

## Optimization of Physiological Processes in Conditions Staged Activation of Motor Activity in Cardiac Patients

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The development of coronary atherosclerosis leads to the formation of coronary heart disease, which threatens early death or disability. Such patients need a shunt operation to restore blood flow in the vessels of the heart. After this operation, patients need complex rehabilitation, which has strict stages. To expand the physical activity of patients after coronary bypass grafting, a system of motor activity consisting of 7 steps is used, modified for use in Russian clinical conditions for the rehabilitation of patients after shunting of blood vessels supplying the myocardium. This technique involves the use of seven stages of motor activation of patients, through the use of complexes of medical-physical culture with a gradual strengthening of gymnastic exercises, through the use of training using exercise bikes and dosed walking in open areas, built on the principle of "from simple to more complex." The first two stages of motor activation are applicable to patients immediately after coronary artery bypass grafting at the stationary stage; 3-5 stages of motor activation are physiologically justified for in-patient rehabilitation; the 6-7 steps of motor activation are applicable to patients on outpatient rehabilitation.

**Keywords:** Physiology, Muscle activity, Rehabilitation, Atherosclerosis,  
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After undergoing cardiac surgery, some features are observed in patients that should be taken into account when forming a rehabilitation program<sup>1</sup>. This is due to the frequent use of cardiopulmonary bypass during the operation and the presence of severe perioperative psycho

emotional stress<sup>2,3</sup>. In addition, for patients with a cardiac surgical profile, "syndrome complexes" are very characteristic: cardiac, poststernotomy, respiratory, hemorheological with impaired microcirculation, psychopathological, hypodynamic, metabolic and postphlebectomy,

which should always be taken into account when forming a program of rehabilitation measures<sup>4,5</sup>.

The main points in the rehabilitation of patients after coronary artery bypass grafting are staging and continuity. To expand the patient regimen after coronary bypass surgery, a system of gradual expansion of motor activity, consisting of 7 stages, is used. It is currently modified for the rehabilitation of patients after ischemic myocardial infarction in Russian clinical conditions<sup>6</sup>. This program is based on the early activation of cardiac patients and the rapid expansion of their physical activity. It provides for the use throughout all seven stages of motor activation of patients, complexes of therapeutic physical culture with a gradual increase in physical exertion with the transition at the III stage of rehabilitation to training using exercise bikes and dosed walking in open areas<sup>7</sup>. All classes are built on the principle of "from simple to more complex." The first two stages of motor activation are used in patients immediately after coronary artery bypass grafting at stage I (stationary); 3-5 stages of motor activation are realized during a stay in a rehabilitation hospital (stage II; in-patient rehabilitation); 6-7th stage of motor activation during outpatient rehabilitation (stage III rehabilitation)<sup>8</sup>.

Purpose: to consider the physiological basis of the rehabilitation process after coronary artery bypass grafting.

The first stage of motor activation of the first stage of patient rehabilitation in the intensive care unit, with an uncomplicated postoperative period, should begin immediately after extubation. The first stage covers the period of stay of the patient on bed rest. Physical activity is allowed after the elimination of pain and usually begins after 1 day. The first 12 hours after surgery, the patient is in strict bed rest with a raised head end. It is fully serviced by medical staff (including passive turns to the side). 12-24 hours after surgery (bed rest), sitting in bed 2-3 times a day with the help of medical staff, washing, brushing, shaving, sitting on the bed, active turns on the side are allowed. From the second day after the operation, the second stage of rehabilitation begins, the patient performs physical therapy in a gentle mode with an emphasis mainly on breathing exercises. Due to the post-sternotomy syndrome, patients have reduced

respiratory function, decreased lung volume and there is a risk of pulmonary complications [9]. Of the methods of general exposure at this time, they use bioresonance therapy, aerotherapy, electrophoresis to heal a postoperative wound. For local exposure, inhalation through a nebulizer is used (mucolytics, bronchodilators, furacilin). The course duration is 7-10 days with a further transition to the next stage of rehabilitation treatment (stage II)<sup>10,11</sup>.

