SHORT-TERM EFFECTS OF THE COMPLEX REHABILITATION PROGRAM INCLUDING NEMEC'S CURRENTS AND THERAPEUTIC EXERCISES IN PATIENTS WITH KNEE OSTEOARTHRITIS.

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Abstract

The purpose of this study is to evaluate the short-term therapeutic effects of treatment with Nemec's medium-frequency currents and therapeutic exercises in patients with knee osteoarthritis.

Material and methods: The study included 54 patients with symptomatic osteoarthritis of the knee joints, II and III radiological degrees on the Kellgren-Lawrence scale with a mean age of 65.4±9.9(40-85), who conducted rehabilitation with Nemec's currents and therapeutic exercises. All patients underwent a ten-day rehabilitation course. The results were evaluated by manual muscle testing test (MMT), measuring the circumference of the knee joint (KJ) with centimeter, test range of motion (Goniometry), pain (VAS), WOMAC Index, before and immediately after therapy. The statistical significance of the changes is $p<0.05$.

Results: A statistically significant decrease in the circumference of KJ after therapy ($p<0.05$), reduction of muscle weakness m. Quadriceps by MMT test ($p<0.05$), reduction of pain (VAS) at rest and activity ($p<0.05$) and WOMAC Index ($p<0.05$) and increase in the range of flexion in the knee joint ($p<0.05$) was observed.

Conclusion: The results of the study showed significant improvement in the functional activity of patients (WOMAC Index). Nemec's medium frequency currents therapy and therapeutic exercises can effectively reduce pain (VAS), swelling, muscle weakness (MMT), and range of motion in patients (ROM) with gonarthritis. The obtained therapeutic effects are probably based on the complex application of Nemec's current in trophic and analgesic parameters and therapeutic exercises.

***Key words**: Knee osteoarthritis, Interferential current therapy, Pain, Muscle weakness m. Quadriceps femoris, Functional activity.*

Introduction

Osteoarthritis (OA) is a widespread musculoskeletal disease that can affect any joint, but most commonly affects the knee joint, the joints of the hands, the hip joint, and the joints of the spine. The disease has an impact not only on the individual patient but also on society as a whole and is associated with increased economic burden [1]. OA of the knee joint accounts for more than 80% of the severity of the disease, with an estimated 19% of the US population aged 45 and over being affected [2-4].

Osteoarthritis is more common in the elderly over the age of 65 [3, 5, 6]. It is characterized by structural damage of the affected joints and loss of cartilage, which leads to a pronounced functional deficit [7]. Radiologically, structural changes are demonstrated by narrowing of the joint space and bone changes (appearance of osteophytes and subchondral bone sclerosis). Very often, however, these structural changes are weakly related to the sensation of joint pain [8]. A significant proportion of patients with radiographic evidence of osteoarthritis of the knee did not report joint pain [9, 10]. According to some authors, only 15% of patients with radiographic evidence of osteoarthritis of the knee have symptomatic osteoarthritis with clinical manifestations of the disease [6, 11].

Symptomatic OA is thought to be preceded by a prolonged preclinical phase characterized by the appearance and development of structural changes in the joint without the presence of clinical symptoms and subjective complaints. Not only changes in the subchondral bone and articular cartilage are essential, but also changes in the muscles around the joint. Muscle weakness is one of the earliest and most common symptoms in patients with gonarthritis and is considered a better predictor of joint narrowing and pain [8]. Decreased functional activity and disability have a significant impact on the psychosocial status of both patients and their families. [12].

In recent years, the severity of musculoskeletal diseases has increased [13]. Wallace IJ et al. (2017) believe that the prevalence of knee OA is 2.1 times higher in post-industrial society than in the early industrialization era [4]. There is a global trend of increasing life expectancy, which suggests that the need for health care for these patients will increase. Until recently, population aging, and high body mass index were considered to be major factors in the prevalence of OA [4], but the role of other factors is likely to need to be assessed.

The mechanical load in the joints and the associated multi-stage inflammatory reactions [14, 15], high body weight and obesity, gender, hormonal status, age, the presence of previous trauma are directly related to the appearance and development of OA. In essence, they are defined as significant risk factors. Occurring changes in the muscles around the joints (including those around the knee joint) are also likely to have an impact on the onset and progression of the disease. It is believed that muscle weakness may be a unifying link in the action of significant risk factors [16, 8]. The presence of chronic pain and reduced functional activity leads to long-term treatment and rehabilitation. This in turn leads to higher health care costs. Resent recommendations for the treatment of degenerative joint diseases emphasize on the active and conscious attitude of the patient to his own disease. Taking care of one's own health, self-monitoring and active interaction with health professionals is the basis of the so-called self-management, which creates a real opportunity for the patient to make informed choices about lifestyle changes, daily activity, and treatment, which will lead to improved health outcomes [17]. The process of research and developing an effective long-term program for management of degenerative joint diseases is still ongoing [18].

