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EFFECTIVENESS OF THE REHABILITATION PROGRAM IN PATIENTS WITH LUMBAR OSTEOCHONDROSIS AND MOTOR STEREOTYPE DISORDERS USING SHOCK WAVE THERAPY

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Ключевые слова: *поясничный остеохондроз, миотонические реакции, двигательные паттерны, ударно-волновая терапия*

Abstract. Effectiveness of the rehabilitation program in patients with lumbar osteochondrosis and motor stereotype disorders using shock wave therapy. Gresko I.V., Kolesnichenko V.A. *The study included 80 patients aged 22-44 (31.7±4.4) years with lumbar osteochondrosis with impaired motor stereotype and myotonic reaction of the lumbar-pelvic region muscles. The patients were randomized into two homogeneous groups depending on the physical rehabilitation program: in the main group a combination of shock wave therapy (SWT) with the Masterplus MP200 extracorporeal shock wave therapy device (5 procedures with a frequency of 11 Hz, an impact force of 3.8-4.0 bar, intervals of 5-7 days) with a program of relaxing exercises according to the method of K. Levit was used; in the control group – only exercises program. The developed program of physical rehabilitation proved its effectiveness by a significant decrease in pain intensity indicators (p<0.001) by VAS scale, ODI disability level (p<0.001) and SKT kinesiophobia level (p<0.01), a significant increase in the spine mobility (p<0.05) and the lumbar spine mobility (p<0.05), flexion in the hip joints (p<0.05). The range of movements during extension, adduction and abduction of the hip joints also increased but not significantly. Normalization of the extensor muscle tone of the lumbar spine was observed in 87.5% of cases, the gluteus muscle tone – in 30.0%, and the piriformis muscle tone – in 27.5%. The frequency of registration of error patterns in the active combined movement of the lumbar segments and the pelvis decreased to 37.5% of cases as a whole. The developed program of physical rehabilitation proved to be effective compared with the results of the isolated application of relaxing exercises with a significant improvement by VAS scale (p<0.05), ODI (p<0.05) and SKT (p<0.05); normalization of the tone of the lumbar extensor muscles and the restoration of control of active movements in the lumbar-pelvic region are more often noted in more than a third of patients.*

Реферат. Эффективность программы реабилитации больных поясничным остеохондрозом с нарушениями двигательного стереотипа с использованием ударно-волновой терапии. Гресько И.В., Колесниченко В.А. *В исследование были включены 80 больных поясничным остеохондрозом с нарушением двигательного стереотипа и миотоническими реакциями мышц пояснично-тазовой области, мужского пола, в возрасте 22 - 44 (31,7±4,4) года. Пациенты были разделены с помощью случайной выборки на две однородные группы в зависимости от программы физической реабилитации: в основной группе применяли сочетание УВТ-аппарат для экстракорпоральной ударно-волновой терапии Masterplus MP200 (5 процедур с частотой удара 11 Гц, силой удара 3,8-4,0 bar, периодичностью проведения 5-7 дней) с программой релаксационных упражнений по методике К. Левита; в контрольной группе - только комплекс упражнений. Разработанная программа физической реабилитации доказала свою эффективность значимым снижением показателей интенсивности боли по VAS (p<0,001), уровней дисабилитации ODI (p<0,001) и кинезиофобии SKT (p<0,01), увеличением подвижности позвоночника (p<0,05) и его поясничного отдела (p<0,05), амплитуды сгибания в тазобедренных суставах (p<0,05). Объем движений при разгибании, приведении и отведении тазобедренных суставов также увеличился, но недостоверно. Нормализация тонуса мышц-разгибателей поясничного отдела позвоночника отмечена в 87,5% наблюдений, ягодичной мышцы – в 30,0%, грушевидной мышцы – в 27,5%. Частота регистрации ложных паттернов при активном совместном движении поясничных сегментов и таза в целом уменьшилась до 37,5% случаев. Разработанная программа физической реабилитации доказала свою эффективность по сравнению с результатами изолированного применения релаксационных упражнений значимым улучшением показателей VAS (p<0,05), ODI (p<0,05), SKT (p<0,05); нормализация тонуса поясничных мышц-разгибателей и восстановление контроля активных движений в пояснично-тазовой области отмечены более чем у трети больных.*

