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Dynamics of pain and disability under the influence of therapeutic exercises and ischemic compression among patients with adhesive capsulitis and myofascial pain syndrome

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Динаміка болю та інвалідності під впливом терапевтичних вправ та ішемічної компресії серед пацієнтів із адгезивним капсулітом та міофасціальним больовим синдромом

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Introduction

Adhesive capsulitis of the shoulder joint (ACSJ), also known as "frozen shoulder", is one of the most widespread causes of shoulder pain and stiffness [1; 2] caused by adhesion formation of the shoulder joint capsule [3]. Adhesive capsulitis occurs in 3–5% of the general population [4]. It is believed that ACSJ is often cured without therapeutic interventions within 1–3 years, while there is evidence of a longer presence of its symptoms [5]. According to the published studies, adhesive capsulitis is a diffuse inflammatory process that affects almost all periarticular soft tissues, including the joint capsule, subacromial bursae, coracohumeral ligament, and biceps tendon sheath [2; 6; 7]. The pathological process is associated with the formation of excessive scar tissue in the shoulder joint, which causes mobility decrease, pain, impaired function, worsening of patient's activity, participation and quality of life [8].

Myofascial pain syndrome (MPS) is a pain condition arising from localized stretched areas of skeletal muscles and fascia, called trigger points (TPs) [9] that can also affect quality of life [10]. An accurate physical examination is usually considered the cornerstone for diagnosing complex of TPs [11].

Physical therapy is one of the main methods of treating ACSJ [12–14] and MPS [11; 15; 16], as well as other pathologies of the musculoskeletal system of ACSJ [17–18]. However, there is currently a lack of studies on rehabilitation of patients with ACSJ and concomitant MPS. This can be caused by the fact that MPS is often not diagnosed, since its symptoms are hidden behind manifestations of other pathological conditions [15; 19].

Connection of the study with scientific programs, plans, topics. The work was carried out according to the plan of scientific research work of National University of Physical Education and Sports of Ukraine for 2021–2025 on the topic "Restoration of functional capabilities, activity and participation of people of different nosological, professional and age groups by means of physical therapy", state registration number 0121U107926.

The purpose of the research

To investigate the effect of therapeutic exercises and ischemic compression on pain and disability indicators among patients with ACSJ and thoracic MPS.

Materials and methods of the research

Participants. The study involved 26 patients, all being treated at GI "Institute of Traumatology and Orthopedics of the National Academy of Medical Sciences of Ukraine". Before undergoing physical therapy, the patients had diagnostic tests and consultations with an orthopedic traumatologist.

There were no patients who received an intra-articular injection of corticosteroids before doctor's consultation, while 9 patients (34.6%) received a steroid injection after doctor's consultation, i.e. before physical therapy. There were no patients who had received physical therapy before. One of the patients took nonsteroidal anti-inflammatory drugs during physical therapy.

Inclusion and exclusion criteria of the study corresponded to those presented in the previous studies [14].

The research was carried out in compliance with the main provisions of the "Ethical Principles for Medical Research Involving Human Subjects", approved by the Declaration of Helsinki (1964–2013), ICH GCP (1996), EU Directive No. 609 (of November 24, 1986), orders of the Ministry of Health of Ukraine No. 690 of September

23, 2009, No. 944 of December 14, 2009, No. 616 of August 03, 2012. The patients participated in the study completely of their own free will, which is confirmed by their personally signed informed consents. Each patient was personally informed of their responsibilities and rights as well as the possibility to end the study at any time without any consequences and explaining the reasons for their actions.

Methods. Medical histories of the patients were analyzed. Goniometry of the shoulder joint, assessment of pain at the endpoints of motion range and in TPs, as well as Shoulder Pain and Disability Index questionnaire were used before the intervention and three weeks after the physical therapy.

Passive and active amplitudes were measured in accordance with the guidelines [20]. Internal and external rotations were measured in the supine position of a patient with his/her shoulder retracted by 15° and a folded towel placed under the elbow. Assessment of pain at the endpoints of motion range and in TPs was carried out according to a numerical scale [21]. Assessment of pain in TPs was carried out when applying 2.5 kg×cm^2 pressure with the help of a digital force gauge VTSYIQI. The highest pain score among TPs was registered.

