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The role of ultrasound in the recovery of patients with knee osteoarthritis

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Abstract
Osteoarthritis is a condition that causes pain and invalidity in people over 40. The patient feels pains, limitation of mobility, physical dysfunction, joint cramps, in stability and walking disorders. The study aims at assessing the effects of ultrasound application and at quantifying the results obtained in order to increase the patients' quality of life that were diagnosed with knee osteoarthritis. The objectives pursued in the study were: to reduce pain, to keep /increase joint mobility, to increase muscle strength, to reduce in stabilit, to minimize physical disability and to increase the patients' quality of life. The study was conducted in an ambulatory regime and respected ethical and deontological principles. The patients' assessment was performed at the beginning and at end of the treatment after 10 days and at the examination after 45 days. In the patients diagnosed with knee osteoarthritis it was found that the use of combined ultrasound, pulsed formed and kinetotherapy treatment in the study group allowed, in addition to the pain reduction, also the mobility and joint function increase, compared only to the kinetotherapy applied to the control group.
Key words: *osteoarthritis, ultrasound, kinetotherapy, disability,*

Introduction

Osteoarthritis is a condition that causes pain and invalidity in people over 40. It is the result of some changes at the cartilage level or it may be caused by trauma, body weight gain and muscle tone changes, especially in the quadriceps, due to metabolic or endocrine causes. The patient feels pains, limitation of mobility, physical dysfunction, joint cramps, in stability and walking disorders. Being a slow progressive disease, the cartilage goes through gradual changes with reduced mobility and the possibility of unfolding ADL. Here are some of the risk factors: age, obesity, traumatisms, low muscle strength, decreased proprioceptive sensitivity, repeated physical activity that affects tension at the muscular joint level, lack of D vitamin and endocrine factors.

The objectives followed in the study were: to reduce pain, to keep /increase joint mobility, to increase muscle strength, to reduce instability, to minimize physical disability and to increase the patients' quality of life. Ultrasound started to be used for therapeutic purposes in 1953, but until 1970 the data on the length, indications and contraindications of their use in physiotherapy were established. Research has shown that ultrasound can produce energy that is stored in tissues and can induce biological effects. A study [1] on data regarding the ultrasound therapeutic applications aimed at reviewing the operating mechanisms and the biological effects resulting from their use. Also, the ultrasound dosimetry was taken into account, its benefits minimizing the risk of side effects in order to obtain optimal results for the patient. Ultrasound can induce both warm and non-thermal effects, such as cavitation or mechanical stress [2],[3]. The use of ultrasound according to the coupling environment allows the transfer of some compounds at the skin level, which is called sonophoresis [4],[5].

Another study in 2010 [6] summarizes a review of the data on the use of ultrasound in physiotherapy. Out of 8 studies (in which 586 patients were involved) showed that the beneficial effects of ultrasound in physiotherapy were higher in 4 studies compared to 2 other studies that did not point out any benefit by using ultrasound. The following parameters were tracked: the length of symptomatology in patients, the use time of ultrasound, the number of treatment days and the total energy used in each treatment. In 2010, Shanks and colleagues [7] conducted a review of the 1975-2009 literature on the efficacy of ultrasound for therapeutic purposes for muscular skeletal disorders at the level of the lower limbs. Out of 15 studies, only 10 met the inclusion criteria and 1 of them was considered to be of high quality (16+ score), 3 studies of medium quality (11-15 score) and 6 studies of low-grade (score <10).

A study published in 2014 [8] pointed out the role of ultrasound continuously applied and in pulsed mode in accelerating the chondrogenesis process by increasing protein 70 in the rat's joint cartilage.

In knee osteoarthritis, a major public health issue, physical activity is recommended. A review published in 2015 [9] showed that benefits are greater in rehabilitation treatment when applying the individualized kinetotherapy program. Five randomized clinical studies were included for 620 patients. There has been a pain reduction appreciated by the visual analogue scale (VAS), an improved physical function after the WOMAC evaluation and an increased quality of life. The aging of the population, the increase in the number of patients with obesity and the sedentary lifestyle lead to an increase in the prevalence of knee osteoarthritis.

