Predictive Value of Lymphocyte to Monocyte Count Ratio on Complete Occlusion of Infarct-Related Arteries in Patients with Non-ST Segment Elevation Myocardial Infarction

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Research Article

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Abstract

Background

Lymphocytes and monocytes are important inflammatory cells in the body, which are involved in the whole process of the formation, progression and rupture of coronary atherosclerotic plaque. The purpose of this study was to explore the predictive value of Lymphocytes to monocytes count rate (LMR) for complete occlusion of infarct-related vessels in NSTEMI patients.

Methods

General information and laboratory examination data of patients with acute myocardial infarction in Henan Provincial People's Hospital from November 2020 to July 2021 were analysed.

Results

We evaluated 103 patients, of which 86 were males and 17 were females. There were 55 cases in complete occlusion group (CO) and 48 cases in incomplete occlusion group (IO). The shock index of CO group was significantly higher than that of IO group (0.6658 ± 0.15199 vs 0.6055 ± 0.12647, t = 2.17, P = 0.032). The APTT and LMR in CO group were significantly lower than those in IO group (28.744 ± 2.912 VS 31.072 ± 6.199, t = 2.383, p = 0.020; 3.475 ± 1.211 VS 4.634 ± 1.588, t = 4.12, p < 0.001, respectively). Univariate and multivariate logistic regression analysis showed that LMR and APTT were independent risk factors for incomplete occlusion of infarct-related vessels in NSTEMI patients (LMR OR = 1.833, 95%CI: 1.318–2.550,P < 001; APTT OR = 1.155, 95%CI: 1.018–1.309,p = 0.025). ROC curve was used to evaluate the predictive value of LMR for incomplete occlusion of infarct-related vessels in NSTEMI patients (AUC = 0.708, 95%CI: 0.608–0.807, P < 0.001), the positive predictive value was 79.3%, the negative predictive value was 66.2%, and the accuracy was 70.0%.

Conclusions

LMR has certain value in predicting whether the infarct-related vessels in NSTEMI patients are completely occluded. High LMR is an independent predictor of incomplete occlusion of infarct related vessels in NSTEMI patients. Therefore, LMR may be used in the emergency department for preoperative risk stratification of NSTEMI patients in the future.

Background

Worldwide, acute myocardial infarction is one of the main causes of sudden death. For such people, early diagnosis and timely percutaneous coronary intervention are important measures to reduce the risk of death. The electrocardiogram(ECG)is the main tool for diagnosing acute myocardial infarction and

initiating reperfusion therapy. However, it is well known that at present, ECG has some difficulties in diagnosing complete occlusion of infarct-related artery (IRA) in patients with non-ST-segment elevation myocardial infarction (NSTEMI). ECG lacks typical signs of complete occlusion of infarct-related vessels, which may lead to delayed treatment, enlarged infarct area and increased mortality(1, 2).

Lymphocytes and monocytes are important inflammatory cells in the body. Recent studies have shown that they are involved in the whole process of the formation, progression and rupture of coronary atherosclerotic plaque(3, 4). The ratio of lymphocyte to monocyte count rate (LMR) is a new inflammatory index after the integration of lymphocyte and monocyte. Lower LMR is related to the higher incidence of unstable angina pectoris or myocardial infarction in patients with coronary heart disease, and low LMR is an independent predictor of rehospitalization of heart failure in patients with coronary heart disease(5–7). The purpose of this study was to explore the predictive value of easy-to-obtain LMR for complete occlusion of infarct-related vessels in NSTEMI patients

Method

Patients with acute myocardial infarction in Henan Provincial People's Hospital from November 2020 to July 2021 were selected as the research objects. 103 consecutive patients who met the inclusion and exclusion criteria were enrolled, of which 86 were males and 17 were females; the average age was 58.3 ± 13.2 years old. Inclusion criteria: 1. Meet the diagnostic criteria of NSTEMI: Troponin T level is higher than the 99th percentile of the upper limit of reference, and ST-T changes on the ECG without ST-segment elevation(8). 2. Within 12 hours of onset. Exclusion criteria: Patients with intravenous thrombolysis, coronary artery bypass grafting, severe heart failure, liver and kidney dysfunction, and patients with recent trauma, massive bleeding or surgery, and patients with infectious diseases, tumors, hematological diseases, and other patients with incomplete relevant data.

