Study on Changes in Some Physiological Parameters Under the Action of Therapeutic Ultrasound

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Low back pain (LBP) is a disease with a high socio-economic and medical impact. Recovery treatment is complex and includes medication (NSAIDs, analgesics, muscle relaxants), physiotherapy and kinesiology. Ultrasound is one of the electrotherapy procedures applied due to its analgesic effects, muscle relaxing properties and massage. The study assesses the evolution of temperature and the number of red blood cells after the application of ultrasound of different intensities and ways. The results are statistically significant for some parameters. Limitations of the study are determined by the relatively small number of study patients, but the results could form the basis of further research.

Keywords: ultrasound, study, physiological parameters

In physiotherapy practice, back pain is the most common complaint, affecting most adults [1]. The treatment is based on rest, administration of nonsteroidal antiinflammatory drugs, medical gymnastics and application of physiotherapy procedures [2].

There is an increasing trend in the use of ultrasound in the management of pain [3].

Ultrasound used in this therapy is based on mechanical waves that oscillate at a frequency of $8x10^5$ Hz and when applied to the target tissue, they produce mechanical, thermal, chemical and biological effects. The biological effects of ultrasound depend on the applied intensity [4]. The most common are: increased cell membrane permeability, vasodilation and hyperemia in connective tissue.

Depending on the dose and duration of administration, ultrasound can produce reversible or irreversible effects at tissue level, but also effects on oxidant/antioxidant balance [5]. Of the physiological effects of ultrasound, we mention: fibrolytic effects and cell membrane permeability, increased redox processes accompanied by local vasodilatation, analgesic-like effects, anti-inflammatory effects due to mechanical vibrator response, local vasodilation by stimulating blood circulation [6].

Low back pain is manifested by the appearance of muscle contraction and nerve impulse transmission problems. Calcium and magnesium ions play a vital role in these events, being necessary to determine total calcium and magnesium in serum [7, 8].

The ultrasounds influence the periosteal reconstruction, affecting vasodilation, venules formation and vascular permeability [9][.

Red blood cells are the most numerous cells in blood, being needed for tissue respiration. They contain hemoglobin which, in normal circumstances, represents 33% of the content of erythrocytes. Reference range for red blood cells is 4.5 to 5.5 x 106 / mL, but it should be noted that this range varies by geographic area, age, diet, climate zone [10].

There are contraindications to ultrasound treatment when patients have skin allergies, dermatitis or skin hematoma or when they have already participated in other forms of complementary physiotherapy [11].

Experiemntal part

We aimed at studying ultrasound effects in the treatment of low back pain recovery. The equipment used for the application of ultrasound was the Chattanooga combine.

The study was retrospective and included 65 patients aged between 18 and 60 years with acute onset of LBP and who came to the doctor for diagnosis and treatment.

Recovery treatment included medication (NSAIDs, analgesics, muscle relaxants), physiotherapy and kinesiology. All patients received the same medication. Also, the same kinesiology procedures were applied to all patients.

Group 1 consisted of 31 patients who received continuous ultrasound in direct coupling using neutral gel. US treatment was applied in the first 5 days with an intensity of 0.3 W/ cm² and in the next 5 days with intensity of 0.7 W/ cm².

The second group, consisting of 34 patients was treated with pulse-mode US in direct coupling using neutral gel. US were applied in the first 5 days with an intensity of 0.3 W/ cm² and in the next 5 days, with the intensity of 0.7W/ cm².

Variables and time of measurement were identical in both groups.

It has been determined the number of red blood cells in peripheral blood before exposure to ultrasound, after 5 days of treatment and at the end of the 10 days of exposure to US. Skin temperature was also measured immediately after the end of ultrasound therapy. To determine the temperature, contact infrared thermometer was used.

For the dynamic assessment of the number of red blood cells, peripheral blood was collected which was analysed in an accredited medical laboratory.

Initial moment (IM) is the baseline at which values were collected before treatment.