One of the constant syndromes of lumbar osteochondrosis is myotonic syndromes, which are accompanied by persistent hypertension of the muscles of the lumbar-pelvic area. This situation leads to the development of enthesopathies [8, 14], restriction of movements in the lumbar spine [2, 7, 15] and in some cases in the hip joint [7, 9] with an impairment of the sequence of muscle activation during the performance of functional tasks [2, 8]. As a result, pathological motor patterns are formed [6]. The latter can alleviate everyday physiological loads, leading to "immortalization" [12] of pathological motor stereotype. However, pathological motor patterns entail the recruitment of additional muscles to perform the corresponding movement. Additional muscles not involved in locomotion receive an uncharacteristic load, which is accompanied by overexertion of the musculoskeletal system with the development of fatigue, the emergence of enthesopathies, the formation of secondary foci of painful irritation and disease progression. In this regard, rehabilitation treatment of patients with lumbar osteochondrosis should include relief of myotonic syndromes of the muscles of the lumbar-pelvic area with the optimization of motor stereotype.

One of the traditional means of restoring muscle function in patients with lumbar osteochondrosis with an impairment of the motor stereotype is exercise therapy (ET). Existing exercise programs can reduce the intensity of pain, reduce the level of disability, increase the mobility of the spine and, thus, contribute to the correction of motor patterns [6, 17]. However, in some cases it is not possible to eliminate myotonic syndromes with exercise therapy. In this regard, we consider it appropriate to use shock wave therapy (SWT) for this category of patients, which reduces the intensity of pain, inflammation, promotes regeneration by stimulating neoangiogenesis and stem cell activity [3].

The aim of the study was to evaluate the effectiveness of shock wave therapy in patients with lumbar osteochondrosis with motor stereotype disorders and myotonic syndromes.

MATERIALS AND METHODS OF RESEARCH

Materials of the study are the protocols of clinical and radiological examination of 80 patients with lumbar osteochondrosis with an impairment of the motor stereotype and myotonic reactions of the muscles of the lumbar-pelvic area. All male patients aged 22-44 (31.7±4.4) years. All patients were observed in the medical center "Intersono" in Lviv in 2017-2018.

Criteria for inclusion in the study: no radicular disorders with lower paresis and/or plegia. Exclusion criteria: systemic diseases, deforming arthrosis of the joints of the lower extremities, fractures of the vertebrae and bones of the lower extremities, as well as operations on the spine and lower extremities in the anamnesis, the presence of spondylolysis and spondylolisthesis of the lumbar vertebrae.

Patients were randomly divided into two groups – the main (n=40) and control (n=40). In both groups, every other day for 3 weeks patients performed a program of relaxation exercises according to the method of K. Levit [1]. In the main group additionally SWT device for extracorporeal shock wave therapy Masterplus MP200 (manufactured by Storz Medical AG, Switzerland) was used. The SWT program included 5 procedures with a periodicity of 5-7 days. During the first procedure, the impact force was minimal and amounted to 3.8 bar with a gradual increase in the impact force to 3.9 bar in the second and fourth procedures, to 4.0 bar – in the third and fifth sessions. The impact frequency of 11 Hz remained unchanged.

In clinical studies, the following was assessed: general mobility of the spine according to the results of the "fingers-floor" test, mobility of the thoracic and lumbar spine by the Schober method, the volume of movements in the hip joints - by the neutral 0-pass method. The functional state (muscle tone, strength) of the muscles of the lumbar-pelvic area (flexor and extensor muscles of the lumbar spine, gluteal, piriformis, iliac-lumbar muscles) according to the results of the relevant diagnostic tests was investigated. Tests assessing control of active movements in the lumbar-pelvic area were also performed. Normally, the active forward inclination of the pelvis is accompanied by bending of the lumbar spine (flexion pattern). Accordingly, the extension pattern of movement characterizes the active backward inclination of the pelvis in combination with the extension of the lumbar segments. Registration of pathological motor patterns (lumbar extension in the case of pelvic flexion movements and lumbar flexion in pelvic extension) indicates an impairment of the motor stereotype.

