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Original Article

Prognostic value of NT-proBNP and uric acid in acute ST-segment elevation myocardial infarction patients after complete revascularization

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Abstract: Objectives: To explore the prognostic value of N-terminal pro-B-type natriuretic peptide (NT-proBNP) and uric acid (UA) in acute ST-segment elevation myocardial infarction (STEMI) patients after complete revascularization (CR). Methods: The clinical and physical data from 125 acute STEMI patients (research group) who underwent CR between December 2017 and December 2020 and 60 healthy individuals (control group) who concurrently underwent physical examinations in the Affiliated Hospital of Guizhou Medical University were retrospectively analyzed in this study. Serum samples were collected from both groups to determine the levels of NT-proBNP and UA. The 3-year follow-up data of acute STEMI patients were collected, which were used to group the patients into a good and a poor prognosis group based on their prognoses to comparatively analyze NT-proBNP and UA levels. Receiver operating characteristic (ROC) curves were drawn to analyze the prognostic value of NT-proBNP and UA in STEMI patients following CR, and survival curves were plotted to observe their influences on patients' 3-year overall survival (OS). Meanwhile, a univariate analysis was conducted to identify factors associated with the 3-year OS of acute STEMI patients after CR. Results: The data showed significantly higher expression levels of serum NT-proBNP and UA in acute STEMI patients than in the controls. Besides, the good prognosis group exhibited markedly lower serum NT-proBNP and UA levels than the poor prognosis group. The areas under the curve (AUCs) of NT-proBNP and UA in predicting the prognosis of acute STEMI patients after CR were all above 0.700, and the AUC of their combined detection reached over 0.800. In addition, high serum NT-proBNP and UA levels were strongly associated with lower 3-year OS rates. As indicated by the univariate analysis, a history of smoking and alcoholism as well as high NT-proBNP and UA levels were closely associated with 3-year OS in acute STEMI patients after CR. Conclusions: NT-proBNP and UA have promising prognostic value in acute STEMI after CR.

Keywords: NT-proBNP, UA, complete revascularization, acute ST segment elevation, myocardial infarction, predicted value

Introduction

Worldwide, acute coronary syndrome (ACS) is a major cause of morbidity and mortality, often leading to acute myocardial infarction (AMI) in the case of ischemic injury-induced myocardial necrosis [1]. ST-segment elevation myocardial infarction (STEMI), which accounts for about one-third of ACS cases, is the most serious type of heart attack. It is characterized by the obstruction of one or more coronary arteries and the resultant restriction of blood flow to the heart [2-4]. STEMI differs from non-ST-segment elevation myocardial infarction (NSTEMI) in its electrocardiogram (ECG) characteristics but shares a similar pathophysiological basis [5]. Both types can cause acute chest discomfort such as pain, compression, tightness, and burning sensation, as well as non-specific clinical symptoms like palpitations, syncope, abdominal pain, and nausea/vomiting [6]. According to epidemiological statistics, the disease is more likely to occur in males with low socioeconomic backgrounds, but the risk of in-hospital death is higher in women, rural hospitals, and in patients of low socioeconomic status [7]. To improve outcomes for STEMI patients, identifying effective prognostic indicators is essential.

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N-terminal pro-B-type natriuretic peptide (NT-proBNP), synthesized and released by ventricular myocytes, is induced by the increased mechanical stretching or filling pressure [8, 9]. Its levels can be influenced by multiple physiological and pathological factors, including age, obesity, anemia, fluid retention, and renal insufficiency [10]. NT-proBNP can be used for the diagnosis and staging of heart failure (HF) and as an independent predictor of adverse prognosis and all-cause mortality in patients with type 2 cardiorenal syndrome [11]. Furthermore, it can be used to predict the recurrence in ACS inpatients, with certain predictive potential for complications and short-term mortality risk in STEMI patients [12]. Uric acid (UA) is the final product of purine metabolism, and its elevated serum levels are often closely linked to pathological events such as hypertension, metabolic diseases, chronic kidney disease, and acute kidney injury (AKI) [13]. Evidence has also linked UA to the development of AKI in ACS patients and monitoring the level of UA can help predict renal function and the risk of AKI in patients to a certain extent [14]. Furthermore, abnormally high serum UA level has been strongly associated with higher short- and long-term mortality rates in STEMI patients, as well as more severe inflammatory reactions after reperfusion [15].

