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Association of Red Cell Distribution Width with Major Adverse Cardiac Events in Non–ST Elevation Acute Coronary Syndrome

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ABSTRACT

Introduction: Red cell distribution width (RDW), routinely reported in the complete blood count, reflects erythrocyte size variability. Although traditionally used in anemia evaluation, elevated RDW has been increasingly linked to cardiovascular morbidity, heart failure, and mortality. Proposed mechanisms include chronic inflammation, oxidative stress, impaired erythropoiesis, and reduced red cell deformability. Acute coronary syndrome (ACS) without ST-segment elevation—comprising unstable angina (UA) and non–ST-elevation myocardial infarction (NSTEMI)—is a major cause of cardiovascular disease, making early risk assessment essential. RDW has emerged as a simple and widely accessible prognostic marker in ACS. This study assesses the prognostic significance of RDW in UA and NSTEMI. **Methodology:** A hospital-based cross-sectional study was conducted over 18 months among adults diagnosed with UA or NSTEMI. Patients with anemia, chronic kidney disease, malignancy, hemoglobinopathies, COPD, pregnancy, recent transfusion, or STEMI were excluded. RDW and clinical parameters were recorded at admission, and patients were categorized into increased (>14%) and normal RDW groups. All participants were monitored for major adverse cardiac events (MACE), including heart failure, arrhythmias, cardiogenic shock, and in-hospital mortality. Chi-square tests were applied, with significance set at $p < 0.05$. **Results:** Of the 260 patients enrolled, 58.1% had elevated RDW. MACE occurred in 20.4% of the study population, with significantly higher prevalence among those with increased RDW (71.7% vs. 28.3%, $p = 0.024$). Elevated RDW was strongly associated with diabetes ($p < 0.001$) and showed borderline significance with hypertension ($p = 0.05$). **Conclusion**: RDW is an inexpensive and effective prognostic indicator in UA/NSTEMI, showing significant associations with adverse outcomes and cardiovascular risk factors. Its routine use may improve early risk stratification and clinical decision-making.

Keywords: Red cell distribution width, Unstable angina, NSTEMI, Prognostic marker, Major adverse cardiac events.

INTRODUCTION:

Red cell distribution width (RDW), a routinely reported parameter in the complete blood count, reflects the degree of anisocytosis and variability in erythrocyte size. Although traditionally used in the differential diagnosis of anemia, emerging evidence suggests that RDW is closely linked to cardiovascular morbidity and mortality. Several large cohort studies have demonstrated that elevated RDW is associated with increased risk of heart failure, incident coronary artery disease, and all-cause mortality, independent of hemoglobin levels and other hematological indices.[1–3] The underlying mechanisms linking RDW to adverse cardiovascular outcomes may involve chronic inflammation, oxidative stress, impaired erythropoiesis, and reduced red cell deformability, all of which can contribute to endothelial dysfunction and a pro-atherothrombotic state.[4,5]

Acute coronary syndrome (ACS) without ST-segment elevation—comprising unstable angina (UA) and non–ST-elevation myocardial infarction (NSTEMI)—remains a major contributor to global cardiovascular morbidity. These conditions are primarily caused by plaque rupture or erosion, leading to partial coronary obstruction and myocardial ischemia.[6] Despite advances in prompt diagnosis and management, risk stratification of UA/NSTEMI patients continues to be crucial for predicting in-hospital complications such as heart failure, arrhythmias, cardiogenic shock, and mortality. Biomarkers that are inexpensive, widely available, and easily reproducible are of particular interest in resource-limited settings. RDW, being part of a routine CBC, has gained attention as a potential prognostic biomarker in ACS. Studies have shown that elevated RDW at admission correlates with higher rates of major adverse cardiac events (MACE), including early mortality, recurrent ischemia, and heart failure in patients with ACS.[7–9]

Given the rising burden of coronary artery disease in developing countries and limitations associated with conventional biomarkers, evaluating the prognostic relevance of RDW in UA and NSTEMI may provide additional clinically meaningful information. This study aims to assess the association between RDW and clinical outcomes in patients presenting with UA and NSTEMI and determine its utility in predicting major adverse cardiac events during hospitalization.

MATERIALS & METHODS:

This was a hospital-based observational cross-sectional study conducted over a period of 18 months among patients admitted with acute coronary syndrome (ACS) without ST-segment elevation at a tertiary care centre. Consecutive patients diagnosed with unstable angina (UA) or non–ST-elevation myocardial infarction (NSTEMI) based on the Joint European Society of Cardiology/American Heart Association/World Heart Federation criteria were screened for eligibility. Patients aged ≥18 years who provided written informed consent were included. Those with anemia (hemoglobin <11 g/dL), chronic kidney disease, malignancy, hemoglobinopathies, cardiomyopathies, chronic obstructive pulmonary disease, pregnancy, recent blood transfusion, or acute STEMI were excluded to avoid confounding effects on red cell indices.

