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Assessment of the Severity of CAD Regarding Number of Vessels Involved

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Abstract

Background: Coronary artery disease (CAD) is characterized by atherosclerotic plaque accumulation in the epicardial arteries. The dynamic nature of the CAD process results in various clinical presentations. Red blood cell distribution width (RDW) is a practical, widely available marker for assessing the severity of coronary artery disease and helps in the risk stratification of patients with CAD. This study aimed to analyze the severity of CAD regarding the number of vessels involved. **Material & Methods:** This descriptive cross-sectional study included 124 purposively selected patients who underwent elective CAG in the Department of Cardiology, Chittagong Medical College Hospital, Chattogram, from January 2020 to June 2021. SPSS 23.0 software was used for processing and analysis at the end of the data collection period. **Results:** The age of the patients ranged from 32-75 years with a mean (±SD) age of 53.4 (±9.9) years. The majority of the patients (83.1%) were male with a male-to-female ratio of 4.9:1. On coronary angiography, the majority of the patients (51/124, 41.1%) had triple vessel disease, followed by double vessel disease in 23 (28.5%) patients, single-vessel disease in 31 (25.0%). In 19 (15.4%) patients no significant lesion was observed in any of the vessels. Gensini score ranged between 1 and 176 in the study with a median score of 56.77. The majority of the patients (69.4%) in the present study had a Gensini score ≥30 indicating severe stenosis. A positive correlation between RDW and coronary artery disease severity in terms of Gensini score (r=0.393). With the increase of RDW, the Gensini score increases. It was found statistically significant (p=<0.001) by Pearson's correlation test. There was a positive correlation between RDW and CAD severity regarding the number of vessels involved (rho =0.5). With the increase of RDW, the number of involved vessels increases. It was found statistically significant (p=<0.001) by Spearman's correlation test. The Median (IQR) value of RDW was 13.5 (13.0-14.0) in patients with mild stenosis compared to 14.5 (13.9-15.0) in patients with severe stenosis. This difference was statistically significant (p<0.001). The median (IQR) value of RDW was the lowest in patients without any significant stenosis in any of the coronary arteries [13.1% (12.7%-13.5%)] and was the highest in patients with triple vessel diseases [14.5% (14.1%-15.0%)].

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Conclusion: This study demonstrated that RDW level was an independent predictor for CAD and the severity of coronary stenosis. So, it can be concluded that RDW is an inexpensive routine laboratory test that might help identify high-risk patients before planning for a more invasive treatment strategy.

Keywords:- Coronary Artery Disease, RDW, Angiography, Anemia.

INTRODUCTION

Recent studies from Bangladesh observed that the prevalence of cardiovascular diseases, especially CAD, is high along with an upward trend.[1,2] Bangladeshis are unduly prone to develop CAD, which is often premature in onset, follows a rapidly progressive course, and is angiographically more severe.[3] Regarding its marker RDW is an important prognostic marker in patients with cardiovascular disorders.[4] A study found a strong association between RDW and inflammatory markers.[5] Similarly, brain natriuretic peptide (BNP) and N-terminal Pro-BNP secretion are also independently related to the severity of CAD.[6] RDW is also associated with BNP and CRP.[7,8,9] During the atherosclerotic process, inflammatory cytokines such as TNF-α, IL-1b, and IL-6 are released. Inflammatory cytokines modulate erythropoiesis by inhibiting erythropoietin gene transcription in the liver and kidney and suppressing erythroid cell maturation in the bone marrow.[10] Thus, mature and immature RBCs get into circulation, increasing cell size heterogeneity and resulting in an elevated RDW.[11] A study suggested that RDW was an independent factor in predicting mortality and new onset of heart failure in patients who had suffered from acute MI without heart failure.[12] Additionally, another study showed that an elevated RDW level was independently related to fatality and recurrent MI within six months.[13] Another study showed that RDW had a sensitivity of 79% and a specificity of 50% for ACS diagnosis when the cutoff value of RDW was 14%.[9] Later, another author demonstrated that the RDW level was significantly higher in patients with CAD than in normal controls and was an independent predictor for CAD and the severity of coronary stenosis.[14] They were thus suggesting that RDW might be a readily available marker for predicting the severity of CAD. Recently, an Indian study revealed that RDW is a practical, widely available marker for assessing the severity of coronary artery disease and helps in the risk stratification of patients with CAD.[15] Another study prospectively evaluated the severity of CAD and RDW in a large Chinese cohort (n=677) who underwent CAG due to the presence of angina-like chest pain or positive treadmill exercise test.[14]

Objectives

General Objective

- To Assess the severity of CAD regarding the number of vessels involved.

