ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at:www.ijmacr.com

Volume – 5, Issue – 6, November – December - 2022, Page No. : 443 - 450

Recognition of early microvascular complications of type 2 diabetes mellitus using hematological and biochemical parameters

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How to citation this article: Dr. Ariba Nasir, Dr. Faiyaz Ahmad, Dr. Seema Awasthi, Dr. Prachi Singh, Dr. Faiza Samin, Dr. Anushka Gupta, "Recognition of early microvascular complications of type 2 diabetes mellitus using hematological and biochemical parameters", IJMACR- November – December - 2022, Vol – 5, Issue - 6, P. No. 443 – 450.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Microvascular complications are the major contributors of morbidity and mortality in diabetic patients. Platelet indices and neutrophil-lymphocyte ratio, microalbumin, HbA1c are an effective tool, which can be used as a predictor for microvascular complications, thereby improving the standards of care.

Aim: Recognition of early microvascular complications of type 2 diabetes mellitus using hematological & biochemical parameters.

Methodology: This observational study included 220 subjects who were divided into control and diabetic group as well as according to duration of diabetes.

Result: The mean neutrophil count, mean blood urea nitrogen and urea, microalbumin and albumin to creatinine were higher in diabetic group as compared to control group. The mean PDW, PCT, HbA1C, fasting blood sugar and random blood sugar, microalbumin, creatinine and albumin to creatinine was significantly more among subjects with duration of diabetes > 5 years. Retinal findings like cotton wool spots, disc changes and Microaneurysm and neurological findings like tingling,

numbness was seen in subjects with duration of diabetes > 5 years.

Conclusion: In the analysis, people with T2DM had significantly different hematological parameters. The difference was greater in patients with T2DM for more than five years when compared to the WBC, neutrophil, neutrophil-lymphocyte ratio, platelet indices BUN, urea, creatinine, microalbumin, ACR ratio and altered platelet indices showed this disparity. Patients having abnormal haemato-biochemical profile are more prone to develop microvascular complications. Routine screening with these parameters is advised in order to commence early preventive treatments.

Keyword: Microalbumin, NLR, PLR, Diabetes Mellitus.

Introduction

Roughly 9% of adults are affected by the dangerous systemic disease known as diabetes mellitus. The many systems in the body are affected by this metabolic disorder.

Numerous variables, including genetic, environmental, and behavioural interactions, contribute to the development of diabetes.[1] By 2030, there would be 80 to 87 million diabetics in India, whereas there will be 438 million (7.8%) people worldwide. [2]

Diabetes microvascular difficulties cause long-term concerns that affect the small blood vessels. This includes retinopathy, neuropathy, and nephropathy. [3]

Diabetes patients who have high levels of glycatedhaemoglobin may have hypertension and vascular disorders because endothelium-mediated vasoactive responses are impaired. [4]

Watala et al. linked glycation-induced structural alterations in haemoglobin molecules to an increase in erythrocyte internal viscosity. [5]

Changes in haemoglobin structure and function, as well as cytoplasmic viscosity inside each red blood cell, have been related to osmotic disturbances within the cell, delayed glycosylation, and a continual rise in HbA1c. These differences may be seen in any or all of the red cell analytical measurements, including Hb, RBC count, HCT, MCV, MCH, and MCHC. [6]

The occurrence and advancement of microvascular difficulties increased in tandem with high blood glucose levels, a longer duration of diabetes, and dyslipidemia, all of which were associated by microalbuminuria levels. Furthermore, the duration of diabetes was connected to an increased chance of acquiring microalbuminuria. Microvascular issues in people with type 2 diabetes are predicted by poor glycemic control, having diabetes for a longer period of time, dyslipidaemia, and progression of microalbuminuria. [3]

According to the findings of one study, diabetics with excessively high platelet activity had far more serious vascular issues. [7]

Platelet purpose and activity are measured by mean platelet volume (MPV). Platelet changes in structure and function have been related to an increased risk of both macrovascular and microvascular disease. [8]

NLR, PLR, and platelet indices have been connected to a variety of medical disorders and pathologies because they are simple, inexpensive, and easy to examine in all laboratory settings. [9] The amount of study focusing on the links that may be created between different types of leukocytes has increased in recent years. [10,11]

The neutrophil-lymphocyte (NLR) and lymphocyte-monocyte (LMR) ratios, as well as associations like the platelet-lymphocyte (PLR) and monocyte-HDL ratios, as well as hematological markers like the RDW, are being studied as possible risk indicators in a number of clinical

diseases. It is feasible to analyse inflammatory indicators as well as potential risk factors using these easy and low-cost approaches. [12]Hematobiochemical testing has the advantages of being available in all labs, being less costly, and having a high level of reliability. It might be used to test the general population for endothelial dysfunction or inflammation. [13]

Subjects and methods

This "Observational study which was done in Department of Pathology" of "Teerthanker Mahaveer Medical College and Research Centre, Moradabad" in collaboration with the "Department of Hematology and Biochemistry". Institution of medical ethics, committee approval was obtained. Written and informed consent was obtained from all participants.

