Pulsed Electromagnetic Field in the Treatment of Chronic Mechanical Low Back Pain

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ABSTRACT

The purpose of this study was to investigate the effects of pulsed electromagnetic field (PEMF) therapy in treating chronic mechanical low back pain (CMLBP). Thirty patients were assigned randomly in to 2 groups (A&B). Each of them included fifteen patients. Group (A), received traditional physical therapy program (Infrared radiation, ultrasonic, stretching and strengthening exercises for the back and abdominal muscles) as well as pulsed electromagnetic field (PEMF). While group (B) received traditional physical therapy only. Pain severity, functional disability and lumbar rang of motion (flexion, extension, right and left side bending) had been measured before and after 4 weeks of treatment for both groups. ***Results:*** *The results showed significant improvement in all parameters of group (A) when comparing with those at group (B).* ***Conclusion:*** *PEMF combined with traditional physical therapy program is a promising approach for treating chronic mechanical low back pain.*

Key words: *Pulsed electromagnetic field, Chronic mechanical low back pain and Traditional Physical therapy.*

INTRODUCTION

Chronic mechanical low back pain (CMLBP) represents a great variety of conditions that cause inappropriate back function. It is considered one of the most frequently treated and most costly disease in modern industrial society[1]. The incidence of low back pain ranges between 60% and 90% of individuals sometime in their life and is the leading cause of disability in people below the age of 45 years[5].

Mechanical low back pain is often chronic, dull, aching pain of varying intensity that affect the lower spine and might spread to the buttocks. Pain increases during activity such bending, twisting, lefting, prolonged standing and sitting[17].

CMLBP has been treated mostly by different physical therapy modalities. Like heat application which had been proven to be effective in relieving, muscle spasm and disability in acute and chronic (LBP)[18]. Ultrasonic also, has a positive effects in increasing range of motion and decreasing pain severity[16].

Therapeutic exercises, help in improving ROM & muscle power and hence back function in CMLBP. Stretching exercises for lumbar paraspinal muscles, quadrates lumbar, tensor fasciae, hamstring, lateral rotators improve flexibility and range of motion in (LBP) patients[14]. Mild stretching exercises for 10 seconds for hamstring, calf and iliopsoas muscles were effective in treatment of (LBP)[8].

Stretching exercises improve flexibility and improve nutrition of intervertebral disc educed by motion and partially by release of endorphins that modify the perception of pain[12].

Also both the spinal flexion and extension strengthening exercises provided significant reduction in LBP severity in

(CMLBP) patients. Activation of lumbar paraspinal and abdominal muscles during therapeutic exercise is important in (CMLBP) patients[11].

Pulsed electromagnetic fields (PEMF), displays frequencies at the low end of the electromagnetic spectrum, from 6 Hz up to 500 Hz. Another characteristic of PEMF waveforms is their rate of change. High rates of change (e.g., Teslas/ second) are able to induce significant biological currents in tissues, thereby enabling them to have greater biological effects than waveforms of lower rates of change, if the biological effect is dependent on the magnitude of the induced current[13].

Since the magnetic field generated can penetrate through high resistance structures such as bone, fat, skin, clothes or even plaster cast, it has been shown that electromagnetic fields provide a practical exogenous method for inducing cell and tissue modification and correcting selected pathological states[2].

Pulsed magnetic field therapy have shown decreased pain and improved functional performance in patients with osteoarthritis of the knee[24].

Magnetic field is the space permeated by the magnetic lines forces surrounding a permanent magnet or coil of wire carry electric current. A magnetic field always exists when there is an electric current flowing. There are three types of magnetic field: a static magnetic field which is fanned in the case of direct current, a time varying magnetic field and pulsed magnetic field. The human body is transparent to the magnetic field, so during application, it acts on all molecules, has non selective action[27].

Magnetic field, has been applied to promote bone healing, treat osteoarthritis and inflammatory disease of musculoskeletal system, alleviate pain and enhance healing of ulcers[16].

So, the purpose of this study was to investigate the effects of PEMF therapy in treating similar disorders like CMLBP.

