

Physical fitness of patients after abdominal aortic aneurysm surgery

Sprawność fizyczna osób po operacji tętniaka aorty brzusznej

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ABSTRACT

INTRODUCTION. The study evaluated the effect of walking training on the physical training of people with a surgically treated abdominal aortic aneurysm (AAA) in a short-term observation.

MATERIAL AND METHODS. In a group of 60 patients, divided randomly into two groups with different models of physiotherapy, blood count parameters, 6-minute walk test variables, spirometry variables and quadriceps torque of the lower limbs were measured before and after the operation.

RESULTS. The statistical analysis of the studied variables indicates a physical reduction in both groups after surgery. Only a few parameters, such as energy expenditure MET, forced vital capacity FVC, quadriceps torque of the right lower extremity, support the physiotherapy model, extended by march training.

CONCLUSIONS. In patients with an abdominal aortic aneurysm, regardless of the type of physiotherapy carried out, there is a reduction in physical function after surgery. The results indicate the need to continue walking training after discharge from the hospital in the second stage of physiotherapy.

KEY WORDS

abdominal aorta surgery, physical training, efficiency, physiotherapy

STRESZCZENIE

WSTĘP. W pracy oceniano wpływ treningu marszowego na sprawność fizyczną osób z tętniakiem aorty brzusznej, leczonych chirurgicznie w obserwacji krótkoterminowej.

MATERIAŁ I METODY. W grupie 60 osób podzielonych losowo na dwie grupy o różnych modelach fizjoterapii dokonano pomiaru przed i po operacji parametrów morfologii krwi, zmiennych testu 6-minutowego, zmiennych badania spirometrycznego oraz momentu sił mięśni czworogłowych kończyn dolnych.

WYNIKI. Przeprowadzona analiza statystyczna badanych zmiennych wskazuje na obniżenie sprawności fizycznej w obu grupach po operacji. Jedynie kilka parametrów, takich jak wydatek energetyczny MET, natężona pojemność życiowa płuc, moment siły mięśni czworogłowych kończyny dolnej prawej, wspiera model fizjoterapii rozszerzonej o trening marszowy.

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WNIOSKI. U pacjentów z tętniakiem aorty brzusznej, niezależnie od rodzaju przeprowadzonej fizjoterapii, dochodzi do obniżenia sprawności fizycznej po leczeniu chirurgicznym. Wyniki badań wskazują na potrzebę kontynuacji treningu marszowego po wypisie ze szpitala w ramach II etapu fizjoterapii.

SŁOWA KLUCZOWE

operacja tętniaka aorty brzusznej, trening fizyczny, sprawność, fizjoterapia

INTRODUCTION

An abdominal aortic aneurysm (AAA) is sustained over time, an extension of the weakened arterial wall with a multifactorial pathogenesis. The destruction or fibrosis of the medial elastic part is formed in the course of progressive atherosclerosis, inflammatory and hemodynamic factors. In the whole world there is an increased incidence of abdominal aortic aneurysm, partly due to the prolongation of human life and the development of some diagnostic methods. The best procedure to treat this disease is to perform a scheduled surgery. It involves resection of the aneurysm and replacing it with a vascular prosthesis [1,2,3]. The procedure itself is a big challenge as it is an especially high risk for the patient. Age, general condition, coexisting disease and related burdens carry a high risk of complications during surgery and in the postoperative period.

The main aim of physiotherapy in surgery after operations in the abdominal cavity is the prevention and treatment of postoperative complications and functional disorders resulting from the planned operation. These objectives are achieved through: maintaining healthy lung ventilation, increasing chest mobility, increased respiratory muscle strength, stimulating an effective cough, ensuring proper venous outflow, maintaining normal muscle movement of the lower limbs and early mobilization for walking. To maintain exercise tolerance, endurance exercise in the form of walk training at an individual pace of a patient under heart rate control, is introduced before and after the operation [4,5,6].

The basic exercise in physical training used after surgical operations is the march, and at the end of one's stay in the department also walking up stairs. Marching exercise starts with walking slowly to the bed, allowing one to quickly return to a sitting position and lying down in the event of exercise intolerance symptoms. A predefined walking training program can be implemented in a continuous or intermittent form. The form of intermittent efforts is recommended for people with a low or medium exercise tolerance with reduced muscle strength and endurance, with intermittent claudication or decreased concomitant respiratory failure [6,7,8].

