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Predictive role of monocyte count for significant coronary artery disease identification in patients with stable coronary artery disease

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Abstract

Background: *The coronary artery disease (CAD) remains the leading cause of morbidity that is characterized by broad spectrum of symptoms. Up to 30% of performed angiographies reveal normal coronary arteries. The aim of the study was to find simple predictor for significant epicardial artery stenosis among patients with chronic coronary syndrome.*

Methods: *There were 187 patients (131 [70%] men and 56 [30%] women) in the median (Q1–Q3) age of 67 [58–72] presenting with stable CAD symptoms enrolled into the present retrospective analysis. The demographical, clinical and laboratory characteristics between patients with normal and significant coronary artery stenosis were compared.*

Results: *The multivariable analysis revealed coexistence of hypercholesterolemia as significant differentiation factor (odds ratio [OR]: 4.38, 95% confidence interval [CI]: 1.78–10.80, p = 0.001) for significant CAD and inverse relation to serum high density lipoprotein (OR: 0.19, 95% CI: 0.05–0.72, p = 0.015) and relation to creatinine concentration (OR: 1.03, 95% CI: 1.00–1.05, p = 0.012). Among whole peripheral blood count analysis, the significant relation was noticed to be hemoglobin concentration (OR: 1.09, 95% CI: 1.10–1.18, p = 0.022) and monocyte count (OR: 32.3, 95% CI: 1.09–653.6, p = 0.017). Receiver operator curve revealed (AUC: 0.641, p = 0.001) with the optimal cut-off value above 0.45 K/uL for monocyte, yelding sensitivity of 81.82% and specificity of 58.06%.*

Conclusions: *The peripheral monocyte count above 0.45 k/uL may be considered as a predictor of significant CAD in symptomatic patients with chronic coronary syndrome.* (Cardiol J 2024; 31, 5: 722–730)

Keywords: coronary artery disease, monocyte, significant stenosis, atherosclerosis, angina

Introduction

Coronary artery disease (CAD) remains the leading cause of morbidity [1, 2], and its probability can be estimated based on patient characteristics and symptoms [3]. If there is a clinical suspicion of CAD, non-invasive or invasive tests should be performed depending on the likelihood stratification [4].

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According to recent reports, patients should be meticulously evaluated before being referred to an invasive strategy, unless the tests indicate a high likelihood of obstructive CAD [5, 6].

Among the non-invasive functional tests in patients with clinical likelihood of obstructive CAD, stress echocardiography [7], coronary computed tomography angiography [8, 9], single-photon emission computed tomography [10], positron emission tomography [11] and cardiac magnetic resonance [12] are proposed as reasonable diagnostic approaches.

One of the driving forces for coronary plaque initiation and progression is inflammatory cascade activation [13]. There is growing evidence that inflammatory processes modification may influence morbidity and mortality [14, 15]. Among simple inflammatory markers, hematological indices obtained from the whole blood count analysis were proven to be an easily accessible and reliable predictors of prognosis in patients with CAD [16–18]. Monocytes were presented in Arnold et al. [19] analysis as related to the severity of CAD. Among inflammatory cellular components, monocytes are postulated as a major source of proinflammatory background of atherogenesis [20].

The aim of the present retrospective analysis was to evaluate the predictive role of monocyte count in patients presenting with stable CAD admitted for coronary angiography.

Methods

One hundred eighty-seven consecutive patients who were admitted to cardiac-internal profile department in 2022 due to the stable CAD symptoms composed the analyzed population. They were assessed using Canadian Cardiovascular Society (CCS) grading system as mean (standard deviation) CCS class 2.1 (0.4). The study group was divided regarding coronary angiography results into patients with normal coronary arteries, which refers to atherosclerotic lesions of less than 30% of lumen narrowing, and significant culprit lesions regarded as hemodynamically significant coronary artery lumen stenosis. Patients with acute coronary syndrome (ACS), advanced chronic or acutely decompensated heart failure, rheumatic, oncological and hematological diseases were excluded from the study.

Patients underwent non-invasive and invasive diagnostics including angiography due to suspected CAD based on symptoms including chest pain and/ /or to shortness of breath and fatigue on exertion. Demographical and clinical data, followed by laboratory and echocardiography results, were collected, as presented in Table 1. The significant stenosis of culprit lesion was estimated as at least 70%, except for left main disease that was regarded as at least 50%.

The informed consent was obtained from each patient and the study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the Bioethics Committee of Poznan University of Medical Sciences No 55/20 from 16 January 2020.

