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Evaluating the effectiveness of various forms of physical therapy in low back pain treatment

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Abstract
Introduction. **The incidence of low back pain has led to the search of the most optimal methods of treatment of this condition, including physical therapy. The study focuses on three such methods: peloid therapy, ultrasound therapy, and magnet therapy.** Material and Methods. **The study sample comprised 70 patients with chronic low back pain resulting from the overload pain syndrome and/or degenerative changes of the joints of the spine. The patients were divided into three groups undergoing three different types of physical therapy: Group I – peat therapy, Group II – ultrasound therapy, and Group III – a wide range of magnet therapy. The VAS scale, Laitinen's questionnaire, Schober's test and Oswestry Disability Index were used to assess the effectiveness of the therapeutic methods.** Results. **In each group of patients, a statistically significant improvement was attained in all tested variables. Comparing the results between treatment groups, a statistically significant difference in the results of the VAS scale was found (with the best results in the group undergoing ultrasound therapy). Post-therapy results of Laitinen's questionnaire, Schober test and the Oswestry Disability Index revealed no statistically significant differences between the groups.** Conclusions. **Peloid therapy, ultrasound therapy and magnet therapy used on patients with low back pain, showed analgesic effects, increased patients' physical activity, and decreased their degree of disability.**

KEYWORDS: peloid therapy, ultrasound therapy, magnet therapy, low back pain.

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What is already known on this topic?
A wide spectrum of physical methods means that they are successfully used in the treatment of musculoskeletal disorders. Low back pain is determined by many authors as an epidemic and are classified as a disease of civilization. The incidence of low back pain causes the sought optimal treatments for this disease.

Introduction

Spinal pain is referred to by many authors as an epidemic and classified as a disease of affluence. In highly developed countries 50-85% of the population [1] experience spinal pains. The incidence of low back pain has led to the search of the most optimal methods of treatment of this condition, most importantly, effective types of physical therapy. The present study is an analysis of three therapeutic methods: peloid therapy (mud therapy), ultrasound therapy, and magnet therapy. One of therapeutic effects of the first two methods is generation of various forms of heat. In the case of mud therapy, warmth is supplied to the tissues from the outside as a result of conduction. The ultrasound wave, which is a mechanical wave, causes vibrations of the matter in which it propagates, and these vibrations produce heat inside the tissue (called endogenous heat). In turn, a characteristic feature of treatment using a low-frequency electromagnetic pulse is athermy, and its therapeutic effects are based on bio-stimulation.

Mud treatments produce complex effects: thermal (treatments using therapeutic mud at 40-45°C), mechanical, physico-chemical, hormonal, enzymatic, immunomodulating, and bactericidal.

Peat has a low thermal conductivity, thus it gives off heat slowly without causing any rapid overheating of the tissue. The mud ingredients penetrate the skin thanks to the disintegrating activity of saponins and humic acids. Humic acids resorb from the skin surface unnecessary waste products excreted from deeper-lying tissues.

Fats, cholesterol, and uric acid are excreted with sweat salts. During mud treatments some minerals and organic substances are also absorbed into the bloodstream. Accelerated metabolism and increased tissue congestion give rise to the absorption and removal of inflammatory metabolites. Local overheating of the tissue increases cellular metabolism and congestion in the deep muscles and joints [2].

At the cell level the low frequency electromagnetic pulse level has been found to accelerate the exchange of electrolyte between the cell and its environment as well as increase the mitotic activity, antimutagenic activity, enzyme activity, and ATP and DNA synthesis. At the tissue level peripheral blood microcirculation is observed, the blood supply improves, and the activity and excitability of nerve fibers and angiogenesis stimulation are increased. This produces analgesic, anti-inflammatory, anti-edematous effects, which speed up the regeneration of tissues [3]. In present-day physiotherapy, extremely low frequency magnetic fields with frequencies below 100 Hz and strength from 0.1 to 20 mT are used.