This study aims to analyze the prognostic value of NT-proBNP and UA in acute STEMI after complete revascularization (CR), given the current scarcity of research in this field.

Data and methods

Patient information

Inclusion criteria: 1) All patients met the diagnostic criteria for STEMI and underwent CR; 2) Patients admitted to the Affiliated Hospital of Guizhou Medical University within 12 hours of onset or within 12-24 hours after presenting evidence of ischemia; 3) Patients with complete 3-year followed up data. Exclusion criteria: 1) Patients with acute/chronic infectious diseases; 2) Patients with acute pulmonary embolism or pulmonary heart disease; 3) Patients with cerebral hemorrhage, malignant tumor, impaired function of the heart, lungs, or kidneys; 4) Patients with pernicious anemia or systemic immune diseases.

Ethical approval was obtained from the Ethics Committee of the Affiliated Hospital of Guizhou Medical University. This retrospective study rigorously screened 125 acute STEMI patients who underwent CR as the research group based on the inclusion and exclusion criteria mentioned above, who were admitted to our hospital from December 2017 to December 2020. Sixty healthy individuals who concurrently underwent physical examinations were included as the control group. There were no significant differences between the two groups in general data (e.g., sex, age), making the two groups clinically comparable (all $P>0.05$).

Detection indicators

The levels of NT-proBNP and UA were recorded and comparatively analyzed between the research and control groups and between the good and poor prognosis groups. Immediately after PCI, 5 mL of venous blood was collected from each patient, and the serum was separated after centrifugation to quantify serum NT-proBNP levels by chemiluminescent immunoassay and UA levels with an automatic biochemical analyzer.

Follow-up

Follow-up was conducted over a period of 3 years, specifically at 1, 6, and 12 months after discharge and once a year thereafter. The overall survival (OS), defined as the time from diagnosis to death or last follow-up, was investigated and recorded through outpatient clinic visits or telephone inquiries.

Statistical methods

Statistical analyses were conducted using SPSS 20.0 software. Count data were expressed in the form of cases (%), and comparisons between two groups were done using X^2 tests. Quantitative data were expressed by the mean ± standard deviation, and the between-group comparisons of quantitative data were made by t tests. Receiver operating characteristic (ROC) curves were drawn, and the area under the ROC curve (AUC) was calculated to observe the predictive performance of NT-proBNP and UA for prognosis of STEMI patients. The Kaplan-Meier method was adopted to draw the 3-year OS of patients, and the Log-rank test was employed for between-group

Table 1. Comparison of general data between control and research groups

Variables	Research group (n=125)	Control group (n=60)	χ^2/t	P
Sex (male/female)	75/50	32/28	0.739	0.390
Age (years)	59.96±9.35	57.57±6.22	1.797	0.074
Body mass index (kg/m^2)	22.54±2.38	22.38±2.23	0.437	0.663
Smoking history (Yes/No)	39/86	22/38	0.548	0.459
Alcoholism history (Yes/No)	28/97	14/46	0.020	0.887
Hypertension (Yes/No)	42/83	24/36	0.724	0.395
Diabetes (Yes/No)	21/104	16/44	2.467	0.116
Hyperlipidemia (Yes/No)	20/105	13/47	0.888	0.346

comparisons. Factors affecting 3-year OS in acute STEMI patients undergoing CR were identified by univariate analysis. A *P* value less than 0.05 indicated statistical significance.

Results

Comparison of general data between the control and research groups

As shown in **Table 1**, the two groups did not differ statistically in sex, age, body mass index (BMI), smoking/alcoholism history, hypertension, diabetes, and hyperlipidemia (all P>0.05).

Comparison of serum NT-proBNP and UA levels between the control and research groups as well as between the poor and good prognosis groups

The research group exhibited notably higher serum NT-proBNP and UA levels than the control group (all P<0.001). Patients were regrouped according to if there was a major adverse cardio- and cerebrovascular event (MACCE)-related to death during the follow-up period, with 93 and 32 cases assigned to good and poor prognosis groups, respectively. Patients with good prognoses were found to have significantly lower NT-proBNP and UA levels in the serum than those in the poor prognosis group (P<0.001), as shown in **Figure 1**.

