Left ventricular performance and exercise capacity in patients aged 65 years and older treated by primary coronary angioplasty or conservatively for acute myocardial infarction – a one-year follow-up

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Abstract

Background: Elderly patients hospitalised for congestive heart failure (CHF) due to myocardial infarction (MI) have very poor prognosis, particularly if CHF symptoms are caused by left ventricular (LV) systolic dysfunction. Early invasive strategy is considered the best method of preventing post-MI LV dysfunction. The clinical impact of early invasive strategy on prognosis in elderly patients with acute MI has yet to be completely defined because of the poor enrolment of elderly patients in large randomised trials.

Aim: To asses whether treatment of acute MI in patients aged >65 years using percutaneous coronary intervention (PCI) results in significantly better long-term cardiovascular performance in comparison with conservative treatment (CT).

Methods: Our study involved 90 MI patients who underwent diagnostic spiroergometry: 40 patients (mean age 73 years) treated conservatively and 50 (mean age 71 years) by PCI. Echocardiographic examinations and spiroergometric tests were performed at 3-, 6- and 12-month follow-up. Plasma NT-proBNP levels were measured on admission and at 6- and 12-month follow-up.

Results: Echocardiographic and spiroergometric parameters were significantly better in PCI patients in each of the analysed periods and showed significant improvement throughout follow-up (the largest between months 3 and 6). In the CT patients these parameters showed significant improvement only between months 3 and 6. After one year, studied parameters were better in PCI patients (LVESD: 3.1±0.4 vs. 3.5±0.6 cm; p <0.001, LVEF: 62.8±6.6 vs. 55.8±8.3%; p <0.001, LVEDD: 4.9±0.4 vs. 5.1±0.5 cm; p=0.03, duration of exertion: 578±73 vs. 528±108 s; p=0.011, METS: 6.2±1.0 vs. 5.7±1.1; p=0.002, peak VO_2: 22±3.4 *vs.* 20.3±3.4 ml/kg/min; p=0.02, VE/VCO_2: 29.1±4.4 vs. 33.3±4.7; p <0.001, $VE/VCO_{2\ slope}$: 23.2±4.7 vs. 27.5±5.1; p <0.001). The groups did not differ in peak VO_2 expressed as peak VO_2 % predicted and plasma NT-proBNP levels. Over the whole follow-up period NT-proBNP levels were negatively associated with LVEF, peak VO_2 and MET, and positively with LVESD and LVEDD recorded at 3 months. In each of the analysed periods spiroergometric parameters significantly correlated with echocardiographic indices recorded at 3 months.

Conclusions: Early PCI for acute MI in patients aged >65 years results in significantly better long-term cardiovascular performance than conservative treatment. The patients showed the most significant improvement in LV performance and exercise capacity between months 3 and 6.

Key words: myocardial infarction, elderly, heart failure, percutaneous coronary intervention, conservative treatment

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Introduction

Chronic heart failure (CHF) has become one of the major problems of public health and, according to the demographic prognosis, it will become the most frequent disease treated by cardiologists in the current century [1]. Heart failure is still a disease with very poor prognosis. According to population studies the mortality within the first year after hospitalisation due to CHF reaches 33% [2]. Heart failure is a disease affecting mostly elderly people, since the occurrence of CHF increases with age and affects 6-10% of patients after 65 years of age [3]. This is associated with the prolonged average lifetime of examined populations and increased percentage of survival of patients after acute myocardial infarction (MI) [4] which is the most common cause of CHF. During 6 years following MI another MI affects 18% of males and 35% of females,

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whereas 22% of males and 46% of females present with CHF [5].

The treatment of acute MI with primary percutaneous coronary angioplasty (pPCI) is considered to be the best method of prevention of post-infarction CHF since it allows revascularisation of the infarct artery in 80-95% of cases [6]. The clinical significance of pPCI in the treatment of acute MI in patients aged >65 years has not been fully established, mainly due to the under-representation of elderly patients in such studies.

The aim of our study was to asses whether treatment of acute MI in patients aged >65 years using pPCI results in significantly better long-term cardiovascular performance in comparison with conservative treatment (CT).

Methods

Study group

Between September 2002 and March 2006, 175 patients older than 65 years, 3 months after MI, were screened in our department. The study included patients in whom MI was diagnosed on the basis of increased cardiac muscle necrosis markers with concomitant typical symptoms and/or ECG features of MI. Patients with MI with ST-segment elevation (STEMI) as well as patients with MI without ST-segment elevation (NSTEMI) were included. After receiving information about the aim of the study and planned observation 32 patients refused to participate in the study. Another 53 patients did not qualify for the spiroergometric test, most often because of advanced pathology of the locomotor system, psychiatric disease, neoplasm or chronic obstructive disease. Additional exclusion criteria were: congenital heart diseases, valvular heart diseases, diseases significantly affecting physical activity and non-diagnostic results of spirometric examination.

Finally, 90 patients were included in the study; 40 patients (group CT) in the acute phase of MI were treated conservatively with heparin because of the too long time from the onset of symptoms to hospitalisation or the lack of consent for pPCI, whereas 50 patients (group pPCI) were treated with pPCI. If there were no contraindications or side effects, patients were treated with angiotensin-converting enzyme inhibitor (or angiotensin II receptor blocker) for at least 2 weeks prior to the first examination.