PATIENTS, MATERIALS AND METHODS

Patients

This study included 30 patients, they have been diagnosed as (CMLBP) (21 female and 9 male), their age ranges from 20 to 40 years they were assigned randomly into two groups: A (experimental group) included 15 patients had received (PEMF and traditional physical therapy program infrared, ultrasonic, stretching exercises and strengthening exercises for back and abdominal muscles), and B (Control group) included 15 patients had received traditional physical therapy program only.All the patients had been treated in the outclinic of the faculty of physical therapy, Cairo University.

Inclusion Criteria

All patients were diagnosed clinically and radiologically by an orthopedist with the following criteria:

- Low back pain for at least 3 months ago.
- Moderate disability & care (20-40%) as determined through Oswestery Low Back Pain Disability Questionnaire.

Exclusion Criteria

- Pregnant and lactating women.
- History of previous back surgery.
- Vertebral compression fracture.
- Neurologic deficit.
- Current lower extremity symptoms.
- Symptoms of vertigo or dizziness.
- Cardiopulmonary disease with decreased activity tolerance.

Instrumentations

A- Instrumentations used for evaluation

Patients were assessed just before and after the treatment sessions. The assessment procedures included the following items.

1- Pain assessment:

Pain assessed by (Visual analog scale (VAS)[15]. VAS is a scale that allows continuous data analysis and uses a 10cm line with 0 (no pain) and 10 (worst pain) on the other end. Patients were asked to place a mark a long the line to denote their level of pain**[15].**

2- Functional disability:

Functional disability of each patient was assessed by Oswestery disability questionnaire[7] (Appendix). It is valid and reliable tool. It is consists of 10 multiple choice questions for back pain, patient select one sentence out of six that best describe his pain, Higher scores indicated great pain.

- Scores (0-20%), minimal disability.
- Scores (20%- 40%), moderate.
- Scores (40% - 60%), severe.
- Scores (60% - 80%), crippled.
- Scores (80% - 100%), patients are confined to bed.

3- ROM assessment:

a- Assessment of lumbar flexion and extension:

Both lumbar flexion and extension had been measured using the Modified-modified Schober technique. This method had been previously tested for validity and reliability**[28].**

b- Lateral flexion:

Lateral flexion was measured as the distance from the tip of the index finger to the floor at maximal comfortable lateral flexion with no forward or backward movements Normal values are at least 12 cm**[19].**

B- Instrumentation used for treatment

1. ASA Magnetic field (Automatic PMT Quattro pro)

ASA magnetic field is a device for magnetotherapy, its model is (Automatic PMT Quattro pro). It consists of an appliance, motorized bed and solenoids (Fig. 1). The appliance must be connected to electrical mains supplying 230v ± 10% at a frequency of 50 or 60 Hz with earth connection. The intensity and spatial lay out of the generated magnetic field depend on the type of solenoid used.

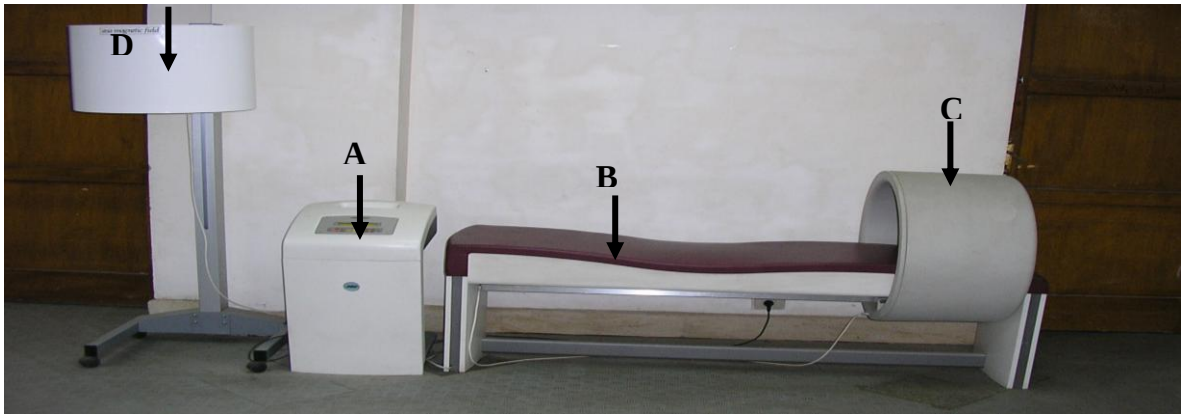

Fig. (1): ASA Magnetic field (Automatic PMT Quarto pro).

