Influence of interferential currents, pulsed low-frequency electromagnetic field and exercises for pain in postmenopausal osteoporosis

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Извадок

Вовед: Остеопорозата предизвикува хронична болка во грбот која доведува до намалување на функционалната способност и квалитет на живот.
Цел: Да се испита влијанието на физикалните модалитети и вежбите врз болката кај пациентки со постменопаузна остеопороза.
Материјал и метод: Рандомизирано проспективно компаративно истражување на пациентки со постменопаузна остеопороза, следени една година во ИФМР. Учествуваа 92 пациентките поделени во три групи. Првата група се состоеше од 32 пациентки кои примаа физикални процедури, втората група од 30 пациентки кои не примаа физикални модалитети и трета контролна група од 30 пациентки. Физикалната терапија се состоеше од физикални модалитети и вежби. Од физикалните модалитети се применуваа интерферентни струи и пулсно никофреквентно електромагнетно поле, секој ден со викенд пауза, вкупно 21 ден. Пациентките од првата и втората група вежбаа 3 пати неделно за целиот период на следење. Третата група не ги практикуваше вежбите. Беа направени две контроли 21-от ден и на крајот од 12-от месец. Проценката на јачината на болка беше со нумеричка скала за болка. За статистички значајно се зема $p<0,05$.
Резултати: Немаше сигнификанта разлика помеѓу групите во однос на просечната возраст ($p<0,21$).На првата контрола резултатите покажаа дека пациентките од третата група имаа сингнификантно повисок скор за болка ($p=0,0003$). На крајот од истражувањето бројот на пациентки со болка беше сигниифкантно помал од контролната група пациентки ($p=0,0029$).
Заклучок: Физикалните модалитети влијаат врз болката кај пациентките со остеопороза.
Клучни зборови: остеопороза, физикални процедури, вежби, болка

Abstract

Introduction: Osteoporosis causes chronic back pain that leads to diminished functional capability and quality of life.
Aim: To examine the influence of physical modalities and exercises on pain in patients with postmenopausal osteoporosis.

Material and methods: This was a prospective study comprising 92 patients with postmenopausal osteoporosis randomly selected and followed for one year at the Institute of Physical Medicine and Rehabilitation in Skopje. Patients were assigned to three groups: the first group of 32 patients underwent physical procedures, the second group of 30 patients did not undergo physical modalities, and the third control group comprised 30 patients. Physical therapy consisted of physical modalities and exercises. Physical modalities included interferential currents and pulsed low-frequency electromagnetic field conducted each day for 21 days with weekend breaks. Patients from the first and the second group performed exercises 3 times per week during the entire follow-up period. The third group of patients did not practice exercises. Two check-ups were made, on day 21 and at the end of the twelfth month. Assessment of pain intensity was made by the use of a numeric pain rating scale.
Results: No significant difference among the groups was observed regarding the mean age of patients ($p<0.21$). The first check-up showed a significantly higher pain score in the third group of patients ($p=0.0003$). At the end of the twelfth month the number of patients with pain was significantly reduced as compared to the control group of patients ($p=0.0029$).
Conclusion: Physical therapy modalities and exercises influence on pain in patients with osteoporosis.
Keywords: osteoporosis, physical procedures, exercises, pain

Introduction

Osteoporosis is a systemic skeletal disease characterized by low bone density and microarchitectural deterioration of bone tissue with a consequent increase in bone fragility and susceptibility to fracture [1]. In the early period osteoporosis is asymptomatic and thus it is named silent epidemics. The first clinical manifestation is a low-energy fracture, most commonly at 7, 8, 9 thoracic and first lumbar vertebrae presenting as an acute pain that lasts for days and weeks and very often is transformed into a chronic pain[2]. In time changes in the physiological spinal curvature appear and more prominent thoracic kyphosis develops. Spinal deformity contributes to compression, vertebral collapse and secondary pressure on discs and surrounding ligaments. Consequently, chronic pain develops, which patients describe as back pain. It usually extends to thorax and abdomen, and sometimes patients present with pains in the hips, arms, ribs and knees.

