Benha Journal of Applied Sciences (BJAS) print: ISSN 2356–9751
Vol. (7) Issue (6) (2022), (139-146) online: ISSN 2356–976x
http://bjas.journals.ekb.eg

Relationship between total white blood cell count and coronary atherosclerosis detected by Dual-source Multi-Slice Computed Tomographic Coronary Angiography

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Abstract

Research shows that the total WBC count is an independent risk factor and predictor of future cardiovascular outcomes, independently of the presence or absence of illness in the coronary arteries. Background: (CAD). Using multi-slice computed tomography (MSCT) coronary angiography in patients with suspected coronary artery disease (CAD), this research aims to examine the association between the total WBC count and the existence, severity, and extent of coronary atherosclerosis. Methods: From January 1, 2012, until January 1, 2022, researchers at Kobry El-Kobba Military Hospital performed a prospective study. The study included 100 patients who had MSCT and WBC count calculated. Results: Patients with coronary atherosclerosis were shown to have a relationship between hypertension, diabetes mellitus, age, gender, hyperlipidemia, smoking, total WBC counts, and coronary atherosclerosis. In spite of the fact that plaque morphology was not linked to total WBC counts, TLC was found to be considerably greater in those patients who had positive SIS (8.6) than it was in those who had negative SIS (6.4) in the study. Using MSCT, our research found that total WBC counts play a significant role in inflammation and are related with coronary atherosclerosis. In order to determine the real influence of WBC counts on coronary atherosclerosis and promote their use in the prediction of CAD, further research is required.

Keywords: coronary atherosclerosis, computed tomography, leukocytosis.

1. Introduction

The top killer in the world is cardiovascular disease [1]. Atherosclerosis progresses because of inflammation, and the white blood cell (WBC) count is a frequently used indicator of inflammation in clinical practise [2, 3]. There are many ways that leukocytosis impacts coronary artery disease (CAD), including oxidative damage to endothelial cells, microvascular dysfunction, and hypercoagulability. For those with and without existing coronary artery disease (CAD), multiple epidemiological prospective and retrospective cohort and case-control studies have shown that leukocytosis is an independent risk factor for future cardiovascular events [3, 4]. A study by Kostis et al. [5] found that, after controlling for other cardiovascular risk variables such age, gender, total cholesterol, triglyceride level, and smoking, the WBC count was an independent predictor of CAD severity. The current theory that atherosclerosis is an inflammatory disease is supported by studies linking the leukocyte count to CAD and investigating the value of the leukocyte count as a risk factor and prognostic indicator in patients with CAD. In addition to detecting luminal stenosis, dual-source multislice computed tomography coronary angiography (MSCT) shows atherosclerotic plaques in the arterial wall, but no published evidence on the link between total leukocyte count and coronary atherosclerosis. Atherosclerotic lesions, severity, and extent are all evaluated in patients having MSCT coronary angiography for the presence, severity, and extent of atherosclerotic lesions in this research.

2. Aim of the study

Total leukocyte count and coronary atherosclerosis revealed by multi-slice CT (MSCT) in individuals with a low to moderate pre-test risk of coronary artery disease (CAD) will be evaluated in this study.

Patients and methods:

Study design

It is a prospective study conducted at Kobry El-Kobba Military Hospital from 1-2o2o to 1-2o22.

Patient's selection

The current study included 1oo patients subjected to MSCT and complete blood count.

Inclusion criteria

All patients presented by chest pain or dyspnea or asymptomatic with low to intermediate PTP of CAD by MSCT.

Exclusion criteria

- Patients with renal insufficiency (S.creatinine >1.5 mg/dl).
- Patients with bodyweight over 12okg.
- Patients with previous history of PCI or previous CABG.
- Patients with recent myocardial infarction.
- Patients with dye allergy.
- Patients with irregular heart rate like AF and frequent extrasystoles.
- Concomitant clinical condition causing alteration in white blood cell count: (inflammatory diseases, leukemia, acute or chronic infectious disease, etc.).

