

The effectiveness of aquatherapy in osteochondrosis of the cervical spine

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Abstract

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The aim of this study was to find the most effective aquatherapy for physical rehabilitation of patients suffering from neurological pain in the cervical spine.

Material & Methods: the study involved 86 patients (59 women, 27 men aged 38 to 55 years). Of these, 43 patients (50%) were in the main group and 43 patients (50%) were in the comparison group. The following were used: observation, aquatherapy, special physical exercises, cervical spine traction, electromyotometry, pain study (VAS), adaptive potential indices and Ruffier-Dixon index, methods of mathematical statistics.

Results: the effect of aquatherapy on pain was the most effective: in the main group there was a significant reduction in pain (disappearance by 83.7%, improvement by 9.3%, minor improvement by 7%). In the control group, significant pain reduction was obtained only in 60.4% of patients (23.3% – improvement, 7% – insignificant improvement, 9.3% – no improvement).

Conclusions: the study showed that the addition of aqua therapy to the main rehabilitation improves the results of treatment of patients with neuralgic manifestations of osteochondrosis of the cervical spine. In the main group there was a significant ($p < 0.05$) decrease in the indices of adaptive potential, Ruffier-Dixon index and diastolic pressure under the influence of aqua therapy, which indicates a decrease in the tension of the cardiovascular system and an increase in the power of the body's adaptive reserves. Mobility indices of the cervical spine improved, blocks of spasmed muscles were relieved, their tone normalized, and pain decreased.

Key words: cervical osteochondrosis, neurological pain in the cervical spine, aquatherapy, physical therapy, rehabilitation, electromyotometry.

Анотація

Едуард Фероян, Георгій Парулава. Ефективність акватерапії при остеохондрозі шийного відділу хребта. Метою даного дослідження було знайти найбільш ефективну акватерапію для фізичної реабілітації пацієнтів, які страждають від неврологічного болю в шийному відділі хребта. **Матеріали і методи:** обстежено 86 пацієнтів (59 жінок, 27 чоловіків віком від 38 до 55 років). З них 43 пацієнти (50%) були в основній групі і 43 пацієнти (50%) в групі порівняння. Використовували: спостереження, акватерапію, спеціальні фізичні вправи, тракцію шийного відділу хребта, електроміотометрію, дослідження болю (VAS), індекси адаптаційного потенціалу та індекс Руф'є-Діксона, методи математичної статистики. **Результати:** дія акватерапії на больовий синдром виявилася найбільш ефективною в основній групі: спостерігалася достовірне зменшення болю (зникнення на 83,7%, покращення на 9,3%, незначне покращення на 7%). У контрольній



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групі достовірно зменшення болю було отримано лише у 60,4 % пацієнтів (23,3% – покращення, 7% – незначне покращення, 9,3% – відсутність покращення). **Висновки:** дослідження показало, що додавання акватерапії до основної реабілітації покращує результати лікування хворих з невралгічними проявами остеохондрозу шийного відділу хребта. В основній групі під впливом акватерапії спостерігалось достовірно ($p < 0,05$) зниження показників адаптаційного потенціалу, індексу Руф'є-Діксона та діастолічного тиску, що свідчить про зниження напруги серцево-судинної системи та підвищення потужності адаптаційних резервів організму. Поліпшилися показники рухливості шийного відділу хребта, знялися блоки спазмованих м'язів, нормалізувався їх тонус, зменшилася біль.

Ключові слова: шийний остеохондроз, неврологічний біль в шийному відділі хребта, акватерапія, фізична терапія, реабілітація, електроміотонометрія.

Introduction

One of the important problems of modern society is human health. Recently the situation in this area is becoming critical – according to some data, 90% of the population have various health ailments (Avdeeva et al., 2019; Vasileva et al., 2019; Vieira et al., 2018). Modern conditions take a toll on the physical and psychological health. Therefore, rehabilitation and rejuvenation are very important.

Modern man has a sedentary lifestyle. As a result, thoracic and cervical muscle groups hold the most load of physical stress keeping everyday poses. Those muscles get fatigued and unable to provide reliable cushioning, resulting in increased stress on the spine, resulting in dystrophic changes primarily in the intervertebral discs (Moore et al., 2019; Malik et al., 2018).

