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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

Influence of a hybrid form of cardiac rehabilitation on exercise tolerance in coronary artery disease patients with and without diabetes

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Abstract

Background: The effectiveness of stationary and ambulatory cardiac rehabilitation of patients with coronary artery disease (CAD) and diabetes has been proven by some authors, but data concerning the effects of hybrid forms of cardiac rehabilitation (HCR) in this population are lacking. A home-based telerehabilitation is a promising form of secondary prevention of cardiovascular diseases in this group of patients.

Aim: The objective of the study was to compare the effects of HCR in CAD patients with and without diabetes mellitus (DM). The secondary endpoint was the assessment of CAD risk factors like low exercise capacity and obesity, in both groups of patients.

Methods: This was a retrospective study, which comprised 125 patients with CAD aged 57.31 ± 5.61 years referred for HCR. They were assigned to Group D (with diabetes; n = 37) or Group C (without diabetes; n = 88). HCR was carried out as a comprehensive procedure that included all core components of cardiac rehabilitation according to guidelines. Before and after HCR all patients underwent a symptom-limited exercise test performed according to the Bruce protocol on a treadmill.

Results: Before HCR the maximal workload was higher in Group C than in Group D (8.13 ± 2.82 METs vs. 6.77 ± 1.88 METs; $p = 0.023$), but after HCR the difference was not significant. In both groups an increase in the maximal workload after HCR was observed (Group D: before HCR 6.81 ± 1.91 METs, after HCR 8.30 ± 2.04 METs; $p < 0.001$; Group C: before HCR 8.31 ± 2.71 METs, after HCR 9.13 ± 2.87 METs; $p = 0.001$). Resting heart rate, double product, and heart rate recovery 1 (HRR_1) declined in both groups. No significant differences in changes in exercise test parameters between both groups' parameters were found.

Conclusions: HCR was effective in patients with DM. The adherence was high. Patients with DM had higher rates of obesity and significantly lower exercise tolerance than patients without DM. Patients from both groups gained similar benefit from HCR in terms of physical capacity, resting heart rate, and heart rate recovery.

Key words: cardiac rehabilitation, telerehabilitation, diabetes

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INTRODUCTION

The worldwide epidemic of diabetes mellitus (DM) is associated with an increased risk of coronary artery disease (CAD) and an impaired prognosis after acute myocardial infarction (AMI), so patients with CAD and DM are in great need of attention [1].

An important tool to manage patients with CAD is cardiac rehabilitation (CR), which improves exercise tolerance, peripheral haemodynamic parameters, endothelial and autonomous nervous system functions, and quality of life, reduces total and cardiovascular mortality, and results in a modification of risk factors [2, 3]. Despite these well-established benefits, CR programmes in Europe are underused, with poor referral and low participation rates and wide variations between countries [4, 5].

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The safety of stationary and ambulatory CR of patients with CAD and DM has been proven by some authors [6–8], but data concerning the effects of hybrid forms of cardiac rehabilitation (HCR) in this population are lacking. A promising form of secondary prevention of cardiovascular diseases in this group of patients is CR as Internet-based interventions or as home-based telerehabilitation [9–11].

The objective of the study was to compare the effects of a hybrid model of training, partly outpatient and partly home-based, and tele-monitored (HCR), in terms of physical capacity, in CAD patients with and without DM. The secondary endpoint was the assessment of CAD risk factors like low exercise capacity and obesity, in both groups of patients.

METHODS

This was a retrospective single-institution cohort study, which comprised patients referred for home-based cardiac telerehabilitation by the Polish Social Insurance Institution (PSII).

Patient population

The cohort group consisted of 155 patients aged 57.31 ± 5.61 years, who had a documented cardiovascular disease and were referred by the PSII for hybrid ambulatory followed by home-based cardiac telerehabilitation, phase III CR, from January 2010 to December 2013. From this group, 125 patients with a mean age of 58.25 ± 4.48 years (112 men and 13 women) with CAD were included in the study and then divided into two subgroups: Group D — with type 2 DM [12] (T2DM) and Group C — without DM. A total of 37 patients with T2DM (29.6% of all CAD patients) and 88 without DM were qualified for analysis.