A. The appliance B. Motorized bed C. Solenoid D. Accessory for transcranial application

2. Infrared radiation:

Infrared has been used as a form of heat for many purposes. Its model is 4004/2N. The device has a power of 400w, voltage 203v and frequency of 50/60Hz. Infrared is sometimes chosen as a form of heat prior to stretching, mobilization, traction, massage and exercise therapy.

3. Ultrasonic device:

Ultrasonic device Phyaction 190 serial number 2745, 230V, 300 mA / 50 - 60Hz, Pus: 8w. It is used for pain relief and break down of adhesions in the case[4].

Treatment procedure

A- Experimental Group:

This group were consisted of 15 patient. They had received:

- Infrared radiation for 20 minutes/session at distance of 60 cm from lumbar region, while patients in prone lying position for 12 session 3/week every other day for one month[23].
- Ultra sonic: for 5 minutes, 1Hz, continuous mode of application 1.5w/cm^2.[4]
- Mild stretching exercises for 30 seconds for hamstring, calf muscles, and back muscles from long setting[6].
- Strengthening exercises for back muscles (bridging and active back extension)[11] and abdominal muscles (sit up exercise, and posterior pelvic tilt)[6]. Each exercise was repeated for 3 times per session with hold for 6 seconds at each end of ROM.
- Pulsed Electromagnetic Field, frequency 10 Hz, intensity of 20 gauss and duration of 15min.[24] While the patient was in prone lying position exposed lumbar spine to (PEMF). Each patient in this group received 3 sessions per week (every other day). The total duration of treatment was one month.

B- Control Group:

- This group was consisted of 15 patient. They had received traditional physical therapy program as described before.

RESULTS

On comparing the results of both groups (A & B) there was a highly statistical significant improvement in experimental group than control group, as regarding pain severity function disability and ROM. The results have been shown in tables (1, 2, 3) and figures (2, 3, 4).

Table (1): Demographic data of patients.

Variables	Control Group (A)	Experiment Group (A)	t-test	
			t	P values
Age (year)	37.27±2.52	36.73±2.52	.473	.80 (N.S.)
Weight (Kg)	72.73±8.66	77.4±10.23	1.349	4.67 (N.S.)
Height (Cm)	164.27±8.71	162.2±9.73	.613	2.07 (N.S.)
Duration of illness (month)	7.53±3.27	8.0±2.93	.412	.47 (N.S.)
Number of sessions	11.35±.83	11.66 ± .81	.421	.67 (N.S.)

Table (2): Comparison between groups before treatment.

Variables	Control Group (A)	Experiment Group (A)	t-test	
			t	P values
Pain Severity	7.66±8.23	8.05±7.93	1.311	.20 (N.S.)
Function disability	48.73±2.03	50.67±1.32	.797	.43 (N.S.)
Flexion	3.20±.67	3.23±.77	.125	.90 (N.S.)
Extension	1.53±.51	1.36±.44	.950	.35 (N.S.)
Right side bending	67.8±2.96	68.53±3.89	.581	.56 (N.S.)
Left side bending	66.93±3.10	69.47±4.02	1.93	.06 (N.S.)

Table (3): Post treatment inter group difference.