Clinical data of all patients were collected, including gender, age, height, weight, smoking history, history of hypertension, history of diabetes and history of myocardial infarction. All patients were measured blood pressure and heart rate in the emergency department after admission. Blood routine, renal function, blood lipids, high-sensitivity C-reactive protein (hs-CRP), and markers of myocardial injury were taken from venous blood.

All patients without contraindications were given aspirin (300 mg) and clopidogrel (600 mg) before operation. Continue to take 100 mg aspirin and 75 mg clopidogrel every day. Heparin 1 mg / kg was injected intravenously before coronary angiography. Two experienced doctors completed coronary angiography via radial artery or femoral artery and evaluated the results of coronary angiography to determine whether the infarct-related vessels were completely occluded. There were 55 cases in complete occlusion (CO) group and 48 cases in incomplete occlusion (IO) group. The infarct-related vessels were comprehensively determined according to the results of ECG, echocardiography and coronary angiography. Complete occlusion of infarct-related vessels was defined as forward TIMI flow grade 0, and

incomplete occlusion was defined as forward TIMI flow grade 1, 2 or 3. Follow-up treatment strategies, including stent implantation, drug balloon or conservative treatment, are determined by the surgeon.

The study was approved by the Medical Ethics Committee of Henan Provincial People's Hospital and was conducted in accordance with the principles of the Declaration of Helsinki. In addition to this, individual informed consent was obtained from all participants.

Statistical analysis:

SPSS 21.0 statistical software was used for data processing. Continuous variables were expressed as mean ± standard deviation, two independent sample t-tests were used for comparison between groups; categorical variables were expressed as percentages, and $\chi 2$ test or Fisher's exact probability method was used for comparison between groups. Significant variables in the univariate analysis were included in the logistic regression model, and the influencing factors of the complete occlusion of the infarct-related vessels were analyzed by the stepwise regression condition method. The receiver operating characteristic (ROC) curve was used to determine the optimal critical value of LMR to predict CO. A two-tailed P value of < 0.05 was considered significant.

Results

General information and laboratory examination of the study groups

The general information and laboratory examination of patients are shown in Table 1. There were no significant differences in weight, height, BMI, history of hypertension, C-reactive protein levels, uric acid, AST, FT3, and FT4 levels between the two groups; The mean age, INR and creatinine levels in the complete occlusion group were slightly lower than those in the incomplete occlusion group; on the contrary, the proportion of men, history of diabetes, history of myocardial infarction, smoking, and the average levels of glycosylated hemoglobin, hemoglobin, platelets, LDH, and CKMB in the complete occlusion group were slightly higher than those in the incomplete occlusion group, but the difference was not statistically significant. The shock index of the complete occlusion group was significantly higher than that of the incomplete occlusion group (0.6658 ± 0.15199 VS 0.6055 ± 0.12647, $t = 2.17$, $p = 0.032$). The APTT and lymphocyte-monocyte count ratios (LMR) of the complete occlusion group were significantly lower than those of the incomplete occlusion group (28.744 ± 2.912 VS 31.072 ± 6.199, $t = 2.383$, $p = 0.020$; 3.475 ± 1.211 VS 4.634 ± 1.588, $t = 4.12$, $p < 0.001$, respectively), and the difference was statistically significant.

