INFLUENCE OF PHYSICAL THERAPY ON INDICATORS OF POSTURAL STABILITY, FALL RISK AND KINESIOPHOBIA IN OLDER AGE GROUP PATIENTS WITH BILATERAL HIP ARTHROPLASTY IN THE LONG-TERM REHABILITATION PERIOD

ВПЛИВ ЗАСОБІВ ФІЗИЧНОЇ ТЕРАПІЇ НА ПОКАЗНИКИ ПОСТУРАЛЬНОЇ СТІЙКОСТІ, РИЗИКУ ПАДІННЯ ТА КІНЕЗІОФОБІЇ У ПАЦІЄНТІВ СТАРШИХ ВІКОВИХ ГРУП З БІЛАТЕРАЛЬНИМ ЕНДОПРОТЕЗУВАННЯМ КУЛЬШОВИХ СУГЛОБІВ У ВІДДАЛЕНОМУ ПЕРІОДІ РЕАБІЛІТАЦІЇ

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Abstracts

Objective – to evaluate the effectiveness of the developed physical therapy program on the indicators of postural stability, risk of falling and kinesiophobia in patients of older age groups with bilateral hip replacement in the long-term rehabilitation period.

Material. 112 elderly people (69.6±1.2 years) were examined. The control group consisted of 42 people who had no history of lower limb joint replacement. The comparison group consisted of 37 people with unilateral total hip replacement. The experimental group consisted of 33 people with bilateral hip replacements, the effectiveness of which is presented in our study. A three-month physical therapy program was developed and implemented for them with the use of therapeutic exercises (using weighted weights, Thera-Band, MFT Challenge Disc Digital); gait training (self-control, practicing gait phases, overcoming an obstacle course), functional training of symmetry of lower limb movements (PROCEDOS PLATFORM 9 platform), Nordic walking; educational component – learning to control one's condition, movement limitations, reducing the risk of falling, awareness of the need for regular rehabilitation interventions; reshaped physical factors – electromyostimulation of the quadriceps femoris muscle, gluteal muscles, and calf muscles. The effectiveness was assessed by the results of stabilometry, Fall efficacy scale, Timed Up & Go test, Tampa Kinesiophobia Scale.

Results. Elderly patients with bilateral hip replacement in the long-term rehabilitation period showed deterioration of postural stability (according to the results of stabilometry), risk of falling (Fall efficacy scale, Timed Up & Go test, kinesiophobia (according to Tampa Kinesiophobia Scale); according to the studied indicators, their condition was worse ($p<0.05$) than in individuals with one hip replacement and the control group. The approved comprehensive physical therapy program of duration showed improvement of the patients' condition due to the impact on the components of the balance function due to the improvement of postural stability, reduction of the risk of falling and kinesiophobia compared to the initial indicators according to all the studied parameters ($p<0.05$).

Conclusions. Physical therapy is advisable to prescribe for the complex correction of signs of postural dysfunction, risk of falling and kinesiophobia in elderly patients with bilateral hip replacement joints.

Key words: physical therapy, bilateral arthroplasty, arthroplasty, hip joint, lower limb, risk of falling, old age.

Мета – оцінити ефективність розробленої програми фізичної терапії на показники постуральної стійкості, ризику падіння та кінезіофобії у пацієнтів старших вікових груп з білатеральним ендопротезуванням кульшових суглобів у віддаленому періоді реабілітації.

Матеріал. Обстежено 112 осіб похилого віку (69,6±1,2 року). Контрольну групу становили 42 особи, які не мали в анамнезі перенесеного ендопротезування суглобів нижніх кінцівок. Групу

порівняння становили 37 осіб з перенесеним одностороннім тотальним ендопротезуванням кульшового суглоба. Експериментальну групу становили 33 особи з двома ендопротезованими кульшовими суглобами, ефективність фізичної терапії яких представлена у нашому дослідженні. Для них була розроблена та впроваджена програма фізичної терапії тривалістю три місяці із застосуванням терапевтичних вправ (з використанням обважнювачів, Thera-Band, MFT Challenge Disc Digital); тренування ходи (самоконтроль, відпрацювання фаз ходи, долання смуги перешкод), функціональне тренування симетричності рухів нижніх кінцівок (платформа PROCEDOS PLATFORM 9), Nordic walking; освітній компонент – навчання контролю свого стану, рухових обмежень, зменшення ризику падіння, усвідомлення необхідності регулярних реабілітаційних втручань; переформовані фізичні чинники – електроміостимуляція чотирьохголового м'яза стегна, м'язів сідниць, литкових м'язів. Ефективність оцінювали за результатами стабілометрії, Fall efficacy scale, тесту Timed Up & Go, Tampa Kinesiophobia Scale.