Specific Objectives

- To describe the demographic characteristics of the patients.

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- To calculate the optimal cutoff point of RDW for the presence or absence of severe CAD.
- To see the correlation between RDW and coronary artery disease severity in terms of the Gensini score.

MATERIAL AND METHODS

This was a descriptive cross-sectional study including 124 patients who underwent elective CAG in the Department of Cardiology, Chittagong Medical College Hospital, Chattogram, from January 2020 to June 2021. A pretested structured case record form containing all the variables of interest was used for data collection. Written informed consent was obtained from all subjects. All necessary laboratory investigations including - RDW, Hb%, MCV, HbA1c, and lipid profile were done. Continuous data were expressed as mean ± standard deviation (SD) for normally distributed data or median and 25%–75% interquartile range for non-normally distributed data. Categorical variables were presented as percentages (%) or proportions. Differences in variables were analyzed using Student t-tests or the Mann–Whitney U tests. Categorical data were evaluated by the Chi-square test or Fisher exact test, as appropriate. A P-value of less than 0.05 was considered significant statistically. SPSS 23.0 software was used for data processing and analysis. Ethical clearance was obtained from the Ethical Review Committee of Chittagong Medical College.

Inclusion Criteria

- Patients were selected for elective CAG for their symptoms related to CAD.
- Patients who had given consent to participate in the study.

Exclusion Criteria

- Patients with pregnancy.
- Patients of iron deficiency anemia, megaloblastic anemia, thalassemia, or on treatment for anemia, such as receiving supplemental iron, folate, or erythropoiesis-stimulating agent.
- Patients who did not give consent to participate in the study.

RESULTS

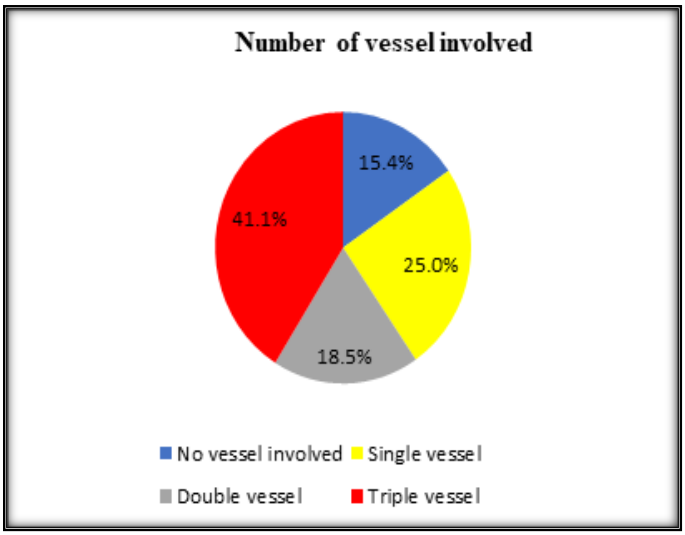

Figure 1: Number of vessels involved among the participants (N=124)

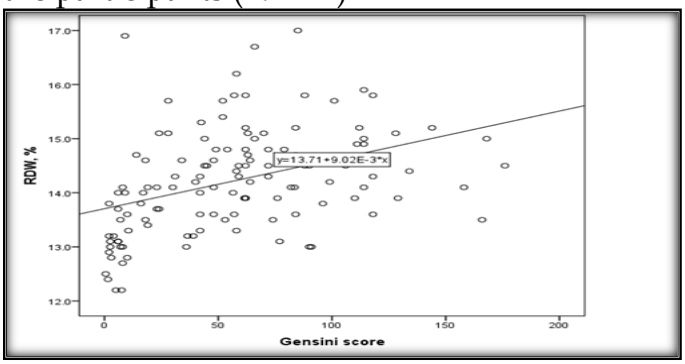

Figure 2: Scatter dot plot showing the correlation between RDW and Gensini Score by Pearson's correlation test

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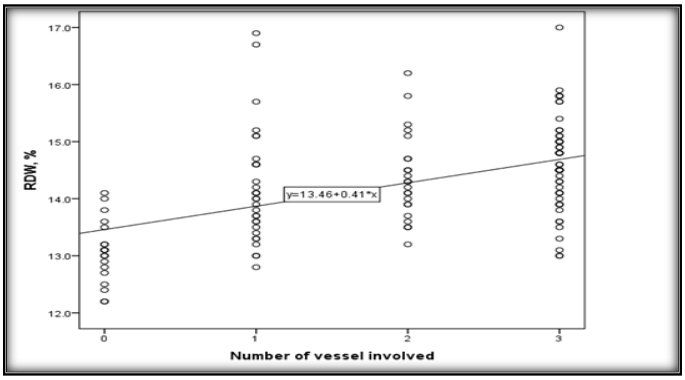