According to the scientific literature, the Shoulder Pain and Disability Index is a reliable questionnaire used by orthopedists and physical therapists to assess properly the level of shoulder-related pain and disability [22]. The study used the version of the questionnaire with a numerical rating scale (from 0 to 10) which included 13 questions referring to one of two subscales: pain (5 questions), disability (8 questions). The result of the subscale was calculated in the following way: the sum of all questions in each subscale was calculated and then converted to a score on a 100-point scale (as a percentage of the theoretical maximum). The total score, i.e. directly the Shoulder Pain and Disability Index, was calculated as the mean value of the two subscales. Higher scores indicate greater amount/level of pain or disability.

Intervention. Physical therapy started after the patients were examined and received consultation of an orthopedic traumatologist. Patients were also consulted by a physical therapist on the specifics of performing therapeutic exercises and ischemic compression of the TPs at home through instructions, demonstrations, and trial performances. The patients received information leaflets and performed further exercises and ischemic compression of TPs independently at home. Planned counseling of the patients by a physical therapist took place at the beginning of the 2nd and 3rd week of the therapy, and the final one at the end of the 3rd week. During all the consultations, the patients provided and clarified information about physical therapy as well as information about the presence of any questions, thoughts and feelings related to the physical therapy to prevent unanswered questions and unexpressed thoughts.

The complex of therapeutic exercises included pendulum and stretching exercises aimed at the shoulder joint and not aimed to move the scapulothoracic joint.

Patients performed pendulum exercises in standing position, leaning forward with a hand of the unaffected shoulder on the table, chair or other convenient support. The injured hand held a small weight (e.g. a 1 kg dumbbell). The patients were explained that such starting position allowed performing passive movements in the shoulder joint. For this, the patient performed several movements of the body so that the arm started to swing like a pendulum. Moving the trunk forward and backward caused movement of the shoulder in the sagittal plane, i.e. flexion and extension. When performing the exercises, it is essential to perform movements of the upper limb in several directions. The amplitude of such oscillations increases gradually.

The patients were also informed that active performance of exercises was also possible in this position, when the movement of the shoulder was initiated by the muscles of the upper limb and waist. For example, to increase the amplitude of flexion in the shoulder joint, one should first perform active extension and relax the arm, which will make a reverse movement to a position perpendicular to the floor and, by inertia, continue the movement to a greater amplitude of flexion. The amplitude of oscillations also increases gradually. At the same time, it is possible to provide additional acceleration to the limb by active contraction at the beginning of the reverse movement (in our case, due to the flexor muscles). However, such forcing was advised to be performed when mastering the basic technique and taking into account pain tolerance. Similar principles were used for movements in other planes.

In case of necessity and under appropriate conditions, patients could change their position to lying on a couch/table with the affected arm hanging down. Active exercise could also be performed in a supine position, which required 90° flexion at the shoulder joint. Approximate duration of performing pendulum exercises was 7–10 minutes.

Therapeutic stretching exercises were aimed at increasing mobility in the shoulder joint. Guidelines on the level of pain when performing stretching exercises took into account individual pain tolerance, but at the same time, attention was paid to the fact that the intensity of pain corresponds to the stretching of the structures that limit movement.

The following exercises were performed to improve the amplitude of bending. The patient sat down by the table facing it, bent his/her elbow and leaned it on the table. Then, by leaning forward and moving forward the elbow, the patient moved the shoulder into flexion position. The second version of performing the exercise to increase the amplitude of flexion involved similar starting position of the patient. However, the elbow was straightened, and only patient's palm was on the table, which was moved forward to increase flexion. The patient remained in the stretching position for 6–10 seconds, then returned to the starting position and tried to relax the muscles as much as possible. The number of repetitions was 10–12 times.

To improve the amplitude of abduction, the patient sat down at the table with his/her affected side facing it, placed the forearm on the table and performed abduction, moving

the forearm away from the body, with the elbow sliding on the surface of the table and the body leaning to the side. The second version of the exercise to improve abduction involved similar starting position. However, only patient's palm was on the table, sliding forward on its surface to increase abduction. When performing these exercises, body tilts were also performed. In particular, with the maximum normal abduction of the shoulder, the patient was lying or almost lying with his/her body on the table. The patient remained in the stretching position for 6–10 seconds, then returned to the starting position and tried to relax the muscles as much as possible. The number of repetitions was 10–12 times.