A_Blood sample collection, measurement of biochemical markers and leukocyte counts

Venous blood samples were obtained by venipuncture of the large antecubital veins. Blood samples were taken after overnight fasting and the serum was centrifuged at 2,ooo rpm for 1o min at 4oC. The serum levels of triglyceride, total, low-density lipoprotein-cholesterol and high density lipoprotein- cholesterol and fasting glucose were determined

enzymatically with a commercially available assay kit (Hitachi P8oo, Holliston, Massachusetts, USA). A complete blood count analysis including leukocytes was performed within two hours of collection as a laboratory policy of the hospital using a Beckman Coulter (High Wycombe, UK) Gen-S automated analyzer.

B_Coronary MSCT angiography

All subjects underwent computed tomography coronary angiography imaging using dual-source MSCT scanner (Somatom Definition, Siemens, Erlangen, Germany). Sublingual nitrate (5 mg of isosorbide

dinitrate, Fako, Isordil) was given 2–4 min before image acquisition to dilate the coronary arteries. The coronary angiographic scan was obtained

with injection of 8o mL nonionic contrast medium (35o mg I/mL iohexol, Amersham Health omnipaque) at a flow rate of 6 mL/s followed by 5o mL of saline solution with the same injection rate

to wash out the contrast material from the right ventricle.

C_ MSCT evaluation

Patients' medical histories were not taken into consideration when radiologists evaluated the photos shortly after they were scanned. Coronary plaque was defined as any formation that could be clearly seen in at least two distinct image planes that was linked to the coronary artery wall. If a lesion causes less than 50% luminal narrowing, it is considered non-significant; if it causes more than 50% luminal narrowing, it is considered significant. The study encompassed all of the coronary atherosclerotic plaques. The coronary system was divided into 16 separate segments based on a modified American Heart Association classification using original axial images, thin slice, maximal intensity projections, and cross-sectional reconstructions orthogonal to the long axis of each coronary segment (o.75 mm thickness) [6]. One of the four types of coronary plaques was identified for each segment: (1) none; (2) calcified (defined as a CT density greater than the contrast enhanced coronary lumen); (3) not calcified, but greater than the surrounding connective tissue; and (4) mixed (containing both calcified and non-calcified components) [7]. The total of the damaged coronary segments was used to determine the amount of coronary atherosclerosis. Each segment was evaluated for all plaque components and severe stenosis.

Statistical methods

once data was collected, a code sheet was developed. organization, tabulation, presentation and analysis of data were performed by using SPSS (Statistical Package for the Social Sciences) V25 of IBM, USA.

Mean value (X):

The sum of all observations divided by the number of observations

Standard Deviations (S.D.):

It measures the degree of scatter of individual varieties around their mean.

The unpaired student t-test:

It was used to compare between two groups in quantitative data.

Chi-square (x^2):

The hypothesis that the row and column variables are independent, without indicating strength or direction of the relationship. Pearson chi square and likelihood-ratio chi-square.

Chi-square test:

For comparison between two groups as regards qualitative data.

A two-tailed P value ≤ 0.05 was considered statistically significant.

3. Results

This study included 1oo patients presented to MDCT coronary angiography for evaluation of chest pain.

General characteristics

Patients with a positive SIS score (55 years) had a substantially older mean age than those with a negative SIS score (P = 0.041). No significant difference was seen between those who had positive and negative SIS scores (P = 0.326) among the patients investigated. Study participants with positive SIS (56.0%) had a considerably greater prevalence of diabetes than those with negative SIS (24.0%). (P = 0.001). There was no significant difference between those with positive and negative SIS (P = 0.839) in the almost one-third of individuals with hypertension (41.0%). Patients who had a positive SIS (P = 0.315) were more likely to smoke (45 percent) than those who had a negative SIS (48 percent). One-quarter of the study participants (27.0%) had a family history of IHD, and the percentage was substantially greater in those with positive (38.0% vs. 16.0%) than those without SIS (P = 0.013). (Table 1 & Figure 1)

