EFFECTIVENESS OF MAGNETOTHERAPY IN THE TREATMENT OF PATIENTS WITH LUMBAR SYNDROME

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ABSTRACT

Introduction: The term low back pain means a feeling of pain at rest or during movement in the lower, lumbar part of the spine. In order to reduce pain, various physical procedures are used: electrotherapy, thermotherapy, laser therapy, magnetotherapy, ultrasound therapy, cryotherapy, kinesitherapy and manual massage. Aim: To examine the effectiveness of magnetotherapy in the treatment of patients with lumbar syndrome. Materials and Methods: The study included patients treated from 01.01.2013. to 31.12.2015. year due to the diagnosis of lumbar pain syndrome in persons whose treatment process included magnetotherapy in the "Beljan" practice as a research group where were treated 113 patients (73 male and 40 female). There were 262 (114 male and 148 female) patients in the Health Center in Metković as a control group in which magnetotherapy was not included in the treatment of any patient. Pain was assessed on the basis of a visual analogue scale. Results: Research showed that the Chi-square test showed a statistically significant difference between the duration of physical therapy by days between the examined and control groups, $\chi 2(2,n=375) = 237.715$; $p<0.001$. Pearson's correlation coefficient $r=0.68$ shows a large statistical difference between the duration of physical therapy of the examined and control groups. The chi-square test showed a statistically significant difference between the kinesitherapy procedures and the examined or control group, $\chi 2(2,n=375) = 28.743$; $p<0.001$. Pearson's correlation coefficient $r=-0.156$ shows an extremely small statistically significant difference between the tested and control groups and kinesitherapy procedures.

Conclusion: The shortest time that the patients spent on physical therapy in the examined group (80 patients) is 0 - 6 days of therapy, the shortest, and in the control group (197 patients) it is 7 - 10 days, the shortest. The working hypothesis that magnetotherapy affects the duration of treatment and the improvement of the functional status of patients with lumbar syndrome has been proven.

Keywords: Lumbar pain syndrome, effectiveness of magnetotherapy

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INTRODUCTION

Millions of people worldwide suffer from low back pain, and extensive research indicates that low back pain affects eight out of ten people (1). Lumbar pain syndrome (LPS) includes a group of different diseases and disorders, the common symptom of which is pain in the lumbar or lumbosacral part of the spine, with or without radiation to the lower extremities (2).

LPS is the most common pain syndrome of modern man and almost 75% of the population has low back pain (3). An intervertebral disc is inserted between each individual vertebra, which enables the mobility of the spine (4,5). The coordinated activity and relationships of the bony, connective and muscular systems in the area of the lumbar spine significantly dictate the biomechanical properties (6). The spinal cord is a cylindrical column 40 to 50 cm long, located in the upper two-thirds of the spinal canal (7). Primary pain is caused by irritation of nerve endings within the annulus fibrosus (mechanical stretching of the annulus or chemical irritation as a result of inflammation caused by mechanical trauma) (8). Already after the age of 30, the intervertebral disc becomes avascular. In cases where all the lamellae of the fibrous ring rupture and the nucleus pulposus protrudes into the spinal canal, we are talking about disc herniation (9,10). The described changes can also cause stenosis of the bony part of the spinal canal with compromise of the dural sac and nerve roots (11). The pathophysiology of radiculopathy has not been fully elucidated (12). The acute syndrome lasts up to six weeks, and the subacute syndrome lasts from 6 to 12 weeks. We speak of chronic pain when pain lasts longer than 12 weeks or when painful episodes are repeated at shorter intervals (13,14). In the advanced stage, we see narrowing of the intervertebral space, sclerosing and osteophytes on the X-ray image (15). Personal history is one of the most important parts of the examination (16). In clinical practice, several tests are used to diagnose low back pain. Most clinical tests cause pain, which requires gentle and quick performance and avoidance of repeated test performance (17). Clinically, it is necessary to differentiate between two basic forms of low back pain: vertebral and vertebrogenic syndrome (18). Laboratory tests in degenerative lumbar disc disease (DLDD) show normal findings. Determination of the erythrocyte sedimentation rate, examination of blood and urine, and if malignancy is suspected, laboratory tests include alkaline phosphatase, ionogram and protein electrophoresis (19).

