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Study of Neutrophil to Lymphocyte ratio and platelet to Lymphocyte ratio in Hypertensive and Normotensives

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ABSTRACT

Background and Aim:
Long-standing hypertension leads to the development of atherothrombotic disease and represents a major global healthcare burden. Platelets and neutrophils play a crucial role in cardiovascular (CV) events and the pathogenesis of atherothrombosis. Recently, the Neutrophil-to-Lymphocyte Ratio (NLR) and Platelet-to-Lymphocyte Ratio (PLR), derived from routine differential blood counts, have been proposed as novel systemic inflammation-based markers for predicting thrombotic events. The present study aimed to evaluate the association of NLR and PLR with hypertension and their potential role as indicators of cardiovascular risk. **Methods:** This cross-sectional study included 40 hypertensive patients aged 40–60 years (both males and females) with a history of hypertension for more than one year or those on antihypertensive therapy, with systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg. The control group consisted of 40 age- and socioeconomically matched normotensive individuals with SBP <140 mmHg and DBP <90 mmHg. Detailed clinical history and physiological parameters were recorded. Blood pressure was measured using the auscultatory method with a sphygmomanometer. Under aseptic precautions, 3 mL of venous blood was collected and analyzed. **Results:** The Neutrophil-to-Lymphocyte Ratio (NLR) was significantly higher in the hypertensive group compared to controls ($p < 0.01$). Although the Platelet-to-Lymphocyte Ratio (PLR) was higher in hypertensive patients, the difference was not statistically significant ($p > 0.05$). **Conclusion:** Hypertensive individuals with elevated NLR may have a higher risk of developing atherothrombotic and atherosclerotic events. NLR can serve as a simple and cost-effective marker for assessing cardiovascular risk in hypertensive patients.

Keywords: Hypertension, Neutrophils, Lymphocytes, Platelets, NLR, PLR

Introduction

Hypertension (HT) is a well-established risk factor for cardiovascular disease.[1] Blood pressure (BP) is a dynamic and continuous variable that fluctuates throughout the day in response to autonomic, humoral, mechanical, myogenic, and environmental stimuli.[2] During sleep, a physiological decline in BP, known as the "nocturnal dip," is expected. A reduction of more than 10% is considered normal, and such individuals are termed "dippers," whereas those with a reduction of less than 10% are classified as "non-dippers."[3]

Alterations in BP variability have been associated with hypertensive target organ damage and an increased risk of cardiovascular events.[4] The exact pathophysiological mechanisms linking BP variability to vascular disease remain unclear; however, it has been suggested that increased BP variability may promote endothelial dysfunction, enhance cytokine expression, and trigger inflammatory processes.[5] Several inflammatory markers, including red cell distribution width (RDW), high-sensitivity C-reactive protein (hs-CRP), and mean platelet volume (MPV), have been found to correlate with BP variability in hypertensive patients.[6]

The total white blood cell (WBC) count and its subtypes—particularly neutrophils and lymphocytes—are widely recognized indicators of systemic inflammation. The neutrophil-to-lymphocyte ratio (NLR), derived from a routine complete blood count, is an inexpensive, easily accessible, and reliable inflammatory marker.[6] NLR has demonstrated prognostic significance in cardiovascular diseases and heart failure.[7] However, there is limited evidence regarding its relationship with BP variability in both hypertensive and normotensive individuals.

Long-standing hypertension contributes to the development of atherothrombotic disease, which represents a major global health burden and accounts for more than 25% of all deaths worldwide.[8] Atherothrombotic events, such as acute myocardial infarction and ischemic stroke, occur due to thrombus formation in coronary or cerebral circulation and are leading causes of morbidity and mortality, particularly in developing countries.

Platelets and neutrophils play a critical role in the pathogenesis of cardiovascular events and atherothrombosis.[9] Recently, the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) have emerged as novel systemic inflammation-based markers for predicting thrombotic events.[6] NLR reflects the balance between inflammation and physiological stress, whereas PLR indicates platelet activation, coagulation status, endothelial dysfunction, and local vascular inflammation. As ratios, NLR and PLR are relatively more stable than individual hematological parameters, which may be influenced by various physiological and pathological factors.[9,10] Therefore, the present study was undertaken to evaluate the association of NLR and PLR with hypertension and to assess their potential role as indicators of cardiovascular risk.

Materials and Methods

Study Design and Ethical Approval:
This cross-sectional study was conducted after obtaining approval from the Institutional Ethics Committee of Chandulal Chandrakar Memorial Medical College, Kachandur, Durg, CG. Written informed consent was obtained from all participants prior to inclusion in the study.

Study Population:
A total of 80 participants aged 40–60 years were enrolled and divided into two groups. The study group included 40 hypertensive patients (both males and females) with previously diagnosed hypertension of more than one year duration or those receiving antihypertensive treatment, with systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg. Participants were recruited from the outpatient Department of Department of Physiology, Chandulal Chandrakar Memorial Medical College, Kachandur, Durg, CG**.** The control group comprised 40 age- and socioeconomically matched normotensive individuals with SBP <140 mmHg and DBP <90 mmHg.