The impact of ultrasounds constitutes a mechanism of thermal, mechanical and physico-chemical processes. Mechanical activity is a fundamental component of the local impact of ultrasounds that causes the effect of micro-massage effect. The degree of overheating depends on the intensity of ultrasound, duration of ultrasound treatment, and physical properties of the tissue. The most overheated are the largest tissues with high contents of structural proteins as well as surfaces, and heterogeneous tissue structures, for example, bone and muscle tissue.

The physico-chemical properties of the ultrasound wave affect primarily tissue colloids (accelerated breakdown of proteins, turning colloidal gel into sol). Most ultrasound-induced chemical reactions involve oxidation, but also reduction, acceleration, diffusion, and effects on pH. Aqueous solutions are subject to the process of oxidation, which results in the breakdown of molecules of hydrogen and hydroxyl radicals. The ultrasonic wave also causes a number of secondary effects in the tissue. It increases the elasticity of the connective tissue, relaxes pathologically contracted muscles, inhibits inflammatory processes, accelerates the absorption of tissue metabolites, and reduces pain [4, 5].

Material and Methods

The study sample comprised 70 patients with chronic low back pain resulting from the overload pain syndrome and/or degenerative changes of the spinal joints.

Group I (n = 30) consisted of 17 women and 13 men aged 31-61 years (mean age: 46.7 years), who had undergone a peloid therapy using peat mush at 42°C, compressed around the lumbo-sacral area of the spine. The patients received a 20-minute mud treatment every day for ten days without the weekend. After each treatment patients took a shower at a temperature of about 37°C, and then rested for half an hour.

Group II (n = 20) consisted of 10 women and 10 men aged 28-68 years (mean age: 52 years) who had received an ultrasound therapy (1 MHz, power density from 0.6 to 1.2 W/cm^2, 6-8 min). The treatment duration and power density were adjusted individually for patients, depending on their current condition and the stage of their therapy. The ultrasound treatments were performed daily (10 in a series), for a period of two weeks, excluding the weekend.

Group III (n = 20) consisted of 11 women and 9 men, aged 32-66 years (mean age: 50.6 years), who had received a magnet therapy (boost triangular/square wave; 10-20 Hz, 10-15 mT, 20 minutes). The shape of the pulse, frequency and value of magnetic induction, were adjusted individually for patients, depending on their current condition and stage of therapy. Treatments were performed daily (10 in a series), for a period of two weeks, excluding the weekend.

The following pre- and post-therapy assessment tests were carried out by all patients (n = 50):

- Schober's test measuring the ability to flex the lower back. The patient is in a standing position. A mark is made on the patient's back at the level of the fifth lumbar vertebra. Two points are marked: 5 cm below and 10 cm above the mark. Then the patient is asked to bend forward while keeping the knees straight. If the distance of the two points do not increase by at least 5 cm (with the total distance greater than 20 cm), then it signifies a restriction in the lumbar flexion. In normal physiological conditions, the previously marked distance should increase for about 6-8 cm [6].

- Pain intensity assessment using the Visual Analog Scale (VAS), from 0 – total lack of pain, to 10 – the strongest pain imaginable [7]. A patient marked a point on the scale corresponding to his/her subjective feeling of pain.
- Laitinen's questionnaire assessing the severity and frequency of pain, amount of used painkillers, and physical activity limitations. In each group the patients marked their answers on a scale from 0 to 4 points [8].
- The Oswerty Disability Index (ODI) quantifying the degree of disability resulting from low back pain [9]. The examined patients answered questions concerning intensity of pain, lifting, ability to care for oneself, ability to walk, ability to sit, sexual function, ability to stand, social life, sleep quality, and ability to travel. Each category is followed by 6 statements describing different potential scenarios in the patient's life related to the topic. The patient then checks the statement which most closely resembles their situation. The answers are scored from 0 to 5 points. The scores for all questions answered are summed, indicating the degree of disability. The interpretation of the results is as follows: 0 to 4 points – no disability; 5 to 14 points – mild disability; 15 to 24 points – moderate disability; 25 to 34 points – severe disability; more than 35 points – extreme suffering and disability.