Table 1
The general information and laboratory examination of patients

Variables	All(103)	CO group(55)	IO group(48)	t/X²	P
Age (y)	58.3 ± 13.2	57.1 ± 13.5	59.6 ± 12.9	0.963	0.338
Male gender (%)	86(83.5)	48(87.3)	38(79.2)	1.222	0..269
BMI (kg/m²)	26.0878 ± 3.28968	26.2461 ± 3.0604	25.9064 ± 3.55838	0.521	0.604
Weight(Kg)	73.558 ± 10.0682	74.234 ± 9.9067	72.782 ± 10.2995	0.728	0.468
Height(cm)	167.928 ± 6.9733	168.188 ± 7.4386	167.63 ± 6.4643	0.404	0.687
Shock index	0.6377 ± 0.14322	0.6658 ± 0.15199	0.6055 ± 0.12647	2.17	**0.032**
Heart rate(beat/min)	78.881 ± 14.1595	80.832 ± 12.8711	76.646 ± 15.3366	1.506	0.135
SBP(mmHg)	126.415 ± 21.6817	124.596 ± 21.933	128.5 ± 21.4288	0.911	0.365
DBP(mmHg)	78.197 ± 16.0513	78.515 ± 15.6034	77.833 ± 16.7082	0.214	0.831
Coronary risk factors Diabetes mellitus	18(17.5)	12(21.8)	6(12.5)	1.543	0.214
Hypertension	50(48.5)	27(49.1)	23(47.9)	0.014	0.905
Previous myocardial infarction	14(13.6)	8(14.5)	6(12.5)	0.091	0.763
Smoking	60(58.3)	36(65.5)	24(50.0)	2.517	0.113
LMR	4.015 ± 1.509	3.475 ± 1.211	4.634 ± 1.588	4.12	**< 0.001**
Lymphocyte count(10^9/L)	1.693 ± 0.803	1.551 ± 0.749	1.856 ± 0.840	1.951	0.054
Monocyte count(10^9/L)	0.450 ± 0.189	0.471 ± 0.199	0.427 ± 0.175	1.185	0.239
Glycosylated hemoglobin(%)	6.351 ± 1.150	6.474 ± 1.423	6.210 ± 0.711	1.213	0.228
Hemoglobin(g/L)	144.476 ± 17.024	146.327 ± 18.348	142.354 ± 15.284	1.184	0.239
C-reactive protein(mg/L)	5.036 ± 9.359	5.267 ± 12.029	4.772 ± 4.872	0.267	0.790

Variables	All(103)	CO group(55)	IO group(48)	t/X²	P
Platelet count(10^9/L)	202.922 ± 50.356	208.891 ± 51.351	196.083 ± 48.827	1.292	0.199
APTT(S)	29.829 ± 4.854	28.744 ± 2.912	31.072 ± 6.199	2.383	**0.020**
INR	1.078 ± 0.152	1.063 ± 0.150	1.094 ± 0.154	1.052	0.295
Creatinine(umol/L)	74.710 ± 69.567	67.919 ± 20.112	82.491 ± 99.611	1.061	0.291
Uric Acid(umol/L)	330.847 ± 82.729	336.321 ± 91.370	324.574 ± 72.015	0.717	0.475
AST(U/L)	77.948 ± 87.975	83.866 ± 89.400	71.167 ± 86.752	0.729	0.468
LDH(U/L)	654.092 ± 428.949	705.863 ± 443.993	594.771 ± 407.546	1.316	0.191
CKMB(U/L)	71.225 ± 87.603	82.477 ± 102.507	58.331 ± 65.300	1.402	0.164
FT3(pmol/L)	3.859 ± 0.951	3.772 ± 0.984	3.960 ± 0.911	1.002	0.319
FT4(pmol/L)	15.025 ± 2.952	15.047 ± 2.961	15.001 ± 2.973	0.079	0.937

Analysis of influencing factors on whether the infarct-related vessels are completely occluded in patients with NSTEMI

Variables with statistical significance in univariate analysis (shock index, APTT, LMR) were included in the multivariate logistic regression model and analyzed by stepwise regression condition. The results are shown in Table 2. Both LMR and APTT are independent risk factors for incomplete occlusion of infarct-related vessels in NSTEMI patients (LMR OR = 1.833, 95% confidence interval (CI): 1.318–2.550,P < 001; APTT OR = 1.155, 95% confidence interval (CI): 1.018–1.309,p = 0.025).

Table 2
Univariate and multivariate logistic regression analysis

	Univariate analysis		Multivariate analysis	
	OR (95% CI)	P	OR (95% CI)	P
Shock index	0.037(0.002–0.855)	0.04		
LMR	1.802(1.311–2.477)	< 0.001	1.833(1.318–2.550)	< 0.001
APTT	1.147(1.022–1.287)	0.02	1.155(1.018–1.309)	0.025

Predictive value of LMR for incomplete occlusion of infarct-related vessels in patients with NSTEMI

The ROC curve of LMR predicting incomplete occlusion of infarct-related vessels in NSTEMI patients is shown in Fig. 1 (AUC = 0.708, 95% confidence interval (CI): 0.68–0.807, $p < 0.001$). The best cut-off value is 4.77. When the LMR is greater than 4.77, the positive predictive value of incomplete occlusion of infarct-related vessels in NSTEMI patients is 79.3%, the negative predictive value is 66.2%, and the accuracy is 70.0%.