Inclusion criteria were: documented CAD and no contraindications for exercise training. Exclusion criteria comprised unstable coronary or cerebral ischaemia, decompensated heart failure (HF), decompensated DM, recent aortic dissection, uncontrolled and malignant hypertension, unstable medical conditions, and the inability to exercise due to musculoskeletal and neuromuscular disorders. CR began no sooner than 12 weeks following the cardiovascular event. Patients with DM were treated in accordance with recent recommendations [9, 12].

Study protocol

The study was designed as a retrospective, non-randomised trial. Each patient gave written, institutional informed consent for participation in the programme. The patients underwent the following assessments at entry and after completing HCR: medical history, physical examination, and exercise treadmill test according to the Bruce protocol.

Exercise testing

Exercise capacity and cardiovascular response to exercise was assessed with a symptom-limited exercise test (ET) performed according to the Bruce protocol on a Woodway treadmill, using an electrocardiogram (ECG) Sun Tech Tango computerised system, before and after rehabilitation. A 12-lead ECG was monitored continuously before, during, and for 10 min after the test. During ET the following parameters were analysed: maximal workload (measured in metabolic equivalents — METs), heart rate per minute (HR, bpm) at rest and at maximal exercise, blood pressure (BP, mm Hg) at rest and at maximal effort, and double product (DP, mm Hg/min), i.e. the product of HR and systolic BP at rest and at maximal effort. Heart rate recovery (HRR_1) in the first minute after the end of maximal exercise was used as the method to assess the reactivation of the parasympathetic nervous system [4]. Absolute indications for terminating of ET were as follows: ST-segment (> 1.0 mm) in leads without Q waves, drop in systolic BP > 10 mm Hg, moderate to severe angina, central nervous system symptoms or signs of poor perfusion (cyanosis or pallor), sustained ventricular tachycardia, technical difficulties in monitoring ECG or systolic BP, maximal perceived exertion (values > 18 of Borg scale), and subject's request to stop [3].

Hybrid cardiac telerehabilitation

The first phase of HCR was carried out in an outpatient rehabilitation centre (8–10 days), and the second phase (11–12 days) was conducted in the home environment. The outpatient form of CR comprised exercise training, education intervention, relaxation sessions, and other secondary prevention strategies for risk factor modification [2]. The training HR for both outpatient and home-based exercise intensity, was calculated using the HR reserve method, based on data achieved in the exercise test [13]. The training zone (trHR) was calculated as follows: trHR = (60–80%) × (maximal HR – resting HR) + resting HR. In addition to the HR control, the Borg scale was used to gauge training intensity. Endurance exercises were a major component of activities, and the recommended training intensity was 12–13 on the Borg scale [4, 14, 15].

In the home-based phase patients performed aerobic endurance training based on different forms, i.e. walking or Nordic Walking or cycloergometer training for 30 min each, breathing exercises, flexibility exercises, and light resistance and systemic exercises. They were asked to exercise at a low intensity for 5 to 10 min before (warm-up) and after (cool-down) the training session. Patients were trained five times a week. All participants were given instructions on their medications and directions to the respective emergency department in case of an emergency. Home-based exercise training was monitored using remote-controlled equipment for tele-ECG and supervised exercise training (Pro Plus Company, Poland). The device enabled the recording of ECG data from three precordial leads and their transmission via a mobile phone network to the monitoring centre, which was located in the department of rehabilitation. A mobile phone was also used for daily voice communication between patient and a physician who asked about their state of health, and if there were no contraindications they were given consent for training [4]. The methods of HCR have been reported in detail elsewhere [4, 11]. In patients with DM blood glucose levels were initially obtained before and after exercise to provide an assessment of the individual's response to exercise. Blood glucose levels < 100 mg/dL and > 300 mg/dL precluded exercise at that time.

