CORRECTION OF STRUCTURAL AND FUNCTIONAL MANIFESTATIONS OF SARCOPENIA USING PHYSICAL THERAPY IN ELDERLY PEOPLE AFTER LIVER RESECTION DUE TO COLORECTAL METASTASES

КОРЕКЦІЯ СТРУКТУРНО-ФУНКЦІОНАЛЬНИХ ПРОЯВІВ САРКОПЕНІЇ ЗАСОБАМИ ФІЗИЧНОЇ ТЕРАПІЇ У ОСІБ ПОХИЛОГО ВІКУ ПІСЛЯ РЕЗЕКЦІЇ ПЕЧІНКИ З ПРИВОДУ КОЛОРЕКТАЛЬНИХ МЕТАСТАЗІВ

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Abstracts

Purpose – to assess the effectiveness of the developed physical therapy program for elderly people after liver resection for colorectal metastases according to the dynamics of functional and structural indicators of sarcopenia.

Material. The control group consisted of 33 elderly people who were not diagnosed with oncological processes and sarcopenia. The group of elderly people after liver resection for colorectal metastases consisted of 33 people who underwent surgical and conservative treatment according to the unified clinical protocols of primary and specialized medical care "Colon cancer", "Rectal cancer". They were divided into two subgroups. The comparison group consisted of 31 people who recovered in the postoperative period according to the recommendations of the specified clinical protocols – modification of nutrition (Pevzner table No. 5), postoperative motor restrictions due to the presence of an abdominal scar, information on the features of further observation and treatment. The main group consisted of 32 people who underwent a developed comprehensive physical therapy program lasting six months in the postoperative period with the use of therapeutic exercises of various directions (aerobic, strength, to improve balance), differentiated according to the early and late postoperative periods, the chemotherapy period and the remote postoperative period, the educational component (in particular, regarding dietary modification, prevention of the risk of falls) taking into account individual rehabilitation goals. The effectiveness was assessed by the results of the Skeletal Muscle Index, handgrip dynamometry, Short Physical Performance Battery, Quality of Life Questionnaire Cancer Related Fatigue-12.

Results. In elderly people after liver resection for colorectal metastases, the presence of sarcopenia was determined by low muscle tissue content (according to the Skeletal Muscle Index), functional manifestations – low hand strength in men and women, impairment in performing the Short Physical Performance Battery, physical weakness according to the results of the 6-minute test, the negative impact of specific fatigue caused by cancer on various activities (according to the Quality Of Life Questionnaire Cancer Related Fatigue-12). The approved comprehensive physical therapy program revealed an improvement in the condition of patients due to the impact on the studied structural and functional manifestations of sarcopenia due to an increase in muscle mass, expansion of motor functional capabilities when performing various activities compared to baseline indicators for all studied parameters ($p<0,05$).

Conclusions. Physical therapy is appropriate for the comprehensive correction of structural and functional signs of sarcopenia at different stages of postoperative recovery in elderly people after liver resection for colorectal metastases.

Key words: physical therapy, rehabilitation, abdominal surgery, hepatobiliary zone, sarcopenia, cancer, old age, geriatric syndromes.

Мета – оцінити ефективність розробленої програми фізичної терапії для осіб похилого віку після резекції печінки з приводу колоректальних метастазів за динамікою функціональних та структурних показників саркопенії.

Матеріал. Контрольна група складалась із 33 осіб похилого віку, у яких не були діагностовані онкологічні процеси та саркопенія. Групу осіб похилого віку після резекції печінки з приводу колоректальних метастазів становили 33 особи, які проходили оперативне та консервативне лікування згідно з уніфікованими клінічними протоколами первинної та спеціалізованої медичної допомоги «Рак ободової кишки», «Рак прямої кишки». Вони були поділені на дві підгрупи. Групу порівняння становила 31 людина, яка відновлювалась у післяопераційному періоді згідно з рекомендаціями зазначених клінічних протоколів – модифікація харчування (стіл по Певзнеру № 5), рухові післяопераційні обмеження внаслідок наявності рубця черевної порожнини, інформація щодо особливостей подальшого спостереження та лікування. Основну групу становили 32 особи, які у післяопераційному періоді проходили розроблену комплексну програму фізичної терапії тривалістю шість місяців із застосуванням терапевтичних вправ різної направленості (аеробних, силових, для покращення рівноваги), диференційованих згідно з раннім та пізнім післяопераційним періодами, періодом хіміотерапії та віддаленого післяопераційного періоду, освітнім компонентом (зокрема, щодо модифікації харчування, профілактики ризику падіння) з урахуванням індивідуальних цілей реабілітації. Ефективність оцінювали за результатами Skeletal Muscle Index, кистьовою динамометрією, Short Physical Performance Battery, Quality of Life Questionnaire Cancer Related Fatigue-12.

