

Pulsed Electromagnetic field versus Microcurrent on Treatment of Mechanical Low Back Pain in Post Menopausal Women

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Abstract: Background: Mechanical low back pain is considered as a serious health problem worldwide especially in post menopausal period because it certainly can limit function and capacity in both work and personal life. Purpose of the study: to investigate and compare the efficacy of pulsed electromagnetic field versus microcurrent in treatment of mechanical low back pain in post menopausal women. Methodology: Thirty post menopausal women complaining from mechanical low back pain participated in this study. Their age ranged from 50 to 60 years. They were divided randomly into two groups of equal number. Group A received the pulsed electromagnetic field therapy while group B received microcurrent therapy on lower back region. Both groups received the same physical therapy program which includes infrared, stretching exercises and strengthening exercises for back and abdominal muscles for four weeks. Pain severity and lumbar range of motion (flexion, extension, right rotation and left rotation) were measured respectively by serum cortisol level and Back range of motion device (BROM) before and after four successive weeks of treatment. Results: indicated that there was statistically significant improvement in back pain and lumbar range of motion in group "A" compared with those in group "B". Conclusion: Pulsed electromagnetic field proved to be more beneficial than microcurrent in improving lumbar range of motion and perceived back pain in post menopausal women with mechanical low back pain.

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1. Introduction:

Low back pain (LBP) has been, and continues to be, one of modern human beings most common and complex ailments. It has been estimated that almost eight out every ten people will experiencing back pain in their life¹³. LBP is increasingly recognized as a complex syndrome with multifactor etiology. Its pathogenic mechanism leads to the development of chronic pain¹⁴. The incidence of LBP ranges between 60% and 90% of individuals sometime in their life and is the leading cause of disability⁴. Mechanical low back pain (MLBP) represents great variety of conditions that causes inappropriate back function. It is considered one of the most frequently treated and most costly in modern industrial societies²⁶. MLBP is defined as pain in lower lumbar region without neurological deficit due to postural or occupational stress lead to irritation of pain sensitive tissue. Those patients characterized by reducing spinal mobility and painful functional activity³. It is often chronic, dull, aching pain of varying intensity that affect the lower spine might spread to the buttocks. Pain is increased during activity such bending, twisting, lifting, prolonged standing and sitting^{22,11}.

In the post menopausal years, all women experience the physical effects of aging and may also be affected by the hormonal changes responsible for menopause. These changes can include serious health conditions. Determining risk factors for these diseases as early as possible allows women to employ preventive strategies. Menopause presents an opportunity for a woman to undergo a personal risk evaluation, whether it's for the first time or a reassessment²³. The relationships between the factors influencing LBP in post menopausal women such as menopausal symptoms, bone mineral density, duration of menopause, hormonal therapy, obesity, inactivity, parity, and osteoarthritis had been studied in 134 post menopausal women. It was proved that women with back pain reported more severe menopausal symptoms than those without back pain and a recognized association was found between the prevalence of LBP in post menopausal women, menopausal symptoms and health habits¹. Pregnancy as well as oral contraceptive use before menopause and the use of estrogens during menopause resulted in higher estrogen levels that increased laxity of joints and ligaments so, chronic LBP may occur⁵.

As a result of wide spread and increases of LBP, it has created the opportunity for developing

variety of approaches to deal with it. There were many trials have been carried out with some success, including the use of active exercise, Trance Electrical nerve stimulation, traction, bed rest, drug therapy, corset and others for managing LBP¹². Pulsed electromagnetic field is a physical therapy modality which has been used widely in the management of nerve paralysis, migraine, carpal tunnel syndrome, LBP, ulcers, bed sores, itching skin disease, chronic osteomyelitis, retarded healing, osteoporosis, frozen shoulder, aseptic necrosis, tennis elbow, calcaneal spur, arthritis, tinnitus, sinusitis, trigeminal pain and other conditions^{25,19}. Electrical stimulation is based on the fact that human body has an endogenous bioelectric system that enhances healing and relieving pain. When the body's endogenous bioelectrical system fails, cannot contribute to either the healing process or pain relieving. External current may serve to mimic the failed natural bioelectric currents, so that pain relieving or processes can be preceded. Microcurrent electrical neuromuscular stimulation (MENS) is better in enhancing cellular physiology processes than other current of higher amplitude, microcurrent is effective in the noxious and inflammatory disorders²⁴. Microcurrent therapy uses extremely small amounts of electrical current to help in relieving pain and healing of the soft tissues injuries⁹