Inclusion and Exclusion Criteria

Recently and previously diagnosed individuals with type 2 diabetes were included in the study. Individuals with a positive HIV and/or suffering systemic disorders such as cardiovascular disease, chronic liver disease, blood disorders or malignancy were excluded from the study.

Procedure of data Collection

Our study included 150 patients (of either gender) with type 2 diabetes and 70 patients with regulated blood sugar levels who reported to the emergency department. The registered people were told of the study's goals and objectives, as well as the overall purpose. Detailed history and examination of the patient will be conducted.

Control group

a) Diabetic patient with history of DM <5 year.

a) Diabetic patient with history of DM >5 year.

After an overnight fast, blood sample was taken under aseptic circumstances. Vacutainers with EDTA (ethylene diamine tetracetic acid) were used to collect blood samples for hematological studies. Neutrophils, lymphocytes, NLR, MPV, PDW, P-LCR, and plateletcrit will be conducted as part of the CBC.

BUN, urea S. creatinine, HbA1c, fasting blood sugar, random blood sugar, and other biochemical markers.

Urine pathology includes microalbumin, A:G ratio, creatinine, pus cells, RBCs, and casts. Fundoscopy and nerve conduction investigations, clinical evaluation of numbness and tingling in neuropathy patients

Data Entry and Analysis

After the statistical analysis was performed using SPSS version 27.0, the data was input into Microsoft excel for further processing. The mean and standard deviation were used to provide quantitative (numerical variables) information, while the frequency and percentage of each category were employed to convey qualitative (categorical variables) information. The student t-test and the chi-square test were used to compare the mean values of the two groups, and the chi-square test was used to examine frequency differences that occurred between the two groups. If the p-value was less than 0.05, the threshold for significance, it was declared to be statistically significant. This was the point at which it was deemed acceptable.

Results

Table1 : Division of study population as per neutrophils, lymphocytes and neutrophil-lymphocyte ratio.

	Groups	Mean	Standard Deviation	Mean Difference	t- test value	p-value
Neutrophils	Diabetes Type2	56.24	17.61	-9.10	-4.013	0.001*

	Control	65.34	10.28			
Lymphocytes	Diabetes Type2	26.34	10.68	0.63	0.442	0.659
	Control	25.71	7.64			
Neutrophil-lymphocyte ratio	Diabetes Type2	2.82	2.60	-0.04	-0.119	0.906
	Control	2.86	1.29			

The mean neutrophils were significantly more among control group compared to diabetes Type 2.

Table 2: Division of study population as per blood urea nitrogen, urea and creatinine

	Groups	Mean	Std. Deviation	Mean Difference	t-test value	p-value
Blood Urea Nitrogen	Diabetes Type 2	14.44	10.63	1.72	2.319	0.038*
	Control group	12.72	3.56			
Urea	Diabetes Type 2	31.04	22.85	3.70	2.320	0.038*
	Control group	27.34	7.66			
Creatinine	Diabetes Type 2	0.91	0.49	0.07	1.125	0.262
	Control group	0.84	0.17			

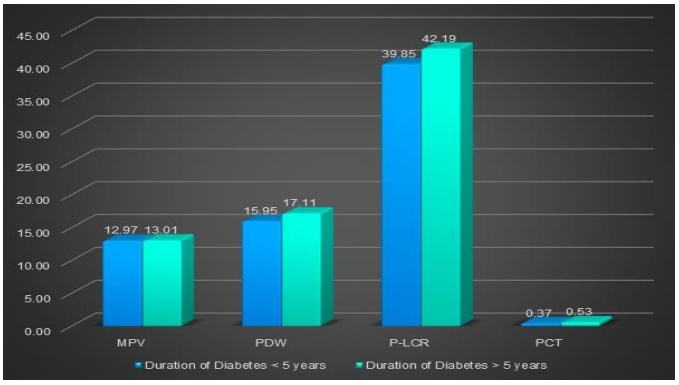
The mean blood urea nitrogen and urea was significantly more among diabetes mellitus type 2 compared to control group.