Material and methods

The study was conducted at the Department of General and Vascular Surgery, Medical University of Silesia Multiprofile Hospital No. 7 in Katowice–Ochojec. The research was conducted with the approval of the Bioethics Committee of the Physical Education Academy in Katowice. The study lasted two years. During this period, 166 people had classical surgery under general anesthesia involving excision of the aneurysm and replacement by a vascular prosthesis. The recruitment of older people with AAA for the trial was based on purposeful selection. People with an abdominal aortic aneurysm were qualified for the study under the following conditions: age 65–75 years, sex – male, stable cardio without neurological disorders, asymptomatic aneurysm – not cracked, no pain, people walking unhindered by the motor system. The study excluded people with neurological disorders, with an unstable coronary artery disease, abdominal aortic aneurysm pain-cracked (symptomatic), aneurysm stratification, patients with an impaired gait, people with a complicated postoperative course that prevents the start of physical training on the first or second day after surgery – the need for replacement of breathing by a ventilator, people with mental illness, and those who are unwilling to cooperate. Two groups of 30 people, 60 people in total with an abdominal aortic aneurysm met the criteria for inclusion in the study. The people were qualified for surgical treatment by the classical method and then divided at random into two groups with different models of rehabilitation (physical therapy) after surgery (control group – Model A; study group – Model B). The assessment of cardiovascular efficiency in each group of patients with AAA was at stage I or II on the NYHA scale. The study groups did not differ from each other in terms of blood counts, physical parameters or the number of days spent in hospital (Tab. I). In control group (30 patients) and study group (30 patients), standard physiotherapy involving education of exercises performed after surgery and learning proper movement patterns while sitting down and standing up to hold the wound was conducted. Exercises performed after operation consisted of breathing exercises, effective coughing exercises, exercises preventing clots (ankle exercises) and improvement exercises with low intensity to limit pulse to 120 beats/minutes (Tab. II).

Table I. Lack of significant differences between groups before surgery**Tabela I.** Brak istotnej poprawy badanych parametrów między grupami przed operacją

Studied variables	Model A n = 30	Model B n = 30
Age	66.2 ± 5.2	66.7 ± 4.9
BMI	26.8 ± 3.9	27.1 ± 3.2
Ht [%]	42.0 ± 4.6	42.9 ± 4.1
E [10 ⁶ /μl]	4.61 ± 0.51	4.62 ± 0.43
6MWT [m]	334 ± 60	356 ± 66
FVC [L]	2.21 ± 0.59	2.51 ± 0.63
FEV1 [L]	2.05 ± 0.68	2.05 ± 0.76
FEV1/FVC [%]	93.9 ± 8.6	91.5 ± 11.8
PEF [L/s]	4.60 ± 1.42	4.96 ± 1.71
Mn Kdp [Nm]	117.06 ± 13.2	116.9 ± 13.4
Mn Kdl [Nm]	113.08 ± 10.9	116.2 ± 13.2
Number of days in hospital	7.2 ± 1.7	6.7 ± 0.8

Table II. Physiotherapy Program for Patients with aortic aneurysm (Model A and Model B)**Tabela II.** Program fizjoterapii osób z tętniakiem aorty brzusznej dla modeli A, B

Pre-surgical period	Post-surgical period
1. Learning respiratory exercises 3 times per day 3–4 cycles, 5 series Uprighting patient between day one and two, high sitting position on first day	1. Respiratory exercises, 'effective cough' – 3–4 cycles, 5 series, five times per day, vibrations, (tapping of chest) chest percussion – 3 times per day
2. Learning 'effective cough' 3 times per day 3 cycles 5 series	2. Active exercises of upper and lower limbs 5–7 cycles, 3 series, 3 times per day
3. Learning anticoagulant exercises 3 times per day for 3 minutes	3. Active exercises of cervical spine 3–4 cycles, one series, two times per day
4. Learning proper sitting down and standing up with holding of post surgical wound 3 times per day	4. Anticoagulant exercises three times per day for 3 minutes
5. General exercises with Cardio exercises up to pulse limit (120 bpm)	5. (Independent exercises) exercise self – three times per day, every exercise repeated several times
	6. General exercises
	7. Cardio exercises up pulse limit (120 bpm)

In study group, standard physiotherapy was extended to march training held in interval cycle (Tab. 3). Training intensity was calculated on basis of exercise test, 6-minute walk test. During calculation of heart rate training to resting heart rate, 50% of heart rate reserve value was added. Applied endurance training interval was indicated in patients with abdominal aortic aneurysm due to disease type, presence of multiple co-morbidities which decreases exercise tolerance. March training in study group was carried out in hospital corridor, under constant control of heart rate using heart rate monitor CASIO CHR-100 and roping for fall prevention. Patients wore during training abdominal belts for postoperative wound protection. Each day prior to exercise, current state of health of each person involved was consulted with cardiologist

to exclude any current contraindications to exercise. In this training, load increase progressed gradually. Each effort minute was followed by minute pause, during which heart rate checked and its rhythm were checked. In this way heart rate limit, which was set at 120 beats/min was controlled.

