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Therapeutic Ultrasound and Pain in Degenerative Diseases of Musculoskeletal System

Mirsad Muftic[1], Ksenija Miladinovic[2]
Faculty of Health Sciences, University of Sarajevo, Bosnia and Herzegovina[1]
Clinic for Physiotherapy and Rehabilitation, Clinical Centre of Sarajevo University Sarajevo, Bosnia i Herzegovina[2]

Corresponding author: Mirsad Muftic, MD, PhD. Faculty of Health Sciences, University of Sarajevo, BiH. Sarajevo. Bosnia and Herzegovina.
E-mail: mhs@bih.net.ba

Original paper
ABSTRACT
Introduction: Therapeutic ultrasound is a physical modality which is constantly expanding range of indications. Analgesic effect of ultrasound is still under discussion. Regardless the extensive application of pulsed ultrasound of low intensity, continuous ultrasound has a better analgesis effect, which is explained by its mechanism of action. **Aims:** The main research objective of this study was to determine the effect of continuous ultrasound to pain caused by degenerative diseases of the musculoskeletal system in the intensity and duration of ultrasound treatment. Other objectives are entailed determining the correlation between the degree of pain reduction with: location of pain, age, gender and body mass index (BMI). **Material and methods:** The study included 68 patients with chronic pain localized in the region of the spine or major joints of the extremities, depending on the localization of the degenerative changes. Patients are divided into two groups. The first group was treated with 10 applications of continuous ultrasound with frequency of 1 MHz, intensity 0.4 W/cm2 for 8 minutes, and the other group with 10 applications of ultrasound with frequency of 1 MHz, intensity 0.8 W/cm 2 for 4 minutes. **Results and Discussion:** Pain intensity was assessed before and after ultrasound therapy performed by subjective visual analogue scale (VAS) for pain, numbered from 0-10, where 0 is the rating for the state of no pain, and 10 grades for severe pain. The average VAS improvement in the first group was 3.97, and 4.74 in second one. The results of F (1.66) = 2.93, p = 0.09 analysis of variance showed no significance difference between the average improvement of two groups. Correlation between the degree of pain reduction showed significance only with BMI, or that higher BMI is associated with a lower degree of pain reduction. The results of this study showed that application of continuous ultrasound in patients with chronic pain, caused by degenerative changes in the musculoskeletal system, led to a significant reduction in pain. Different intensity and duration of ultrasound application showed no significant effect on the degree of pain reduction. Body mass index showed significant negative correlation with the degree of pain reduction, but age, gender and location of pain did not show significant correlation.
Key words: therapeutic ultrasound, musculoskeletal pain.

1. INTRODUCTION

World Association for the study of pain – IASP (International Association for the Study of Pain) has decided that in the 2009/2010 year focuses on musculoskeletal pain (MP) because it is an enormous problem that affects millions of people worldwide. Compared to other types of pain, the highest number of people in the world experience exactly MP (1).

Problem of musculoskeletal pain is complex and includes different types of pain, whether it is about an anatomical location of the pain, or about subjective sensations that occur in a patient. So MP, among others, includes neck pain, pain in the limbs, bone pain, chronic generalized pain, described as "drilling ", "boring" or "tightening". It can be acute (the injury) or chronic (in rheumatoid arthritis), mild or strong, local or diffuse.

Clinical types of MP can be represented as: bone (injuries, tumors, degenerative disease), muscular (injury, autoimmune disorders, circulatory disorders, infections, tumors), tendon and ligamentary (injuries, mechanical inflammation due to over use), fibromyalgic (includes muscles , tendons, fascia, ligaments, joint capsules), arthritic (autoimmune diseases, degenerative diseases, infections, metabolic disorders, a vascular disorders, conditions after injuries), bursatic (infections, fibromyalgia) and projecting (in diseases of the internal organs).

Factors contributing to the higher incidence of MP are: increase in the elderly population, sedentary lifestyle and increased incidence of obesity.

Basic characteristics of MP are: a) deep tissue hyperalgesia (localized or generalized),

b) abnormal muscle function, c) projecting pain to distant somatic structures, and d) the transition from acute to chronic pain.

Pathophysiologicaly, MP sensation is result of activation of polimodal muscle nocioceptors from group III (A δ fibers) and from group IV (C fibers) (2).

These nocioceptors can be sensitized by release of neuropeptids from the nerve endings, which eventually leads to hyperalgesia and central sensitization of neurons of posterior horn of spinal cord, manifested as prolonged neuronal discharge, as increased response to defined noxious stimulus , as well as respond to un noxious stimulus, and as expansion of the field of sensitivity (2).

Clinical tests that are commonly used to evaluate the MP and assess patient functionality are: VAS (visual analogue scale), GFS (General functional scores), RMDS (Roland and

Morris Disability Scale), OPDI (Oswestry Pain Disability Index), MPQ (McGill Pain questionnaire).

