BALNEO RESEARCH JOURNAL
English Edition
eISSN 2069-7619 pISSN 2069-7597
ROMANIAN ASSOCIATION OF BALNEOLOGY

The study on the importance of effects after the ultrasound use in the recovery of patients with lower lumbar discopathy

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Balneo Research Journal DOI: http://dx.doi.org/10.12680/balneo.2018.227 Vol.9, No.4, December 2018 p: 433–437

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Abstract
The low back pain is a public health problem, affecting the adult population and the young one. It is estimated that 90% of the population will experience at least one episode of lower lumbar pain during their lifetime, half of whom may have a second painful episode during the same year. Frequently, the mechanical cause (the pain is somatic and deep, caused by lesions in the musculoskeletal tendon or ligament, in non-specific degenerative or inflammatory diseases) but also the psychosocial factors are incriminated. In low back pain, ultrasounds were used for the analgesic effect, muscle relaxing and for the hyperemia effect. The paper has as purpose the study of the effects of applying ultrasound in relieving symptoms of the low back pain. The physical therapy had the purpose of relaxing the muscles in the sub-acute phase, stretching the paravertebral muscles, relaxing the pelvis, toning the abdominal muscles, stretching the psoas-iliac and the sciatic muscles. All the patients received pharmacological treatment consisting in non-steroidal, neurotrophic anti-inflammatory medicines. The evaluation of the patients was performed at the beginning and at the end of the treatment after 10 days and at the examination after 3 months. For the two groups (study and control), the assessment was made on the basis of some indices and scales, where statistically significant results were obtained in both groups, especially for the group receiving the ultrasound treatment (the pulsed form to avoid the thermal effect) and kinetotherapy.
Key words: *low back pain, ultrasound, kinetoteraphy, physical therapy,*

Introduction

The low back pain is a public health problem, affecting the adult population and the young one. It is estimated that 90% of the population will experience at least one episode of lower lumbar pain during their lifetime, half of whom may have a second painful episode during the same year.[1] There are some studies which show that in the developed countries 1 out of 5 adults claim lower lumbar pain, the prevalence being in England of 40% and in USA of 7-25%. Male adults are more likely to get sick. Frequently, the mechanical cause (the pain is somatic and deep, caused by lesions in the musculoskeletal tendon or ligament, in non-specific degenerative or inflammatory diseases) but also the psychosocial factors (Wadell considers low back pain as being determined by dysfunctions at the level of the soft tissue) are incriminated. The risk factors associated with the painful lumbar syndrome are related to the living environment, but also to the social demographic, occupational and psychological backgrounds.

O 'Brien synthesized in a study the biophysical mechanisms of ultrasound in 2007 [2]:

-thermal and non-thermal effects (in correlation with the amplitude of the waves)

-absorption – a part of the ultrasound wave is turned into heat

- non-thermal effects –generated by the acoustic cavity

- the mechanism of cavitation - which includes the force of radiation, the shock waves and the free radicals.

When the ultrasonic wave has a continuous emission, its frequent exposure parameters, intensity and strength are monitored, and when the ultrasonic wave is pulsatile, the shape of the impulse, the duration and the recurrence frequency are also taken into consideration besides the frequency.

DURMUS communicated in 2013 the results of a study showing the effects of ultrasound and medication use along with physical exercise in relieving pain, disability, walking ability, mobility, and the quality of life for the people with lower lumbar pain.[3] A study in 2008 by SRBELY [4] analyzed 313 articles published between 1985-2008, which monitored the therapeutic effects and mechanisms of ultrasound. Seventeen studies met the methodological criteria. Five out of these studies showed the positive effects of ultrasound, nine showed the beneficial effects on pain and functional changes, and five articles showed the effects of cartilage healing, also proving an increased intraarticular absorption of molecules with high weight (hyaluronic acid) under the action of sonophoresis.

Ultrasound therapy is used continuously (the emitted energy has maximum capacity) and the pulsating or pulsed form (it has the advantage of reducing the thermal effect and potentiates the relaxing one, allowing “tissue restoration” and avoiding adaptation).[5]