In all groups, number of days spent in hospital after surgery were taken under consideration. Before and after the treatment, the morphological parameters in the field of red cell mass volume – hematocrit and the number of red blood cells were studied. Before surgery and after surgery, a 6 minute walk test was performed on patients with an abdominal aortic aneurysm. This measurement was performed twice – once before elective surgery and the second time after the surgery, on the seventh day after surgery, before dis-

Table III. Walk training program for Model B
Tabela III. Program treningu marszowego dla modelu B

Pre surgical period	Post surgical period
Frequency:	Frequency:
I day – once per day	I day – once per day
II day – 2 times per day	II day – 2 times per day
III day – 3 times per day	III day – 3 times per day
Next day before surgery – 3 times per day	Next day after surgery – 3 times per day
Time of exercise:	Time of exercise: Total time of walking per day
I day – 4 minutes: 1 minute of exercise /1 minute break	I day – 1 minute (1 minute): 1 min exercise/1minute break
II day – 5 minutes: 1 minute of exercise /1 minute break	II day – 2 minutes (4 minutes): 1 min exercise/1 minute break
III day – 6 minutes: 1 minute of exercise /1 minute break	III day – 3 minutes (9 minutes): 1 min exercise/1 minute break
Next day before surgery – 6 minutes of walking	IV day – 4 minutes (12 minutes): 1 min exercise/1 minute break
	V day – 5 minutes (15 minutes): 1 min exercise/1 minute break
	VI day – 6 minutes (18 minutes),
	VII day – 8 minute (24 minutes), every following day 8 minutes

charge from the hospital (the test each time was repeated twice and the better result was recorded). During the test, the heart rate was monitored by a CASIO CHR-100 pulsometer (made in Japan by CASIO). If the period of stay was shorter than seven days, then this test was performed on any patient after the surgery at discharge from the hospital. The corridor of the surgery clinic wing, where the test was performed, was 30 meters long and individual sections were marked to measure the exact distance. Before the test, the blood pressure and heart rate of each person with AAA were measured. The test was performed in the presence of a cardiologist [9,10,11,12,]. Each patient's training heart rate and indirectly average walking speed and energy expenditure in terms of MET units were calculated based on the corridor test [14]. The study of respiratory assessment of the overall health of the planned surgical treatment was performed by Aspel A4 AsCARD with extra spirometry SPIRO-31(made in Poland by ASPEL). Spirometry on patients with (AAA) was performed twice during the patient's stay in the hospital –the first time prior to surgery and once on the seventh day after the operation. If the period of stay after surgery was shorter than seven days, that measurement was performed on all patients at discharge from the hospital. Measurements were done in all the groups, each time the test was repeated three times. The variables studied were: forced vital capacity (FVC), forced expiratory volume in one second (FEV 1), peak expiratory flow (PEF), the ratio of forced expiratory volume to vital capacity due to pulmonary (FEV1/FVC). Muscle torque of the quadriceps was also measured with the use of a diagnostic and therapeutic seat type UPR-01 A/S (made in Poland by OPIW). The torque measurement of strength was performed twice, once before surgery and on the seventh day after the opera-

tion. If the period of stay after surgery was shorter than seven days, that measurement was performed on all patients at discharge from the hospital. The measurement was repeated three times, where the best result was recorded. The mean values and standard deviations of the parameters were calculated. The Kolmogorov-Smirnov test was used to assess normality. To estimate the statistical significance of differences between the groups, the U Mann-Whitney test was used, and for changes during time, the Wilcoxon test was used. The statistically significant level of $p < 0.05$ was assumed.

RESULTS

After the surgery significant declines in the studied parameters in blood counts, distance traveled in the corridor test measured and calculated on the basis of average speed, as well as energy expenditure MET were observed in all the groups. A decline in all the groups measured the spirometric variables and torque forces of the quadriceps muscles was registered as well. The study group compared to the control group had a significantly smaller decrease in the parameters of energy expenditure calculated on the basis of the 6-minute walk test MET, forced expiratory vital capacity of lung FVC and quadriceps strength torque of the right leg (Tab. IV).