The project of this study was accepted by the Institutional Ethics Committee.

The measurement of NT-proBNP

In 47 patients (21 from group I and 26 from group II) the concentration of N-terminal brain natriuretic peptide (NT-proBNP) was measured. The first measurement was performed 48 hours after the onset of the infarct pain, the next one 6 and 12 months after MI. The concentrations of NT-proBNP were measured in the plasma of venous blood using a quantitative electroluminescence test by means of the ELECSYS system and Roche Diagnostics kits.

Echocardiographic examination

All patients underwent echocardiographic examination 3, 6 and 12 months following MI. Standard resting echocardiographic examination was performed using a Hewlett-Packard Sonos 1000 device with a 2.5 and 3.5 MHz transducer. The analysis included left ventricular (LV) end-diastolic diameter (LVEDD in cm), LV end-systolic diameter (LVESD in cm) and LV ejection fraction (EF) in %. The measurements were performed in the long axis and parasternal short axis view with M-mode technique in the 3rd and 4th intercostal space and 2D technique with dual-chamber apical view. The results of the analysed parameters were obtained as a mean of five subsequent measurements.

Spiroergometric test

In all patients 3, 6 and 12 months following MI the spiroergometric test on a treadmill (Aspel B 612, C model, Zabierzów, Poland) was performed, according to the modified Bruce protocol. The test was continued until fatigue or the occurrence of breathlessness. Metabolic parameters were registered in 10-second intervals using a Sensor Medics system (United Kingdom Ltd., Greenock, Scotland, 1992 IBM CORP.). The expenditure of oxygen (VO_2 in l/min), production of carbon dioxide (VCO_2 in l/min) and minute ventilation (VE in l/min) were recorded. According to the established recommendations, the result of the examination was considered diagnostic if on exertion the value of respiratory exchange ratio RER (displaying VCO_2 to VO_2 ratio) exceeded 1.0 [7].

The conducted analysis included the initial heart rate (HR) and heart rate on exertion (HRmax.), initial systolic (SBP) and diastolic (DBP) blood pressure, duration of exertion (T ex.), metabolic equivalent (MET), peak oxygen expenditure (peak VO_2), peak oxygen expenditure presented as a percentage of the value adjusted to gender and age (peak VO_2–%N), ventilation carbon dioxide equivalent on exertion (VE/VCO_2) and index of exertion ventilation, the so-called $VE/VCO_{2\ slope}$ index, calculated as the ratio of linear regression dependence between VE and VCO_2 during the entire exertion.

Statistical analysis

The results of the measurements of quantitative features are presented as arithmetic mean with standard deviation (x ± SD). For qualitative features the relative frequencies of occurrence of each feature were calculated and are presented in %. Echocardiographic parameters and the results of spiroergometric test were compared in each group and between the groups. The statistical analysis for unrelated variables was performed using Student's t-test or unifactorial variance analysis (ANOVA) after confirmation of the normal distribution with the Shapiro-Wilk test or Levene's test of unity of variances. Nonparametric Mann-Whitney U-test was used to compare differences between mean values in the compared groups if not normal

distribution noted. The significance of the differences between related variables was evaluated with nonparametric Wilcoxon test. To analyse discrete/qualitative variables, bi- and multifactorial cross tables with Chi square tests were used (Pearson's test for large numbers of variables and Fisher's exact test for small numbers of variables). The correlations were calculated as pairs of variables. Pearson's index was used for quantitative variables, whereas the Spearman rho or Kendall tau-b correlation coefficient was used for quantitative variables which did not present a normal distribution or for categorical variables. The level of significance was established as $p < 0.05$.

Results

The clinical characteristics of the studied groups are shown in Table I. The studied groups did not differ significantly in terms of demographic parameters. The frequency of STEMI occurrence in both groups was similar. The patients treated with pPCI underwent, if necessary, revascularisation of other vessels (of two vessels in 11 patients, three vessels in 4 patients). In 12 patients PCI was performed in two stages with the time interval not exceeding 6 weeks from MI. Subjects from the CT group did not have coronary revascularisation during one year following MI. At the end of follow-up, 20 patients from this group had coronary angiography performed (10 patients were diagnosed with one-vessel disease, 4 patients with two-vessel disease, and 6 patients had three-vessel disease). The groups did not differ in terms of the distribution of risk factors. A high percentage of patients had hyperlipidaemia and hypertension. The analysis of chronic pharmacological treatment revealed no significant differences between the groups.

In the CT group only 39 patients were examined after 6 and 12 months because of one case of sudden death 4 months following MI.

The comparative analysis of the parameters of echocardiographic examination is presented in Table II. In the early period after MI patients from the pPCI group had significantly lower values of LVESD and higher values of EF in comparison to the CT group. There were no differences in LVEDD values between groups. A significant improvement of evaluated parameters was observed during each examination in the pPCI group. In the CT group a significant improvement was observed only in the examination after 6 months. One year after MI the group treated with pPCI presented with significantly improved LVEDD, LVESD and EF values.