For pain treatment non-steroid anti-inflammatory drugs, opioids, anti-epileptic drugs and antidepressants are recommended. Having in mind the adverse events and side effects of these drugs, physical agents including electrotherapy play an important role in management of chronic pain[3].

It is recommended to treat osteoporosis with bisphosphonates, proper nutrition which means intake of 800-1000 ml calcium per day and 800 IU vitamin D per day as well as physical activity[4].

In our study of chronic pain treatment we applied two modalities of physical therapy: interferential current therapy and magnetic therapy.

Interferential current (IFC) therapy has physiological and therapeutic effect on tissues, which is analgesic, sympatholytic, and positive trophic. In addition, it enhances tissue metabolism, accelerates resorptive processes, and has antiedematous and anti-inflammatory effect [5] . IFC are alternating medium-frequency amplitude modulated currents with sinusoidal form, which happens endogenous in the tissues with interference of two medium-frequency non-modulated currents by two independent electric circuits that differ by intensity, phase and frequency ranging from 1 to 100 Hz. The meta-analysis of Jorge *et al.* has presented

interferential currents as an efficient treatment in pain relief [6]. We used IF currents with constant frequency of 100 Hz for analgesia[7].

Magnetic therapy is an indispensable segment of physical therapy; it is easily applied and to a large extent harmless to the human organism. We applied low-frequency pulsed electromagnetic fields (PEMF) in this study. It has influence on each cell in the body where it is applied. Cell membrane permeability is changed; it affects the process of diffusion and active transport, enhances tissue oxygenation and metabolism; it activates osteoblasts, chondroblasts and fibroblasts [8,9]. PEMF is efficient in reducing chronic pain, which is a result of deterioration of connective tissue (cartilage, tendons, ligaments and bones). It can be applied as an alternative to the non-steroid inflammatory drugs in management of chronic pain[10].

Continuous practicing of exercises for a longer period diminishes pain in patients with osteoporosis[11,12].

Aims of the study

To assess the effectiveness of physical therapy modalities (interferential currents and PEMF) in management of pain in patients with osteoporosis.

Material and method

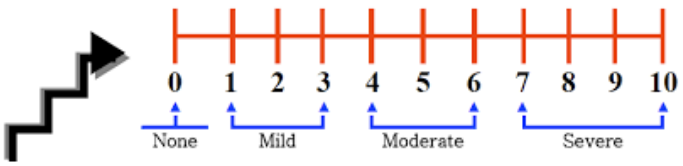
This was a randomized comparative blind clinical study. It included 92 patients with postmenopausal osteoporosis diagnosed at the Institute of Physical Medicine and Rehabilitation in Skopje, R. Macedonia, according to the criteria of the World Health Organization, a T-score of $\leq$ -2.5. Inclusion criterion of patients in the study was diagnosed osteoporosis. Exclusion criteria were as follows: secondary osteoporosis, febrility, lumbar sciatica, pacemaker, cardiorespiratory instability, arrhythmia, malignant disease, neurological diseases. Patients were randomly assigned to three groups: the first group underwent physical modalities and performed exercises, the second group underwent exercises program, and the third control group of patients did not practice exercises.

All patients took medicines for osteoporosis, which consisted of bisphosphonates, calcium 1000 mg per day and vitamin D 800 IU per day. Patients did not take analgesic pharmacologic agents.

Patients underwent physical modalities once a day for 21 days with weekend breaks. Therapeutic exercises started at the Institute of Physical Medicine and Rehabilitation and were practiced twice a week during the period of investigation. The follow-up period lasted for one year, when two check-ups were made; the first one on day 21 and the second at 12 months.

The survey was approved by the Ethics Committee for Human Research at the Faculty of Medicine, Ss. Cyril and Methodius University, Republic of Macedonia (Num.03-124/2, approved 22.03.2015). All patients were informed on the type and modalities of therapy and exercises and were given answers to all questions related to the examination. All patients were treated in compliance with the Declaration of Helsinki.

Back pain intensity in all patients was determined by the use of a numeric pain rating scale consisting of 11 items described in Fig. 1. This scale has been recognized in clinical metric pain reliability and validity [13].