For each participant, demographic data, clinical history, and cardiovascular risk factors—including diabetes mellitus, hypertension, and smoking status—were recorded. Blood samples were collected at admission to determine red cell distribution width (RDW), cardiac biomarkers (troponin T/I, CPK-MB), fasting glucose, and other routine biochemical parameters. RDW was measured using an automated hematology analyzer, and a value >14% was considered elevated. Patients were categorized into two groups: increased RDW and normal RDW. Blood pressure was measured using a standard sphygmomanometer, and diabetes mellitus was diagnosed according to American Diabetes Association criteria. All patients underwent serial ECG monitoring every 12 hours, and 2D echocardiography was performed after clinical stabilization.

Patients were followed prospectively during their hospital stay for the development of major adverse cardiac events (MACE), defined as any occurrence of congestive heart failure, arrhythmias, cardiogenic shock, or in-hospital mortality. Management decisions—including the use of anti-ischemic therapy, antiplatelet agents, anticoagulants, and invasive interventions—were at the discretion of the treating physician, in accordance with standard ACS guidelines. Statistical analyses were performed using appropriate tests, including chi-square test for categorical variables and $p < 0.05$ was considered statistically significant.

RESULTS:

A total of 260 eligible patients with unstable angina or NSTEMI were enrolled, and their demographic, clinical, and laboratory profiles were evaluated to assess RDW distribution and its relationship with cardiovascular risk factors and in-hospital outcomes. Based on RDW values, participants were classified into normal and increased RDW groups, and the occurrence of major adverse cardiac events (MACE)—including heart failure, arrhythmias, cardiogenic shock, and mortality—was recorded during hospitalization.

Table 1. Baseline Demographic, Clinical, and Laboratory Characteristics of the Study Population (n=260)

		Frequency	**Percentage**
Gender	Male	121	46.5%
	Female	139	53.5%
Age	<40	4	1.5%
	41-50	70	26.9%
	51-60	83	31.9%
	61-70	71	27.3%
	>70	32	12.3%
RDW	Increased RDW	151	58.1%
	Normal RDW	109	41.9%
UA/NSTEMI	NSTEMI	142	54.6%
	Unstable Angina	118	45.4%
MACE	Congestive heart failure	23	8.8%
	Arrhythmia	15	5.8%
	Cardiogenic shock	12	4.6%
	Death	3	1.2%
	No major adverse cardiac event	207	79.6%

Diabetes	Yes	103	39.6%
	No	157	60.4%
Hypertension	Yes	151	58.1%
	No	109	41.9%

The cohort showed a slight female predominance (53.5%), and the majority were middle-aged to older adults, with most falling between 41 and 70 years of age. Elevated RDW was observed in 58.1% of patients. NSTEMI was marginally more common than unstable angina (54.6% vs. 45.4%). MACE occurred in 20.4% of individuals, with congestive heart failure being the most frequent complication. A substantial proportion had comorbidities, notably diabetes (39.6%) and hypertension (58.1%), highlighting a population with considerable underlying cardiovascular risk. Overall, the baseline characteristics reflect a clinically vulnerable group with a high burden of risk factors and a notable prevalence of RDW elevation. (Table 1)

Table 2. Distribution of RDW Levels Among Patients with NSTEMI and Unstable Angina

	Increased RDW		**Normal RDW**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**
NSTEMI	89	62.68%	53	37.32%	142	54.62%
UNSTABLE ANGINA	62	52.54%	56	47.46%	118	45.38%

Patients with NSTEMI showed a higher proportion of increased RDW (62.68%) compared to those with unstable angina (52.54%). Overall, elevated RDW was more common in NSTEMI cases, suggesting greater hematological variability in this subgroup. (Table 2)

Table 3. Association of Red Cell Distribution Width (RDW) with Demographic and Clinical Variables Among Patients with UA/NSTEMI (n = 260)