All subjects underwent spiroergometric test. The results of this test performed 3, 6 and 12 months after MI are shown in Table III. The cause of termination of exercise test was in each case fatigue or breathlessness, never chest pain. No differences were noted in terms of HR, HRmax, SBP and

Table I. General clinical characteristics of the examined patients. The number and percent (in bracket) of patients are shown unless otherwise stated

Parameter	CT group n=40	pPCI group n=50	P
Age [years]	73±5	71±5	NS
Females (%)	14 (35)	12 (24)	NS
BMI [kg/m^2]	27.1±3	27.5±3.5	NS
Anterior MI (%)	20 (50)	26 (52)	NS
STEMI (%)	28 (70)	35 (70)	NS
CHF class according to NYHA I (%)	13 (32.5)	26 (52)	NS
II (%)	19 (47.5)	16 (32)	NS
III (%)	8 (20)	8 (16)	NS
Risk factors:			
History of previous MI (%)	9 (22.5)	13 (26)	NS
Revascularisation (%)	2 (5)	3 (6)	NS
Hyperlipidemia (%)	38 (95)	50 (100)	NS
Hypertension (%)	37 (92.5)	43 (86)	NS
Cigarette smoking (%)	12 (30)	14 (28)	NS
Obesity (BMI >30 kg/m^2) (%)	7 (17.5)	10 (20)	NS
Diabetes [%]	5 (12.5)	8 (16)	NS
Positive family history (%)	8 (20)	6 (12)	NS
Treatment:			
Aspirin (%)	40 (100)	50 (100)	NS
Statins (%)	40 (100)	50 (100)	NS
β-blocker (%)	39 (97.5)	50 (100)	NS
ACE-I/AT$_1$ receptor blocker (%)	38 (95)	44 (88)	NS
Nitrate (%)	8 (20)	5 (10)	NS
Diuretics (%)	16 (40)	11 (22)	NS
Cardiac glycosides (%)	1 (2.5)	1 (2)	NS

Abbreviations: BMI – body mass index, ACE-I – angiotensin converting enzyme inhibitor, NYHA – New York Heart Association, SD – standard deviation

Table II. The comparison of echocardiographic parameters. Mean values ± SD are shown

Parameter	CT group	pPCI group	p
LVEDD [cm]			
• examination after 3 months	5.40±0.55	5.31±0.45	NS
• examination after 6 months	5.17±0.47•	5.03±0.46•	NS
• examination after 12 months	5.11±0.49•	4.92±0.45•*	0.03
LVESD [cm]			
• examination after 3 months	3.81±0.67	3.55±0.53	0,04
• examination after 6 months	3.54±0.57•	3.18±0.43•	0,001
• examination after 12 months	3.46±0.59•	3.06±0.39•◆	<0.001
EF [%]			
• examination after 3 months	50.52±7.04	55.06±8.22	0.003
• examination after 6 months	55.37±7.37•	61.36±7.18•	<0.001
• examination after 12 months	55.83±8.30•	62.84±6.63•▲	<0.001

Abbreviations: LVEDD – left ventricular end-diastolic diameter, LVESD – left ventricular end-systolic diameter, EF – ejection fraction
*•p <0.001 examination 2 vs. 1 and examination 3 vs. 1, *p <0,001 examination 3 vs. 2, ◆p=0.001 examination 3 vs. 2*
▲p=0.005 examination 3 vs. 2

Table III. The comparison of stress test parameters. Mean values ± SD are shown

Parameter	CT group	pPCI group	p
RER			
– examination after 3 months	1.06±0.06	1.07±0.07	
– examination after 6 months	1.05±0.07	1.06±0.06	NS
– examination after 12 months	1.06±0.07	1.07±0.06	
HR [beats/min]			
– examination after 3 months	68.0±7.,9	68.2±8.6	
– examination after 6 months	69.5±10.7	68.4±9.1	NS
– examination after 12 months	70.8±9.4	67.7±9.0	
HRmax [beats/min]			
– examination after 3 months	115,2 ± 12,4	116,2 ± 11,9	
– examination after 6 months	115,6 ± 13,2	119,6 ± 11,6•	NS
– examination after 12 months	118,6 ± 15,4	118,9 ± 12,3	
SBP [mmHg]			
– examination after 3 months	124.5±12.9	123.7±13.0	
– examination after 6 months	123.6±11.9	124.0±13.5	NS
– examination after 12 months	124.5±11.3	122.8±12.9	
DBP [mmHg]			
– examination after 3 months	72.5±7.1	72.2±7.1	
– examination after 6 months	72.9±6.8	72.4± 7.2	NS
– examination after 12 months	72.9±7.9	73.1±6.8	
Tex [s]			
– examination after 3 months	463.8±98.9	528.9±98.9	0.003
– examination after 6 months	507.1±114.4••	578.6±105.9◆	0.003
– examination after 12 months	528.1±108.7◆	578.3±73.1◆	0.011

Abbreviations: HR – heart rate, SBP – systolic blood pressure, DBP – diastolic blood pressure, Tex – exertion time, beats/min – beats/minute, s – seconds
•p <0.04 examination 2 vs. 1, ••p=0.001 examination 2 vs. 1, ◆p <0.001 examination 2 vs. 1 and examination 3 vs. 1

DBP values between the groups at any of the analysed stages.

