EARLY EFFECTS OF INPATIENT (PHASE I) AND OUTPATIENT (PHASE II) CARDIAC REHABILITATION IN PATIENTS WITH POST MYOCARDIAL INFARCTION AND SUBSEQUENT TREATMENT USING CORONARY ARTERY BYPASS GRAFTING OR CORONARY ARTERY STENT IMPLANTATION

Zbigniew Nowak, Rafał Gnat, Michał Plewa

University School of Physical Education, Katowice, Poland

Submitted in January, 2003

Along with the increasing number of coronary artery bypass grafting (CABG) or coronary artery stent implantation (CASI) patients, the problem of establishing an appropriate rehabilitation program for these two groups of patients arises. The objective of this study was to assess the level of exercise tolerance in post myocardial infarction (MI) patients treated surgically with one or the other of these two procedures, who were subjected to the proposed rehabilitation program. Two groups of male patients were investigated. The first group consisted of 24 patients, who underwent the CABG procedure; the second – of 24 patients, who underwent the CASI procedure. The assessment of exercise tolerance was performed on the basis of treadmill stress tests (according to Bruce’s protocol). The test was first performed prior to the surgical procedures and then after completion of the proposed rehabilitation program consisting of two phases. In the CASI group the time and the covered distance of the stress test increased significantly after the procedure. The average metabolic cost increased significantly as well. In the CABG group the stress test time increased significantly, as did the covered distance, maximal HR, double product and the workload. Also the drop in the number of pathological reasons for the test termination was statistically relevant. The programme of rehabilitation used in the present study justified its efficacy, bringing about a considerable increase in exercise tolerance in both groups studied.

Keywords: CABG, CASI, physical capacity, treadmill stress test.

INTRODUCTION

Surgical procedures in patients with post myocardial infarction (MI) have become a generally accepted and commonly performed method of treatment. Research conducted on coronary artery bypass grafting (CABG) patients has shown a considerable improvement of their clinical status. In the mid 1980’s, a coronary artery stent implantation (CASI) procedure was introduced as an alternative to the CABG. Along with the increased number of CABG or CASI patients, the problem of establishing an appropriate rehabilitation program for these two groups of patients arose, and so did the problem of assessing its efficacy.

The objective of this study was to assess the level of exercise tolerance in patients, post MI treated surgically with the CABG or the CASI, who were subjected to the proposed rehabilitation program both during phase I and phase II of the treatment.

MATERIALS AND METHODS

Two groups of male patients were subjected to this study. The first group studied consisted of 24 patients of 38–69 years of age (50.6 ± 8.5 years on average), who underwent the CABG procedure when they were 3 months post MI (CABG group). Those patients demonstrated stenosis of 3 coronary arteries or with an extensive area of ischaemia when fewer arteries were narrowed.

The second group studied consisted of 24 patients of 35–68 years of age (53.5 ± 9.7 years on average), who underwent a coronary stenting procedure when they were 4–6 weeks post MI (CASI group). That procedure was performed in patients who were diagnosed with stenosis of 1 or 2 coronary arteries, with a small area of ischaemia. Specific data concerning the number of implanted stents and grafted bypasses is shown in Fig. 1.

All patients were informed of the objective of the conducted study and of the form of the treatment they were to be subjected to. In all cases their consent was obtained.

The hospital rehabilitation program for CABG group lasted 9 days and included:

- 1st to 2nd day (intensive care unit): breathing exercises, active range of motion exercises for upper and lower extremities in supine and sitting positions, supine-to-stand transfer training;
- 3rd to 5th day (exercise room): breathing exercises, active range of motion exercises for upper and lower extremities in supine and sitting positions, supine-to-stand transfer training;
- 6th to 7th day (exercise room): breathing exercises, active range of motion exercises for upper and lower extremities in supine and sitting positions, supine-to-stand transfer training;
- 8th to 9th day (exercise room): breathing exercises, active range of motion exercises for upper and lower extremities in supine and sitting positions, supine-to-stand transfer training.
lower extremities in sitting, isometric exercises, postural reeducation exercises;
• 6th to 9th day (exercise room): active range of motion exercises for upper and lower extremities in sitting and standing positions, gait training, stair climbing.

After completion of nine days of rehabilitation, 20 patients from the CABG group were immediately discharged from hospital, whereas four remained at hospital for a total of 12 days due to wound healing problems.