Результати. У пацієнтів похилого віку з білатеральним ендопротезуванням кульшових суглобів у віддаленому періоді реабілітації визначено погіршення постуральної стійкості (за результатами стабілометрії), ризик падіння (Fall efficacy scale, Timed Up & Go тестом), кінезіофобію (за Tampa Kinesiophobia Scale); за досліджуваними показниками їхній стан був гіршим ($p<0,05$), ніж у осіб з одним ендопротезованим кульшовим суглобом та контрольною групою. Апробована програма фізичної терапії виявила покращення стану пацієнтів через вплив на компоненти функції рівноваги за рахунок покращення постуральної стійкості, зменшення ризику падіння та кінезіофобії порівняно із вихідними показниками за всіма досліджуваними параметрами ($p<0,05$).

Висновки. Засоби фізичної терапії доцільно призначати для корекції ознак постуральної дисфункції, ризику падіння та кінезіофобії у пацієнтів похилого віку з білатеральним ендопротезуванням кульшових суглобів.

Ключові слова: фізична терапія, білатеральна артропластика, ендопротезування, кульшовий суглоб, нижня кінцівка, ризик падіння, похилий вік.

Introduction. Degenerative lesions of the hip joints occupy the first place among similar diseases of other joints and often lead to permanent disability. Disability in this pathology reaches 60% [5]. The most effective method of treating patients with diseases of the hip is total replacement, which accounts for 30% of all surgical interventions on it [12]. The operation allows you to achieve an almost immediate positive effect.

Patients with bilateral hip pathology, where there are signs of decompensation of the static-dynamic function of the musculoskeletal system, are particularly difficult to treat. Up to 800.000 hip replacement surgeries are performed annually in the world [12]. In 10–20% of cases, both hip joints are operated on [3; 11].

Bilateral hip arthroplasty (BHA) is performed in two variants – sequentially, in two stages with a time gap, or in one stage, during one anesthesia.

The first variant is more common due to the lower surgical risk and the probability of unsuccessful results. However, the final result of the treatment cannot be achieved until the second intervention is performed, which prolongs the patient's rehabilitation period. In the interval between consecutive operations, the affected joint experiences increased load. This causes acceleration of pathological changes in it and contributes to the further progress of static-dynamic disorders, and the gradual redistribution of the increased load on the operated joint can lead to negative consequences and cause an unfavourable outcome [3; 4].

An increase in the time interval between operations worsens the results of treatment, increases the risk of complications of the second implantation. Indications for bilateral arthroplasty are pathological processes of both hip joints. Replacing diseased joints at once allows the patient to return to an active lifestyle earlier and get a good functional result faster [6].

According to a number of authors, the number of complications in single-stage and sequential bilateral arthroplasty is comparable and does not have significant differences [9; 12]. There is a significant reduction in economic costs – from 10 to 30% for each case of single-stage BHA, mainly due to the time of hospitalization and the duration of incapacity for work [10]. However, the use of the method of single-stage bilateral arthroplasty, despite its high efficiency, is associated with high operational risk and significant surgical aggression [4; 6]. Therefore,

currently single-stage bilateral arthroplasty has not yet gained wide enough application among orthopedists.

Most authors assess the effectiveness of surgical treatment for bilateral hip joint diseases mainly on the basis of clinical and radiological data [5; 12], which does not sufficiently characterize the state of the main links of the musculoskeletal system during the recovery process.

The effectiveness of physical therapy is characterized by a high level of evidence for the restoration of function after hip replacement [2; 10] and for the correction of signs of geriatric pathology [1; 7; 8]. However, despite the rapid increase in the number of people with two hip replacements, there are virtually no works that highlight the features of physical therapy for this group of people. The study of this issue determines the relevance of the presented work.

Aim of the study is to assess the effectiveness of the developed physical therapy program on the indicators of postural stability, risk of falling and kinesiophobia in patients of older age groups with bilateral hip arthroplasty in the long-term rehabilitation period.