Statistical analysis was performed using Statistica 12.0. The distribution of variables was checked with the Shapiro-Wilk test. The results were presented as descriptive statistics (arithmetic means, standard deviation, minimum, maximum). In order to compare the test results before and after the treatment in all groups the t-distribution and Student's t-test were used for the groups ($\alpha = 0.05$). To compare the test results between the three groups after the treatment, ANOVA was used ($\alpha = 0.05$).

Results

Table 1 presents descriptive statistics and Student's t-test results of Group I patients before and after the therapy.

Table 1. Descriptive statistics and Student's t-test distribution in Group I ($\alpha = 0.05$)

Variable		Descriptive statistics					Student's t-test	
		n	$\bar{x}$	SD	Min.	Max	t	p
VAS	before	30	6.066	0.739	5.00	7.00	4.197264	0.000027
	after	30	4.900	1.268	1.00	6.00		
Laitinen's questionnaire: pain severity	before	30	1.833	0.698	1.00	3.00	4.197264	0.000027
	after	30	0.933	0.365	0.00	2.00		
Laitinen's questionnaire: pain frequency	before	30	2.033	0.718	1.00	3.00	4.372373	0.000012
	after	30	0.933	0.365	0.00	2.00		
Laitinen's questionnaire: use of pain killers	before	30	1.166	0.592	0.00	2.00	3.179797	0.001474
	after	30	0.733	0.739	0.00	2.00		
Laitinen's questionnaire: limitation of physical activity	before	30	1.766	0.727	1.00	3.00	2.665570	0.007686
	after	30	1.466	0.507	1.00	2.00		
Schober's test	before	30	5.466	0.973	4.00	7.00	4.014509	0.000060
	after	30	6.300	0.987	5.00	8.00		
ODI	before	30	14.666	4.138	10.00	22.00	4.782139	0.000002
	after	30	10.166	3.074	6.00	17.00		

n – number of observations; $\bar{x}$ – arithmetic mean; Min. – minimum; Max – maximum; SD – standard deviation; t – Student's t-test value; p – level of probability

Table 2. Descriptive statistics and Student's t-test distribution in Group II (α = 0.05)

Variable		Descriptive statistics					Student's test	
		n	x̄	SD	Min.	Max	t	p
VAS	before	20	6.100	1.447	3.00	8.00	13.5807	0.000000
	after	20	3.000	1.123	1.00	5.00		
Laitinen's questionnaire: pain severity	before	20	2.400	0.940	1.00	4.00	8.81631	0.000000
	after	20	0.900	0.640	0.00	2.00		
Laitinen's questionnaire: pain frequency	before	20	2.650	0.875	1.00	4.00	11.0000	0.000000
	after	20	1.000	0.648	0.00	2.00		
Laitinen's questionnaire: use of pain killers	before	20	2.000	0.917	0.00	4.00	6.84970	0.000002
	after	20	0.900	0.552	0.00	2.00		
Laitinen's questionnaire: limitation of physical activity	before	20	2.200	0.951	1.00	4.00	6.90182	0.000001
	after	20	0.050	0.510	0.00	2.00		
Schober's test	before	20	4.550	1.356	3.00	7.00	11.4612	0.000000
	after	20	6.100	1.447	4.00	8.00		
ODI	before	20	22.350	7.942	8.00	35.00	14.5487	0.000000
	after	20	11.150	5.183	3.00	19.00		

n – number of observations; x̄ – arithmetic mean; Min. – minimum; Max – maximum; SD – standard deviation; t – Student's t-test value; p – level of probability

Table 3. Descriptive statistics and Student's t-test distribution in Group III (α = 0.05)