The hospital rehabilitation program for the CASI group lasted six days and included:
• 1st to 2nd day (exercise room): breathing exercises, active range of motion exercises for upper and lower extremities in supine and sitting positions, supine-to-stand transfer training;
• 3rd to 4th day (exercise room): active range of motion exercises for the upper and lower extremities in sitting and standing positions, ambulating;
• 5th to 6th day (exercise room): active range of motion exercises for the upper and lower extremities in sitting and standing positions, ambulating, gait training, stair climbing.

The above-captioned inpatient cardiac rehabilitation program was completed by 22 patients from the CASI group. Two quit the program on the fifth day, leaving hospital at their own request.

The outpatient rehabilitation program lasted 21 days and was similar for both groups of patients. All patients began that phase within 3 weeks of the day of their discharge from hospital. The phase II rehabilitation program included:
• exercises in various starting positions and with the use of rehab supplies and exercise equipment (exercise room; twice a day, 20 minutes each session)
• interval exercise training program on cycle ergometer, 4 minutes of work interval followed by 2 minutes of rest interval (3 times a week, 30–45 minutes each session)
• swimming exercises (swimming pool; 3 times a week, 20–30 minutes each session, breast stroke)
• gait training (gradually from 2 to 6 kilometres)

All patients completed the phase II rehabilitation program.

HR response to physical exercise at the time of initial measurement was essential as far as setting the training load, which was adjusted between 60–70 % (in subjects aged over 60) (Belardinelli et al., 1995; Killavouri et al., 1995; Killavouri et al., 2000; Meyer et al., 1997; Sturm et al., 1999) and 70–80 % (in subjects aged under 60) of HR increase value obtained in that measurement (Braunwald, 1997; European Heart Failure Training Group, 1998; Fletcher et al., 1990; Hambrecht et al., 2000; Reinhart et al., 1998; Willenheimer et al., 1998).

The assessment of exercise tolerance was performed on the basis of results obtained during submaximal stress tests on a treadmill (according to Bruce’s protocol). The stress tests were performed twice in each group, first prior to the CABG or CASI procedure (initial test) and then after completion of the entire rehabilitation program (final test). The following parameters were analysed: test time [min], covered distance [m], heart rate [beats per minute] and blood pressure [mmHg] responses to exercise, metabolic cost [METs], double product, reasons for stress test interruption (physiological: heart rate rise limit, fatigue; pathological: stenocardia, dyspnoea, ST segment depression, disturbances in rhythm). All results obtained on the treadmill stress test were gathered with the use of Optimus-Oxford computer software.
All stress tests were supervised by a qualified and experienced hospital employee and additionally by a medical doctor (cardiologist). They both supervised the stress test for all 48 patients.

Stress test performance sometimes results in undesirable responses, as observed in some patients. A surface which continues to move underfoot, variations in treadmill inclination and/or strange noises generated by the equipment, make some patients grip the treadmill railing tightly, hold their breath, lean forward or walk in an atactic way. To avoid the mentioned above problems, the test procedure was clearly explained to all patients. Patients were also allowed to perform a pre-test for 2–3 minutes. Persons supervising the main test did not use any form of verbal encouragement to stimulate patients to overcome higher loads, which otherwise could have resulted in an unreasonable extension of the stress test time. That, along with the opportunity of performing the pre-test, enabled us to assess objectively patients’ functional capacity.

Both initial and final tests, as well as all training sessions, were performed at the Cardiac Rehabilitation Department and in the ergometric laboratory of Górnośląskie Centrum Medyczne (Upper Silesian Medical Centre) in Katowice-Ochojec, Poland. Training and measurement conditions were identical for all patients.

The results obtained were subjected to statistical analysis, which included the calculation of distribution of measured variables with the use of the W Shapiro-Wilk’s test. In some cases, the data deviation from normal distribution appeared to be statistically relevant. For these variables non-parametrical tests were used then, such as the U Mann-Whitney’s test (for description of relevance of differences between groups) and the Wilcoxon’s test (for description of relevance of differences within particular groups). The t-Student’s test was used as the parametric equivalent of the above mentioned tests for independent and dependent data, respectively. Prior to the t-Student’s test (independent data), homogeneity of variance for each analysed pair of variables was assessed with the use of the Levene’s test. Lack of homogeneity was found only in one case, and here, in addition to the t-Student’s test, the assessment of variation of both parameters was used (Cohran-Cox’s test). For the purpose of qualitative analysis, the McNemar’s test was used.