To improve external rotation, the patient faced the doorframe (post or another support), bent the elbow at 90°, with the elbow resting on the body and the palm resting on the support. Turning the trunk and the whole body in the opposite direction from the arm by stepping in place and gradually turning, the shoulder went into a greater angle of external rotation. The second version of this exercise involved using a high table to perform the exercise in a standing position or a regular table and chair to perform the exercise in a sitting position. First, the patient put the forearm on the table and leaned on it a little to fix the position of the forearm. Then, as in the previous exercise, the patient performed a gradual turn of the trunk in the opposite direction from the arm, walking or moving on a chair. In this way, the shoulder went into a greater angle of external rotation. The patient remained in the stretching position for 6–10 seconds, then returned to the starting position and relaxed. The number of repetitions comprised 10–12 times.

The therapeutic exercise for internal rotation was performed in the following way: the healthy hand threw a rope or a towel behind the back (the healthy hand was near the back of the head), with the affected hand grasping the other end of the rope/towel. Then, the healthy hand pulled the rope up, bringing the lower palm behind the back and forcing the affected shoulder to perform external rotation.

Having mastered the previous exercises and improved the amplitudes of movements in the shoulder joint, the patients performed additional stretching exercises. In particular, the following exercise improved internal rotation: the affected hand was placed behind the back (the back of the hand to the back); meanwhile the other hand was used to pull the affected hand up to the level of the waist. The patient remained in the stretching position for 4–8 seconds, then returned to the starting position and relaxed. The number of repetitions comprised 4–6 times.

The following exercise was performed to improve internal rotation: the affected hand was placed on the waist, with the elbow directed laterally; the other hand grabbed the elbow and gradually pulled it forward. The patient remained in the stretching position for 4–8 seconds, and then returned to the initial position. The number of repetitions comprised 4–6 times. To increase the amplitude of rotation in this exercise, the hand could be placed on the waist with its backside, or the area of pressure could be shifted to the forearm.

The following exercise was used to improve external rotation: the affected hand was placed on the table, with the shoulder slightly retracted and the elbow directed backwards; the other hand grasped the elbow and gradually pulled it downwards. The patient remained in the stretching position for 4–8 seconds, and then returned to the initial position. The number of repetitions comprised 4–6 times.

The following exercise was performed to improve abduction and flexion: the patient stood next to the wall facing it, with the palm placed on the wall as high as possible, and tried to walk the fingertips calmly up the wall. The patient remained in the stretching position for 4–8 seconds, then returned to the starting position and relaxed. A healthy hand could support an affected one. The number of repetitions comprised 4–6 times.

The approximate duration of stretching exercises was 15–20 minutes. In case a long rest between the exercises was necessary, the duration could be increased. The exercises were performed twice a day.

Besides, MPS therapy involved ischemic compression, which was performed by the patient independently once a day according to the guidelines presented in the previous studies [14]. The duration of ischemic compression was 15–20 minutes.

The patients were recommended to perform all their activities, including household ones, with maximum range of motion in the shoulder joint.

Statistical analysis. The obtained results were processed by the methods of mathematical statistics. The IBM SPSS Statistics 21 program was used. Since the results of the vast majority of indicators did not correspond to the law of normal distribution, the median (Me) and the upper and lower quartiles (25%; 75%) were calculated for all the indicators. In case the results of indicators corresponded to the law of normal distribution, $\overline{X}\pm S$ was additionally calculated. To compare the results, Student's t-test was used for dependent samples with a normal distribution, with the Wilcoxon test being used in other cases (the criterium was converted by the program to Z value).

Research results and discussion

The studied group of patients included 65.4% of females. $\overline{X}\pm S$ values for age in the group of patients were 51.15±9.19 years. Me (25%; 75%) indicators of symptoms duration comprised 4.75 (3; 7.13) months. Half of the patients had the right shoulder joint affected by ACSJ and affected dominant upper extremity. It should be noted that the pain index in TPs before participation in physical therapy was assessed by patients at the level of 9 (9; 9) points.