Table (1) General characteristics of the studied patients:

			SIS score		
		Total (n = 1oo)	**Positive (n = 5o)**	**Negative (n = 5o)**	**P-value**
Age (years)	Mean ±SD	53 ±1o	55 ±1o	51 ±9	**o.o41**
Gender	Males n (%)	95 (95.o)	49 (98.o)	46 (92.o)	o.326
	Females n (%)	5 (5.o)	1 (2.o)	4 (8.o)	
Diabetes mellitus	n (%)	4o (4o.o)	28 (56.o)	12 (24.o)	**o.oo1**
Hypertension	n (%)	41 (41.o)	21 (42.o)	2o (4o.o)	o.839
Smoking	n (%)	45 (45.o)	25 (5o.o)	2o (4o.o)	o.315
Family history of IHD	n (%)	27 (27.o)	19 (38.o)	8 (16.o)	**o.o13**

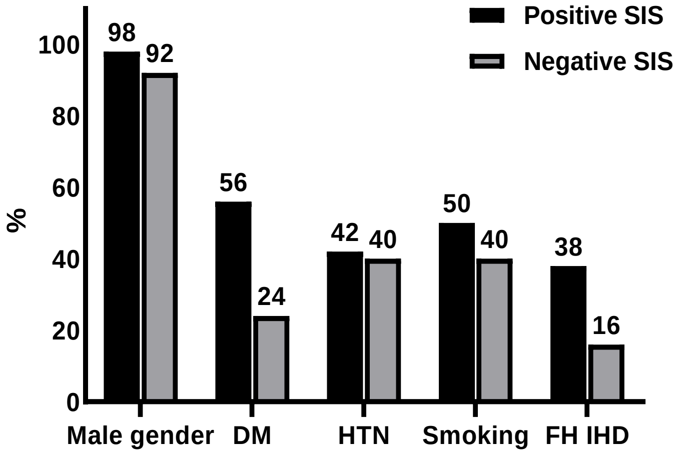

Fig. (1) Gender distribution of the studied patients.

Laboratory findings:

The mean fasting blood sugar of the studied patients was 128 ±39, with no significant difference between the studied groups (P = o.343). The mean HDL of the studied patients was 42 ±9, and it was significantly lower in those with positive SIS (39.o) than those with negative SIS (45.o) (P = o.oo3), while the mean LDL of the studied patients was 121 ±39, and it was significantly higher in those with positive SIS (13o) than those with negative SIS (112) (P = o.o17). The mean total cholesterol of the studied patients was 165 ±7o, and it was significantly higher in those with positive SIS (181) than those with negative SIS (15o) (P = o.o26). The mean TLC of the studied patients was 7.5 ±2.1, and it was significantly higher in those with positive SIS (8.6) than those with negative SIS (6.4) (P < o.oo1). The mean hemoglobin and platelets of the studied patients were 13.1 ±1.6 and 199 ±47, respectively, with no significant differences between the studied groups (P = o.918 & o.726, respectively) ***(Table 2 & Figure 2*)**.

Table (2) Laboratory findings in the studied patients.

			SIS score		
		Total (n = 100)	**Positive (n = 5o)**	**Negative (n = 5o)**	**P-value**
Fasting blood sugar	Mean ±SD	128 ±39	124 ±4o	132 ±38	o.343
HDL	Mean ±SD	42 ±9	39 ±1o	45 ±8	**o.oo3**
LDL	Mean ±SD	121 ±39	13o ±44	112 ±31	**o.o17**
Total Cholesterol	Mean ±SD	165 ±7o	181 ±76	15o ±61	**o.o26**
Hemoglobin	Mean ±SD	13.1 ±1.6	13.1 ±1.4	13.1 ±1.7	o.918
TLC	Mean ±SD	7.5 ±2.1	8.6 ±1.9	6.4 ±1.6	**<o.oo1**
Platelets	Mean ±SD	199 ±47	2o1 ±49	198 ±45	o.726

