Original article

Left ventricular dysfunction and NT-proBNP levels in patients with one-vessel disease after first ST-elevation myocardial infarction treated with primary coronary angioplasty

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Abstract

Background: Cardiovascular diseases continue to be the main cause of death in the general population. Despite the fact that primary percutaneous coronary intervention (PCI) improves prognosis in patients with acute myocardial infarction (AMI), heart failure can still develop in some of these subjects. Measurement of natriuretic peptide levels has been shown to be useful in the detection of left ventricular (LV) dysfunction and the risk stratification of patients with AMI.

Aim: To evaluate the role of NT-proBNP in the identification of patients with early systolic LV dysfunction after first AMI with one- -vessel disease successfully treated with primary PCI.

Methods: 161 consecutive patients with first ST-elevation AMI treated with primary PCI with stent implantation (occlusion in infarct-related artery was the patient's only lesion) were included. Measurement of NT-proBNP level and echocardiography were performed on the 4-5th day of AMI.

Results: In 53 (33%) patients LV dysfunction (defined as EF < 55%) was detected. The remaining 108 (67%) patients had normal LV systolic function. Multivariate regression analysis revealed that NT-proBNP level > 463.4 pg/ml (median level) was the strongest predictor of EF < 55%. A strong negative correlation between EF and NT-proBNP concentration measured on the 4-5th day of AMI was observed (r = –0.54), which increased with decreasing EF value.

Conclusions: Elevated levels of NT-proBNP are the strongest predictor of early LV dysfunction in low-risk patients after first AMI with one-vessel disease treated with primary PCI with complete coronary revascularisation.

Key words: coronary disease, natriuretic peptides, heart failure

Introduction

Cardiovascular diseases continue to be the main cause of death in the general population. Among them, acute myocardial infarction (AMI) and heart failure remain the leading causes of morbidity and mortality in the developed countries.

Early and complete restoration of blood flow in the infarct-related artery (IRA) is the principal mechanism by which reperfusion therapy improves outcomes in patients with AMI. During the last years, primary percutaneous coronary intervention (PCI) has become a common method for achieving IRA recanalisation. Primary PCI performed during the first hours after the onset of chest pain plays an important role in the prevention of left ventricular (LV) dysfunction, heart failure and death after AMI [1-5].

Myocardial necrosis is characterised by loss of contractile tissue and changes of ventricular geometry. This would be anticipated to modify the function of heart muscle. The transthoracic echocardiographic examination is the most popular method for non-invasive detection of LV function and risk stratification after acute coronary syndromes (ACS). Numerous studies have demonstrated that ejection fraction (EF) or other closely related parameters are powerful guides to predict the risk of future events [6-8].

Measurement of the natriuretic peptides (BNP and NT- -proBNP) plays an important role in the diagnosis of heart

failure [9]. Elevated BNP or NT-proBNP concentrations have been shown to be useful in detecting LV dysfunction and risk stratification across the whole spectrum of ACS [10 - 17].

The aim of the study was to evaluate the role of NT--proBNP in the identification of patients with early systolic dysfunction after first AMI with one-vessel disease successfully treated with primary PCI.

Methods

Study group

A total of 161 consecutive patients with first ST--elevation AMI treated with primary PCI with stent implantation were included in the study. In all these patients an isolated IRA lesion with no other significant coronary artery stenoses was observed and complete coronary revascularisation defined when TIMI III flow (Thrombolysis in Myocardial Infarction scale) was achieved. The other inclusion criteria were: no prior history of heart failure; no prior coronary revascularisation (angioplasty or surgical); and absence of severe valvular diseases, chronic atrial fibrillation, cardiomyopathy, cardiogenic shock, renal insufficiency and implantable pacemaker.

The study protocol was approved by the Medical University of Lodz Bioethics Committee. All patients provided signed informed consent and participation agreement.

Investigations performed

Determination of serum NT-proBNP concentration was performed with Elecsys 1010 (Roche Diagnostics) 4-5 days after the onset of AMI (at discharge from the hospital). On the 4-5th day of AMI the patients were subjected to transthoracic echocardiographic examination with calculation of EF by modified biplane Simpson's method. The wall motion index (WMI) was calculated according to the 16-segment division of the LV. The LV systolic dysfunction was defined as EF < 55%.