Results

There were 187 patients (131 [70%] men and 56 [30%] women) in the median (Q1–Q3) age of 67 (58–72) years who were enrolled into retrospective analysis. They were divided into two subgroups based on the coronary angiography results. Although both groups were characterized by similar anginal symptoms estimated in CCS class with mean values of 2.0 (0.23) vs. 2.0 (0.49), respectively ($p = 0.076$), they differed in CAD occurrence. Group 1 consisted of 69 symptomatic patients (35 males and 34 females) in the mean age of 68 (63–73) with normal coronary arteries, while group 2–118 symptomatic patients (96 males and 22 females) in the mean age of 67 (63–72) with significant CAD, requiring either percutaneous coronary intervention (51 [74%] patients) or coronary artery bypass grafting (18 [26%] patients). The patients varied regarding sex ($p < 0.001$) and body mass index ($p = 0.026$). There were no statistically significant differences concerning co-morbidities nor family history ($p = 0.054$) as presented in Table 1.

Laboratory test results

The laboratory results collected on admission included whole blood count analysis, lipid profiles, thyroid-stimulating hormone and kidney function analysis and is presented in Table 2. The patients were screened for myocardial injury markers on admission.

There were significant differences in peripheral whole blood count analysis between both groups regarding: white blood cell count ($p = 0.004$), neutrophil count ($p = 0.002$), monocyte ($p < 0.001$), hemoglobin ($p = 0.001$), hematocrit ($p = 0.004$), mean corpuscular volume ($p = 0.029$) and mean corpuscular hemoglobin concentration ($p = 0.025$).

The statistically significant differences between inflammatory indexes were found between both groups including neutrophil-to-lymphocyte

Table 1. Demographic and clinical characteristics of the analyzed groups

	Group 1; No disease (n = 69)	Group 2; Significant coronary disease (n = 118)	P
Demographic:			
Age [years]	68 (63–73)	67 (63–72)	0.444
Sex: male/female	35 (51%)/34 (49%)	96 (81%)/22 (19%)	< 0.001*
BMI	29 (26–35)	28 (25–30)	0.026*
CCS class	2 (0.23)	2 (0.49)	0.073
Clinical:			
Arterial hypertension	54 (78%)	102 (86%)	0.179
Diabetes mellitus	23 (33%)	40 (34%)	0.614
Smoking	27 (39%)	59 (50%)	0.274
COPD	6 (9%)	9 (8%)	0.557
Hypercholesterolemia	54 (78%)	100 (85%)	0.798
PAD	4 (6%)	12 (10%)	0.282
Kidney dysfunction	6 (9%)	18 (15%)	0.054
Atrial fibrillation	5 (7%)	11 (9%)	0.996
Stroke	3 (4%)	7 (6%)	0.189
Family history of CVD	25 (36%)	24 (20%)	0.056
Echocardiography:			
LVd [mm]	49 (45–53)	47 (45–54)	0.466
RVd [mm]	29 (27–31)	29 (27–31)	0.973
IVs [mm]	11 (10–12)	11 (10–13)	0.091
PWd [mm]	10 (9–11)	11 (10–13)	0.001*
LVEF [%]	60 (55–60)	60 (55–60)	0.647

Continuous variables are expressed as the medians (Q1–Q3) whereas categorical variables are expressed as the numbers (n) with percent (%); *statistically significant. BMI — body mass index; CCS — Canadian Cardiovascular Society; COPD — chronic obstructive pulmonary-disease; CVD — cardiovascular disease; IV — interventricular septum; LVd — left ventricular diameter; LVEF — left ventricular ejection fraction; RVd — right ventricular diameter; PAD — peripheral artery disease; PWd — posterior wall diameter

ratio (p = 0.046), monocyte-to-lymphocyte ratio (p = 0.001) and systemic inflammatory response index (p ≤ 0.001).

The lipid profile's results on admission were significantly different between both groups, including total serum cholesterol (p < 0.001), low-density lipoprotein fraction (LDL; p = 0.007) and high-density lipoprotein fraction (HDL; p < 0.001).

Significant differences were found in serum creatinine between groups (p < 0.001), but not in the glomerular filtration rate (p = 0.340).

Logistic regression

The logistic regression analysis was performed for the evaluation of prognostic parameters of CAD occurrence in the study subgroups (normal angiography vs. significant CAD) and is presented in Table 3.

The multivariable analysis revealed coexistence of hypercholesterolemia as a significant differentiation factor (odds ratio [OR]: 4.38, 95% confidence interval [CI]: 1.78–10.80, p = 0.001) for significant CAD and inverse relation to serum HDL (OR: 0.19, 95% CI: 0.05–0.72, p = 0.015) and relation to creatinine concentration (OR: 1.03, 95% CI: 1.00–1.05, p = 0.012). Among whole peripheral blood count analysis, the significant relation was noticed to be hemoglobin concentration (OR: 1.09, 95% CI: 1.10–1.18, p = 0.022) and monocyte count (OR: 32.3, 95% CI: 1.09–653.6, p = 0.017) as presented in Table 3.

Receiver operating characteristic curves for predicting significant coronary atherosclerosis

In the multivariable analysis, the creatinine, serum HDL cholesterol fraction, hematocrit and monocyte count were found significant. The receiver operator curves for mentioned parameters were performed.