Statistical analysis

The collected data were analysed using IBM SPSS version 21. To compare baseline characteristics between Group D and Group C the χ^2 test was used. To compare the distribution of sex, taking insulin and oral glucose-lowering agents in patients with and without DM, the Fisher test was used because of the small size of the groups. Because of the lack of normal distribution the Mann-Whitney test was used to compare the number of days of absence in patients with and without DM. Student's t-test was performed to assess the independent and dependent samples for normally distributed variables, and the Wilcoxon test was used for variables not distributed normally in the analysis of effects of CR. P-values less than 0.05 were considered significant. The following variables were non-normally distributed: MET and change in MET, New York Heart Association (NYHA) class and change in NYHA class, and change in HR at rest.

RESULTS

Baseline characteristics

Patients with DM had higher rates of obesity (p = 0.004) than patients without DM. Independence test χ^2 showed statistically significant differences in the distribution of body mass index (BMI) in Group D and in Group C and moderate strength of association between groups (χ^2 = 13.618; p = 0.003; *V* = 0.330). The highest differences between both groups were observed in the number of patients with BMI 26 (37.5% patients with DM and only 13.5% patients without DM) and in the group of patients with highest values of BMI (17% of patients with DM and 45.7% patients without DM had BMI higher than 32.73). In the middle ranges of BMI the differences between groups were lower and the percentage of patients with BMI between 26 and 29 and between 29 and 32.73 was approximately 20% in each group.

The significant relationship in the meaning of tendency to higher rates of arterial hypertension occured in the group without DM. Patients with DM had a tendency to take loop diuretics more frequently than patients from the control group. There were no significant differences in other baseline characteristics between both groups.

The baseline clinical and demographic characteristics of participants from both groups are summarised in Table 1.

Adherence

Out of 37 patients with DM, 36 patients completed the whole program. The reasons for discontinuation of the program were personal obligations. The mean number of days of absence in the HCR was 1.22 ± 2.76 days.

No tested patients were excluded from home-based training or finished the training earlier for major adverse cardiac events or other cardiovascular reasons.

Comparison of exercise capacity between patients with DM and without DM before and after HCR

Analysis was performed to determine whether there were important differences between the results of people with and without DM before and after rehabilitation. It revealed a statistically significant difference in the initial workload on the treadmill measured in METs between the groups. Before rehabilitation the maximal workload was significantly higher in patients without DM. The results are shown in Table 2.

Effects of CR on exercise capacity in patients with DM (Group D) and without DM (Group C)

In both groups a significant increase in the maximal workload on a treadmill after rehabilitation was observed. The value of resting HR and DP at rest declined. Similarly, in patients without DM (Group C) the value of the maximal workload on a treadmill also increased significantly, and resting HR and DP at rest declined. Moreover, resting systolic BP and HR in the first minute after the exercise test decreased significantly as well. The results are shown in Table 3.

Differences in changes in ET parameters before and after CR in both groups

In the next step, differences in changes in ET parameters in patients with and without DM were calculated and compared. In order to analyse this the differences in the values before CR and after CR were calculated for every patient. No statistically significant differences in changes in ET between both groups' parameters were found (Table 4).

DISCUSSION

Cardiac telerehabilitation is a promising new tool to improve long-term adherence to a healthy lifestyle after centre-based CR and seems to be cost-effective [16, 17]. A hybrid model of training, partly outpatient and partly home-based, helps patients to learn how to exercise first in the centre during supervised sessions, is useful to acquire the habit of regular exercise training and gives time for education, psychological counselling, and pharmacological treatment optimisation. The growing population of patients with CAD in the world includes patients with DM. In randomised control trials, exercise training has beneficial effects on the indices of their physical function and glucose metabolism. It improves not only their muscular strength, flexibility, balance, agility, and endurance,

Table 1. The baseline clinical and demographic characteristics of patients with diabetes (Group D) and without diabetes (Group C)