Score 0 – patients have no pain
Grade 1, 2, 3 – patients have mild pain, score 1
Grade 4, 5, 6 – patients have moderate pain, score 2
Grade 7, 8, 9 – patients have severe pain, score 3.

Pain rating scale was made at the beginning, on day 21 and at the end of the examination.

Physical modalities

Interferential currents (IFC) are produced by the machine Inteldin, serial number 1177, Electronic Design. IF current is applied, const. 100 Hz, for 15 minutes. The current is applied at the thoracic-lumbar region using four electrodes. The electrodes are placed on the patient's skin. The skin has to be intact, healthy. Patients feel the therapy as a deep vibration and they explain the feeling as being pleasant.

Magnetic therapy is conducted with low-frequency pulsed electromagnetic field produced by the apparatus Magomil 2 of Electronic Design, with 8 MT intensity and 25 Hz frequency in the thoracic-lumbar region. The patient lies during the application of the magnetic therapy for 30 minutes.

Kinesitherapy is consisted of exercises, which are isometric and isotonic for strengthening and extending the paravertebral muscles, muscles of the upper and lower extremities, pectoral muscles, abdominal muscles and respiration exercises.

Statistical analysis of data was done with standard statistical methods, which were used to calculate the percentage of arithmetic mean with standard deviation.

The following statistical tests were used: t-test, Mann-Whitney U test and Friedman ANOVA. Comparison of pain intensity was made in each group and between the two groups on admission, on day 21 and at 12 months. Values of $p<0.05$ were considered to be statistically significant.

Results

Comparison of the three groups of patients with regard to the age showed no statistical significance ($p=0.3$). The largest number of patients in all three groups were at the age between 60 and 69 years, 62.5%, 46.67%, 63.33%, respectively (Table 1). A statistically non-significant difference was also observed in the level of education between the groups; the patients with completed high school being predominant in both examined groups and in the control group, 46.88%, 56.67%, 43.33%, respectively (Table 1).

Table 1. Statistical difference among groups regarding age and level of education of patients

Variable	Phys.+	Exercises	CG	p value

	exercises			
Age groups	n (%)			
40 – 49	0	3(10)	1(3.33)	Fisher
50 – 59	8(25)	12(40)	8(26.67)	p=0.3
60 – 69	20(62.5)	14(46.67)	19(63.33)	
70 – 75	4(12.5)	1(3.33)	2(6.67)	
Education	n (%)			
Primary	7(21.88)	5(16.67)	10(33.33)	X=2.77
High	15(46.88)	17(56.67)	13(43.33)	p=0.59
University	10(31.26)	8(26.67)	7(23.33)	

X (Chi-square test)

The mean body mass index (BMI) was 27.3±3.6 kg/m2 in the group treated with physical agents and exercises, 26.83±4.0 kg/m2 in the group which performed only exercises, and 26.91±4.1 kg/m2 in the group which did not receive physical agents or practiced exercises. Differences in the mean body mass index among the three groups registered at the beginning of the study were statistically not significant (p=0.88) (Table 2).

Table 2. Statistical difference among groups for BMI

Variable	**Phys.+ exercises**	**Exercises**	**CG**	**p value**
BMI kg/m2	**(mean±SD) / (min – max)**			
Admission	(27.3 ± 3.6)	(26.83 ± 4.0)	(26.91 ± 4.1)	F=0.13
	(22.6 – 35.1)	(20.2 – 34.2)	(19.92 – 36.65)	p=0.88

F (ANOVA)

Majority of patients in the three groups had a present deformity, with 84.38% in the group treated with physical agents and exercises, 76.67% in the group which performed exercises, and the largest percentage (90%) was observed in the control group of patients. The method of treatment of primary osteoporosis did not significantly depend on the frequency of the present deformity (p=0.38%) (Table 3). Kyphosis had 59.38% of patients who were treated with physical agents and exercises, 53.33% of patients who performed exercises, and 63.33% of patients without this type of therapy. Smaller percentage of patients from all three groups had kyphoscoliosis (25%, 23.33%, 26.67%, respectively). The type of the deformity was not significantly different among the three groups of patients (Table 3).