MP therapy involves pharmacological and non-pharmacological treatment. In non-pharmacological treatment, especially for chronic MB, physical modalities are of great significance, and they are in combination with patient education, cognitive therapy and psychosocial training. TENS (Transcutaneous electronerve stimulation), acupuncture, ultrasound, thermal modalities (hot and cold compresses), manual therapy (manipulation, massage) and the exercises are physical modalities that are commonly used in this indication field.

Therapeutic ultrasound (UZ) is a physical modality that has the broadest application and is commonly used in clinical practice. In the last decade its use has changed. Earlier, it was primarily used for its thermal effect, and is now it increasingly used for nonthermal effects, especially in the reconstruction of soft tissue, wound healing and the healing of bone fractures. Thermal effects are attributed to the continuous UZ and nonthermal effects to the pulsed UZ of small intensity (LIPUS Low-Intensity Pulsed Ultrasound).

In addition to these biophysical effects of therapeutic UZ, his secondary physiological effects must not be forgotten, among which is the first analgesic effect, followed by a spasmolytic, anti-inflammatory, simpaticolitic , tissue regulation and trophic effects, improving microcirculation, increasing permeability of the cell membrane, increasing the biosynthesis of proteins , the regulation of muscle tone and improving the cell metabolism.

The greatest analgesic effect is attributed to the thermal effect of ultrasound because it leads to increased metabolic activity in the tissue, improving circulation and relaxation of rigid structure of the soft tissues, especially in degenerative musculoskeletal system.

As previously mentioned, the continuous therapeutic ultrasound has a pronounced thermal effect.

Systematic reviewed study that is included in the Cochrane database from 2010. highlights the therapeutic efficacy in the treatment of the pain in osteoarthritis of the knee and improving the functionality of the patients.

Results of the survey conducted in Australia 2007th years have shown that therapeutic ultrasound remains the most popular physical agent that is used in physiotherapy practice. (4).The survey that was conducted in the U.S. showed that the use of therapeutic UZ due to the reduction of pain is in fifth place. In 83.6% of cases, UZ is being applied to reduce inflammation of the soft tissues, in 70.9% of cases due to increased tissue elasticity, in 68.8% of cases due to the remodeling of scar tissue, in 52.5% of cases due to wound healing , in 49.3% of cases due to the reduction of pain ,in 35.1% of cases due to the reduction of the oedema (5).

2. OBJECTIVES

The main objective of this study was to examine the efficacy of continuous ultrasound in the treatment of chronic musculoskeletal pain.

Other objectives were:

- To examine the influence of various parameters of ultrasound application to reduce pain
- To examine the correlation between age, sex, BMI (Body Mass Index) and location of pain (vertebral and limb) with the effect of continuous ultrasound on pain.

3. PATIENTS AND METHODS

This prospective study included 68 patients with chronic musculoskeletal pain. The pain caused by degenerative changes in the area of the spinal column is marked was vertebral, and pain caused by degenerative changes in the joints of the extremities was marked as limb pain. Patients were divided into two groups. The first group of 34 patients was treated with 10 applications of continuous ultrasound intensity of 0.8 W/cm2 for 4 minutes, and the second group of 34 patients was treated with 10 applications of continuous ultrasound intensity of 0.4 W/cm2 for 8 minutes. The intensity of pain was assessed by subjective numerical scale of pain (Visual Analogue Scale - VAS) that contains numeration of 0-10, where 0 is no pain condition, and 10 is the score for the strongest pain. VAS was a parameter set by the effect of ultrasound therapy. The statistical analysis used descriptive statistical methods, analysis of variance and chi-square test.

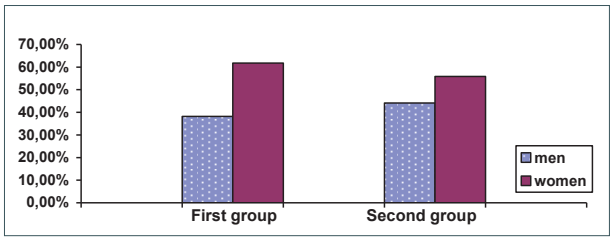

Diagram 1. Gender structure of the patients

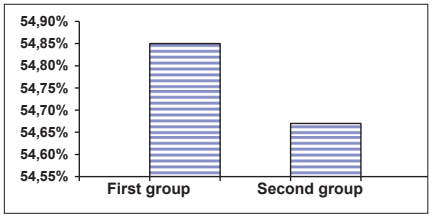

Diagram 2.Avarage age of the patients in years

4. RESULTS

In an analysis of patients' gender structure, Chi-square test showed that there was no statistically significant difference in gender representation between the two groups of patients ($\chi 2 = 2.4$, df = 1, p = 0.62). The first group was 38.2% men and 61.8% of women in the second group 44.1% of men and 55.9% women. (Diagram 1)

Statistical analysis of the age structure of the patients showed that the average age of patients in the first group was 54.85 years, while in another it was 54.67 years. (Diagram 2).