Treatment of lumbar pain syndrome depends on the cause. A conservative approach is most often used because the pain tends to self-heal (in 90% of cases the pain subsides within two months). Conservative (non-surgical) therapeutic measures consist of drug therapy and kinesitherapy treatment (strengthening of the stabilizer muscles of the lumbar segment of the spinal column) and physical agents (20). Orthopedic aids in the sense of corsets and orthoses have not proven to be effective in the treatment of lumbar pain syndrome (21). The treatment of the chronic form of LPS is multimodal, and the most consistent

therapeutic recommendations include a multidisciplinary approach, informing the patient (education), exercises, physical and psychological interventions (22). New treatment strategies include stem cells, growth factor and gene therapy (23).

Physical therapy

The physical therapy methods we use in the treatment of lumbar syndrome are cryotherapy, TENS (TENS, from English Transcutaneous electrical nerve stimulation), interference or Nemec currents, diadynamic currents, ultrasound therapy, laser, kinesitherapy and exercises according to Brunk, McKenzie and Regan (8,13,24-27).

Magnetic therapy

Indications for magnetotherapy are: functional disorders caused by exogenous, endogenous or iatrogenic harmful substances, rehabilitation, mobilization after injuries in accidents and serious events due to injury or illness, such as stroke. Treatment with a wide range of indications, relatively minor side effects and almost no contraindications. It also works to improve oxygen supply and improve circulation, psychological stabilization, stimulation of metabolism, acceleration of regeneration and increase of immune activities and general increase of overall psychophysical ability. The magnetic fields of all magnetic systems in the modern world are pulsating. This is why we talk about pulsed electrical magnetic fields (PEMF). This is a feature that distinguishes magnetic field therapy from numerous physiotherapy devices, which have low penetration (low depth), which is why their effect manifests itself mostly superficially. Magnetic field strength or flux density is expressed in teslis (T) or gauss (G), which is an old but still the most common unit of measurement, where 1 T corresponds to a value of 10,000 G (8). Contraindications are acute and serious circulatory disorder, diabetic angiopathy, coronary insufficiency or pre-infarction condition, pacemaker, risk of bleeding, hypotension, pregnancy, juvenile diabetes, acute infections and fungal diseases (24).

The effect of magnetotherapy on the human body

The effects of magnetotherapy on the human body are: stimulation of cartilage cells, regeneration of nerves where damaged cells can be stimulated by PEMF that encourages nerve cells to grow, wound healing and pain relief (8). Treatment with a magnetic field is applied using devices that can determine the intensity, polarity of the waves, the shape of the waves, the frequency and duration of the pulses, as well as the constant or changing magnetic field and the frequency. The number of procedures can range from several consecutive days to several months. Depending on the goal to be achieved, it is necessary to dose the optimal intensity (24). In the work of Beljan et al. the research included patients treated in the Physical Therapy and Rehabilitation Clinic "Beljan" as a test group in which 113 patients were treated in which magnetotherapy was included, and in the Health Center in Metković as a control group in which 262 patients were treated in which

magnetotherapy was not included. The research showed that the duration of treatment is shorter in patients who were treated with magnetotherapy in the Beljan Clinic. The aim of this study was to examine effectiveness of magnetotherapy in the treatment of patients with lumbar syndrome.