Table 3. Statistical difference among groups regarding present deformity and type of deformity

Variable	**Phys.+ exercises**	**Exercises**	**CG**	**p value**

Present deformity	**n (%)**			
No	5(15.63)	7(23.33)	3(10)	Fisher
Yes	27(84.38)	23(76.67)	27(90)	p=0.38
Type of deformity	**n (%)**			
Kyphosis	19(59.38)	16(53.33)	19(63.33)	Fisher
Kyphoscoliosis	8(25)	7(23.33)	8(26.67)	p=1.0

Pain

On admission, pain was present in all patients treated with physical agents and exercises: in 90% of patients who performed exercises, and in 93.33% of the controls. A statistically non-significant difference among the three groups of patients was observed regarding the frequency of onset of pain (Table 4). Also, the intensity of pain was not significantly different among patients undergoing different type of therapy (p=0.39).

Table 4. Statistical difference among groups regarding distribution and intensity of pain on admission

Variable	Phys.+ exercises	Exercises	CG	p value
Pain score begin.	n (%)			
No pain	0	3(10)	2(6.67)	Fisher
Present pain	32(100)	27(90)	28(93.33)	p=1.95
Score of present pain (beginning)		n (%)		
Small pain	3(9.38)	4(13.33)	1(3.33)	H=1.88
Moderate pain	16(50)	12(40)	12(40)	p=0.39
Severe pain	13(40.63)	11(36.67)	15(50)	

H (Kruskal – Wallis)

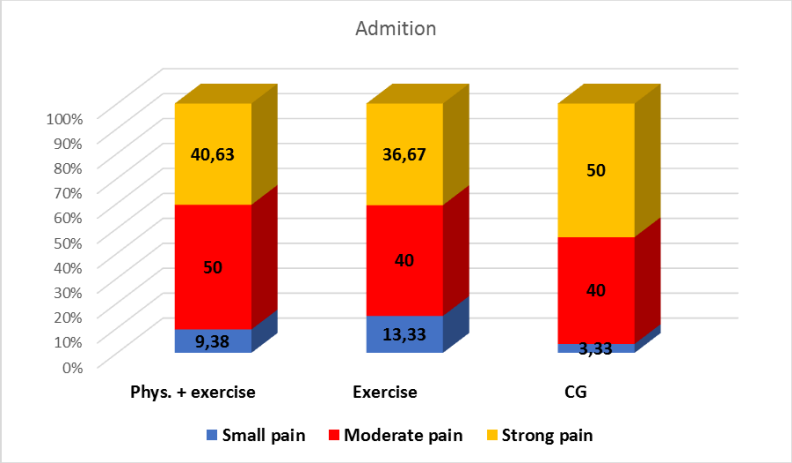


Figure 1. Significant difference among groups with regard to intensity of pain on admission

The check-up on day 21 showed that approximately 70% of patients in all three groups experienced pain and the difference was not significant (p=0.989). On the other hand, the intensity of pain was significantly different among patients from the three groups (p=0.005). Patients who were treated with physical agents and exercises more often had small pain than patients who only performed exercises and patients without therapy (56.25%, 33.33%, 20%, respectively). Control group of patients had a severe pain more often than patients who received combined therapy and patients who performed exercises alone (23.33%, 6.25%, 6.67%, respectively) (Table 5).

Table 5. Statistical difference among groups regarding distribution and intensity of pain on day 21

Variable	Phys.+ exercises	Exercises	CG	p value
Score pain – 21 day n (%)				
No pain	9(28.13)	8(26.67)	8(26.67)	X=0.022
Present pain	23(71.88)	22(73.33)	22(73.33)	p=0.989
Score for present pain – 21 day n (%)				
Small pain	18(56.25)	10(33.33)	6(20)	Fisher
Moderate pain	3(9.38)	10(33.33)	9(30)	p=0.005**
Strong pain	2(6.25)	2(6.67)	7(23.33)	

X (Chi-square)

