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Original Article

Hematological Parameters in Type2 Diabetes Mellitus: A Comparative Study with Healthy Blood Donors as Controls -in Tertiary Care Centre

M. Prashanth[1], C. Sushma[2], V.Poojitha Ram[3], M.Bharathi Sree[4]

[1]Postgraduate, Department of Pathology, S.V. Medical College, Tirupati, Andhra Pradesh, India
[2]Associate Professor Department of Pathology, S.V. Medical College,Tirupati,AndhraPradesh,India
[3,4]Assistant Professor, Department of Pathology , S.V. Medical College, Tirupati, Andhra Pradesh, India

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Corresponding Author:

Dr. M. Prashanth
Postgraduate, Department of Pathology, S.V. Medical College, Tirupati, Andhra Pradesh, India

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ABSTRACT

Background: Total hip arthroplasty (THA) is one of the most successful orthopedic procedures for relieving pain and restoring function in patients with advanced hip disorders. However, postoperative pain remains a major concern affecting rehabilitation, early ambulation, hospital stay, and patient satisfaction. Transdermal analgesic patches have emerged as an alternative strategy for sustained postoperative pain control with fewer systemic adverse effects.
Aim: To compare the safety and efficacy of transdermal buprenorphine patch and transdermal ketoprofen patch with conventional analgesics in postoperative pain management following total hip arthroplasty.
Methodology: This prospective comparative study was conducted at Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly over a period of 18 months. A total of 96 patients undergoing primary unilateral total hip arthroplasty were enrolled and divided equally into three groups of 32 each. Group A received transdermal buprenorphine patch, Group B received transdermal ketoprofen patch, and Group C received conventional paracetamol regimen. Pain intensity was assessed using Numeric Rating Scale (NRS) at serial postoperative intervals. Rescue analgesic requirement, adverse drug events, duration of hospital stay, patient acceptability, and satisfaction were recorded and compared.
Results: Pain scores were significantly lower in the transdermal buprenorphine group throughout the postoperative period, with consistently lower NRS scores from postoperative day 2 to postoperative day 5 compared with ketoprofen and conventional analgesic groups ($p<0.001$). Rescue analgesia was required in 12.5% patients in Group A, 21.9% in Group B, and 56.3% in Group C. Adverse drug events occurred in 28.1%, 37.5%, and 53.1% patients respectively. Mean hospital stay was shortest in the ketoprofen group (5.9 ± 1.3 days) and longest in the conventional group (7.2 ± 1.7 days).
Conclusion: Transdermal buprenorphine and ketoprofen patches were effective and safe alternatives to conventional analgesics after THA. Buprenorphine showed superior analgesic efficacy with reduced rescue analgesic requirement and improved postoperative recovery.

Keywords*: Inflammatory markers, NLR, PLR, ESR, MCV, HbA1c, Inflammation, anemia.*

INTRODUCTION

Diabetes is a global metabolic disorder increased among elderly due to excess calorie intake and sedentary life style.Diabetes mellitus is characterised by persistent hyperglycemia that leads to increased risk of micro and macrovascular complications(1). Chronic hyperglycemia also leads to oxidative stress,inflammatory response , lipid metabolism(2) .Increased oxidative stress induces hematological alterations that affects the function,structure and metabolism of red blood cells (R.B.C), white blood cells (W.B.C) and platelets(3).

A large proportion of diabetic individuals exhibit features of metabolic syndrome, wherein insulin resistance plays a pivotal pathophysiological role in predisposing to cardiovascular disease. Persistent hyperglycemia promotes nonenzymatic glycation of hemoglobin, leading to the formation of glycated hemoglobin (HbA1c), which serves as a reliable biomarker for long-term glycemic control over approximately 8–12 weeks. Elevated HbA1c levels have been implicated in endothelial dysfunction, impaired vasoreactivity, and increased cardiovascular risk. Additionally, glycation-induced structural modifications in hemoglobin and associated increases in erythrocyte cytoplasmic viscosity contribute to altered red blood cell deformability and hemorheological properties. These alterations may be reflected in hematological indices, including hemoglobin concentration, red blood cell count, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration. Consequently, assessment of red cell indices, in conjunction with HbA1c, may provide valuable insights into the progression of diabetes and its associated microvascular complications.