Результати. У осіб похилого віку після резекції печінки з приводу колоректальних метастазів визначено наявність саркопенії за низьким вмістом м'язової тканини (за Skeletal Muscle Index), функціональними проявами – низькою силою кисті у чоловіків та жінок, порушеннями під час виконання Short Physical Performance Battery, фізичною слабкістю за результатами проведення 6-хвилинного тесту, негативним впливом специфічної втоми, спричиненої раком, на різні активності (за Quality of Life Questionnaire Cancer Related Fatigue-12). Апробована комплексна програма фізичної терапії виявила покращення стану пацієнтів через вплив на досліджувані структурні та функціональні прояви саркопенії за рахунок збільшення м'язової маси, розширення рухових функціональних можливостей під час виконання різних активностей порівняно із вихідними показниками за всіма досліджуваними параметрами ($p<0,05$).

Висновки. Засоби фізичної терапії доцільно призначати для комплексної корекції структурних та функціональних ознак саркопенії на різних етапах післяопераційного відновлення у осіб похилого віку після резекції печінки з приводу колоректальних метастазів.

Ключові слова: фізична терапія, реабілітація, операції на органах черевної порожнини, гепатобіліарна зона, саркопенія, онкологічні захворювання, похилий вік, геріатричні синдроми.

Introduction. Colorectal cancer is one of the most common malignant tumors, which ranks 3rd in frequency after lung cancer, prostate cancer and breast cancer depending on the patient's gender. In Ukraine, the incidence of this type of oncopathology is approximately 7 new cases per 100 thousand population [15].

According to the European Working Group on Sarcopenia, sarcopenia is understood as a complex clinical syndrome that includes a decrease in muscle mass, a decrease in muscle function and strength [2]. This complex clinical syndrome is based on a complex of age-related and neurohumoral changes, and nutritional disorders. This geriatric syndrome is one of the five main risk factors for morbidity and mortality in people over 65 years of age. Sarcopenia is often found in inflammatory diseases, malignant neoplasms or organ failure, determining the specifics of treatment and rehabilitation intervention [5].

Progressive malnutrition is an inevitable companion of cancer. Decreased appetite and general weakness are the earliest and most common symptoms of cancer; in 20–25% of patients, refractory cachexia becomes the leading factor of mortality at the final stage of the cancer process. It has been proven that nutritional deficiency worsens the functional status and quality of life of patients, the tolerance of specific treatment, and overall and cancer-specific survival [3; 7].

Of significant prognostic importance is the fact of a decrease not only in total body weight, but also in changes in its component composition. Sarcopenia is actually a progressive generalized decrease in lean mass due to the muscle component. In obese patients, a situation may occur when the body mass index (BMI) is increased, but muscle mass is reduced, the so-called sarcopenic obesity [5]. The development of sarcopenia is more characteristic

of solid tumors, primarily of the head, neck and gastrointestinal tract, in which the frequency of diagnosis of this syndrome can reach 70% [11].

Assessment of sarcopenia at the preoperative stage is of the same importance as the T category of the primary tumor and the presence of a positive resection margin. The presence of sarcopenia increases the risk of severe postoperative complications and worsens the tolerability of neoadjuvant chemotherapy, and is a factor in reducing overall survival in solid tumors [1; 7].