MATERIALS ANS METHODS

The research was conducted from 01.01.2013. – 31.12.2015. year in the Physical Therapy and Rehabilitation Practice "Beljan" as a test group in which 113 (73 male and 40 female) patients were treated and in the Health Center in Metković as a control group in which 262 (114 male and 148 female) patients were treated. Of the physical procedures, PEMF, multidisk applicator" BTL 5800 with a maximum frequency of 166 MHz and a maximum intensity of a pulsed magnetic field of 950 G was used in all subjects in the examined group, while in the control group, interfering currents and TENS were used the most. Of the kinesitherapy procedures, Regan exercises were performed the most in both the examined (73 patients) and control (189 patients) groups. The research compared the duration of therapy by days between the tested and control groups, as well as the intensity of pain, which was measured by the VAS scale, where magnetotherapy was included in all patients in the tested group, in contrast to the control group where not a single patient had magnetotherapy included in the treatment LBS.

The criteria for inclusion in the therapy are:

1. patients diagnosed with lumbar pain syndrome based on clinical examination and supplementary procedures (X-ray, CT, MRI),
2. patients in whom magnetotherapy was included in the examined group,
3. control group patients without magnetic therapy,
4. patients regardless of age, gender and occupation.

Exclusion criteria are:

1. patients who stopped coming to therapy,
2. patients without complete diagnostics.

The research is retrospective, analytical, descriptive and control. The location of the study was the Physical Therapy and Rehabilitation Clinic "Beljan" in Tomislavgrad (examined group) and the Health Center in Metković (control group). In the period from January 1, 2013 to December 31, 2015.

Descriptive statistics procedures were used to describe the sample and sub-sample, taking into account the set hypotheses, and in accordance with the types and characteristics of the measuring instruments:

1. the significance of differences between subsamples, that is, different categories of participants, was calculated using the Pearson chi-square test (with Yates correction when necessary) when it came to nominal variables.
2. Microsoft Excel 2007 and the statistical package IBM SPSS, version 21.0 (SPSS, Inc., 2009, Chicago, IL, USA) were used for data analysis.

RESEARCH RESULTS

Table 1. Ratio of duration of physical therapy by days.

Duration in days	**Groups**					
	Examined			Control		
	M	F	Total (%)	M	F	Total (%)
0 – 6	51	29	80 (70,8)			
7 – 10	20	10	30 (26,5)	85	112	197 (75,2)
11 – 15	2	1	3 (2,7)	29	36	65 (24,8)
Total	73	40	113 (100)	114	148	262 (100)

The chi-square test showed a statistically significant difference between the duration of physical therapy per day between the tested and control groups. $\chi 2(2,n=375) = 237,715$; $p<0.001$. Pearson's correlation coefficient $r=0.68$ shows a significant difference between the duration of physical therapy of the tested and control groups.

In the largest number of respondents, 80 (51 male and 29 female), treatment with physical therapy in the examined group lasted from 1 to 6 days, the shortest. For the largest number of subjects, 197 (85 male and 112 female), treatment with physical therapy in the control group lasted 7-10 days, the shortest.

Table 2. Physical therapy procedures.

Physical therapy procedures	**Groups**					
	Examined			Control		
	M	F	Total (%)	M	F	Total (%)
Magnetic therapy	73	40	113 (100)			
TENS	55	29	84 (74)	89	119	208 (79)
Interference currents	35	24	59 (52)	92	123	215 (82)
Cryotherapy	26	6	32 (28)			
Ultrasound therapy	21	14	35 (31)	66	94	160 (61)
Diadynamic currents	32	12	44 (39)	46	82	128 (48)
Laser therapy	51	28	79 (69)			

The chi-square test of independence showed a statistically significant difference between the tested and control groups and magnetotherapy. $\chi2(1,n=375) = 370.265$; $p<0.001$. Pearson's correlation coefficient r= -1 shows a complete negative difference between the tested and control groups with magnetic therapy.

The chi-square test of independence (with continuity correction according to Yates) did not show a statistically significant difference between the control and test groups with TENS. $\chi2(1,n=375) = 0.895$; $p=0.344$. Pearson's correlation coefficient r=0.056 shows an extremely small statistically significant difference between the tested and control groups with TENS.