Prognostic value of NT-proBNP and UA in acute STEMI patients after CR

For the prognostic prediction of acute STEMI patients after CR, the AUC of NT-proBNP was 0.767 (95% CI: 0.654-0.879), with an optimal cutoff of 1606.00, and a sensitivity and specificity of 62.50% and 90.32%, respectively. For UA, the AUC was 0.711 (95% CI: 0.621-0.801), with an optimal cutoff of 418.50, a sensitivity of 84.38%, and a specificity of 59.14%. The AUC of their combined detection was 0.804 (95% CI: 0.705-0.903), with optimal cutoff, sensitivity, and specificity of 0.430, 62.50%, and 91.40%, respectively (**Table 2**; **Figure 2**).

Effect of serum NT-proBNP and UA levels on 3-year OS in acute STEMI patients after CR

The optimal cut-offs of serum NT-proBNP and UA for predicting the prognosis of acute STEMI patients after CR was taken as the critical points to divide patients into high and low expression groups. The correlation of the two indexes with patients' 3-year OS was then discussed. After plotting the survival curve, it was found that high levels of serum NT-proBNP and UA were closely related to significantly lower 3-year OS rate (all P<0.05) (**Figure 3**).

Univariate analysis of 3-year OS in acute STEMI patients undergoing CR

Univariate analysis showed that instead of sex, age, BMI, hypertension, diabetes, and hyperlipidemia (P>0.05); smoking, alcoholism, high NT-proBNP, and high UA were significantly associated with low 3-year OS rate in acute STEMI patients after CR (all P<0.05) (**Table 3**).

Discussion

Although revascularization strategies, reperfusion, and pharmacological interventions have reduced the risk of acute myocardial infarction (AMI) - related mortality to some extent, AMI remains a leading cause of global mortality [4]. Researchers have continuously explored prognosis prediction-associated biomarkers in STEMI patients. For example, Dong G et al. [16] proposed that platelet-to-lymphocyte ratio (PLR) can be utilized to predict the in-hospital and long-term outcomes of STEMI patients