Despite the fact that muscle mass loss is a component of the anorexia and cachexia syndrome of the oncological patient, sarcopenia may be the only and earliest manifestation of nutritional insufficiency in malignant neoplasms without loss of adipose tissue, anemia and general asthenia [3; 11].

Specific treatment in oncology may be accompanied by increased sarcopenia, which may be associated with the development of side effects of chemo– and radiotherapy (diarrhea, mucositis), as well as with the stress reaction and the inability of patients to adequately eat in the postoperative period. Some drugs for the medical treatment of tumors themselves provoke a decrease in muscle mass (taxanes, cisplatin, doxorubicin, etoposide, sorafenib, everolimus) [7]. The mechanism of drug-induced sarcopenia is not fully understood, but it is based on the activation of the same intracellular signaling pathways that disrupt the balance of muscle protein synthesis/degradation [1].

Oncological rehabilitation is a special area of restorative interventions that takes into account the specifics of the clinical course of malignant tumors and changes in the patient's condition during chemotherapy or surgical treatment, in particular from the perspective of sarcopenia correction [10; 13]. Also, in the world literature there are works on the rehabilitation of patients during the treatment of tumors of the lower gastrointestinal tract [6; 12], differentiated geriatric rehabilitation [5; 8; 9]. However, in Ukraine there are no physical therapy programs for such patients adapted to domestic clinical protocols and patient routes, which made the presented work relevant.

Aim of the study is to assess the effectiveness of the developed physical therapy program for elderly people after liver resection for colorectal metastases according to the dynamics of functional and structural indicators of sarcopenia.

Material and methods. During the study, 96 elderly people were examined (47 men and 49 women aged 60–75 years, average age 69.2±0.8 years).

The control group was 33 elderly people (14 men, 19 women) who were not diagnosed with oncological processes and sarcopenia.

The group of elderly people after liver resection for colorectal metastases consisted of 33 people who underwent surgical and conservative treatment according to the unified clinical protocols of primary and specialized medical care "Colon Cancer", "Rectal Cancer". They were divided into two subgroups.

The comparison group (CG) consisted of 31 people (16 men, 15 women) who recovered in the postoperative period according to the recommendations of the indicated clinical protocols – modification of nutrition (Pevzner table No. 5), postoperative motor restrictions due to the presence of an abdominal scar, information on the features of further observation and treatment.

The main group (MG) consisted of 32 people (17 men, 15 women), who underwent a developed comprehensive physical therapy program in the postoperative period, the effectiveness of which in correcting the signs of sarcopenia is presented in this study.

Inclusion criteria:

– advanced age (60–75 years according to the World Health Organization classification);

– sarcopenia according to the criteria of the European Working Group on Sarcopenia in Older People [2] – a combination of low handgrip strength with unsatisfactory results of the Short Physical Performance Battery, confirmed by the results of computed tomography (determination of the cross-sectional area of skeletal muscles at the level of the third lumbar vertebra);

– metastatic colorectal cancer;

– metachronous and synchronous metastases to the liver of diagnosed colorectal cancer;

– condition after resection of a section of the large intestine for colorectal cancer (remote postoperative period);

– condition after liver resection (combined with cholecystectomy) for colorectal metastases;

– access to the abdominal organs – J-shaped laparotomy according to Macauchi;

– absence of exacerbation of chronic or acute concomitant pathology of internal organs at the time of examination;

– consent to active participation in the recommended interventions and / or examinations.

Exclusion criteria:

– primary tumor, synchronous metastases;

– colorectal cancer IVB;

– complicated postoperative period;

– moderate and severe cognitive impairment;

– cachexia [4], which is a contraindication to surgical intervention according to the criteria: loss of more than 10% of body weight in 2 months, BMI less than 18.5, Prognostic Nutritional Index less than <35, C-reactive protein more than 25 mg / l, albumin less than 30 g / l.

The goal of the developed physical therapy program was: reducing the severity of signs of sarcopenia; increasing body weight; improving balance and reducing the risk of falling; facilitating socialization, performing basic and instrumental activities of daily living; reducing the severity of psychoemotional depression.

The developed comprehensive physical therapy program was developed according to the clinical routes of patients with colorectal cancer at different stages of treatment, taking into account general and special principles of oncological rehabilitation [6; 12; 13] (table 1).