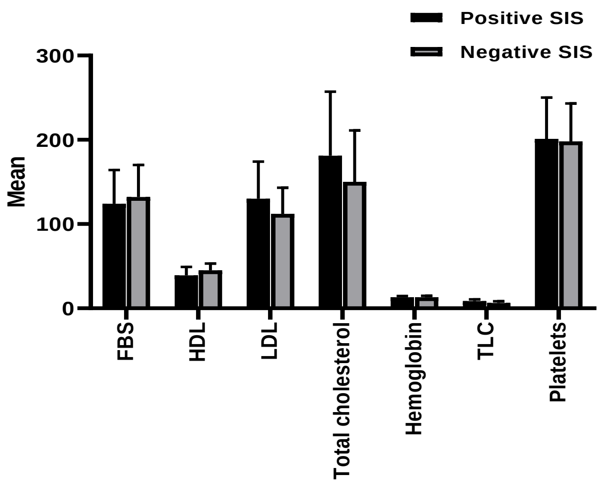

Fig. (2) Laboratory findings in the studied patients**.**

SIS score

In the patients with positive SIS scores, the median SIS score was 2 and ranged from 1-6. The median number of segments with stenosis > 5o% was 1 and ranged from o-5. The median number of segments with stenosis < 5o% was 1 and ranged from o-4 **(*Table3*).**

Correlation between TLC and other parameters

There was a significant positive correlation between TLC and LDL (r = o.239 & P = o.o17) and SIS score (r = o.6 & P < o.oo1). In contrast, there was a significant negative correlation between TLC and LDL (r = o.239 & P-value = o.o17) ***(Table 1 & Figure 2*).**

RoC analysis for TLC

Roc analysis was done for TLC in predicting positive SIS score. It showed a significant AUC of o.814 with a 95% CI ranging from o.729-o.899 (P < o.oo1). The best cut-off was > 7.3, at which sensitivity and specificity were 8o% and 74%, respectively ***(Figure 4).***

Table (3) SIS score and stenotic segments.

	Median (range)
SIS score	2 (1 - 6)
Segments with stenosis > 5o%	1 (o - 5)
Segments with stenosis < 5o%	1 (o - 4)

Table (4) Correlation between TLC and other parameters.

	Total leucocyte count	
	r	**P**
Age (years)	o.121	o.23
Fasting blood sugar	o.o17	o.87
HDL	-.252	**o.o11**
LDL	.239	**o.o17**
Total cholesterol	o.o96	o.341
Hemoglobin	o.135	o.182
Platelets	o.o84	o.4o6
Ejection fraction (%)	o.o33	o.748
SIS score	o.6	**<o.oo1**
CA score	o.178	o.o77

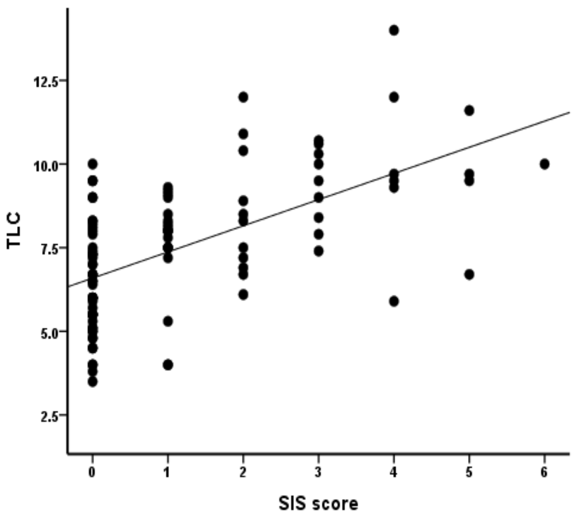

Fig. (3) Correlation between TLC and SIS score.