The pPCI group presented with significantly greater exercise duration at all follow-up stages. In both groups a significant prolongation of exercise duration was observed in the examination after 6 and 12 months in comparison to the examination after 3 months.

The MET values were significantly greater in the pPCI group at all analysed stages (Figure 1). Both groups presented with a significant increase of MET values after 6 months.

Throughout the entire observation period the values of peak VO_2 were significantly greater in the pPCI group than in the CT group (Figure 2). The comparison of the peak

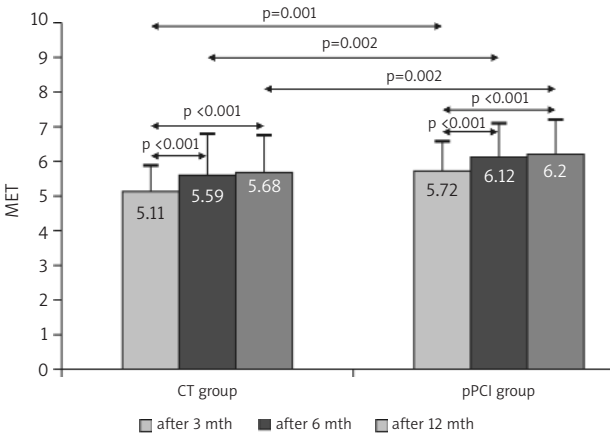

Figure 1. Comparison of the metabolic equivalent (MET) at peak exercise between groups and within groups

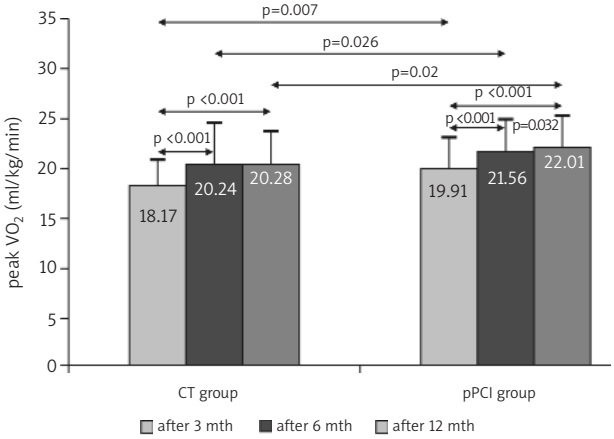

Figure 2. Comparison of the peak oxygen consumption (peak VO_2) between groups and within groups

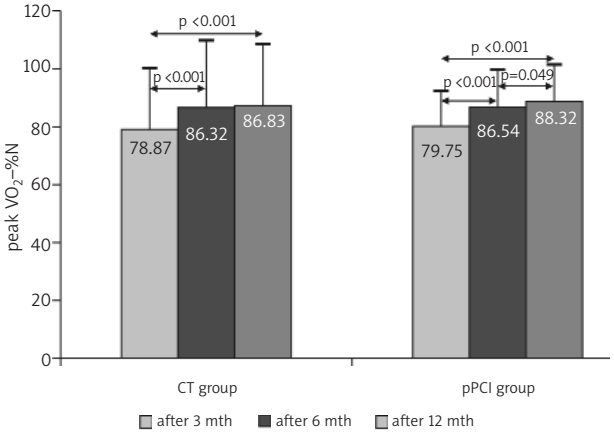

Figure 3. Comparison of the peak oxygen consumption expressed as a percentage of values predicted for age and sex (peak VO_2–%N) between groups and within groups

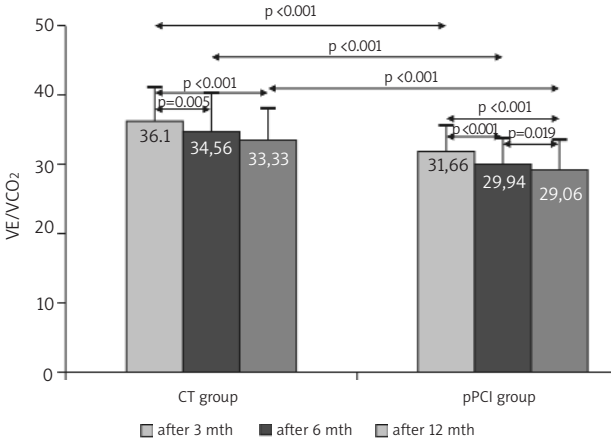

Figure 4. Comparison of the ventilatory equivalent of carbon dioxide (VE/VCO_2) at peak exercise between groups and within groups

