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Study of hematological indices in patients with diabetes mellitus and hypertensive diabetes mellitus

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Abstract

Background: Role of hematological indices in the development of micro and macrovascular complication is well established but study comparing hematological indices in patients of diabetes with and without hypertension is lacking.

Aims and Objective: To compare the hematological parameters among diabetes patients with and without hypertension and to compare hematological parameters with extend of glycemic control among diabetes patients. Correlation of hematological parameters with renal function test was also done.

Materials and Methods: A prospective study including 141 patients in the Department of Medicine, Mayo Institute of Medical sciences, Baranaki between January 2016 to May 2016 was done. Diabetic patients were divided in to those with hypertension and without hypertension. Patients were also divided as good control (HbA1c <7%), poor control (HbA1c between 7-9%) and uncontrolled (HbA1c >9). Red blood cell indices such as total red blood cells (RBCs), hemoglobin (Hb), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and red blood cell distribution width (RCDW) were estimated and in platelet indices; platelet count (PLT), mean platelet volume (MPV) and platelet large cell ratio (PLCR) were estimated. Iron, tranferin saturation (TS) and total iron-binding capacity (TIBC) were also estimated in present study. Correlation between renal function test (RFT) and hematological parameters were also performed.

Results: Out of 141 patients, 42 (29.79%) were having diabetes alone whereas 99 (70.21%) diabetics were having hypertension. Mean age (year), height (meter), weight (kg), BMI (kg/m^2), fasting blood glucose (mg/dl), post prandial blood glucose (mg/dl), HbA1c (%) and average blood glucose (mg/dl) were 47.24±11.02 vs 54.87±10.15, 6.36±28.66 vs 4.95±23.34, 69.52±13.64 vs 72.34±13.46, 24.73±6.30 vs 26.76±5.71, 147.68±45.94 and 140.44±42.29, 252.16±91.67 vs 230.85±78.10, 9.11±2.24 vs 8.19±1.81 and 220.91±69.55 vs 189.08±52.33 in patients of diabetes alone and hypertensive diabetics respectively. Total RBC (10^6/µL) (4.78±0.70 vs 4.39±1.06), PCV (%) (43.85±4.58 vs 40.46±7.92) and PLT (10^3/µL) (216.16±82.59 vs 185.66±54.38) were significantly higher in patients with diabetes alone as compared to hypertensive diabetics respectively ($p<0.05$) whereas, RCDW (%) (42.58±16.80 vs 51.56±12.02) was significantly higher in hypertensive diabetics as compared to patients with diabetes only ($P<0.05$). Significant difference was obtained for RCDW, PDW, MPV, PLT and PCT between patients with good, poor and uncontrolled diabetes mellitus ($p<0.05$). Hemoglobin was negatively correlated with blood urea (r=-0.418, p=<0.0001) and uric acid (r=-305, p=0.001) and positively correlated with calcium (0.310, p=0.001). PCV was negatively correlated with blood urea (r=-0.266, p=0.004) and uric acid (r=-0.356, p=<0.0001) whereas it was positively correlated with calcium (r=0.202, p=0.032). A negative correlation was found between MCV and blood urea(r=-0.204, p=0.023), RCDW and blood urea (r=-0.296, p=0.001) and PLT and calcium (r=-0.261, p=0.005).

Conclusion: Patients with diabetes had high level of total RBC, PCV and PLT whereas patients with hypertension and diabetes were having higher values of RCDW. Patients with uncontrolled diabetes have significantly higher RCDW, PDW, MPV, PLT and PCT as compared to patients with good control. Patients with low Hb level were found to have elevated renal function test parameters in patients with diabetes.

Keywords: diabetes, hypertensive diabetes, hematological parameters, renal function test

1. Introduction

According to International Diabetes Federation 2015 report, globally around 415 million people are living with diabetes and the number is expected to rise by 642 million by 2040. In India, a total 69.2 million people are living with diabetes [1].

Altered level of many hematological parameters such as red blood cells (RBCs), white blood cells (WBC), and the platelet function has been observed in patients with the diabetes [2-4]. Many studies have advocated the importance of raised level of WBC and RBC count in the diagnosis of metabolic syndrome [5-6]. Many epidemiologic studies have also suggested a close relationship between hematological parameters and different components of metabolic syndrome [7]. Even a number of studies have supported the association between hematologic parameters with insulin resistance.