Patients' self-assessment of their functional status included registration of: 1) lumbar pain intensity by a 100 mm visual analog scale (VAS); 2) the level of disability rehabilitation due to lumbar pain (according to the disabilitation index (ODI) according to the Oswestry Disability Questionnaire, version 2.0; 3) the level of kinesiophobia (SKT) by Tampa scale of kinesiophobia.

The structural state of the vertebral segments was determined by the results of the analysis of survey lumbar spondylograms in standard (anterior-posterior and lateral) projections, parasagittal and axial scans of magnetic resonance imaging (MRI) of the lumbar spine.

Clinical trials were performed twice – during the initial examination and after the end of treatment programs.

In statistical studies, classical methods of descriptive statistics were used, and the t-test was evaluated according to the Student's method with a significance level of $p<0.05$ using a licensed statistical program for processing the results.

RESULTS AND DISCUSSION

Characteristics of the orthopedic status of patients of the main and control groups at the initial examination are presented in Table 1. The intensity of lumbar pain and the associated level of disability reflected the pronounced functional disorders in the musculoskeletal system. Thus, VAS in the main and control groups reached an average of 61.5±7.8 mm and 64.0±7.6 mm, respectively; ODI – 54.3±9.6 points and 52.8±10.1 points, respectively. As expected, the level of kinesiophobia was also high (42.5±3.8 points and 41.7±4.0 points, respectively), especially given the fact that most patients were residents of rural areas and the main type of their production activities was associated with physical loads.

Table 1

Clinical indicators of patients with lumbar osteochondrosis with disorders of motor patterns from the main and control groups before treatment (M±m)

Groups		t-test Student
main n=40	control n=40	
	VAS, мм	
61.5±7.8	64.0±7.6	t=0.4; p>0.05
	ODI, points	
54.3±9.6	52.8±10.1	t=0.3; p>0.05
	SKT, points	
42.5±3.8	41.7±4.0	t=0.2; p>0.05
	Flexion in the hip joints, deg.	
95.5±7.9	98.8±8.4	t=0.3; p>0.05
	Stretching in the hip joints, deg.	
1.5±1.1	1.4±1.7	t=0.2; p>0.05
	Adduction in the hip joints, deg.	
37.5±8.2	38.8±9.4	t=0.2; p>0.05
	Abduction in the hip joints, deg.	
31.8±4.6	36.2±6.5	t=0.5; p>0.05
	External rotation in the hip joints, deg.	
42.3±5.6	40.8±7.9	t=0.3; p>0.05
	Internal rotation in the hip joints, deg.	
40.8±6.4	44.0±8.3	t=0.4; p>0.05
	Schober test for the thoracic spine, cm	
6.3±1.9	6.0±1.7	t=0.3; p>0.05
	Schober test for the lumbar spine, cm	
2.3±1.4	2.2±1.8	t=0.2; p>0.05
	Test "fingers-floor", cm	
24.5±4.9	24.7±5.4	t=0.4; p>0.05

Limitation of functional capabilities of the muscles of the lumbar-pelvic area due to hypertension and decreased strength (up to 4.2±0.2 points in the main and 4.1±0.2 points in the control groups) of the extensor muscles of the lumbar region spine (100.0% of observations), gluteal muscle (37.5% and 35.0%, respectively), piriformis (32.5% and 35.0%, respectively), iliopsoas muscle (22.5% and 20.0%, respectively) was revealed. Testing of the flexor muscles of the torso showed a decrease in strength (77.5% and 72.5%, respectively), while myotonic reactions were observed in only 12.5% of cases in each group. Painful palpation of bone landmarks – places of the beginning and attachment of the investigated muscles (spinous processes of lumbar vertebrae, a wing of an iliac bone, a dorsal surface of sacrum, a major trochanter) attracts attention. Under conditions of increased muscle tone, the biomechanical rigidity of muscles increases in the final phase of movement with a change in the architecture of the cytoskeleton, especially in the junction of muscles – tendon – bone, which can lead to fatigue overload with the development of enthesopathies [14]. Excessive mechanical loading of muscles that are in a state of hypertension, changes the magnitude and rate of viscous-elastic deformation in response to the applied force, which can change the tension of muscle fibers [14] and increase the development of pain [4].

