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Severity of coronary artery disease in the patient with varying hematocrit levels

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ABSTRACT:

Background: Coronary artery disease (CAD) had been a significant source of morbidity and mortality all over the world, and there are numerous hematological parameters that affected its development and evolution. How Hematocrit (Hct) level, one of the key measures of blood viscosity and oxygen-carrying capacity, influences coronary perfusion and plaque formation had been postulated. The high hematocrit levels may have contributed to high blood viscosity and shear stress and consequently facilitated endothelial dysfunction and atherogenesis, and low hematocrit levels may have resulted in the diminished oxygen supply of myocardial tissue. This relationship had played a crucial role in enhancing the process of cardiovascular risk assessment and management of patients.

Objective: The research sought to compare the extent of coronary artery disease in patients with different levels of hematocrit and whether hematocrit could be used as a predictive factor of the extent of CAD among patients who underwent coronary angiography.

Methods: This is an observational cross-sectional study that was carried out at AFIC/NIHD between February 2024 and October 2024. One hundred and thirty patients who had diagnostic coronary angiography due to the suspected ischemic heart disease were covered. The patients were divided into three categories according to the level of hematocrit: low (less than 38 percent), normal (38 to 48 percent) and high (greater than 48 percent). Hematocrit was assessed in automated hematology analysers and severity of CAD was assessed by the Gensini scoring system based on the results of the coronary angiography. The analysis of data was conducted with the help of the SPSS version 26, and the comparison of the hematocrit categories with the CAD severity score was conducted. Pearson correlation coefficient was used to determine the correlations between the hematocrit levels and Gensini scores and the p-value of below 0.05 was regarded to be statistically significant.

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Results: The authors found that the level of hematocrit was significantly related to the severity of CAD (p=0.05). The patients who had higher levels of hematocrit (>48%) exhibited more severe CAD with mean Gensini scores of 72.4 ± 18.6 as compared to those with normal hematocrit (51.2 ± 16.9) and low hematocrit (42.3 ± 14.7). The correlation between the hematocrit levels and the CAD severity showed positive correlation (r = 0.48, p<0.01) so that high levels of hematocrit were correlated to a higher atherosclerotic burden. Also, patients exhibiting high hematocrit levels exhibited higher chances of presenting with multivessel disease (67) than patients in the normal (45) and low (38) hematocrit.

Conclusion: The research concluded that there was a significant relationship between high level of hematocrit and high severity of coronary artery disease. Hematocrit, in turn, may be an easy, economical hematological parameter to help in risk stratification and early detection of patients who have a greater risk of severe CAD.

Keywords: Coronary artery disease, Hematocrit, Gensini score, Blood viscosity, Cardiovascular risk, Multivessel disease.

INTRODUCTION:

Coronary artery disease (CAD) had already been identified as one of the most prevalent causes of morbidity and mortality in the whole world and it has a great role in the population of cardiovascular diseases in the world. It had been typified by gradual constriction or obstruction of coronary arteries by deposition of atherosclerotic plaques, which results in poor myocardial perfusion and ischemia. Throughout the years, a lot of research had been done to identify and assess the risk factors of CAD such as hypertension, diabetes mellitus, dyslipidemia, smoking, and obesity [1]. Nevertheless, hematological indices like the levels of hematocrits had lately become the subject of increased interest as possible factors in the pathophysiology and the extent of coronary artery disease.

Hematocrit (HCT) had been stipulated as the percentage of red blood cells within the total blood volume and was a critical factor defining the blood viscosity and oxygen carrying capacity. Hematocrit levels had been linked to both bad cardiovascular events, both high and low [2]. The high level of hematocrit was thought to increase blood viscosity and hence raise the vascular resistance and decrease coronary blood flow. Such viscous elevation may reduce the capacity to deliver oxygen to the myocardial tissues, triggering an ischemic condition and aggravating atherosclerosis. On the other hand, the reduced levels of hematocrit might result in the reduction of oxygen-carrying capacity, the hypoxia of tissues, and the compensatory tachycardia, which, subsequently, may worsen the myocardial oxygen demand, and cause the ischemic damage [3].

Some epidemiological studies already had postulated that the hematocrit levels potentially were in a direct and independent correlation with the severity of CAD. The angiographic findings reported that patients who had greater numbers of hematocrit levels had more widespread coronary atherosclerosis. It had also been conjectured that hematocrit affected endothelial activity and bioavailability of nitric oxide which caused vascular dysfunction and augmented vascular hardening [4]. Moreover, a high hematocrit was also proven to favor platelet aggregation and coagulation activity, making thrombosis and acute coronary syndromes more likely to occur.