F1 is the time, 5 days after treatment, when temperature readings and the number of red blood cells are collected,

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at the end of applying US of an intensity of 0.3 W/ cm² and at the beginning of applying the dose of 0.7 W/ cm².

F2 is the time, 10 days after treatment, when temperature readings and the number of red blood cells are collected, at the end of applying US of 0.7 W / cm².

Results and discussions

Demographic data of the study groups G1 and G2 are shown in the (fig. 1).

For G1, the number of red blood cells in peripheral blood was determined before exposure to ultrasound (IM) after 5 days of treatment (F1) and at the end of 10 days of treatment (F2) (table 1).

Also, the temperature was measured in three significant moments for our study.

Skin temperature, measured by direct contact, increased from 33.8^{0}C to 37.1^{0}C by applying continuous ultrasound of different intensities (table 2).

For group G1, the number of red blood cells in peripheral blood was determined before exposure to ultrasound (IM), after 5 days of treatment (F1) and at the end of 10 days of treatment (F2) (table 3).

For group G2, skin temperature was measured in those three significant moments of our study.

Skin temperature, measured by direct contact, increased from 33.8 to 37.1^{0}C by applying pulse-mode ultrasound of different intensities (table 4).

If we study the evolution of student t-test values for the two groups of patients, we will get the values presented in table 5.

For G1, where continuous ultrasound was applied, evolution of temperature parameter between IM and the end of treatment (F2) was extremely statistically significant.

In group G2, where pulse-mode ultrasound was applied, the evolution of temperature was statistically significant only after applying ultrasound of a higher intensity.

Analysing the evolution of the number of red blood cells parameters in G1, we note that it is statistically significant at F1 and extremely statistically significant at end of treatment (F2).

Evolution of the number of red blood cells parameter is statistically significant in group G2.

Student t-test that compares the results obtained for G1 for different time intervals, measurements, shows statistically significant results for all moments.

For G1, temperature increase during treatment is accompanied by decreasing the number of red blood cells.

After applying student t-test to compare the final results obtained for the two groups G1 and G2, (fig. 2) we note a

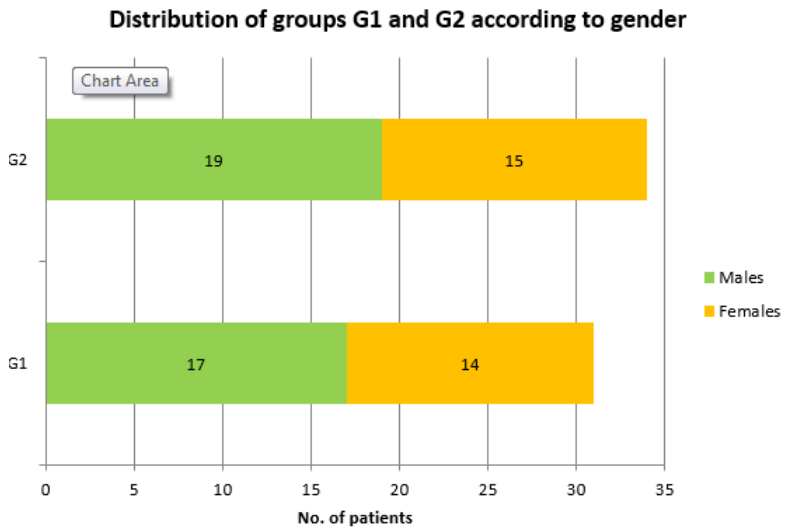

Fig. 1. Distribution of groups G1 and G2 according to gender

Table 1

EVOLUTION OF THE NUMBER OF RED BLOOD CELLS PARAMETER IN GROUP G1

Statistic functions L1	Number of red blood cells - IM 10^6/ µL	Number of red blood cells - F1 10^6/ µL	Number of red blood cells - F2 10^6/ µL
Median	5.5	5.2	4.5
Standard deviation	0.123091491	0.197414113	0.13292097

Statistic functions L1	Temperature -IM ^{0}C	Temperature - F1 ^{0}C	Temperature - F2 ^{0}C
Median	33.8	36.8	37.1
Standard deviation	0.223252989	0.237077063	0.205459093