MATERIALS AND METHODS

Study Design and Setting

This was a cross-sectional, hospital-based observational study conducted in the Department of Pathology, Clinical Pathology Central Laboratory, Sri Venkateswara Ramnarayan Ruia Government General Hospital (SVRRGGH), Tirupati, Andhra Pradesh. The study was carried out over a period of six months following approval from the Institutional Scientific and Ethics Committee. All procedures were performed in accordance with institutional ethical standards and with informed consent from participants.

Study Population

The study included people with age groups of 21-80 years among which most of them are diagnosed as type 2 diabetics by HbA1c (glycated hemoglobin) method .A total of 120 subjects were participated in the study out of which ,people with type 2 diabetes have showed the alterations in hematological parameters and inflammatory markers.

Inclusion and Exclusion Criteria

Patients who are already diagnosed with Type 2 Diabetes Mellitus with in 5 years and is on regular monitoring were included.

• Diabetic Patients with inflammatory disorders ,other comorbidities and Type -1 diabetics and Inadequate blood samples were excluded.

Data and Sample Collection

Venous blood samples were collected aseptically in two vacutainers — one containing ethylenediaminetetraacetic acid (EDTA) for hematological analysis and HbA1C measurement. . All samples were processed in the central laboratory under standard biosafety conditions.

Laboratory Investigations

Complete Blood Count was performed using Erba Elite H580 Five part Hematology Analyzer.
HbA1C was measured using Transasia XL640 .
ESR was done using Westergren tube.

Morbidity Assessment

Morbidity in this study was assessed indirectly through hematological alterations associated with Type 2 Diabetes Mellitus, reflecting underlying inflammation and metabolic imbalance. Inflammatory Markers increased indicate chronic low-grade inflammation, a hallmark of T2DM. Elevated NLR and PLR suggest increased cardiovascular and metabolic risk.Reduced PNR may reflect platelet activation and altered immune response.

Statistical Analysis

The statistical methods used in the study include Unpaired t-test for comparison of normally distributed variables .Mann–Whitney U test for non-normally distributed data.One-way ANOVA to compare parameters across three groups (Group 1, 2, 3).Pearson Correlation Test to assess relationship between hematological parameters and HbA1c.Multivariate Analysis to evaluate association of baseline variables and comorbidities. A p-value of < 0.05 considered statistically significant.

RESULTS

• In this study, a total of 120 subjects were included, out of which 60 were non-diabetic healthy subjects (group 1) with their age ranging from 21-43 years and 60 were type-2 diabetic subjects with their age ranging from 22-79 years . • The diabetic subjects were divided into 2 groups, one with HbA1c$\leq$7(group 2) and other with HbA1c>7(group 3).

The majority of the subjects among all the groups were males.

TABLE : 1 – COMPARSION OF PATIENT DEMOGRAPHICS BASED ON HBA1C VALUES:

Age in years	Group -1 (Non – Diabetics)		Group-2 (HbA1C≤7)		Group-3 (HbA1C≥7)		Total
	Male	Female	Male	Female	Male	Female	
21-30	16	10	2	2	-	-	30
31-40	18	10	4	2	6	-	40
41-50	2	4	2	2	8	6	24
51-60	-	-	-	-	6	6	12
61-70	-	-	-	-	10	2	12
71-80	-	-	-	-	-	2	2

In this study there was a significant age group of 21-40 years with non diabetes,where as 41-70 years age group came under group-3 (HbA1c>7).

TABLE-2: COMPARISION OF HEMATOLOGICAL PARAMETERS IN GROUP-1 (NON-DIABETICS) VS GROUP-2(DIABETICS WITH HbA1C≤7)

Parameters	GROUP-1 (NON-DIABETICS)	GROUP-2(DIABETICS WITH HbA1C≤7)	P-Value
RBC	4.513	4.77	0.2285
MCV	81.68	82.94	0.0290
WBC	8843	11495	<0.0001
MPV	9.30	9.45	0.9846
NLR	2.03	6.66	0.0012
PNR	62.28	50.11	<0.0001
PLR	111.19	159.8	<0.0001
ESR	28.5	41.42	<0.0001

In this study , there was significant increase in mean MCV, WBC Count, NLR, PLR and ESR values in group-2(HbA1c) when compared to non-diabetics.