The initial assessment of the patients' condition (pre-test) was carried out in the preoperative period. The repeated examination (post-test) was carried out after 6 months of observation for CG individuals and the implementation of a physical therapy program for MG patients (monitoring the achievement of individual long-term rehabilitation goals).

To assess the dynamics of the severity of sarcopenia, its structural and functional parameters were determined.

To determine the severity of sarcopenia, computed tomography was performed on a Siemens Somatom X.cite CT Scanner. The Skeletal Muscle Index (SMI) was determined by the size of the skeletal muscle area – the cross-sectional area at the level of the third lumbar vertebra (LIII) corrected for the square of height (the norm is 52.4 cm^2/m^2 for men and 38.5 cm^2/m^2 for women) [4].

The functional consequences of sarcopenia were characterized according to the EWGSOP (2019) criteria – reduced skeletal muscle strength relative to age-specific gender-specific handgrip dynamometry results and deterioration of skeletal muscle function based on the results of a short battery of physical functioning tests – Short Physical Performance Battery (SPPB), which included an assessment of balance, walking speed over a distance of 4 meters and 5 times getting up from a chair [2].

The impact of muscle weakness and fatigue level on the ability to move as a basis for performing activities of daily living was determined by a 6-minute test (distance walked, fatigue level on the Borg scale of 20 points).

The level of Cancer related Fatigue, which is primarily associated with muscle weakness, and its impact on various activities (interference with daily life, social sequelae) was determined using the European Organization for Research and Treatment of Cancer (EORTC) QLQ-FA12 questionnaire (Quality Of Life Questionnaire Cancer Related Fatigue with 12 questions) [14].

The study was conducted taking into account the principles of the Declaration of Helsinki of the World Medical Association "Ethical principles of medical research involving human participants". Informed consent to participate in the study was obtained from all elderly people after liver resection for colorectal metastases and control group individuals involved in the presented study. The study protocol was discussed and approved at a meeting of the Bioethics Commission of the Vasyl Stefanyk Precarpathian National University.

Statistical processing of the results was performed in the IBM SPSS Statistics program. To describe the obtained quantitative characteristics, the arithmetic mean (M), standard

Table 1

Scheme of a comprehensive physical therapy program for the elderly after liver resection for colorectal metastases