Variable		Descriptive statistics					Student's t-test	
		n	x̄	SD.	Min	Max	t	p
VAS	before	20	5.400	1.535	3.00	8.00	11.4612	0.000000
	after	20	3.850	1.496	0.00	6.00		
Laitinen's questionnaire: pain severity	before	20	1.600	0.820	1.00	3.00	3.94277	0.000873
	after	20	1.150	0.587	0.00	2.00		
Laitinen's questionnaire: pain frequency	before	20	1.900	0.788	1.00	3.00	4.48527	0.000254
	after	20	1.300	0.656	1.00	3.00		
Laitinen's questionnaire: use of pain killers	before	20	1.700	1.031	0.00	3.00	5.81187	0.000013
	after	20	0.900	0.852	0.00	2.00		
Laitinen's questionnaire: limitation of physical activity	before	20	1.550	1.099	0.00	3.00	4.35890	0.000338
	after	20	1.050	0.998	0.00	3.00		
Schober's test	before	20	5.350	1.424	3.00	8.00	4.75622	0.000135
	after	20	6.050	1.316	3.00	8.00		
ODI VAS	before	20	16.900	8.620	7.00	39.00	15.1407	0.000000
	before	20	12.000	8.220	3.00	34.00		

n – number of observations; x̄ – arithmetic mean; Min. – minimum; Max – maximum; SD – standard deviation; t – Student's t-test value; p – level of probability

The results of Group I patients revealed a statistically significant difference in all tested variables. Following the VAS and Laitinen's questionnaire results both pain intensity and pain frequency were shown to decrease, and the use of painkillers was reduced. The patients' motor activity improved and the level of their disability decreased, as measured by the ODI.

Table 2 shows descriptive statistics and Student's t-test results Group II patients before and after the therapy.

The results of the Group II patients revealed statistically significant differences in all tested variables. Following the VAS and Laitinen's questionnaire results pain frequency was shown to decrease, and the use of painkillers was reduced. The patients' motor activity was improved and the level of their disability decreased, as measured by the ODI.

Table 3 shows descriptive statistics and Student's t-test results of Group III patients before and after the therapy.

The results of Group III patients revealed statistically significant differences in tested variables. Following the VAS and Laitinen's questionnaire results pain frequency was shown to decrease, and the use of painkillers was reduced. The patients' motor activity was improved and the level of their disability decreased, as measured by the ODI.

Next, the post-therapy results were compared between Group I, Group II, and Group III using an ANOVA test for independent variables. The results of the analysis are shown in Table 4.

Table 4. Descriptive statistics and a comparison of post-therapy results between Group I, Group II and Group III (α = 0.05)

Variable		Descriptive statistics					ANOVA	
		n	$\bar{x}$	SD	Min.	Max	F	p
VAS scale post-therapy	Group I	30	4.900	1.268	1.00	6.00	13.16969	0.000015
	Group II	20	3.000	1.123	1.00	5.00		
	Group III	20	3.850	1.496	0.00	6.00		
Laitinen's questionnaire: pain intensity post-therapy	Group I	30	0.933	0.365	0.00	2.00	1.41426	0.250268
	Group II	20	0.900	0.640	0.00	2.00		
	Group III	20	1.150	0.587	0.00	2.00		
Laitinen's questionnaire: pain frequency post-therapy	Group I	30	0.933	0.365	0.00	2.00	2.84599	0.065119
	Group II	20	1.000	0.648	0.00	2.00		
	Group III	20	1.300	0.656	1.00	3.00		
Laitinen's questionnaire: use of pain killers post-therapy	Group I	30	0.733	0.739	0.00	2.00	0.449785	0.639677
	Group II	20	0.900	0.552	0.00	2.00		
	Group III	20	0.900	0.852	0.00	2.00		
Laitinen's questionnaire: limitation of physical activity post-therapy	Group I	30	1.466	0.507	1.00	2.00	3.178609	0.057992
	Group II	20	0.050	0.510	0.00	2.00		
	Group III	20	1.050	0.998	0.00	3.00		
Schober's test post-therapy	Group I	30	6.300	0.987	5.00	8.00	0.295999	0.744756
	Group II	20	6.100	1.447	4.00	8.00		
	Group III	20	6.050	1.316	3.00	8.00		
ODI post-therapy	Group I	30	10.166	3.074	6.00	17.00	0.667601	0.516316
	Group II	20	11.150	5.183	3.00	19.00		
	Group III	20	12.000	8.220	3.00	34.00		