The multivariate analysis and receiver operating characteristic (ROC) analysis revealed predictive values for best prediction of significant coronary artery stenosis occurrence, of the following

Table 2. Laboratory results in group 1 (normal angiography) vs. group 2 (significant coronary disease)

	Group 1 (n = 69)	Group 2 (n = 118)	P
Whole blood count:			
WBC [K/uL]	6.5 (5.5–7.3)	7.4 (6.1–8.9)	0.004*
Neutrophils [K/uL]	3.9 (3.3–4.6)	4.6 (3.8–5.8)	0.002*
Lymphocytes [K/uL]	1.8 (1.5–2.2)	1.8 (1.5–2.1)	0.851
Monocytes [K/uL]	0.38 (0.30–0.47)	0.46 (0.36–0.54)	< 0.001*
NLR	2.2 (1.7–2.8)	0.31 (0.24–0.44)	0.046*
MLR	0.21 (0.16–2.8)	4.7 (4.5–4.9)	0.001*
SIRI	0.82 (0.63–1.15)	9.3 (8.8–9.7)	< 0.001*
SII	501 (374–616)	43 (43–46)	0.079
Eo [K/uL]	0.14 (0.08–0.23)	13.4 (13–13.8)	0.386
Baso [K/uL]	0.04 (0.03–0.06)	235 (209–256)	0.056
LUC [K/uL]	0.13 (0.11–0.16)	0.14 (0.11–0.17)	0.407
RBC [M/uL]	4.6 (4.4–4.9)	4.7 (4.4–5.0)	0.243
Hemoglobin [mmol/L]	8.9 (8.6–9.4)	9.3 (8.5–9.6)	0.015*
Hematocrit [%]	41 (40–43)	43 (40–45)	0.004*
MCV [K/uL]	90 (88–93)	92 (88–95)	0.029*
MCHC [K/uL]	21.5 (21.1–21.8)	21.3 (20.9–21.7)	0.025*
RDW [fL]	13.4 (13.0–13.9)	13.6 (13.1–14.1)	0.070
Platelets [K/uL]	216 (194–270)	231 (188–265)	0.832
MPV [fL]	8.4 (8.0–9.4)	8.8 (8.0–9.6)	0.095
Lipid profile:			
TC [mmol/L]	4.1 (3.6–4.5)	3.5 (3.3–4.4)	< 0.001*
LDL [mmol/L]	2.5 (1.9–3.8)	2.0 (1.7–2.8)	0.007*
HDL [mmol/L]	1.3 (1.2–1.6)	1.2 (1.0–1.3)	< 0.001*
Triglycerides [mmol/L]	1.3 (1.0–1.7)	1.3 (0.9–1.6)	0.909
Uric acid [umol/L]	351 (284–403)	389 (310–403)	0.339
Kidney function test:			
Creatinine [mmol/L]	80 (70–93)	85 (78–103)	< 0.001*
GFR [mL/min]	75 (68–87)	74 (56–90)	0.340
Myocardial injury marker:			
CK-MB [ug/L]	1.88 (1.07–2.73)	1.56 (1.24–2.45)	< 0.001*
Troponin-I [ug/L]	0.004 (0.003–0.005)	0.005 (0.004–0.006)	0.010*
Thyroid:			
TSH [uU/mL]	1.41 (0.92–2.34)	1.21 (1.06–2.17)	0.365

Continuous variables are expressed as the medians (Q1–Q3); *statistically significant; Baso — basophil count; CK-MB — creatine phosphokinase myocardial band; Eo — eosinophil count; GFR — glomerular filtration rate; HDL — high density lipoprotein cholesterol; LDL — low density lipoprotein cholesterol; LUC — large unstained cells count; MCHC — mean corpuscular hemoglobin concentration; MCV — mean corpuscular volume; MLR — monocyte-to-lymphocyte ratio; MPV — mean platelet volume; NLR — neutrophil-to-lymphocyte ratio; RBC — red blood cells; RDW — red cell distribution width; SII — systemic inflammatory index; SIRI — systemic inflammatory response index; TC — total cholesterol; TSH — thyroid stimulating hormone; WBC — white blood cells

indicators: serum creatinine (area under the curve [AUC]: 0.647, p = 0.001) which presented the optimal cut-off value above 78 mg/dL yielding sensitivity of 69.57% and specificity of 54.55%; serum HDL below 1.22 mmol/L (AUC: 0.641, p = 0.002) yielding sensitivity of 69.64% and specificity of 56.72%; hematocrit above 41% (AUC: 0.618, p = 0.007) yielding sensitivity of 64.76% and specificity of 59.42%; and monocyte count (AUC: 0.641, p = 0.001) with the optimal cut-off value above 0.45 K/uL yielding sensitivity of 81.82% and specificity of 58.06% as presented in Figure 1.