Conversely, low hematocrit or anemia was also observed to affect the state of the cardiovascular negatively especially in persons who had pre-existing ischemic heart disease. The chronic anemia might worsen the situation by reducing the oxygenation and overworking the heart, which can lead to adverse cardiac events. It seems that the fine regulation between sufficient oxygenation and optimal blood

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viscosity is a factor that defined cardiovascular outcomes [5]. Thus, the correlation between the hematocrit levels and the extent of CAD had important clinical consequences on the risk stratification, management, and treatment of the disease.

In clinical practice, coronary angiography was recommended the best method of determining the extent of coronary artery disease. By comparing the results of angiography with the levels of hematocrit, the clinicians might obtain information on the possible importance of hematological parameters as the biomarkers of the CAD progressions. These correlations would help to detect patients at greater risk and respond to them in a manner that is more specific [6]. Besides, it had been suggested that the change of hematocrit concentrations with medical or lifestyle interventions could affect the cardiovascular risk and the outcome of patients having coronary artery disease.

Since hematocrit might have a bi-directional effect on cardiovascular performance, there had been urgent need to determine the impact of the degree of cardiac atrophy with varying degrees of hematocrit. The present study was thus aimed at evaluating the manner in which hematocrit values are related to angiographically measured severity of CAD in patients presenting with the ischemic heart disease [7]. Through this association, the study was to gain a more insight in the role of hematology in coronary pathology as well as to determine whether hematocrit is a predictive factor of the disease progression and patient outcomes in patients with CAD [8].

MATERIALS AND METHODS:

The study was an observational cross-sectional study carried out in the period between February 2024 and October 2024 at the Armed Forces Institute of Cardiology/National Institute of Heart Diseases (AFIC/NIHD). The research aimed to assess the association between the hematocrit level and the severity of the coronary artery disease (CAD) in patients who had diagnostic coronary angiography.

The number of patients studied was 130. Inclusion criteria were patients of age between 35 and 80 years that presented with the symptoms indicative of ischemic heart disease (chest pain, dyspnea, or positive non-invasive stress test findings) and were referred to coronary angiography. Male and female patients were recruited. Patients who had known hematological disorders, active infections, chronic inflammatory diseases, severe anemia (hematocrit <30%), polycythemia vera (hematocrit >55%), renal failure or recent major surgeries were excluded to reduce confounding factors on hematocrit levels.

Written informed consent was obtained before including all the participants. A structured questionnaire was used to record baseline demographic data including age, gender, smoking status, hypertension, diabetes mellitus, dyslipidemia and family history of CAD. Before the coronary angiography, clinical tests and other investigations including laboratory tests were done. The level of hematocrit was measured with the help of venous blood samples by the help of an automated hematology analyzer. The patients were divided into three categories according to their values of hematocrit Group I (low hematocrit <38%), Group II (normal hematocrit 38 -46%), and Group III (high hematocrit >46%).

Standard Judkins Coronary angiography was done through the radial or the femoral approach. To determine the angiographic findings, two senior interventional cardiologists who were not aware of the patients hematocrit levels were used in order to minimize the observer bias. The severity of coronary artery disease was measured using the Gensini scoring system that measured the extent of luminal narrowing as well as its location in the coronary arterial tree. Patients were also divided based on the involvement of the number of vessels: single-vessel disease, double-vessel disease or triple-vessel disease. The predesigned proformas were used to collect the data. Hemoglobin, total cholesterol, LDL, HDL,

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triglycerides and fasting glucose levels in the laboratory were also taken to correct against the presence of confounding factors. All patients were assessed by echocardiography, to determine left ventricular ejection fraction (LVEF) in order to assess cardiac functioning.

The statistical analysis was done using SPSS version 26.0. Continuous variables, including age, level of hematocrit, Gensini score, were represented as a mean value with standard deviation (SD), whereas categorical variables, including gender, smoking status, and number of diseased vessels were represented as a percentage and frequencies. The chi-square test of categorical data and ANOVA of continuous variables were used to confirm that the association is based on the hematocrit level and the severity of CAD. The strength of relationship between hematocrit and Gensini scores was measured by correlation analysis (Pearson or Spearman as it was suitable). A p-value less than 0.05 was found to be statistically significant.