Variables	Control Group (A)	Experiment Group (A)	t-test	
			t	P values
Pain Severity	41.133±12.56	52.4±7.51	2.981	.006**
Function disability	29.33±7.92	35.53±4.59	2.621	.014**
Flexion	4.80±1.85	6.1±1.49	2.113	.044*
Extension	1.96±693	2.83±1.04	2.674	.012**
Right side bending	17.40±4.15	24.87±3.98	5.027	.0001**
Left side bending	17.87±3.60	25.73±3.82	5.797	.0001**

*Significant at 0 .05 level ** Significant at 0 .01 level

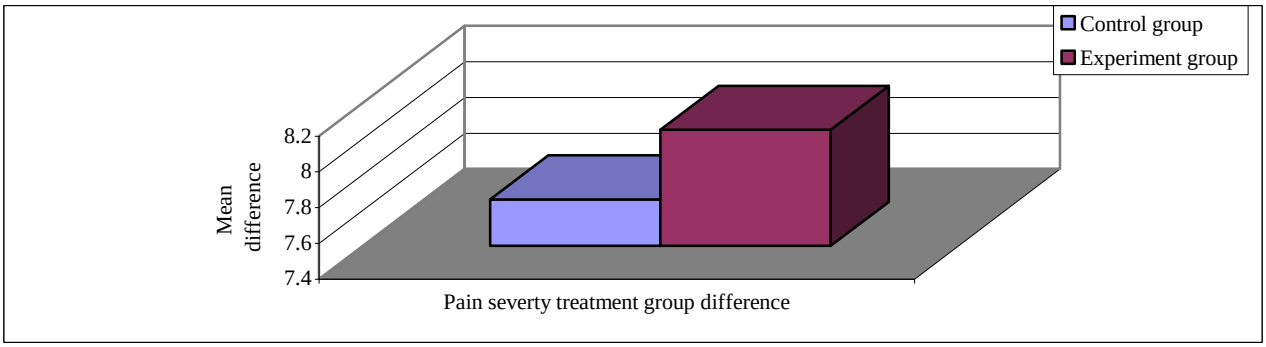

Fig. (2): Post treatment inter group difference of Pain Severity.

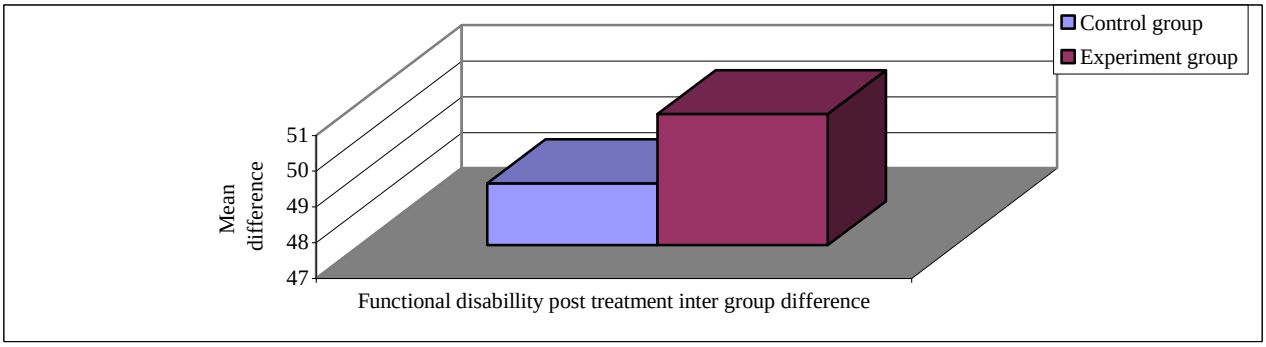

Fig. (3): Post treatment inter group difference of functional disability.

