IMPACT OF REHABILITATION PROGRAM FOR PATIENTS WITH KNEE OSTEOARTHRITIS AND DIABETES MELLITUS

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Abstract

Aim: To evaluate the therapeutic effects of complex rehabilitation involving electrotherapy and kinesiotherapy on functional activity in patients with knee osteoarthritis and comorbidities of diabetes mellitus using a WOMAC Osteoarthritis Index.

Materials and Methods: The study included 144 patients with knee osteoarthritis- Kellgren-Lavrence II and III degree (101 women and 43 men, mean age 66.0±10.3 years). 14% of all patients had knee osteoarthritis and comorbidities of diabetes mellitus in mean age 67.4±9.4 years (women- 65.0% and 35.0%- men). Patients with knee osteoarthritis and comorbidities of diabetes mellitus conducted ten sessions of complex rehabilitation, including electrotherapy (interferential currents or Deep Oscillation-therapy) and therapeutic exercises.

Results: The results were scored by assessment of the WOMAC Index at four time points: pretreatment, after treatment after the first and third months. There was no statistically significant difference in pretreatment WOMAC Index($p=0.869$) in patients with osteoarthritis and diabetes mellitus and without diabetes mellitus. A statistically significant reduction in WOMAC Index($p<0.001$), subscales Pain($p<0.001$), Stiffness($p<0.001$), and Function($p<0.001$), was reported, which was sustained 3 months after the complex rehabilitation.

Conclusion: The results showed prolonged, at least three months increase of functional activity in patients with knee osteoarthritis and diabetes mellitus after the complex rehabilitation (Deep Oscillation-therapy or interferencial currents and therapeutic exercises). Is established reducing the WOMAC Index, subscales Pain, Stiffness and Function. The rehabilitation program is individual and requires an adequate assessment of rehabilitation potential. Electrotherapy is appropriate to precede kinesiotherapy. In our opinion better objectiveing of the results obtained requires the study to continue.

Key words: *Knee osteoarthritis, Diabetes mellitus, Deep Oscillation therapy, Interferential currents, Therapeutic exercises.*

Introduction

Osteoarthritis (OA) and diabetes mellitus (DM) are common diseases. Worldwide, it is predicted increase of their incidence and prevalence [1, 2]. DM is a metabolic disease characterized by hyperglycemia resulting from a disorder of insulin secretion, insulin action, or both together [3]. It occurs in two basic forms: Type 1 DM, which is characterized by decreased insulin production with autoimmune or post-infectious etiology. Type 2 diabetes often affects the elderly and is associated with insulin resistance at the cellular level. In both forms of DM, there is a prolonged hyperglycemia which leads to osmotic and oxidative stress and is associated

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with damage to the nerve structures of the eyes, kidneys and other tissues [4]. Diabetes is an important public health problem, one of the four priority non-infection diseases. Global distribution (age-standardized) of diabetes has almost doubled since 1980, from 4.7% to 8.5% in the adult population. This reflects the increase in associated risk factors, such as overweight or obesity [5].

OA is defined as a chronic joint disease based on primary degeneration and destruction of articular cartilage, with proliferation of bone tissue and formation of osteophytes and subchondral bone sclerosis. Inflammatory changes in the synovial membrane (reactive synovitis) and other surrounding tissues have secondary character [6]. More arguments are being gained in favor of the claim that OA is a primary metabolic disorder, where metabolic, lipid and hormonal factors play a decisive role in its appearance and progression [7]. It has been shown that "white fat" is an endocrine organ that produces and secretes molecules with cytokine properties called adipocytokines. They participate not only in the regulation of the nutritional behavior and the energy balance of cells, The overweight is associated with a higher incidence of OA on the supporting joints, whereas the higher body mass index (BMI) is associated more with OA on the upper joints. It was proved that fat loss and not reduction of body weight alone is associated with an improvement in OA. Metabolism factors, including adipocytokines, are the likely link between obesity and OA and the low-grade inflammation that occurs with it [9, 10].