A patient is considered ready for an expansion of motor activity if the heart rate rises, when the therapeutic load is performed by no more than 20 beats / min, and blood pressure - by 10-40 mm Hg, in the absence of new changes on the electrocardiogram, clinical symptoms of myocardial ischemia or heart failure<sup>12</sup>. At this stage, there is a further expansion of motor activity and complexes of medical-physical culture gradually increasing in intensity are prescribed to patients. Before discharge from the hospital, the patient should conduct several trainings on simulators (exercise bike, treadmill). The load when using this equipment in the first 2-3 approaches should be minimal, up to the "idle speed". In the first 2-3 classes, patients master the very idea of training on simulators and are accustomed to dealing with them. They should realize that, despite the disease, they begin a new stage in their life - the stage of preventing physical inactivity by increasing household physical activity<sup>13,14</sup> (Figure 1).

Contraindications to active physical rehabilitation (starting from the second stage of motor activity) of patients after coronary artery bypass grafting are: acute coronary syndrome, chronic heart failure of the IV functional class, ventricular extrasystoles, paroxysmal tachyarrhythmias that occur during physical exertion (sinoatrial and atrioventricular block 2-3 degrees), stable arterial hypertension or a hypertonic reaction to physical activity with an increase in systolic blood pressure > 180 mm Hg, diastolic blood pressure > 100 mm Hg. Art., unchanged by optimal antihypertensive therapy, decreased systolic blood pressure eH 20 mm Hg during exercise, severe aortic stenosis, acute pericarditis, myocarditis, uncontrolled diabetes mellitus, thromboembolism or thrombophlebitis (up to 3 months), acute cerebrovascular accident

or transient ischemic attack (up to 3 months), acute infectious disease, bleeding, increased body temperature, severe diastasis of the sternum<sup>15,16</sup>.

The second stage of recovery of patients who underwent coronary artery bypass grafting takes place in a rehabilitation center. As a rule, it begins from 7-10 days after surgery. Intravenous laser therapy or intravenous ozone therapy or bioresonance therapy or aerophytotherapy are added to the general exposure methods. Of the methods of local exposure, peripheral

classical therapeutic massage, massage in the electric field of the cervical-collar region, low-intensity laser radiation on the heart region and postoperative scars, peripheral magnetotherapy, ultraphonophoresis are used<sup>17</sup>. The duration of the course is 10-15 days before moving to the next stage of rehabilitation treatment. On the 6-7th day after surgery, the patient is transferred to the free mode of the III stage of motor activity. Before discharge from the hospital, the patient's exercise tolerance is determined using a bicycle ergometry



**Fig. 1.** Lesson on an exercise bike

(<https://mforum.com.au/wp-content/uploads/2019/09/050919-exercise-rehab-cycle-old-man.jpg>)



**Fig. 2.** Group exercise physical therapy

(<http://satori34.ru/wp-content/uploads/2019/02/rhuEFyAhqY.jpg>)

test or treadmill ergometry, a 6-minute walk test, and in some patients, radioisotope scintigraphy visualizing myocardial perfusion<sup>18,19</sup>.

The third stage of motor activation provides the patient with significant independence in everyday life in the second half of his stay in a rehabilitation hospital. Physiotherapy is carried out in a sitting and standing position. The patient is allowed dosed walking and regular walks in the hospital, communication with visitors and other activity not physically difficult. After 7-10 days in a rehabilitation hospital and with a satisfactory reaction of the patient's body to an expansion of activity within the third stage of muscle loads, it is transferred to the fourth stage<sup>20,21</sup>.