Table 2

EVOLUTION OF TEMPERATURE PARAMETER IN GROUP G1

Statistic functions	Number of red blood cells - IM 10^6/ µL	Number of red blood cells - F1 10^6/ µL	Number of red blood cells - F2 10^6/ µL
Median	5.5	5.1	4.9
Standard deviation	0.100711753	0.154611649	0.245919073

Table 3
EVOLUTION OF RED BLOOD CELLS PARAMETER IN GROUP G2

Statistic functions L2	Temperature - IM ^{0}C	Temperature - F1 ^{0}C	Temperature - F2 ^{0}C
Median	33.7	34.3	36.2
Standard deviation	0. 38357714	0.183225076	0.190613046

Table 4
EVOLUTION OF TEMPERATURE PARAMETER IN GROUP G2

Comparison interval /t-student	Temperature Group G1	Temperature Group G2	Number of red blood cells Group G1	Number of red blood cells Group G2
MI-F1	0.001689896	0.005006749	0.011474449	0.030441468
F1-F2	0.001436975	0.002192216	0.017981183	0.016622834
MI-F2	1.61047E-05	0.001904243	0.001416999	0.013957731

Table 5
EVOLUTION OF STUDENT-T TEST VALUES IN GROUPS G1 AND G2

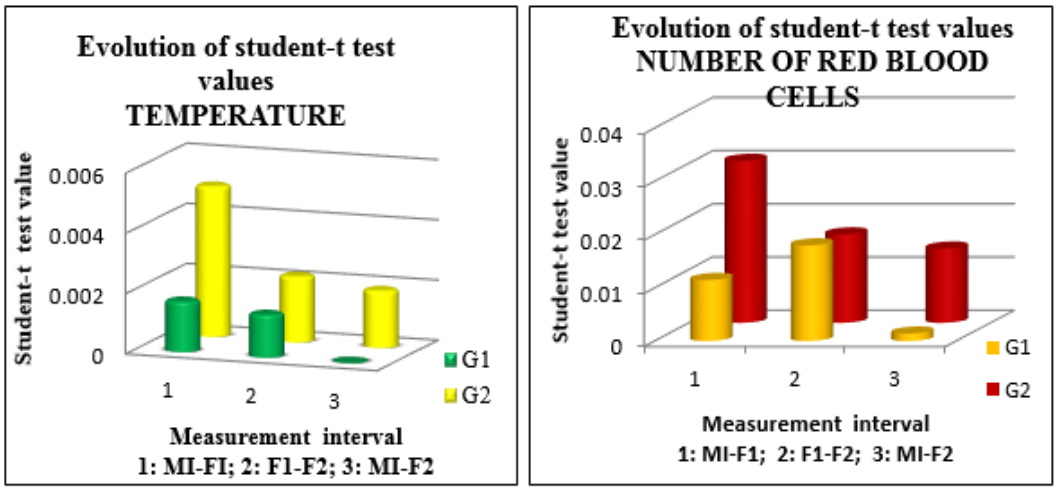

Fig. 2. Evolution of student-t test values in groups G1 and G2. a. Temperature b. Number of red blood cells

statistically significant link, with p-value <0.05, both for skin temperature measurements and for red blood cells.

Conclusions

The two study groups were homogeneous in terms of number of patients and gender.

Comparing the evolution of studied parameters, due to exposure to ultrasound applied in different modes: continuous and pulsed, it has been found a lower number of red blood cells and increased local temperature.

Upon temperature increase during ultrasound treatment, metabolism intensification occurs which causes a transient reduction in the number of red blood cells, reduction that occurs in the collected data as a false decrease.

Limitations of the study are given by the small number of patients included in the study, longer-term clinical trials being required to verify the persistence of effects brought by ultrasound therapy for clinical improvement.

Most often, pulse-mode ultrasound is used due to the fact that the effect is more easily controllable and less thermal effects occur.

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Manuscript received: 29.12.2016