SHORT TERM EFFECTS OF LOW-FREQUENCY AND LOW INTENSITY ELECTROSTATIC FIELD IN PATIENTS WITH KNEE JOINT OSTEOARTHRITIS

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Abstract: Introduction: Osteoarthritis (OA) is a widespread disease among adult population and is one of the major public health problems. OA is leading cause of disability the joints of lower limbs: knee and hip. As global life expectancy increases, it predicted that OA will be the leading cause of damage resulting in permanent disability. In cases of OA a reduction in cartilage tissue is observed, which is radiographically demonstrated by narrowing of the joint space and bone changes, osteophytes and subchondral bone sclerosis. However, a significant proportion of patients with radiological evidence of gonarthrosis do not report joint pain. It is important to evaluate the changes occurring in the surrounding tissues. Muscle weakness of m. quadriceps femoris may occur before pain and impaired joint function. The development and application of new non-pharmacological methods in the rehabilitation of degenerative joint diseases is particularly important.

Purpose: To establish the short-term therapeutic effects of treatment with Low-frequency and Low-intensive electrostatic field, applied through Deep Oscillation® method and complex of therapeutic exercises in rehabilitation of patients with osteoarthritis of the knee.

Materials and methods: We conducted a one-year observational study involving 23 patients with clinical symptoms and radiologically proven II and III stage according Kellgren-Lawrence gonarthrosis, aged between 42 and 78 years, were observed. 15 of them were women average age 61.73±12.9 years vs 8 - males average age 61.75±9.6 years (p=0.997). The duration of the current pain-episode was 1.7±0.7 months. The treatment was conducted in 10 sessions and included: Low-frequency and Low-intensity electrostatic field and complex therapeutic exercises.

Results: The results were evaluated before and after completion of therapeutic course by assessing pain (VAS) at rest, when walking, climbing and descending on stairs, Manual Muscle Testing, Measurment of the knee joint circumference, Test Range of Motion and WOMAC Osteoarthritis Index, V.LK 3.1. were tracked. For processing statistical data SPSS v.13 was used. There was a statistically significant reduction of pain syndrome at rest (p<0.001), walking (p<0.001), descending stairs (p<0.001), climbing (p<0.001). Reduction of knee joint circumference (p<0.001). Increasing the range of flexion before Me (Range) from 105° (90°-120°) versus 120° (100°-125°) after therapy. Reduced deficiency at an extension from 3.48± 4.38 before therapy to recovery of the extension. Improved total WOMAC Index (p<0.001), Stiffness (p<0.001) and Function (p<0.001).

Conclusion: The short-term effects of the application of Low-frequency and Low-intensive electrostatic field in complex with therapeutic exercises show reduction of clinical symptoms and improvement of daily functional activity in patients with knee joint osteoarthritis. Reduction of pain of rest and physical activity (walking, descending and climbing stairs) is observed, oedema is reduced, joint range of motion increases, immediately after completion of the therapeutic course. Because of the small number of patients included in the study for better objectifying of the effects of the low-frequency and low-intensity electrostatic field, the studies should continue.

Keywords: Knee osteoarthritis, Low-frequency and Low-intensive electrostatic field, Deep Oscillation® therapy, Pain, therapeutic exercises