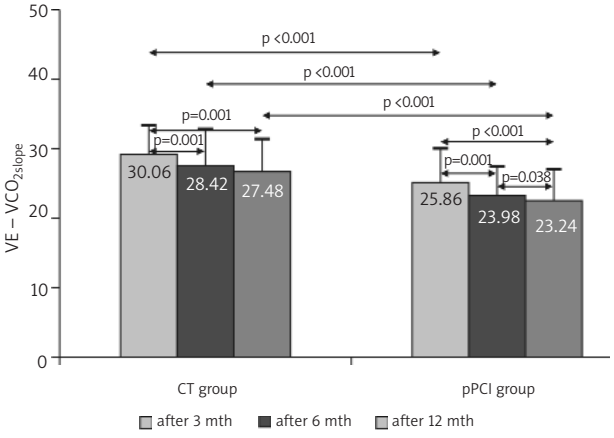

Figure 5. Comparison of the VE/VCO_2 slope index between groups and within groups

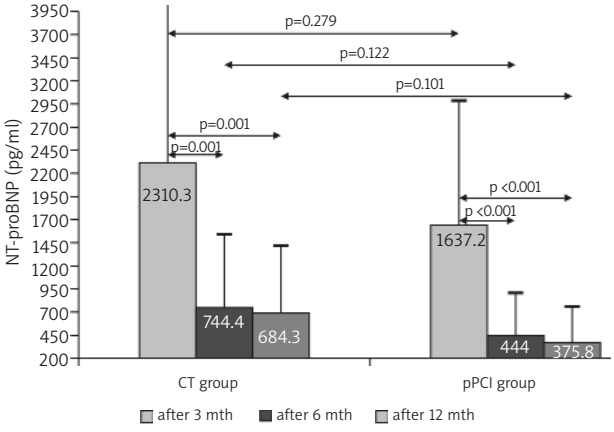

Figure 6. Comparison of the NT-proBNP levels between groups and within groups

Table IV. Correlations between NT-proBNP values and ECHO and CPX parameters

NT-proBNP After 3 months	At admission	After 6 months	After 12 months
EF	r=–0.61; p=0.000	r=–0.34; p=0.019	r=–0.32; p=0.028
peak VO_2	r=–0.51; p=0.000	r=–0.40; p=0.006	r=–0.42; p=0.004
ME	r=–0.44; p=0.002	r=–0.37; p=0.011	r=–0.37; p=0.011
LVESD	r=0.63; p=0.000	r=0.34; p=0.022	r=0.32; p=0.028
LVEDD	r=0.62; p=0.000	r=0.40; p=0.006	r=0.37; p=0.011

oxygen expenditure presented as peak VO_2–%N revealed that both groups presented with high and almost equal peak VO_2 values at all analysed stages (Figure 3). In the pPCI group a significant increase in the value of peak VO_2 as well as peak VO_2–%N was observed from examination to examination. The greatest increases were noted at the examination after 6 months, and the lowest – after 12 months. In the CT group a significant increase in the values of both parameters was observed only after 6 months. In both groups a significant improvement of both parameters was observed one year following MI in comparison to the initial study.

The values of VE/VCO_2 were significantly lower in the pPCI group after 3, 6 and 12 months (Figure 4). In the pPCI group in subsequent examinations the values of VE/VCO_2 decreased, and a greater decrease was observed in the examination after 6 months compared with the examination after 12 months. In the CT group a significant improvement was observed only after 6 months. In both groups a significant improvement of VE/VCO_2 values was observed one year following MI.

The values of VE/VCO_2 slope were significantly lower in the pPCI group at all analysed stages (Figure 5). A subsequent decrease in the values of this parameter in the pPCI group was observed, greater after 6 than after 12 months. In the CT group the values of this parameter decreased significantly (p=0.001) only after 6 months. Both groups presented with a significant decrease of VE/VCO_2 slope values a year after MI in comparison to the examination after 3 months.

Throughout the entire observation period there were no significant differences in the NT-proBNP concentrations between the groups (Figure 6). In both groups only at the examination after 6 months was a significant decrease in the concentration of this biomarker observed. A significant decrease of NT-proBNP values was observed in both groups one year following MI in comparison to the initial examination.

Throughout the entire observation period correlations between the values of NT-proBNP concentrations and ECHO as well as peak VO_2 and MET parameters, registered in the examination after 3 months, were observed (Table IV).

Discussion

In the PAMI I study age over 65 years was considered an independent risk factor of death in AMI [8]. Despite the fact that age is unequivocally considered an independent risk factor of unfavourable outcomes of the treatment of MI, proper guidelines in the group of older patients were not finally established, mainly because of insufficient participation of these patients in clinical studies. It is doubtful whether the observations made in the studies of younger patients could be fully applied to elderly patients, who usually present with greater atherosclerotic changes, more often suffer from other concomitant diseases and present with more risk factors of atherosclerosis. Dyslipidaemia and hypertension proved to be the most common risk factors of MI occurrence in patients older than 65 years. This observation is compatible with the results of the Lipidogram 2004 study, which showed that dyslipidaemia and hypertension are the most common cardiovascular risk factors in Poland [9].

The strategy of early invasive treatment should be the preferred method of treatment of patients with MI, especially of elderly patients at high risk of developing post-infarct of CHF. The benefits of treatment of MI with early PCI in patients over 65 years of age are documented [10]. Studies on the Polish population also demonstrated that elderly people benefit from invasive treatment of MI [11]. Nevertheless, the results of observation studies obtained from the registry of patients hospitalised because of acute coronary syndromes, demonstrate that elderly patients rarely undergo coronary invasive procedures and also less frequently receive conservative treatment with a confirmed favourable influence on prognosis [12].