This study was performed to investigate and compare the effect of pulsed electromagnetic field versus microcurrent stimulation on reducing mechanical low back pain (MLBP) and improving lumbar range of motion in post menopausal women.

2. Materials, Methods and Subjects:

Thirty post menopausal women complaining of MLBP for more than 3 months were diagnosed by an orthopedist and referred from orthopedic out – clinics of Cairo University Hospitals to participate in this study. Their ages ranged from 50 to 60 years. They were assigned randomly into 2 groups in equal number. Group (A) received the pulsed electromagnetic field therapy while group (B) received microcurrent therapy. Both groups received same physical therapy program which include infrared, stretching exercises and strengthening exercises for back and abdominal muscles for four weeks. BMI of all subjects were <30 Kg/m².

Exclusion Criteria:

All participated women did not have low bone mineral density or pathologic disorders at spine, hip, knee or ankle as well as previous surgery at the lumbar vertebrae and genital prolapse. They were housewives and did not smoke. They did not receive

any type of hormonal replacement therapy and or pain killer drugs throughout the study.

Instrumentation:

A) Evaluation

1-Weight-height scale

It was used for measuring weight & height of each patient for BMI calculation to exclude obese patient >30 Kg/m².

2- Elexcess twenty ten device:

It manufactured by Roch Company - Germany and used to analyze a venous blood sample to estimate the serum cortisol level (SCL).

3- Back Range of Motion Device(BROM):

It was used for measuring trunk motion (flexion, extension, lateral flexion and rotation). It uses a unique combination of inclinometer and goniometer technology with a standardized protocol to easily provide objective repeatable measurement. It is a valid and reliable instrument for measuring lumbar range of motion¹⁶.

B) Therapeutic

1-Pulsed electromagnetic field therapy (PEMF)

The pulsed electromagnetic unit ASA magnetic field (Automatic PMT Quattro pro) and its serial number is (00001543). It consists of an appliance, motorized bed and solenoids. The appliance was connected to electrical mains supplying 230V at a frequency of 50 or 60 Hz with earth connection. It generated pulsed magnetic field up to 100 Hz and intensity varied according to the type of solenoid. It was used in the treatment of patient in group "A".

2- Microcurrent electrical neuromuscular stimulation (MENS) device:

Zimmer Elektromedizin is a device of electrical stimulation. It consists of three devices, Galva 5, Sono 5 and Vaco 5. Microcurrent electrical stimulation is program number 17 in Galva 5 device. It made in Germany It is a device of electrical stimulation. It was equipped with two self electrodes; each electrode was about 8 Cm in diameter. . It was used in the treatment of patients in group B.

3-Infrared unit:

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

Procedures

A) Evaluation

Each patient of both groups was asked to fill out the information sheet and signed a written consent form before starting. Then she was informed about assessment & treatment. Patients were instructed to report any side effects during the treatment sessions.

- Pain assessment:

Pain assessment was done by measuring the serum cortisol level via elxcess twenty ten device. A venous blood sample of 8C.C was taken in the morning at 9 am, centrifuged and stored at 20°C till analyzed. Serum cortisol level was measured before as well as after one month of treatment.