Osteochondrosis of the spine is one of the most common diseases of the century (Hurwitz et al., 2018; Kruzhihin, 2021; Mukina et al., 2021; Primakova et al., 2018; Seliverstov et al., 2022). In cervical osteochondrosis muscles are in protective muscle tone, aimed to reduce irritation of the spinal nerve roots (Castien et al., 2019; Koury, 1996; Miyagi et al., 2022; Sklyarenko et al., 2018; Scheer et al., 2013). In this case, a prolonged tension (spasm) of the trapezius muscle and cervical muscles is accompanied by increased compression on spinal arteries, which ultimately leads to decreased cerebral blood circulation, which will manifest in such symptoms as visual impairment, weakness, sleep disorders, memory, heavy-headedness (Daminov et al., 2019).

It is well known that swimming is the most effective tool for the treatment of ailments of spine (Amurskaya et al., 2018; Bulgakova 2008). Orthopedists include swimming and hydro kinesiotherapy in

treatment complex for scoliosis, considering them to be as effective as physical therapy (Bulgakova, 2008).

Aquatherapy is the training and body development using water. The goal of aquatherapy is to form a qualitatively new, higher level of body's physical abilities for patients with various ailments (Churyukanov et al., 2018; Koury, 1996).

The corrective effect of aquatherapy is based on the absence of gravitational forces and, as a result, reflex relaxation of the muscular-ligamentous apparatus (Wilk et al., 2013). The general strengthening effect achieved through exercises using resistance of water, while maintaining strength of the back muscles, abdomen muscles, shoulder girdle (Villalta et al., 2013).

Aquatherapy also strengthens cardio-vascular and breathing system therefore raising immunity.

Despite the healing effect of aquatherapy (Gholami-Borujeni et al., 2017; Wilk et al., 2013), this method, in our opinion, draws minimal attention for rehabilitation of cervical osteochondrosis.

The purpose of this study was to find the most effective uses of aquatherapy for the physical rehabilitation for patients suffering from neurological pain in the cervical spine.

Techniques, developed by us, includes not only therapeutic exercises in the water, but also therapeutic workout in the gym for better effect.

Material and methods of research

Participants

The study was conducted in September through December of 2018 with 86 patients (59 women, 27 men 38-55 years old (average age 46,5 years old), with light neurological disorders during acute cervical osteochondrosis. The study was done in the specialized Department of Tbilisi Balneological Resort (Georgia) with prescribed medical and physio-balneological treatment. Patients mainly complained of pain in the cervical spine (76,7%) and shoulder (57%), headaches (69,8%), numbness and pain in the arms (84,9%), poor sleep (38,4%), irritability (30,2%). During examination attention was drawn to the severe tension of the muscles of cervical and upper thoracic spine (100%). The most common were trapezius (91,9%), rhomboids major and minor (84,9%), levator scapulae (100%), pectoralis minor (30,2%), oblique capitis inferior (38,4%) and sternocleidomastoid (96,6%). Those muscles had painful knots and functional limitations. Blood pressure was usually normal (50%) or high (41,9%), less often – low (8,1%). Clinically, more often had place cervicocranial syndrome (91,9%), cervicobrachial syndrome (11,6%), vertebrogenic cervico-thoracalgia (8,1%), vestibul-

opathy (23,3%).

Special attention was paid to patients with complaints of headaches, dizziness, ringing in the head and ears – symptoms indicating the presence of vestibular dysfunction. In younger patients it often occurs in the subclinical course of cervical osteochondrosis, which is detected by x-ray.

Methods

Radiography revealed signs of cervical osteochondrosis of varying severity in all (100%) patients, especially C₄₋₆ arthrosis uncovertebralis, lordosis straightening, sometimes kyphosis, disc protrusion C₅₋₆ (2-3 mm) was detected in 39 patients with magnetic resonance imaging. Ultrasound dopplerography of extracranial vessels showed a tendency to angiospasm (34 patients), venous discirculation and obstruction of venous outflow in vertebro-basilar insufficiency (42 patients), deficits of blood circulation in the vertebral artery (19 patients), rarely in the internal carotid artery, asymmetry of the linear velocity of blood flow through the main arteries, poorly developed collateral circulation, signs of stenosis of the vertebral artery (23 patients).