n – number of observations; $\bar{x}$– arithmetic mean; Min. – minimum; Max – maximum; SD – standard deviation; F – ANOVA test value; p – level of probability

The results of the comparison revealed statistically significant differences in the post-therapy VAS scale between the groups of patients. The comparison of p-values of ANOVA test ($\alpha = 0.05$) showed no statistically significant differences in the post-therapy results of Laitinen's questionnaire, Schober's test and ODI between the three groups of patients.

Discussion

The study aimed to assess the efficacy of three different forms of physical therapy in low back pain treatment. The examined forms of physical therapy were shown to be effective in terms of pain relief as well as improvement of spinal mobility and reduction of the degree of disability in the patients under study. A significant difference in post-therapy outcomes between the groups of patients was revealed by the results of the VAS. The biggest change was observed after application of the ultrasound therapy. The analysis of the other variables showed no statistically significant differences between the groups. These results indicate that physical therapy has significant effects in the treatment of low back pain; however, the authors are aware of various limitations of their analysis such as the relatively small study sample as well as lack of randomization and a control group. There have been relatively few published studies on the effectiveness of these physical factors in treatment of low back pain syndromes.

Peloid is a raw material of natural origin with recognized medicinal properties; however, there have been very few studies in Poland regarding this form of therapy. Jakubowska et al. [10] in their study of the efficiency of balneological therapy carried out tests on 34 patients with osteoarthritis of the peripheral joints and the spinal column, who had undergone spa treatment. The best therapeutic results were attained after gymnastics in saline and a peloid pool. Mordak et al. [11] revealed beneficial effects of peloid on the pain level and mobility of the lower spine in 20 patients with a degenerative lumbosacral spine. Ponikowska et al. [12] conducted a randomized, double blind trial assessing the effectiveness of two peat preparations in 30 patients with degenerative spine conditions. Within 6-8 months, all patients took an active product or a placebo in the form of ionophoresis and carried out swimming and physical exercise. The treatment cycle lasted 21 days. The effectiveness of the therapy was assessed with standardized clinical assessment pain VAS scale, WOMAC SCALE test, Likert scale test of morning stiffness, and quality of life assessment using the ODI. Also laboratory tests: ESR, CRP, Fibrinogen, lipidogram, PTT and glycemia were performed. Most parameters showed improvement, both after the active product and a placebo therapy. Much better results in terms of changes in blood pressure, PTT, back pain, LDL-cholesterol, and quality of life were attained after the cycle treatment with the active product.

Ziółkowska et al. [13] compared the efficacy of therapy with ready-made peat slices with that of poultice compresses used in traditional mud therapy in treatment of osteoarthritis of the spine. The study sample comprised 52 patients with low back pain, who were divided into two groups. In Group A (n = 33) local compresses with a single slice of peat were placed across the lumbosacral area. Warmth was kept with the use of a heating pad during the entire duration of the treatment. In Group B (n = 19) a traditional peat poultice was applied locally on the lumbosacral part of the spine. Ten 30-min treatments were carried out. The results were analyzed six weeks after the completion of the therapy. The therapeutic effectiveness was assessed with the WOMAC SCALE, Laitinen's questionnaire, VAS, fingers-floor test and through checking the morning stiffness, quality of life according to the Oswestry questionnaire, and daily blood pressure tests. The WOMAC SCALE test results and patients' subjective evaluation showed greater effectiveness of traditional peloid packs. However, there was no effect of peat treatments on the blood pressure of patients undergoing the therapy.