Statistical analysis

The results are presented as mean ± standard deviation (SD) for continuous variables and as per cent for categorical variables. Differences in categorical variables between groups were evaluated with the χ^2 test. Differences between mean values for continuous variables were evaluated with Student's t-test or Mann-Whitney U test.

Logistic regression was used to estimate the relationship between discrete parameters and continuous variables or discrete independent variables. Potential risk factors of EF < 55% were subjected to the univariate risk analysis model of logistic regression. To determine the strongest independent predictors, independent variables significantly changing the fit of univariate models were included in the multivariate model. The Spearman's or Pearson's correlation coefficient was used to assess the association between EF and NT-proBNP concentration on the 4-5th day of AMI.

A p value < 0.05 was accepted for all tests. Statistical analysis was performed with the SPSS PC and STATISTICA software.

Results

The studied population consisted of 123 men and 38 women, aged from 35 to 82 years, mean 56 ± 10.8 years. The IRA were as follows: left anterior descending artery (LAD) in 65 (40%), circumflex branch (Cx) in 34 (21%) and right coronary artery (RCA) in 62 (39%) patients.

In 53 (33%) patients the EF was <55% whereas the remaining 108 (67%) patients had normal LV systolic function. In patients with LV dysfunction, a decrease in EF < 40% was observed in 5 (4.5%) patients. The clinical and demographic characteristics of patients with or without reduced EF are compared in Table I. In the group of patients with EF < 55%, the levels of NT-proBNP were nearly 4-fold higher than in those with normal LV systolic function (p < 0.001).

We observed a strong negative correlation between EF and NT-proBNP concentration in the whole study population (r = −0.54) (Figure 1). Dividing patients into groups according to EF value, the association increased with the reduction of EF (r = −0.23 in the group with normal LV systolic function, r = −0.38 in patients with EF in the range 40-54% and r = −0.49 for the group with EF < 40%) (Figure 2).

Univariate analysis showed a significant relationship between EF < 55% and the following variables: patients' age, male gender, anterior wall infarction, Killip class on admission > I, CK-MB concentration, glomerular filtration rate, fibrinogen concentration, NT-proBNP level, and diuretic treatment during hospitalisation. Multivariate regression analysis revealed that only NT-proBNP concentration > 463.4 pg/ml (median value), anterior wall infarction, CK-MB levels and the need for diuretic treatment in the acute stage of AMI were independently associated with EF < 55% (Table II).

Discussion

Early invasive treatment of ST-elevation AMI decreases the risk of development of heart failure in these patients [1-5]. On the basis of available literature it is estimated that despite restoring IRA patency, unfavourable remodelling of the LV and heart failure development can be observed in as many as 30% of patients during early and long-term follow-up [6, 18]. In our study, LV dysfunction during the first days after AMI was observed in 33% of patients. The majority of them had the EF slightly decreased (40-54%), whereas a significant decrease in EF < 40% was observed in only 5 (4.5%) patients.

Table I. Comparison of the clinical and demographic characteristics of patients with reduced and preserved left ventricular function

Variable	EF < 55% n = 53 (33%)	EF ≥ 55% n = 108 (67%)	p
Age [years]	60.3 ± 11.8	54.4 ± 9.7	0.001
Gender: women, n (%) men, n (%)	18 (34) 35 (66)	20 (18.5) 88 (81.5)	0.031
Hypertension, n (%)	25 (47)	53 (49)	0.811
Diabetes, n (%)	25 (47)	53 (49)	0.811
Time from the onset of chest pain to PCI [hours]	7.5 ± 13.6	4.5 ± 3.6	0.033
Anterior wall infarction, n (%)	18 (34)	11 (10)	0.0003
CK-MB [U/l]	157.1 ± 166	91.6 ± 87	0.001
Troponin T [ng/ml]	1.19 ± 0.8	1.03 ± 0.8	0.210
Total cholesterol [mg/dl]	222.5 ± 56.2	223.1 ± 47.2	0.937
CRP [mg/l]	13.2 ± 4.0	8.1 ± 6.7	0.0001
NT-proBNP on 4-5th day [pg/ml]	2020 ± 2086	531 ± 659	< 0.0001
EF [%]	47.2 ± 5.6	62.5 ± 5.0	< 0.001
WMI	1.7 ± 0.4	1.2 ± 0.2	< 0.001
Diuretic treatment, n (%)	15 (28)	6 (5.5)	0.001