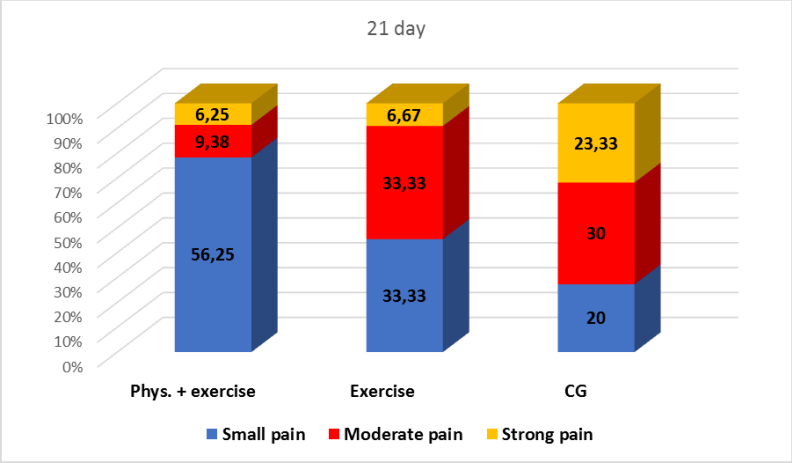


Figure 2. Intensity and distribution of pain in all three groups on day 21

On the last check-up, after one-year follow-up of patients, 34.38% of patients, who received interferential currents, magnetic therapy and exercises for osteoporosis, declared persistence of pain; 36.67% of patients who practiced exercises for osteoporosis, and significantly larger number of patients, 73.33%, who received no physical agents and did not practice exercises (p=0.0029) (Table 6).

Table 6. Statistical difference among groups regarding pain distribution after one year

Variable	Phys.+ exercises	Exercises	CG	p value
Pain at 12 months	n (%)			
No pain	21(65.63)	19(63.33)	8(26.67)	X=11.64
Present pain	11(34.38)	11(36.67)	22(73.33)	p=0.0029**

X (Chi-square)

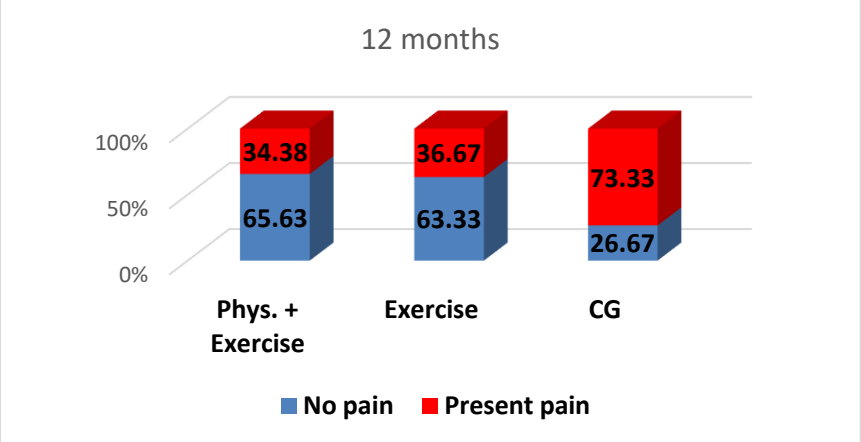


Figure 3. Pain distribution in three groups of patients at 12 months

Discussion

We live in a society where the percentage of elderly population is increasing and hence the focus of interest is on osteoporosis. Since it is a silent disease, its first clinical manifestation is a low-energy fracture manifested with a back pain. Patients suffering from a long-term and persistent pain take analgesic agents for a considerable period. Long-term use of analgesic agents has a negative impact on the health due to their adverse effects. On the other hand, physical modalities such as interferential currents and magnetic therapy are safe for the patients.

In our study we examined the combined analgesic effect of interferential current therapy and analgesic effect of magnetic therapy along with their pooled effect on pain intensity. Osteogenic stimulatory effect of magnetic therapy was not analyzed due to the short follow-up period.

In the beginning of the study the ratio of distribution ($p=0.195$) and pain intensity ($p=0.39$) in patients was insignificant.

Distribution of patients and pain intensity was examined at three time points, at the beginning, on day 21 and at the end of the study, after one year.

