked to many biomarkers of inflammation and its complications. Many studies have shown reduced life span and number of RBC in patients with DM [6]. There are studies which show increased mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit (PCT), and platelet (PLT) counts are associated with diseases related to endothelial dysfunction like metabolic syndrome, DM and arterial diseases [7-13].

The liver plays an important role in carbohydrate and lipid metabolism. Increased activities of liver enzymes are indicators of hepatocellular injury and also associated with insulin resistance, metabolic syndrome and type 2 DM [14-16]. Patients with DM have induced dyslipidemia which is characterized by elevated level of total cholesterol, triglycerides, low level of high-density lipoprotein (HDL) and increased low-density lipoprotein (LDL) [17]. There are only few studies regarding association of hematological profile and lipid profile in patients with DM in Indian population and no studies in southern districts of Odisha state.

2. Objectives

With the paucity of literatures, this study was undertaken to analyze the possible association of complete blood counts (CBC) parameters and lipid profile in type 2 DM with respect to their complications.

3. Methods

This w as a cross-sectional study and carried out in patients with type 2 DM attending to the Department of General Medicine, M.K.C.G. Medical College, Berhampur, Odisha from August 2021 to July 2023. As per the American Diabetes Association 2017, patients with fasting blood sugar (FBS) of ≥ 126 mg/dL and/or post-prandial blood sugar (PPBS) of ≥ 200 mg/dL and/or HbA1c of ≥ 6.5% were considered for diagnosis of type 2 DM. By assuming 9.0% of the population with DM in the study area with considering 95% of confidence level and precision of 5%, the minimum number of samples required for the study was 126.

After giving consent for the study, 5 mililiters of venous blood was collected from the subjects for various investigations by a trained laboratory technician. Two milliliters was collected in EDTA vial for CBC and HbA1c analysis and 2 milliliters in plain vial for lipid profile analysis and 1 milliliter in fluoride vial for FBS analysis. Another 2 milliliters of venous blood was collected in fluoride vial for 2 hours PPBS analysis. CBC including platelets morphology was done within 12 hours of blood collection by using XN1000 blood analyzer (Sysmex Pvt Ltd). HbA1c, plasma glucose level and lipid profiles was analyzed within the same day of sample collections by EM360 biochemistry analyzer (Transasia Pvt Ltd). This research proposal was approved by the institutional ethical committee of M.K.C.G. Medical College, Berhampur (No.1057/ Chairman-IEC, M.K.C.G. Medical College, Berhampur on dated 20th July 2021).

A designed case format containing the set of information along with hematological (CBC along with platelet morphology indices), lipid profile (triglyceride, cholesterol, HDL-C), HbA1c, glucose level and clinical parameters were filled-up for each patient during recruitment. All the recruited patients were categorized into two groups depending on their clinical severity i.e. (1) type 2 DM patients with complications (complicated) and (2) type 2 DM patients without complications (Uncomplicated). The various compli-cations like retinopathy, nephropathy, neuropathy, coronary artery disease (CAD), cardiovascular disease (CVD), foot ulcer etc were considered. The comparison of hematological and biochemical parameters was carried out in diagnosed type 2 DM patients with and without complications by Mann-Whitney test. Correlations of various hematological parameters with lipid profile were analyzed by using Spearman correlation coefficient. All the statistical analysis was carried out by using SPSS version 16. A p value of <0.05 was considered as statistical significant

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4. Results

During the study period of 2 years, a total of 138 cases diagnosed with type 2 DM attending to the Department of Medicine were included for the study. Out of 138 cases, 50 (36.2%) were uncomplicated and rest 88 (63.8%) were presented with various complications including retinopathy (44.2%) followed by nephropathy (37.7%), CVD (29.0%), neuropathy (20.3%), CAD (13.0%), and diabetic foot (12.3%) etc. (Figure 1).

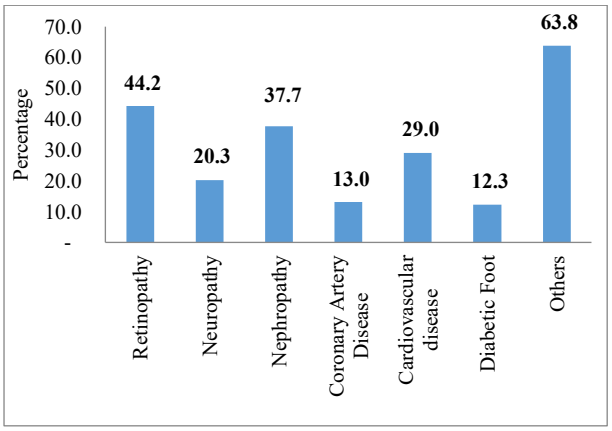

Figure-1: Clinical presentation of study subjects with Type 2 Diabetes Mellitus (n=138)

On comparison of various laboratory parameters between patients with and without complications, FBS, 2 hours PPBS and HbA1c were significantly low in uncomplicated group compared to patients with complications. Further among the CBC analysis, MCHC and WBC were found to be higher in complicated cases. Among the platelet indices, PDW, MPV and PLCR were significantly high in patients with complications; while PLT and PCT were comparable between the groups. The lipid profiles (triglycerides, cholesterol, HDL-C and LDL-C) between the groups were comparable. Urea and creatinine were significantly high in complicated cases (Table-1).