The **Aim** of present study is to evaluate the short-term therapeutic effects of treatment with Nemec's medium-frequency currents and therapeutic exercises in patients with knee osteoarthritis.

Materials and Methods

The study included 54 patients (37 women and 17 men, mean age 65.4 ± 9.9 years) with symptomatic Kellgren-Lawrence grade II and III osteoarthritis of the knee, with no evidence of active synovitis. The study included patients who met the following criteria: age over 38 years, radiological data for OA II and III degree according to Kellgren-Lawrence in KJ, pain in KJ during most days of recent months, crepitations during active movements in KJ, morning stiffness lasting 30 minutes or less. The study did not include patients under the age of 38, with radiological data for OA I and IV degree according to Kellgren-Lawrence, presence of OA and anamnestic data for acute KJ trauma, patients with reflected lumbar spine pain or hip joint, active synovial inflammation with warming and redness of the knee and patients who are currently being treated with NSAIDs and/or analgesics, or have had intra-articular manipulations up to 6 months before physiotherapy with hyaluronic acid or corticosteroids, as well as general contraindications for electrotherapy. Before the start of rehabilitation, the clinical condition of all patients was examined by a doctor Specialist in Physical and Rehabilitation Medicine. In medical history patients report knee pain, joint stiffness, and limited functional activity. Rehabilitation interventions include ten sessions with interfering currents in analgesic and trophic parameters and therapeutic exercises performed

immediately after electrotherapy. Nemec's interferential currents are applied by means of 4 electrodes, contact, locally around the knee joint. Therapeutic parameters - analgesic, trophic and stimulating (90-100 Hz, 5 min and 0-100 Hz 15 min.).

The current is individually dosed, sufficient to obtain vibration in the depth of the muscles located under the electrodes. Analytical exercises mainly for Vastus medialis et lateralis of m. Quadriceps femoris, resistance exercises, range of motion exercises, balance training and gait were applied. The treatment was carried out in accordance with the Declaration of Helsinki (1964, amended in 2013), after informed consent of the patient, and each patient may refuse to conduct therapy at any time during treatment.

For the purposes of the study, a questionnaire was developed, which patients fill out at their first visit to a physical medicine specialist, including questions concerning professional activity, reason for visiting a doctor with the possibility of more than one answer, information about the referring doctor, previous treatment with physical factors in the last 3 years.

Clinical results were assessed at the beginning and in the end of the rehabilitation course by: measuring the circumference of the knee joint (centimetria of the knee joint), range of motion - measurement in the affected joint by goniometry and manual muscle testing to determine the degree of muscle weakness of the Quadriceps femoris (MMT allows to compose, corresponding to the current state, kinesitherapy program for diseases of the musculoskeletal system).

Knee pain was assessed by applying the Visual Analog Scale (VAS) for pain at rest, walking on flat surface, going down and upstairs. It is a one-dimensional scale that is widely used in clinical practice. VAS is a straight line from 0 to 10 cm (0 mm to 100 mm), at the beginning and in the end, with two descriptors representing extreme values of pain intensity (0 - no pain and 10 extremely severe pain) at each end. Patients themselves determine the intensity of their pain.

A self-administered WOMAC Index (Western Ontario and McMaster Universities Osteoarthritis Index) questionnaire was used to assess subjective complaints and the degree of functional impairment. It is designed for elderly patients with knee and hip joints damage. A modification of V.LK 3.1 was used in the study, which included a 5-point pain assessment, a 2-point stiffness, and a 17-point daily life function. The severity of the symptoms is assessed by verbal Likert scale in 5 points: 0- missing; 1- mild; 2- moderate; 3- severe; 4- very severe. The bigger the sum of the three subsections the higher degree of functional impairment and limitation in daily activity. Statistical analyses: SPSSv.25 was used for statistical data processing. The statistical significance of the changes is $p<0.05$.

