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Research

A Prospective Study of Platelet to Lymphocyte Ratio in Short Term Mortality in Patients with Stroke

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Abstract

Background: Stroke is a major cause of mortality and long-term disability worldwide. Early identification of patients at high risk of adverse outcomes remains a clinical challenge. Inflammation and thrombosis play central roles in stroke pathophysiology. The platelet-to-lymphocyte ratio (PLR), an inexpensive inflammatory marker derived from routine blood counts, has emerged as a potential prognostic biomarker in cerebrovascular diseases.
Objective: To evaluate the association between platelet-to-lymphocyte ratio and short-term mortality in patients admitted with acute stroke.
Methods: This prospective observational study was conducted among patients diagnosed with stroke and admitted to a tertiary care hospital. Platelet and lymphocyte counts obtained at admission were used to calculate PLR. Clinical severity was assessed using the National Institutes of Health Stroke Scale (NIHSS) and functional outcomes were evaluated using the Modified Rankin Scale (mRS). Patients were followed for 30 days to assess short-term mortality. Statistical analysis was performed to determine the association between PLR, clinical severity and mortality outcomes.
Results: Higher PLR values at admission were significantly associated with increased short-term mortality. Elevated PLR showed a positive correlation with higher NIHSS scores and poorer functional outcomes as measured by mRS. Patients with elevated PLR demonstrated a higher risk of mortality within 30 days compared to those with lower PLR values.
Conclusion: Platelet-to-lymphocyte ratio is a simple, cost-effective and readily available biomarker that is significantly associated with short-

term mortality in stroke patients. Incorporation of PLR alongside established clinical scales such as NIHSS and mRS may improve early risk stratification and prognostic assessment, particularly in resource-limited settings.

Keywords: Stroke; Platelet to Lymphocyte Ratio; Inflammation; Prognosis; Mortality; National Institutes of Health Stroke Scale (NIHSS); Modified Rankin Scale

Introduction

Stroke is a leading cause of mortality and long-term disability worldwide and remains a major public health challenge despite advances in acute management and secondary prevention strategies [1]. The global burden of stroke continues to rise, particularly in low and middle income countries, where demographic transitions, increasing prevalence of vascular risk factors, and limited access to specialized stroke care contribute to poor outcomes [2, 3]. Acute ischemic stroke accounts for the majority of stroke cases and is associated with substantial early mortality and long-term functional impairment.

Early prognostication in acute stroke is essential for guiding clinical decision-making, optimizing resource allocation and counselling patients and caregivers. Clinical assessment tools such as the National Institutes of Health Stroke Scale (NIHSS) and the Modified Rankin Scale (mRS) are widely used to assess stroke severity and functional outcomes, respectively [4,13,14]. While these tools provide valuable clinical information, they do not fully capture the underlying biological processes that influence stroke progression and early mortality.

Inflammation and thrombosis play central roles in the pathophysiology of acute stroke. Cerebral ischemia triggers a complex cascade involving endothelial dysfunction, platelet activation, leukocyte recruitment, oxidative stress and the release of pro-inflammatory cytokines, all of which contribute to neuronal injury and secondary brain damage [5, 6]. These inflammatory mechanisms not only influence initial stroke severity but also affect short-term outcomes and survival.

Platelets are key mediators of thrombus formation and vascular inflammation. Activated platelets release inflammatory mediators and interact with leukocytes and endothelial cells, thereby amplifying ischemic injury [7]. In contrast, lymphocytes are involved in immune regulation and stroke-induced lymphopenia has been associated with increased stroke severity, susceptibility to infections and poorer clinical outcomes [8]. The balance between platelet activation and lymphocyte-mediated immune response may therefore provide important prognostic information.

The platelet-to-lymphocyte ratio (PLR), derived from routine complete blood count parameters, integrates these thrombotic and inflammatory pathways into a single, easily obtainable marker. PLR has emerged as a useful prognostic indicator in various cardiovascular and cerebra vascular disorders [9]. Several observational studies have reported an association between elevated PLR and adverse outcomes in patients with acute ischemic stroke, including increased stroke severity, poorer functional outcomes and higher mortality [10, 11, and 12]. Compared with other inflammatory biomarkers, PLR is inexpensive, widely available and easily reproducible, making it particularly attractive for use in routine clinical practice and resource-limited settings.