Table 3. Logistic regression analysis of patients without coronary artery disease vs. patients with single coronary artery atherosclerosis

Parameters	Univariable analysis			Multivariable analysis		
	OR	95% CI	P	OR	95% CI	P
Sex	3.24	1.67–6.42	0.001	–	–	–
Age	1.01	0.97–1.05	0.538	–	–	–
BMI	0.94	0.87–1.02	0.240	–	–	–
Clinical:						
HA	1.33	0.58–3.01	0.494	–	–	–
DM	0.73	0.40–1.36	0.321	–	–	–
COPD	0.73	0.26–2.07	0.557	–	–	–
Hypercholesterolemia	2.41	1.17–4.93	0.016	4.38	1.78–10.80	0.001
PAD	1.88	0.58–6.06	0.003	–	–	–
AF	0.83	0.30–2.29	0.715	–	–	–
Stroke in history	0.81	0.25–2.67	0.735	–	–	–
Smoking	1.44	0.79–2.63	0.236	–	–	–
Family history	0.69	0.35–1.39	0.302	–	–	–
CCS syndromes	1.16	0.59–2.30	0.338	–	–	–
Echocardiographic:						
LVd	1.12	0.92–1.03	0.286	–	–	–
RVd	1.09	0.92–1.08	0.439	–	–	–
IVs	1.03	0.90–1.16	0.689	–	–	–
PWd	0.98	0.93–5.16	0.378	–	–	–
LVEF	0.98	0.93–1.03	0.331	–	–	–
Morphology:						
WBC	1.11	0.94–1.32	0.225	–	–	–
Neutrophils	1.19	0.96–1.48	0.106	–	–	–
Lymphocytes	0.85	0.52–1.40	0.525	–	–	–
Monocytes	53.2	6.32–653.6	0.002	32.3	1.09–653.6	0.017
NLR	1.17	0.92–1.48	0.193	–	–	–
MLR	1.52	1.10–2.11	0.012	–	–	–
SIRI	1.60	1.05–2.44	0.028	–	–	–
SII	1.00	1.00–1.00	0.141	–	–	–
Eo	1.40	0.25–7.97	0.704	–	–	–
LUC	2.76	0.01–1692	0.756	–	–	–
RBC	1.31	0.69–2.47	0.410	–	–	–
Hemoglobin	1.23	0.86–1.77	0.264	–	–	–
Hematocrit	1.09	1.00–1.18	0.033	1.09	1.01–1.18	0.022
MCV	1.02	0.99–1.05	0.185	–	–	–
MCH	0.70	0.08–6.38	0.750	–	–	–
MCHC	0.66	0.39–1.10	0.112	–	–	–
RDW	1.16	0.84–1.59	0.362	–	–	–
Platelets	1.00	1.00–1.00	0.331	–	–	–
Lipidogram:						
TC	0.84	0.64–1.11	0.216	–	–	–
LDL	0.86	0.65–1.13	0.275	–	–	–
HDL	0.13	0.04–0.42	0.001	0.19	0.05–0.72	0.015
Triglycerides	0.93	0.63–1.38	0.724	–	–	–
Another laboratory:						
Uremic acid	1.00	1.00–1.00	0.468	–	–	–
CK-MB	1.05	1.00–1.11	0.070	–	–	–
Troponin	0.88	0.00–5.28	0.318	–	–	–
Creatinine	1.03	1.01–1.05	0.001	1.03	1.00–1.05	0.012
GFR	0.98	0.97–1.00	0.127	–	–	–

AF — atrial fibrillation; BMI — body mass index; CI — confidence interval; CCS — Canadian Cardiovascular Society; CK-MB — creatine kinase myocardial band; COPD — chronic obstructive pulmonary disease; DM — diabetes mellitus; Eo — eosinophil count; GFR — glomerular filtration rate; HA — arterial hypertension; HDL — high density lipoprotein cholesterol; IVs — intraventricular septum diameter; LDL — low-density lipoprotein cholesterol; LVd — left ventricular diameter; LUC — large unstained cells count; LVEF — left ventricular ejection fraction; MCH — mean corpuscular hemoglobin; MCHC — mean corpuscular hemoglobin concentration; MCV — mean corpuscular volume; MLR — monocyte to lymphocyte ratio; MPV — mean platelet volume; NLR — neutrophil to lymphocyte ratio; OR — odds ratio; PAD — peripheral artery disease; PWd — posterior wall diameter; RBC — red blood cells; RDW — red cells distribution width; RVd — right ventricular diameter; SII — systemic inflammatory index; SIRI — systemic inflammatory response index; TC — total cholesterol; WBC — white blood count