Period	Intervention
Preoperative period (1–2 days before liver resection) Initial assessment	Patient education (learning about movement limitations due to postoperative suture; practicing putting on compression underwear, abdominal bandage; learning about nutrition principles; informing about the content of the physical therapy program)
Early postoperative period – 5–7 days after surgery (inpatient period)	Active verticalization (1–2 days). Wearing compression stockings. Wearing an abdominal bandage. Nutritional support (sipping). Breathing therapeutic exercises (leveling the effects of intubation). Therapeutic exercises in relaxed starting positions with avoidance of abdominal tension. Aerobic: walking. Aerobic therapeutic exercises intensity: continuous and interval bouts at 50–60% HRmax; 8–10 RPE (6–20 Borg scale). Resistance therapeutic exercises: Free weights (0.5–1 kg) for major muscle groups (arms, abdominal muscles, thigh, and gluteus region; all major muscles of the upper– and lower-body). Resistance therapeutic exercises intensity: 6–8 repetitions, 1 set per exercise (2–4 exercises targeting major muscle groups); 10–12 RPE (Borg 6–20 scale); 50–60% of one-repetition maximum. Duration: 30–40 min sessions. Daily supervised exercise.
Late postoperative period (outpatient) – 3 weeks after surgery: – outpatient observation at the place of residence for 3 weeks; – 10–14 days – removal of sutures; – repeated consultation with the surgeon after 3 weeks.	Educational component (nutritional recommendations: Pevzner table 5, intake of 1-1.2 g of protein per 1 kg of body weight per day [2]; strategies for reducing the risk of falls). Therapeutic exercises to improve balance and coordination. Therapeutic exercises to improve the amplitude of movements in the joints of the limbs and trunk. Aerobic: brisk walking. Aerobic therapeutic exercises intensity: continuous and interval bouts at 60-70% HRmax; 11–12 RPE (6–20 Borg scale). Resistance therapeutic exercises: Free weights (1–1.5 kg) and Therabands for major muscle groups (arms, abdominal muscles, thigh, and gluteus region; all major muscles of the upper– and lower-body). Resistance therapeutic exercises intensity: 8–10 repetitions, 2 sets per exercise (4–6 exercises targeting major muscle groups); 12–13 RPE (Borg 6–20 scale); 60–70% of one-repetition maximum. Duration: 60 min sessions. 3 supervised sessions per week. 3 unsupervised sessions per week.
Long-term postoperative period (1–6 months after surgery): – 1–3 months: chemotherapy + physical therapy (telerehabilitation, independent exercises); – 4–6 months: physical therapy (telerehabilitation, independent exercises)	Educational component (nutritional recommendations: Pevzner table 5, intake of 1–1.2 g of protein per 1 kg of body weight per day [2]; strategies for reducing the risk of falls). Therapeutic exercises to improve balance and coordination. Therapeutic exercises to improve the amplitude of movements in the joints of the limbs and trunk. Aerobic: brisk walking, jogging, running (treadmill). Aerobic intensity: continuous and interval bouts at 70–90% HRmax; 13–15 RPE (6–20 Borg scale). Resistance therapeutic exercises: Free weights (more than 1.5 kg – individually), machine exercises and Therabands for major muscle groups (arms, abdominal muscles, thigh, and gluteus region; all major muscles of the upper– and lower-body). Resistance therapeutic exercises intensity: 10–15 repetitions, 3 sets per exercise (6–8 exercises targeting major muscle groups); 13–14 RPE (Borg 6–20 scale); 70–80% of one-repetition maximum. Duration: at least 60 min sessions. 1 supervised session per 2 weeks. Minimum of 3 unsupervised sessions per week.
Notes: HRmax – maximal heart rate; RPE – rating of perceived exertion.	

deviation (S) and standard error of the mean (D) were calculated. Differences were considered statistically significant at p<0,05.

Results. When conducting physical therapy for the elderly after liver resection for colorectal metastases, a number of barriers were identified – physical weakness, severe fatigue, psychoemotional depression, kinesiophobia, side effects of chemotherapy drugs (nausea, weakness, dizziness, etc.). Accordingly, the level of load during these periods was selected individually, trying to maintain the general plan of physical therapy.

When examining men and women in the control group, SMI indicators showed a preserved muscle profile without signs of sarcopenia, which confirms its status as a reference. In both gender groups, a significant decrease in SMI (p<0,05) was observed before the start of rehabilitation compared to the control group, which indicates sarcopenia caused by the oncological process and surgical intervention. The physical therapy program significantly increased SMI in patients with liver cancer, particularly in men (+16,10 cm^2/m^2, p<0,05) and women (+11,42 cm^2/m^2, p<0,05) (Figure 1).

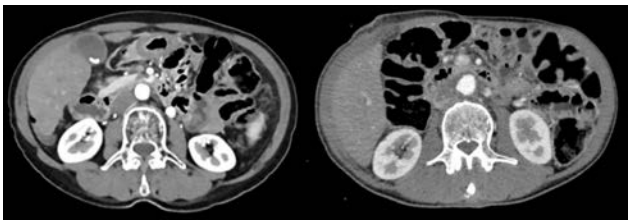

Fig. 1. Clinical case. Dynamics of the cross-sectional area of muscles at the level of the third lumbar vertebra (LIII) under the influence of the developed physical therapy program (patient K., 70 years old, on the left – preoperative period, on the right – after completion of the physical therapy program)

The overall improvement in CG in men was 15.93%, in women – 19.39%, in MG, respectively, 40.16% and 28.04%. However, the level of the control group was not reached (p>0.05) (Table 2).

We associate the result of the comparison group with improved nutrition in the postoperative period (associated primarily with pain reduction), normalization of usual activity.

The analysis of the dynamics of hand muscle strength in elderly people after liver resection for colorectal metastases showed the presence of significant differences between the study groups, as well as the positive effect of the implemented physical therapy program.