Our results indicate that PCI is an effective method of prevention of CHF in the group of patients over 65 years of age. We demonstrated that patients treated invasively have better exercise capacity at each stage of one-year follow-up compared with patients treated conservatively. It is difficult to compare these results with results obtained by other authors since similar detailed studies in literature are lacking.

Echocardiography proved to be the best tool to detect asymptomatic LV dysfunction as well as to confirm the development of CHF in asymptomatic patients [13]. It was shown earlier that even a slight enlargement of LV in the early period after MI increases the risk of death and of the occurrence of post-MI CHF twice or three times [14]. It was also demonstrated that LVESV is a better parameter describing the prognosis after MI than the anatomy of the coronary vessels [15].

Our study demonstrated that patients treated invasively presented with a significantly better haemodynamic parameters at each follow-up stage. Significant improvement was observed in the group treated conservatively only after 6 months. The LV systolic function evaluated in the early stage after MI proved to be a predictor of the performance of the cardiovascular system in long-term observation. It was shown that the better the haemodynamic parameters evaluated in echocardiography in the examination after 3 months, the better the parameters of exercise capacity and lower concentrations of NT-proBNP examined 6 and 12 months after MI.

Despite the fact that the echocardiographic parameters do not always correlate with the degree of exertion capacity, it was demonstrated that patients treated invasively presented with better values of metabolic and ventilation parameters obtained in the spiroergometric test. Patients treated invasively presented with significantly greater exercise tolerance (T ex., MET) at all stages of observation. Greater exertion capacity in these patients was characterised by significantly higher values of peak VCO_2 and significantly lower values of VE/VCO_2 and VE/VCO_2 slope. Moreover, patients treated with invasive methods showed progressive improvement of exertion capacity in the yearly observation, whereas in the group treated conservatively a significant improvement of the assessed parameters was observed only in the examination after 6 months.

The ability to intake oxygen on exertion (peak VO_2) is considered the most objective indicator of exercise capacity [9]. The measurement of peak VO_2 is characterised by good reproducibility and therefore is the most commonly used parameter to objectively evaluate the improvement or the deterioration of CHF. However, normal or slightly decreased values of peak VO_2 (over 18 ml/kg/min) do not have any diagnostic or prognostic value [16]. The ratio of carbon dioxide (VCO_2) production to ventilation (VE) during physical exercise is also important, because in patients with CHF an inadequate increase in the frequency of breathing during exertion is observed and leads to excessive ventilation. According to some investigators the parameters of exertion ventilation (in our study VE/VCO_2, VE/VCO_2 slope) obtained during the spiroergometric test allow extensive evaluation of the progression of CHF, and can be a source of important prognostic information [16, 17]. The results of our study confirmed that the analysis of expired CO_2 and the evaluation of VE/VCO_2 described cardiac performance more precisely than peak VO_2. Throughout the entire observation period the values of peak VO_2 were high in both groups, and when presented as the percentage of the norm for age and sex they did not differentiate the study groups. Instead, at all observation stages the groups were significantly different in terms of the values of VE/VCO_2 and VE/VCO_2 slope, which were better in the group treated invasively. The patients treated conservatively did not reach the values obtained in the initial examination of patients treated invasively for almost half a year of follow-up.

The diagnosis of CHF in elderly patients is sometimes difficult due to coexisting diseases such as chronic respiratory diseases, as well as due to the frequent occurrence of CHF despite proper systolic function of LV. The measurement of BNP is currently the biochemical basis for CHF diagnosis. In our patients we measured NT-proBNP, which is a biologically inactive N-terminal fragment of proBNP, from which BNP is also created. It has been suggested that it is a more sensitive marker of LV dysfunction because in patients with acute MI a greater increase of NT-proBNP than BNP is observed and has a greater discriminating value for early CHF diagnosis than BNP [18]. The results of our study confirmed that NT-proBNP measured in the acute phase of MI is a prognostic factor of CHF development in the early period after MI. We demonstrated that increased concentrations of NT-proBNP on admission correlated with impaired haemodynamic parameters assessed by echocardiography and also with decreased parameters of exercise capacity in the spiroergometric test performed after 3 months. In patients after MI the concentrations of natriuretic peptides correlated with the dilation, remodelling and dysfunction of LV [19]. We showed that impaired systolic function of LV in the early period after MI correlated with increased concentration of NT-proBNP in the long-term observation.

All patients who participated in the programme received optimal treatment. The results obtained in the study indicate that proper treatment brings benefits also to patients older than 65 years. In our previous studies we demonstrated that in the general population patients treated invasively presented with improved cardiovascular performance 3 months after MI; however, it did not improve throughout one-year follow-up [20]. The results obtained in this study may suggest that patients older than 65 years benefit from invasive treatment more than younger patients. Moreover, we may assume that the patients treated conservatively constituted initially a group with a lower risk of MI complications, as they survived the acute phase of the disease despite treatment less effective and were able to perform a diagnostic spiroergometric test three months after MI.