On the first check-up (21 day), pain intensity was significantly different among the three groups of patients ($p=0.005$). Patients who underwent a combined therapy for three weeks, that is, who were treated with physical agents and exercises experienced a smaller pain than patients who performed only exercises and patients without therapy (56.25%, 33.33%, 20%, respectively). On the other hand, patients from the control group more often experienced a severe pain than patients who were treated with combined therapy for three weeks and patients who performed only exercises (23.33%, 6.67%, 6.25%, respectively, $p<0.005$) (Table 5).

The significant pain relief in the first group of patients was due to application of physical agents in the first three weeks of the study, and, in fact, it was a result of application of IFC and PEMF which physiotherapeutic effect resulted in pain reduction. Several studies have been conducted on the analgesic effectiveness of IFC and PEMF when they have been applied alone or in combination with physical agents and exercises.

Zambito A *et al*. evaluated the analgesic efficacy of IFC and horizontal therapy (electrical nerve stimulation) together with a standard exercise program in patients with chronic low back pain. Similar to our study, they included 94 patients; some of them suffered from osteoporosis and took regular drug therapy for osteoporosis as well as practiced exercises. Patients were divided in three groups: the first group comprised patients who were treated with IFC, the second group received horizontal therapy, and the third control group received no physical agents. All patients performed the exercise program. Pain intensity was measured at the beginning and after completion of the physical procedures. The results showed a statistically significant decrease in pain intensity in the first and second group compared to the placebo group ($p<0.05$). On the other hand, at the end of the follow-up period no statistically significant difference regarding pain between the groups was found[14].

Olawale *et al*. investigated the analgesic efficacy of IFC combined with exercises for low back pain in 65 patients, at the age similar to that of our patients, and applied the same number of IFC as in our study. Time duration of IFC application was 15 min. Each of the subjects in the study was treated with IFC and specific therapeutic exercises for the spine, twice a week. Pain intensity prior to and after completion of the physical procedures was determined. Their results were in agreement with ours, indicating a significant pain decrease ($p < 0.001$) from 6.29 ± 2.16 prior to treatment to 2.54 ± 1.86 after treatment [15].

In another study conducted by Lee PB *et al.* the PEMF effectiveness was presented in decreasing chronic back pain. Patients were divided into two groups, active and placebo groups. As an outcome measure the numeric pain rating scale was used. Patients were treated with physical procedures for 3 weeks, as we did in our study. The results obtained for the active group with PEMF showed a significant pain relief ($p<0.05$) [16].

The advantage of our research is in the combination of physical agents, which proved to be effective in pain relief. Same results were obtained in the study of Pieber *et al.* where the effect of different physical agents in treatment of muscular-skeletal pain was evaluated. Their study included 40 patients, at the age of 18-80 years, divided into two groups, interventional group of 30 patients and control group of 10 patients. Similar to the results obtained in our study, there was a significant decrease in pain intensity ($p=0.016$) at the end of the application in interventional group of patients compared to the control group[17] .

In our study, after one-year follow-up of patients, pain persisted in 34.38% of patients who received interferential currents, magnetic therapy and exercises for osteoporosis, followed by 36.67% of patients who performed exercises, and a significantly larger number of patients (73.33%) who did not undergo physical therapy or performed exercises ($p=0.0029$). The number of patients with pain was significantly reduced as compared to the control group of patients (Table 6). Reduced number of patients with pain was mainly due to their regular practicing of exercises. Reduced number of patients with pain in the third group was due to their regular application of pharmacological therapy for osteoporosis.

The mechanism for pain reduction with exercises has still not been clarified, and it might be a result of the biological effect of the exercises on the human organism.

The role of physical procedures was significant in the first three weeks in patients with postmenopausal osteoporosis, whereas the decrease in pain in the further course of the study was due to the regular practicing of the exercises, which was seen at the end of the study.

Conclusion

Interferential currents and pulsed low-frequency electromagnetic field are one of the possible combinations of physical modalities that influence on pain relief in patients with postmenopausal osteoporosis. Exercises maintain the benefit obtained by application of physical agents in the early period of treatment. Continuous and long-term practicing of exercises decreases pain in patients with postmenopausal osteoporosis.

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