Mean PNR value was significantly decreased in group-2(HbA1c) when compared to non- diabetics.

TABLE-3: COMPARISION OF HEMATOLOGICAL PARAMETERS IN GROUP-1 (NON-DIABETICS) VS GROUP-3 (DIABETICS WITH HbA1C≥7)

Parameters	GROUP-1 (NON-DIABETICS)	GROUP-2(DIABETICS WITH HbA1C≤7)	P-Value
RBC	4.513	4.56	0.3042
MCV	81.68	86.15	0.0159
WBC	8843	11298	<0.0001
MPV	9.30	9.1	0.5755
NLR	2.03	5.69	0.0002
PNR	62.28	53.9	<0.0001
PLR	111.19	164.64	<0.0001
ESR	28.5	53.22	<0.0001

In this study , there was significant increase in mean MCV, WBC Count, NLR,PLR and ESR values in group-3(HbA1c>7) when compared to Non- Diabetics. • Mean PNR value was significantly decreased in group-3(HbA1c>7) when compared to Non- Diabetics.

TABLE-4: COMPARISION OF HEMATOLOGICAL PARAMETERS IN GROUP-2(DIABETICS WITH HbA1C≤7) VS GROUP-3 (DIABETICS WITH HbA1C≥7)

Parameters	GROUP-2 (DIABETICS WITH HbA1C≤7)	GROUP-3(DIABETICS WITH HbA1C≥7)	P-Value
RBC	4.77	4.56	0.4404
MCV	82.94	86.15	0.0001
WBC	11495	11298	0.6574
MPV	9.45	9.1	0.5504
NLR	6.66	5.69	0.9932

PNR	50.11	53.9	0.7104
PLR	159.8	164.64	0.0454
ESR	41.42	53.22	<0.0001

In this study , there was **significant increase in mean MCV,PLR and ESR** values in group-3(HbA1c>7) when compared to group-2(HbA1c≤7). • There was a decrease in Mean RBC Count, WBC Count, NLR and MPV values in group-3(HbA1c>7) when compared to group -2(HbA1c≤7). But they were not stastically significant.

DISCUSSION

This study demonstrates that Type 2 Diabetes Mellitus (T2DM) is associated with significant alterations in hematological indices, reflecting the interaction between chronic hyperglycemia and systemic inflammation. The observed elevation in WBC count, NLR, PLR, and ESR among diabetic patients supports the presence of a persistent low-grade inflammatory state in T2DM (2). The present study demonstrated a significant reduction in hemoglobin levels among diabetic patients. This decrease may be attributed to chronic hyperglycemia, which promotes non-enzymatic glycation of hemoglobin and red blood cell (RBC) membrane proteins, ultimately impairing RBC deformability and shortening their lifespan. Persistent hyperglycemia also induces oxidative stress and alters erythrocyte metabolism, further contributing to reduced RBC survival along with diminished erythropoietin production and the suppressive effects of chronic inflammation on bone marrow activity, may contribute to anemia.(4-7).

A significant increase in total leukocyte count was observed, indicating the presence of a chronic low-grade inflammatory state in diabetic patients. Hyperglycemia stimulates the release of pro-inflammatory cytokines such as interleukin-6 and tumor necrosis factor-alpha, which in turn enhance leukocyte proliferation and activation. The observed neutrophilia further supports this inflammatory response, as neutrophils play a central role in innate immunity and are rapidly mobilized under metabolic stress conditions. Elevated leukocyte counts have been shown to correlate with insulin resistance and impaired glucose metabolism, highlighting their role as markers of systemic inflammation and predictors of disease progression(8).