DISCUSSION

Patients with an abdominal aortic aneurysm require specialized medical preparation consisting of

Table IV. Summary of results of physical training variables studied
Tabela IV. Podsumowanie wyników zmiennych różnego rodzaju treningu fizycznego

Measured variables	Model A -Before-	Model B -Before -	Statistical significance	Model A -After -	Model B -After-	Statistical significance
Ht [%]	42.0 ± 4.6	42.9 ± 4.1	NS	35.5 ± 4.4	37.2 ± 4.5	NS
E [10 ⁶ μl/l]	4.61 ± 0.51	4.62 ± 0.43	NS	3.88 ± 0.58	3.96 ± 0.55	NS
6MWT [m]	334 ± 60	356 ± 66	NS	270 ± 65	311 ± 74	NS
6MWT [v]	3.51 ± 0.51	3.57 ± 0.51	NS	2.91 ± 0.59	3.10 ± 0.57	NS
6MWT[MET]	2.62 ± 0.28	2.68 ± 0.31	NS	2.27 ± 0.31	2.46 ± 0.35	p < 0.05
FVC [L]	2.21 ± 0.59	2,51 ± 0,63	NS	1.72 ± 0.63	2.10 ± 0.58	p < 0.05
FEV1 [L]	2.05 ± 0.68	2.05 ± 0.76	NS	1.64 ± 0.62	1.88 ± 0.68	NS
FEV1/FVC [%]	93.9 ± 8.6	91.5 ± 11.8	NS	94.6 ± 7.2	94.4 ± 7.2	NS
PEF [L/s]	4.60 ± 1.42	4.96 ± 1.72	NS	4.15 ± 1.69	4.60 ± 1.85	NS
Mn Kdp * [Nm]	117.06 ± 13.2	116.9 ± 13.4	NS	103.1 ± 6.9	113.7 ± 9.8	p < 0.05
Mn Kdl * [Nm]	113.8 ± 10.9	116.2 ± 13.2	NS	101.2 ± 8.1	108.6 ± 8.5	NS
Hr training [1/min]	76.5 ± 6.1	76.0 ± 7.3	NS	77.1 ± 6.6	77.6 ± 8.1	NS

Mn Kdl* – quadriceps torque left lower limb

Mn Kdp* – quadriceps torque right lower limb

a thorough diagnosis of cardiac, surgical and diagnostic specialist physiotherapy procedure. Exercise testing in patients with an abdominal aortic aneurysm and evaluation indicators of ventilation is an important component of the medical preparation before surgery. Doing the Right Thing Physiotherapy, including breathing exercises, anticoagulants, generally improves with instruction as exercise reduces the risk of cardio-respiratory complications after surgery. After abdominal surgery, antithrombotic exercises and lower limb exercises help venous outflow and support the abdominal muscles. This is important for a faster return of bowel motility, which prevents bulge and creates a better working diaphragm. The methods of endurance exercise carried out in the form of walking repeated several times a day before and after surgery also support the prevention of postoperative complications and disorders, accelerate post-operative improvement [5]. The ability to walk independently without the help of a third party provides the patient with complete independence in performing basic activities every day such as using the toilet. This provides a sense of security and comfort but also spontaneously initiates gait training continued in the afternoon in the form of walks carried out in the company of family.

Major vascular procedures, in particular concerning the reconstruction of the abdominal aorta by the classical method, have a significant impact on the degree of reduction in ventilation rates, disruption of normal heart rate, blood pressure, and respiratory rate. The results of major surgery and general anesthesia are muscle weakness and balance problems, which disturb physical fitness. Therefore, necessary in this case is the search for other solutions to maintain physiotherapy, which meets the expectations for special

training and further improvement after this difficult operation.

Comparative analysis of the age, body mass index, blood count, measure of the distance in the corridor test, spirometry measurement parameters, and the quadriceps muscles torque were performed on patients with an abdominal aortic aneurysm both before and after surgery. Before the surgery, no statistically significant differences between the two groups were observed. However, after the operation, all the test parameters deteriorated especially those that affect physical performance such as the quadriceps torque, corridor test variables and spirometric measurement variables. The effectiveness of physical training in cardiovascular diseases is reflected in numerous publications on the subject [13,15,16,17,18]. In this case, forward gait training was insufficient to maintain physical fitness beyond the individual parameters which saw a difference compared to the control group. This phenomenon may explain the short duration of the training. The results indicate the need for continued walking training after discharge from the hospital in the second stage of physiotherapy.

CONCLUSIONS

1. All patients in each group had significantly reduced physical fitness.
2. The positive impact of walking training is noticeable only in the maintenance of quadricep muscle strength, MET, forced vital capacity in the first week postoperative follow-up.
3. Results of the study indicate the need for continued walking training after discharge from hospital in the second stage of physiotherapy.

Author's contribution

Study design – B. Wnuk, D. Ziaja, J. Durmała

Data collection – B. Wnuk

Statistical analysis – B. Wnuk

Data interpretation – B. Wnuk

Manuscript preparation – B. Wnuk, J. Frąckiewicz, K. Wądołowski

Literature research – J. Frąckiewicz, K. Wądołowski

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