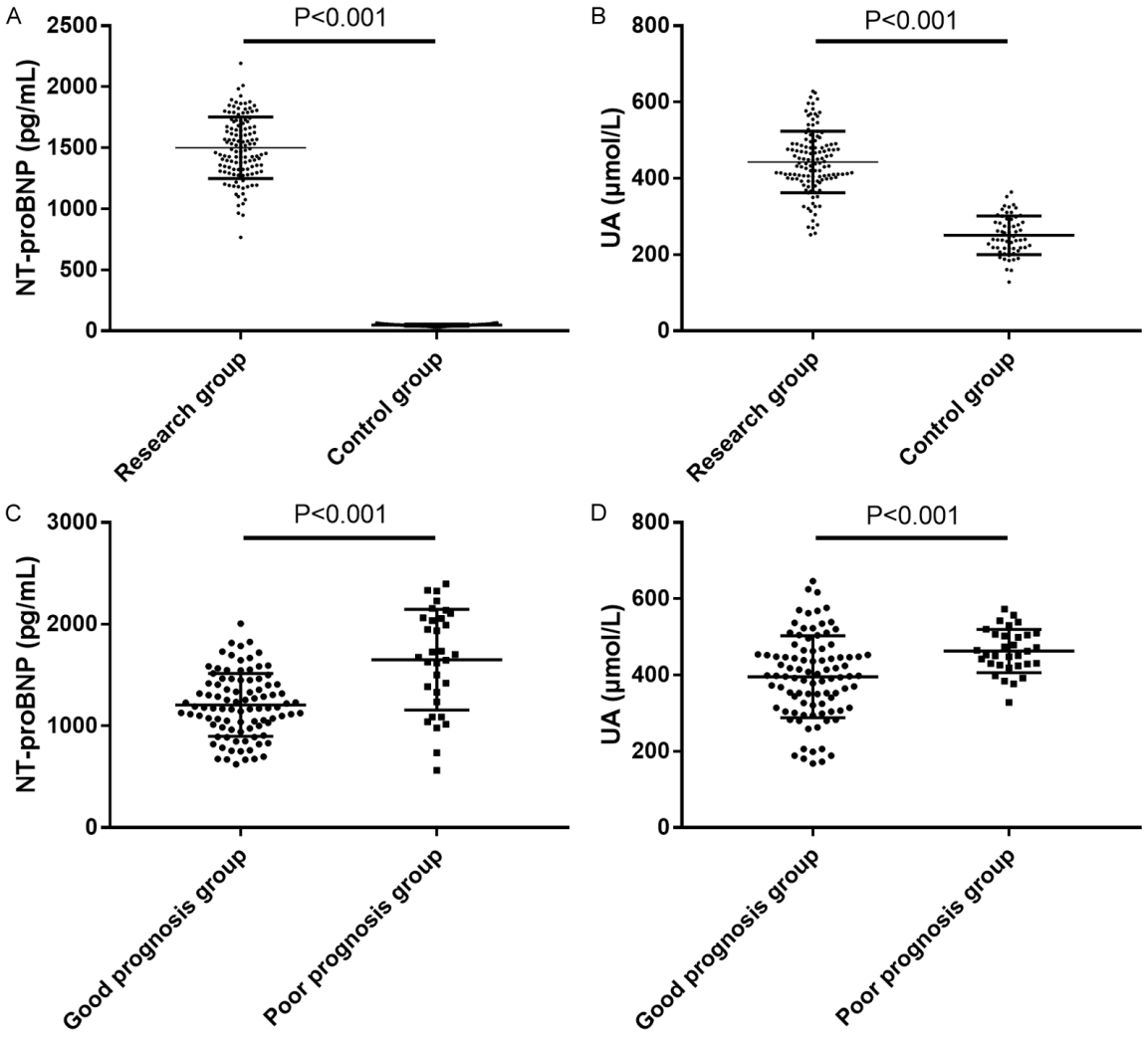

Figure 1. Comparison of serum NT-proBNP and UA levels. A. Serum NT-proBNP in control and research groups. B. Serum UA in control and research groups. C. Serum NT-proBNP in good and poor prognosis groups. D. Serum UA in good and poor prognosis groups. Note: NT-proBNP, N-terminal pro-B-type natriuretic peptide; UA, uric acid.

Table 2. Prognostic value of NT-proBNP and UA in acute STEMI patients after complete revascularization

Indicators	AUC	95% CI	S.E.	Cut-off	Sensitivity (%)	Specificity (%)
NT-proBNP	0.767	0.654-0.879	0.057	1606.00	62.50	90.32
UA	0.711	0.621-0.801	0.046	418.50	84.38	59.14
Combined detection	0.804	0.705-0.903	0.050	0.430	62.50	91.40

Note: NT-proBNP, N-terminal pro-B-type natriuretic peptide; UA, uric acid; STEMI, ST-segment elevation myocardial infarction; AUC, area under the curve.

treated by primary percutaneous coronary intervention (pPCI), with its high levels strongly correlated with bleak prognoses. According to Birdal O et al. [17], the Naples Prognostic Score (NPS), as a simple risk score, has certain clinical value in identifying high-risk STEMI patients, predicting low left ventricular ejection fraction (LVEF), and forecasting hospital mortality, shock rate, and non-reflux rate.

In this study, we first found significantly elevated serum NT-proBNP and UA in the research group, suggesting that serum NT-proBNP and UA may mediate the onset and progression of