RESULTS

Study groups were primarily analysed according to age parameters. No statistical relevancy was found here (p = 0.2755), therefore it may be stated that this variable neither affected further statistical analysis, nor final conclusions.

In the CASI group the stress test time increased significantly after the procedure, from the mean value of 7.40 up to 9.51 minutes (p = 0.0006), as did the covered distance, from the mean value of 312.5 up to 441.25 meters (p = 0.00015*). The average metabolic cost increased significantly as well, reaching the value of 12.49 METs versus 10.1 METs recorded at the time of the initial test (p = 0.0014*) (TABLE 1). The number of the tests terminated due to pathological criteria decreased, though no statistical relevancy was noted here (p = 0.1305) (Fig. 2).

Similar changes were noted in the CABG group, here the time of the stress test increased significantly from the value of 5.51 to 8.40 min (p = 0.000006), as did the covered distance from 231.83 to 361.71 meters (p = 0.00083*) and the work load from 7.84 to 10.6 METs (p = 0.00123*). The values of maximum HR and double product have increased considerably as well, from 123.42 to 136.88 beats/minute (p = 0.00071), and from 20770.8 to 23267 (p = 0.0139), respectively (TABLE 2). Also statistically relevant was the drop in the number of pathological reasons which were recognised as the criteria for the stress test termination (p = 0.00051) (Fig. 2).

**TABLE 1**
Mean values and standard deviations of results; trust level of differences between initial and final tests in the CASI group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Initial test</th>
<th>Final test</th>
<th>P level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time [min, sec]</td>
<td>7.40 ± 2.17</td>
<td>9.51 ± 2.17</td>
<td>0.0006</td>
</tr>
<tr>
<td>Distance [m]</td>
<td>312.5 ± 135.57</td>
<td>441.25 ± 138.23</td>
<td>0.00015*</td>
</tr>
<tr>
<td>HR [beat/min]</td>
<td>134.88 ± 14.65</td>
<td>138.33 ± 13.39</td>
<td>NS</td>
</tr>
<tr>
<td>SBP [mmHg]</td>
<td>176.84 ± 22.02</td>
<td>176.67 ± 23.16</td>
<td>NS</td>
</tr>
<tr>
<td>DBP [mmHg]</td>
<td>86.04 ± 10.42</td>
<td>86.88 ± 12.92</td>
<td>NS</td>
</tr>
<tr>
<td>Work load [MET]</td>
<td>10.1 ± 2.37</td>
<td>12.49 ± 2.37</td>
<td>0.0014*</td>
</tr>
<tr>
<td>DP</td>
<td>23752.5 ± 3959.8</td>
<td>24438.3 ± 3944.1</td>
<td>NS</td>
</tr>
</tbody>
</table>

HR – heart rate
SBP – systolic blood pressure
DBP – diastolic blood pressure
DP – double product
The initial assessment of differences between the CABG and CASI group was performed in relation to the following parameters: stress test time (7.40 versus 5.51 min; p = 0.0058), covered distance (312.5 versus 231.83 m; p = 0.0063**), maximum HR (134.88 versus 123.42 beats/minute; p = 0.0339), work load (10.1 versus 7.84 METs; p = 0.001**) and double product (23752.5 versus 20770.8; p = 0.02). Therefore it may be concluded that patients from the CABG group demonstrated a considerably lower exercise tolerance (TABLE 3).

After the surgical procedure, the characteristics of results changed. All differences found between groups before, now appeared not to be statistically relevant, except the work load (12.49 versus 10.6 METs; p = 0.0036**) and the covered distance (441.25, versus 361.71 m; p = 0.04). Therefore the results of patients from the CABG group were similar to those obtained by patients from the CASI group (TABLE 4).