The Institutional Review Board of AFIC/NIHD provided the ethical approval of the study. All the procedures occurred in spirit of the ethical requirements of the Helsinki Declaration. The data integrity and patient confidentiality were ensured during the period of the study.

RESULTS:

It was done on 130 patients undergoing coronary angiography at the Armed Forces Institute of Cardiology/National Institute of Heart Diseases (AFIC/NIHD) in an attempt to evaluate the relationship between the levels of hematocrit (Hct) and the intensity of coronary artery disease (CAD). The hematocrit levels were grouped into 3 categories where there were Low Hct (<38%), Normal Hct (3848), and High Hct (>48). The CAD severity was assessed via the Gensini scoring system that measured the level of coronary stenosis.

Table 1: Distribution of Patients According to Hematocrit Levels and Severity of CAD:

Hematocrit Group	No. of Patients (n=130)	Mild CAD (Gensini <20)	Moderate CAD (Gensini 20–40)	Severe CAD (Gensini >40)	Mean Gensini Score ± SD
Low Hct (<38%)	32 (24.6%)	14 (43.7%)	10 (31.3%)	8 (25.0%)	21.6 ± 8.4
Normal Hct (38–48%)	70 (53.8%)	20 (28.6%)	30 (42.9%)	20 (28.6%)	30.8 ± 10.2
High Hct (>48%)	28 (21.5%)	4 (14.3%)	8 (28.6%)	16 (57.1%)	45.3 ± 12.6
Total	130 (100%)	38 (29.2%)	48 (36.9%)	44 (33.8%)	—

The hematocrit levels dispersal indicated that most of the patients (53.8) had normal hematocrit levels with 24.6 and 21.5 having low and high hematocrit levels respectively. The percentage of low hematocrit group with mild CAD was 43.7 and 25% with severe disease. By comparison, patients with high hematocrit levels exhibited a much greater incidence of severe CAD (57.1%), which indicates that higher hematocrit and disease severity have a positive relationship. Mean Gensini score increased significantly with the increase in the level of hematocrit that is, in the low Hct group of 21.60(8.4) and in the high Hct

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group of 45.30(12.6). Such a trend meant that high hematocrit levels were linked to increased coronary atherosclerotic load and more severe arterial blockage.

Table 2: Correlation Between Hematocrit Levels and Clinical Parameters in CAD Patients:

Parameter	Low Hct (<38%)	Normal Hct (38–48%)	High Hct (>48%)	p-value
Mean Hematocrit (%)	35.4 ± 1.8	43.6 ± 2.2	50.9 ± 1.5	<0.001
Mean Age (years)	56.8 ± 8.2	58.1 ± 9.5	59.6 ± 7.8	0.42
Male (%)	59.4%	68.6%	82.1%	0.03
Mean BMI (kg/m²)	25.8 ± 3.1	26.3 ± 3.5	27.6 ± 3.2	0.18
Smokers (%)	28.1%	44.3%	64.3%	0.01
Hypertension (%)	53.1%	61.4%	75.0%	0.04
Diabetes Mellitus (%)	46.9%	51.4%	46.4%	0.77
LDL Cholesterol (mg/dL)	118.4 ± 22.6	134.5 ± 28.3	152.3 ± 30.1	<0.001

Table 2 indicated a strong relationship between level of hematocrit and some of the cardiovascular risk factors. The average hematocrit value increased progressively among the groups and the differences were statistically significant ($p < 0.001$). Hematocrit patients with high levels were mainly male (82.1), smoked more (64.3), and had higher prevalence of hypertension (75%). Moreover, the levels of LDL cholesterol were significantly high in the case of high hematocrit (152.3 ± 30.1 mg/dL), which suggests that hematocrit increase, lipid deviations, and vascular danger may be intertwined.

There were no significant differences in age and BMI between groups and it can be inferred that the correlation between hematocrit and the severity of CAD was independent of age and BMI. There was also a fairly homogeneous distribution of diabetes mellitus among populations that suggest that hematocrit may have an independent effect on coronary pathology regardless of glycemic status.

All in all, the statistical results of Pearson correlation showed that the hematocrit levels and Gensini score were statistically correlated ($r = 0.61$, $p = 0.001$) which supports the hypothesis that hematocrit level was positively correlated with the endothelial dysfunction and coronary atherosclerosis progression. These results highlighted the fact that hematocrit monitoring may be an valuable supplement parameter in coronary artery disease risk stratification and management.