Before the intervention (pre-test), the hand dynamometry indicators in men of the study groups were significantly inferior to the similar indicators of the control group, in which the average value was 34.33±2.16 kg (p<0,05). In CG, this indicator was 17.45±1.05 kg, and in MG – 19.20±1.41 kg. Similar dynamics were observed among women: in the control group – 20.46±1.09 kg; in CG – 10.07±0.75 kg; in MG – 9.11±0.62 kg.

After completing the physical therapy program (post-test), a statistically significant increase in hand strength was recorded in men in the main group – up to 26.08±1.52 kg, which is an increase of 35.83% compared to the baseline level (p<0.05). In the comparison group, the increase was less pronounced – up to 20.63±1.23 kg (+18.24%, p<0.05). Among women in MG, a significant improvement was also recorded – from 9.11±0.62 to 15.49±1.05 kg (+70.02%, p<0.05), while in CG – from 10.07±0.75 to 13.46±1.00 kg (+33.64%, p<0.05) (Table 3).

The level of the control group at the normative limits (17 kg in women and 29 kg in men) was not reached in any of the subgroups, which

Table 2

Dynamics of SMI indicators in elderly people after liver resection for colorectal metastases under the influence of a physical therapy program (M±SD)

SMI, cm2/ m2	Control group (n=33)	CG (n=31)		MG (n=32)	
		pre-test	post-test	pre-test	post-test
Men	62.35±2.45	42.81±2.77*	49.63±1.76*○	40.09±2.30*	56.19±1.73*○●
Women	44.82±2.07	30.12±1.52*	35.96±1.12*○	33.66±1.55*	45.08±1.19*○●

Notes (here and hereinafter): * – p<0.05, statistically significant difference with the corresponding parameters of the control group; ○ – p<0,05, statistically significant difference between the corresponding examination parameters before and after physical therapy; ● – p<0,05, statistically significant difference between the corresponding parameters of CG and MG.

indicates the severity of the initial changes and the need for long-term correction.

After analyzing the results of the Short Physical Performance Battery in elderly people who underwent liver resection for colorectal metastases, a significant difference in functional indicators between the groups was found. In particular, the results confirm the effectiveness of the targeted physical therapy program in improving the physical capacity of patients. At the initial examination, the absolute values of the patients were at the level of sarcopenia (asthenia) – less than 7 points (Table 4). In the Chair Stand Test, which assesses the strength of the lower extremities, patients in the control group had the highest indicator – 3.42±0.52 points, which indicates the absence of pathology. In CG and MG, the indicators at the pre-intervention stage were 1.75±0.34 points and 1.88±0.29 points, respectively. After the intervention, an improvement of 2.63±0.15 points was recorded in MG, which is statistically significant ($p<0.05$) and indicates an improvement in lower limb muscular endurance.

In balance tests (assessment of standing stability), the dynamics also demonstrate a positive effect: in CG the indicator increased from 1.67±0.23 points to 2.51±0.30 points, and in MG – from 1.50±0.16 points to 3.01±0.22 points. The improvement in the main group was more pronounced and statistically significant compared to CG ($p<0.05$), which may be due to the structured nature of the training program and the emphasis on exercises to control body position.

Gait Speed also showed significant improvement in MG: from 1.67±0.25 points to 2.74±0.16 ($p<0.05$), while in CG – from 1.52±0.16 points to 2.13±0.27 points ($p<0.05$). This result is important given the prognostic value of gait speed in elderly patients. The total score on the SPPB scale, which allows for a holistic assessment of the patient's functional status and risk of falling, increased in the main group from 5.05±0.22 to 8.38±0.18 points, which is an increase of 66%. In CG, the improvement was less pronounced – from 4.94±0.21 to 6.90±0.16 points (+40%). In the control group, the level remained consistently high – over 10 points. In absolute numerical values, MG individuals have moved to the presarcopenia (preasthenia) level.

The results of the 6-minute walk test demonstrate the significant effectiveness of the physical therapy program in restoring functional endurance in elderly patients after liver resection for colorectal metastases (Table 5).