Various CBC parameters and lipid profiles were correlated with the FBS, 2 hours PPBS and HbA1c in both complicated and uncomplicated cases separately. None of the variables were correlated in un-complicated cases with type 2 DM except triglyceride which was positively (r, 0.323; P, 0.022) associated with HbA1c (Table-2). In cases with complications, PLT level was found to be negatively correlated with 2 hours PPBS and HbA1c. Similar observation has also been found in WBC level. Triglyceride level was positively correlated with FBS, 2 hours PPBS and HbA1c respectively (Table-3).

Table-1: Comparison of socio-demographic, biochemical and CBC parameters in Type 2 DM with and without complications. Bold letter represent a P value of <0.05)

Parameters	Complicated cases with Type 2 Diabetes Mellitus (n=88)	Un-complicated cases with Type 2 Diabetes Mellitus (n=50)	P-Value
Age (years)	54.69 ± 10.05	50.64 ± 10.57	0.085
BMI (kg/m^2)	24.72 ± 4.32	24.00 ± 3.47	0.316
FBS (mg/dL)	190.2 ± 79.17	155.6 ± 46.99	**0.005**
2 hours PPBS (mg/dL)	292.1 ± 10858	220.4 ± 70.50	**< 0.0001**
HbA1c	8.99 ± 2.28	7.76 ± 1.67	**0.001**
Hb (g/dL)	10.56 ± 2.02	11.08 ± 2.19	0.159
HCT (%)	31.72 ± 6.17	34.06 ± 6.74	0.093
MCV (fL)	77.98 ± 8.39	79.15±8.82	0.438
MCHC (g/dL)	33.22±1.67	32.56±1.63	**0.025**
WBC (10^3/uL)	11.55 ± 4.58	9.44 ± 3.55	**0.006**
PLT (10^3/uL)	217.43±84.5	235.2±81.67	0.232
PDW (%)	13.52 ± 2.46	12.21±2.49	**0.003**
MPV (fL)	11.19±0.89	10.51±1.16	**<0.0001**
PLCR (%)	34.36±7.36	29.51±10.14	**0.002**
PCT (%)	0.24 ±0.11	0.22 ±0.10	0.525
Triglyceride (mg/dL)	147.93 ± 76.50	166.26 ±92.49	0.213
Cholesterol (mg/dL)	171.78 ±53.15	173.92 ±59.37	0.828
HDL-C (mg/dL)	41.57 ±14.77	37.86 ±12.58	0.138
LDL (mg/dL)	94.84 ±42.63	98.86 ±38.50	0.583
Urea (mg/dL)	79.0±83.12	29.52 ±16.43	**< 0.0001**
Creatinine (mg/dL)	3.78 ±7.56	0.70 ±0.26	**0.005**
eGFR	56.76 ±37.62	109.4 ± 16.35	**<0.001**

5. Discussion

In this cross-sectional study of 138 cases with type 2 DM, more than 2/5th cases were presented with retinopathy. Though the clinical spectrum of DM varies with respect to geographical area, retinopathy has been found to be the major clinical presentation in these patients globally, accounting around 20% among all the complications [3, 18, 19]. The high occurrence in this study may be due to the sampling methods as only hospital attendee has been considered in this study.

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Table 2: Correlation of variables in un-complicated cases with type 2 diabetes mellitus (n=50). Bold letter represent a P value of < 0.05.

Parameter	FBS		2 hours PPBS		HbA1c	
	r	P value	r	P value	r	P value
Hb (g/dL)	-0.038	0.792	0.008	0.957	-0.030	0.835
HCT (%)	0.062	0.666	0.071	0.623	0.025	0.863
MCV (fL)	0.081	0.567	0.203	0.157	0.040	0.780
MCHC (g/dL)	-0.259	0.069	-0.11	0.447	-0.098	0.497
WBC (10^3/uL)	-0.271	0.057	-0.030	0.838	-0.094	0.517
PLT (10^3/uL)	0.024	0.871	0.006	0.967	-0.161	0.265
PDW (%)	0.073	0.615	-0.064	0.660	-0.068	0.638
MPV (fL)	0.048	0.740	0.024	0.870	-0.130	0.369
PLCR (%)	-0.094	0.62	-0.114	0.431	-0.024	0.871
PCT (%)	-0.094	0.515	0.062	0.668	-0.124	0.389
Triglyceride (mg/dL)	0.234	0.101	0.149	0.302	0.323	**0.022**
Cholesterol (mg/dL)	-0.051	0.724	-0.013	0.928	0.103	0.475
HDL-C (mg/dL)	-0.152	0.293	-0.082	0.573	-0.122	0.398
LDL (mg/dL)	-0.122	0.398	-0.095	0.511	0.027	0.855
Urea (mg/dL)	0.051	0.727	0.223	0.119	0.110	0.447
Creatinine (mg/dL)	-0.203	0.156	0.078	0.591	0.160	0.268

Table 3: Correlation of variables in complicated cases with type 2 diabetes mellitus (n=88). Bold letter represent a P value of < 0.05.