The chi-square test of independence (with continuity correction according to Yates) showed a statistically significant difference between the tested and control groups with interfering currents. $\chi2(1,n=375) = 34.242$; $p<0.001$. Pearson's correlation coefficient r=0.309 shows a small statistically significant difference between the tested and control groups with interfering currents.

The chi-square test of independence (with continuity correction according to Yates) showed a statistically significant difference between the control and test groups with cryotherapy. $\chi2(1,n=375) = 77.529$; $p<0.001$. Pearson's correlation coefficient r= - 0.465 shows a mean negative statistically significant difference between the tested and control groups with cryotherapy.

The chi-square test of independence (with continuity correction according to Yates) showed a statistically significant difference between the tested and control groups and ultrasound therapy. $\chi2(1,n=375) = 26.032$; $p<0.001$. Pearson's correlation coefficient r= 0.269 shows a mean negative statistically significant difference between the tested and control groups with ultrasound therapy.

The chi-square test of independence (with continuity correction according to Yates) did not show a statistically significant difference between the tested and control groups with diadynamic currents. $\chi2(1,n=375) = 2.740$; $p=0.098$. Pearson's correlation coefficient r= 0.091 shows an extremely small statistically significant difference between the tested and control groups with diadynamic currents.

The chi-square test of independence (with continuity correction according to Yates) showed a statistically significant difference between the tested and control groups with laser therapy. $\chi2(1,n=375) = 227,869$; $p<0.001$. Pearson's correlation coefficient r= -0.787 shows a large negative statistical difference between the tested and control groups with laser therapy.

All subjects in the examined group were covered by magnetic therapy (113). In the control group, the largest number of respondents was affected by interference currents (215). Magnetotherapy was included in the treatment process for all patients in the study group, while magnetotherapy was not included in any of the subjects in the control group.

Table 3. Kinesitherapy procedures.

Kinesitherapy procedures	**Groups**					
	Examinated			Control		
	M	F	Total (%)	M	F	Total (%)
Regan exercises	45	28	73 (64,6)	86	103	189 (72,1)
McKenzie exercises	19	9	28 (24,8)	28	45	73 (27,9)
Brunck exercises	9	3	12 (10,6)			
Total	73	40	113	114	148	262

The chi-square test showed a statistically significant difference between the kinesitherapy procedures and the examined or control group, $\chi 2(2,n=375) = 28.743$; $p<0.001$. Pearson's correlation coefficient r=-0.156 shows an extremely small statistically significant difference between the tested and control groups and kinesitherapy procedures.

Exercises according to Brunk were statistically significantly more used by patients in the study compared to the control group. All respondents in the examined group were included in one of the mentioned exercise programs, and the largest number was in the Regan program, 73 of them (45 male and 28 female). In the control group, the largest number of respondents, 189 (86 male and 103 female), was included as in the examined group according to Regan's exercise program.

Table 4. Chi square test of VAS scale for pain.

	Value	*Df*	*Asymp. Sig. (2-sided)*
PearsonChi-Square	165,067	6	,000
Likelihood Ratio	154,288	6	,000
Linear-by-Linear Association	,246	1	,620
N of Valid Cases	113		

The chi-square test showed a statistically significant difference in the average pain rating according to the VAS scale before and after therapy in the examined group, $\chi 2(6,n=113) = 165.067$; $p<0.001$. The average pain rating according to the VAS scale in the examined group is significantly lower after the therapy compared to the time before the therapy.

Assessment of pain intensity in patients before and after therapy in the control group was not performed.

DISCUSSION

In this research, we examined the length of therapy and the effectiveness of magnetotherapy in the test and control groups. Through research, we obtained results indicating that the duration of physical therapy for the largest number of patients 80 (51 male and 29 female) in the test group was 1-6 days, the shortest, and in the control group the duration of physical therapy for the largest number of patients 197 (85 male and 112 female) was 7-10 days, the shortest.