Abnormal hematological parameters are observed in patients with chronic renal failure and among them anemia is the most common abnormality seen in patients with diabetes mellitus. Chronic renal failure is associated with variety of hematological abnormalities. Anemia is the most common, consistent and severe of the various hematological abnormalities [8].

There is lot of studies comparing hematologic parameters in patients with diabetes and hypertensive diabetics, but study comparing hematologic parameters in hypertension with

diabetes and diabetes only is lacking.

In present study we tried to compare the hematologic parameters in patients of diabetes with and without hypertension and also tried to find out the correlation of hematological parameters with renal function test.

2. Materials and Methods

A prospective study included 141 diabetic patients, in the Department of Medicine, Mayo Institute of Medical sciences, Barabanki from January 2016 to May 2016.

All the patients were divided in to patients who were having diabetes without hypertension and patients those were hypertensive diabetics. Patients were also divided as good control (HbA1c <7%), poor control (HbA1c between 7-9%) and uncontrolled (HbA1c >9) to compare hematological parameters. A written Informed consent from all patients and Institutional Ethics Committee approval was obtained before starting the study.

Demographic parameters such as age, height, weight and body mass index (BMI) were recorded for all the patients. Glycemic parameters such as fasting plasma glucose (FPG), post prandial glucose (PPG), HbA1c and average blood glucose were estimated after drawing blood from all the patients. In hematological parameters; red blood cell indices such as total RBC, hemoglobin, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and red blood cell distribution width (RCDW) were estimated and in platelet indices; platelet count (PLT), mean platelet volume (MPV) and platelet large cell ratio (PLCR) were estimated. Iron, tranferin saturation (TS) and total iron-binding capacity (TIBC) were also estimated in present study.

All the statistical analysis was performed using IBM SPSS ver. 20. Mean and standard deviations were calculated for time varying variables and percentages were calculated for categorical variables. P value<0.05 was considered as significant.

3. Results

Out of 141 patients, 42 (29.79%) were having diabetes only whereas 99 (70.21%) were hypertensive along with diabetes. There were 34 (80.95%) male and 8 (19.04%) female in patients with diabetes whereas there were 76 (76.76%) male and 23 (23.23%) female in hypertensive diabetic group.

Table 1: Demographic parameters between both the groups

Variable	DM (n=42)	DM+HTN=99	P value
Age (year)	47.24±11.02	54.87±10.15	0.0003
Height (meter)	6.36±28.66	4.95±23.34	NS
Weight (kg)	69.52±13.64	72.34±13.46	NS
BMI (kg/m^2)	24.73±6.30	26.76±5.71	NS
FBS(mg/dl)	147.68±45.94	140.44±42.29	NS
PPG (mg/dl)	252.16±91.67	230.85±78.10	NS
HbA1c (%)	9.11±2.24	8.19±1.81	0.021
ABG (mg/dl)	220.91±69.55	189.08±52.33	0.022

Data is expressed as mean± SD, DM+ HTN; diabetic hypertensive, DM; diabetes, BMI; body mass index, FBG; fasting blood glucose, PPG; post prandial glucose, HbA1c; glycated hemoglobin, ABG; average blood glucose calculated from HbA1c values, p value <0.05 is considered as significant

Table 2: Comparison of hematological parameters between diabetes and hypertensive diabetes

Variable	DM (n=42)	DM+HTN (n=99)	P value
Iron	69.08±20.18	70.14±30.07	NS
TIBC (µmol/L)	354.53±83.34	367.88±63.24	NS
TS	33.39±78.31	19.93±8.96	NS
Total RBC (10^6/µL)	4.78±0.70	4.39±1.06	0.014
Hb (g/dL)	13.16±1.88	12.56±1.96	NS
PCV (%)	43.85±4.58	40.46±7.92	0.005
MCV (fL)	90.31±9.07	92.17±10.82	NS
MCH (pg)	27.91±2.84	27.79±2.95	NS
MCHC (g/dL)	30.94±1.73	30.14±3.19	NS
RCDW (%)	42.58±16.80	51.56±12.02	0.004
PDW (fL)	17.78±4.71	19.31±3.65	NS
MPV (fL)	13.66±2.68	15.08±12.97	NS
PLT (10^3/µL)	216.16±82.59	185.66±54.38	0.041
PLCR (fL)	45.57±9.79	43.66±11.83	NS