1. INTRODUCTION

Osteoarthritis (OA) is a widespread disease among elderly people and is one of the major public health problems. OA is leading cause of disability the joints to lower limb: knee and hip. With the increase in life expectancy worldwide, it is estimated that by 2020 osteoarthritis will occupy the fourth position as a cause leading to permanent disability [1]. According to data from the National Statistical Institute of the Republic of Bulgaria from a survey carried out in 2008, in Health Status section, in total 41.4% of the respondents reported "general musculoskeletal pain", 16.1% reported joint pain as a reason for a visit to a doctor. In 2014, after a second study, 7.5% of the
respondents reported osteoarthritis (no inflammatory arthritis), 4.5% of them men and 10.2% female [2]. For the Region of Stara Zagora, according to the data from the Regional Health Inspectorate of Stara Zagora in 2016, 9.4% of all newly discovered diseases were in the musculoskeletal system [3]. The structural features of osteoarthritis are reduction of cartilage tissue, which is radiologically demonstrated by narrowing of the joint space and bone changes, osteophytes and subchondral bone sclerosis. However, structural changes are poorly related to the sensation of joint pain [4]. A significant proportion of patients with radiographic evidence of gonarthritis, have no joint pain [5,6]. Important are not only the changes in intra-joint structures, but also changes occurring in the surrounding tissues. The degree of damages as a result of gonarthritis is often judged only by radiographic data. Bones, ligaments, cartilage, joint capsule, muscles performing movement, and nerve structures that control it should be considered as a basic functional unit of the locomotory system. If any of these components is functionally incomplete, the function of the joint itself will be impaired [7,8,9,10,5]. Muscle weakness of m. quadriceps femoris in gonarthritis occurs before joint pain and impaired joint function. The deficiency of muscle strength and proprioception in OA of the knee joint is probably caused by the limited function of the quadriceps muscle in order to reduce the pain. Improving of the muscle function, and especially the muscle force by excersise, is associated with a reduction of pain and an improved knee joint function in OA [11]. The development and application of new non-pharmacological methods in the complex treatment and rehabilitation of degenerative joint diseases are among the priorities of modern physical and rehabilitation medicine.

2. OBJECTIVE
To establish the short-term therapeutic effects of Low frequency and Low intensity Electrostatic field therapy applied by Deep Oscillation® method and a comlex of therapeutic exercises in the rehabilitation of patients with knee osteoarthritis.

3. MATERIALS AND METHODS
23 patients with clinical symptoms, diagnosed with II and III stage of gonarthritis according to Kellgren-Lawrence, aged between 42 and 78 years, were included in the study for a period of one year. Of these, 15 were women with average age of 61.73 ± 12.9 years vs 8 males with an average age of 61.75 ± 9.6 years (p = 0.997). The duration of current pain-episode was 1.7 ± 0.7 months. In 8 of the patients the left and in 15-right knee joint (KJ) were affected (KJ). There was no statistical relationship between the type of knee joint affected (right or left KJ) and the degree of osteoarthritis (χ²=0.212; p=0.685). The treatment was conducted in 10 sessions. All patients underwent a therapeutic course with Low-frequency and Low-intensity electrostatic field and complex of therapeutic exercises. Results were tracked at the beginning and in the end of the treatment course by VAS pain test at rest, at move, climbing and descending stairs, Manual Muscle Test, Measurement of the knee joint circumference, Test Range of Motion and WOMAC Osteoarthritis Index /Western Ontario and McMaster University Osteoarthritits Index/, developed for adult patients with osteoarthritis. Modification V.LK3.1 has been used. Statistical analysis: Quantitative data is represented as Mean and Standard Deviation (SD) if the distribution is either normal or Median (Me) and Range if different than normal. The normality was tested by the Shapiro-Wilk test. Comparisons of quantitative data before and after therapy were performed by the One sample Student t-test or the Wilcoxon Signed Ranks test. The category data was presented in percentages and analyzed by Fisher's Exact Test. Statistical significance was at p<0.05. The data was analyzed with SPSS for Windows v.13.

Clinical and radiographic criteria for inclusion in the study were as follows: age 38 or over, knee pain in most of the days of recent months, crepitus in joint when moving, morning stiffness (30 minutes or less), radiographic data for OA in KJ according to Kelgreen - Laurence II and III. The study excludes patients under 38 years of age, patients with OA of KJ and severe joint trauma of the same, general contra-indications for electrotherapy (decompensated cardiovascular diseases, including pacemaker, acute infectious conditions, sensitivity to electric fields, etc.), radiographic data for the I and IV stage of OA of KJ according to the Kelgreen - Laurence. The therapeutic goals of the rehabilitation of patients with symptomatic gonarthritis with Low-frequency and Low-intensity electrostatic field and complex therapeutic exercises were: reduction of pain and stiffness, reduction of edema of the around joint tissues and muscular weakness, improvement of the range of motion in affected joint and locomotive function, increase of the daily functional activity. In the studied group, the Low frequency and Low-intensity electrostatic field was applied by the Deep Oscillation® method using a 9.5 cm hand applicator (Deep Oscillation Evident®). The procedure involves treatment of KJ, surrounding tissues and the m. Quadriceps femoris area. Therapeutic Modality: Variable Frequency 100-144 Hz 5 min. Permanent frequency 85 Hz 5min. Variable frequency 14-20 Hz 4 min. Modulation mode 1:1 (light vibrations). The complex of therapeutic exercises was carried out immediately after the electrical procedure. It included aerobic exercise, analytical exercise for femur muscles, focusing on Vstus
formed consent