Despite growing interest in PLR as a prognostic biomarker, evidence from prospective studies evaluating its association with short-term mortality in stroke patients remains limited, particularly in Indian populations. Differences in demographic characteristics, comorbidity profiles and healthcare infrastructure highlight the need for region-specific data. Furthermore, standardized cutoff values for PLR and its integration with established clinical scales have not been clearly defined [15].

Therefore, the present prospective observational study was undertaken to evaluate the association between platelet-to-lymphocyte ratio at admission and short-term mortality in patients with acute stroke. Additionally, the study aimed to examine the relationship between PLR, stroke severity as assessed by NIHSS and functional outcomes measured using the Modified Rankin Scale.

Materials and Methods

This prospective observational study was conducted in the Department of General Medicine at a tertiary care teaching hospital in Hyderabad, Telangana, India. Patients admitted with a clinical diagnosis of stroke were consecutively enrolled during the study period. Stroke diagnosis was confirmed based on clinical features and neuroimaging findings using computed tomography or magnetic resonance imaging. Adult patients aged 18 years and above with available baseline laboratory data were included in the study. Patients with active infections, chronic inflammatory or autoimmune diseases, haematological disorders, malignancy, severe hepatic or renal dysfunction, or those receiving immunosuppressive therapy were excluded to minimize confounding effects on inflammatory markers.

Demographic details, clinical characteristics and vascular risk factors including age, gender, smoking status, alcohol consumption, hypertension, diabetes mellitus and dyslipidaemia were recorded using a standardized data collection form. Baseline vital parameters, laboratory investigations and lipid profiles were documented at the time of admission. Venous blood samples were collected prior to initiation of definitive therapy and complete blood count analysis was performed using an automated haematologyanalyser. The platelet-to-lymphocyte ratio (PLR) was calculated by dividing the absolute platelet count by the absolute lymphocyte count obtained from the same blood sample.

Stroke severity at presentation was assessed using the National Institutes of Health Stroke Scale (NIHSS), a validated tool for quantifying neurological impairment in acute stroke patients. Functional outcomes were evaluated using the Modified Rankin Scale (mRS) at the time of hospital discharge, with higher scores indicating greater functional disability. Patients were followed for a period of 30 days from the time of admission and short term mortality within this period was recorded as the primary outcome measure.

Statistical analysis was performed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, while categorical variables were presented as frequencies and percentages. Group comparisons were performed using Student's *t*-test or Mann–Whitney *U* test for continuous variables and chi-square test for categorical variables, as appropriate. Correlations between PLR and clinical severity scores were analysed using correlation coefficients. A *p*-value of less than 0.05 was considered statistically significant.

The study protocol was reviewed and approved by the Institutional Ethics Committee and written informed consent was obtained from all participants or their legally authorized representatives. All study procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Results

Study Population and Short-Term Outcomes

A total of 113 patients with acute stroke were included in the analysis. Of these, 104 patients (92.04%) survived, while 9 patients (7.96%) died within 30 days of hospital admission, indicating a relatively low short-term mortality rate in the study population.

Baseline Demographic and Clinical Characteristics

The majority of patients were aged ≥50 years, with the highest proportion observed in the 60–69 year age group (30.1%), followed by those aged ≥70 years (23.9%). Female patients constituted 52.2% of the cohort, while 47.8% were male.Common vascular risk factors included hypertension (60.2%), diabetes mellitus (55.8%), alcohol consumption (63.7%) and smoking (47.8%).

No statistically significant association was observed between age group, gender, smoking status, alcohol consumption, hypertension, or diabetes mellitus and short-term mortality ($p > 0.05$ for all).