Figure 3: Scatter dot plot showing the correlation between RDW and number of the vessel by Spearman's correlation test

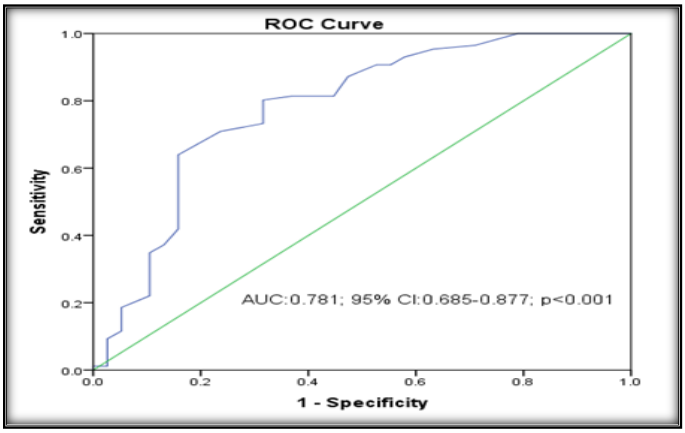

Figure 4: The receiver–operating characteristic (ROC) curve analysis of RDW for predicting severe stenosis.

The age of the patients ranged from 32-75 years with a mean (±SD) age of 53.4 (±9.9) years. The majority of the patients (83.1%) were male with a male-to-female ratio of 4.9:1 [Table 1] On coronary angiography, the majority of the patients (51/124, 41.1%) had triple vessel disease, followed by double vessel disease in 23 (28.5%) patients, single-vessel disease in 31 (25.0%). In nineteen (15.4%) patients no significant lesion was observed in any of the vessels. [Figure1] Gensini score ranged between 1 and 176 in the study with a median score of 56.77. The majority of the patients (69.4%) in the present study had a Gensini score ≥30 indicating severe stenosis. [Table 2] A positive correlation between RDW and coronary artery disease severity in terms of Gensini score (r=0.393). With the increase of RDW, the Gensini score increases. It was found statistically significant (p=<0.001) by Pearson's correlation test. [Figure2] There was a positive correlation between RDW and CAD severity regarding the number of vessels involved (rho =0.5). With the increase of RDW, the number of involved vessels increases. It was found statistically significant (p=<0.001) by Spearman's correlation test. [Figure 3] Median (IQR) value of RDW was 13.5 (13.0-14.0) in patients with mild stenosis compared to 14.5 (13.9-15.0) in patients with severe stenosis. This difference was statistically significant (p<0.001). [Table 3] The median (IQR) value of RDW was the lowest in patients without any significant stenosis in any of the coronary arteries [13.1% (12.7%-13.5%)] and was the highest in patients with triple vessel diseases [14.5% (14.1%-15.0%)]. The median RDW value in patients with single-vessel and double-vessel diseases was 14.0% and 14.3%, respectively. Independent-Samples Kruskal-Wallis Test revealed that these differences in the median values were significant. However, pairwise comparisons demonstrate a significant difference only between the group with no vessel involvement and the other groups. [Table 4] The AUROC for RDW was 0.781 with a p-value of <0.001, indicating a statistically significant association of RDW with the severity of CAD. With a cut-off value of 13.85%, RDW had a sensitivity of 80.0% and specificity of 68.4% for predicting severe stenosis [Figure 4].

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Table 1: Demographic characteristics of the studied patients (N=124).

Variables	**Response**
Age (years)	
Mean (±SD)	53.4 ± 9.9
Range	32-75
Sex (N%)	
Male	103 (83.1)
Female	21 (16.9)

Table 2: Angiographic severity of the studied patients by Gensini score (N=124).

CAG parameters	**N (%)**
Gensini Score	
Median (IQR)	56.7 (19.0-83.9)
Range	1-176
Stenosis severity	
Mild stenosis (Gensini score 0-29)	38 (30.6)
Severe stenosis (Gensini score ≥30)	86 (69.4)

IQR: Interquartile range

Table 3: Association between RDW levels and severity of stenosis (N=124).