Parameter	FBS		2 hours PPBS		HbA1c	
	r	P value	r	P value	r	P value
Hb (g/dL)	0.165	0.125	0.110	0.310	0.095	0.380
HCT (%)	0.112	0.301	0.035	0.746	0.086	0.428
MCV (fL)	0.164	0.128	0.169	0.116	0.197	0.065
MCHC (g/dL)	0.047	0.665	0.111	0.304	-0.095	0.378
WBC (10^3/uL)	-0.202	0.059	-0.252	**0.018**	-0.201	0.061
PLT (10^3/uL)	-0.193	0.072	-0.247	**0.020**	-0.271	**0.011**
PDW (%)	-0.003	0.980	-0.073	0.499	-0.065	0.545
MPV (fL)	0.143	0.185	0.155	0.148	0.141	0.189
PLCR (%)	0.099	0.359	0.115	0.288	0.082	0.449
PCT (%)	-0.120	0.264	-0.116	0.283	-0.161	0.133
Triglyceride (mg/dL)	0.304	**0.004**	0.213	**0.046**	0.274	**0.010**
Cholesterol (mg/dL)	0.002	0.966	-0.005	0.966	0.049	0.650
HDL-C (mg/dL)	-0.164	0.127	-0.128	0.234	-0.122	0.256
LDL (mg/dL)	0.009	0.931	-0.018	0.928	0.043	0.688
Urea (mg/dL)	-0.038	0.772	-0.031	0.772	0.017	0.877
Creatinine (mg/dL)	-0.048	0.657	-0.048	0.657	-0.032	0.769

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In this present study an attempt was made to compare various laboratory parameters among the type 2 DM patients with respect to their clinical complications. On comparison, FBS and 2 hours PPBS and HbA1c were found to be significantly high in type 2 DM patients with complications compared to un-complicated cases. Among the hematological parameters, MCHC, WBC, PDW, MPV and P-LCR were significantly high in complicated patients. Glucotoxicity and lipotoxicity in type 2 DM results in enhanced inflammatory process and perpetuates a vicious cycle. Elevated WBC is a classical inflammatory marker and reveals association of inflammation with impaired glucose metabolism, insulin resistance and DM. Type 2 DM patients have more propensities for coagulopathy and thrombo-embolic complications. In these patients, there is increased platelets activation, adhesion and aggregation because of several metabolic disturbances and abnormalities in several signaling pathways [7]. The same characteristics features of various platelets indices have also been reflected in these studies. Other studies also showed increase in the MPV and PDW level in diabetic vascular complications [11-13]. Increased phosphorylation and glycosylation of cellular proteins, decreased bioavailability of nitric oxide (vasodilator), impaired Ca^{++} metabolism, systemic inflammation and oxidative stress in DM patients leads to platelets activation and thrombosis [20]. In our study platelet count and PCT were comparable in both complicated and un-complicated cases which are supported by many earlier studies.

A variety of interrelated lipid and lipoprotein abnormalities are common in type 2 DM [21]. Dyslipidemia in type 2 DM are usually prone to develop chronic heart disease as well as other complications of atherosclerosis [22]. In type 2 DM, blood glucose level were found to be positively correlated with triglycerides and LDL-C level; while some of the studies did not report any association [23,24]. In this present study, triglycerides level was found to be positively correlated with HbA1c level in un-complicated cases; while it was found to be significantly associated with fasting glucose, 2 hours PPBS and HbA1c level in complicated type 2 DM cases. These differences among the studies may be due to different in study population with different diets and habits, genetic and environmental factors and, analysis of various variables and confounding factors in the association [25].

In this study, there are few limitations as this study has been undertaken in a hospital based set-up where already diagnosed cases were included in the analysis especially for the complicated cases. Second, the complicated cases had already on treatment that may influence the laboratory parameters individually. Third, patients were not followed-up which may provide further clinical information.

In conclusion, the abnormal hematological (CBC analysis) and lipid profile in patients with type 2 DM may be used as a predictors for increased risk of complications or can be treated as a marker for the progression of disease from un-complicated to complicated type 2 DM. Along with the routine blood sugar parameters and lipid profile, a CBC analysis which is cost effective will be beneficial for the management of diabetes and its complications in type 2 DM patients.

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Authors contributions:

NM and PP: study design and supervision; SR, MN and PP: samples collection, laboratory analysis and data collection; PP: statistical analysis; NM, SR, and PP: manuscript draft preparation; NM, PP, AM and JN: final manuscript review. All the authors have read and accepted the final manuscript.

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Conflict of interest: None

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