Material and methods. In the process of solving the goal and objectives of the study, 112 elderly people (60–75 years old, mean age 69.6±1.2 years) were examined.

The control group consisted of 42 people (19 men, 23 women) who had no history of lower limb arthroplasty (their involvement in the study is justified by the hypothesis of the difference in the functional state of people with functionally normal lower limbs and with bilateral arthroplasty).

The comparison group (CG) consisted of 37 people (17 men, 20 women) with a unilateral total hip arthroplasty (their involvement in the study is justified by the hypothesis of a difference in the functional status of patients with unilateral and bilateral arthroplasty).

The experimental group (EG) consisted of 33 people (15 men, 18 women) with two hip arthroplasty joints, the effectiveness of physical therapy of which is presented in our study.

Inclusion criteria in the study:

– undergone staged bilateral total hip arthroplasty;

– indications for BHA – changes associated with hip osteoarthritis;

– surgery for the second hip arthroplasty was performed after reaching the lower age limit of old age (not younger than 60 years);

– period after endoprosthesis of the second hip joint – at least 6 months;

– method of fixation of endoprosthesis – cement;

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

Exclusion criteria:

– staged bilateral total hip arthroplasty performed in young or middle age;

– staged bilateral total hip arthroplasty BHA due to trauma, dysplastic arthrosis, etc.;

– revision endoprosthesis;

– complicated course of the postoperative period (endoprosthesis infection, bone fracture, dislocation or instability of the endoprosthesis, etc.);

– clinically significant neurological or orthopedic pathology that could affect motor functions and balance;

– the presence of severe somatic concomitant pathology (in particular: oncological pathology, renal failure, severe heart failure, severe dementia);

– insufficient body weight, morbid obesity;

– exacerbation of existing chronic pathology at the time of the study.

The developed physical therapy program took into account the features of the functional consequences of BHA – the need to maintain a symmetrical load on the endoprosthesis during its functioning and limit the amplitude of movements to prevent dislocation, as well as the general condition of patients associated with the characteristics of the load in old age. The duration of the developed physical therapy program is 12 weeks (outpatient stage (21 days), mixed format of implementation (outpatient and independent classes) – 4 weeks, independent therapeutic classes according to the provided program) – 5 weeks.

The developed physical therapy program included four components.

1) therapeutic exercises to correct the strength of the lower limbs (using weights, Thera-Band), joint flexibility, balance (using MFT Challenge Disc Digital) – during all periods of intervention;

2) gait training (self-control in front of the mirror, practicing gait phases, overcoming a conditional obstacle course), functional training of symmetry of lower limb movements (PROCEDOS PLATFORM 9 platform), Nordic walking – during all periods of intervention;

3) educational component – learning to control one's condition, motor limitations, reducing the risk of falling, awareness of the need for regular rehabilitation interventions;

4) reshaped physical factors – electromyostimulation of the quadriceps muscle of the thigh, gluteal muscles, calf muscles.

The main tasks of the developed physical therapy program, identified during the examination of patients, and methods for solving them are given in Table 1.

Stage examinations of EG patients were conducted at the beginning of the study (first examination) and after 3 months of implementing the physical therapy program (repeated examination).

All patients were examined twice on the ST-150 stability platform. The study was conducted using the generally accepted method with closed and open eyes when placing the feet according to the accepted American standard. The following indicators were analyzed: root mean square deviation (displacement) of the projection of the general center of pressure along two axes – horizontal and vertical (X and Y, mm); speed of movement of the general center of pressure V (mm/s) – the ratio of the length of the study path to the time of the study; area of the statokinesiogram S (mm2) – the surface occupied by the statokinesiogram (part of the plane bounded by the statokinesiogram curve); efficiency coefficient (points) – assesses the influence of vision on the balance function.

The consequences of balance disorders in the form of the risk of falling and kinesiophobia were determined. Assessment of fear of falling during everyday movements was performed using the 100-point Fall efficacy scale (FES). To determine balance, the Timed Up & Go test was performed, which is designed to detect changes in the balance of unstable elderly patients as an indicator of the risk of falling. The level of kinesiophobia (risk of falling, weakness, imbalance) was determined using the Tampa Kinesiophobia Scale (TKS).