Our study showed no marked significance in MPV ,where as elevated MPV is seen with previous studies by Kodiatte et al(1), Demirtunc et al(9), Hekimsoy et al (10). Nutitional anemia leads to reactive thrombocytosis and elevation of MPV in diabetics.MPV is a parameter used to assess platelet size and it is a potential biomarker of platelet reactivity.Major source of energy for platelets is glucose. In DM, due to chronic hyperglycemia, platelets are overwhelmed with glucose and subjected to synthesis of glycogen contributing to increase in MPV. Osmotic swelling of the platelets leads to increase in MPV• MPV also depends upon the platelet granule content, number of glycoprotein molecules on platelet membrane and thromboxane synthesizing capacity. [11] Also seen decreased MPV with studies done by joshi AA et al (12) as the study was based in a rural population, where anaemia is common. Factors like prevalence of iron deficiency anaemia, medication, duration of diabetes, may influence the results of MPV.

Among these parameters, NLR emerged as a consistent marker, showing elevation across both glycemic groups. This observation is in agreement with previous studies by Shiny et al. (13) and Bhat et al. (14), which demonstrated a positive association between NLR and glycemic status. Furthermore, Chandrashekara et al. (15) reported that elevated NLR correlates with diabetic complications, reinforcing its role as a reliable inflammatory biomarker. Decreased NLR has been seen with previous studies by Cameron et al (16) due to anti- inflammatory effect of metformin that reduces the inflammation taken by cases. Chronic hyperglycemia causes Advanced Glycation End Products (AGEs) that increase cytokine release ,Oxidative Stress that increases Reactive oxygen species , Polyol Pathway Activation leads to NADPH depletion causes oxidative damage . All favors toward increased neutrophil activation . Cortisol, inflammatory cytokines like TNF-α and insulin resistance leads to decreased lymphocyte proliferation .All these together causes increased NLR production in diabetics(17).

Platelet-related indices also showed significant alterations, with increased PLR and decreased PNR, suggesting enhanced platelet activation and inflammatory dysregulation in T2DM. These findings are comparable to those reported by Sefil et al. (18). However, Verdoia et al. (19) observed no significant variation in PLR, indicating possible heterogeneity due to population differences and study design. In contrast, MPV did not show significant variation in the present study, which is consistent with findings by Jindal et al. (20), suggesting limited sensitivity of MPV as an inflammatory marker.

Red cell parameters revealed a significant increase in MCV, particularly in patients with poor glycemic control. This may be attributed to oxidative stress, altered erythrocyte membrane stability, and metabolic disturbances associated with chronic hyperglycemia (21). Similar findings were reported by Alebiosu et al. (22), who demonstrated increased MCV in diabetics in relation to glycemic control. Where as Ziaee et al(23) observed no significant difference in MCV between diabetic and prediabetic individuals. Decreased MCV levels were observed by Hardikar et al.(24) due to underlying iron deficiency anemia which may alters the HbA1c levels.

Importantly, worsening glycemic control was associated with further increases in MCV, PLR, and ESR, highlighting the relationship between hyperglycemia and inflammatory burden. However, the absence of statistically significant differences in certain parameters between diabetic subgroups suggests that some hematological changes may occur early and stabilize over time. Overall, these findings emphasize that CBC-derived indices, particularly NLR and PLR, are simple, cost-effective, and reproducible markers of inflammation in T2DM, with potential utility in routine clinical practice.

CONCLUSION

T2DM is associated with significant hematological alterations indicative of systemic inflammation. Elevated WBC count, NLR, PLR, and ESR, along with decreased PNR and increased MCV, were observed in diabetic patients, with more pronounced changes in those with poor glycemic control. Moreover, elevated NLR and PLR have been associated with the development of diabetic complications including nephropathy, retinopathy, and cardiovascular disease, thereby underscoring their prognostic significance as cost-effective and easily accessible biomarkers.

Further large-scale prospective studies are required to validate their prognostic significance and clinical applicability.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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Authors' Contributions

M Prashanth: concept and design of the study, acquisition of data, statistical analysis, drafting of the manuscript. C Sushma: concept and design, interpretation of data, critical revision of the manuscript. V Poojita Ram : laboratory supervision, interpretation of data, critical revision of the manuscript. M Bharati Sree: interpretation of data, critical revision of the manuscript. All authors read and approved the final version of the manuscript to be published.

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