### TABLE 2
Mean values and standard deviations of results; trust level of differences between initial and final tests in CABG group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Initial test</th>
<th>Final test</th>
<th>P level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time [min, sec]</td>
<td>5.51 ± 2.17</td>
<td>8.40 ± 2.03</td>
<td>0.000006</td>
</tr>
<tr>
<td>Distance [m]</td>
<td>231.83 ± 156.40</td>
<td>361.71 ± 122.64</td>
<td>0.00083*</td>
</tr>
<tr>
<td>HR [beat/min]</td>
<td>123.42 ± 19.71</td>
<td>136.88 ± 12.58</td>
<td>0.00071</td>
</tr>
<tr>
<td>SBP [mmHg]</td>
<td>167.5 ± 20.48</td>
<td>169.58 ± 21.56</td>
<td>NS</td>
</tr>
<tr>
<td>DBP [mmHg]</td>
<td>86.04 ± 14.06</td>
<td>80.83 ± 10.49</td>
<td>NS</td>
</tr>
<tr>
<td>Work load [MET]</td>
<td>7.84 ± 2.34</td>
<td>10.6 ± 1.87</td>
<td>0.00123*</td>
</tr>
<tr>
<td>DP</td>
<td>20770.8 ± 7715.0</td>
<td>23267.0 ± 3950.2</td>
<td>0.0139</td>
</tr>
</tbody>
</table>

HR – heart rate  
SBP – systolic blood pressure  
DBP – diastolic blood pressure  
DP – double product
DISCUSSION

It may be assumed that the results obtained during initial examination reflected the patients’ clinical picture. Analysis of differences between groups showed, that patients referred to CASI procedure were able to tolerate much higher exercise loads, when compared with those who were to undergo the CABG procedure. Statistically relevant differences were found in almost all measured parameters, except systolic and diastolic blood pressure. It is apparent that the extent of MI and a number of critically stenosed coronary arteries contributed to such results. In spite of continually improving results of percutaneous revascularization procedure, open heart surgery remains an irreplaceable method in treatment of ischaemic heart disease, especially in the presence of stenosis of 3 or more coronary arteries (CABRI Trial Participants, 1995; Caracciolo & Davis, 1995; Engblom & Hama lainen, 1992; Mark & Nelson, 1994; The Writing Group for the Bypass Angioplasty Revascularization Investigation /BARI/, 1997). As was already stated,

<table>
<thead>
<tr>
<th>Variable</th>
<th>CASI</th>
<th>CABG</th>
<th>P level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time [min, sec]</td>
<td>7.40 ± 2.17</td>
<td>5.51 ± 2.17</td>
<td>0.0058</td>
</tr>
<tr>
<td>Distance [m]</td>
<td>312.5 ± 135.57</td>
<td>231.83 ± 156.40</td>
<td>0.0063**</td>
</tr>
<tr>
<td>HR [beat/min]</td>
<td>134.88 ± 14.65</td>
<td>123.42 ± 19.71</td>
<td>0.0339</td>
</tr>
<tr>
<td>SBP [mmHg]</td>
<td>176.84 ± 22.02</td>
<td>167.5 ± 20.48</td>
<td>NS</td>
</tr>
<tr>
<td>DBP [mmHg]</td>
<td>86.04 ± 10.42</td>
<td>86.04 ± 14.06</td>
<td>NS</td>
</tr>
<tr>
<td>Work load [MET]</td>
<td>10.1 ± 2.37</td>
<td>7.84 ± 2.34</td>
<td>0.001**</td>
</tr>
<tr>
<td>DP</td>
<td>23752.5 ± 3959.8</td>
<td>20770.8 ± 7715.0</td>
<td>0.02</td>
</tr>
</tbody>
</table>

HR – heart rate  
SBP – systolic blood pressure  
DBP – diastolic blood pressure  
DP – double product

### TABLE 4
Mean values and standard deviations of results; trust level of differences between CASI and CABG groups in final test

<table>
<thead>
<tr>
<th>Variable</th>
<th>CASI</th>
<th>CABG</th>
<th>P level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time [min, sec]</td>
<td>9.51 ± 2.17</td>
<td>8.40 ± 2.03</td>
<td>NS</td>
</tr>
<tr>
<td>Distance [m]</td>
<td>441.25 ± 138.23</td>
<td>361.71 ± 122.64</td>
<td>0.04</td>
</tr>
<tr>
<td>HR [beat/min]</td>
<td>138.33 ± 13.39</td>
<td>136.88 ± 12.58</td>
<td>NS</td>
</tr>
<tr>
<td>SBP [mmHg]</td>
<td>176.67 ± 23.16</td>
<td>169.58 ± 21.56</td>
<td>NS</td>
</tr>
<tr>
<td>DBP [mmHg]</td>
<td>86.88 ± 12.92</td>
<td>80.83 ± 10.49</td>
<td>NS</td>
</tr>
<tr>
<td>Work load [MET]</td>
<td>12.49 ± 2.37</td>
<td>10.6 ± 1.87</td>
<td>0.0036**</td>
</tr>
<tr>
<td>DP</td>
<td>24438.3 ± 3944.1</td>
<td>23267.0 ± 3950.2</td>
<td>NS</td>
</tr>
</tbody>
</table>