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 was obtained from all elderly patients with the consequences of hip arthroplasty 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 obtained results was carried out using the SPSS 18 program for Windows, the mean values (M) and standard deviation (SD)

Table 1

Clinical consequences of BHA and their correction by physical therapy

Clinical consequences of BHA	Therapeutic exercises	Gait	Educational component	Preformed physical factors
Discomfort in the hip joints	+	+	+	+
Limping	+	+		
Lower limb weakness	+	+		+
Balance disorder	+	+	+	
Kinesiophobia	+	+	+	
Difficulty in performing activities of daily living	+	+	+	
Back pain	+	+	+	
Psycho-emotional depression	+	+	+	

were calculated. To check the type of distribution of the indicators under study, the one-sample Kolmogorov-Smirnov test was used. Since the data of the variables under study in the groups corresponded to a normal distribution, the statistical significance of the differences in the dependent samples was established using the parametric Student's t-test. The difference compared to the initial indicators was considered statistically significant at $p \leq 0.05$.

Results of the study. Among the individuals with BHA involved in the study, 21.9% (7 individuals) participated in the physical therapy program from 6 months to 1 year after repeated hip endoprosthesis, 65.6% (21 individuals) participated in the program for 1–3 years, and 12.5% (4 individuals) participated in the program for more than 3 years.

The period between the first and second hip endoprosthesis was less than one year in 31.3% (10 individuals), 1–3 years in 40.6% (13 individuals), and more than 3 years in 28.1% (9 individuals).

The reasons for the second hip endoprosthesis were unbearable pain (18.8% – 6 individuals), severe functional impairments that make movement difficult (25% – 8 individuals), and a combination of these (56.3% – 18 individuals).

It should be noted that the technique of endoprosthetics of the second hip involves its installation with observance of the symmetry of bone landmarks, which indicates the adequacy of the surgical intervention, however, visual asymmetry of the lower extremities is determined due to soft tissues (Figure 1).

In EG patients, a significant decrease in the magnitude of oscillations along the frontal axis was observed both with eyes open (by 29.7%) and with eyes closed (by 49.88%). These changes were statistically significant ($p<0.05$) both in relation to the initial values in EG ($p<0.05$) and in comparison with CG ($p<0.05$) (Table 2).

Similarly, in EG, a significant decrease in postural oscillations along the sagittal axis was noted: by 28.03% with eyes open and by 10% with eyes closed. The changes were statistically significant ($p<0.05$), indicating an improvement in stability both in conditions of visual control and without it.

Fig. 1. Clinical case. Patient G., 75 years old. Radiographs in direct and lateral projections (condition of the endoprosthesis, changes in the spine). Appeara nce of the lower extremities

The indicators of the trajectory length of the center of pressure (S) increased after therapy in EG, which, on the one hand, indicates an increase in active participation in balance control. An increase was noted with open eyes (by 20.62%) and with closed eyes (by 15.27%), which is identical to the CG level ($p>0.05$).

The speed of movement of the center of pressure in EG also increased after therapy: with open eyes – by 46.86%, with closed eyes – by 28.38%. This indicates improved dynamics of postural reactions after rehabilitation exposure.

The key integral indicator is the balance efficiency coefficient. In EG, it increased by 27.2% ($p<0.05$), which significantly exceeds the indicators before therapy.

This allows us to state that the rehabilitation program in EG contributes to improving postural control, reducing the amplitude and speed of fluctuations of the center of pressure, which generally indicates increased stability in elderly patients after BHA.

The logical functional consequence of postural instability, established by the results of stabilometry, was the risk of falling and kinesiophobia). Table 3 presents an assessment of the effectiveness of physical therapy in

reducing the risk of falling and fear of movement in patients in the experimental group. The data indicate a significant improvement in the psychophysiological state of patients after completing the physical rehabilitation program.

Fall Efficacy Scale is a tool that reflects the level of confidence of patients in preventing falls. A decrease in the indicator indicates an increase in confidence in their own stability and a decrease in the fear of falling. Its absolute improvement was 16.87 points (23.39%, $p<0.05$), which indicated an improvement in motor control and physical qualities, self-confidence, and learning the principles of safe motor activity

Improvement in the functional "Timed Up & Go" test demonstrates an increase in mobility and speed of movement, which is an important marker of reducing the risk of falls in daily activity. Absolute improvement in EG under the influence of physical therapy was 6.60 s (31.19%, $p<0.05$).