Discussion

The main findings of this study are as follows: firstly, High LMR and APTT are independent predictors of incomplete occlusion of infarct-related vessels in NSTEMI patients; secondly, When the LMR is greater than 4.77, 79.3% of the infarct-related vessels in NSTEMI patients are incomplete occlusion. When the LMR is less than 4.77, 66.2% of the infarct-related vessels in NSTEMI patients are complete occlusion, and the prediction accuracy is 70.0%.

NSTEMI is dangerous and has a high mortality and disability rate. Early and non-invasive evaluation of the severity of coronary artery disease in NSTEMI patients is helpful to carry out risk stratification management, reduce the incidence of complications and improve the prognosis. Especially for NSTEMI patients with complete vascular occlusion, early intervention has better clinical and angiographic results than conservative treatment or delayed PCI(9). This may be because complete vascular occlusion tends to have larger infarct area and worse clinical prognosis(10). Coronary atherosclerotic plaque rupture and acute thrombosis are the main pathological basis of NSTEMI. The activation of inflammatory cells and enhanced inflammatory response can lead to plaque instability, accelerate plaque rupture and promote thrombosis(11). Lymphocytes and monocytes are important inflammatory cells in the body. They both play an important role in the occurrence, development and rupture of coronary atherosclerotic plaque. Studies have shown that the decrease of lymphocytes can aggravate the load of coronary atherosclerotic plaques, accelerate the formation of plaque lipid necrotic cores, and weaken the fibrous caps of plaques. It is an important reason for the rupture of coronary atherosclerotic plaques(4, 12). Studies have shown that monocytes can adhere to the intima of the arteries and directly damage the vascular endothelium, and then enter the subintimal space of the artery wall and differentiate into macrophages. Through their own scavenger receptors, they can take up a large amount of oxidized-LDL to generate foam cells. This results in the decrease of plaque stability. In addition, monocyte-macrophages can also increase the risk of plaque rupture by secreting a variety of inflammatory factors, promoting the production of matrix metalloproteinases and inducing apoptosis of smooth muscle cells(3). The results of this study showed that the average lymphocyte count of the incomplete occlusion group tended to be higher than that of the complete occlusion group, and the average monocyte count tended to be lower than that of the complete occlusion group. The average LMR in incomplete occlusion group was significantly higher than that of the occlusion group, which is consistent with the previous research conclusions(13).

When myocardial infarction occurs, the patient's sympathetic nerve excites and releases a large amount of catecholamines, which may interact with α2-adrenergic receptors on platelets to convert factor XII into XIIa, or activate factor XII through the kininase system. The activation of factor XII initiates the endogenous coagulation pathway, which is monitored by APTT and is characterized by the shortening of APTT(14). Acute myocardial infarction is related to enhanced blood coagulation. In the case of unstable angina pectoris or endothelial injury, the body's hypercoagulable state can lead to complete occlusion of the coronary arteries. In this study, the APTT of the complete occlusion group was significantly shorter than that of the incomplete occlusion group, and the results were consistent with previous studies.

Shock index can reflect the perfusion status of tissue and coronary artery. It increases when acute blood volume decreases and left ventricular function is impaired. It is negatively correlated with cardiac output index, left ventricular stroke volume and mean arterial pressure. It is reported that STEMI patients with elevated shock index on admission have more obvious myocardial and microvascular injury(15). This study found that the admission shock index of the complete vascular occlusion group was significantly higher than that of the incomplete occlusion group, which is consistent with the results of previous studies.

Wang's research results showed that 27% of NSTEMI patients had complete occlusion of criminal vessels. This part of the patients had a larger infarct size and a higher 6-month mortality rate(2). The incidence of complete vascular occlusion in NSTEMI patients in our study is inconsistent with the results of Wang et al. This may be because our study is a single-center retrospective study and there is a certain selection bias. In addition, the sample size included in our study is small, and there is a certain sampling error.

Diabetes, hypertension, smoking, etc. are related to higher incidence of cardiovascular disease, more severe vascular diseases and worse clinical outcomes(16). Our study also shows a trend that the incidence of diabetes, hypertension, and smoking in the complete occlusion group is higher than that in the incomplete occlusion group. If the sample size is enlarged, this trend may show statistical significance.

Limitations

Limitations of this study include that this is a single-center retrospective study, most of the patients are male, the sample size is small, and the distribution of infarct-related blood vessels is not recorded. In addition, some NSTEMI patients may have recanalization after complete vascular infarction. When TIMI blood flow is greater than grade 0 during coronary angiography, these patients will be divided into incomplete occlusion group. Therefore, the conclusions of this study still need to be further confirmed by prospective, multi-center and large sample studies.