- A statistically significant reduction in muscle weakness before and after treatment (t(22)=7.598, p<0.001). An increase in angular degrees. An increase in stiffness was observed in affected knee joint (Z=4.206, p<0.001). Prior to physiotherapeutic treatment, the average circumference of the joint was 40.35 ± 3.85, and after treatment 39.09±3.91. The range of motion in the knee joint was observed after completion of physiotherapy (FT). A statistically significant difference was recorded before and after therapy (Z=4.272, p<0.001), at the beginning of treatment Me=105º (100º-120º) and after Me=120º (100º-125º). To determine the degree of muscle weakness of m. Quadriceps femoris a Manual Muscle Testing was used. The patients were divided into 4 groups depending on the degree of muscle weakness (2 Poor, 3 Fair, 4 Good, 5 Normal). A statistically significant reduction in muscle weakness before Me=3(2-4), and after Me=4(3-5), (Z=3.286, p=0.001) was observed. In the beginning of the treatment course, 4.3% of patients were rated with Poor (2) for m. Quadriceps femoris, 91.3% with Fair (3) and only 4.3% with a Dood (4). After the completion of rehabilitation, patients with rate Good were 34.8% and Normal 21.7% 43.5%, table 1.

<table>
<thead>
<tr>
<th>MMTm. Quadriceps</th>
<th>2- Poor</th>
<th>3- Fair</th>
<th>4- Good</th>
<th>5- Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before treatment</td>
<td>4.3%</td>
<td>91.3%</td>
<td>4.3%</td>
<td></td>
</tr>
<tr>
<td>After treatment</td>
<td>43.5%</td>
<td>34.8%</td>
<td>21.8%</td>
<td></td>
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</tbody>
</table>

The WOMAC Osteoarthritis Index /Western Ontario and McMaster Universities Osteoarthritis Index/ has been developed to assess lower limb osteoarthritis in elderly patients. The study uses V.LK3.1 modification, which includes assessment of pain in 5 points, stiffness in 2 points and function in daily life in 17 points. The symptoms were assessed according to the verbal Likert scale in 5 points: 0-Missing; 1-Weak; 2-Moderate; 3-Strong; 4-Very strong. The higher the result, the more pronounced are the symptoms and the degree of functional impairment. Statistical dependence (Z=4.201, p<0.001) was observed, reducing the total WOMAC score before Me=64(47-78) and after rehabilitation Me=51.1±9.9, table 2.

<table>
<thead>
<tr>
<th>WOMAC Me(range))</th>
<th>Me before therapy</th>
<th>Me after therapy</th>
<th>Statistical dependance</th>
</tr>
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<tbody>
<tr>
<td>WOMAC Score</td>
<td>64.0 (47.0-78.0)</td>
<td>52 (35.0-71.0)</td>
<td>Z=4.201, p&lt;0.001</td>
</tr>
<tr>
<td>WOMAC Stiffness</td>
<td>5.0 (3.0-7.0)</td>
<td>3.0 (1.0-6.0)</td>
<td>Z=4.070, p&lt;0.001</td>
</tr>
<tr>
<td>WOMAC Function</td>
<td>47.0 (36.0-65.0)</td>
<td>40.0 (29.0-53.0)</td>
<td>Z=4.206, p&lt;0.001</td>
</tr>
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</table>