In the control group, which included patients without oncological pathology, the distance covered in 6 minutes was 351.09±8.16 m, which is a reference value for the age-related

Table 3

Dynamics of handgrip dynamometry in elderly people after liver resection for colorectal metastases under the influence of a physical therapy program (M±SD)

Hand strength, kg	Control group (n=33)	CG (n=31)		MG (n=32)	
		pre-test	post-test	pre-test	post-test
Men	34.33±2.16	17.45±1.05*	20.63±1.23*○	19.20±1.41*	26.08±1.52*○●
Women	20.46±1.09	10.07±0.75*	13.46±1.00*○	9.11±0.62*	15.49±1.05*○●

Table 4

Short Physical Performance Battery dynamics in elderly individuals after liver resection for colorectal metastases under the influence of a physical therapy program (M±SD)

SPPB subscale, points	Control group (n=33)	CG (n=31)		MG (n=32)	
		pre-test	post-test	pre-test	post-test
Chair Stand Test	3.42±0.52	1.75±0.34	2.26±0.42	1.88±0.29	2.63±0.15
Balance tests	3.50±0.31	1.67±0.23	2.51±0.30	1.50±0.16	3.01±0.22
Gait speed test	3.12±0.12	1.52±0.16	2.13±0.27	1.67±0.25	2.74±0.16
Total score	10.04±0.22	4.94±0.21	6.90±0.16	5.05±0.22	8.38±0.18

population. The indicators of the studied groups before the intervention were significantly lower: in CG – 263.10±10.42 m (by 25.06%, p<0.05), and in MG – 276.57±8.16 m (by 21.23%, p<0.05), which indicates a significantly reduced physical endurance after surgery.

After the implementation of the physical therapy program, the distance in the CG increased to 305.41±9.15 m (by 16.08%), while in the MG it increased to 338.42±9.37 m (by 22.36%), which is a statistically significant improvement both compared to the initial values (p<0.05) and in the intergroup comparison with the CG (p<0.05). Thus, the dynamics of recovery of tolerance to physical exertion was significantly better in the main group, which confirms the effectiveness of the individualized rehabilitation program.

Assessment of the level of subjective fatigue according to the Borg scale additionally indicates a decrease in the feeling of fatigue after therapy. In CG, the level of fatigue during the 6-minute walk test decreased from 16.22±0.52 points to 12.56±0.44 points (22.8%, p<0.05), indicating insufficient adaptation to physical activity. While in MG, the indicator decreased from 15.61±0.90 points to 10.15±0.22 points (35%, p<0.05), demonstrating not only an increase in physical endurance, but also an improvement in the quality of physical activity tolerance.

Overall, the results indicate that the physical therapy program significantly increased the level of physical performance, reduced fatigue, and improved the functional capabilities of patients.

The study assessed the dynamics of cancer fatigue in elderly patients using the QLQ-FA12 questionnaire scales before and after physical therapy (Table 6).

According to the physical fatigue scale, the decrease in CG was 16.85% (p<0.05), in MG – 27.59% (p<0.05). The decrease in emotional fatigue in CG was 14.56% (p<0.05), in MG – 25.89% (p<0.05). The decrease in cognitive fatigue was estimated by CG patients at 17.48% (p<0.05), in MG – at 32.70% (p<0.05). The decrease in the severity of the impact of fatigue on interference with daily life in the CG was 15.79% (p<0.05), in the MG – 31.93% (p<0,05). Fatigue also had a smaller impact on social sequelae: in the CG by 16.67% (p<0.05), in the MG by 33.72% (p<0.05). The total QLQ-FA12 score in the CG improved by 16.91% (p<0.05), in the MG

Table 5

Dynamics of the results of the 6-minute walk test in elderly people after liver resection for colorectal metastases under the influence of the physical therapy program (M±SD)

6-minute walk test parameters	Control group (n=33)	CG (n=31)		MG (n=32)	
		pre-test	post-test	pre-test	post-test
Distance, m	351.09±8.16	263.10±10.42*	305.41±9.15*○	276.57±8.16*	338.42±9.37○●
Fatigue level according to the 6–20 Borg scale, points	10.87±0.78	16.22±0.52*	12.56±0.44*○	15.61±0.90*○	10.15±0.22○●