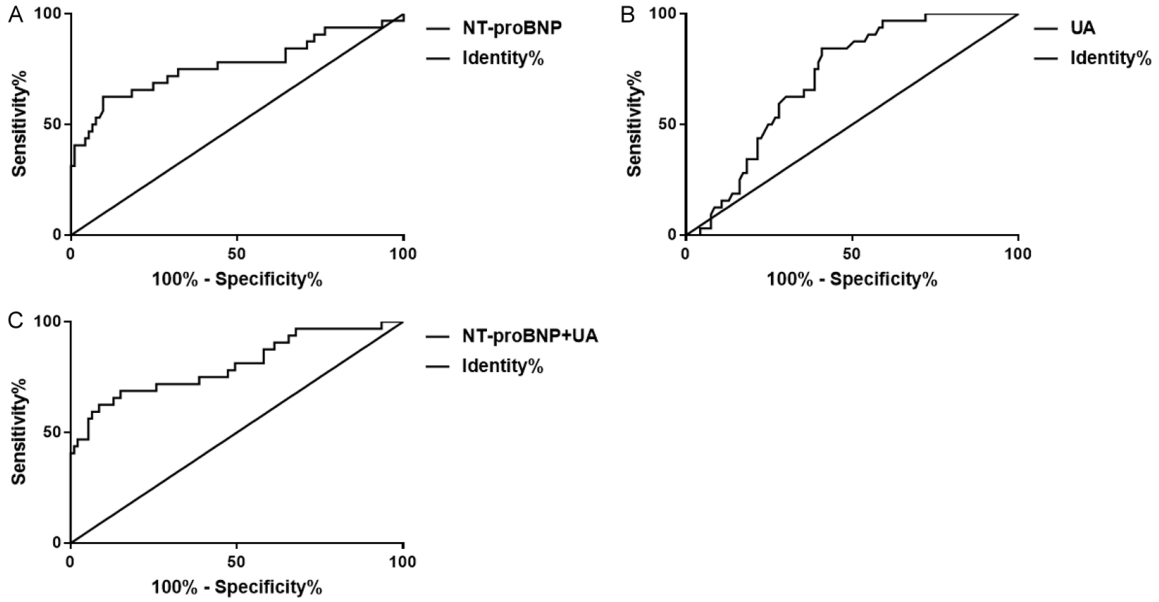

Figure 2. ROC analysis. A. AUC of NT-proBNP in predicting the prognosis of acute STEMI patients after complete revascularization. B. AUC of UA in predicting the prognosis of acute STEMI patients after complete revascularization. C. AUC of NT-proBNP+UA in predicting the prognosis of acute STEMI patients after complete revascularization. Note: ROC, receiver operating characteristic; NT-proBNP, N-terminal pro-B-type natriuretic peptide; UA, uric acid; ROC, Receiver operating characteristic; AUC, area under the curve; STEMI, ST-segment elevation myocardial infarction.

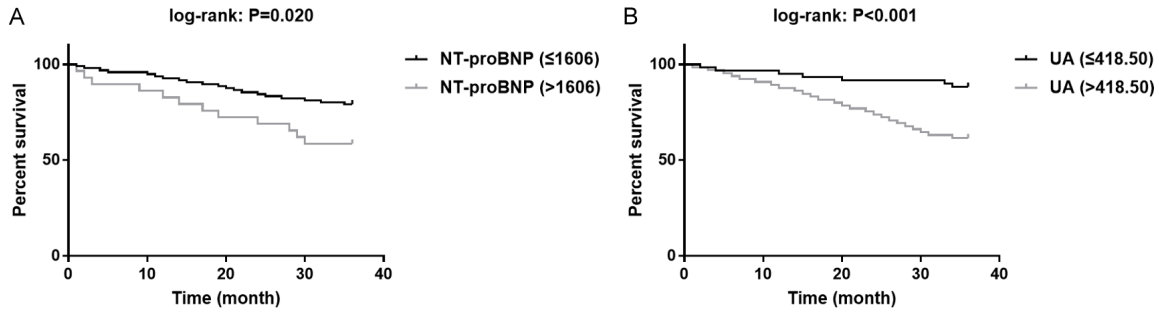

Figure 3. Effect of serum NT-proBNP and UA levels on 3-year OS in patients with acute STEMI after complete revascularization. A. Effect of serum NT-proBNP levels on 3-year OS in acute STEMI patients after complete revascularization. B. Effect of serum UA levels on 3-year OS in acute STEMI patients after complete revascularization. Note: NT-proBNP, N-terminal pro-B-type natriuretic peptide; UA, uric acid; OS, overall survival; STEMI, ST-segment elevation myocardial infarction.

acute STEMI after CR. The dynamic mechanism of NT-proBNP in acute STEMI following CR may be partly attributed to microvascular system obstruction caused by the release of necrotic myocardial cells, infarct dilation during the recovery phase of ischemia-reperfusion injury, and subsequent left ventricular remodeling [18]. In the study of Radwan H et al. [19], NT-proBNP helps to predict the severity of coronary artery disease in ACS patients and has prognostic value, consistent with our research results. The mediating mechanism of UA in acute STEMI following CR may be related to its promotion of LDL-C oxidative modification, promotion of inflammatory cascades, stimulation of vascular smooth muscle proliferation, and activation of platelets, triggering intravascular thrombosis and inducing atherosclerosis and vascular stenosis [20]. In the research by Kumbhalkar S et al. [21], serum UA was shown to be significantly correlated with the occurrence and progression of coronary artery disease and help evaluate the severity of coronary heart disease, similar to our research results.