Tampa Kinesiophobia Scale is an indicator reflecting the level of fear of movement (kinesiophobia). A significant decrease indicates a significant decrease in the psychoemotional barrier to physical activity, which is one of the key factors in restoring postoperative functional status. Its absolute improvement in EG was 23.92 points (41.13%). This point can also be considered as a factor in reducing social isolation, the ability to walk, shop, visit relatives, etc.

Discussion. Stabilometry allows monitoring of postural control disorders. It is known that patients with musculoskeletal pathology have impaired afferentation from the proprioceptors of the muscular, capsular and ligamentous apparatus [10; 12]. The source of information about body position is also the visual and vestibular analyzers.

Using computerized stabilometry, we analyzed balancing parameters and indicators of support symmetry in patients after total hip arthroplasty

Table 2

Dynamics of the main indicators of stabilometry in elderly people after BHA under the influence of a physical therapy program (M±SD)

Stabilometry index	Control group (n=42)	CG (n=37)	EG (n=33)	
			first examination	repeat examination
Eyes open, X, mm	-0.63±0.32	-2.66±0.75*	-3.45±0.81*●	-1.20±0.55*○●
Eyes closed, X, mm	-2.38±0.41	-4.09±0.74*	-6.13±1.07*●	-2.48±0.85*○●
Eyes open, Y, mm	-32.45±1.45	-56.12±2.08*	-71.85±3.16*●	-53.11±3.62*○
Eyes closed, Y, mm	-42.84±3.18	-66.25±5.01*	-72.58±4.18*●	60.34±5.12*○
Eyes open, S, mm	120.95±10.40	194.13±11.28*	234.15±11.23*●	200.08±6.12*○
Eyes closed, S, mm	192.63±11.12	253.44±15.25*	292.13±10.60*●	240.23±13.16*○
Eyes open, V, mm	6.51±0.76	10.35±1.12*	15.20±1.07*●	9.63±0.75*○
Eyes closed, V, mm	12.01±1.13	20.37±2.16*	26.15±1.84*●	22.57±2.16*○
Efficiency coefficient, points	110.45±7.42	203.96±11.09*	259.44±13.52*●	211.46±8.95*○

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

Table 3

Dynamics of indicators of the risk of falling kinesiophobia in elderly people after bilateral BHA under the influence of a physical therapy program (M±SD)

Indicator	Control group (n=42)	CG (n=37)	EG (n=33)	
			first examination	repeat examination
Fall efficacy scale, points	42.16±2.13	60.13±5.11*	72.13±4.12*●	55.26±2.63*○
Timed Up & Go, s	12.46±0.70	17.69±1.03*	21.16±1.09*●	14.56±0.65*○
Tampa Kinesiophobia Scale, points	24.30±2.38	42.11±3.07*	58.16±5.16*●	34.24±2.71*○●

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

who are in the long-term rehabilitation period. As the results of the study showed, before the course of physical therapy, a violation of the general center of pressure was noted in most patients. By the end of rehabilitation, the proportion of patients with stable balance increased, a decrease in visual control of body position was noted with an increase in proprioceptive control, and the influence of vision on the balance function decreased ($p < 0.05$). It is known that in the pathology of the musculoskeletal system and damage to the proprioceptors of the capsular-ligamentous apparatus, maintaining body position is compensated by the visual analyzer [6; 11].

Therefore, to increase the effectiveness of rehabilitation after bilateral hip replacement, it is necessary to take into account the functional asymmetry of the legs, and to develop a physical therapy program aimed at individual selection of a complex of therapeutic exercises, physiotherapeutic methods, and improvement of vital functions.

Conclusions.

1. Elderly patients with bilateral hip replacement in the long-term rehabilitation period showed a deterioration in postural stability (according to the results of stabilometry), risk of falling (Fall efficacy scale, Timed Up & Go test, kinesiophobia (according to Tampa Kinesiophobia Scale); according to the studied indicators, their condition was worse ($p<0.05$) than in individuals with one hip replacement and the control group.

2. The approved complex of a three-month physical therapy program with the use of therapeutic exercises, gait training and functional training, educational component, electromyostimulation revealed an improvement in the condition of patients due to the impact on the components of the balance function due to the improvement of postural stability, reduction of the risk of falling and kinesiophobia compared to the initial indicators for all studied parameters ($p<0.05$).

3. Physical therapy should be prescribed for the complex of postural dysfunction, fall risk, and kinesiophobia in elderly patients with bilateral hip replacement.

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