Both diseases have common epidemiological characteristics and significant clinical heterogeneity. These are complex diseases with significant clinical heterogeneity and multifactorial etiology. Aging is a risk factor for both T2DM and OA [4]. Globally, about 422 million adults lived with diabetes in 2014, compared to 108 million in the 1980s. This reflects the increase in associated risk factors, such as overweight or obesity [11]. The incidence of OA increases with age, affecting 13.5% of the population aged 25 and older and 33.6 percent of people over the age of 65 [12]. Another important risk factor for both diseases is obesity. A large proportion of OA patients have obesity [13], which is widespread in patients with Type 2 [14]. OA and DM often coincidentally exist because of their high prevalence and general risk factors. Nearly half (47.3%) of DM patients have some form of arthritis [15]. The presence of co-morbid conditions usually increases the care needs of individual patients, reduces the efficiency of care, and increases health-related costs. The development of OA may also complicate DM [4].

Aim: To evaluate the therapeutic effects of complex rehabilitation, including electrotherapy and kinesiotherapy on functional activity in patients with gonarthriti and accompanying diabetes mellitus applying WOMAC Osteoarthritis Index.

Materials and Methods: The study included 144 patients with Kellgren-Lavrence symptomatic gonarthritis II and III with no evidence of active knee joint synovitis, 101 women and 43 men. All patients were over 38 years of age, with osteoarthritis of the knee joint (KJ) according to the American College of Rheumatology(ACR) and compensated diabetes mellitus, which is medically controlled. The mean age (mean ± SD) of all patients was 66.0 ± 10.3 (40-87) years. The mean age of women was 66.8 ± 10.4 years, and for men - 64.2 ± 10.0 years. 14% from all 144 patients had diabetes mellitus, 65.0% of women and 35.0% of men. The mean age in patients with diabetes was 67.4±9.4(49-82). Women was in mean age 69.5±10.0(49-82), and men 63.4±7.2(58-79). In primary ambulatory examination by a specialist in physical medicine, patients reported pain in the knee joint, joint stiffness and restricted functional activity. From the study, all patients with active synovitis on the knee, decompensated diabetes mellitus, decompensated cardiovascular disease, including a pacemaker and patients contraindicated for electrotherapy were excluded. The patients conducted ten sessions of complex rehabilitation including electrotherapy (medium frequency interferential currents and Low- frequency and low-intensity electrostatic field- Deep Oscillation therapy) and complex therapeutic exercises.

The interferential current is applied by means of 4 electrodes, contacting locally in the field of knee joint (KJ) with analgesic and trophic frequencies (90-100Hz, 5min and 0-100Hz 15min.) and the current strength is individually dosed sufficient to obtain deep vibration of the muscles located under the electrodes. Deep Oscillation therapy is applied by a 9.5 cm hand applicator. The procedure involves treatment of the KJ, the surrounding tissues, and the m. Quadriceps femoris area. Therapy Modes: Variable frequency 100-144 Hz 5 min, constant frequency 85 Hz 5 min., Variable frequency 14-20 Hz 4 min, modulation mode 1:1 (slight vibrations). Kinesitherapy (KT) is performed immediately after the electrotherapy. The kinesitherapeutic program includes individually dosed therapeutic exercises: analytical gymnastics with emphasis on Vstus medialis et lateralis of m. Quadriceps femoris, resistance exercises, exercise to increase the volume of movement, gait training.

The clinical outcomes in the beginning, after the end of the treatment on the first and the third month after the rehabilitation course are objectively assessed by the WOMAC Index (Western Ontario and McMaster Universities Osteoarthritis Index). It is designed for adult patients with osteoarthritis and is a self-administered questionnaire. The study uses V.LK 3.1, which includes assessment of pain at 5 points, stiffness at 2 points and a function in daily life at 17 points. The severity of the symptoms is assessed on a verbal scale of Likert at 5 points: 0 - missing; 1- weak; 2- moderate; 3 - strong; 4 - very strong. For the statistical data processing SPSSv.16 was used. The statistical significance of the changes is $p < 0.05$.