Exclusion Criteria:
Participants with comorbid systemic diseases such as diabetes mellitus, tuberculosis, rheumatoid arthritis, osteoarthritis, systemic lupus erythematosus, or other chronic inflammatory conditions were excluded. Additionally, individuals with hematological disorders, those undergoing chemotherapy or receiving medications affecting white blood cell counts, recent acute infections (within the past 6 months), acute coronary syndrome, recent glucocorticoid therapy (within the past 3 months), and those with a history of heart failure, chronic kidney disease, liver disease, or cerebrovascular disease were excluded.[11]

Data Collection and Measurements:
A detailed clinical history was obtained from all participants. Anthropometric measurements including height and weight were recorded, and body mass index (BMI) was calculated. Pulse rate and blood pressure were measured using a standard mercury sphygmomanometer by the auscultatory method. Measurements were taken in the sitting position after 5 minutes of rest in both arms, and the higher reading was used for analysis.

Laboratory Analysis:
Under aseptic precautions, 3 mL of venous blood was collected in EDTA vacutainers from the median cubital vein. Samples were analyzed using an automated hematology analyzer (ABX Micros 60) in the Department of Pathology, New Civil Hospital, Surat. Neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) were calculated from the differential leukocyte count.

Statistical Analysis:
Data were analyzed using SPSS software version 18.0. Continuous variables were expressed as mean ± standard deviation (SD). Comparisons between groups were performed using the unpaired Student's *t*-test. Pearson's correlation coefficient (*r*) was used to assess the relationship between blood pressure and hematological parameters (neutrophils, lymphocytes, platelets, NLR, and PLR) within the hypertensive group. A *p*-value <0.05 was considered statistically significant.

Results

The baseline characteristics of the study and control groups are presented in **Table 1**. There were no statistically significant differences between the two groups with respect to age, height, weight, and body mass index (BMI) ($p > 0.05$), indicating that the groups were comparable.

Hemodynamic parameters are shown in **Table 2**. Pulse rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure (PP), and mean arterial pressure (MAP) were significantly higher in the hypertensive group compared to the normotensive group (pulse: $p < 0.05$; all other parameters: $p < 0.01$).

As shown in **Table 3**, neutrophil, lymphocyte, and platelet counts were significantly higher in hypertensive patients compared to controls (neutrophils: $p < 0.01$; lymphocytes: $p < 0.05$; platelets: $p < 0.01$).

The neutrophil-to-lymphocyte ratio (NLR) was significantly elevated in the hypertensive group compared to controls (**Table 4**, $p < 0.01$). Although the platelet-to-lymphocyte ratio (PLR) was higher in hypertensive individuals, the difference was not statistically significant ($p > 0.05$). Correlation analysis within the hypertensive group (**Table 5**) demonstrated that neutrophil counts showed a significant positive correlation with SBP, DBP, PP, and MAP ($p < 0.01$ for all). Lymphocyte counts also showed a significant positive correlation with SBP, DBP, PP, and MAP ($p < 0.01$ for all). Platelet counts were positively correlated with SBP and DBP ($p < 0.01$), PP ($p < 0.05$), and MAP ($p < 0.01$). Similarly, NLR showed a significant positive correlation with SBP and DBP ($p < 0.01$), and with PP and MAP ($p < 0.05$). PLR demonstrated a significant positive correlation with DBP and MAP ($p < 0.05$), but not with SBP or PP.

Table 1: Comparison of age, height, weight and BMI between study and control groups.

	Study group	**Control group**	P-value
Age	48.8±5.2	46.7±5.1	0.072
Height	152.7±10.8	150.2±10.5	0.297
Weight	71.1±6.4	69.6±6.4	0.298
BMI	29.9±3.1	29.5±3.1	0.566

Table 2: Pulse, systolic blood pressure, diastolic blood pressure, pulse pressure, mean arterial pressure in study and control groups

	Study group	**Control group**	P-value
Pulse	82.5±4.03	80.8±3.2	0.04
Systolic blood pressure	146.1±11.1	118.6±10.1	0.0001
Diastolic blood pressure	90.9±5.6	79.8±3.7	0.0001
Pulse Pressure (PP)	54.4±6.7	40.7±4.0	0.00001
Mean Arterial	110.1±5.4	89.1±3.2	0.0001

Pressure (MAP)			

Table 3: Neutrophil, lymphocyte and platelet counts in study and control groups.

		Control group	P-value
Neutrophil	5997.8±260.9	4418.9±260.4	0.0001
lymphocyte	2436.3±113.01	2227.8±120.9	0.0001
platelet	292250±48000	240825±58139	0.0001

Table 4: Neutrophil to Lymphocyte Ratio (NLR) and platelet to lymphocyte ratio (PLR) in study and control groups.

