

Original Article

Evaluation of different serum uric acid levels on the prognosis of patients with ST-segment elevation myocardial infarction after emergency percutaneous coronary intervention

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Abstract: Objective: To explore the implication of different serum uric acid (UA) levels on the prognosis in patients with ST-segment elevation myocardial infarction (STEMI) after emergency percutaneous coronary intervention (PCI). Methods: A prospective study was conducted on 290 patients with STEMI who underwent PCI and were combined with hyperuricemia. According to high and low control levels of serum UA at initial diagnosis, they were divided into a low-level group with 85 cases, a medium-level group with 105 cases, and a high-level group with 100 cases. The status of coronary angiography and neutrophil/lymphocyte ratio (NLR) in the different groups were compared. The linear correlation between UA and NLR was analyzed by Pearson correlation analysis. The left ventricular function at 3 months after operation and the incidence of adverse events in the 5-year of follow-up visit were determined. Results: There was a statistical difference in the proportion of triple-vessel lesion among three groups ($P < 0.05$), and the incidence of triple-vessel lesion in the high-level group was higher than that in the low-level and medium-level groups (all $P < 0.05$). There was a statistical difference in the NLR level of the three groups ($P < 0.05$), and the NLR level in the high-level group was higher than that in the low-level and medium-level groups (all $P < 0.05$). The UA level was positively correlated with the peripheral blood NLR ($r = 0.325$, $P < 0.001$). After treatment, the left ventricular ejection fraction (LVEF) of patients in the high-level group was lower than that in the low-level and medium-level groups (all $P < 0.05$), while the left ventricular end-systolic diameter (LVESD), left ventricular end-diastolic diameter (LVEDD) and left atrial diastolic diameter (LADD) were higher than those in the low-level and medium-level groups (all $P < 0.05$). The number of cases with heart failure and cerebrovascular events in the high-level group were more than those in the low-level group, and the total incidence of adverse events in the high-level group was higher than that in the low-level and medium-level groups (all $P < 0.05$). Conclusion: The elevated serum UA level is correlated with the occurrence of hypertension, the elevated NLR level and the decreased left ventricular function. The elevated serum UA level increases the incidence of adverse events after emergency PCI in patients with STEMI.

Keywords: Serum uric acid, ST-segment elevation myocardial infarction, post-PCI, adverse events, prognosis

Introduction

Coronary heart disease is a common disease in elderly patients, and its morbidity and mortality are on the rise every year. In China, the prevalence rate of coronary heart disease is about 0.77-1.24%, and the mortality rate in urban populations is 107.5 per 100,000 people, which is higher than that of rural populations of 105.37 per 100,000 [1]. STEMI, a type of coronary heart disease, it is characterized by an acute onset, high mortality and disability rate. The main pathogenesis of STEMI is the

ischemic necrosis of myocardial cells caused by the sharp drop in coronary artery blood supply [2, 3]. The most effective treatment, clinically, for STEMI is to dredge the blocked vessel using PCI [4, 5]. However, studies have found that PCI treatment can achieve better curative effects in short term, while long-term studies have indicated that patients still have a high mortality rate and incidence of major adverse cardiovascular events (MACE) [4, 5]. Therefore, it is particularly important to actively search for risk factors or markers for adverse events in patients with STEMI.

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Serum UA has a wide range of physiological functions in the human body [6]. Uric acid itself has antioxidant properties, which can reduce the occurrence of oxidative stress in the body, and may have a certain neuroprotective effect [7, 8]. However, the UA level significantly increases due to the increased oxidative stress response in the body caused by injury. The properties of high concentration of UA in the blood are transformed from anti-oxidation to pro-oxidation, which further promotes the oxidation of lipoproteins in atherosclerotic plaques and the proliferation of smooth muscle cells, and finally causes damage to the vascular endothelium [9]. The incidence of hyperuricemia is increasing annually, and the elevation of UA level can promote the oxidative stress response and the release of inflammatory factors in the human body [10]. Studies have shown that the elevation of UA level can increase the hospitalization rate and fatality rate of patients with acute coronary syndrome [11]. However, there are few studies on whether the serum UA level at the initial diagnosis can predict the long-term poor prognosis of STEMI after PCI treatment. Based on this, this study conducted a 5-year prognostic follow-up visit for patients with STEMI after PCI, and investigated the correlation between UA level and long-term prognosis. The reports are as follows.