Results

The study included 144 patients with Kellgren-Lavrence grade II and III symptomatic gonarthritis with no evidence of active knee joint synovitis were included in the study at four time points: pretreatment after treatment after the first and third months. Patients were divided into two groups: A Test group(TG) (n = 20) included patients with knee osteoarthritis and diabetes mellitus and Control group(CG) (n = 124) - patients with gonarthritis with no evidence of diabetes mellitus. WOMAC Index (Western Ontario and McMaster Universities Osteoarthritis Index) was used to evaluate the results. Daily functional activity and its dynamics were evaluated before and after the completed rehabilitation in patients with gonarthritis and accompanying diabetes mellitus. The questionnaire was developed to evaluate osteoarthritis of the lower limb joints in adult patients. The higher the result is, the more pronounced the symptoms and higher the degree of functional impairment are. A statistically significant decrease in the total WOMAC after treatment and improved functional activity of the patients after the rehabilitation course was observed. Prior to conducting a comprehensive rehabilitation, a statistically significant difference between patients with accompanying diabetes and without diabetes in the values of total WOMAC Index (Me(Range)) for Test group is 62.5(40.0-70.0)) and Control group - 61.0(46.0-78.0) was not observed (Z=-0.165, p=0.869). No statistically significant difference with respect to the values of all three subscsle: Pain, Stiffness and Function was found. For subscale WOMAC Pain values in both groups were as follows Test group 13.0 (8.0-16.0) and Control group 13.0 (7.0-17.0), without a significant difference (Z=-0.056; p=0.956). Subscale WOMAC Stiffness Test group (5.0 (2.0 -6.0)) and Control group - (4.5 (2.0-7.0); (Z=-0.928;p=0.353). No statistically significant difference for WOMAC Function scale was observed before treatment in the two groups – Test group 45.0 (34.0-56.0) and Control group (34.0-58.0); (Z =-0.634; p=0.526). Patients with osteoarthritis of the KJ and comorbid diabetes are monitored before treatment and at three time periods - immediately after treatment, after the first and the third month. Prior to the rehabilitation program, the total WOMAC (Me (Range)) was 62.5 (40-78). Immediately after rehabilitation a decrease in the total WOMAC 49.5 (35-71) was observed and this tendency remained at the end of the first month with total WOMAC 46.0 (37-58) and after third month with total WOMAC 50.5 (40-63). The dynamics of the total WOMAC values and the three subscales for the monitored period

are presented in Table 1. A statistically significant difference was found in the total WOMAC- $\chi^2(3)=36.701$; $p<0.001$. No significant difference was observed after 1 month and after treatment ($q = 1.102$, $p = 1.000$), as well as after the third month ($q =-1.715$, $p=0.518$). There was a statistically significant reduction in total WOMAC in patients prior to therapy (Me= 62.5) and after the third month (Me=50.5); ($Z=-3.504$; $p<0.001$). With regard to the WOMAC Pain scale, a statistically significant difference was detected for the observed period - $\chi^2(3)=41.192$; $p<0.001$. WOMAC Pain shows a statistically significant decrease after the third month of treatment compared with the beginning of rehabilitation (Me=10.0); ($Z =-3.656$; $p <0.001$). There is no significant difference between WOMAC Pain after the end of the first month and after treatment ($q=-0.919$, p=1,000), as well as after treatment and after the third month ($q=-1.531$, $p=0.755$) and between 1-st month and 3-rd month ($q=-2,449$, $p=0.086$). There is a reduction in the subjective sensation of pain, which persists for at least three months (Table 1). The WOMAC Stiffness shows a statistically significant difference in WOMAC stiffness - $\chi^2(3)=29.204$; $p<0.001$ for the four observed time points. There was a statistically significant reduction in this subscale after the third month ((Me=3.5); ($Z=-2.956$; $p=0.003$) versus the pre-treatment period (Me=5.0). A significant difference between WOMAC stiffness after 1-st month and prior to therapy ($q=4.348$; $p<0.001$), after and before therapy ($q=3.491$; $p=0.003$) was found. After the complex rehabilitation, a statistically significant difference was found in the WOMAC Function ($\chi^2(3)=38.394$; $p<0.001$) for the four time periods. There was a statistically significant decrease in WOMAC Function after the applied therapy ($Z=-3.775$; $p<0.001$) and a decrease of the indicator after the third month (Me=37.0) versus pretreatment (Me=45.0); ($Z=-3.775$; $p<0.001$). At least a three-month reduction in functional limitations in patients with osteoarthritis of KJ and accompanying diabetes mellitus has been observed.