Statistical analysis revealed significant differences between the results of the first and second assessment of the amplitude of movements in the shoulder joint and the level of pain when reaching the maximum amplitude (table 1), which indicates the positive dynamics of these indicators and the effectiveness of the physical therapy

Table 1

Me (25%;75%) indicators of the amplitude of movements in shoulder joint and pain when reaching the maximum amplitude

Movement		Amplitude,°		p	Pain, points		p#
		before PT	after PT		before PT	after PT	
Abduction	passive	55.5 (50.8; 60.3)	88 (84.8; 96.3)	<0.001*	9 (9; 9)	6 (6; 6)	<0.001
	active	52 (46.8; 57.5)	84.5 (81.8; 94.3)	<0.001#	9 (8; 9)	5 (5; 5)	<0.001
Flexion	passive	68.5 (64; 72)	98.5 (96; 135)	<0.001#	9 (9; 10)	6 (6; 6)	<0.001
	active	64.5 (62; 70.3)	96.5 (93.8; 130.3)	<0.001#	9 (8; 9)	5 (5; 5)	<0.001
Internal rotation	passive	15 (13.8; 17.3)	48 (45.8; 50)	<0.001#	9 (9; 9)	6 (6; 6)	<0.001
	active	12 (11; 14.3)	44 (41.8; 46)	<0.001#	9 (8; 9)	5 (5; 5)	<0.001
External rotation	passive	18 (15.8; 19.3)	48 (45.8; 50)	<0.001#	9 (9; 9)	6 (6; 6)	<0.001
	active	14 (12.8; 17)	45 (43; 47.3)	<0.001#	9 (8; 9)	5 (5; 5)	<0.001

Notes:
1. * – according to the Student's t-test;
2. # – according to the Wilcoxon test;
3. PT – physical therapy.

Table 2

Me (25%;75%) indicators of the Shoulder pain and Disability subscale questions, points

Questions		Period		Criterium*	p
		Before PT	After PT		
1	Pain at its worst	10 (8; 10)	6 (6; 7)	-4.514	<0.001
2	Pain when lying on the involved side	9.5 (6; 10)	4 (4; 5)	-4.132	<0.001
3	Pain when reaching for something on a high shelf	10 (7.75; 10)	5 (4; 6.25)	-4.477	<0.001
4	Pain when touching the back of your neck	9 (7; 10)	5 (4; 5)	-4.306	<0.001
5	Pain when pushing with the involved arm	9.5 (8; 10)	5 (4; 6)	-4.393	<0.001
6	Difficulty when washing your hair	10 (7; 10)	7 (4; 7)	-4.439	<0.001
7	Difficulty when washing your back	9.5 (8; 10)	7 (6; 8)	-4.425	<0.001
8	Difficulty when putting on an undershirt or jumper	10 (8; 10)	7 (5; 8)	-4.502	<0.001
9	Difficulty when putting on a shirt that buttons down the front	8 (6; 9)	5 (5; 7)	-4.441	<0.001
10	Difficulty when putting on your pants	7 (5; 9)	6 (3.75; 7)	-3.606	<0.001
11	Difficulty when placing an object on a high shelf	10 (8.75; 10)	7 (5; 8)	-4.491	<0.001
12	Difficulty when carrying a heavy object of 10 pounds (4.5 kilograms)	8.5 (5; 9)	5 (3; 7)	-4.050	<0.001
13	Difficulty when removing something from your back pocket	9 (8; 10)	7 (6; 7)	-4,434	<0,001

Note: * – the Wilcoxson test.

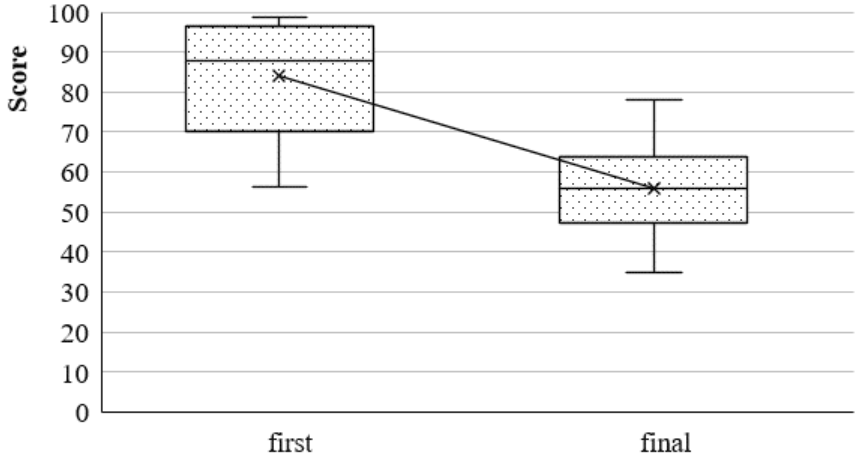

Fig. 1. Specifics of the distribution of shoulder pain and disability index at the first and final assessments

used. It should be noted that $\overline{X}$±S indicators for passive abduction comprised 54.77±6.98° at the first assessment and 89.35±6.75° at the final assessment.