	Group D (n = 37)	Group C (n = 88)	P
Males	34 (91.90%)	78 (88.60%)	0.75
Age [years]	59.16 ± 3.91	57.86 ± 4.66	0.115
Number of days of absence in the cardiac rehabilitation programme	1.22 ± 2.76	1.61 ± 4.51	0.94
Body mass index [kg/m^2]	31.70 ± 4.4	28.55 ± 4.56	0.001
Current smoker	7 (21.20%)	15 (18.10%)	0.697
Smoking history	26 (81.30%)	65 (79.30%)	0.8
Myocardial infarction	26 (70.30%)	64 (72.70%)	0.78
Heart failure	5 (13.50%)	10 (11.40%)	0.767
Percutaneous coronary intervention	26 (70.30%)	62 (70.50%)	0.98
Coronary artery bypass grafting	6 (16.20%)	20 (22.70%)	0.413
Co-morbidities:			
Arterial hypertension	34 (91.90%)	69 (78.40%)	0.071
Atrial fibrillation chronic or persistent	4 (10.80%)	3 (3.40%)	0.1
Hyperlipidaemia	19 (51.40%)	38 (43.20%)	0.403
Obesity	23 (62.20%)	30 (34.50%)	0.004
Overweight	14 (37.80%)	43 (49.40%)	0.236
Ca-blocker	10 (28.60%)	16 (18.60%)	0.226
Beta-blocker	34 (97.10%)	78 (91.80%)	0.283
Angiotensin converting enzyme inhibitors	23 (65.70%)	64 (75.30%)	0.285
Clopidogrel/dabigatran	16 (45.70%)	40 (47.10%)	0.893
Inhibitor PP	16 (45.70%)	37 (44.00%)	0.868
Aspirin	28 (80.00%)	77 (90.60%)	0.111
Statins	33 (94.30%)	78 (91.80%)	0.634
Fibrates	1 (2.90%)	2 (2.40%)	0.872
Loop diuretics	5 (14.30%)	4 (4.70%)	0.070
Oral anticoagulants	3 (8.60%)	7 (8.20%)	0.952
Insulin therapy	8 (22.90%)	0 (0.00%)	< 0.001
Oral glucose-lowering agents	25 (71.40%)	1 (1.20%)	< 0.001

but also mental health, anxiety, and insomnia. Moreover, it decreases levels of haemoglobin A1C [18, 19]. The main result of our study was that the HCR, partly outpatient and partly home-based and tele-monitored (HCR), enhanced functional capacity, measured via exercise test on a treadmill, and influenced some resting parameters as a result of exercise tolerance improvement in patients with DM.

Patients with DM referred by a social insurance institution for HCR had higher rates of obesity than patients without DM, while it is known that nearly 90% of diabetic patients develop T2DM mostly relating to excess body weight according to the World Health Organisation, so the role of education during rehabilitation programs in this group is not to be underestimated. Moreover, obesity is strongly inherited [20]. The results obtained from a study conducted with diabetic patients in Verona, who were followed up for 10 years, showed that in patients > 65 years old a moderate excess weight predicted longer survival, whereas obesity was a negative prognostic factor in patients < 65 years old [21]. The results concerning the effects of HCR on exercise capacity were not a surprise, as the adherence to the program was high. It seems that the ECG monitoring at home favours good compliance, which was also observed in patients with cardiovascular diseases rehabilitated by similar methods [4] and even in HF patients who performed Nordic Walking as a form of aerobic training [22]. Remote monitoring is used not only for telerehabilitation, but also for telecare of "cardiac" patients. De Lusignan et al. [23] showed good compliance with telemonitoring and telecoaching of patients with HF, while Lieback et al. [24] proved high compliance for remote telemonitoring using external sensors and implantable cardiac pacing devices in HF patients. Both studies were prospective and randomised. Unlike in the aforementioned papers, patients from our study were recruited from the population referred for rehabilitation

Table 2. Comparison of exercise test results between patients with diabetes (Group D) and without diabetes (Group C) before and after hybrid form of cardiac rehabilitation (HCR)