The study did not include patients with severe neck pain, who had signs of disc prolapse, as well as disc protrusion 4 mm and higher, and those who as a result of a single course of conservative therapy, conducted on an outpatient basis in municipal medical institutions, achieved a stable clinical effect without relapses in the course of observation.

It should be noted that all study groups of patients are comparable in age-sex composition, clinical course, prescription of the disease, etiological factor, were homogeneous and comparable, and all participants signed agreement form for participation in the study.

Procedure

The control group was formed of 43 people who are independently engaged in swimming. On average, they took a class three times a week of the pool swam 500 m. As the main method of swimming Breaststroke with raised head was recommended (Amurskaya, 2018; Bulgakova, 2008). In the final part of the lesson, we use special symmetrical stretching exercises, breathing and relaxation exercises, hanging on a high bar, lying on the water (with support and breathing exercises). We also used massage (classical and segmental) for the muscles of the collar zone, back, upper and lower extremities (to improve microcirculation, relieve neuromuscular tension), performed 1-2 times per week with a duration of 30-40 min. In the gym we used standard physical exercises similar to physical therapy (Pyastolova, 2018). All patients of the control group underwent "dry" vertical traction mechano-therapeutic system Eltrac 471 (Enraf-

Nonius, Nederland) with help of Glisson loop in the pool with a head holder and the use of cargo 2-4 kg on the lumbar region for 15 minutes every other day for a course of 8 to 12 procedures.

For the main group (43 patients) we used: aquatherapy (Koury, 1996; Wilk et al., 2013) and physical exercises by Katsuzō Nishi (2009). Classes was taken 3 times a week. All patients of main group underwent vertical stretching (automatic intelligent traction system "Aist", Russia) in the pool with head holder use of cargo 2-4 kg on the lumbar region for 15 minutes every other day for a course of 8 to 12 procedures. After stretching was recommended wearing Shantz collar, especially with prolonged stress like driving the car. We used massage (classical and segmental) for the muscles of the collar zone, back, upper and lower extremities (to improve microcirculation, relieve neuromuscular tension), performed 1-2 times per week with a duration of 30-40 min.

The following research methods were used:

- Measurement of pulse and blood pressure. The Ruffier-Dickson index (Bacquaert, 2014) and adaptation potential (Baevskiy et al., 1997);
- Assessment of mobility (flexibility) of the spine by anthropometric determination of linear characteristics;
- Electromyotometry (Uflyand, 1971);
- Pain studies by Visual Scale Pain Intensity Assessment (VAS) mm (Damdinov et al., 2019);
- Observation.

The study of blood pressure and pulse was done using the compact semi-automatic electronic device-UA-702 (Japan) with a measurement range from 20 to 300 mm Hg. The cuff was placed on the bare shoulder at a distance of 2-3 cm above the elbow joint. Studies were performed traditionally in the initial position of the patient lying on his back. These parameters were recorded before and after classes at the beginning and end of the study.

The adaptive capacity (AC) formula was made as a result of correlation and regression analysis of data, includes: age (Y/O), height (H) and body weight (BW), systolic blood pressure (sBP) and diastolic blood pressure (dBP), heart rate (HR). Each indicator got a coefficient assigned:

$$AC = (0.011 \times HR + 0.014 \times sBP + 0.008 \times dBP + 0.014 \times \frac{Y}{O} + 0.009 \times H) - 0.27$$

Individual values of AC were distributed according to four qualitative gradations established and recommended by physiologists: satisfactory adaptation – no more than 2,10 points; tension of adaptation mechanisms – from 2,11 to 3,20 points; unsatisfactory adaptation-from 3,21 to 4,30 points; failure of adaptation – from 4,30 and more points (Baevskiy et al., 1997).