The obtained results of the Wilcoxon test confirmed positive dynamics in the results of Shoulder pain and Disability subscales of the questionnaire (table 2) which proves the effectivenessof the used PT. It should be noted that 0 points indicate the absence of pain in the questions of the Pain subscale and the absence of difficulties in the questions of the Disability subscale. At the same time, 10 points indicate the worst imaginable pain in the Pain subscale questions and great difficulties requiring assistance in the Disability subscale questions.

The dynamics of the Pain subscale was characterized by the fact that Me indicators (25%; 75%) decreased from 90 (69.5; 100) points to 50 (46; 52) points (Z = –4.461; p<0.001). Statistical indicators of the Disability subscale decreased from 85 (74.06; 95) points to 61.88 (51.25; 74.06) points (Z = –4.462; p<0.001).

The presented changes in the results in the questionnaire questions and subscales influenced the fact that the results of shoulder pain and disability index were statistically different, namely improved, according to the Wilcoxon test (Z = –4.458; p<0.001) (fig. 1). It should be noted that the index decreased from 87.94 (70.34; 96.38) points to 55.75 (47.31; 63.84) points.

It should be noted that the final assessment of the pain index in TPs improved statistically and comprised 4 (4; 4.25) points (Z = -4.680; p<0.001).

The obtained results confirmed the effectiveness of the used physical therapy among patients with ACSJ and MPS, namely, therapeutic exercises for ACSJ therapy and ischemic compression for MPS therapy. Me indicator of active abduction increased by 32.5°, and of active flexion – by 32°. Amplitude of active internal rotation increased by 32°, and of external rotation – by 31°. Besides, the study revealed positive dynamics and statistically significant changes in pain when reaching the maximum amplitude and pain in TPs during their compression. All the studied questions of the Shoulder Pain and Disability Index questionnaire improved significantly. Accordingly, this resulted in the improvement of the results of Pain and Disability subscales, as well as of the total score of the index. In particular, Me value of the Pain subscale decreased by 40 points, and of the Disability subscale – by 23.12 points.

Currently, there are no scientific studies on the impact of therapeutic exercises and ischemic compression on pain and disability indicators in people with ACSJ combined with thoracic MPS. At the same time, the effectiveness of therapeutic exercises in reducing pain, improving motion range in the shoulder joint, reducing disability indicators was studied in patients with ACSJ, and the effectiveness of ischemic compression and a number of manual interventions – in patients with MPS.

In the study of S.A. Ali and M. Khan, a group of patients with ACSJ who performed therapeutic exercises 3 times a week for 5 consecutive weeks improved their indicators of pain, motion range, shoulder pain and disability index. In particular, the average dynamics of pain according to the visual-analog scale comprised 2.33 points, with shoulder pain and disability index being 23 points [23].

The assessment of counseling and therapeutic exercises for patients with shoulder pain and stiffness presented in the study of J.F. Chen [24] also confirmed their effectiveness, namely in improving pain and disability indicators according to a similar index, as well as active motion range a month after the therapy. In particular, the dynamics of the index showed that the average value decreased from 60% to 47%. At the same time, the amplitude of flexion increased from 101° to 114°, and of abduction – from 75° to 97°.

The study of F.J. Montañez-Aguilera et al. [25] indicated immediate effects after using ischemic compression of myofascial TPs. These effects were manifested in the dynamics of the active range of motion of the cervical spine, basal electrical activity of the left trapezius, tolerance to pressure on myofascial TP, local pain assessment (caused by applying pressure of 2.5 kg×cm^2 using an analog algometer).

Thus, the obtained results confirm and complement conclusions of previous studies on the effectiveness of therapeutic exercises and ischemic compression.

Prospects for further research

Prospects for further research are to study the influence of therapeutic exercises and ischemic compression on indicators of quality of life among patients with ACSJ and MPS.