Table 6

Dynamics of Cancer related Fatigue according to QLQ-FA12 in elderly people after liver resection for colorectal metastases under the influence of the physical therapy program (M±SD)

Symptom scales (average score)	CG (n=31)		MG (n=32)	
	pre-test	post-test	pre-test	post-test
Physical fatigue	3.56±0.08	2.96±0.16○	3.48±0.10	2.52±0.09○●
Emotional fatigue	3.16±0.11	2.70±0.09○	3.09±0.16	2.29±0.11○●
Cognitive fatigue	3.09±0.08	2.55±0.16○	3.15±0.09	2.12±0.08○●
Interference with daily life	3.42±0.07	2.88±0.10○	3.32±0.08	2.26±0.12○●
Social sequelae	3.30±0.05	2.75±0.11○	3.41±0.08	2.26±0.08○●
Total score	86.12±5.32	71.55±3.40○	82.37±7.01	55.28±3.46○●

by 32.91% ($p<0.05$). Accordingly, the physical therapy program demonstrated a statistically significant improvement in all components of the QLQ-FA12 in patients of both groups. However, it was in the main group, where individualized rehabilitation was used, that a significantly higher improvement dynamics was found – both in individual subscales and in the integral indicator. This indicates the high effectiveness of targeted physical therapy in reducing the manifestations of cancer-related fatigue among elderly patients after surgery.

Discussion. Sarcopenia is an important clinical problem of modern oncology, requiring a multidisciplinary solution, in particular by means of therapy and rehabilitation. Its presence negatively affects the prognosis of the disease and the quality of life of patients. The development of this pathological condition is based on metabolic changes caused by the influence of the tumor and the treatment being carried out, as a result of which the degradation of muscle protein begins to prevail over its synthesis [7; 11]. Sarcopenia is a risk factor for death, a predictor of the worst response to chemotherapy and increased toxicity, and an increase in the frequency of postoperative complications. Given the high prevalence and prognostic significance of sarcopenia in oncology, the need for its diagnosis at different stages of treatment becomes obvious [1; 10].

Numerous studies have proven that sarcopenia is a factor that affects the life expectancy of patients with gastrointestinal tumors. It has also been shown that sarcopenia is weakly correlated with the patient's body area. This is related to the opinion of a number of authors that the sarcopenia index SMI may be a more accurate prognostic factor of toxicity, since the distribution of chemotherapeutic drugs and their associated toxicity are mainly determined by lean body mass [3; 7]. Accordingly, our study complements the scientific research [6; 12; 13] on the importance of correcting sarcopenia in cancer patients, contributing to improving their quality of life and, potentially, increasing life expectancy. At the same time, the physical therapy program we developed is characterized by its adaptation to the practical health care system.

Conclusions.

1. In elderly people after liver resection for colorectal metastases, the presence of sarcopenia was determined by low muscle tissue content (according to the Skeletal Muscle Index), functional manifestations – low hand strength in men and women, impairment in performing the Short Physical Performance Battery, physical weakness according to the results of the 6-minute test, the negative impact of cancer related fatigue (in particular, the physical component) on various activities (according to the Quality Of Life Questionnaire Cancer Related Fatigue – 12).

2. A six-month comprehensive physical therapy program with the use of therapeutic exercises of various directions (aerobic, strength, to improve balance), differentiated according to the early and late postoperative periods, the chemotherapy period and the long-term postoperative, educational component (in particular, regarding nutrition modification) taking into account individual rehabilitation goals, revealed an improvement in the condition of patients due to the impact on the structural and functional components of sarcopenia due to an increase in muscle mass, expansion of motor functional capabilities when performing various activities compared to baseline indicators for all studied parameters ($p<0.05$).

3. Physical therapy should be prescribed for the comprehensive correction of structural and functional signs of sarcopenia at different stages of postoperative recovery in elderly people after liver resection for colorectal metastases.

Information on conflict of interest. There is no conflict of interest.

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