Table 3. Univariate analysis of 3-year OS in acute STEMI patients undergoing complete revascularization

Variables	Survival group (n=93)	Dead group (n=32)	χ^2	P
Sex			2.352	0.125
Male (n=75)	58 (62.37)	17 (53.13)		
Female (n=50)	35 (37.63)	15 (46.88)		
Age (years old)			0.064	0.801
<60 (n=61)	46 (49.46)	15 (46.88)		
≥60 (n=64)	47 (50.54)	17 (53.13)		
Body mass index (kg/m^2)			0.439	0.508
<23 (n=61)	47 (50.54)	14 (43.75)		
≥23 (n=64)	46 (49.46)	18 (56.25)		
History of smoking			4.923	0.027
Yes (n=39)	24 (25.81)	15 (46.88)		
No (n=86)	69 (74.19)	17 (53.13)		
History of alcoholism			5.642	0.018
With (n=28)	16 (17.20)	12 (37.50)		
Without (n=97)	77 (82.80)	20 (62.50)		
Hypertension			0.951	0.329
With (n=42)	29 (31.18)	13 (40.63)		
Without (n=83)	64 (68.82)	19 (59.38)		
Diabetes			0.793	0.373
With (n=21)	14 (15.05)	7 (21.88)		
Without (n=104)	79 (84.95)	25 (78.13)		
Hyperlipidemia			2.592	0.107
With (n=20)	12 (12.90)	8 (25.00)		
Without (n=105)	81 (87.10)	24 (75.00)		
NT-proBNP (pg/mL)			7.329	0.007
<1606 (n=96)	77 (82.80)	19 (59.38)		
≥1606 (n=29)	16 (17.20)	13 (40.63)		
UA (μmol/mL)			6.807	0.009
<418.50 (n=60)	51 (54.84)	9 (28.13)		
≥418.50 (n=65)	42 (45.16)	23 (71.88)		

Note: NT-proBNP, N-terminal pro-B-type natriuretic peptide; UA, uric acid; STEMI, ST-segment elevation myocardial infarction; OS, overall survival.

Another study suggests that high-level UA can also indicate no reflux/slow reflux in STEMI patients undergoing pPCI [22].

In addition, the serum NT-proBNP and UA levels were notably higher in patients with poor prognoses versus those with good prognoses, suggesting that high serum levels of NT-proBNP and UA in acute STEMI patients after CR may be closely related to adverse prognoses. Further analysis showed that the AUC of NT-proBNP and UA in predicting the prognosis of patients with acute STEMI after CR was 0.767 and 0.711, respectively; the sensitivity and specificity of the former were 62.50% and 90.32%, respectively, while those of the latter were 84.38% and 59.14%, respectively. The combined detection of the two indicators achieved an AUC of up to 0.804, with a sensitivity of 62.50% and a specificity of 91.40%. The above results show that NT-proBNP is superior to UA in predicting the prognosis of acute STEMI patients after CR and that their combined detection can improve diagnostic performance to some extent. The analysis of 3-year OS revealed a close link between high serum NT-proBNP and UA levels and lower 3-year OS. In the report of Schellings DA et al. [23], NT-proBNP also has favorable predictive value for the 30-day mortality of NSTEMI patients,

supporting our research findings. It has also been indicated that NT-proBNP can serve as a prognostic indicator for major adverse cardiac events 12 months after intervention in NSTEMI and HF patients, with certain evaluation potential for cardiac death and AMI [24]. There are also studies indicating that UA can be combined with creatinine (Cr) (UA/cr; the higher the UA, the lower the Cr) as a predictor of an increased risk of in-hospital adverse events in elderly AMI patients [25]. Finally, univariate analysis revealed that a history of smoking and alcoholism, as well as high NT-proBNP and UA levels, were closely associated with decreased 3-year OS in acute STEMI patients who underwent CR.

The innovation of this study is mainly reflected in the confirmation of the clinical application value of NT-proBNP and UA in acute STEMI after CR, that is, the combination of the two can serve as a powerful indicator for predicting the prognosis of such patients, not only improving predictive efficacy, but also indicating the survival outcomes of patients (3-year OS). Our research findings provide more options for predicting the prognosis of acute STEMI patients after CR, while also offering new directions for clinical prognostic risk stratification in such patients. However, this study has several limitations. First, it did not conduct an in-depth statistical analysis on the relationship between the duration of smoking and alcohol abuse histories and patient prognosis. Second, the duration of high expression levels of NT-proBNP and UA in the serum of acute STEMI patients after CR was not statistically analyzed. Further research in this area can help further understand the clinical significance and value of the two indicators. Finally, no prospective analysis was conducted to elucidate the pathophysiological roles of NT-proBNP and UA in acute STEMI patients after CR.