Limitations

The number of subjects included in the study is notably small; however, it is a non-selected, ambulatory group of patients after MI followed for a relatively long period. The division into study groups was not done on the basis of randomisation but resulted from doctors' decisions. As a result, there were baseline differences between the groups (for example in terms of the time that passed between the onset of the infarct pain and the beginning of treatment), and this might have influenced the results. Our examination protocol excluded patients with more advanced CHF. Only

patients who survived the first three months after MI and were able to perform the diagnostic spiroergometric test were selected for the study. Therefore, the recruitment of patients could have influenced the values of the examined parameters during yearly observation.

Conclusions

In the group of patients older than 65 years:

1. Treatment of MI with PCI prevents the development of post-MI CHF more efficiently than conservative treatment.
2. Invasive treatment of MI leads to better performance of the cardiovascular system three months after MI, which is further improved during one-year follow-up.
3. The greatest improvement in physical capacity is observed between the 3rd and 6th month following MI.
4. High concentration of NT-proBNP in the acute phase of MI is a predictor of the CHF development in the early period after MI.
5. Impaired LV systolic function in the early period after MI is a predictor of the occurrence of CHF in the long-term follow-up.

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References

1. Mosterd A, Hoes AW, de Bruyne MC, et al. Prevalence of heart failure and left ventricular dysfunction in the general population. *Eur Heart J* 1999; 20: 447-5.
2. Cowie MR, Wood DA, Coats AJ, et al. Survival of patients with a new diagnosis of heart failure: a population based study. *Heart* 2000; 83: 505-10.
3. Cowie MR, Wood DA, Coats AJS, et al. Incidence and etiology of heart failure; a population-based study [comment]. *Eur Heart J* 1999; 20: 421-8.
4. Cowie MR, Wood DA, Coats AJS, et al. Incidence and etiology of heart failure. *Eur Heart J* 1997; 18: 208-25.
5. American Heart Association: 2001 Heart and Stroke Statistical Update. *American Heart Association*, Dallas 2000.
6. deBoer M, Reiber J, Suryapranata H, et al. Angiographic findings and catheterization laboratory events in patients with primary coronary angioplasty or streptokinase therapy for cute myocardial infarction. *Eur Heart J* 1995; 16: 1347-55.
7. Working Group on Cardiac Rehabilitation and Exercise Physiology and Working Group on Heart Failure of the European Society of Cardiology. Recommendations for Exercise Testing in Chronic Heart Failure patients. *Eur Heart J* 2001; 22: 37-45.
8. Nunn CM, O´Neill WW, Rothbaum D, et al. Long-term outcome after primary angioplasty: report from the Primary Angioplasty in Myocardial Infarction (PAMI-I) trial. *J Am Coll Cardiol* 1999; 33: 640-6.
9. Mastej M, Jóźwiak J, Lukas W, et al. Ocena i porównanie parametrów lipidogramu w zależności od płci oraz wskaźnika masy ciała BMI. *Kardiol Pol* 2006; 64, 8 (supl. 2): 153-60.
10. Bach RG, Cannon CP, Weintraub WS, et al. The effect of routine, early invasive management on outcome for elderly patients with non-ST-segment elevation acute coronary syndromes. *Ann Intern Med* 2004; 141: 186-95.
11. Zielińska M, Bolińska H, Karczmarek K, et al. Acute myocardial infarction in the elderly. Is primary coronary angioplasty the treatment of choice? In-hospital follow-up results. *Kardiol Pol* 2004; 60: 100-3.
12. Avezum A, Makdisse M, Spencer F, et al. Impact of age on management and outcome of acute coronary syndrome: observations from the Global Registry of Acute Coronary Events (GRACE). *Am Heart J* 2005; 149: 67-73.
13. Redfield MM, Jacobsen SJ, Burnett JC, et al. Burden of systolic and diastolic ventricular dysfunction in the community: appreciating the scope of the heart failure epidemic. *JAMA* 2003; 289: 194-202.
14. St John Sutton M, Pfeffer MA, Plappert T, et al. Quantitative two-dimensional echocardiographic measurements are major predictors of adverse cardiovascular events after acute myocardial infarction. The protective effects of captopril. *Circulation* 1994; 89: 68-75.
15. White HD, Norris RM, Brown MA, et al. Left ventricular end-systolic volume as the major determinant of survival after recovery from myocardial infarction. *Circulation* 1987; 76: 44-51.
16. Ponikowski P, Francis DP, Piepoli MF, et al. Enhanced ventilatory response to exercise in patients with chronic heart failure and preserved exercise tolerance: Marker of abnormal cardiorespiratory reflex control and predictor of poor prognosis. *Circulation* 2001; 103: 967-72.
17. Robbins M, Francis G, Pashkow FJ, et al. Ventilatory and heart rate responses to exercise: better predictors of heart failure mortality than peak oxygen consumption. *Circulation* 1999; 100: 2411-7.
18. Mueller T, Gegenhuber A, Poelz W, et al. Head to head comparison of the diagnostic utility of BNP and NT-proBNP in symptomatic and asymptomatic structural heart disease. *Clin Chim Acta* 2004; 341: 41-8.
19. deLemos JA, Morrow DA. Brain natriuretic peptide measurement in acute coronary syndromes: ready for clinical application? *Circulation* 2002; 106: 2868-70.
20. Pawłowska-Jenerowicz W, Lechowicz W, Dąbrowski M, et al. Favourable impact of acute myocardial infarction treatment by percutaneous coronary intervention on cardiovascular efficiency during one-year observation. *Post Kardiol Interw* 2006; 5: 199-206.