Stroke Severity and Functional Outcomes

Based on the National Institutes of Health Stroke Scale (NIHSS) at admission, most patients presented with moderate (42.5%) or moderate–severe (42.5%) stroke severity, while 10.6% had severe stroke. Increasing NIHSS severity was significantly associated with mortality, with higher death rates observed in more severe categories (χ^2, $p = 0.0021$).

Functional outcomes assessed using the Modified Rankin Scale (mRS) at discharge showed that 46.9% of patients had moderate disability (mRS 3–4), while 10.6% had severe disability or death (mRS 5–6). Higher mRS scores were significantly associated with increased mortality (χ^2, $p = 0.0014$).

A weak but statistically significant positive correlation was observed between NIHSS and mRS scores (Spearman's $\varrho = 0.21$, $p = 0.0226$), indicating that greater stroke severity was associated with worse functional outcomes (Figure 3).

Blood Pressure, Lipid Profile and Hospital Stay

The mean systolic blood pressure was 146.55 mmHg and the mean diastolic blood pressure was 89.29 mmHg. Most patients had lipid parameters within normal ranges, including total cholesterol (88.5%), LDL cholesterol (60.2%), HDL cholesterol (80.5%) and triglycerides (92.9%).The mean duration of hospital stay was 10.79 ± 3.97 days.

None of these parameters showed a statistically significant association with short-term mortality ($p > 0.05$).

Platelet-to-Lymphocyte Ratio (PLR) and Short-Term Mortality

PLR values ranged from 67.30 to 496.89, with a mean of 200.72 ± 101.63. The distribution of PLR was non-normal (Shapiro–Wilk test, $p < 0.0001$) and demonstrated right skewness (Figure 1).

Patients who died within 30 days had significantly higher PLR values (337.52 ± 94.71) compared to survivors (188.88 ± 93.59). This difference was highly statistically significant (Mann–Whitney U = 119.00, $p = 0.0002$) (Figure 2).

Key Finding

Among all variables analysed, PLR, NIHSS and mRS showed a significant association with short-term mortality, whereas demographic factors, comorbidities, blood pressure and lipid parameters did not.

Table 1. Baseline Demographic and Clinical Characteristics of Stroke Patients (n = 113)

Variable	n (%)
Age group (years)	
<40	6 (5.3)
40–49	24 (21.2)
50–59	22 (19.5)
60–69	34 (30.1)
≥70	27 (23.9)
Gender	
Female	59 (52.2)
Male	54 (47.8)
Smoking	54 (47.8)
Alcohol consumption	72 (63.7)
Diabetes mellitus	63 (55.8)
Hypertension	68 (60.2)

Table 2. Stroke Severity, Functional Outcome and Hospital Stay

Parameter	n (%) / Mean ± SD
NIHSS severity	
Minor (1–4)	5 (4.4)
Moderate (5–15)	48 (42.5)
Moderate–Severe (16–20)	48 (42.5)
Severe (21–42)	12 (10.6)
Modified Rankin Scale (mRS) at discharge	
mRS 0–2 (mild)	48 (42.5)
mRS 3–4 (moderate)	53 (46.9)
mRS 5–6 (severe/death)	12 (10.6)
Hospital stay (days)	10.79 ± 3.97

Table 3. Blood Pressure and Lipid Profile of Study Population

Parameter	Value
Systolic BP (mmHg)	146.55 ± 20.19
Diastolic BP (mmHg)	89.29 ± 10.53
Total cholesterol (normal)	100 (88.5%)
LDL cholesterol (normal)	68 (60.2%)
HDL cholesterol (normal)	91 (80.5%)
Triglycerides (normal)	105 (92.9%)

Table 4. Platelet-to-Lymphocyte Ratio (PLR) and Short-Term Mortality

Variable	Survived (n = 104)	Died (n = 9)	p-value
PLR (mean ± SD)	188.88 ± 93.59	337.52 ± 94.71	**0.0002***
30-day mortality	104 (92.0%)	9 (8.0%)	—