Abbreviations: CK-MB – cardiac fraction of creatine kinase, CRP – C-reactive protein, NT-proBNP – N-terminal pro-brain natriuretic peptide, EF – ejection fraction, WMI – wall motion index

Table II. Multivariate predictors of EF < 55%

Variable	OR	−95% CI	+95% CI	p
NT-proBNP > 463.4 pg/ml (median value)	8.94	3.55	22.48	< 0.001
Diuretic treatment	4.93	1.61	15.10	0.005
Anterior wall infarction	3.40	1.46	7.90	0.004
CK-MB [U/l]	1.004	1.001	1.008	0.023

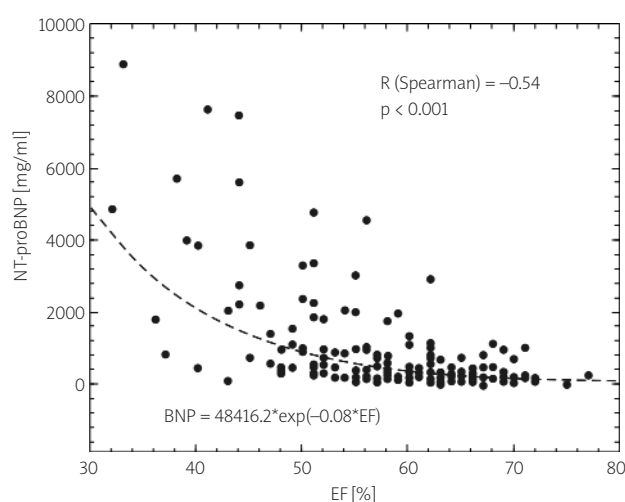*Abbreviations: as in Table I*

Figure 1. The correlation between NT-proBNP levels and EF in the whole studied population
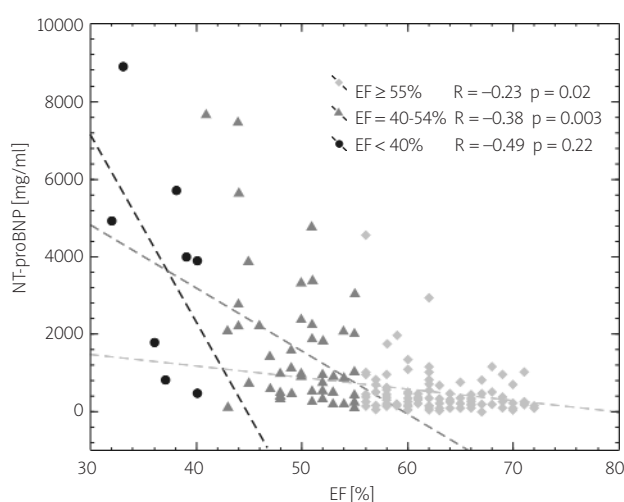

Figure 2. The correlation between NT-proBNP levels and EF in patients with normal (EF ≥ 55%), slightly decreased (EF = 40-54%) and impaired (EF < 40%) left ventricular systolic function

Left ventricular dysfunction (particularly a decrease of EF < 40%) is a strong negative prognostic factor after AMI [6-8, 19]. Moreover, well documented in a wide spectrum of ACS is the prognostic value of natriuretic peptides. Levels of BNP and NT-proBNP change rapidly in the course of AMI. Within the first 24 h their concentrations increase and then drop gradually [20, 21]. Occurrence of the so-called biphasic release (another increase in concentration on the 5-7th day of AMI) may indicate LV dysfunction and the risk of remodelling of cardiac muscle. Both BNP and NT-proBNP measured in the acute phase of myocardial ischaemia are powerful and independent predictors of cardiovascular death or development of heart failure during short- and long-term follow-up regardless of the time of their determination in an early stage of AMI, or on admission to hospital or on consecutive days of hospitalisation [8, 12-17, 22-25].