Conclusion

In conclusion, LMR has certain value in predicting whether the infarct-related vessels in NSTEMI patients are completely occluded. High LMR is an independent predictor of incomplete occlusion of infarct related vessels in NSTEMI patients. Therefore, LMR may be used in the emergency department for preoperative risk stratification of NSTEMI patients in the future.

Abbreviations

LMR: lymphocytes to monocytes count rate

CO group: complete occlusion group

IO group: incomplete occlusion group

APTT: activated partial thromboplastin time

IRAinfarct-related artery

NSTEMI: Non-ST-segment elevation myocardial infarction

ECG: Electrocardiogram

PCI: Percutaneous coronary intervention

TIMI: Thrombolysis in myocardial infarction

Declarations

Ethics approval and consent to participate

The study was approved by the Medical Ethics Committee of Henan Provincial People's Hospital and was conducted in accordance with the principles of the Declaration of Helsinki. In addition to this, individual informed consent was obtained from all participants.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

ZS and CY designed the study. All authors contributed to the writing of this manuscript. CY performed the coronary angiography procedures. ZS and CY performed statistical analyses and prepared figures. All authors read and approved the final manuscript.

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Not applicable

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Tables

Due to technical limitations, table 1,2 is only available as a download in the Supplemental Files section.

Figures

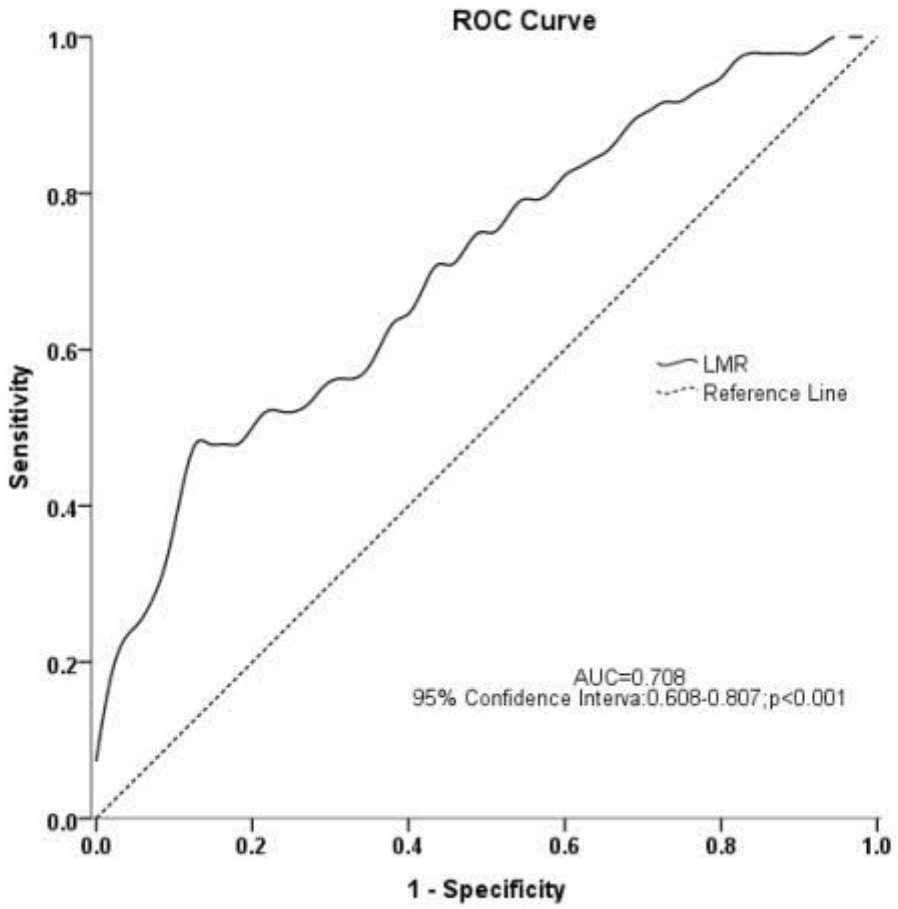

Figure 1

The ROC curve of LMR predicting incomplete occlusion of infarct-related vessels in NSTEMI patients

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Table1and2.xlsx