	Before HCR (Group D)	Before HCR (Group C)	P	After HCR (Group D)	After HCR (Group C)	P
Maximal workload [METs]	6.77 ± 1.88	8.13 ± 2.82	0.023	8.40 ± 2.04	9.13 ± 2.87	0.221
HR rest [bpm]	76.67 ± 12.71	79.81 ± 11.90	0.215	74.24 ± 10.61	72.48 ± 11.98	0.462
HR max [bpm]	126.03 ± 19.49	127.79 ± 19.55	0.648	129.56 ± 19.05	125.15 ± 10.36	0.284
SBP at rest [mm Hg]	137.92 ± 19.62	136.79 ± 15.93	0.738	134.74 ± 18.74	129.28 ± 18.91	0.161
DBP at rest [mm Hg]	84.32 ± 11.89	85.35 ± 13.48	0.689	82.91 ± 9.57	83.95 ± 12.06	0.657
SBP max [mm Hg]	168.35 ± 25.40	168.54 ± 26.34	0.971	172.00 ± 25.37	167.14 ± 25.88	0.359
DBP max [mm Hg]	85.35 ± 15.46	87.11 ± 13.88	0.537	87.71 ± 11.68	87.33 ± 13.68	0.889
DP at rest [mm Hg/min]	11031.22 ± 2455.47	10541.98 ± 2156.57	0.272	9987.53 ± 1905.83	9386.72 ± 2188.01	0.167
Maximal DP [mm Hg/min]	21324.81 ± 5169.13	21747.42 ± 5544.33	0.694	22488.12 ± 5837.83	21138.47 ± 5658.58	0.252
HRR_1 [bpm]	98.32 ± 21.87	96.49 ± 17.81	0.628	94.50 ± 22.60	89.59 ± 17.47	0.213
NYHA	1.16 ± 0.50	1.18 ± 0.47	0.586	1.11 ± 0.40	1.12 ± 0.33	0.589

MET — metabolic equivalent, defined as the amount of oxygen consumed while sitting at rest and equal to 3.5 mL O2 per kg body weight × min; HR — heart rate; DBP — diastolic blood pressure; SBP — systolic blood pressure; DP — double product, i.e. product of heart rate and SBP; HRR_1 — heart rate recovery in the first minute after ending exercise stress test; NYHA — classification of New York Heart Association

Table 3. Results of exercise test in patients with diabetes (Group D) and without diabetes (Group C) before and after hybrid form of cardiac rehabilitation (HCR)

	Before HCR (Group D)	After HCR (Group D)	P	Before HCR (Group C)	After HCR (Group C)	P
Maximal workload [METs]	6.81 ± 1.91	8.30 ± 2.04	< 0.001	8.31 ± 2.71	9.13 ± 2.87	0.001
HR rest [bpm]	79.88 ± 12.41	74.24 ± 10.61	0.002	76.61 ± 12.52	72.48 ± 11.98	0.003
HR max [bpm]	126.59 ± 20.20	129.56 ± 19.05	0.299	127.94 ± 19.37	125.15 ± 10.36	0.171
SBP at rest [mm Hg]	137.97 ± 19.82	134.74 ± 18.74	0.260	136.14 ± 16.03	129.28 ± 18.91	0.001
DBP at rest [mm Hg]	83.15 ± 11.54	82.91 ± 9.57	0.898	85.03 ± 13.41	83.95 ± 12.06	0.502
SBP max [mm Hg]	169.00 ± 24.70	172.00 ± 25.37	0.565	168.33 ± 26.87	167.14 ± 25.88	0.667
DBP max [mm Hg]	83.74 ± 14.91	87.71 ± 11.68	0.157	86.87 ± 13.99	87.33 ± 13.68	0.793
DP at rest [mm Hg/min]	11046.09 ± 2524.28	9987.53 ± 1905.83	0.002	11041.38 ± 2132.13	9386.72 ± 2188.01	< 0.001
Maximal DP [mm Hg/min]	21495.65 ± 5205.55	22488.12 ± 5837.83	0.335	21762.87 ± 5636.35	21138.47 ± 5658.58	0.262
HRR_1 [bpm]	99.32 ± 22.29	94.50 ± 22.60	0.090	96.66 ± 16.35	89.59 ± 17.47	0.001
NYHA	1.17 ± 0.51	1.11 ± 0.40	0.157	1.18 ± 0.47	1.12 ± 0.33	0.025