Materials and methods

Clinical data

A total of 290 patients who were treated in the Department of Cardiology in Aviation General Hospital from January 2014 to July 2015 were selected for this prospective study, and they all underwent PCI and were combined with hyperuricemia. Based on the high and low control levels of serum UA at initial diagnosis, patients were divided into three groups, with 85 cases in the low-level group, 105 cases in the medium-level group, and 100 cases in the high-level group. This study was approved by the Ethics Committee of Aviation General Hospital. All patients included in this study signed an informed consent form.

Inclusion and exclusion criteria

Inclusion criteria: (1) Patients met the diagnostic criteria of STEMI established by the Chinese

Medical Association and were confirmed by coronary angiography to be treated with PCI; (2) Patients were above 18 years old; (3) This was the first episode of STEMI in patients; (4) Patients received PCI treatment; (5) Patients were previously diagnosed with hyperuricemia and took urate lowering drugs [12].

Exclusion criteria: (1) Patients with congenital heart disease, persistent atrial fibrillation, cardiomyopathy, etc; (2) Patients with malignant tumors; (3) Patients combined with hypotensive shock and severe electrolyte disorders; (4) Patients with blood system diseases.

Methods

The normal level of serum UA is 210-420 $\mu\text{mol/L}$ for men and 150-360 $\mu\text{mol/L}$ for women. Patients were grouped according to the inclusion level of UA: low-level group (UA < 210 $\mu\text{mol/L}$ for men and UA < 150 $\mu\text{mol/L}$ for women), medium-level group (210 $\mu\text{mol/L}$ \leq UA \leq 420 $\mu\text{mol/L}$ for men, 150 $\mu\text{mol/L}$ \leq UA \leq 360 $\mu\text{mol/L}$ for women) and high-level group (UA > 420 $\mu\text{mol/L}$ for men and UA > 360 $\mu\text{mol/L}$ for women) [7]. The relevant data and indicators of patients after admission were recorded.

Outcome measures

Observation of coronary angiography in different groups: The lesion location included the left anterior descending artery, circumflex artery and right coronary lesions. The lesion vessel number included single-vessel, double-vessel and triple-vessel lesions. Whether intra-aortic balloon counter-pulsation and thrombus aspiration technology were used in the angiography process were observed.

Determination of NLR before operation: Before operation, two tubes of cubital venous blood were extracted after admission, with 5 mL in each tube. A routine blood test was performed by the Coulter LH750 automatic blood cell analyzer (Beckman Coulter, USA). The correlation between UA and NLR was analyzed by Pearson correlation analysis.

Assessment of left ventricular function at 3 months after operation: Cardiac ultrasonography was performed by cardiac color Doppler ultrasound (Model: PHILIPS IU22, Philips com-

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Table 1. Comparison of general information (n, x ± sd)

Items	Low-level group (n = 85)	Medium-level group (n = 105)	High-level group (n = 100)	χ ² /F	P
Gender (Male/Female)	69/16	88/17	85/15	0.502	0.778
Age (year)	62.30±9.30	61.30±9.10	62.90±9.60	0.769	0.464
Systolic blood pressure (mmHg)	152.18±7.19	159.67±8.20*	164.84±7.95***#	60.310	< 0.001
Diastolic blood pressure (mmHg)	83.18±7.19	88.20±7.82*	92.68±7.25***#	37.421	< 0.001
Triglyceride (mmol/L)	1.77±0.64	1.78±0.63	1.81±0.68	0.097	0.907
Total cholesterol (mmol/L)	5.51±0.79	5.61±0.73	5.63±0.74	0.659	0.581
High-density lipoprotein (mmol/L)	1.09±0.37	1.13±0.35	1.14±0.37	0.479	0.620
Low-density lipoprotein (mmol/L)	3.82±0.84	3.84±0.74	3.91±0.68	0.472	0.624
Hemoglobin (g/L)	138.52±10.46	139.45±9.73	137.25±10.14	1.224	0.296
Serum albumin (g/L)	41.78±4.76	42.81±4.86	42.67±4.74	1.233	0.293
Body mass index (kg/m ²)	24.07±3.98	25.14±4.12	24.14±4.21	2.118	0.122
Fasting blood glucose (mmol/L)	7.89±3.75	8.03±4.13	8.04±4.19	0.039	0.962
Hypertension	48	69	87***#	22.220	< 0.001
Type 2 diabetes	46	65	86***#	21.234	< 0.001
Smoking	45	67	78***#	18.823	< 0.001
Taking anticoagulant drugs	36	45	49	4.421	0.109

Note: Compared with the low-level group, *P < 0.05, ***P < 0.001; compared with medium-level group, #P < 0.05.

pany, USA). The LVEF, LVESD, LVEDD and LADD were measured.