RDW (%)	**Severity of stenosis**		**P value**
	Mild stenosis (Gensini score 0-29)	**Severe stenosis (Gensini score ≥30)**	
Median (IQR)	13.5 (13.0-14.0)	14.5 (13.9-15.0)	<0.001*
Range	12.2-17.0	13.0-17.0	

*Mann-Whitney U test.

Table 4: Association between RDW levels and number of vessels involved (N=124).

No. of vessels involved	**RDW (%)**		**P value**
	Median (IQR)	**Range**	
No vessel involved	13.1 (12.7-13.5)	12-17	<0.001*
Single vessel	14.0 (13.5-14.6)	13-17	
Double vessel	14.3 (13.9-14.7)	13-16	
Triple vessel	14.5 (14.1-15.0)	13-17	

* Independent-Samples Kruskal-Wallis Test

DISCUSSION

In this study, the age of the patients ranged from 32-75 years with a mean (±SD) age of 53.4 (±9.9) years. The majority of the patients (83.1%) were male. The mean age of the current study population was similar to another study.[16] The RDW in the current study ranged from 12.2% to 17.0%, with a mean value of 14.2% (±1.0). These agreed with the findings of another study (Mean ±SD 13.7 ± 1.19; Min – Max 10.1 – 17.8).[17]

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The RDW levels for enrolled individuals in another study ranged from 11.2% to 20.0%, with a median of 12.8% and a mean (of 12.89±0.79).[14] Another author stated that not all cases of ACS had coronary stenosis. [18] In the current study, out of 124 patients with previous symptoms of myocardial ischemia, 19 (15.4%) patients had no significant stenosis in any vessels (considered as no angiographic CAD in the present study). Similarly, it was observed that 17.53% of their study population with either ACS or stable angina had normal coronaries on CAG. [16] In the current study, the Gensini score was used to assess the angiographic severity of CAD quantitatively. CAG is the gold standard for the clinical judgment of CAD, and the Gensini score is a quantitative indicator for estimating the severity of coronary artery stenosis based on CAG. Gensini score is a widely used angiographic scoring system for quantifying the severity of CAD.[19] The different cutoff value of the Gensini score was used in various studies to classify severe stenosis.[20] The present study also demonstrated a significantly higher median RDW value in patients with severe stenosis than in their counterparts (14.5% versus 13.5%, p<0.001). These findings were in agreement with the previous similar study conducted in the Chinese population where the RDW value increased along with the Gensini score values of 1–6, 7–13, and >13 (12.63±0.54, 13.00±0.71, 13.39±0.98) respectively (p < 0.001), and in Indian population the RDW values increased along with the Gensini score values of 1–6, 7–13 and >13 (14.53±0.88, 14.55 ±1.07, 14.68 ± 1.10) respectively (p < 0.0001).[14,15] Similar to the positive correlation with Gensini score present study also demonstrated a significant positive correlation between the number of vessels involved and RDW (Spearman correlation coefficient rho=0.5). In the present study, the patients with no vessel involvement had the least median RDW (13.1%), and the patients with three-vessel CAD had the highest median RDW (14.5%). These agreed with a study on 580 acute MI patients and showed a relation between high RDW and a higher percentage of three-vessel lesions in those patients.[21] However, a study failed to detect any significant correlation between RDW and CAD. The authors reported that their conclusion is contrary to most similar studies owing to the heterogeneity of patients' selection criteria and using different inclusion and exclusion criteria.[22] According to ROC analysis, AUC for RDW was 0.781 (<0.001), and the cutoff value of 13.85% RDW had a sensitivity of 80.0% and specificity of 68.4% for the prediction of severe stenosis. All these findings from the present study and previous similar works indicate that RDW has a good discriminatory ability to assess the severity of CAD.

Limitations of the Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community. Moreover, it was done among the patients of ACS, so the results cannot be applied to the overall patients of CAD. The assessment of the severity of CAD was performed by coronary angiography. Dual-source multi-slice computed tomographic coronary angiography or intravascular ultrasound, or optical coherence tomography may be more sensitive in evaluating the severity of CAD. Other synchronous inflammatory biomarkers of the patients were not evaluated in the study.

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CONCLUSIONS

This study demonstrated that RDW level was an independent predictor for CAD and the severity of coronary stenosis. So, it can be concluded that RDW is an inexpensive routine laboratory test that might help identify high-risk patients before planning for a more invasive treatment strategy.

Recommendation

RDW is a widely available, inexpensive test to predict individuals at risk of severe CAD who might be potential candidates for a more invasive therapeutic approach. A further large-scale multicenter study from Bangladesh is necessary to validate the present research findings and determine an optimal cutoff point of RDW.

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