MET — metabolic equivalent; HR — heart rate; DBP — diastolic blood pressure; SBP — systolic blood pressure; DP — double product, i.e. product of heart rate and SBP; HRR_1 — heart rate recovery in the first minute after ending exercise stress test; NYHA — classification of New York Heart Association

Table 4. Comparison of changes in exercise test parameters in patients with diabetes (Group D) and without diabetes (Group C)

	Group D	Group C	P
Maximal workload [METs]	–1.49 ± 2.08	–0.81 ± 1.91	0.133
HR rest [bpm]	5.65 ± 9.55	4.13 ± 11.97	0.475
HR max [bpm]	–2.97 ± 16.43	2.78 ± 17.92	0.112
SBP at rest [mm Hg]	3.24 ± 16.45	6.86 ± 17.44	0.305
DBP at rest [mm Hg]	0.24 ± 10.60	1.08 ± 14.19	0.757
SBP max [mm Hg]	–3.00 ± 30.12	1.19 ± 24.51	0.439
DBP max [mm Hg]	–3.97 ± 15.99	–0.46 ± 15.35	0.273
DP at rest [mm Hg/min]	1058.56 ± 1845.17	1054.66 ± 2100.43	0.993
Maximal DP [mm Hg/min]	–992.47 ± 5912.65	624.41 ± 4915.62	0.135
HRR_1 [bpm]	4.82 ± 16.10	7.06 ± 17.42	0.523
NYHA	0.06 ± 0.23	0.06 ± 0.24	0.921

MET — metabolic equivalent; HR — heart rate; DBP — diastolic blood pressure; SBP — systolic blood pressure; DP — double product, i.e. product of heart rate and SBP; HRR_1 — heart rate recovery in the first minute after ending exercise stress test; NYHA — classification of New York Heart Association

by PSII, which could bias adherence. The mean number of days of absence was about one day in patients with and without DM. Patients from Group D had significantly lower exercise tolerance measured by METs than patients without DM before the study, but after CR these differences disappeared. Patients without DM improved their results but not as much as diabetic patients, who were probably more motivated. In the effect of rehabilitation, the changes in exercise tolerance remained non-statistically significant between both groups. Parameters from the ET demonstrate that exercise capacity improved similarly in the diabetic and non-diabetic groups, which means that patients from both groups gained similar benefit from five-week HCR in terms of physical capacity. ET was used to evaluate the safety of exercise training at various intensities and to formulate an exercise prescription. The ET results in our study were obtained using the Bruce treadmill protocol because of the assumed time efficiency of using this protocol compared with time-consuming low-intensity protocols and in order to compare results obtained by the same method, although there have been very few reports in the literature of patients with coronary disease and HF undergoing exercise testing on this protocol (in our study 12% patients suffered from HF). In fact, it is widely felt that the Bruce protocol is too vigorous for patients with HF, but in literature we can find evidence that it is safe even in severe HF patients. Strzelczyk et al. [25] claim that the Bruce treadmill protocol can be used to assess ambulatory patients with severe systolic HF for cardiac transplant listing.

Differences in exercise performance and effects of ambulatory or stationary CR between diabetic and non-diabetic patients are well documented in the literature, but it seems that together with the technological progress in medicine, the home-based or hybrid form of rehabilitation will be more and more available for patients with CAD in the future, so it is reasonable to focus on these forms of treatment in the research concerning CR.

To date, there have been only a few studies assessing the effects of a HCR in patients suffering from cardiovascular diseases, but there is no data concerning patients with CAD and DM. Thus, our contribution seems valuable for future application of this relatively cheap form of treatment in the increasing population of patients with diabetes.

Limitations of the study

The study was designed as a retrospective non-randomised trial without a control group, which made it impossible to do a direct comparison other than to say that HCR in patients with CAD and diabetes is feasible, that adherence by patients is good, and participants improved their exercise tolerance. Another study limitation is the lack of the analysis of BMI after HCR and other factors concerning diabetes care and treatment, like plasma glucose level deviations during exercise sessions, haemoglobin A1C tests or assessment of the intensity and change in diabetes-related complications like retinopathy, nephropathy, or neuropathy, which will be the subject of further scientific consideration.