Conclusions

Physical therapy, which included counseling patients with ACSJ and concomitant thorasic MPS and subsequent independent performance of therapeutic exercises and ischemic compression, improved the indicators in all the questions of the Shoulder Pain and Disability Index questionnaire, its subscales and the total score.

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Мета: дослідити вплив терапевтичних вправ та ішемічної компресії на показники болю та інвалідності серед пацієнтів із адгезивним капсулітом плечового суглоба та міофасціальним больовим синдромом у грудному відділі.

Матеріали та методи. 26 пацієнтів взяли участь у дослідженні. Гоніометрія плечового суглоба, оцінка болю у кінцевих точках амплітуди руху та у тригерних точках, а також опитувальник «Індекс болю та інвалідності у плечі» використовувалися до втручання та після закінчення тритижневої фізичної терапії. Пацієнти отримували консультацію фізичного терапевта, на якій їм надавалася інформація щодо особливостей виконання терапевтичних вправ та ішемічної компресії тригерних точок вдома за допомогою інструктажу, демонстрації та пробного виконання. Пацієнт отримував також інформаційний буклет. Надалі вправи та ішемічна компресія виконувалися вдома самостійно. Комплекс терапевтичних вправ включав маятникові вправи та вправи на розтягування. Планове консультування пацієнтів фізичним терапевтом відбувалося також на початку 2 і 3 тижня терапії, а заключне – наприкінці 3 тижня.

Результати. Заключні показники амплітуди руху та болю були статистично ліпшими, порівняно з початковими результатами. Динаміка домену біль характеризувалася тим, що показники Me (25%; 75%) зменшилися з 90 (69,5; 100) балів

до 50 (46; 52) балів (Z = -4,461; p<0,001). Оцінка домену інвалідність зменшилася з 85 (74,06; 95) балів до 61,88 (51,25; 74,06) балів (Z = -4,462; p<0,001). Представлені зміни результатів у доменах вплинули на те, що й результати індексу болю та інвалідності у плечі статистично відрізнялися, а саме поліпшилися з 87,94 (70,34; 96,38) балів до 55,75 (47,31; 63,84) балів.

Висновки. Застосування фізичної терапії, котра включала консультування пацієнтів і подальше самостійне виконання ними терапевтичних вправ та ішемічної компресії, призвело до поліпшення результатів у доменах і загального бала індексу болю та інвалідності в плечі.

Ключові слова: фізична терапія, реабілітація, мануальна терапія, опорно-руховий апарат, плечовий суглоб, активність.

Purpose: to investigate the effect of therapeutic exercise and ischemic compression on pain and disability scores among patients with adhesive capsulitis of the shoulder joint and myofascial pain syndrome in the thoracic region.

Materials and methods. 26 patients participated in the study. Goniometry of the shoulder joint, assessment of pain at range of motion endpoints and at trigger points, and the Shoulder Pain and Disability Index questionnaire were used before the intervention and after three weeks of physical therapy. Patients received a physical therapist's consultation, during which they were given information about the specifics of performing therapeutic exercises and ischemic compression of trigger points at home through instruction, demonstration, and trial performance. The patient also received an information booklet. Later, exercises and ischemic compression were performed at home independently. The complex of therapeutic exercises included pendulum exercises and stretching exercises. Planned counseling of patients by a physical therapist also took place at the beginning of the 2nd and 3rd week of therapy, and the final one at the end of the 3rd week.

Results. Final range of motion and pain scores were statistically better compared to baseline. The dynamics of the pain domain was characterized by the fact that the indicators Me (25%; 75%) decreased from 90 (69.5; 100) points to 50 (46; 52) points (Z = -4.461; p<0.001). The disability domain score decreased from 85 (74.06; 95) points to 61.88 (51.25; 74.06) points (Z = -4.462; p<0.001). The presented changes in the results in the domains affected the fact that the results of the Shoulder Pain and Disability Index were also statistically different, namely, they improved from 87.94 (70.34; 96.38) points to 55.75 (47.31; 63.84) point.

Conclusions. The use of physical therapy, which included patient counseling and subsequent independent performance of therapeutic exercises and ischemic compression, led to improved outcomes in the domains and total score of the Shoulder Pain and Disability Index.

Key words: physical therapy, rehabilitation, manual therapy, musculoskeletal system, shoulder joint, activity.

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