Ocena wydolności układu krążenia w okresie rocznej obserwacji po przebytym zawale serca w grupie chorych po 65. roku życia; porównanie efektów leczenia wczesną angioplastyką wieńcową i leczenia zachowawczego

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Streszczenie

Wstęp: Hospitalizacji osób starszych z rozpoznaniem niewydolności serca (NS) towarzyszy zawsze bardzo poważne rokowanie, szczególnie gdy objawy NS są efektem dysfunkcji skurczowej lewej komory. Leczenie ostrej fazy zawału mięśnia sercowego wczesną angioplastyką wieńcową uważa się za najlepszą metodę zapobiegania pozawałowej NS. Kliniczne znaczenie wczesnej angioplastyki w leczeniu zawału serca u chorych po 65. roku życia nie jest w pełni ustalone, głównie z powodu niedostatecznego uczestnictwa osób starszych w badaniach.

Cel: Ustalenie, czy leczenie wczesną angioplastyką wieńcową zawału serca w grupie chorych po 65. roku życia skutkuje istotnie lepszą wydolnością układu krążenia w okresie odległym w porównaniu z leczeniem zachowawczym.

Metody: Obserwacją objęto 90 chorych, u których uzyskano diagnostyczny wynik spiroergotestu. W ostrej fazie zawału mięśnia sercowego 40 chorych było leczonych zachowawczo (grupa I), a 50 inwazyjnie (grupa II). Po 3, 6 i 12 miesiącach u wszystkich chorych wykonywano badanie echokardiograficzne oraz test spiroergometryczny (CPX). W badaniu echokardiograficznym analizie poddano wymiar końcoworozkurczowy (LVEDD) i końcowoskurczowy (LVESD) oraz wielkość frakcji wyrzucania (EF) lewej komory, a w CPX wyjściową częstotliwość pobudzeń serca (HR) oraz na szczycie wysiłku (HRmax), wyjściowe skurczowe (SBP) i rozkurczowe (DBP) ciśnienie tętnicze, czas trwania wysiłku (Twys.), ekwiwalent metaboliczny (MET), szczytowe zużycie tlenu (*peak* VO_2), szczytowe zużycie tlenu wyrażone jako procent wartości należnej dla płci i wieku (*peak* VO_2 – %N), wentylacyjny równoważnik dwutlenku węgla na szczycie wysiłku (VE/VCO_2) oraz wskaźnik wentylacji wysiłkowej ($VE\text{-}VCO_{2\ slope}$). Poziom peptydu natriuretycznego typu B (NT-proBNP) oznaczano przy przyjęciu do szpitala oraz po 6 i 12 miesiącach obserwacji.

Wyniki: W grupie leczonej inwazyjnie rejestrowano istotnie lepsze wartości parametrów echokardiograficznych oraz wskaźników CPX przez cały okres obserwacji. Ulegały one systematycznie istotnej poprawie z badania na badanie. W grupie leczonej zachowawczo uległy one istotnej poprawie tylko po 6 miesiącach od przebytego zawału mięśnia sercowego. Po roku od zawału wartości wszystkich rejestrowanych parametrów były lepsze w grupie leczonej inwazyjnie ($p < 0{,}001$ dla LVESD i EF, $p = 0{,}03$ dla LVEDD, $p = 0{,}011$ dla Twys., $p = 0{,}002$ dla MET, $p = 0{,}02$ dla *peak* VO_2, $p < 0{,}001$ dla VE/VCO_2 i $VE\text{-}VCO_{2\ slope}$). Na każdym etapie obserwacji stężenia NT-proBNP korelowały z wartościami parametrów echokardiograficznych i CPX rejestrowanymi w badaniu po 3 miesiącach: (–) z EF, *peak* VO_2 i MET, a (+) z LVESD i LVEDD. Na każdym etapie obserwacji wskaźniki CPX korelowały z parametrami echokardiograficznymi rejestrowanymi w badaniu po 3 miesiącach.

Wnioski: U chorych po 65. roku życia leczenie zawału serca wczesną angioplastyką wieńcową skutkuje istotnie lepszą wydolnością układu krążenia w okresie rocznej obserwacji w porównaniu z leczeniem zachowawczym. U chorych w tej grupie wiekowej największą poprawę wydolności układu krążenia rejestruje się pomiędzy 3. a 6. miesiącem od zawału serca, niezależnie od sposobu leczenia w ostrej fazie choroby.

Słowa kluczowe: zawał serca, starsi, wydolność układu krążenia, angioplastyka wieńcowa, leczenie zachowawcze

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