The study of active control of movements in the lumbar-pelvic region showed the predominance of pathological flexion patterns (80.0% in the main and 77.5% in the control group). False extension movements were observed in 12.5% of cases in each of the groups. Normal combined movements of the lumbar spine and pelvis were preserved in 3 (7.5%) and 4 (10.0%) patients, respectively.

The presence of hypertonia of the muscles of the lumbar-pelvic area was accompanied by limited flexion in the spine (according to the "fingers-floor" test) and lumbar spine (according to the Schober test), limited movement in the sagittal and frontal planes in the pelvic joints. Rotational movements in the latter, as well as the amplitude of flexion in the thoracic spine, were on average within normal limits. It should be noted the homogeneity of the main and control groups: by all compared indicators the differences are statistically insignificant (Student's t-test does not exceed 0.5; p>0.05) (Table 1).

The results of radiological diagnostics of the lumbar spine allowed to establish the structural asymmetry of LIII, LIV, LV vertebrae due to the asymmetric size of the articular (77.5%, 85.0%, 70.0%, respectively) and transverse (51.3%, 46.4 %, 76.3%, respectively) processes, discontinuity of articular facets (72.5%, 81.3%, 57.5%, respectively), tropism anomalies (47.5%, 55.0%, 52.5%) respectively), rotations of spinous processes (67.5%, 63.8%, 33.8%, respectively). In all patients there were moderate signs of degeneration of the lower lumbar segments.

Thus, in the examined patients with lumbar osteochondrosis there were myotonic reactions, pathological motor patterns and decreased muscle strength of the lumbar-pelvic area with limited mobility of the spine, lumbar spine, hip joints, significant limitation of daily activity.

The use of physical rehabilitation in the main and control group allowed to improve the studied clinical indicators in both groups of patients. At the same time, the degree of restoration of the functional capabilities of the musculoskeletal system in each of the groups was different.

In the case of intra-group comparison of the results of physical rehabilitation in the main group (relaxation exercises for the muscles of the pelvic area in combination with SWT) found a significant decrease in VAS indicators (p<0.001), ODI (p<0.001), SKT (p<0.01) and a significant increase in the mobility of the spine (p<0.05) and its lumbar area (p<0.05), as well as the amplitude of flexion in the hip joints (p<0.05) at the end of treatment. The average volume of adduction, abduction and hip extension in patients of the main group also increased, but without statistically significant differences (Table 2). The study of the functional state of the muscles of the lumbar-pelvic area in the dynamics showed an increase in strength (4.8±0.6 points) and normalization of the tone of the extensor muscles of the lumbar spine in 87.5% of cases, buttocks (in 30.0%), piriformis (27.5%) and iliac-lumbar muscles (2.5%) in the main group. In these patients, there was also a decrease in erroneous movements for flexion (32.5%) and extension patterns (up to 7.5% of cases) when performing movements in the lumbar-pelvic area.

Intra-group comparison of the results of physical rehabilitation in the control group (a set of relaxation exercises for the muscles of the lumbar-pelvic area) also showed an improvement in all studied indicators. However, statistically significant differences were observed due to a decrease in the intensity of lumbar pain VAS (p<0.01) and the ODI disabilitation index (p<0.05) (Table 3). Functional capabilities of the muscles of the lumbar-pelvic area in the control group expanded by increasing the strength of the studied muscles to an average of 4.5±0.4 points, relief of myotonic reactions of the extensor muscles of the lumbar spine in 55.0% of cases, gluteal muscle – in 10.0%, piriformis – in

17.5%, iliopsoas muscle – in 2.5% of cases. A decrease in the frequency of pathological patterns during movements in the lumbar-pelvic area was registered: flexion – in 62.5%, extension – in 7.5% of observations.