In addition to the calculation of AC were also determined the values of the Ruffier-Dickson index – the criterion of the reserve of the functional state of the cardiovascular system, according to the formula:

$$\text{Ruffier-Dickson index} = \text{HR} \times \frac{\text{sBP}}{100}$$

Individual values of the Ruffier-Dickson index were distributed according to three established qualitative gradations: high reserves of the functional state of the cardiovascular system – 80,0 and more conventional units; average reserves – from 81,0 to 90,0 conventional units and low reserves – from 91,0 and more units (Bacquaert, 2014).

Electromyotometry was performed with help of Uflyand (1971) myotonometer (the device, designed to precisely calculate the tone of striated human muscles according to the density (elasticity) measurement of various muscles in conventional units). The tone of the neck muscles and trapezius was determined at rest, also at the beginning and end of the pedagogical study (September-December).

Statistical analysis

Statistical data analysis was performed using SPSS 22.0 for Windows (32 BIT). The obtained data were processed by the method of variational statistics, the reliability of the obtained results (p) was calculated by the Student's t -criterion.

Results of the study

The results of the study confirmed the effectiveness of the chosen technique, which was expressed in:

- improvement of correction of tone imbalance of vertebral muscles of the neck;

- maintaining a high level of dynamic and static endurance of the neck muscles;
- improving the functional state of the cardiovascular and respiratory system;
- achievement of the hardening effect expressed by increased level of body resistance to respiratory diseases.

The class load in the main group was assigned according to functional state of patients, the assessment of which was based on indicators of the cardiovascular system: pulse, blood pressure, Ruffier-Dickson index and adaptive potential. Results of the first survey (September) did not reveal significant differences ($p > 0,05$) in the state of the cardiovascular system in the patients of the main and control groups (Table 1).

It should be noted, that in both groups patients were characterized by numbers of adaptive potential and the Ruffier-Dickson index, indicating the stress of cardiovascular system and an unsatisfactory level of adaptation. Remember, that a satisfactory level of adaptive potential is not more than 2,10 points, and the Ruffier-Dickson index is not more than 81-90 relative units.

After four months of classes, the change in this numbers was observed in both groups, but in the main group they were more noticeable. Thus, in the main group after aquatherapy there was a significant ($p < 0,05$) decrease in indicators of Adaptive Capacity, Ruffier-Dickson index and vascular (Table 2).

Indicators of mobility of the cervical spine after the completion of the course of classes definitely ($p < 0,05$) improved (Figure 1).

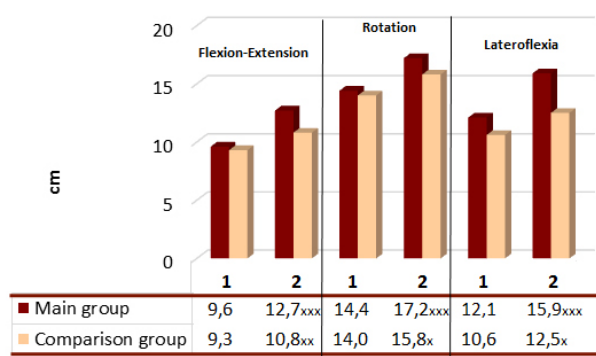
Table 1. The functional state of the cardiovascular system at the beginning of the study

Groups	HR before exercise (bpm)	HR after exercise (bpm)	BP before exercise (mm Hg)		BP after exercise (mm Hg)		AC (in points)	Ruffier-Dickson index (relative units)
			sBP	dBP	sBP	dBP		
Main group, $\bar{X} \pm \sigma$	79,5 \pm 8,2	89,9 \pm 9,5	129,2 \pm 17,8	85,3 \pm 9,8	135,4 \pm 17,7	89,1 \pm 10,1	2,30 \pm 2,2	94,3 \pm 13,5
Comparison group, $\bar{X} \pm \sigma$	77,5 \pm 7,0	87,9 \pm 7,5	127,4 \pm 16,4	84,8 \pm 8,3	136,1 \pm 19,4	86,7 \pm 10,8	2,28 \pm 2,2	94,1 \pm 14,0
p	>0,05	>0,05	>0,05		>0,05		>0,05	>0,05