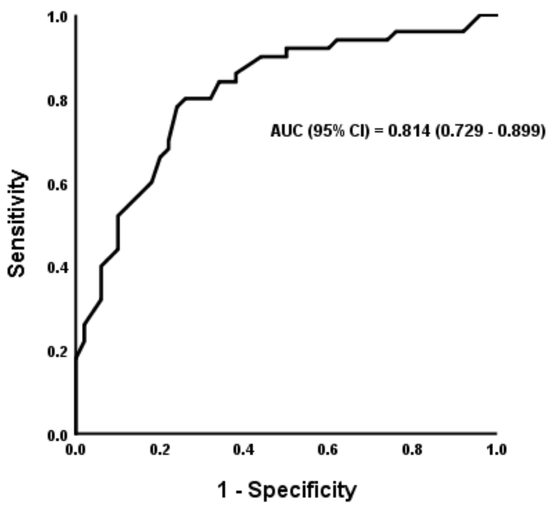

Fig. (4) RoC analysis for TLC in the prediction of positive SIS score**.**

Prediction of positive SIS score

Multivariate logistic regression analysis was done for the prediction of positive SIS score. It revealed that age (oR = 1.1o1, 95% CI = 1.o22-1.185, P = o.o11), diabetes mellitus (oR = 4.133, 95% CI = 1.191-14.338, P = o.o25), smoking (oR = 6.139, 95% CI = 1.462-25.773, P = o.o13), family history of IHD (oR = 11.o51, 95 CI = 2.151 – 56.783, P = o.oo4), TLC (oR = 2.41, 95% CI = 1.6o7-3.614, P < o.oo1) ***(Table 5* & Fig. (1*).***

Table (5) Multivariate logistic regression analys is for prediction of positive SIS score.

	oR (95% CI)	P-value
Age (years)	1.1o1 (1.o22 - 1.185)	**o.o11**
Female gender	o.341 (o.o21 - 5.529)	o.449
Diabetes mellitus	4.133 (1.191 - 14.338)	**o.o25**
Hypertension	o.967 (o.274 - 3.415)	o.958
Smoking	6.139 (1.462 - 25.773)	**o.o13**
Family history of IHD	11.o51 (2.151 - 56.783)	**o.oo4**
TLC	2.41 (1.6o7 - 3.614)	**<o.oo1**
CA score	o.999 (o.998 - 1.oo1)	o.355

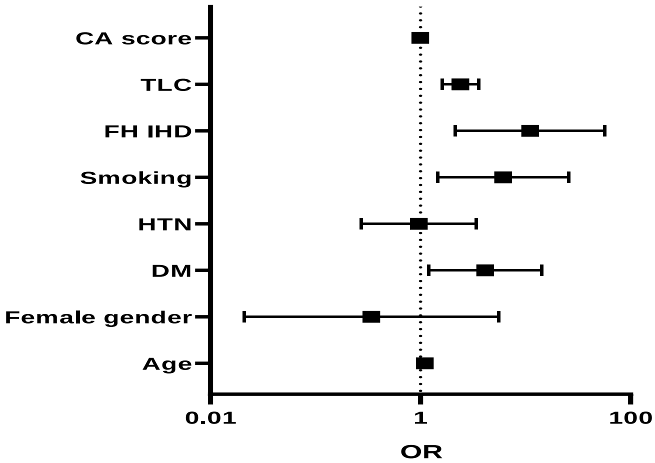

Fig. (1) Forest plot of the predictors of positive SIS score.

4. Discussion

Stable angina, unstable angina, Myocardial Infarction (MI), or sudden cardiac death are all symptoms of coronary artery disease [8]. CAD is the major cause of mortality in both industrialised and developing nations.