Table 2

Clinical indicators of patients with lumbar osteochondrosis with disorder of motor patterns from the main group before and after treatment (M±m)

Main group (n=40)		t-test Student
before treatment	after treatment	
VAS, mm		
61.5±7.8	22.4±8.1	t=22; p<0.001
ODI, points		
54.3±9.6	26.3±6.5	t=12; p<0.001
SKT, points		
42.5±3.8	19.0±4.2	t=19; p<0.001
Hip flexion, deg.		
95.5±7.9	121.8±6.4	t=2.8; p<0.05
Hip extension, deg.		
1.5±1.1	2.7±1.4	t=0.8; p>0.05
Adduction in hip joints, deg.		
37.5±8.2	42.8±6.7	t=1.7; p>0.05
Abduction in hip joints, deg.		
31.8±4.6	36.4±3.7	t =1.5; p>0.05
External rotation in hip joints, deg.		
42.3±5.6	42.9±4.9	t =0.2; p>0.05
Internal rotation in hip joints, deg.		
40.8±6.4	42.4±5.1	t =0.3; p>0.05
Schober test for thoracic spine, cm		
6.3±1.9	6.6±2.0	t = 0.99; p>0.05
Schober test for lumbar spine, cm		
2.3±1.1	3.9±2.3	t = 2.8; p<0.05
Test “fingers-floor” cm		
24.5±4.9	11.7±6.2	t=12; p<0.001

Table 3

Clinical indicators of patients with lumbar osteochondrosis with disorder of motor patterns from the control group before and after treatment (M±m)

Control group (n=40)		t-test Student
before treatment	after treatment	
VAS, mm		
64.0±7.6	32.7±9.4	t=9; p<0.01
ODI, points		
52.8±10.1	38.7±12.6	t=2.6; p<0.05
SKT, points		
41.7±4.0	26.2±11.7	t=2.1; p>0.05
Hip flexion, deg.		
98.8±8.4	112.1±4.3	t=0.8; p>0.05
Hip extension, deg.		
1.4±1.7	1.8±2.1	t=0.2; p>0.05
Adduction in hip joints, deg.		
38.8±9.4	44.6±10.4	t=0.8; p>0.05
Abduction in hip jonts, deg.		
36.2±6.5	39.1±8.4	t=0.4; p>0.05
External rotation in hip joints, deg.		
40.8±7.9	41.5±8.2	t=0.2; p>0.05
Internal rotation in hip joints, deg.		
44.0±8.3	43.9±10.2	t=0.2; p>0.05
Schober test for thoracic spine, cm		
6.0±1.7	6.3±1.4	t=0.2; p>0.05
Schober test for lumbar spine, cm		
2.2±1.8	3.4±2.1	t=1.6; p>0.05
Test “fingers-floor”, cm		
24.7±5.4	16.2±4.6	t=1.8; p>0.05

The results of intergroup comparison of the studied indicators after the end of treatment programs in the main and control groups showed higher efficiency of SWT in combination with relaxation exercises. Compared with the control group (isolated use of exercise therapy) in the main group there was an improvement in almost all studied parameters, of which significant differences were observed as for VAS ($p<0.05$), ODI ($p<0.05$) and SKT ($p<0.05$) (Table 4). Attention is drawn to the increase in the relaxation effect of exercises on the relaxation of the muscles of the lumbar-pelvic area in the case of combination with SWT. The influence of the combined action of therapeutic gymnastics and physical factors enabled to normalize muscle tone more often in patients of the main group. There was observed an increase in restoration of the tone of the lumbar extensor muscles by 27.5% more than in the control group, by 20% – in the gluteal muscle, and a 10% increase in piriform muscle. This enabled to restore the motor stereotype of lumbar-pelvic movements in general in 55.0% of observations in the main and in 20.0% – in the control groups.