A close correlation between BNP or NT-proBNP levels and EF has been emphasised in the literature [8, 15, 26-29]. In our study, elevated level of NT-proBNP (> 463.4 pg/ml) was the strongest independent predictor of decreased EF at discharge from the hospital. The correlation coefficient between the concentrations of NT-proBNP and EF was r = −0.54 and was higher than the outcomes available in the literature, where it varied between low (r = −0.29 [28]), moderate (r = −0.38 [26], r = −0.4 [27]) and high values (r = −0.6 [15]). We also observed an increase of the correlation coefficient values together with the decrease of EF. The correlation between NT-proBNP and systolic function of LV was the lowest in the group of patients with normal EF, increased in patients with EF between 40 and 54%, and was the highest in patients with EF < 40%, although due to the small number of patients in this group it was statistically insignificant.

The limitations of the study could be the small number of patients with impaired LV function. In addition, among all the patients, only a few of them showed a slightly decreased, whereas the clear majority of them had normal LV systolic function, which is why the group may not be representative of all patients with AMI. On the other hand, a majority of studies included a large proportion of patients with impaired LV systolic function and the results may not be generalisable to low-risk patients with one-vessel lesion successfully treated with primary PCI [29, 30].

Conclusion

Elevated levels of NT-proBNP are the strongest predictor of early LV dysfunction in low-risk patients after first AMI with one-vessel disease treated with primary PCI with complete coronary revascularisation.

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Niewydolność lewokomorowa a stężenia NT-proBNP u pacjentów z chorobą jednonaczyniową, po pierwszym zawale mięśnia sercowego z uniesieniem odcinka ST, poddanych angioplastyce naczyń wieńcowych

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Streszczenie

Wstęp: Choroby układu krążenia są obecnie najczęstszą przyczyną zgonów. Nowoczesne leczenie ostrego zawału mięśnia sercowego (AMI) metodą pierwotnej przezskórnej interwencji wieńcowej (PCI) ma na celu poprawę rokowania, jednakże pomimo wczesnego leczenia inwazyjnego u części chorych dochodzi do rozwoju pozawałowej niewydolności serca. Oznaczanie stężenia peptydów natriuretycznych jest przydatne w detekcji dysfunkcji lewej komory (LV) i stratyfikacji ryzyka w populacji pacjentów po AMI.

Cel: Ocena rozwoju pozawałowej dysfunkcji LV i roli oznaczania NT-proBNP u osób po pierwszym AMI z uniesieniem odcinka ST, z chorobą jednonaczyniową, leczonych metodą pierwotnej PCI, u których uzyskano pełną rewaskularyzację wieńcową.

Metody: Do badania zakwalifikowano 161 kolejnych chorych z pierwszym AMI z uniesieniem odcinka ST, z izolowaną zmianą w tętnicy dozawałowej, leczonych metodą pierwotnej PCI z implantacją stentu, u których uzyskano przepływ TIMI 3. Badanie echokardiograficzne oraz oznaczenie stężenia NT-proBNP wykonano w 4.–5. dobie AMI (przy wypisie ze szpitala).

Wyniki: Grupę badaną stanowiło 53 (33%) pacjentów ze stwierdzoną w badaniu echokardiograficznym dysfunkcją skurczową LV (EF < 55%); pozostałe 108 (67%) osób włączono do grupy kontrolnej. W analizie wieloczynnikowej podwyższone stężenie NT-proBNP powyżej mediany (463,4 pg/ml) było najsilniejszym wskaźnikiem wystąpienia obniżonej EF (< 55%). Obserwowano silną ujemną korelację pomiędzy wielkością EF i stężeniami NT-proBNP (r = –0,54), która wzrastała wraz ze spadkiem EF.

Wnioski: Podwyższone stężenie NT-proBNP jest najsilniejszym czynnikiem predykcyjnym wystąpienia obniżonej EF we wczesnym okresie AMI, także w grupie pacjentów niskiego ryzyka, z chorobą jednonaczyniową, po przebytym AMI leczonym metodą pierwotnej PCI, u których uzyskano pełną rewaskularyzację wieńcową.

Słowa kluczowe: choroba wieńcowa, peptydy natriuretyczne, niewydolność serca

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