Falagasa et al. [14] made a review of 29 randomized controlled trials (1720 patients) assessing the effectiveness of balneotherapy in: osteoarthritis (8 studies); fibromyalgia (4); ankylosing spondylitis arthritis of the spine (4); rheumatoid arthritis (4); psoriatic arthritis (3 studies); pain syndromes of the spine (3); Parkinson's syndrome (3). In 17 trials a significant reduction in pain was achieved as compared with the control group.

Pitler [15] made meta-analysis of randomized controlled trials evaluating the efficacy of balneotherapy in the treatment of chronic pain syndrome of the lumbar spine. A control group comprised patients awaiting treatment and taking medication. The author assessed the results as "encouraging" in reference to pain reduction, and stressed the need for further research.

Only few articles evaluating the efficacy of magnet therapy and ultrasound therapy (used as monotherapy) in low back pain treatment can be found. Borowicz et al. [16] in their study revealed analgesic and muscle tension reducing effects of spinal therapy. Zgorzalewicz-Ferguson et al. [17] in their comparison of the effectiveness of magnet therapy and classical massage, did not find any significant differences between applicable therapies. After applying a massage or magnet therapy, patients' pain and disability were significantly reduced; however, the mobility of the spine improved slightly. Analgesic therapy has been also confirmed by other authors [18].

Charłusz et al. [19] compared the effectiveness of three therapeutic methods for the treatment of lumbosacral spine pain episode syndrome: low-energy laser therapy, sonotherapy, and vacuum therapy associated with Trabert currents. The effects of the therapies were assessed using the VAS scale, Laitinen's questionnaire, Schober's test, and the finger-floor test. The test results showed the lowest analgesic efficacy of ultrasound therapy and the smallest improvement in the global mobility of the spine (finger-floor test), but the greatest extension of the spine.

Kowalczyk et al. [20] studied 90 patients with degenerative changes in the lumbosacral spine divided into three therapeutic groups: Group I – sonotherapy, Group II – kinesiotherapy, and Group III – combined therapy (kinesiotherapy preceded by sonotherapy). The effectiveness of the therapies was assessed using the VAS, Laitinen's questionnaire, and Oswesrty Disability Index. The results of the study showed a significant reduction in the level of pain, degree of disability, and an increase in spinal mobility in all groups under study, with no statistically significant differences between the groups.

A meta-analysis on the effectiveness of sonotherapy in the treatment of chronic pain of the lower back by Ebadi et al. [21] is also noteworthy. The authors reviewed articles from the MEDLINE, EMBASE, PEDRO and PsycLit databases. The analysis included 7 randomized controlled trials (362 patients). As a result of the meta-analysis, the authors observed a lack of high quality evidence of the effectiveness of ultrasound therapy in reducing pain and improving the quality of life in patients with chronic lower back pains syndromes. At the same time, the authors of this review suggest that there is a need to carry out well-designed research into the effectiveness of this form of therapy.

Conclusions

1. Peloid therapy, ultrasound therapy and magnet therapy undertaken by patients with low back pain revealed analgesic effects, increased patients' physical activities, and decreased patients' degree of disability.
2. A statistically significant difference was found in the post-therapy VAS scale results between the groups of patients. The most favourable analgesic effect was obtained in a group of patients who had undertaken an ultrasound therapy.
3. A statistically significant difference in post-therapy Laitinen's questionnaire, a Schober's test and Oswestry Disability Index results was not demonstrated between the studied groups of patients.

What this study adds?

The peloidotherapy, sonotherapy and magnetotherapy, applied for patients with low back pain, showed analgesic effect, increased activities of patients and decreased their degree of disability. The most favourable analgesic effect was obtained in a group which sonotherapy was used.

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