HR – heart rate  
SBP – systolic blood pressure  
DBP – diastolic blood pressure  
DP – double product
studied patients referred for treatment of CASI were shown to have stenosis of no more than 2 coronary arteries with a small area of ischaemia, therefore they did not need open heart surgery.

The main objective of either the coronary bypass or stenting procedure is the removal of obliteration located in coronary arteries, which is supposed to relieve pain symptoms, improve the quality of life (activities of daily living) and increase the level of physical activity. Such effects may be experienced by patients already within the first months following the procedure (Booth & Deupree, 1991; Caine & Harrison, 1991; Jenkins & Stanton, 1983; Klersy & Collarini, 1997; Sjoland & Caidahl, 1997). The improvement may be noted in changes of objective parameters such as extension of stress test time and toleration of higher loads [METs] (Sjoland & Caidahl, 1997; Engblom & Korpiälähi, 1997; Ross et al., 1978; Ross & Monro, 1981; Stanton & Jenkins, 1984), which was found in the present study as well. The time period of 2–3 months after the procedure, that is immediately after the completion of phase II of cardiac rehabilitation is, according to many authors, the time period, in which the improvement of exercise tolerance and thus quality of life is the most considerable. After the lapse of 6–12 months after the procedure and even later, that improvement is to a lesser extent (Caine & Harrison, 1991; Klersy & Collarini, 1997; Sjoland & Caidahl, 1997; Tziciencekia-Green & Steptoe, 1994). Therefore it seems to be highly advisable to implement permanent exercise programmes (of adequate intensity, under supervision of physical therapists) which would constitute prophylactic measures aiming at prevention of another MI.

The conducted analysis of level of exercise tolerance clearly indicates that utilisation of non-invasive methods of treatment, along with appropriate rehabilitation, brings the expected results in treatment of post MI patients. The programme of rehabilitation which was used in the present study justified its efficacy, bringing a considerable increase of exercise tolerance to both groups studied. Results of stress tests conducted after the completion of phase II rehabilitation show, that the most significant improvement of exercise capacity is noted in the CABG group. The analysis of both groups revealed relevant differences only in the two following parameters: the amount of load [METs] and the covered distance. These results prove the need of cardiac rehabilitation after cardiosurgical procedures, though some authors still question its role, claiming that the coronary artery surgical procedure itself results in improvement of a patient’s exercise capacity (Dubach et al., 1995; Agren et al., 1989). Fortunately, there are only a few authors who support this kind of statement, and it is generally known that limitation of or even elimination of rehabilitation from the treatment course of patients after cardiosurgical procedures brings many undesirable side effects. Not only is the issue of rehabilitation so crucial, but also the length in time of its duration during the inpatient phase. The present study has shown significant improvement of exercise capacity in both groups studied, though the most considerable increase was noted in patients who underwent the CABG procedure, despite the fact that this procedure is much more traumatic than the stenting one. It seems that it is the duration time of inpatient rehabilitation which affects the results. In the CASI group, rehabilitation lasted 6 days, but 2 patients quit rehabilitation on the fifth day, and that unfavourably affected the results of the study. In the CABG group rehabilitation was continued for 9 days after the surgery, and in case of 4 of the patients, even for 12 days.

Exercise capacity rated at the level of 5 METs in patients with ischemic heart disease predicts a poor prognosis. However after the (especially complicated and extensive) MI, these patients very often reach a level of 5–7 METs (Fletcher et al., 1990). These opinions were confirmed in our observations. Patients who underwent extensive MI managed to obtain a level of about 7.8 METs during the initial test. They were referred for the CABG procedure, and after completion of phase I and II of rehabilitation, their exercise capacity increased up to the level of 10.6 METs, which is a relatively good result. A similar level of relatively good exercise capacity (10.1 METs) was reached during the initial test by patients who were to undergo the CASI procedure. The level of 13 METs and over, despite some undesirable responses observed during the test, is considered to be a very good result and patients from the CASI group managed to reach an average level of 12.49 METs after completion of rehabilitation.