Discussion

In the study conducted by us, we aim to evaluate the therapeutic effects of complex rehabilitation, including electrotherapy (Deep Oscillation or interference midrange current) and Kinesitherapy on functional activity in patients with gonarthrosis and accompanying diabetes mellitus by administration of WOMAC Osteoarthritis Index. The results show that osteoarthritis of the knee joint leads to increased pain symptoms and limited daily functional activity. No statistical difference was found in the total WOMAC Index and the three subscales Pain, Stiffness and Function among patients with osteoarthritis of the KJ and accompanying diabetes and those without diabetes. All patients included in the study prior to the complex rehabilitation had painful symptoms, knee stiffness and limited functional activity. A number of authors point out the relationship between high levels of pain and limited functional activity, resulting in decreased physical activity, increased permanent disability and reduced participation in sports and social activities. Reducing pain and increasing physical function can lead to a potential increase in the level of functional and social activity of patients with OA of KJ [16]. After reviewing literature available, we have not found many studies studying the impact of diabetes mellitus on osteoarthritis. Some authors, Frey MI and associates do not detect the existence of such dependence. [17]. While Dahaghin S and associates believe that diabetes mellitus and obesity can potentiate the development of OA and are more common in OA patients [18]. The active involvement of patients in the rehabilitation process is essential. According to the current recommendations for the treatment of degenerative joint diseases, patients and the information have important role in their own illness and their adequate and active attitude to their own health. Many patients underestimate their active participation in the healing process, and doctors underestimate the importance of training for patient compliance [19, 20]. The formation of the active attitude of patients with OA of the knee joint associated with the implementation of non-pharmacological therapies in the field of physical medicine could prove crucial in the process of treatment and rehabilitation of these patients [19, 21].

In our study a statistically significant reduction in WOMAC Pain following the Comprehensive Rehabilitation Program was observed. We we assume that the implementation of complex rehabilitation, which includes electrotherapy (in order to reduce the pain, to impre trophic tissue and periarticular muscles) and therapeutic exercise, in accordance with the degree of muscle weakness leads to an increase in daily functional activity and to a reduction in the amounts of WOMAC total values and in subscales Pain, Stiffness and Function.

Low- frequency and low-intensity electrostatic field is the basis of the Deep Oscillation treatment method. Main therapeutic effects are realized as a result of the electric field pulse generated with low frequency from 5 to 250 Hz, with small amperage 5–7 μA and biphasic mode. Therapeutic effects depend on the frequency range [22, 23]. Rapid and sustained pain relief, improvement of microcirculation and reduction of swelling is achieved. The fibrinolytic effect and increased tissue elasticity lead to normalization of the muscle tone and improves mobility of joints system. Anti-inflammatory and immune-stimulating effect is observed [24-30].