In another study published in 2015, three research teams evaluated 54 studies by following the results of using kinetotherapy elements in osteoarthritis, by assessing the pain, the physical function and the quality of life. The conclusions of the study show short-term benefits of physical exercise, between 2-6 months after the interruption of the pain treatment but also an improvement in physical function. The effects are comparable to the estimations reported for the NSAID.[10]

Ultrasound can have therapeutic effects on the biological tissues due to vibrations, producing thermal and non-thermal physiological effects. There are studies showing that the use of a 1 MHz frequency probe produces an average increase of 1.7 °C in the deep tissue. The ultrasound use involves gel for better coupling with the application area, generates more heat 5 minutes after the use , and the application depends on the area under treatment and the power density used. A rate of application of 7-8 cm/sec is recommended to ensure local warming.

If the thermal effect that is most effective in warming the collagen tissue from the dermis level is pursued, the applied ultrasound should have a higher intensity and the ultrasound will be done continuously. We are discussing about increasing the tissue temperature to 40-45 °C, resulting in plethora, with a role in chronic inflammatory conditions.

Within the inflammatory process, the ultrasound stimulate the phagocytic role of macrophages, but also act on mast cells and platelets , the degranulation of mast cells is produced with arachidonic acid-releasing, which is before the synthesis of prostaglandins and leukotrienes that act as inflammatory mediators. Ultrasound acts as an "inflammatory optimizer", and the inflammatory response is essential in the tissue repair.[12] In addition to this effect, ultrasound is also the promoter of the proliferative phase, and their action is shown especially on dense collagen tissue.[13]

It has been found that ultrasound applied in a low-dose pulse mode have a role in increasing the protein synthesis, and some studies showed the role of ultrasound in collagen synthesis. Ultrasound play a role in the remodelling of scar tissues whereas the colagen is modified from type III to type II, increasing the traction resistance and the scar mobility, a process which is of average or long duration, of one year or even more. In 1996, a BYL study showed that ultrasound has the ability to influence the orientation of collagen fibers.[14],[15]

The therapeutic effects of ultrasound were proved in knee arthrosis [16], based on Cochrane studies' results and in patello-femoral syndrome. [17] In arthritis, ultrasound was used due to the action on biomolecules. [18] The collagen is a spiral multiple protein, which contains glycol, proline and oxiproline, presenting tendons in the conjunctive tissue and form of fibres in the dermis. As a result of the ultrasound application, the cleavage of the polypeptide bonds is produced; the configuration of the protein spiral is modified, indicating that these macromolecules are sensitive to the action of ultrasonic waves. [19]

Purpose

The study aims at assessing the effects of ultrasound application and at quantifying the results obtained in order to increase the patients' quality of life that were diagnosed with knee osteoarthritis.

Material and method

A BTL series device was used to produce electrotherapy and ultrasonic currents with a frequency of 1 MHz. The ultrasound intensity was between 0.4-0.6W / cm². The application was pulsed and the kinetic method was applied for 6 minutes daily. A non-steroidal anti-inflammatory gel-like has been used. Kinetotherapy included physical exercises to tone the muscles and to increase joint mobility. It was taken into account that exercises performed on the bicycle do not subject the knees to an additional load.

A number of 115 patients in the study and diagnosed with knee osteoarthritis were treated within the ambulatory regime. The inclusion criteria in the study were the following: age between 45-74, clinical and radiological diagnosis of knee osteoarthritis, the presence of at least one painful

episode, patients without other comorbidities and patients who agreed to participate in the study. The exclusion criteria were: age under 45 and over 74, chronic conditions in compensated/ decompensated stages, mental illnesses and patients' refusal to participate in the study. All the patients received pharmacological treatment consisting in non-steroidal anti-inflammatory, relaxing, neurotrophic, antioxidant, dietary supplements containing glucosamine and chondroitin.

The patients were divided into two groups:

-the study group that received pharmacological treatment, ultrasound and kinetic therapy

-the control group that received pharmacological treatment and kinetic therapy

The patients' assessment was performed at the beginning and at end of the treatment after 10 days and at the examination after 45 days.

The assessed parameters were: pain, joint mobility, physical dysfunction, in stabilit and quality of life. For this purpose, the following were used: for pain, the VAS visual analogue scale, the WOMAC scale that evaluated the pain, rigidity, the functionality, and the QOL scale for the quality of life. The average values and the standard deviation were calculated, and the "t-student" test was used to compare the mean values of the quantitative variables.