		Increased RDW		**Normal RDW**		**Total**		**Chi-square**	**p-value**
		n	**%**	**n**	**%**	**n**	**%**		
Age (years)	<40	4	100.0%	0	0.0%	4	1.5%	6.114	0.191
	41-50	37	52.9%	33	47.1%	70	26.9%		
	51-60	44	53.0%	39	47.0%	83	31.9%		
	61-70	45	63.4%	26	36.6%	71	27.3%		
	>70	21	65.6%	11	34.4%	32	12.3%		
Gender	Female	68	56.2%	53	43.8%	121	46.5%	6.328	0.567
	Male	83	59.7%	56	40.3%	139	53.5%		
MACE	Major adverse event	38	71.7%	15	28.3%	53	20.4%	5.073	0.024
	No MACE	113	54.6%	94	45.4%	207	79.6%		
Diabetes	Yes	80	77.7%	23	22.3%	103	39.6%	26.894	<.001
	No	71	45.2%	86	54.8%	157	60.4%		
Hypertension	Yes	80	53.0%	71	47.0%	151	58.1%	3.843	0.05
	No	71	65.1%	38	34.9%	109	41.9%		

Table 3 shows that RDW levels varied across age groups, with higher proportions of increased RDW observed in older patients, although the association was not statistically significant ($p = 0.191$). Gender distribution also did not differ significantly between RDW categories ($p = 0.567$). A significant association was noted between RDW and clinical outcomes: patients who experienced major adverse cardiac events (MACE) had a considerably higher prevalence of elevated RDW (71.7%) compared to those without MACE (54.6%) ($p = 0.024$). RDW was also strongly associated with diabetes, with 77.7% of diabetic patients showing increased RDW compared to 45.2% of non-diabetics ($p < 0.001$). Hypertension demonstrated a borderline significant relationship, with elevated RDW more common among hypertensive individuals (53.0%) than those without hypertension ($p = 0.05$). Overall, elevated RDW showed meaningful associations with adverse outcomes and key cardiovascular risk factors, underscoring its potential as a useful prognostic marker in UA/NSTEMI patients.

DISCUSSION:

In this study of 260 patients with unstable angina and NSTEMI, elevated RDW was observed in more than half of the study population and was significantly associated with adverse cardiovascular outcomes. Patients with increased RDW experienced higher rates of major adverse cardiac events (MACE), including heart failure, arrhythmias, cardiogenic shock, and mortality, compared with those having normal RDW values. These findings align with previous research demonstrating that RDW is a powerful and independent predictor of morbidity and mortality in acute coronary syndrome (ACS).[10,11]

Felker et al. reported that elevated RDW strongly correlated with adverse outcomes in heart failure populations, supporting the notion that RDW reflects underlying pathological processes relevant to cardiovascular disease.[2]
The strong association between elevated RDW and diabetes in our study highlights the interplay between metabolic dysregulation and hematological changes. Chronic hyperglycemia, oxidative stress, and low-grade inflammation seen in diabetes impair erythropoiesis and red cell survival, resulting in greater anisocytosis.[12] Similar results were reported by Lippi et al., who demonstrated that RDW correlates significantly with inflammatory markers such as C-reactive protein and erythrocyte sedimentation rate, suggesting that RDW may serve as a surrogate marker for systemic inflammation.[4] This may partially explain the increased prevalence of elevated RDW among diabetic and hypertensive patients in our cohort.
The association between higher RDW and MACE observed in the present study also supports growing evidence that RDW is an important prognostic indicator in non–ST elevation ACS. Studies by Uyarel et al. and Cavusoglu et al. demonstrated that high RDW at admission predicted mortality, recurrent ischemia, and arrhythmias in ACS patients undergoing percutaneous coronary intervention.[7,8] The underlying biological mechanisms may include impaired erythrocyte deformability, increased oxidative stress, endothelial dysfunction, and reduced microvascular perfusion—all of which contribute to myocardial ischemia and adverse outcomes.[13] Thus, RDW provides clinically relevant prognostic information beyond conventional biomarkers.
Our findings further highlight the use of RDW as an inexpensive and readily available tool in the early risk stratification of ACS. Given that RDW is routinely measured as part of the complete blood count (CBC), incorporating RDW into standard evaluation protocols may enhance the early identification of high-risk patients, especially in resource-limited settings where advanced biomarkers or imaging modalities may not be readily accessible. Nevertheless, RDW is influenced by multiple systemic factors, and its interpretation should be integrated with clinical context and other diagnostic parameters. Larger, prospective studies are needed to validate the predictive value of RDW and to explore whether combining RDW with established risk scores can further improve prognostic accuracy.

CONCLUSION:

Elevated red cell distribution width (RDW) was significantly associated with major adverse cardiac events and key cardiovascular risk factors in patients with unstable angina and NSTEMI. As an inexpensive and routinely available hematological parameter, RDW offers valuable prognostic information that can aid in early risk stratification and clinical decision-making. Incorporating RDW into the assessment of non–ST elevation ACS may enhance the identification of high-risk patients and improve overall management strategies.

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