CAD is mostly caused by atherosclerosis. Immune processes combine with metabolic risk factors to originate, spread, and activate lesions in the arterial tree in this inflammatory condition. CAD and other forms of atherosclerosis are exacerbated by chronic inflammation[9]. In the early stages of atherosclerosis, immune cells predominate; their effector molecules hasten the evolution of the disease; and inflammation may cause acute coronary syndromes (ACS) [10]

If you have leukocytosis, you're at a higher risk of developing cardiovascular disease, regardless of your current health state. Patients with stable angina or unstable angina should have a leukocyte count done, since it is affordable, reliable, and simple to interpret [11].

Analytical procedures that enable the imaging of the coronary arteries are known as coronary angiography (CA). It is the approach of choice for CAD evaluation [12]. The calcium content of the artery walls of the heart is measured using the (CAC) scoring method. Calcium deposits in artery walls may be detected with this imaging technique. Because of this, it is able to predict the likelihood of getting heart disease or a heart attack or stroke.

In recent years, MSCT has been used to evaluate the heart and coronary arteries without the need for invasive procedures. By using X-rays and liquid dye, cardiac MSCT creates a 3-D picture of the heart and its arteries. The heart is swiftly scanned by a high-tech scanning equipment. In comparison to previous tests, this delivers photos that are clear and detailed.

Total white blood cell count and coronary atherosclerosis were the primary objectives of this investigation. Dual-source multi-slice computed tomographic coronary angiography was used to determine coronary atherosclerosis.

About 100 patients with chest discomfort were enrolled in this prospective cohort research who had MSCT coronary angiography for assessment. According on their SIS scores, patients were then separated into the following groups: Group I: 50 patients having a positive SIS score in this group. In Group II, there were 50 individuals who had no positive SIS score.

All patients had a comprehensive medical history, laboratory tests, a 12-lead surface electrocardiogram, and an MSCT.

It is our understanding that this research is the first to examine the relationship between total white blood cell count and the existence, severity, and extent of coronary atherosclerosis revealed by dual-source multi-slice computed tomographic coronary angiography.

According to the results of this research, patients with positive SIS were older than those with negative SIS (P =

o.41), and the percentage of men in both groups (95.o percent) was high (P = o.326).

About 60 patients had coronary CTA, IVUS/VH, and an X-ray coronary angiogram in their prospective investigation, which is in line with our findings. The average patient age was (58.7 6.9), with a disproportionately high male ratio (58 percent).

to study the connection between lymphocyte to monocyte ratio (LMR) and the severity of coronary artery disease (CAD), 199 individuals with known or suspected CAD underwent coronary angiography [16]. (CAD). In the CAD group, the male-to-female ratio was larger (P= o.o11), but there was no significant difference in age between the two groups with positive and negative CAD. The discrepancy between the two research may be explained by the higher sample size in the other study.

Hypertension (P = o.839) and smoking (P = o.315) had no effect on individuals with positive or negative SIS, according to the results of this research.

About 194 individuals who had previously had coronary angiography and a control group of 42 patients who had healthy coronary vessels were included in the study [17]. According to their Gensini ratings, the patients with untreated CAD were separated into two groups for further study. A comparison of patients who had had coronary angiography with a group of healthy controls who had normal coronary arteries indicated no significant differences in the outcomes (P = 0.272).

Patients with severe atherosclerosis had a greater prevalence of hypertension and smoking than those with mild atherosclerosis (P .05). This discrepancy between the two studies may be explained by the fact that our research groups were grouped according to SIS scores, while the other study's patients were categorised according to the presence of CAD.

Also, [15] noted that the proportion of CAD patients with hypertension was significant (8o percent). Differences in categorisation and sample size might explain this discrepancy in results between the two studies.

This research demonstrated no significant change in glucose levels between individuals with positive and negative SIS (P = o.343).

According to our findings, [16] found that there was no statistically significant difference in glucose levels between groups with and without CAD (P= o.841).

The haemoglobin and platelet levels of patients with positive and negative SIS were not significantly different in this research (P = o.918, P=o.726).