Table 2. Functional state of the cardiovascular system at the end of the study

Groups	HR before exercise (bpm)	HR after exercise (bpm)	BP before exercise (mm Hg)		BP after exercise (mm Hg)		AC (in points)	Ruffier-Dickson index (relative units)
			sBP	dBP	sBP	dBP		
Main group, $\bar{X} \pm \sigma$	73,3 \pm 6,9	85,6 \pm 8,3	121,8 \pm 14,73	75,2 \pm 9,8*	133,6 \pm 17,7	87,3 \pm 10,1	1,09 \pm 2,0*	88,2 \pm 10,8*
Comparison group, $\bar{X} \pm \sigma$	74,6 \pm 7,2	86,3 \pm 8,2	125,7 \pm 16,76	83,8 \pm 8,2	136,1 \pm 17,2	85,7 \pm 11,1	2,15 \pm 2,4	92,2 \pm 13,4*
p	>0,05	>0,05	>0,05	<0,001	>0,05		<0,05	<0,01

Note: * – significance of differences between survey indicators September – December.



Note: 1 – Before the study; 2 – After research;
x – $p < 0,05$; xx – $p < 0,01$ xxx – $p < 0,001$.

Fig. 1. Cervical spine mobility level indicators

Analysis of electromyotometry data showed that at the beginning of the study, the control and main groups had no significant differences ($p > 0,05$) in terms of tone of the back muscles and trapezius. Under the influence of the training course (aqua therapy) positive changes (decrease in tone) are observed in both groups, but in the main group difference in muscle tone value of the symmetrical muscles is less noticeable, which is very important for the formation of correct posture (Table 3).

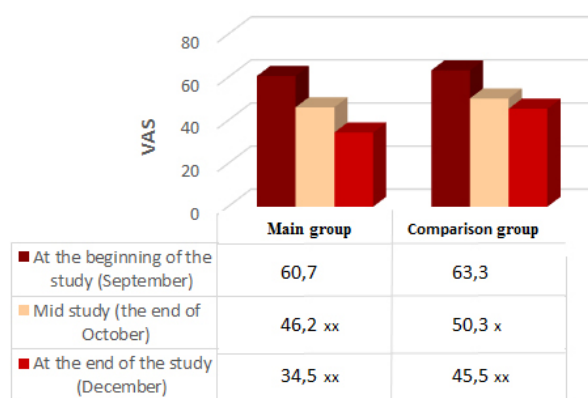
A slight decrease in the tone of the neck muscles and trapezius in control group members, apparently, indicates that swimming with the head raised above the water surface does not make it possible to relax the muscles of the neck and upper shoulder girdle.

The positive dynamics of pain syndrome was more pronounced in main group patients (Figure 2).

At the beginning of the study the patient groups did not differ in pain parameter. The procedures, developed by us, resulted in a 53.8% decrease in the intensity of pain syndrome in patients of the Main group, compare to 30,8% decrease observed in patients of the Control group. The decrease in pain intensity occurred throughout the study. Difference between end of the first month and at the end of the study were significant ($p < 0,01-0,001$). Such persistent reduction of pain syndrome in pa-

tients of the Main group proves the therapeutic effectiveness of our treatment.

There were 36 (83,7%) patients in the main group with significant improvement at the end of the study, and 26 (60,4%) patients in the control group. Medium improvement was observed in 4 (9,3%) patient of the main group and in 10 (23,3%) patients of the comparison group. There was a slight improvement, respectively, in both groups 3 (7%) of the patient. In the Main group there were no patients without improvement, while in the Comparison group no improvement was noted in 4 (9,3%) patients.



Note: x – $p < 0,01$ for indicators in the middle of the study, xx – $p < 0,001$ for indicators at the end of the study.

Fig. 2. Pain severity dynamics (according to VAS) during therapy in patients of the main and control groups (relative units)

Also, classes of aquatherapy and swimming had a positive effect to the functional state of the cardiovascular system, expressed in the reduction of heart rate at rest, respectively, 75,5 to 74,2 beats. min^{-1} ($p > 0,05$). In patients with vertigo and other manifestations of vertebrobasilar insufficiency in the main group there was a disappearance of vertigo in 29 of 43 (67.4%) and a decrease in its manifestation in 14 patients (32.6%). In the control group, dizziness disappeared in 19 patients (44.2%) and decreased in 24 (55.8%).