Results

The study included 54 patients (37 women and 17 men), mean age 65.4 ±9.9(40-85) years) with symptomatic gonarthritis II and III degrees, according to Kellgren-Lawrence. The mean age for women was 66.7±9.2(51-85), and for men 65.9 ± 11.7 (42-85). 38 (70%) of the patients were with second degree gonarthritis and 16 (30%) - with third degree. The mean body mass index in patients was 28.7±1.6(24.7-31.9). The mean duration of the current exacerbation period of symptomatic gonarthritis was 5.89±1.67 (3-9) weeks. The average total duration in years from diagnosis is 7(1-20) years. 46% of them are of the working age (22% employees, 24% workers) and 54% - retired (7% - retired employees and 46% of retired workers). 30% of the patients were with primary education, 59% - secondary education and 11% - higher education. 70% of the patients experience physical workload associated with the profession. In 65% of those surveyed, their profession required prolonged standing, 41% - prolonged sitting in a forced position, and 50% had frequent squats and kneeling. 8% have been involved in active sports, and 6% have reported knee injuries in the past.

After processing and analysis of the questionnaires filled in by the patients regarding the reason for visiting a Doctor of Physical Medicine, it was found that the main reason for visiting a doctor was pain, followed by difficulty in walking - 83%, stiffness in KJ - 39%, followed by limited daily activity - 28% (Patients were allowed to report more than one cause, if necessary).

Patients who were referred for physiotherapy at the discretion of a general practitioner /GP/ were 30%, by GPs with active patient participation - 20%, at the discretion of a specialist /orthopedist, rheumatologist/ - 40% and by a specialist with active search of physiotherapeutic treatment by the patient - 10%.

Out of all patients referred to a physical therapist, 35% were undergoing physical factor therapy for the first time, 39% had undergone gonarthritis rehabilitation in the past 3 years, and 26% had undergone physical factor procedures in association with another disease. Patients who have undergone physiotherapy treatment for OA of the knee joint or for another disease in the last three years prevail.

Before the start of the rehabilitation course and after its completion, all patient passed through kinesiological assessment, including: centimetria of the knee joint, goniometry of the range of motion in the affected knee joint, and manual muscle test (MMT) for assessment of the degree of muscle weakness m. Quadriceps femoris.

The circumference of the affected knee joint (Mean±SD) in all patients before therapy was 41.6±2.1 cm. In women (n=37) it was 41.1±2.3 cm, and in men (n=17) - 42.8±1.2 cm. The average circumference of KJ after therapy was 40.8±3.1 cm., respectively, in women it was 40.1±3.4 cm, and in men - 42.4±1.2 cm. The range of flexion in angular degrees for the knee joint before therapy was 113.2±6.2(100.0-120.0)º, respectively women with 112.7±6.4 (100.0-120.0)º, and men - 114.1±5.7(100.0-120.0)º. The mean range of flexion after therapy was 119.6±5.5(105.0-125.0)º -women with 119.3±5.3(105-125) º, and men - 120.3±6.0(105.0-125.0)º. The degree of muscle weakness of the Quadriceps determined after the MMT (Me (Range)) test was 2.75 (2.25-4.00). It was 2.75 (2.25-4.00) for women and 2.75 (2.25-3.75) for men. After therapy, a decrease in muscle weakness and an increase in the test score for the monitored patients was found - 3.75(2.75-4.25). It was 3.75(2.75-4.25) for women and 3.75(2.75-4.00) for men. Table 1 presents the dynamics of the indicators measured in the kinesiological analysis of patients: circumference of the affected knee joint at centimetria, volume of flexion for the knee joint and the degree of muscle weakness per m. Quadriceps femoris before and after the rehabilitation program.

VAS (Visual analogous scale: 0 is no pain to 10 – severe pain) was used to assess pain in patients with osteoarthritis of the knee at rest, walking, descending, and climbing upstairs. The dynamics of the indicator for the monitored period is presented in Table 2. There was a statistically significant reduction in pain after rehabilitation at rest ($p<0.001$), walking ($p<0.001$), descending ($p<0.001$) and climbing upstairs ($p<0.001$).

The WOMAC Index (Western Ontario and McMaster Universities Osteoarthritis Index) was used to assess functional activity. The dynamics in the values of the index was monitored before and after the complex rehabilitation. A statistically significant decrease in the value of total WOMAC after therapy and improvement in the functional activity of patients after the rehabilitation course was observed. The dynamics in the values of the total WOMAC, subscales Pain, Stiffness and Function are presented in Table 3. A reduction in the values of WOMAC Index ($p<0.001$), subscales Pain ($p<0.001$), Stiffness ($p<0.001$) and Function ($p<0.001$) was observed.