During the stress test, some of the CABG patients complained of pain in the thorax area or in the lower extremities. These are typical symptoms experienced by patients who have undergone a sternotomy and the procedure of saphenous vein graft removal. According to Jenkins and Stanton (1983), within the first 6 months since the surgical procedure, 35–39 % of patients complain of symptoms in the thorax area and in the lower extremities, 48 % report fatigue and general weakness and 18 % experience shortness of breath. Engblom et al. (1992), besides pain experienced in the sternum (33 %) and shoulder areas (22 %), also mentions episodes of dysrhythmia (31 %). Some of the above mentioned symptoms may be of psychological origin as well (Mayou & Bryant, 1987). Therefore the finding of such symptoms in study patients (with normal values of objective parameters such as HR and BP) were not treated as a pathological response to exercise.

In the cases of three CASI patients, the final results of the test appeared to be slightly worse than the ones recorded during the initial test, which resulted in a lower increase of exercise tolerance among patients from this group. There are many reports proving the high effectiveness of the CASI procedure (Fischman et al., 1994; Serruys et al., 1994), and so it was observed in our study too, though the problem of restenosis remains difficult to eliminate. In the case of
the above mentioned three patients, there was a quick restenosis (within 1.52 months after the procedure). It was due to proliferation of tunica intima cells of the coronary artery. This observation is in accordance with the results of the European Programme BENESTENT II (Legrand et al., 1997). Perhaps frequent restenosis results from technical mistakes made during stents implantation, and even in our centre (after completion of this study), there were cases of patients who, as early as one month after the procedure, were reporting symptoms typical for angina pectoris, which were later confirmed during the initial stage of the stress test. Some authors (Mintz et al., 1996) claim, however, that the main reason for such sudden restenosis is the proliferation of cells constituting the neointima and production of extracellular matrix. None of the patients from the CABG group obtained worse results at the time of the final test, when compared with the results of the initial test. However it does not seem reasonable to assess the effectiveness of any of the analysed treatment methods only on the basis of the data acquired. Our own observations show that individual cases of sudden restenosis were also found in patients who were post CABG procedure. In the presented study however, this kind of problem was found in post CASI procedure patients only.

REFERENCES


ČASNÉ EFEKTY ÚSTAVNÍ (FÁZE I) A AMBULANTNÍ (FÁZE II) SRDEČNÍ REHABILITACE U PACIENTŮ PO INFARKTU A NÁSLEDNÉ LÉČBĚ METODOU
TRANSPLANTACE Bypassu Koronárního Tepny Nebo Implantace Koronárního Stentu
(Souhrn anglického textu)

Společně s rostoucím počtem pacientů po transplantaci koronárního bypassu (CABG) nebo implantaci stentu (výztuž) koronární artérie (CASI), se objevil problém stanovení odpovídajícího rehabilitačního programu pro tyto dvě skupiny pacientů. Záměrem této studie bylo zhodnotit úroveň snesitelné zátěže u pacientů, kteří byli po prodělaném infarktu myokardu léčeni chirurgicky oběma metodami a kteří později byli podrobeni navrhnutému rehabilitačnímu programu.


Po skončení léčby se u skupiny pacientů se stentem čas zátěžového testu a ujetá vzdálenost výrazně zvýšily. Rovněž se výrazně zvýšil průměrný metabolický výdej. U skupiny s bypassem se čas zátěžového testu výrazně zvýšil, rovněž ujetá vzdálenost, maximální odpor, dvojnásobný výsledek a pracovní zátěž. Statisticky významný byl rovněž pokles v počtu patologických důvodů pro ukončení testu.

Program rehabilitace použitý v předložené studii odůvodňuje svou efektivnost, přínásí značný význam snesitelné zátěže u obou skupin.

Klíčová slova: CABG (transplantace bypassu koronární tepny), CASI (implantace výztuž – stentu koronární tepny), tělesná výkonnost, šlapadlový zátěžový test.