Occurrence of adverse events: The included patients were followed up for 5 years by outpatient visits and telephone, with the deadline of 31 July 2020. The adverse events including heart failure, angina pectoris, stent thrombosis occurrence, restenosis or occlusion, cerebrovascular events and death within 5 years after treatment were recorded.

Statistical analysis

SPSS 17.0 statistical software was used to analyze the data. Continuous variables were represented by mean ± standard deviation (x ± sd), and independent sample t-test was used for the data conformed to normal distribution and homogeneity of variances. The count data was expressed as the number of cases (percentage) (n, (%)), and Pearson's chi-square test (χ²) was used. The linear correlation between UA and NLR was analyzed by Pearson correlation analysis. P < 0.05 was considered statistically significant.

Results

Comparison of general information

There were differences in systolic blood pressure, diastolic blood pressure, hypertension,

type 2 diabetes and smoking among the three groups (P < 0.001). There were no statistical differences in other general information (all P > 0.05). See **Table 1**.

Comparison of coronary angiography

There was a statistical difference in the proportion of triple-vessel lesions among the three groups (P < 0.05). The incidence of triple-vessel lesions in the high-level group was higher than that in the low-level and medium-level groups (all P < 0.05). See **Table 2**.

NLR levels of the three groups and the correlation between UA and NLR

There was statistical difference in NLR level of the three groups (P < 0.05), and the NLR level in the high-level group was higher than that in the low-level and medium-level groups (all P < 0.05). The UA level was positively correlated with NLR (P < 0.001). See **Table 3** and **Figure 1**.

Comparison of cardiac function after PCI treatment

After treatment, the LVEF of patients in the high-level group was lower than that in the low-level and medium-level groups (all P < 0.05), while the LVESD, LVEDD and LADD were higher than those in the low-level and medium-level groups (all P < 0.05). See **Table 4**.

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Table 2. Comparison of coronary angiography

Items	Low-level group (n = 85)	Medium-level group (n = 105)	High-level group (n = 100)	χ^2	P
Left anterior descending artery lesion	64	77	75	0.117	0.943
Circumflex artery lesion	35	42	42	0.086	0.958
Right coronary lesion	46	51	62	3.754	0.153
Lesion vessel number					
Single-vessel lesion	42	55	50	0.195	0.907
Double-vessel lesion	26	35	21	4.159	0.125
Triple-vessel lesion	17	15	29*.#	6.743	0.034
Intra-aortic balloon counter-pulsation	15	21	23	0.824	0.662
Thrombus aspiration technology	29	34	38	0.124	0.940

Note: Compared with the low-level group, *P < 0.05; compared with medium-level group, #P < 0.05.

Table 3. Comparison of NLR levels of the three groups

Items	Low-level group (n = 85)	Medium-level group (n = 105)	High-level group (n = 100)	F	P
NLR (%)	3.78±1.69	3.81±2.01	4.36±1.41*.#	3.491	0.032

Note: Compared with the low-level group, *P < 0.05; compared with medium-level group, #P < 0.05. NLR: neutrophil/lymphocyte ratio.

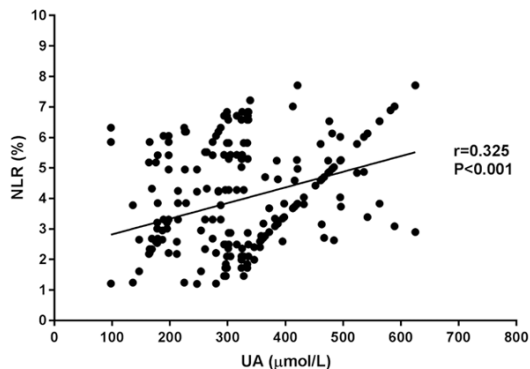


Figure 1. Correlation between UA and NLR. NLR: neutrophil/lymphocyte ratio; UA: uric acid.

Comparison of the incidence of adverse events within 5 years

The number of cases with heart failure and cerebrovascular events in the high-level group were more than that in the low-level group, and the total incidence of adverse events in the high-level group (74.00%) was higher than that in the low-level group (34.12%) and medium-level group (48.57%) (all P < 0.05). See **Table 5**.

Discussion

The most effective treatment for patients with STEMI is PCI [13, 14]. Studies have shown that

hyperuricemia is an independent risk factor for cardiovascular disease [15]. Previous studies have found that high level UA can lead to the occurrence of short-term MACE [16]. Hyperuricemia can increase the occurrence of hypertension, and the risk of hypertension increases by 15%-23% with every 60 mmol/L increase of serum UA [17]. This study indicated that blood pressure increased with the elevation of uric acid, which was consistent with the above findings.