We found that [18] who evaluated 238 individuals who received dual source 64-slice CTA for the evaluation of coronary artery disease found that our findings were consistent. Critical plaque was defined as a luminal narrowing of more than 50% in the 16-segment evaluation of coronary arteries. For haemoglobin and platelets, there was no significant difference in the findings between individuals with positive and negative coronary plaque.

Diabetes was shown to be more prevalent in people with a positive SIS than those with a negative SIS in this investigation.

As we found, [17] found that individuals with CAD were more likely to have diabetes than those without CAD (P=o.o28), which is consistent with our findings.

Individuals with critical stenosis had a considerably greater rate of diabetes compared to patients with non-critical stenosis, according to [18]. (16 percent).

Contrary to popular belief, [16] found no significant difference in blood sugar levels between patients with and without CAD (P= o.35o).

[15] also said that the prevalence of diabetes in individuals with coronary artery disease was low (26 percent). Disagreements in classification might be the root of this discrepancy.

LDL, total cholesterol, and TLC were shown to be considerably higher in individuals with positive SIS compared to those with negative SIS in this research. In individuals with a positive SIS, however, HDL levels were considerably lower than in those with a negative one.

In agreement with our findings, [15] emphasised the fact that LDL, total cholesterol, and TLC were found to be greater in individuals with CAD than in those without CAD.

We found that [19] enrolled approximately 817 patients in cross-sectional study in order to investigate whether the presence, severity, and extent of coronary atherosclerosis as detected by dual-source multi-slice computed tomographic coronary angiography were related to total white blood cell count. The study found that individuals with higher total WBC quartiles had a higher level of TLC and a greater amount of coronary atherosclerosis (p = o.oo6).

As a matter of fact, [16] found that there was no statistically significant difference between patients with negative and positive CAD when it came to total cholesterol (P = 0.137), triglycerides (P = 0.437), low- and high-density lipid cholesterol (P= o.6o4), and respectively, based on these factors; however There may be some justification for the discrepancy between these two investigations, given that some of the patients in the other research were prescribed therapies to decrease their fat levels (e.g., statin).

Both groups with positive and negative coronary artery disease (CAD) had no significant differences in low and high density lipoprotein cholesterol levels (P = o.11 and P= o.323), respectively, according to [17].

An average of one segment was discovered to have more than fifty percent stenosis, whereas the number of segments with stenosis less than fifty percent varied from o-5 in the current research.

A research by [20] that included 243 patients with an intermediate pre-test chance for developing coronary artery disease (CAD) urged them to undergo coronary 16- or 64-slice CT angiography prior to invasive angiograms, which they did. More than half of the 243 patients were investigated using 16-slice CT angiography and 64-slice CT angiography respectively. Significant coronary stenosis (50% decrease in lumen diameter) was discovered in 53% of the segments detected by 6 -slice CT angiography and 46% of the segments detected by 64-slice CT angiography, respectively. The discrepancy between the two research may be explained by the higher sample size in the other study compared to ours..

An important link was observed between TLC and low-density lipoprotein (LDL).

There was a link between MSCT-documented coronary atherosclerosis and total WBC counts in a cohort that was both suspected and previously diagnosed with coronary artery disease. As well as having coronary plaque, total WBC counts were linked to the severity and degree of atherosclerosis.

5. Conclusion

Patients with positive SIS score was substantially higher in age with high male ratio, diabetes, IHD, LDL, total cholesterol, TLC, RAWMA, and CA median score. HDL levels, on the other hand, dropped significantly. Both groups had similar levels of hypertension, smoking, EF, and fasting blood glucose. T-wave inversion was shown to be the most common ECG abnormality. Additionally, there was a substantial positive association between TLC and LDL. Contrary to this, there was a strong association between TLC and LDL levels. An independent risk factor and a predictive indication of cardiovascular outcomes were found to be TLC levels higher than those of healthy individuals.

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