In summary, elevated levels of serum NT-proBNP and UA are closely related to the progression of acute STEMI after CR, as well as lower 3-year OS. The combination of the two has a higher diagnostic efficacy in predicting patient outcomes. Serum NT-proBNP and UA can both serve as prognostic predictors for patients with acute STEMI after CR.

Disclosure of conflict of interest

None.

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References

[1] Ozaki Y, Hara H, Onuma Y, Katagiri Y, Amano T, Kobayashi Y, Muramatsu T, Ishii H, Kozuma K, Tanaka N, Matsuo H, Uemura S, Kadota K, Hikichi Y, Tsujita K, Ako J, Nakagawa Y, Morino Y, Hamanaka I, Shiode N, Shite J, Honye J, Matsubara T, Kawai K, Igarashi Y, Okamura A, Ogawa T, Shibata Y, Tsuji T, Yajima J, Iwabuchi K, Komatsu N, Sugano T, Yamaki M, Yamada S, Hirase H, Miyashita Y, Yoshimachi F, Kobayashi M, Aoki J, Oda H, Katahira Y, Ueda K, Nishino M, Nakao K, Michishita I, Ueno T, Inohara T, Kohsaka S, Ismail TF, Serruys PW, Nakamura M, Yokoi H and Ikari Y; Task Force on Primary Percutaneous Coronary Intervention (PCI) of the Japanese Cardiovascular Interventional Therapeutics (CVIT). CVIT expert consensus document on primary percutaneous coronary intervention (PCI) for acute myocardial infarction (AMI) update 2022. Cardiovasc Interv Ther 2022; 37: 1-34.

[2] Yildiz M, Wade SR and Henry TD. STEMI care 2021: addressing the knowledge gaps. Am Heart J Plus 2021; 11: 100044.

[3] Janjani P, Motevaseli S, Salimi Y, Bavandpouri SM, Ziapour A, Salehi N and Karami S. Clinical and epidemiological profile of ST-segment elevation myocardial infarction patients in a megacity of west of Iran. Health Sci Rep 2023; 6: e1187.

[4] Bhatt DL, Lopes RD and Harrington RA. Diagnosis and treatment of acute coronary syndromes: a review. JAMA 2022; 327: 662-675.

[5] Harrington DH, Stueben F and Lenahan CM. ST-elevation myocardial infarction and non-ST-elevation myocardial infarction: medical and surgical interventions. Crit Care Nurs Clin North Am 2019; 31: 49-64.

[6] Mitsis A and Gragnano F. Myocardial infarction with and without ST-segment elevation: a contemporary reappraisal of similarities and differences. Curr Cardiol Rev 2021; 17: e230421189013.

[7] Ahuja KR, Saad AM, Nazir S, Ariss RW, Shekhar S, Isogai T, Kassis N, Mahmood A, Sheikh M and Kapadia SR. Trends in clinical characteristics and outcomes in ST-elevation myocardial infarction hospitalizations in the United States, 2002-2016. Curr Probl Cardiol 2022; 47: 101005.

[8] Shen Y, Zhang X, Li C, Wang X, Ye Y, Yuan J, Gong H, Zou Y and Ge J. Pressure overload promotes cystatin C secretion of cardiomyocytes to regulate the MAPK signaling pathway and mediate cardiac hypertrophy. Ann Transl Med 2020; 8: 1514.

[9] Omura J, Habbout K, Shimauchi T, Wu WH, Breuils-Bonnet S, Tremblay E, Martineau S, Nadeau V, Gagnon K, Mazoyer F, Perron J, Potus F, Lin JH, Zafar H, Kiely DG, Lawrie A, Archer SL, Paulin R, Provencher S, Boucherat O and Bonnet S. Identification of long noncoding RNA H19 as a new biomarker and therapeutic target in right ventricular failure in pulmonary arterial hypertension. Circulation 2020; 142: 1464-1484.