By using ultrasound according to the coupling environment, the transport of compounds at the skin level is allowed, a method called sonophoresis.[6] The therapeutic ultrasound used in physiotherapy has a low risk of side effects. The biological effects of the ultrasound are obtained by applying low intensities.[7] A study published in 2003 [8] identifies intramuscular temperature changes (depending on the intensity and duration parameters), depending on the ultrasound application devices. In this study, the ultrasound was applied by using 3 application devices with a frequency of 3 MHz and a power of 1.5W / cm² for 10 minutes and there were determined the temperature (° C), the duration (seconds) at a depth of 1,6 cm below the work surface. Only for one device a record of intramuscular temperature of over 40°C was found even in a shorter period of time, namely under 6 minutes after the application. Other studies identified modifications of temperatures at the surface of the tegument after the use of ultrasound. [9] One objective of using ultrasound within physiotherapy is the heat generation. A 2017 study [10] after the heating process at the interfaces near the transducer and the bone (skin/fat tissue, fat tissue/muscles, muscles/bone) by using computer simulation and materials that imitate tissues (ghosts). The termocouple monitoring on a computational model and experimental parameters in the COMSOL R software platform were used. The results showed for a 10 mm depth a temperature increase of 42°C regardless of the presence of the bone, possibly due to the warming of the transducer and the interference phenomena. For the area near the bone, the temperature increase was of 6 °C, lower than the provided one (21 °C). By increasing molecular vibrations in the tissue, ultrasounds can generate heat, so they also have a thermal component, although this is not the first effect in therapy. [11] As for the ultrasound, the frequency of 1 or 3 MHz , the distance between 2 equivalent points on the waveform of the respective environment, which may be 1.5 mm at a frequency of 1 MHz and 0.5 mm at a frequency of 3 MHz will be taken into account. The coupling environments have the purpose of minimizing the impedance difference for the interfaces and of eliminating the air spaces between the transducer and the skin. These coupling environments may consist in water, oils, creams or gels. It is believed that a good coupling environment has to fill all the air voids, in order to be relatively viscous, to have appropriate impedance to the environment it connects, and to transmit ultrasounds with minimal absorption. It seems that gel environments are the most preferred.[12],[13] The ultrasound manifests reflectie properties (which take place due to impedance differences) and refraction properties (in case the fascicle does not reach the limit of 90°). It seems that the refraction will occur at an angle of 15° at the skin interface .[14] Another property of the ultrasound is the absorption, a large proportion being absorbed and only a small portion of the energy remains in order to obtain the therapeutic effects. As for the used method, most clinicians prefer the pulsed form or the impulses.[15] The impulse duration was of 2 ms and there are several possibilities of using this form: 1:1 and 1:4. In 1:1 mode, the 2 ms duration is followed by the 2 ms shutdown time, and in the 1:4 mode, the action time is 2 ms and the shutdown time is of 8 ms. This treatment is mainly used in acute conditions. When calculating the dose, the operating cycle will be taken into account (% of the time the device is running) which is 50% for mode 1:1 and 20% for mode 1:4. Over the past 15 years, some researchers have focused on the non-thermal effects. As the results of cavitation and acoustic streaming, the cell membrane becomes “stimulated” and increases the activity level for the cell. The potential of the cell membrane is modified along with the modification of transport of Na, Ca and the control mechanisms of enzymes involved in metabolic processes on protein synthesis are also modified. Ultrasound acts as a trigger of these processes, whereas the increase in the cellular activity is a benefit of using ultrasounds. [16] In low back pain, ultrasounds were used for the analgesic effect, muscle relaxing and for the hyperemia effect.[17]

Purpose

The paper has as purpose the study of the effects of applying ultrasound in relieving symptoms of the low back pain.

Material and method

A BTL series device that produces ultrasound with a frequency of 1 MHz was used. This frequency has been chosen because it is known that there is a connection between the absorption of the energy emitted and the frequency of application. At high frequency, the energy is absorbed especially at the surface and does not reach the target area, whereas at low frequency, the ultrasound goes deeper with energy dissipation on its trajectory. The ultrasound intensity was between 0.2-0.5W / cm². The physical therapy had the purpose of relaxing the muscles in the sub-acute phase, stretching the paravertebral muscles, relaxing the pelvis, toning the abdominal muscles, stretching the psoas-iliac and the sciatic muscles. Within the chronic phase there has been an emphasis on toning the abdominal, paravertebral muscles. The used methods were Williams and Niederhöffer-Becker.

A number of 82 patients were registered in the study under ambulatory regime, patients diagnosed with low back pain. The inclusion criteria in the study were the following: the age between 30-60, painful and functional symptoms clinically and radiologically determined, the presence of at least one painful episode in the lumbar area, no comorbidities, the patients consent to participate in the study. The exclusion criteria were the following: the age under 30 years and over 60, associated chronic conditions, neuro-psychic disorders, the patients' refusal to participate in the study.

All the patients received pharmacological treatment consisting in non-steroidal, neurotrophic anti-inflammatory medicines.

The patients were divided into two groups:

-the study group that received treatment by ultrasound and kinetotherapy

-the control group that received only kinetotherapy

The evaluation of the patients was performed at the beginning and at the end of the treatment after 10 days and at the examination after 3 months. The supervised parameters were: pain, mobility, physical dysfunctions, quality of life. For this, the following were used: for pain, the VAS visual analogue scale, for mobility, the Schober Index and the Roland Morris Scale, for quality of life, the QOL Scale. The average values and the standard deviation were calculated, and the "t-student" test was used in order to compare the mean values of the quantitative variables.