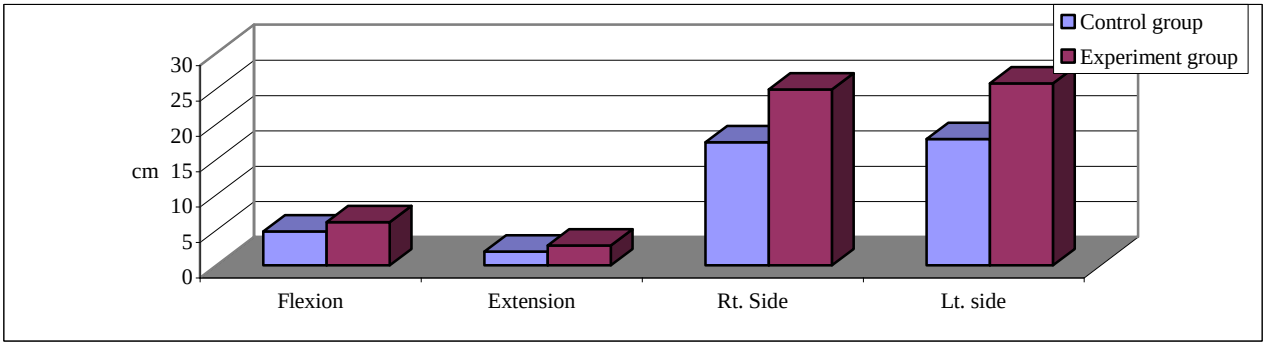

Fig. (4): Post treatment inter group difference of lumbar ROM.

DISCUSSION

The results of this study revealed that both the traditional physical therapy program and PEMF programs were effective in reducing pain severity, functional disability and increasing the range of motion of lumbar spine (flexion, extension, right and left side bending). But, pulsed electromagnetic field combined with traditional physical therapy was more effective than traditional program alone in treating CMLBP.

The analgesic effect of pulsed electromagnetic field therapy could be attributed to one of the following mechanisms:

First, the physiologic mechanisms of pain relief due to application of magnetic field may be due to presynaptic inhibition or decreased excitability of pain fibers[10]. Others postulated that magnetic field influence the small C-fibers[9,27]. Those authors, also, found that exposure to magnetic field produce a reversible blockade of sodium-dependent action potential firing and calcium dependent response to the irritant.

Second, the molecular mechanism of the effect of magnetic field may involve conformational changes in the ion channels or neuronal membrane. Considering the time required for the effect on action potentials, multiple mechanisms must be acting simultaneously, possible including indirect effect such as reduction in activity of channel posphorylating enzymes[22].

Third, evidence exists that pulsed electromagnetic field can modulate the actions of hormones, antibodies and neurotransmitters surface receptor sites of a variety of cell types[1].

Bassett et al., (1989) reported that PMF was used to reduce edema and improve microcirculation, possibly by facilitating water reposition, inhibit inflammation, accelerates hematoma resolution and enhance microcirculation[3].

Improvement in functional ability for (CMLBP) patients in the current study could be attributed to the positive anti-inflammatory and analgesic effect of (PEMF) which lead to decrease pain and inflammation and improve back functions.

Pulsed electromagnetic field is useful in reducing pain and relief of muscle spasm, so improves patient functions and trunk range of motion in chronic mechanical low back pain patients[9]. Also, it decreases joint and muscle pain, decreases joint swelling and stiffness and improves soft tissue repair and so increases mobility and quality of life[24].

On the basis of the present data, it is possible to conclude that (PEMF) therapy combined with traditional physical therapy

program is effective in reducing pain, functional disability and improving lumbar rang of motion in patients with (CMLBP).

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Appendix

Oswestry disability index version 2.0
Could you please complete this questionnaire? It is designed to give us information as to how your back (or leg) trouble has affected your ability to manage in every day life.
Please answer every section. Make one box only in each section that most closely describes you today.

Section 1: pain intensity
- I have no pain at the moment.
- The pain is very mild at the moment.
- The pain is moderate at the moment.
- The pain is fairly severe at the moment.
- The pain is very severe at moment.
- The pain is the worst imaginable at the moment.

Section 2: personal care (washing, dressing, etc.)
- I can look after myself normally without causing extra pain.
- I can look after myself normally but it's very painful.
- It's painful to look after myself and I'm slow and careful.
- I need some help but manage most of my personal care.
- I need help every day in most aspects of self care.
- I don't get dressed, wash within difficulty, and stay in bed.

Section 3: lifting
- I can lift heavy weights without extra pain.
- I can lift heavy weights but it gives extra pain.
- Pain prevents me from lifting heavy weights off the floor but I can manage if they are conveniently positioned, e.g., on a table.
- Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned.
- I can lift only very light weights.
- I can't lift or carry anything at all.

Section 4: walking
Pain doesn't prevent me walking any distance.
Pain prevents me walking more than 1 mile.
Pain prevents me walking more than a quarter of a mile.
Pain prevents me walking more than 100 yards.
I can only walk using a stick or crutches.
I'm in pain most of the time and have to crawl to the toiler.