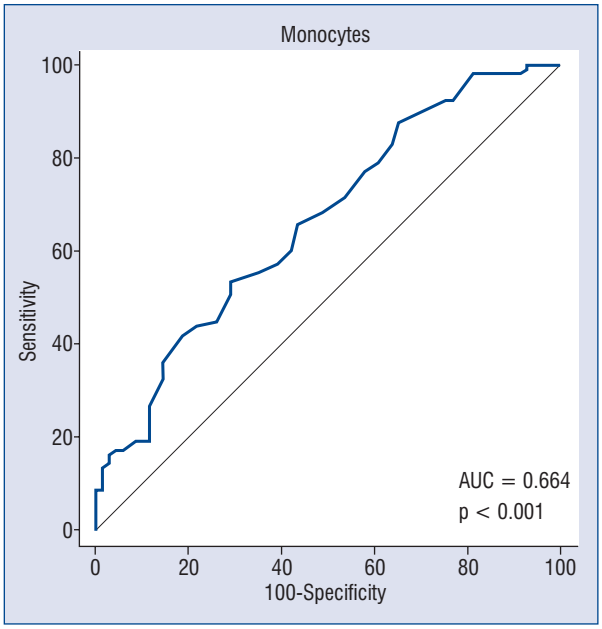

Figure 1. Receiver operation curve for significant coronary artery disease prediction related to peripheral monocyte count; AUC — area under curve

Following the current results presenting the value of monocyte count for significance of culprit lesions in coronary artery bed, the assessment of the peripheral blood analysis and clinical symptoms was performed. In the logistic regression analysis CCS classificantion of 2 or higher grade was used. Exactly the same parameters were included as in the primary analysis, and multivariable analysis found significance of co-existence of arterial hypertension (OR: 0.01, 95% CI: –9.21–0.07, p = 0.021), echocardiographic results including left ventricle diameter (OR: 0.78, 95% CI: 0.08–0.90, p = 0.042) and right ventricle diameter (OR: 1.75, 95% CI: 1.37–9.76, p = 0.009). The laboratory results presented the following parameters as significant in the multivariable model: neutrophil count (OR: 5.26, 95% CI: 1.02–11.52, p = 0.019), monocyte count (OR: 3.72, 95% CI: 0.708–12.08, p = 0.049), and hematocrit (OR: 0.603, 95% CI: 0.063–0.947, p = 0.025).

Discussion

Results presented in this retrospective analysis indicate possible predictive factors of significant coronary artery stenosis on coronary angiography among patients with stable angina.

The novelty of the performed study is the possible relation between significant CAD and the peripheral monocyte count in symptomatic patients. The more possible implication of the present results in clinical practice regarding patients with stable coronary disease, rely on a more accurate diagnosis of the subgroup who should undergo coronary catheterization due to the significance of the disease. According to recent results, patients presenting with chronic coronary syndrome can be treated pharmacologically [21], however simple parameters available from the whole blood count analysis may point out the subgroup in which invasive strategy is justified.

The relation between elevated concentration of monocytes-related cytokines and ACS risk was already postulated by Hojo et al. [22] and presented in a histopathological examination by Sato et al. [23]. The subendothelial infiltration of monocyte type cells with edematous change, increased endothelial permeability and damage caused by coronary vasospasm [23]. Standard risk factors include lipid profiles. Moreover, significant CAD has been associated with infections [24], that were found related to infarct size and hemodynamic instability in ST-segment elevation myocardial infarction patients.

The possible relation between inflammatory activation measured by lymphocyte to monocyte ratio in non-obstructive CAD was reported by Akil et al. [25]. Microvascular angina refers to anginal symptoms relieved by nitroglycerine and beta/-/calcium-blockers use in non-obstructive CAD [26]. The monocyte-to-HDL-cholesterol ratio is another marker associated with inflammation, which was presented in Dogan and Oylumlu [27] analysis as significant for microcirculatory dysfunction in patients with non-obstructive disease and anginal symptoms. The correlation between surrogate marker of inflammation, which is the neutrophil-to-lymphocyte ratio and anginal symptoms in female population, was shown by Okyay et al. [28]. The results of the present analysis indicate a relation between myocardial hypoperfusion related to significant CAD and inflammatory activation measured by peripheral monocyte count. The monocyte role in patients with defined epicardial atherosclerosis was presented in the Schirmer et al. study [29].

The prevalence of anginal patients with no obstructive coronary arteries is estimated to be as high as 40%, whereas coronary spasm or microvascular diseases are reported as mechanistic explanation in nearly half of the patients [30]. Inducible myocardial ischemia due to microvascular dysfunction is an important finding in symptomatic patients regardless of sex according to Murthy et al. analysis [31].

The relation between inflammatory activation and non-obstructive coronary angina was presented [32], as well as in ACSs requiring percutaneous interventions [33]. The present study reflects the association between inflammatory activation and coronary atherosclerosis likelihood in symptomatic patients.