		Control group	P-value
NLR	2.6±0.4	1.9±0.5	0.0001
PLR	128.4±3.6	123.2±6.5	0.0001

Table 5: Correlation between systolic blood pressure, diastolic blood pressure, pulse pressure and mean arterial pressure with neutrophil, lymphocyte, platelets, NLR and PLR in study group.

		SBP	DBP	PP	MAP
Neutrophil	r	0.54	0.51	0.55	0.52
lymphocyte	r	0.34	0.32	0.41	0.47
platelet	r	0.46	0.44	0.35	0.48
NLR	r	0.49	0.43	0.33	0.36
PLR	r	0.31	0.38	0.21	0.37

Discussion

In the present study, 40 hypertensive and 40 normotensive subjects aged 40–60 years were evaluated to assess the association of neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) with hypertension and cardiovascular risk. Baseline characteristics, including age, height, weight, and body mass index (BMI), were comparable between the two groups, with no statistically significant differences observed. This comparability minimizes confounding and strengthens the validity of the observed associations.

Hemodynamic parameters, including pulse rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure (PP), and mean arterial pressure (MAP), were significantly higher in hypertensive individuals compared to normotensive controls. These findings are consistent with previous studies, such as that by Pusuroglu H et al., which demonstrated elevated SBP, DBP, and PP in hypertensive groups.[12]

Hypertension is increasingly recognized as a chronic low-grade inflammatory condition. White blood cell (WBC) indices, particularly neutrophils and lymphocytes, serve as markers of systemic inflammation.[13] In the present study, neutrophil and lymphocyte counts were significantly higher in hypertensive individuals, supporting the inflammatory basis of hypertension. Similar findings were reported by Tatsukawa

Y et al., who observed a significant association between elevated neutrophil counts and the incidence of hypertension, particularly among women.[14]

Platelets also play a crucial role in cardiovascular events by contributing to thrombus formation following endothelial injury or atherosclerotic plaque rupture.[15] Although some studies, such as that by Nadar S et al., reported altered platelet indices like increased mean platelet volume rather than platelet count, the present study demonstrated significantly higher platelet counts in hypertensive individuals, further emphasizing the prothrombotic state associated with hypertension.[16]

A key finding of this study was the significantly elevated NLR in hypertensive subjects. This is in agreement with previous studies by Park B et al., Sunbul M et al., and Pusuroglu H et al., which reported higher NLR levels in hypertensive and non-dipper hypertensive populations.[12,17,18] NLR reflects the balance between neutrophil-mediated inflammation and lymphocyte-mediated regulatory pathways and has been identified as a marker of chronic low-grade inflammation. Elevated NLR has also been associated with arterial stiffness, coronary artery disease, and increased cardiovascular mortality.[19,20]

Although PLR was higher in hypertensive individuals in the present study, the difference was not statistically significant. Previous studies have shown mixed results, with some reporting significantly elevated PLR in hypertensive patients, particularly in non-dipper hypertension.[18,22] PLR reflects platelet activation, endothelial dysfunction, and vascular inflammation, all of which contribute to atherothrombotic processes.[23]

Correlation analysis revealed significant positive associations between neutrophil counts, lymphocyte counts, platelet counts, and NLR with SBP, DBP, PP, and MAP. These findings are consistent with earlier studies demonstrating a relationship between inflammatory markers and blood pressure parameters.[12,24] PLR also showed a significant positive correlation with DBP and MAP. These correlations further support the role of inflammatory and hematological parameters in the pathophysiology of hypertension and its complications.

The clinical relevance of these findings lies in the simplicity and cost-effectiveness of these markers. NLR and PLR can be easily derived from routine complete blood count (CBC) tests and may serve as accessible tools for early risk stratification of cardiovascular events in hypertensive patients.[25,26]

Limitations:
The present study has certain limitations. The sample size was relatively small, and the cross-sectional design limits causal inference. Additionally, long-term follow-up and inclusion of other inflammatory markers could provide more comprehensive insights.

Conclusion

The present study demonstrates that hypertensive individuals have significantly higher neutrophil-to-lymphocyte ratio (NLR) and a trend toward higher platelet-to-

lymphocyte ratio (PLR) compared to normotensive controls. Elevated NLR shows a strong association with blood pressure parameters and may indicate an increased risk of atherothrombotic and atherosclerotic events. NLR is a simple, reliable, and cost-effective inflammatory marker that can be incorporated into routine clinical evaluation for early identification of cardiovascular risk in hypertensive patients. Although PLR showed a positive trend, further large-scale studies are required to establish its clinical significance. Future research with larger sample sizes and longitudinal follow-up is recommended to validate these findings and to explore the prognostic utility of NLR and PLR in hypertension-related cardiovascular outcomes.

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