Discussion

In our study we aimed to observe the therapeutic effects of the complex application of Interferential medium frequency current and therapeutic exercises program and the

possibilities of the applied by us physical factors to influence the subjective assessment of functional activity and pain in patients with gonarthritis.

Clinically, osteoarthritis is manifested by pain, swelling, stiffness, crepitations in the joint, muscle weakness, and decreased range of motion [19, 20]. OA is the cause of severe prolonged pain, restriction of daily activity and reduced quality of life [11, 21].

The results obtained by us show that osteoarthritis of the knee joint leads to increased pain symptoms and limited daily functional activity in the studied patients. Pain was reported by all patients included in the study as the leading reason for visiting a doctor. Half of the patients had several coexisting causes: pain, difficulties in walking and limited functional activity. Pain is one of the main symptoms of knee OA. According to a number of studies, pain is result of the interaction of many factors: gender, age, body mass index, education, psychological, genetic factors and local pathology of the affected joint. Emphasis is placed on the role of the peripheral and central sensitization, which also determine pain in the knee joint [1, 22]. However, what causes pain and why some patients experience pain and others do not is still being studied [1]. In another study, Huang KH. et al. (2017) investigated the relationship between high pain levels and the reduced daily functional activity. According to them, there is a link between reduced physical activity, increased permanent incapacity for work and reduced social activity. Reducing pain and increasing physical function, according to them, could lead to a potential increase in the level of functional and social activity of patients with OA of KJ [7].

A statistically significant reduction in pain at rest and during physical activity after the complex rehabilitation program was observed by the study team. Probably the complex rehabilitation, which includes appropriate selection of electrical procedures to reduce pain, improve tissue and periarticular muscle trophism and therapeutic exercises that are consistent with the degree of muscle weakness leads to increased daily functional activity and reduced values of total WOMAC and the three scales Pain, Stiffness, and Function.

It is accepted that the analgesic effect of Interferential current can be carried out by several different mechanisms: on one hand by inhibition of nociceptive type C fibers in connection with the "Pain gate" pain control theory of "Malzack and Wall" [23, 24]. Another mechanism is related to the improvement of blood circulation in the area of the current application, which leads to increased blood circulation and subsequently to increased export of body fluids and pain-producing substances from the area of the pathological focus. Probably another mechanism is responsible for the reduction of pain by including a "descending mechanism of pain suppression", which is also associated with the endogenous release of opioid substances. Frequency 0-100Hz of Nemec's Interferential current is successfully used to achieve peripheral vasodilation and improvement of peripheral blood circulation [25]. It should be noted that a number of authors study the efficiency of the interference current in relation with m. Quadriceps femoris. It is believed that interference current therapy may result in 50% higher activation of the Quadriceps femoris than that achieved at maximal volitional contraction [26-29].

An essential role in the process of initial appearance and development, and subsequently of treatment and rehabilitation has the functional state of the muscles. Reducing muscle imbalance and improving muscle activity leads to maintaining and increasing mobility in the joints, their stability and function. The muscles around the joint give dynamic resistance to normal and pathologically altered joints [8, 30-33].

Muscle weakness is one of the earliest and most common symptoms in patients with osteoarthritis of the knee and it is considered to be a better predictor of joint narrowing and pain [8, 34-36]. Changes in the cartilage of the joint and subchondral bone, as well as changes in the extraarticular structures – muscles and tendons are essential for the appearance and progression of OA, while the role of the afferent sensory system is still being studied [8].

Often, the severity of osteoarthritis of the knee joint is assessed only based on imaging studies that reflect only the changes in the cartilage of the joint and the underlying subchondral bone. However, when determining the severity of the disease, the established changes in the bones, cartilage, ligaments, joint capsule, muscles that implement the movement and the nerve structures that control it should be considered, because all these structures form a single so-called basic functional unit of the musculoskeletal system [3, 9, 37-39].

It is still debated whether muscle weakness and subsequent atrophy are caused by degenerative changes in the knee joint or whether muscle weakness develops before the degeneration process progresses. It is assumed that the muscle weakness of m. Quadriceps femoris is a predictor of OA and is more common in women [40, 41], and that afferent sensory dysfunction is important for disease progression. Muscle function is more closely related to joint pain than narrowing of the joint space, which makes it a potential therapeutic target because it is more susceptible to change [8, 42]. In patients with osteoarthritis of the knee, significant muscle damage is found, which directly affects physical function, and therapeutic interventions should be aimed at overcoming these disabilities [33, 43]. The application of appropriate, tailored to correspond the functional state of the joint kinesitherapy procedures could reduce pain and improve the function of the affected joint.