Among other possible indicators, the multivariable analysis revealed the predictive value of serum HDL in accordance with previous reports [34]. In the current study, the hypercholesterolemia was found in majority of patients and though significant differences regarding lipid profiles were found, only HDL was pointed out to be predictive in the multivariable analysis. Recently, the new, large-scale data were published suggesting inflammatory profile is much more important than lipid profile in patients with stable angina. According to this study, residual inflammatory risk is a stronger determinant risk of future cardiovascular events than residual cholesterol risk [35]. In the analysis of the present group, LDL-cholesterol levels were even slightly, but significantly, higher in the "no disease" population when compared to the "significant coronary artery disease" population. Moreover, the sex differences in clinical scenario of chronic coronary syndrome were postulated [36]. Addiction to smoking is still an epidemiological problem [37].

An association between hematocrit values and anginal symptoms was found, although the results were within the normal range in both groups. The relation between the mentioned parameters and anginal symptoms has been already reported [38], and there was a tendency for variable results in individual patients [39].

Moreover, the relation between serum creatinine concentration and significant coronary disease are presented, consistent with previous reports [40]. However, the glomerular filtration rate results did not confirm this finding.

Limitations of the study

Present results were based on a single center retrospective analysis with a limited group of patients. The monocyte count was estimated by the concentration in peripheral blood, but monocytes' activation was not measured. Patients' drug panel list nor history of previous viral infection episodes was not analyzed. Further, more sophisticated research is required, in larger populations. However, in the contemporary "post-COVID health debt" era, new methods are expected to optimize and shorten the non-invasive algorithms in patients with a clinical likelihood of obstructive CAD.

Finally, the AUC of 0.641 may be considered as relatively low. However, it should be pointed out, that there are still several clinical and laboratory parameters which indicate the significance of CAD. Thus, monocyte count is one of them and not the only one, though observations herein lead to the conclusion that this parameter is substantially considerable.

Conclusions

The peripheral monocyte count above 0.45 k/uL may be considered as a predictor of significant CAD in symptomatic patients with chronic coronary syndrome.

Conflict of interest: None declared.

References

1. Kubica A, Pietrzykowski Ł, Michalski P, et al. The occurrence of cardiovascular risk factors and functioning in chronic illness in the Polish population of EUROASPIRE V. Cardiol J. 2022 [Epub ahead of print], doi: 10.5603/CJ.a2022.0102, indexed in Pubmed: 36385605.
2. Malakar AKr, Choudhury D, Halder B, et al. A review on coronary artery disease, its risk factors, and therapeutics. J Cell Physiol. 2019; 234(10): 16812–16823, doi: 10.1002/jcp.28350, indexed in Pubmed: 30790284.
3. Bertolone DT, Gallinoro E, Esposito G, et al. Contemporary management of stable coronary artery disease. High Blood Press Cardiovasc Prev. 2022; 29(3): 207–219, doi: 10.1007/s40292-021-00497-z, indexed in Pubmed: 35147890.
4. Knuuti J, Wijns W, Saraste A, et al. ESC Scientific Document Group. 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes. Eur Heart J. 2020; 41(3): 407–477, doi: 10.1093/eurheartj/ehz425, indexed in Pubmed: 31504439.
5. Tolunay H, Kurmus O. Comparison of coronary risk scoring systems to predict the severity of coronary artery disease using the SYNTAX score. Cardiol J. 2016; 23(1): 51–56, doi: 10.5603/CJ.a2015.0074, indexed in Pubmed: 26503075.
6. Winther S, Schmidt SE, Rasmussen LD, et al. Validation of the European Society of Cardiology pre-test probability model for obstructive coronary artery disease. Eur Heart J. 2021; 42(14): 1401–1411, doi: 10.1093/eurheartj/ehaa755, indexed in Pubmed: 33180904.
7. Pellikka PA, Arruda-Olson A, Chaudhry FA, et al. Guidelines for performance, interpretation, and application of stress echocardiography in ischemic heart disease: from the American Society of Echocardiography. J Am Soc Echocardiogr. 2020; 33(1): 1–41.e8, doi: 10.1016/j.echo.2019.07.001, indexed in Pubmed: 31740370.
8. Zaleska M, Kołtowski Ł, Maksym J, et al. Alternative methods for functional assessment of intermediate coronary lesions. Cardiol J. 2020; 27(6): 825–835, doi: 10.5603/CJ.a2019.0027, indexed in Pubmed: 30912574.
9. Nørgaard BL, Leipsic J, Gaur S, et al. NXT Trial Study Group. Diagnostic performance of noninvasive fractional flow reserve derived from coronary computed tomography angiography in suspected coronary artery disease: the NXT trial (Analysis of Coronary Blood Flow Using CT Angiography: Next Steps).