[10] Eriksson B, Wandell P, Dahlstrom U, Nasman P, Lund LH and Edner M. Limited value of NT-proBNP as a prognostic marker of all-cause mortality in patients with heart failure with preserved and mid-range ejection fraction in primary care: a report from the swedish heart failure register. Scand J Prim Health Care 2019; 37: 434-443.

[11] Ma M, Luo Q, Dong X, Cui S, Hocher B, Zeng S, Liang W, Li Q, Chen X, Chen X, Meng Y, Lu Y, Yang D and Yin L. N-terminal prohormone B-type natriuretic peptide variability acts as a predictor of poor prognosis in patients with cardiorenal syndrome type 2. Bioengineered 2021; 12: 12407-12419.

[12] Qin Z, Du Y, Zhou Q, Lu X, Luo L, Zhang Z, Guo N and Ge L. NT-proBNP and major adverse cardiovascular events in patients with ST-segment elevation myocardial infarction who received primary percutaneous coronary intervention: a prospective cohort study. Cardiol Res Pract 2021; 2021: 9943668.

[13] Borghi C and Cicero AFG. Serum uric acid and acute coronary syndrome: is there a role for functional markers of residual cardiovascular risk? Int J Cardiol 2018; 250: 62-63.

[14] Puti E, Rasyid H, Tandean P, Sanusi H, Kasim H, Bakri S, Aman M and Seweng A. High uric acid level increases the risk of acute kidney injury in acute coronary syndrome patients. Caspian J Intern Med 2021; 12: 323-326.

[15] Mandurino-Mirizzi A, Cornara S, Somaschini A, Demarchi A, Galazzi M, Puccio S, Montalto C, Crimi G, Ferlini M, Camporotondo R, Gnecchi M, Ferrario M, Oltrona-Visconti L and De Ferrari GM. Elevated serum uric acid is associated with a greater inflammatory response and with short- and long-term mortality in patients with ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention. Nutr Metab Cardiovasc Dis 2021; 31: 608-614.

[16] Dong G, Huang A and Liu L. Platelet-to-lymphocyte ratio and prognosis in STEMI: a meta-analysis. Eur J Clin Invest 2021; 51: e13386.

[17] Birdal O, Pay L, Aksakal E, Yumurtas AC, Cinier G, Yucel E, Tanboga IH, Karagoz A and Oduncu V. Naples prognostic score and prediction of left ventricular ejection fraction in STEMI patients. Angiology 2024; 75: 36-43.

[18] Mathbout M, Asfour A, Leung S, Lolay G, Idris A, Abdel-Latif A and Ziada KM. NT-proBNP level predicts extent of myonecrosis and clinical adverse outcomes in patients with ST-elevation myocardial infarction: a pilot study. Med Res Arch 2020; 8: 10.18103/mra.v8i2.2039.

[19] Radwan H, Selem A and Ghazal K. Value of N-terminal pro brain natriuretic peptide in predicting prognosis and severity of coronary artery disease in acute coronary syndrome. J Saudi Heart Assoc 2014; 26: 192-198.

[20] Ndrepepa G. Uric acid and cardiovascular disease. Clin Chim Acta 2018; 484: 150-163.

[21] Kumbhalkar S and Deotale R. Association between serum uric acid level with presence and severity of coronary artery disease. J Assoc Physicians India 2019; 67: 29-32.

[22] Hu X, Yang X, Li X, Li G, Zhou Y and Dong H. Elevated uric acid is related to the no-/slow-reflow phenomenon in STEMI undergoing primary PCI. Eur J Clin Invest 2022; 52: e13719.

[23] Schellings DA, Adiyaman A, Dambrink JE, Gosselink AM, Kedhi E, Roolvink V, Ottervanger JP and Van't Hof AW. Predictive value of NT-proBNP for 30-day mortality in patients with non-ST-elevation acute coronary syndromes: a comparison with the GRACE and TIMI risk scores. Vasc Health Risk Manag 2016; 12: 471-476.

[24] Shon HS, Bae JW, Kim KO, Cha EJ and Kim KA. Biomarker for the prediction of major adverse cardiac events in patients with non-ST-segment elevation myocardial infarction. Osong Public Health Res Perspect 2017; 8: 237-246.

[25] Jiang L, Jin J, He X, Hu X, Guo L, Chen G and Zhou Y. The association between serum uric acid/serum creatinine ratio and in-hospital outcomes in elderly patients with acute myocardial infarction. BMC Cardiovasc Disord 2024; 24: 52.