Subscale Stiffness (0-8t points) is assessed by 2 questions. A statistically significant reduction in stiffness was observed in affected KJ (Z=4.070; p<0.001). In the beginning of the course it was 5.0 (3.0-7.0) and after treatment it was 3.0 (1.0-6.0). The dynamics in functional activity was evaluated by a Subscale Function (0-68t points) with 17 questions. After the rehabilitation course, there was increase in functional activity in patients with osteoarthritis of KJ, expressed as a reduction in WOMAC Function. A statistically significant difference (Z=4.206, p<0.001) was reported before Me=47.0 (36.0-65.0) and after complete rehabilitation Me=40.0(29.0-53.0).
5. DISCUSSION
Following the observational study a statistically significant reduction in pain at rest and physical activity (walking, descending and climbing stairs), reduction of edema of the around joint tissues, muscle weakness of m. Quadriceps femoris and increased movement in the knee joint were observed. The values of the total WOMAC Index and Subscales Stiffness and Function were reduced and the self-assessment of the functional activity in the day-to-day activities improved. The therapeutic effects achieved in treatment with Low-frequency and Low-intensity electrostatic field depend directly on the applied constant or variable frequency [12]. The analgesic effect was manifested rapidly and has a long-lasting effect [13]. The Gate control of pain impulses was activated [14] and a psychological effect of the procedure [15] appeared. The oxidation of the lipids is inhibited as well as the production of oxygen-containing radicals, which is in the basis of the anti-inflammatory effect [16,17]. Ineffective shunt blood flow, vasodilatation of the capillaries and subsequent microcirculation was improved [18,19]. The delivered from the mastocutes biologically active substances histamine, protease, serotonin, heparin provided prolonged vasodilatation [19]. An reabsorption of edema and lymphodrainage effect is observed [16,20] occurs. The elasticity of tissues was increased - reduction and/or prevention of fibrosis was prevented. Increased joint mobility was observed [21]. The muscle spasm in the area of impact with the Low-frequency and Low-intensity electrostatic field by affecting nerve endings and nerve fibers was reduced. The trophic and regenerative processes based on activation of local mechanisms of tissue blood flow, increasing of local microhemodynamics, increasing of transport functions of blood, improving of trans-capillary exchange were improved. Many studies prove that patients with KJ osteoarthritis have weakness in the Quadriceps femoris muscle, impaired proprioception and balance and frequent falls tendency. The muscle weakness correlates with pain and impaired function and appears as a result of arthrogenic reductions in volitional contraction and reflex inhibition induced by pain and swelling [22]. There is significant evidence of the effect of kinesitherapy on osteoarthritis, especially in the knee joint. Systematic surveys prove its positive effect on pain, function and general condition [23,24]. M. Fransen and McConnell, on the base of a meta-analysis of 32 randomized controlled trials involving 3626 patients within Cochrane Collaboration, find platinum stage of evidence that exercise reduces pain and improves function in gonarthritis, and the effect is comparable to that of non-steroidal anti-inflammatory agents [24,25]. Our study confirms the results obtained in the complex rehabilitation of patients with gonarthritis involving the application of Deep Oscillation® therapy. Onose G. et al. reported reduction in pain and improved movement in patients with osteoarthritis in a complex with targeted kinesitherapy [26].

6. CONCLUSION
The short-term effects of the application of Low-frequency and Low-intensive electrostatic field in complex with therapeutic exercises show reduction of clinical symptoms and improvement of daily functional activity in patients with knee joint osteoarthritis. Reduction of pain of rest and physical activity (walking, descending and climbing stairs) is observed, oedema is reduced, joint range of motion increases, immediately after completion of the therapeutic course. Because of the small number of patients included in the study for better objectifying of the effects of the low-frequency and low-intensity electrostatic field, the studies should continue. However, the short-term results of the observational study show that Low-frequency and Low-intensive electrostatic field (Deep Oscillation® therapy) and therapeutic exercises could be an effective option for functional recovery in the complex treatment and rehabilitation of patients with knee joint osteoarthritis.

BIBLIOGRAPHY