J Am Coll Cardiol. 2014; 63(12): 1145–1155, doi: 10.1016/j.jacc.2013.11.043, indexed in Pubmed: 24486266.
10. Dorbala S, Ananthasubramaniam K, Armstrong IS, et al. Single photon emission computed tomography (SPECT) myocardial perfusion imaging guidelines: instrumentation, acquisition, processing, and interpretation. J Nucl Cardiol. 2018; 25(5): 1784––1846, doi: 10.1007/s12350-018-1283-y, indexed in Pubmed: 29802599.
11. Saraste A, Knuuti J. ESC 2019 guidelines for the diagnosis and management of chronic coronary syndromes: Recommendations for cardiovascular imaging. Herz. 2020; 45(5): 409–420, doi: 10.1007/s00059-020-04935-x, indexed in Pubmed: 32430520.
12. Kramer CM. Stress cardiac magnetic resonance, revascularization, and all-cause mortality: do we have a final answer? Circ Cardiovasc Imaging. 2021; 14(10): e013512, doi: 10.1161/CIRCIMAGING.121.013512, indexed in Pubmed: 34610758.
13. Zakynthinos E, Pappa N. Inflammatory biomarkers in coronary artery disease. J Cardiol. 2009; 53(3): 317–333, doi: 10.1016/j.jjcc.2008.12.007, indexed in Pubmed: 19477372.
14. Ridker PM, Rifai N, Clearfield M, et al. Measurement of C-reactive protein for the targeting of statin therapy in the primary prevention of acute coronary events. N Engl J Med. 2001; 344(26): 1959–1965, doi: 10.1056/NEJM200106283442601, indexed in Pubmed: 11430324.
15. Nidorf SM, Fiolet ATL, Mosterd A, et al. Colchicine in patients with chronic coronary disease. N Engl J Med. 2020; 383(19): 1838–1847, doi: 10.1056/NEJMoa2021372, indexed in Pubmed: 32865380.
16. Liu GQ, Zhang WJ, Shangguan JH, et al. Association of derived neutrophil-to-lymphocyte ratio with prognosis of coronary heart disease after PCI. Front Cardiovasc Med. 2021; 8: 705862, doi: 10.3389/fcvm.2021.705862, indexed in Pubmed: 34604350.
17. Urbanowicz T, Olasińska-Wiśniewska A, Michalak M, et al. The prognostic significance of neutrophil to lymphocyte ratio (NLR), monocyte to lymphocyte ratio (MLR) and platelet to lymphocyte ratio (PLR) on long-term survival in off-pump coronary artery bypass grafting (OPCAB) procedures. Biology (Basel). 2021; 11(1), doi: 10.3390/biology11010034, indexed in Pubmed: 35053032.
18. Maleki M, Tajlil A, Separham A, et al. Association of neutrophil to lymphocyte ratio (NLR) with angiographic SYNTAX score in patients with non-ST-Segment elevation acute coronary syndrome (NSTE-ACS). J Cardiovasc Thorac Res. 2021; 13(3): 216–221, doi: 10.34172/jcvtr.2021.40, indexed in Pubmed: 34630969.
19. Arnold KA, Blair JE, Paul JD, et al. Monocyte and macrophage subtypes as paired cell biomarkers for coronary artery disease. Exp Physiol. 2019; 104(9): 1343–1352, doi: 10.1113/EP087827, indexed in Pubmed: 31264265.
20. Moore KJ, Sheedy FJ, Fisher EA. Macrophages in atherosclerosis: a dynamic balance. Nat Rev Immunol. 2013; 13(10): 709–721, doi: 10.1038/nri3520, indexed in Pubmed: 23995626.
21. Hochman JS, Anthopolos R, Reynolds HR, et al. ISCHEMIA Research Group. Initial invasive or conservative strategy for stable coronary disease. N Engl J Med. 2020; 382(15): 1395–1407, doi: 10.1056/NEJMoa1915922, indexed in Pubmed: 32227755.
22. Hojo Y, Ikeda U, Takahashi M, et al. Increased levels of monocyte-related cytokines in patients with unstable angina. Atherosclerosis. 2002; 161(2): 403–408, doi: 10.1016/s0021-9150(01)00636-0, indexed in Pubmed: 11888524.
23. Sato T, Takebayashi S, Kohchi K. Increased subendothelial infiltration of the coronary arteries with monocytes/macrophages in patients with unstable angina. Histological data on 14 autopsied patients. Atherosclerosis. 1987; 68(3): 191–197, doi: 10.1016/0021-9150(87)90198-5, indexed in Pubmed: 3426653.
24. Li G, Saguner AM, An J, et al. Cardiovascular disease during the COVID-19 pandemic: Think ahead, protect hearts, reduce mortality. Cardiol J. 2020; 27(5): 616–624, doi: 10.5603/CJ.a2020.0101, indexed in Pubmed: 32789839.