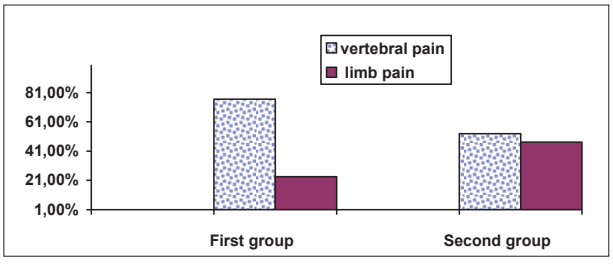

Diagram 3. Anatomical distribution of musculoskeletal pain

T-test for independent samples found no statistically significant difference (t=0.05; p=0.96), and chi-square test showed that there was no statistically significant difference by age groups (20-40 years, 40–60 years, 60-80 years and over 80 years old) within the two groups of patients with different ultrasound therapy. (χ2=03.02, df=3, p=0:39).

In the first group, 76.5% of patients had vertebral pain, and 23.5% of patients had limb pain. In the second group, 52.9% of patients had vertebral pain, and 47.1% of patients had limb pain. (Diagram 3) In the first group , Chi-square test showed a statistically significance (χ2 =9:53, p= .002) :more patients had vertebral pain (76.5%) compared to limb pain (23.5%). In the second group, Chi-square test showed a statistically insignificance (χ2= .12, p= .73).

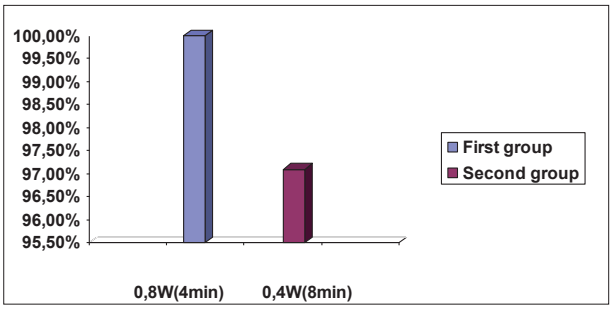

Diagram 4. Average reduce of pain

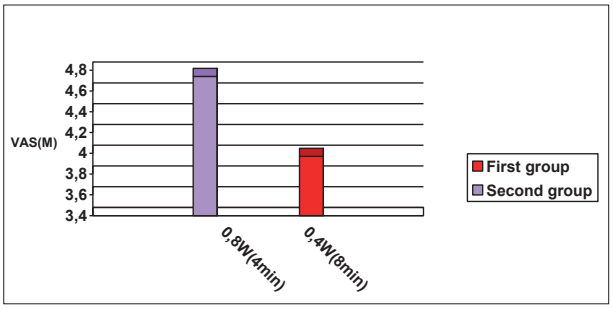

Diagram 5. Average reducing the pain according to Visual analog scale (VAS)

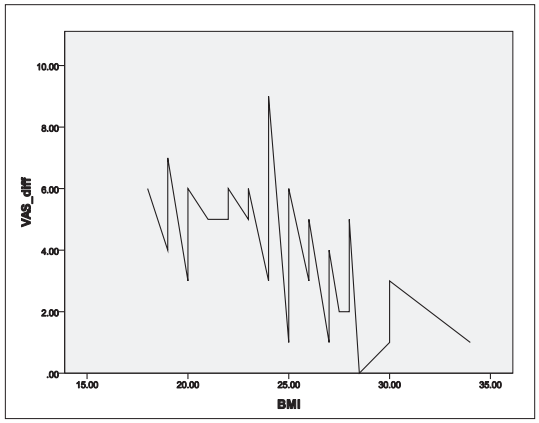

Diagram 6. Correlation between BMI and pain score according to VAS Group 2 :UZ therapy 0.4 W

After treatment with ultrasound in the first group (0.4 W/cm2, 8 minutes) the pain decreased in all patients (100%), while the second group (0.8 W/cm2, 4 minutes) pain was reduced in 97% of patients. (Diagram 4).

Avarage improvement of pain score according to VAS in the first group of patients was 4.74 (M=4.74, SD=1.69), and the other group 3.97 (M=3.97, SD=1.98) (Diagram 5). Analysis of variance showed that the difference between the average value of VAS improvement between the two groups was not statistically significant.

In the first group of patients, no statistically significant correlation has been established with the degree of improvement of pain score by VAS , respectively the correlation between age and VAS diff (p = .25), sex and VAS diff (p = .93), BMI and VAS diff (p = .84), and the location of pain and VAS diff (p = .98).

The second group showed statistically significant correlation between BMI and change in pain score by VAS : r=–.59, p<.001. BMI and degree of improvement of pain score VAS were negatively correlated, respectively higher BMU is associated with a lower degree of improvement of pain score by VAS (Diagram 6).

5. CONCLUSION

Results of the study indicate a significant reduction of pain in degenerative musculoskeletal system after continuous treatment with ultrasound.

On VAS with numeration 0-10 , average score for reduction of pain in the first group was M=4.74, in the second group was M=3.97. Varying intensity and duration of ultrasound application showed no significant effect on the degree of pain reduction. Body mass index showed significant negative correlation with the degree of pain reduction in the group of patients who have been treated with intensity 04W/cm2 for 8 minutes, and the patient age, gender and location of pain showed no significant correlation in either group of patients.

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