The analgesic action of interfering currents is realized in several ways: partly by inhibition of type C nociceptive fibers, "Pain gate" pain control theory of "Malzack and Wall" [31, 32]. Improving blood circulation in the area leads to increased circulation and increased efflux of fluids and pain-inducing substances from the pathological outbreak. Pain reduction is also mediated by the inclusion of a "downward mechanism of pain suppression" mediated by endogenously released opioid substances. Interference current with a frequency of 0-100Hz has been successfully applied to achieve a peripheral vasodilatation and improvement of peripheral circulation [33]. With regard to m. quadriceps femoris IFT therapy can lead to a 50% higher activation of the quadriceps of the thigh compared to that achieved at maximum volitional contraction [34-35]. Improving muscle activity and reducing muscle imbalance leads to maintaining mobility in the joints, their stability and function. Peripheral muscles confer dynamic resistance to normal and pathologically changed joints [36-38]. Muscle weakness is one of the earliest and most common symptoms in patients with gonarthritis and is a better predictor of narrowing of the joint space and pain [37, 38, 40, 41]. For the appearance and progression of the knee joint OA, changes in joint cartilage and subchondralinate bone as well as changes in the extraarticular structures: muscles, tendons are essential. An important role is played by the changes in the afferent sensor system [38]. Often the severity of gonarthritis is assessed only on the basis of the imaging data, verifying the changes in the articular cartilage and the subchondral bone. The assessment of severity should be based on established changes in bone, cartilage, ligaments, joint capsule, muscles performing movement and nerve structures that control it. All these structures are involved in the formation of a basic functional unit of the locomotory system [43-47]. It is still questionable whether muscular weakness and subsequently atrophy are caused by degenerative changes in the knee joint or muscular weakness preceded it. Currently, it is assumed that the muscle weakness of m. Quadriceps femoris is a predictor of OA and more common in female [48-49] and afferent sensory dysfunction is important for the progression of the disease. Muscle function is more closely related to joint pain than the narrowing of the joint space and is more easily modifiable, making it a potential therapeutic target [38]. Eymard F. et al. (2015) investigate the effect of diabetes mellitus on the progression of osteoarthritis of the knee joint. In their study, 6.6% of patients had diabetes mellitus. The authors found that in patients with type 2 diabetes, the annual narrowing of the joint space was higher, statistically significant than in patients without diabetes mellitus and correspond to BMI, age, hypertension and dyslipidemia [50]. Magnusson, K. et al. (2015) states that out of all components of the metabolic syndrome, only diabetes mellitus has been identified as an independent risk factor for the progression of knee OA. In pain syndrome analysis, they found higher pain levels in patients with DM and OA of KJ, but further studies in this area are still needed [51]. In recent years, there has been increased evidence of DM's

effect on OA's development, severity and therapeutic outcome [4]. It is important that the effect of the undiagnosed DM on OA should also be assessed [52].

American Diabetes Association recommends the inclusion of appropriate physical activity and therapeutic exercises in patients with DM. During physical activity, oxygen consumption may increase up to 20 times, and in the working muscles there may be an even greater increase. Skeletal muscles use their own glycogen and triglyceride stocks as well as free fatty acids (FFAs), resulting from the degradation of fatty triglycerides and glucose released by the liver, at a considerably higher rate. In order to maintain the function of the central nervous system, blood sugar levels are remarkably well maintained during physical activity[53].

The preparation of the complex rehabilitation program in patients with osteoarthritis of KJ and diabetes mellitus requires an adequate assessment of the overall clinical status and rehabilitation potential of the patient. The rehabilitation program is strictly individual and the therapeutic exercises are applied in accordance with the principles of gradual increase in type and number and repetition of the therapeutic exercises. Incorporating proper electroprocedures for reducing pain in KJ and improving tissue trophicity is appropriate to precede the kinesiotherapeutic complex. A better understanding of the relationship between DM and OA could help improve OA's therapeutic outcomes [4]. Applying electro-procedures and therapeutic exercises could improve the functional condition of the joint, could reduce the pain and improve the function of the affected joint and improve the quality of life of these patients, which requires further research in this area.

Conclusion

The results of the study show a prolonged, at least three-month increase in functional activity in patients with knee osteoarthritis and diabetes mellitus after complex rehabilitation, which includes interferential current procedures or Deep Oscillation and therapeutic exercises. A reduction of the total WOMAC Index and subscales Pain, Stiffness and Function was established. The preparation of the complex rehabilitation program requires an adequate assessment of the overall clinical status and rehabilitation potential of patients. The rehabilitation program is strictly individual. The inclusion of appropriate electrotherapy for the reduction of pain in knee joint and improvement of tissue trophicity should precede the kinesiotherapeutic complex. In our opinion better objectiveing of the results obtained requires the study to continue.

Table. 1 The dynamics of the total WOMAC Index and subscales Pain, Stiffness and Function Me(Range) for the studied period

Period	Total WOMAC	WOMAC Pain	WOMAC Stiffness	WOMAC Function
Prior to therapy	60(52-74)	13(8-16)	5(2-6)	45(34-56)
After therapy	52(39-57)	9.5(5-13)	3.5(1-5)	37(29-53)
1-st month	47(37-58)	8.0(5-13)	3.0(1-5)	35.5(30-42)
3-rd month	51(40-63)	10(6-13)	3.5(1-6)	37.0(32-48)

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