25. Akıl MA, Oylumlu M, Oylumlu M, et al. Predictive value of lymphocyte to monocyte ratio for cardiac syndrome X. Eur Rev Med Pharmacol Sci. 2022; 26(12): 4303–4308, doi: 10.26355/eurrev_202206_29069, indexed in Pubmed: 35776031.
26. Soleymani M, Masoudkabir F, Shabani M, et al. Updates on pharmacologic management of microvascular angina. Cardiovasc Ther. 2022; 2022: 6080258, doi: 10.1155/2022/6080258, indexed in Pubmed: 36382021.
27. Dogan A, Oylumlu M. Increased monocyte-to-HDL cholesterol ratio is related to cardiac syndrome X. Acta Cardiol. 2017; 72(5): 516–521, doi: 10.1080/00015385.2017.1299521, indexed in Pubmed: 28853337.
28. Okyay K, Yilmaz M, Yildirir A, et al. Relationship between neutrophil-to-lymphocyte ratio and impaired myocardial perfusion in cardiac syndrome X. Eur Rev Med Pharmacol Sci. 2015; 19(10): 1881–1887, indexed in Pubmed: 26044235.
29. Schirmer SH, Fledderus JO, van der Laan AM, et al. Suppression of inflammatory signaling in monocytes from patients with coronary artery disease. J Mol Cell Cardiol. 2009; 46(2): 177–185, doi: 10.1016/j.yjmcc.2008.10.029, indexed in Pubmed: 19059264.
30. Gdowski MA, Murthy VL, Doering M, et al. Association of isolated coronary microvascular dysfunction with mortality and major adverse cardiac events: a systematic review and meta-analysis of aggregate data. J Am Heart Assoc. 2020; 9(9): e014954, doi: 10.1161/JAHA.119.014954, indexed in Pubmed: 32345133.
31. Murthy VL, Naya M, Taqueti VR, et al. Effects of sex on coronary microvascular dysfunction and cardiac outcomes. Circulation. 2014; 129(24): 2518–2527, doi: 10.1161/CIRCULATIONAHA.113.008507, indexed in Pubmed: 24787469.
32. Pasqualetto MC, Tuttolomondo D, Cutruzzolà A, et al. Human coronary inflammation by computed tomography: Relationship with coronary microvascular dysfunction. Int J Cardiol. 2021; 336: 8–13, doi: 10.1016/j.ijcard.2021.05.040, indexed in Pubmed: 34052238.
33. Cimmino G, Di Serafino L, Cirillo P. Pathophysiology and mechanisms of acute coronary syndromes: atherothrombosis, immune-inflammation, and beyond. Expert Rev Cardiovasc Ther. 2022; 20(5): 351–362, doi: 10.1080/14779072.2022.2074836, indexed in Pubmed: 35510629.
34. Johannesen CD, Mortensen MB, Langsted A, et al. Apolipoprotein B and non-hdl cholesterol better reflect residual risk than LDL cholesterol in statin-treated patients. J Am Coll Cardiol. 2021; 77(11): 1439–1450, doi: 10.1016/j.jacc.2021.01.027, indexed in Pubmed: 33736827.
35. Ridker PM, Bhatt DL, Pradhan AD, et al. Inflammation and cholesterol as predictors of cardiovascular events among patients receiving statin therapy: a collaborative analysis of three randomised trials. Lancet. 2023; 401(10384): 1293–1301, doi: 10.1016/S0140-6736(23)00215-5, indexed in Pubmed: 36893777.
36. Andreotti F, Maggioni AP, Scambia G. Sex- and genderspecific precision medicine for chronic coronary syndromes: challenges and opportunities. Kardiol Pol. 2021; 79(4): 373–375, doi: 10.33963/KP.15948, indexed in Pubmed: 33896157.

37. Kozieł P, Jankowski P, Kosior DA, et al. Smoking cessation in patients with established coronary artery disease: data from the POLASPIRE survey. Kardiol Pol. 2021; 79(4): 418–425, doi: 10.33963/KP.15854, indexed in Pubmed: 33687865.
38. Paquette M, Bernard S, Baass A. Hemoglobin concentration, hematocrit and red blood cell count predict major adverse cardiovascular events in patients with familial hypercholesterolemia. Atherosclerosis. 2021; 335: 41–46, doi: 10.1016/j.atherosclerosis.2021.09.015, indexed in Pubmed: 34547589.
39. Ramljak S, Lock JP, Schipper C, et al. Hematocrit interference of blood glucose meters for patient self-measurement. J Diabetes Sci Technol. 2013; 7(1): 179–189, doi: 10.1177/193229681300700123, indexed in Pubmed: 23439176.
40. Liu F, Ma G, Tong C, et al. Elevated blood urea nitrogen-to-creatinine ratio increased the risk of coronary artery disease in patients living with type 2 diabetes mellitus. BMC Endocr Disord. 2022; 22(1): 50, doi: 10.1186/s12902-022-00954-3, indexed in Pubmed: 35227230.