* Mann–Whitney U test

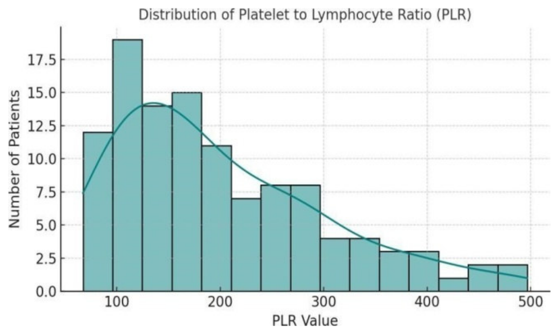

Fig 1: Distribution of Platelet-to-Lymphocyte Ratio (PLR) Among Stroke Patients

Histogram showing the distribution of platelet-to-lymphocyte ratio (PLR) values in the study population. PLR values demonstrated a right-skewed distribution, indicating variability in systemic inflammatory response among patients admitted with stroke.

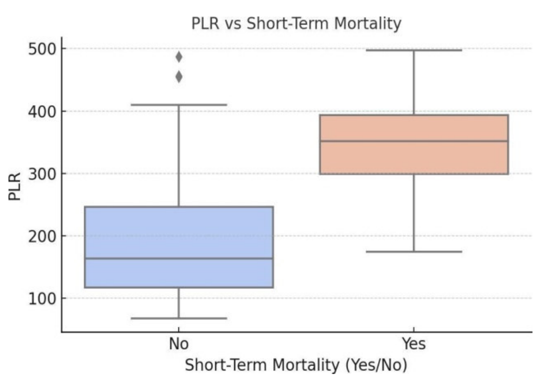

Fig 2: Comparison of Platelet-to-Lymphocyte Ratio According to Short-Term Mortality

Box-and-whisker plot comparing PLR values between patients who survived and those who died within 30 days of stroke onset. Patients who experienced short-term mortality had significantly higher PLR values compared to survivors (Mann–Whitney U test, $p = 0.0002$).

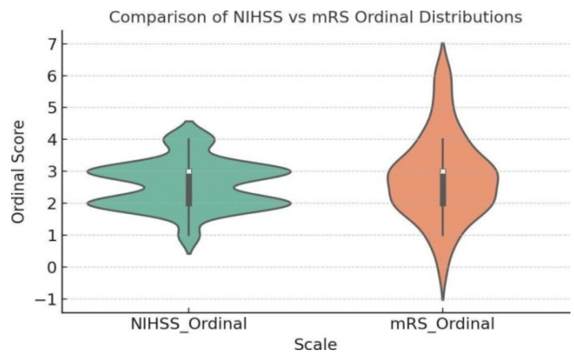

Fig 3:. Comparison of NIH Stroke Scale (NIHSS) and Modified Rankin Scale (mRS) Ordinal Distributions

Violin plots illustrating the ordinal distribution of NIHSS scores at admission and mRS scores at discharge. A statistically significant positive correlation was observed between NIHSS and mRS scores, indicating that greater stroke severity was associated with worse functional outcomes (Spearman's ϱ = 0.21, $p = 0.0226$).

Discussion

The present prospective observational study evaluated the prognostic significance of the platelet-to-lymphocyte ratio in patients admitted with acute stroke and demonstrated that elevated PLR at admission was significantly associated with short-term mortality. Among the various demographic, clinical, and laboratory parameters analysed, PLR emerged as one of the strongest predictors of early mortality, alongside established clinical severity measures such as the NIH Stroke Scale and Modified Rankin Scale.

Inflammation plays a critical role in the pathophysiology of acute stroke, influencing infarct progression, secondary brain injury and systemic complications. Platelets contribute to thrombus formation, endothelial activation and release of pro-inflammatory mediators, whereas lymphocytes reflect immune regulation and stress-induced immunosuppression following cerebral ischemia. An elevated PLR therefore represents a combined marker of heightened thrombotic activity and inflammatory burden, which may explain its strong association with adverse outcomes observed in this study.

The significant difference in PLR values between survivors and non-survivors highlights its potential utility as an early prognostic biomarker. Patients who died within 30 days had markedly higher PLR levels compared to survivors, supporting the hypothesis that an exaggerated inflammatory response is linked to poorer short-term outcomes. The non-normal, right-skewed distribution of PLR further emphasizes the heterogeneity of inflammatory responses among stroke patients and supports the use of non-parametric statistical methods for its analysis.