CONCLUSIONS

In the present study we showed that: (1) Hybrid form of CR was effective in patients with DM; (2) The adherence to the program was high; (3) Patients with DM had higher rates of obesity than patients without DM; (4) Patients with DM had significantly lower exercise tolerance measured by METs than patients without DM; (5) Patients from both groups gained similar benefit from HCR in terms of physical capacity, resting HR, and heart rate recovery.

Conflict of interest: *none declared*

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Wpływ hybrydowej rehabilitacji kardiologicznej na tolerancję wysiłku fizycznego u pacjentów z chorobą wieńcową z cukrzycą i bez cukrzycy

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Streszczenie

Wstęp: Przydatność i bezpieczeństwo ambulatoryjnej i stacjonarnej rehabilitacji kardiologicznej pacjentów z chorobą wieńcową (CAD) i cukrzycą zostało przez wielu autorów udowodnione, jednak brakuje w literaturze danych na temat skuteczności hybrydowej rehabilitacji kardiologicznej (HCR) w tej populacji. Rehabilitacja kardiologiczna w warunkach domowych poprzedzona rehabilitacją ambulatoryjną, której celem jest nauczenie pacjenta metod treningu fizycznego i edukacja w zakresie czynników ryzyka chorób układu sercowo-naczyniowego, jest obiecującą formą wtórnej prewencji.

Cel: Celem głównym badania było porównanie efektów HCR u pacjentów z CAD z cukrzycą i bez cukrzycy. Celem szczegółowym była ocena czynników ryzyka CAD, m.in. niskiej wydolności fizycznej i otyłości w obu grupach pacjentów.

Metody: Badanie polegało na retrospektywnej analizie danych 125 pacjentów w wieku 57,31 ± 5,61 lat z CAD skierowanych na HCR. Pacjentów zakwalifikowano do Grupy D (z cukrzycą; n = 37) lub Grupy C (bez cukrzycy; n = 88). Przed i po HCR u każdego pacjenta wykonano test wysiłkowy na bieżni ruchomej wg protokołu Bruce'a. Program rehabilitacji domowej był ustalany indywidualnie. Uczestnictwo oceniano jako liczbę opuszczonych dni ćwiczeń.

Wyniki: Przed HCR maksymalne obciążenie uzyskane podczas testu wysiłkowego na bieżni ruchomej było wyższe w Grupie C niż w Grupie D (8,13 ± 2,82 METs *vs*. 6,77 ± 1,88 METs; p = 0,023), po HCR różnica nie była istotna statystycznie. Zarówno w grupie pacjentów z cukrzycą, jak i w grupie bez cukrzycy zaobserwowano wzrost maksymalnego obciążenia w czasie testu wysiłkowego mierzonego w MET (Grupa D: przed HCR 6,81 ± 1,91 METs, po HCR 8,30 ± 2,04 METs; p < 0,001; Grupa C: przed HCR 8,31 ± 2,71 METs, po HCR 9,13 ± 2,87 METs; p = 0,001). Spoczynkowy rytm serca, produkt podwójny i czas powrotu rytmu serca (HRR_1) obniżyły się istotnie po rehabilitacji w obu grupach. Nie stwierdzono istotnych zmian w różnicy parametrów ocenianych po HCR i przed HCR między grupami.

Wnioski: Hybrydowa rehabilitacja kardiologiczna była efektywna u pacjentów z cukrzycą. Poziom uczestnictwa w programie był wysoki. U chorych na cukrzycę częściej niż u osób bez cukrzycy stwierdzano otyłość i niższą tolerancję wysiłku fizycznego w porównaniu z pacjentami bez cukrzycy. Chorzy z obu grup osiągnęli podobne korzyści z HCR mierzone podczas testu wysiłkowego na bieżni ruchomej, uzyskując istotny spadek spoczynkowego rytmu serca i czasu powrotu rytmu serca.

Słowa kluczowe: rehabilitacja kardiologiczna, telerehabilitacja, cukrzyca

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