Section 5: sitting
I can sit in any chair as long as I like.
I can sit in my favorite chair as long as I like.
Pain prevents me from sitting for more than 1 hour.
Pain prevents me from sitting for more than have an hour.
Pain prevents me from sitting for more than 10 minutes.
Pain prevents me from sitting at all.

Section 6: standing
I can stand as long as I want without extra pain.
I can stand as long as I want but it gives me extra pain.
Pain prevents me from standing for more than 1 hour.
Pain prevents me from standing for more than half an hour.
Pain prevents me from standing for more than 10 minutes.
Pain prevents me from standing at all.

Section 7: sleeping
My sleep is never disturbed by pain.
My sleep is occasionally disturbed by pain.
Because of pain I have less than 6 hours' sleep.
Because of pain I have less than 4 hours' sleep.
Because of pain I have less than 2 hours' sleep.
Pain preventing me from sleeping at all.

Section 8: Sex life (if applicable)
My sex life is normal and causes no extra pain.
My sex life is normal but causes some extra pain.
My sex life is nearly normal but is very painful.
My sex life is severely restricted by pain.
My sex life is nearly absent because of pain.
Pain prevents any sex life at all.

Section 9: Social life
My social life is normal and causes no extra pain.
My social life is normal but increases the degree of pain.
Pain has no significant effect on my social life apart from limiting my more energetic interests, e.g., sport, etc.
Pain has restricted my social life and I don't go out as often.
Pain has restricted social life to my home.
I have no social life because of pain.

Section 10: Traveling
I can travel any where without pain.
I can travel any where but it gives extra pain.
Pain is bad but I manage journeys over 2 hours.
Pain restricts me to journeys of less than 1 hour.
Pain restricted me to short necessary journeys less than 30 minutes.
Pain prevents me from traveling except to receive treatment.

Scoring the Oswestry disability questionnaire
For each section of six statements the total score is 5; if the first statement is marked, the score is 0; if the last statement is marked, it is 5. Intervening statements are scored according to rank. If more than one box is marked in each section, take the higher score. If all 10 sections are completed the score is calculated as follow: If 16 (total scored) out of 50 (total possible score) x 100 =32%. If one section is missed (or not applicable) the score is calculated: example: 16 (total scored)/45 (Total possible score) x 100 = 35% therefore, the final score may be summarized as: (total score)/ (5 x number of questions answered) x 100%. The authors suggest rounding the percentage to a whole number for convenience (Fairbank et al., 2000).

الملخص العربي

استخدام المجال المغناطيسي المتقطع في علاج آلام أسفل الظهر الميكانيكية المزمنة

يهدف هذا البحث إلى دراسة فاعلية المجال المغناطيسي المتقطع في علاج ألم أسفل الظهر الميكانيكي المزمن، وقد أجرى هذا البحث على 30 مريض تم تقسيمهم عشوائياً إلى مجموعتين متساويتين وهما المجموعة التجريبية وتضم 15 مريضاً والمجموعة الحاكمة وتضم 15 مريضاً أيضاً وشمل البرنامج العلاجي تعريض الظهر لمرضى المجموعة التجريبية إلى المجال المغناطيسي المتقطع بالإضافة إلى برنامج العلاج الطبيعي التقليدي ويشمل (الأشعة تحت الحمراء- الموجات الصوتية- تمرينات الإطالة- تمرينات التقوية لعضلات الظهر والبطن) وقد تم أيضاً علاج المجموعة الحاكمة بواسطة برنامج العلاج الطبيعي التقليدي فقط وقد أجريت القياسات لهاتين المجموعتين قبل وبعد الفترة العلاجية والتي امتدت إلى أربعة أسابيع وقد أوضحت النتائج وجود تحسن بالنسبة لتخفيف آلام الظهر وتخفيف العجز الوظيفي وتحسين حركة ثنى الجذع للإمام والخلف والجانب الأيمن والجانب الأيسر بالنسبة لمرضى المجموعة التجريبية بالمقارنة بمرضى المجموعة الحاكمة .