In the work Miladinović et al. where they examined the effects of magnetotherapy and TENS in chronic low back pain. A group of 16 patients was treated with TENS and a group of 17 patients with magnetotherapy, where magnetotherapy showed better effectiveness (28). The results they show are in accordance with the results of our research.

In the work Omar et al. they examined 40 patients, 20 with PEMF and 20 with placebo, who suffered from lumbar radiculopathy. The effects of PEMF versus placebo in patients with lumbar radiculopathy, they found significant differences in patients treated with PEMF who had less pain. They found that PEMF therapy is an effective method for the conservative treatment of lumbar radiculopathy caused by lumbar disc prolapse. In addition to improving clinically observed radicular symptoms, PEMF also appears to be effective in reducing nerve root compression as evidenced by improvement in SSEP parameters after treatment (29). The results of this research are consistent with our research.

In the work of Khoromi et al. they examined the effect of the magnetic field in patients with chronic low back pain in two groups, with different strengths of the PEMF and obtained the same effect in reducing pain and that higher strength and longer duration of therapy are more effective in patients with chronic lumbar syndrome (30). The results of this study confirming the reduction of pain in patients with lumbar syndrome are consistent with our research.

In the work of Fortin et al. applied the electromagnetic field to 38 patients with low back pain and 30 patients with pain in the cervical spine. The patients underwent 4 therapies with a duration of 30 min. The average value of the VAS scale decreased by 30% in the group of patients with lumbar syndrome and by 70% in patients with cervical spine pain. The treatment showed good results in both groups, without side effects (31). The results of this research are consistent with our research.

In the work of Andrade et al it was performed a comprehensive database search using Pubmed, Scopus, Cochrane Library and PEDro databases to assess the effectiveness of the PEMF therapy in reducing pain and clinical symptomatology in patients with low back pathological conditions. The search was performed from January 2005 to August 2015 and conducted by two independent investigators, which scrutinize the reference list of most relevant studies. The methodological quality was assessed by the PEDro scale and the level of evidence was set according Oxford Center for Evidence-Based Medicine scale. Six

studies were eligible inclusion on the qualitative analysis and five into the quantitative analysis, scoring an overall 6.8 points according the PEDro scale. The studies showed heterogeneity concerning the intervention protocols. Nevertheless, the effect sizes' indicated a clear tendency to reduction of the pain intensity favoring the PEMF groups, reaching a minimal clinically important difference. Conclusion is that PEMF therapy seems to be able to relieve the pain intensity and improve functionality in individuals with low back pain conditions (32). The results of this research are consistent with our research.

A low-frequency magnetic field is often used in the treatment of pain syndromes and chronic wounds. It is considered that there is a stabilization of the potassium-sodium pump, and thus the membrane potential; the energy metabolism increases and the partial pressure of oxygen increases, which contributes to a better supply of nutrients in the affected area (27).

There is no doubt that PEMF create numerous biophysical effects in the human body at different levels. These effects relate to an increase in the resistance of the cell membrane, an effect on the enzyme-coenzyme correlation, an effect on the antigen-antibody reaction, an increase in the crystallization rate of certain substances, an increase in oxygen concentration, and an increase in the coagulation rate. Under the influence of magnetic field, a piezoelectric effect is created in the collagen (26).

The disadvantages of this research are that in the control group, no cryotherapy or laser was included in the treatment of LBS. In the examined group, cryotherapy was included in 32 patients and laser in 79 out of 113 patients. Although in the examined group, cryotherapy and laser were not included in the treatment of all patients and magnetotherapy was included, this still represents certain limitations where it is not possible to prove how successful cryotherapy and laser were. We can say that cryotherapy and laser therapy, as well as the uneven number of respondents who used other therapeutic methods, significantly influenced the results of the study. Additional limitations can be: a small sample, including more health institutions, insufficient research into the mode of action of magnetotherapy. The contribution of this research is the fact that, despite the mentioned limitations, PEMF was included in all patients in the examined group, in whom the duration of therapy by days as well as by the VAS scale was significantly reduced. This proved that PEMF affects the reduction of pain and duration of symptoms as well as functional status in patients with lumbar syndrome.