The active participation of patients in the rehabilitation process is essential. One third of the patients in the study actively required treatment with the factors of Physical and Rehabilitation Medicine. According to contemporary recommendations for treatment of degenerative joint diseases, it is essential that patients have a good awareness of their own disease, and they develop an active attitude towards their own health. Patients often underestimate their active participation in the therapeutic process, and doctors in turn underestimate the importance of training for the patient [17, 44]. The role of the formation of an active attitude in patients with OA of the knee joint, associated with the application of the means and methods of physical and rehabilitation medicine is very important because it could have a positive impact on the treatment and rehabilitation of these patients [17, 45].

In summary, we can say that the short-term results of the complex rehabilitation show a decrease in swelling in the joint, increased range of motion, reduction of muscle imbalance, which are directly related to pain and reduced physical activity. The preparation of the complex rehabilitation program requires a precise assessment of the general clinical status and the rehabilitation potential of the patient. The application of appropriate electrotherapy to reduce swelling and pain in the KJ and to improve tissue trophism should be carried out before the complex of therapeutic exercises. The rehabilitation program applied by us led to an improvement in the self-assessment of functional activity (WOMAC Index) in patients with osteoarthritis of the knee. No adverse reactions related to the physical factors administered were observed during the physiotherapy course of treatment. Continuation of the study would contribute to a better objectification of the therapeutic effects of the complex application of Nemec's currents and therapeutic exercises.

Conclusion:

The results of the conducted study show a significant improvement in the functional activity and WOMAC Index of patients. Nemec's medium frequency current and therapeutic exercises can effectively reduce pain (VAS), can affect swelling, muscle weakness, and range of motion in patients with gonarthritis. Applied complex rehabilitation, which includes electrotherapy with Nemec's currents and therapeutic exercises, can be a potentially effective therapy in the treatment and rehabilitation of patients with osteoarthritis of the knee joint. In the future, the study could be expanded with the goal to objectify better the results obtained.

Potential conflict of interest: There is no potential conflict of interest.

Table 1 Dynamics of centimetria, range of flexion and degree of muscle weakness per m. Quadriceps femoris.

	Women (n=37)	Men (n=17)	Total(n=54)	
Centimetria	Me(Range)	Me(Range)	Mean±SD,(Range)	P
Before Therapy	41.0 (37.0-46.0)	43.0(41.0-45.5)	41.6±2.1(37.0-46.0)	
After Therapy	40.5 (24.5-45.5)	42.5(40.0-45.0)	40.8±3.1 (24.5-45.5)	p<0.001
Flexion º	Me(Range)	Me(Range)	Mean±SD, (Range)	
Before Therapy	115.0(100.0-120.0)º	115.0(100.0-120.0)º	113.2±6.2(100.0-120.0)	
After Therapy	120.0(105.0-125.0)º	120.0(105.0-125.0)º	119.6±5.5(105.0-125.0)	p<0.001
MMT- test	Me (Range)		Me (Range)	
Before Therapy	2.75 (2.25-4.00)	2.75 (2.25-3.75)	2.75 (2.25-4.00)	
After Therapy	3.75 (2.75-4.25)	3.75 (2.75-4.00)	3.75 (2.75-4.25)	p<0.001

Table 2. Dynamics of pain at rest and physical activity

Pain Mean±SD	Pain/rest	Pain/walking	Pain/descending	Pain/climbing
Before Therapy	2.70±0.84	4.02±0.92	6.63±1.05	5.57±1.08
After Therapy	0.69±0.75	1.76±0.67	3.37±0.98	2.59±0.98
Statistical difference	p<0.001	p<0.001	p<0.001	p<0.001

Table 3. Dynamics in total WOMAC Index and subscales for the observed period

Me(Range)	WOMAC Total	WOMAC Pain	WOMAC Stiffness	WOMAC Function
Before Therapy	61.5 (49-78)	13.0 (10-17)	4.0 (2-6)	44.0 (34-58)
After Therapy	51.0 (39-62)	10 (5-12)	3.5 (1-5)	38.5 (30-51)
Statistical difference	p<0.001	p<0.001	p<0.001	p<0.001

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