Table 4

Clinical indicators of patients with lumbar osteochondrosis with disorder of motor patterns from the main and control group after treatment (M±m)

Groups		t-test Student
main n=40	control n=40	
	VAS, mm	
22.4±8.1	32.7±9.4	t=2.7; p<0.05
	ODI, points	
26.3±6.5	38.7±12.6	t=2.5; p<0.05
	SKT, points	
19.0±4.2	26.2±11.7	t=2.8; p<0.05
	Hip flexion, deg.	
121.8±6.4	112.1±4.3	t=1.1; p>0.05
	Hip extension, deg.	
2.7±1.4	1.8±2.1	t=0.7; p>0.05
	Adduction in hip joints, deg,	
42.8±6.7	44.6±10.4	t=0.2; p>0.05
	Abduction in hip joints, deg.	
36.4±3.7	39.1±8.4	t=0.2; p>0.05
	External rotation in hip joints, deg.	
42.3±5.6	41.5±8.2	t=0.2; p>0.05
	Internal rotation in hip joints, deg.	
42.4±5.1	43.9±10.2	t=0.2; p>0.05
	Schober test for thoracic spine, cm	
6.6±2.0	6.3±1.4	t=0.2; p>0.05
	Schober test for lumbar spine, cm	
3.9±2.3	3.4±2.1	t=0.3; p>0.05
	Test "fingers-floor", cm	
11.7±6.2	16.2±4.6	t=1.2; p>0.05

Extracorporeal shock wave therapy is considered as an effective, safe and non-invasive treatment of enthesopathies and nonspecific lumbar pain [10, 11, 18]. The mechanism of action of shock waves on the musculoskeletal system has not been fully studied. It is believed that their mechanical force is converted into biochemical signals of cells; there is a transduction of exogenous stimuli through the extracellular matrix [3] with the modification and reorganization of biopolymer macromolecules with a direct effect on the potential of proteins and enzymes [11].

It has been proved that SWT has a resorbing effect and the possibility of separation of connective tissue and osteophytes [15]. SWT enhances microcirculation, neoangiogenesis, proliferation and tissue regeneration with immunomodulatory and immunostimulatory effect [3]. Due to this, the action of extracorporeal shock waves has a significantly more pronounced therapeutic effect compared to the effects of exercise therapy [10], they (waves) are able to significantly more (compared to control) reduce VAS, ODI and worry and anxiety level associated with waiting for pain [19], improving the dynamics of dynamic postural balance [18].

The relatively low relaxation effect of SWT and exercise therapy in priform muscle syndrome in our material may be related to this. At this time, the use of modern means of visualization of soft tissues [20] and surgical endoscopic techniques allowed to identify in the "comprehensive" [16] syndrome of piriform muscle a number of pathological conditions – internal sciatic muscle syndrome, upper twin muscle syndrome, variants of the anatomical structure of the piriform muscle (the presence of additional muscle) and/or sciatic nerve (branching of the sciatic nerve at the level of the piriform muscle) [16, 20]. In such cases, during the movements accompanied by stretching of the piriform muscle (flexion, abduction and internal rotation of the hip) there occurs entrapment of the sciatic nerve [16, 20] in the narrowed space between the lower border of the piriform muscle, the upper twin muscle and sacroiliac ligament [3, 16] with relevant clinical symptoms.

CONCLUSIONS

1. The use of the developed program of physical rehabilitation (combination of extracorporeal shock wave therapy with the program of relaxation exercises) by patients with lumbar osteochondrosis with myotonic reactions and disorder of motor stereotype is effective and after treatment is accompanied by a significant decrease in pain intensity by VAS ($p<0.001$), levels of disablity ODI ($p<0.001$) and SKT kinesiophobia ($p<0.01$), a significant increase in the mobility of the spine ($p <0.05$) and its lumbar area ($p<0.05$), as well as the amplitude of flexion in the hip joints ($p<0,05$). Normalization of the tone of the extensor muscles of the lumbar spine was observed in 87.5% of cases, gluteal muscle – in 30.0%, piriformis – in 27.5%. The reduction of erroneous movements in active combined movement of the lumbar segments and pelvis in general to 37.5% of cases was found.
2. The developed physical rehabilitation program proved its effectiveness by a significant improvement in VAS ($p<0.05$), ODI ($p<0.05$) and SKT ($p<0.05$); normalization of the tone of the lumbar extensor muscles and reduction of the reproduction of pathological motor patterns during movements in the lumbar-pelvic area in more than a third of patients, as compared with the results of isolated application of relaxation exercises.

Conflict of interest. The authors declare no conflict of interest.

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