CONCLUSION

The shortest time that the patients spent on physical therapy in the examined group (80 patients) is 0 - 6 days of therapy, the shortest, and in the control group (197 patients) it is 7 - 10 days, the shortest. After performing physical therapy for people with lumbar pain syndrome, a greater effectiveness in the duration of the therapy was shown in patients who were treated in the "Beljan" Clinic, in which the patients were treated with pulsed electrical magnetic field compared to

the control group in which the patients were not treated with magnetotherapy. Given that in practice, certain currents (TENS, interference, etc.) are most often used as agens of physical therapy, in diagnoses related to painful conditions of the spine, it is evident from this research that PEMF should be used as one of the first choices in compared to the mentioned agents.

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EFIKASNOST MAGNETOTERAPIJE U LIJEČENJU PACIJENATA S LUMBALNIM SINDROMOM

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SAŽETAK

Uvod: Pojam križobolje označava osjećaj boli u mirovanju ili pri kretanju u donjem, slabinskom dijelu kralježnice. U cilju smanjenja bolova koriste se različite fizikalne procedure: elektroterapija, termoterapija, laserska terapija, magnetoterapija, ultrazvučna terapija, krioterapija, kineziterapija i manualna masaža.

Cilj: Ispitati efikasnost magnetoterapije u liječenju pacijenata s lumbalnim sindromom.

Materijal i metode: U istraživanju su obuhvaćeni pacijenti liječeni od 01.01.2013 g. do 31.12.2015 g. zbog dijagnoze lumbalnog bolnog sindroma kod osoba kod kojih je u proces liječenja bila uključena magnetoterapija u Ordinaciji „Beljan“ kao ispitivanoj grupi gdje je liječeno 113 (73 muškog i 40 ženskog spola) pacijenata. U Domu zdravlja u Metkoviću kao kontrolnoj grupi kod koje u liječenju nije bila uključena magnetoterapija ni kod jednog pacijenta bilo je 262 (114 muškog i 148 ženskog spola) pacijenata. Procjena boli rađena je na osnovu vizualne analogne skale.

Rezultati: Istraživanja su pokazala da je Hi - kvadrat test pokazao je statistički značajnu razliku između trajanja fizikalne terapije po danima između ispitivane i kontrolne grupe, $\chi^2(2,n=375) = 237,715$; $p<0,001$. Pearsonov koeficijent korelacije $r=0,68$ pokazuje veliku statističku razliku između trajanja fizikalne terapije ispitivane i kontrolne grupe. Hi-kvadrat test pokazao je statistički značajnu razliku između procedura kineziterapije i ispitivane odnosno kontrolne skupine, $\chi^2(2,n=375) = 28,743$; $p<0,001$. Pearsonov koeficijent korelacije $r=-0,156$ pokazuje izuzetno malu statistički značajnu razliku između ispitivane i kontrolne grupe i procedura kineziterapije.

Zaključak: Najkraće vrijeme koje su pacijenti proveli na fizikalnoj terapiji u ispitivanoj grupi (80 pacijenata) iznosi 0 - 6 dana terapije najkraće, a u kontrolnoj grupi (197 pacijenata) iznosi 7 – 10 dana, najkraće. Dokazana je radna hipoteza da magnetoterapija utječe na trajanje liječenja i poboljšanje funkcionalnog statusa pacijenata s lumbalnim sindromom.

Ključne riječi: Lumbalni bolni sindrom, pulsirajuće magnetno polje

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