Demographic data

The study group included 40 patients, of which 21 (52.5%) female patients and 19 (47.5%) male patients. The group control had 42 patients, of which 20 (47.61%) female patients and 22 (53.39%) male patients. (Table no.1)

Table no.1 Distribution of patients per groups

Group	Sex	Number	%
Study	female	21	52.5
group	male	19	47.5
Control	female	20	47.61
group	male	22	53.39

A number of 22 (55%) from the study group were from the urban area and 18 (45%) from the rural area, while in the control group 26 patient were from the urban area, (61.9%) and 16 patients from the rural area (38.1%). (Table no. 2)

Table no. 2 Distribution of patients according to the living environment

Group	Area	Number	%
Study	urban	22	55
group	rural	18	45
Control	urban	26	61.9
group	rural	16	38.1

As for the age groups, it is noticed that most of the patients fit into de 40-49 age category, namely 20 patients in the control group and 19 in the study group, followed by the 50-59 age category with 12 patients in the control group and 11 patients in the study group. For the 30-39 age category, each groups had 10 patients. (Table no. 3)

Table no. 3 Distribution of patients per age categories

Lot	Sex	30-39	40-49	50-60	Total
Group	female	5	10	6	21
Study	male	5	9	5	19
group	female	6	9	5	20
Control	male	4	11	7	22
	Total	20	29	20	82

Results

For the study group, after the application of indices and assessment scales the following were found: a significant decrease of pain, assessed by the VAS scale, the increase of the lumbar spine mobility, assessed by Schober index, the fingers-ground index and the Roland-Morris scale. Significant results were also found in the increase of the quality of life with the aid of the QOL scale. (Table 4)

Table no. 4 Evolution of parameters in the study group

Scale/	Study group (with ultrasound)		
Index	Initial	Final	Control
VAS	6.5 ± 1.1368	4 ± 0.2265	2.5 ± 0.1581
Fingers-ground index	40 ± 9.7058	30 ± 5.2939	18 ± 1.0669
Schober index	3.5 ± 0.3678	4 ± 0.3789	4.5 ± 0.3614
Roland-Morris	15 ± 2.5459	13 ± 2.4931	10 ± 1.7029
QOL	77.5 ± 12.1397	68 ± 10.0108	56 ± 9.9352

The results of the t-student test are also statistically significant for all the indices taken into consideration, as it can be found in Table 5.

Table no. 5 The evolution of the t-student test for the assessment parameters in the study group

Scala/test t-student	initial-final	final-control	initial-control
VAS	0.0377	0.0276	0.0169
Fingers-ground index	0.0187	0.0409	0.0039
Schober index	0.0027	0.0021	0.0001
Roland-Morris	0.0037	0.0131	0.0011
QOL	0.0031	0.0065	0.0004

Statistically significant results for all the assessment moments are noted for all the evaluated parameters. For the control group, following the application of indices and the assessment scales the following are noticed: a significant decrease of pain, assessed by the VAS scale, the increase of the lumbar spine mobility, assessed by Schober index, the fingers-ground index and the Roland-Morris scale as well as significant results in the quality of life with the aid of the QOL scale. (Table 6)

Table no. 6 The evolution of parameters in the control group

Scale/	Control group (without ultrasound)		
Index	Initial	Final	Control
VAS	6.5 ± 1.0874	5 ± 0.8083	3 ± 0,7152
Fingers-ground index	40 ± 9.1286	33 ± 6.4662	22 ± 3.8379
Schober index	3.5 ± 0.3795	3.5 ± 0.4547	4 ± 0.4215
Roland-Morris	15 ± 2.7133	14 ± 2.5803	13 ± 2.2861
QOL	68 ± 12.2593	65 ± 9.5533	60 ± 8.9196

The results of the t-student test are also statistically significant for all the indices taken into consideration and for all the assessment moments, as it can be found in Table 7.

Table no. 7 The evolution of t-student test for the assessment parameters in the control group

Scala/test t-student	initial-final	final-control	initial-control
VAS	0.0121	0.0418	0.0089
Fingers-ground index	0.0178	0.0292	0.0085
Schober index	0.0007	0.0028	0.0002
Roland-Morris	0.0009	0.0011	0.0002
QOL	0.0006	0.0011	0.0001

Conclusions

For the two groups (study and control), the assessment was made on the basis of some indices and scales, where statistically significant results were obtained in both groups, especially for the group receiving the ultrasound treatment (the pulsed form to avoid the thermal effect) and kinetotherapy. Applying the two elements of therapy resulted in pain reduction, increased mobility and flexibility of the lumbar spine and increased quality of life, especially in the study group, the results being statistically significant with $p < 0.05$ for the scales and the assessment index used.

The individualization of ultrasound and kinetotherapy treatment has favorable recovery effects and has allowed significant results to be obtained.

Discussions

After the combined treatment of ultrasound and kinetotherapy, the pain was reduced, the articular mobility was increased at the lumbar region level, the improvement in the abdominal and paravertebral muscular tone was found. After the use of ultrasound as pulsed form, non-thermal effects were found especially at the local level with the emphasis of the analgesic, relaxing effect.

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