Data is expressed as mean± SD, DM+ HTN; diabetic hypertensive, DM; diabetes, Hb; hemoglobin, PVC; packed cell volume, MCV; mean corpuscular volume, MCH; mean corpuscular hemoglobin, MCHC; mean corpuscular hemoglobin concentration, RCDW, red blood cell distribution width, PDW; platelet distribution width, TS; tranferin saturation, MPV; mean platelet volume, PLT; platelet Count, PLCR; platelet large cell ratio, TIBC; total iron-binding capacity, fL; femtolitre, p value <0.05 is considered as significant

Table 3: Showing comparison of hematological parameters with glycemic control

Parameters	Good Control* N=36	Poor Control* N=61	Uncontrolled* N=44	p
Hb (g/dL)	12.55±2.20	12.29±2.02	13.44±1.46	NS
PCV (%)	40.70±8.03	40.55±7.06	42.66±7.11	NS
MCV (fL)	92.86±15.36	92.01±8.25	90.20±7.66	NS
MCH (pg)	28.59±3.22	27.79±3.05	27.29±2.38	NS
MCHC (g/dL)	30.73±4.49	30.23±2.40	30.30±1.49	NS
RCDW (%)	52.09±16.16	47.93±14.76	47.20±12.06	a, b
PDW (fL)	19.02±3.90	18.33±4.48	19.43±12.06	c
MPV (fL)	17.17±21.76	13.79±2.41	13.88±1.89	a, b
PLT (10^3/μL)	180.59±74.98	202.29±64.20	196.65±58.67	a, b
PLCR (fL)	43.93±14.66	45.11±11.08	43.34±8.72	NS
PCT	0.24±0.08	0.26±0.08	2.81±0.70	b, c

**Good Control; HbA1c <7, Poor Control; HbA1c between 7-9%, Uncontrolled; HbA1c >9, All the data is expressed as mean±SD, P<0.05 considered as statistically significant as determined by ANOVA with post-hoc multiple comparison Bonferroni test; a- significant difference between good and poor control, b- significant difference between good and uncontrolled, c- significant difference between uncontrolled and poor control, NS; not significant, Hb; hemoglobin, PVC; packed cell volume, MCV; mean corpuscular volume, MCH; mean corpuscular hemoglobin, MCHC; mean corpuscular hemoglobin concentration, RCDW, red blood cell distribution width, PDW; platelet distribution width, TS; tranferin saturation, MPV; mean platelet volume, PLT; platelet Count, PLCR; platelet large cell ratio, TIBC; total iron-binding capacity, fL; femtolitre.*

Table 4: Correlation between renal function test and hematological parameters

RFT		HB	PCV	MCV	MCH	MCHC	RCDW	PDW	MPV	PLT	PLCR	PCT
Creatinine	r	-0.131	-0.046	0.001	-0.093	-0.103	0.019	0.168	0.001	-0.068	0.124	-0.016
	p	0.144	0.627	0.989	0.303	0.251	0.837	0.077	0.990	0.451	0.193	0.870
Blood Urea	r	-0.418	-0.266	-0.204	-0.158	0.088	-0.296	0.031	-0.086	-0.050	-0.044	-0.045
	p	<.0001	0.004	0.023	0.078	0.331	0.001	0.746	0.367	0.583	0.645	0.638
Uric Acid	r	-0.305	-0.356	-0.115	-0.151	-0.047	0.148	-0.114	0.053	0.179	-0.105	-0.033
	p	0.001	<.0001	0.211	0.098	0.609	0.115	0.233	0.577	0.050	0.272	0.734
Calcium	r	0.310	0.202	0.142	0.181	0.030	0.024	0.157	0.082	-0.261	0.106	-0.042
	p	0.001	0.032	0.128	0.052	0.752	0.801	0.098	0.393	0.005	0.267	0.665
S Creatinine Ratio	r	0.005	0.166	-0.072	-0.148	-0.082	-0.218	0.052	-0.011	-0.027	-0.035	-0.040
	p	0.955	0.080	0.451	0.119	0.392	0.021	0.589	0.910	0.781	0.711	0.673