Stroke severity, assessed using the NIHSS, showed a strong association with mortality, consistent with existing literature. Patients with higher NIHSS scores experienced higher short-term mortality, reaffirming the importance of early neurological assessment in risk stratification. Functional outcomes measured by the mRS at discharge were also significantly associated with mortality, underscoring the prognostic value of functional disability in predicting early survival. The observed positive correlation between NIHSS and mRSscores indicates that greater initial neurological impairment generally translates into worse functional outcomes, although the modest strength of this correlation suggests that additional biological and clinical factors influence recovery.

In contrast, demographic variables such as age and gender, lifestyle factors including smoking and alcohol consumption and comorbidities such as diabetes mellitus and hypertension did not show statistically significant associations with short-term mortality in this cohort. Similarly, blood pressure parameters and lipid profile measures were not significantly related to early mortality. These findings suggest that while traditional vascular risk factors are important in stroke occurrence, they may be less predictive of short-term survival once an acute stroke has occurred, particularly in the presence of strong indicators of disease severity and systemic inflammation.

The findings of this study have important clinical implications. PLR is an inexpensive, easily accessible marker derived from routine complete blood counts and can be calculated at the time of admission without additional cost or testing. Incorporating PLR into early assessment protocols, alongside established clinical scales such as NIHSS, may enhance risk stratification and help identify patients at higher risk of early mortality who may benefit from closer monitoring and more aggressive management.

Strengths and Limitations

Strengths

This study has several important strengths. The prospective observational design allowed for systematic data collection and minimized recall bias. Standardized and validated clinical assessment tools, including the National Institutes of Health Stroke Scale (NIHSS) and the Modified Rankin Scale (mRS), were used to evaluate stroke severity and functional outcomes, enhancing the reliability of clinical measurements.

The use of the platelet-to-lymphocyte ratio, derived from routine complete blood counts, represents a practical and cost-effective approach that is readily applicable in everyday clinical practice, particularly in resource-limited settings. Additionally, the study evaluated short-term mortality, a clinically meaningful outcome that reflects the effectiveness of acute stroke management.

The consistency observed between elevated PLR, higher stroke severity, worse functional outcomes and increased mortality strengthens the biological plausibility of the findings and supports the role of PLR as a potential prognostic biomarker in acute stroke.

Limitations

Despite its strengths, the study has certain limitations that should be acknowledged. The study was conducted at a single tertiary care center with a moderate sample size, which may limit the generalizability of the findings to broader populations. The relatively small number of mortality events may have reduced the statistical power to detect associations with some clinical and demographic variables.

Inflammatory markers, including PLR, were measured only at admission and serial measurements were not performed; therefore, temporal changes in inflammatory status could not be assessed. Additionally, although several clinical and laboratory variables were analysed, multivariate regression analysis was not performed to adjust for potential confounders.

Finally, long-term outcomes beyond 30 days were not evaluated and the findings are limited to short-term mortality. Future multicentre studies with larger sample sizes, longer follow-up periods and adjusted analytical models are needed to confirm these results and establish standardized PLR cutoff values for clinical use.

Conclusion

This prospective observational study demonstrates that an elevated platelet-to-lymphocyte ratio at admission is significantly associated with short-term mortality in patients with acute stroke. PLR showed a strong relationship with established indicators of disease severity and functional outcome, including the NIH Stroke Scale and Modified Rankin Scale. In contrast, traditional demographic factors, comorbidities, blood pressure parameters and lipid profiles were not significantly associated with early mortality.

Given its simplicity, low cost and wide availability, PLR may serve as a valuable adjunct to existing clinical assessment tools for early risk stratification in stroke patients. Incorporation of PLR into routine evaluation at admission could help identify high-risk individuals who may benefit from intensified monitoring and management. Further large-scale, multicentre studies are required to validate these findings and to define standardized PLR cutoff values for clinical application.

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Conflicts of Interest
None declared.

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