Table 3: Division of study population as per Microalbumin, creatinine, albumin to creatinine ratio.

	Groups	Mean	Std. Deviation	Mean Difference	t-test value	p-value
Microalbumin	Diabetes Type 2	1.62	0.86	0.40	3.674	0.001*
	Control group	1.22	0.40			
Creatinine	Diabetes Type 2	0.08	0.08	-0.01	-0.954	0.341
	Control group	0.10	0.15			
Albumin to creatinine ratio	Diabetes Type 2	21.55	14.26	4.59	2.600	0.010*
	Control group	16.96	5.49			

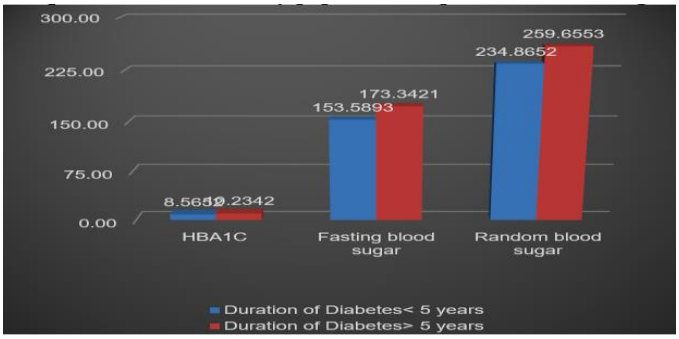
The mean Microalbumin and albumin to creatinine was significantly more among diabetes mellitus type 2 compared to control group.

Graph 1: Division of study population as per platelet indices.



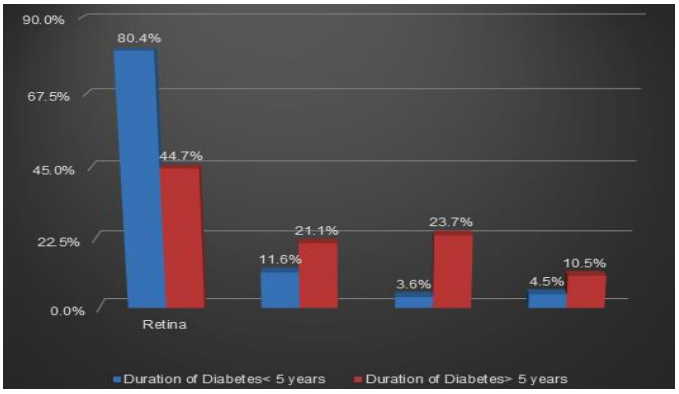
The mean PDW and PCT was significantly more among subjects with duration of diabetes > 5 years.

Graph 2: Division of study population as per HbA1C, fasting blood sugar and random blood sugar.



The mean HbA1C, fasting blood sugar and random blood sugar was significantly more among subjects with duration of diabetes > 5 years.

Graph 3: Division of study population according to retinal findings.



Cotton wool spots, disc changes and microaneurysm were significantly more among Diabetes > 5 years.

Table 5: Division of study population according to neuropathy

	Duration of Diabetes	
Neuropathy	< 5 years	> 5 years
Absent	96	23
	85.7%	60.5%
Present	16	15
	14.3%	39.5%
χ^2values = 10.979, p-value = 0.001*		

Neurological findings were significantly more among span of diabetes > 5 years compared to < 5 years. Neurological findings were assessed on the basis of: numbness, tingling and nerve conduction studies.

Discussion

Individuals with type 2 diabetes were found to have considerably higher mean platelet volume and Plateletcrit than those in the control group. These conclusions were drawn from the data of our investigation. Kumar et al. [14] discovered that there was no apparent difference between the groups when comparing mean platelet counts.

Diabetes mellitus type 2 patients are more likely to experience coagulation problems and thromboembolic events. This is because T2DM is linked to an increased risk of insulin resistance. Platelets play a crucial role, and studies have revealed that diabetes individuals have increased platelet adhesion, activation, and aggregation as a result of irregular regulation of various signaling pathways and metabolic disturbances such as insulin resistance, hyperglycemia, and dyslipidaemia.