Previous study showed that high level UA in the human body can promote the release of inflammatory factors and aggravate the oxidative stress response [18]. NLR is a predictor of inflammation. Study suggested that NLR level can be used as an evaluation indicator for the long-term prognosis of patients with acute coronary syndrome after PCI [19], and studies have indicated that NLR also plays an important role in the occurrence and development of other heart diseases [20-22]. In this study, it was found that UA was positively correlated with NLR, which may be associated with the high level of UA that promotes the release of inflammatory factors and increases the inflammation response, thereby resulting in the elevation of NLR *in vivo*. Aggravation of inflammation is also an important cause of vascular disease. In this study, the proportion of triple-

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Table 4. Comparison of cardiac function after PCI treatment

Items	Low-level group (n = 85)	Medium-level group (n = 105)	High-level group (n = 100)	F	P
LVEF (%)	47.32±12.32	44.54±11.22	41.16±9.67***.#	7.681	< 0.001
LVESD (mm)	33.98±7.62	34.23±7.84	37.52±9.14***.#	5.146	0.005
LVEDD (mm)	40.06±7.62	42.18±7.92	45.82±10.24***.#	10.481	< 0.001
LADD (mm)	30.82±7.89	32.76±8.02	35.72±8.37***.#	8.652	< 0.001

Note: Compared with the low-level group, ***P < 0.001; compared with medium-level group, #P < 0.05, **P < 0.01. PCI: percutaneous coronary intervention; LVEF: left ventricular ejection fraction; LVESD: left ventricular end-systolic diameter; LVEDD: left ventricular end-diastolic diameter; LADD: left atrial diastolic diameter.

Table 5. Comparison of the incidence of adverse events within 5 years

Items	Low-level group (n = 85)	Medium-level group (n = 105)	High-level group (n = 100)	χ ²	P
Heart failure	19	33	44*.#	9.931	0.007
Angina pectoris	4	5	6	0.213	0.889
Stent thrombosis occurrence, restenosis or occlusion	4	8	12	3.341	0.191
Cerebrovascular events	1	3	8*	6.074	0.048
Death	1	2	4	1.736	0.420
Total cases	29 (34.12)	51 (48.57)	74 (74.00)*.#	10.346	0.006

Note: Compared with the low-level group, *P < 0.05; compared with medium-level group, #P < 0.05.

vessel lesions in the high-UA level group increased significantly, which may be related to the above research mechanism. Since UA is closely related to the occurrence of hypertension, study showed that UA also increases the incidence of cardiovascular adverse events while promotes the occurrence of hypertension [23]. Long-term hypertension can lead to left heart dysfunction, and study showed that NLR in patients with PCI treatment is negatively correlated with LVEF. In patients with acute coronary syndrome, the NLR level significantly increases when LVEF value is less than 50%, indicating that the higher the NLR, the more serious the myocardial damage, the lower the cardiac function and the more likely for left cardiac insufficiency [24]. This study also found that with the increase of UA levels, the left ventricular dysfunction was more obvious, which may be an important factor in increasing long-term adverse events.

UA is an independent risk factor for cardiovascular disease, which can promote a poor prognosis [25, 26]. Study showed that compared with the non-hyperuricemia group, the risks of all-cause mortality and cardiovascular events have significantly increased in the hyperuricemia group [27]. Monitoring the NLR level in patients with acute coronary syndrome can predict their long-term prognosis and the

occurrence of adverse events. The lower the NLR level, the better the prognosis and the lower the incidence of adverse events [28]. Study showed that when the NLR value is 3.39, the sensitivity to predict 2-year all-cause mortality and incidence of adverse events in patients with acute coronary syndrome is 70% and the specificity is 77% [29]. Another study showed that NLR can also predict all-cause mortality and cardiogenic death after PCI treatment in patients with stable coronary artery disease [30]. This study showed that UA was positively correlated with NLR, and the incidence of 5-year adverse events was different in patients with different UA levels, which may be related to the above mechanisms.

This is a single-center study with small sample size, and the effect of UA intervention on prognosis was not investigated. Therefore, a multi-center randomized controlled study can be conducted to expand the sample size. The study of UA intervention on the incidence of adverse events in patients with STEMI after emergency PCI can be further researched.

To sum up, the increase of serum UA promotes the occurrence of hypertension, elevates NLR, decreases of left ventricular function and increases the incidence of adverse events after emergency PCI in patients with STEMI.

Disclosure of conflict of interest

None.

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