P<0.05 considered as statistically significant as determined by Pearson Correlation coefficient, r- correlation coefficient, RFT; renal function test, Hb; hemoglobin, PVC; packed cell volume, MCV; mean corpuscular volume, MCH; mean corpuscular hemoglobin, MCHC; mean corpuscular hemoglobin concentration, RCDW, red blood cell distribution width, PDW; platelet distribution width, TS; tranferin saturation, MPV; mean platelet volume, PLT; platelet Count, PLCR; platelet large cell ratio, TIBC; total iron-binding capacity, fL; femtolitre.

4. Discussion

Increase in blood glucose level is one of the factors that change the erythrocyte morphology. The extent of change in shape of erythrocyte depends on the level of blood glucose level. All this affects the flow property of blood due to alteration and deformation [9]. The present study compares the hematological parameters between patients with diabetes alone and hypertension along with diabetes.

Jabeen *et al.* performed a study on 170 diabetic patients to determine the relationship of glycemic control on hematological parameters in diabetes mellitus patients, reported that among hematological parameters MPV and PDW were significantly increased in diabetes patients as compared to non-diabetics [10]. Significant difference was obtained for RCDW, PDW, MPV, PLT and PCT between patients with good, poor and uncontrolled diabetes mellitus (p<0.05) (table 3), which is in accordance with Jabeen *et al.*

Raised level of such indices can be utilized as the possible indicators for finding the risk of developing micro and macro vascular complication in diabetes patients [11] in present study total RBC, PVC and PLT were significantly high in patients with diabetes whereas RCDW was significantly high in hypertensive diabetes patients.

The possible reasons for high RBC value among diabetes patients may be due to smoking, chronic kidney disease, carbon monoxide exposure, alcoholism or liver disease [12] in present study, such risk factors were not studied. But a study done by Chen *et al.* at Taiwan with 857 patients reported contrary results, they reported that RBC count was comparable between groups who were having high insulin resistance [13].

Hemoglobin level was significantly correlated with blood urea, uric acid and calcium; PVC had significant correlation with blood urea, uric acid and calcium; MCV showed positive correlation with blood urea, RCDW was negatively correlated with blood urea and PLT count was significantly correlated with calcium. Rathod *et al.* also reported a negative correlation of Hb with blood urea which is consistent with the present study data [8]. Suresh *et al.* performed a study on 50 Chronic renal failure patients and reported significantly (P<0.05) reduced level of RBC, Hb, hematocrit and platelet count which is similar to the present study data [14].

A study done by Alam *et al.* on 403 diabetic patients reported that hemoglobin was comparable in both the group whereas ESR was significantly higher in diabetes patients as compared to non-diabetes patients which is in accordance with the present study findings [15].

Asmah *et al.* assessed the connection between oxidative stress and haematological parameters in patients with and without diabetes. Asmah *et al.* did not find any difference in haematological parameters except WBC count, all other parameters such as hemoglobin, platelets and haematocrit levels were similar in patients with and without diabetes which is in accordance with the present study findings [16].

Biadgo *et al.* also performed a similar comparative study on 296 participants and reported significant difference in red blood cell distribution width between patients with diabetes and non-diabetes. Almost similar results were depicted by the present study [17]. Biadgo *et al.* also reported that platelet indices such as mean platelet volume and platelet distribution width were significantly higher in diabetes patients, but in present study we found the contrary results [17].

The present study had few limitation of being less in sample size; a large clinical trial is needed to confirm the present study findings.

5. Conclusion

Patients with diabetes had higher level of total RBC, PCV and PLT whereas patients with hypertension and diabetes were having higher values of RCDW. Hematological parameters such as RCDW, PDW, MPV, PLT and PCT were high in patients with uncontrolled diabetes mellitus. Low level of hemoglobin is one of the risk factor for increase in blood urea and uric acid level. Present study recommends the screening for hematological parameters and RFT in patients with uncontrolled diabetes mellitus.

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