This is because diabetes people have more platelets that may stick to, activate, and aggregate with one another. The increased adhesion, activation, and aggregation of platelets in diabetic persons may be attributed to the

dysregulation of several signaling pathways that occurs in diabetes patients. [23]

In the current investigation, the mean blood urea nitrogen and urea levels in T2DM were significantly higher than in the Control group. Biri et al. [15] discovered that blood urea and serum creatinine levels were considerably higher in diabetics, which might be a marker of pre-renal impairment. This study is similar to that of Madhusudan Rao et al.,[16], who described the relationship between long-term plasma glucose levels and blood urea levels. This finding is consistent with the findings of Anjaneyulu and Chopra [17], who observed that higher levels of urea and creatinine in diabetic rats promote progressive renal damage.

Individuals with T2DM showed substantially higher average blood sugar levels when fasting, blood sugar levels during random sampling, and HbA1C values when compared to those without T2DM. According to Biri et al. [15], those with diabetes had significantly greater levels of mean FBS, postprandial blood sugar, and HbA1C than those without diabetes.

According to the findings of this study, the ratio of microalbumin and albumin to creatinine was considerably higher in persons with T2DM compared to patients in the control group. Individuals with T2DM showed higher mean plasma creatinine, urine microalbuminuria, albumin creatinine ratio, and HbA1c levels. Karar and his colleagues came to the following conclusions after doing this analysis. [17]

The patients in this study who had diabetes for more than five years had significantly higher mean PDW and PCT levels. Individuals with type 2 diabetes who had microvascular difficulties had significantly higher levels of MPV, PDW, and P-LCR in diabetic participants who had retinopathy, nephropathy, and neuropathy compared to diabetic patients who did not develop these disorders, according to Taderegew et al. [18]. Mi et al. published their findings in a journal.[19]

Individuals over 40 had a significantly higher platelet larger cell ratio (P-LCR/%) value than those under 40, according to Sampath Kumar et al (2021) [20]. This value was much greater and correlated positively with age. Guys in Group 1 who were older than 40 years old had a significantly higher plateletcrit value (0.297 0.067 (>40)) than males who were younger than 40 years old, and this value was positively related to age.

Individuals with diabetes for more than five years had significantly greater levels of blood creatinine, urea, and urea nitrogen than those with diabetes for less than five years, according to the current study. Amartey et al. [21] discovered no statistically significant change in the uric acid (p=0.191), urea (p=0.905), or creatinine ratios.

Cotton wool patches, disc changes, and microaneurysms were significantly more prevalent in diabetic patients who had been present for more than five years in this study. Individuals with diabetes for more than five years exhibited significantly more neurological abnormalities than those with diabetes for less than five years. It was shown that 32.4% of people with type 2 diabetes had problems with their microvascular circulation. Studies in Wollega, Ethiopia, revealed a rate of 31.2%, while study in Ghana revealed a frequency of 35.3%. [22]. [23] The outcomes of a research done in Gondar, Ethiopia, revealed a substantially higher incidence (20.4%). [117]

Conclusion

According to the statistical analysis, the haematological parameters of people with T2DM differed significantly from those of control participants. When compared to the total WBC count, neutrophil count, NLR, platelet indices BUN, urea, creatinine, microalbumin, ACR. This

difference was considerably more significant in patients with T2DM for more than five years. This disparity was also observed in those with higher-than-average platelet counts. Platelet counts, average platelet volume, and anthropometric features were all found to have a strong association with one another. This fact was discovered thanks to the application of correlation analysis. As a result, assessing haematological changes in persons with T2DM will be critical since it will allow a physician to build a timely and thorough treatment approach that will block the formation of serious difficulties. This is why it is really important. When it comes to the effective management of type 2 diabetes, it is critical to remember to do frequent haematological marker examinations.

In terms of haematological problems, the patient's diabetes duration as well as their dietary habits should be carefully evaluated. It would be better if we conducted longitudinal study with a larger sample size in order to correctly assess the issue. In addition, persons with T2DM may consider having a morphological and coagulation profile assessment. It is concluded that diabetic patients have an abnormal Haematobiochemical profile. So, it is recommended that diabetic patients undergo routine and frequent screening for their haematological and biochemical profiles in order to initiate early preventative measures and reduce the morbidity associated with it. Secondary prevention, early identification, and correction of altered Hematological and biochemical parameters in diabetes patients in rural primary care settings or tertiary care centres would be cost effective, reducing hospital admissions, slowing the progression of renal disease, and improving life quality.

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