At the fourth stage of motor activation, a load complex of medical-physical culture is performed in a group way. Patients are allowed to enter the hospital for walking and dosed walking to perform a complex of physiotherapy in the open air. During walks, the pace of walking is allowed arbitrary, slow, with stops at will. Training walking outside the hospital is carried out at a distance of 300–500 m with a walking pace of 70–80 steps in 1 min. Learning to climb stairs by 1-2 flights of stairs is carried out under the supervision of a methodologist of physiotherapy. The stairs will be repeated in 5-10 minutes. Household walking is allowed at a slower pace (60–70 steps in 1 min, to a distance of 1 km in 2-3 receptions)<sup>22,23</sup> (Figure 2).

The fifth step of motor activity involves free walks of 30–40 min outside the hospital premises, climbing stairs 1-2 floors training walking to a distance of 1000 m, at a pace of 80 steps in 1 min with the gradual development of a training walk, at a pace of up to 100 steps in 1 minute. Then the patient is discharged and sent to continue the rehabilitation in the clinic. It is recommended that the patient perform cardio training on power and cyclic simulators in the mode of stepwise increasing physical activity. General exposure methods are allowed - interval hypoxic training, complex halotherapy, dry carbon dioxide baths, bioresonance therapy, aeroionotherapy, aerophytotherapy. Of the methods of local exposure, classic therapeutic back massage is used according to the gentle method, massage in the electrostatic field of the front surface of the chest, low-intensity laser radiation on the heart<sup>24,25</sup>.

The outpatient stage of cardiac rehabilitation conditionally provides for early and late sub-stages. An early sub-stage takes place with the active participation and frequent visits of patients to the clinic. The main task of the early sub-stage of outpatient rehabilitation is to gradually increase the level of the patient's functional capabilities, his physical performance, improvement of his psychological status and preparation of the patient to return to professional activity. The program includes counseling on anti-atherosclerotic nutrition, control of blood lipid composition, body weight, blood pressure. In addition to the cardiologist, physiotherapist, the role of a social worker, possibly a home nurse, is important in this phase. The implementation of programs for the early sub-stage of outpatient cardiac rehabilitation is a key factor in the successful rehabilitation of the patient after coronary artery bypass grafting. Patients continue to perform cardio training on power and cyclic simulators in the mode of dosed incrementally increasing physical activity<sup>26,27</sup>.

Late sub-step outpatient rehabilitation after coronary artery bypass grafting, continues to the end of the 1st year after surgery. It begins after the programs for early sub-steps of outpatient rehabilitation, but no later than the end of the 4th month after surgery. The patient remains under observation, but visits the clinic routinely 1 time in 3 months. for the final verification and correction of medical recommendations [28].

Physical rehabilitation of patients undergoing coronary artery bypass grafting is a complex, well-designed complex of recreational activities. However, its efficiency is not always high. For this reason, more research is needed to increase the effectiveness of the system of physical rehabilitation of patients undergoing coronary artery bypass grafting.

## CONCLUSION

The basis of rehabilitation of patients after coronary artery bypass grafting, is the phasing and continuity. To expand the physical activity of patients after coronary artery bypass grafting using the system of motor activity, consisting of 7 steps, modified for use in Russian clinical setting with the aim of rehabilitation of patients after

shunt surgery on the myocardium. This technique involves the use of seven stages of motor activity of patients, due to the use of complexes of therapeutic physical culture with the gradual strengthening gymnastic exercises, through the use of your workouts using exercise bikes and dosed walking in the open countryside, built on the principle “from simple to more complex.” The first two stages of motor activation are applicable to patients immediately after coronary artery bypass surgery at a hospital stage; 3-5 stages of motor activation is physiologically justified for inpatient rehabilitation; 6-7 stages of motor activation applicable to patients undergoing outpatient rehabilitation.

#### Conflict of interest

No conflict of interest is declared.

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The study was conducted at the expense of the authors.

#### Ethics Committee Resolution

The study was approved by the local ethics committee of the Russian State Social University on September 15, 2018 (protocol '11).

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