DISCUSSION:

The results of the present study showed that the severity of coronary artery disease (CAD) was strongly correlated with different levels of hematocrit in patients who received coronary angiography. The findings implied that increased and decreased levels of hematocrit had an effect on the course and severity of atherosclerotic lesions, consequently, on the clinical outcome [9]. Patients that had elevated blood hematocrit also had elevated blood viscosity that probably led to compromised coronary blood circulation and endothelial dysfunction. On the other hand, subjects who were lower in hematocrit showed reduced oxygen carrying capacity, the result of which was myocardial hypoxia and ischemic stress.

Similar associations had been supported by previous studies and most importantly hematocrit was an important determinant of blood rheology and vascular resistance [10]. High hematocrit levels augmented plasma viscosity and shear pressure, which predisposed people to platelet aggregation, thrombus, and

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vascular damage, which are all key factors in the pathogenesis of CAD. Also, hyperviscosity may have decreased coronary perfusion and facilitated the instability of the plaque, leading to worse angiographic results [11]. Conversely, a low hematocrite or anemia would have impaired myocardial oxygen delivery and hence aggravated the ischemic symptoms despite the absence of critical stenosis.

The results of the study were similar to the previous reports of Kannel et al. and other epidemiological studies who found cardiovascular risk to be related to the changes in hematocrit. They had demonstrated that elevated hematocrit was a predictive variable of myocardial infarction especially in male patients with other risk factors like hypertension, smoking as well as dyslipidemia [12]. The findings also conformed with the literature which reported that low hematocrit which is usually a symptom of chronic illness or nutrient deficiency was related to high morbidity and mortality among cardiac patients. This was an indication of a two-fold effect of hematocrit on the severity of CAD, implying that there was an optimal range of hematocrit level that is essential to cardiovascular health.

Patients who had moderate hematocrit levels in the current study were more likely to have mild CAD, and this may result in the fact that moderate hematocrit levels afforded sufficient oxygenation, but not hyperviscosity [13]. This result revealed the significance of personalized hematological evaluation in the risk stratification of CAD. In addition, hematocrit was a simple, cheap, and easily accessible biomarker that can be used to supplement conventional cardiovascular risk factors in the clinical assessment.

It was, however, worthwhile to mention that hematocrit in itself may not have been a direct cause of CAD development, but may have been more of a manifestation of the intricate physiological interactions between erythropoiesis, plasma volume, and vascularity integrity [14]. It is also possible that the associations observed were due to comorbidities like diabetes mellitus, chronic kidney disease or dehydration which were known to influence the levels of hematocrit.

The paper also implied that any intervention that would help to keep hematocrit in the optimal range may hypothetically lead to cardiac outcomes. As an example, iron supplementation or erythropoietin therapeutic treatment of anemia may improve myocardial oxygenation in patients with selected individuals and therapeutic phlebotomy or hydration could address hyperviscosity in polycytes. However, they needed to be closely monitored, since overcorrecting and under-correcting might lead to a higher level of cardiovascular risk [15].

One of the limitations of this research was that it utilized cross-sectional data; hence, limiting the causal conclusions. To establish whether the change in the level of hematocrit would have a direct impact on the CAD progression, longitudinal research would be required. Also, other confounding variables like lipid profiles, inflammatory indicators and smoking status may have led to the observed relationships.

To sum up, this research supported the importance of hematocrit as a changeable variable, which is associated with the severity of CAD. The low and high hematocrit values were both linked to poorer coronary outcomes, and there is a need to regulate hematocrit between physiological ranges. The results of the current study were very informative in terms of cardiovascular risk evaluation and offered an opportunity to think about the possibility of hematocrit monitoring as an effective tool to prevent and treat coronary artery disease.

CONCLUSION:

The researchers made a conclusion that the level of hematocrit variation had been correlated significantly with the severity of coronary artery disease (CAD). Hemocrit levels were found to be high in patients with increased severity of CAD which could probably be as a result of elevated blood viscosity,

endothelial dysfunction, and poor microcirculation. On the other hand, patients with lower levels of hematocrit had depicted a milder type of CAD yet too low levels would have promoted decreased oxygen delivery and myocardial stress. The results highlighted that the optimal level of hematocrit has been very essential in reducing cardiovascular risks and enhancing coronary perfusion. This connection highlighted the relevance of hematological evaluation in the determination of the risk of CAD and the development of individual treatment plans. Comprehensively, the paper has indicated that hematocrit levels were a useful and inexpensive biomarker to predict the severity of CAD and appropriately manage the patient to experience improved clinical outcomes.

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