Table 3. Muscle tone at rest (relative units)

Groups	Neck muscle tone				Trapezius muscle tone			
	At the beginning of the study (September)		At the end of the study (December)		At the beginning of the study (September)		At the end of the study (December)	
	Left	Right	Left	Right	Left	Right	Left	Right
Main group, $\bar{X} \pm \sigma$	74,1 \pm 6,98	77,0 \pm 10,14	60,2 \pm 3,59	58,2 \pm 5,11	74,2 \pm 4,99	73,5 \pm 4,98	64,2 \pm 3,44	65,5 \pm 4,77
	$p < 0,001$				$p < 0,001$			
Comparison group, $\bar{X} \pm \sigma$	73,9 \pm 5,97	71,5 \pm 5,47	69,8 \pm 6,25	68,5 \pm 7,37	69,6 \pm 4,52	68,2 \pm 5,85	66,9 \pm 7,68	65,8 \pm 7,50
	$p < 0,01$				$p < 0,01$			

Discussion

Thus, studies have shown that adding aqua therapy to basic rehabilitation can improve the results of treatment in patients with neuralgic manifestations of cervical osteochondrosis of the spine.

Condition of patients within physical rehabilitation procedures is an urgent task during the development of various rehabilitation programs, and we support those professionals who are largely focused on non-traditional means, the main role among which is occupied by therapeutic forms of motor activity (Epifanov et al. 2015; Deryabina et al. 2017; Primakova et al. 2018).

In general, characterizing the results obtained, it should be noted that swimming is the most effective remedy for treating spinal ailments (Amurskaya et al., 2018; Bulgakova, 2008), and doctors increasingly include swimming in the treatment complex for spinal problems, considering them as effective as physiotherapy exercises (Bulgakova, 2008). Our studies have shown that, unlike swimming, aquatherapy forms a qualitatively new, higher level of physical capabilities of the body in patients with various problems of the cervical spine. The corrective effect of aquatherapy is based on the absence of gravitational forces and, as a result, reflex relaxation of the musculoskeletal system (Wilk et al., 2013). In the study, the general strengthening effect was achieved through exercises using water resistance, while maintaining the strength and tone of the muscles of the neck, shoulder girdle, back, and abdominal muscles. Also, clinical evidence suggests that aquatherapy strengthens the cardiovascular and respiratory systems as well, thereby boosting immunity. In general, characterizing the results obtained, it should be noted that despite the healing effect of aquatherapy (Gholami-Borujeni et al., 2017; Wilk et al., 2013), this method, in our opinion, should be introduced into the process of patient rehabilitation with various pathologies of the cervical spine.

Conclusion

Especially significant effect of aquatherapy were on

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pain: there was a significant decrease in pain in the main group (83.7% – disappearance, 9.3% – medium improvement, 7% – slight improvement). In the control group, a significant reduction in pain was obtained by only 60.4% of patients (23.3% – improvement, 7% – slight improvement, 9.3% did not show improvement). Also, in the main group, under the influence of aqua therapy, there was a significant ($p < 0.05$) decrease in indicators of adaptive potential (AC), Ruffier-Dickson index and diastolic pressure, which indicates a decrease in the stress on the cardiovascular system and an increase in the power of adaptive reserves of the body. Improved indicators of mobility of the cervical spine, removed blocks of spasmodic muscles, normalization of muscle tone.

Thus, the results of a comparative analysis prove the effectiveness of aquatherapy in the complex of physical rehabilitation of osteochondrosis of the cervical spine.

Author's contribution

Conceptualization, G.P.; methodology, G.P.; check, G.P.; formal analysis, E.F.; investigation, E.F.; data curation, E.F.; writing – rough preparation, E.F.; writing – review and editing, G.P.; supervision, G.P.; project administration, E.F. All authors have read and agreed with the published version of the manuscript.

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Conflicts of Interests

The authors declare no conflict of interest.

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