Demographic data

The study group comprised 56 patients, of which 32 (57.14%) female patients and 24 (43.86%) male patients. The group control had 59 patients, of which 31 (52.54%) female patients and 28 (47.46%) male patients. The data were registered in Table no.1)

Tabel no. 1. Distribution of patients in the two groups

Group	Sex	Number	%
Study	female	32	57.14
group	male	24	43.86
Control	female	31	52.54
group	male	28	47.46

Depending on the age, it is found that most of the patients were in the 55-64 age group, respectively 26 patients in the study group and 25 in the control group, followed by the age group 50-59 years with 21 patients in the control group and 17 patients in the study group, and in the 45-54 age group there were 13 patients for each group. The data can be found in Table no 2.

Table no. 2. Distribution of patients per age group

Group	Sex	45-54	55-64	65-74	Total
Study	female	8	14	10	32
group	male	5	12	7	24
Study	female	7	13	11	31
group	male	6	12	10	28
	Total	26	51	38	115

Results

After the assessment based on assessment scales, the following were found in the study group: pain reduction, measured by VAS and Womac scales, rigidity and physical dysfunction reducing, which led to an increase in the quality of life of the patients. (Table 3)

Table no. 3. The evolution of pain, rigidity and the quality of life in the study group

Scale/	Study group (with ultrasound)		
Index	Initial	Final	Control
VAS	7 ± 1.3947	4.5 ± 0.9326	3 ± 0.4439
Pain Womac	14 ± 1.0592	10 ± 0.4439	6 ± 0.5393
Rigidity Womac	7 ± 0.4558	5 ± 0.4261	3 ± 0.4558
Physical function Womac	30 ± 10.5217	20 ± 6.8542	15 ± 2.5645
QOL	87 ± 8.2263	68 ± 8.4654	56 ± 8.3682

The results of the t-student test for the study group are also statistically significant for all the parameters assessed, as it can be found in Table no. 4.

Table no. 4 Evolution of the t-student test for evaluation parameters in the study group

Scale/t-student test	initial-final	final-control	initial-control
VAS	0.0345	0.0302	0.0156
Pain Womac	0.0154	0.0321	0.0079
Rigidity Womac	0.0154	0.0353	0.0085
Physical function Womac	0.0461	0.0302	0.0196
QOL	0.0092	0.0062	0.0012

In the control group, after the application of the assessment scales, there is a reduction in pain, evaluated by VAS and Womac scales, improvement in the joints functionality and decreasing its rigidity, contributing to the quality of life which was appreciated by the QOL scale. (Table 5)

Table no. 5 The evolution of pain, rigidity, and the quality of life in the control group

Scale/	Control group (without ultrasound)		
Index	Initial	Final	Control
VAS	6 ± 1.4031	4 ± 1.4663	3 ± 1.0838
Pain Womac	14 ± 1.1599	10 ± 0.56775	5 ± 0.5368
Rigidity Womac	6 ± 0.4644	4 ± 0.4983	2 ± 0.4644
Physical function Womac	45 ± 13.5791	30 ± 5.6598	15 ± 1.3141
QOL	68 ± 11.8283	65 ± 9.4453	55 ± 8.7475

As a result of the t-student test, the results are statistically significant for the VAS and QOL scale for all the assessment moments except for the Womac scale for pain, rigidity and physical function for final-control, where $p > 0.05$, as shown in the table 6.

Table no. 6. The evolution of the t-student test for the assessment parameters in control group

Scale/t-student test	initial-final	final-control	initial-control
VAS	0.0352	0.0267	0.0138
Pain Womac	0.0157	0.0543	0.0135
Rigidity Womac	0.0228	0.0641	0.0189
Physical function Womac	0.0407	0.0676	0.0345
QOL	0.0006	0.0048	0.0009

Conclusions

After the complex treatment of ultrasound and kinetic therapy, the following were noticed:

-the reduction of pains

-the improvement of the joint mobility

-the increase in stability and ensuring static and dynamic balance

-the increase in muscle strength and muscle tone

- the individualized application of recovery treatment is important.

Discussions

In the patients diagnosed with knee osteoarthritis it was found that the use of combined ultrasound, pulsed formed and kinetotherapy treatment in the study group allowed, in addition to the pain reduction, also the mobility and joint function increase, compared only to the kinetotherapy applied to the control group. The obtained results were statistically significant in the study group for all the assessment moments compared to the control group where statistically insignificant results for the Womac scale at the final-control evaluation times, possibly on the one hand the non-application of ultrasound within the recovery program, but also due to the non-continuation of the kinetic therapy treatment at home, as indicated by the physical therapist.

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