- BROM assessment:

It was done by BROM device where the subject was instructed to stand straight with feet apart. The hands were hanged loosely at the subject's sides. The examiner stood beside the subject and adjusted the Velcro straps on the base so three fingers can be inserted and the thumb placed over the wing then traced the outline of the subject's feet on a piece of paper attached to the ground so subsequent measurement could be taken in the same position. S1 was palpated by the examiner and marked with adhesive dots by standing behind the subject and placed his fingers on the top of the iliac crests and the thumb on the midline of the back at L4-L5 junction. L4 and L5 spinous process are reference point from which can identify other vertebrae, then the examiner palpated inferiorly for the spinous process of S1 to locate and mark T12. Then measurement of trunk flexion, extension, side bending, external and internal rotation were performed by taking the pointer reading.

B) Therapeutic

All patients in the both groups were received the same physical therapy routine that consisted of:

1- Superficial heating (infrared lamp) for 20 min./session at distance of 60 cm from lumbar region, while patients in prone lying position for 12 session /week.

2- Exercise program that consisted of:

- Self – stretching exercise for the lumbar erector spinae muscles and tissues posterior to the spine.
- Mild stretching exercises for 30 seconds for hamstring, calf muscles, and back muscles from long setting
- Strengthening exercises for back muscles as bridging and active back extension.
- Abdominal muscles as sit up exercise and posterior pelvic tilt

Each exercise was performed five times/session, with hold for 5 counts with one minute rest between each exercise, it was done 3 days/week, day after day for one month.

3- PEMF for group A

PEMF was applied once daily, 3 times /week for 4 weeks. Each session was conducted for 20 minutes over the lower lumbar region with the patient was placed in a comfortable prone lying position. Pulsed electromagnetic field frequency was 10 Hz, intensity of 20 gauss and duration of 20 min.

4- MENS for group B

MENS was applied once daily, 3 times /week for 4 weeks. Each session was conducted for 20 minutes over the lower lumbar region with the patient was placed in a comfortable prone lying position. The electrodes were soaked with normal saline and placed over the lower lumbar region paravertebrally with 5 Cm in between and adhesive plaster was used for fixing the electrodes.

Statistical Analysis:

Data were collected and analyzed using mean, standard deviation and unpaired t-test. All statistically significant differences were determined with a confidence interval of 95% and thus at $p < 0.05$.

3. Results

In this study MLBP was recorded by serum cortisol level and back range of motions for each subject in both groups A&B before and after 4 weeks of treatment.

In concerning Serum Cortical Level, There was statistically non significant difference in pre treatment values between both groups ($P < 0.71$). While there was a statistically highly significant difference after treatment ($P < 0.004$). This indicates significant reduction in pain level in group A than group B.

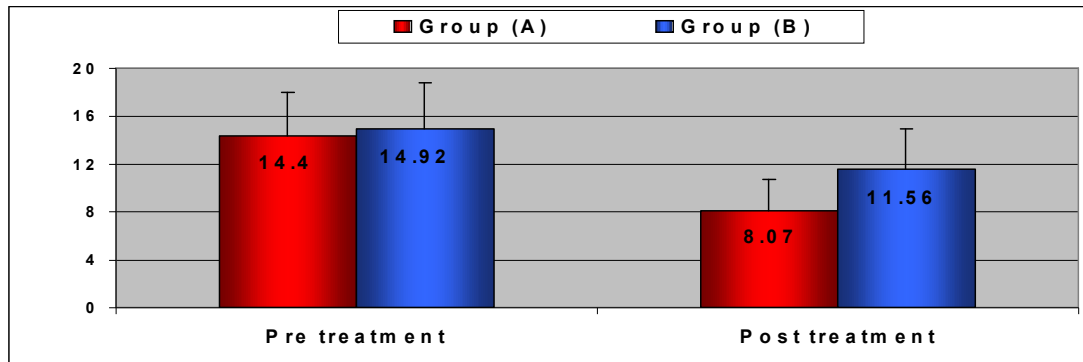
In concerning Lumbar range of motion:

Lumbar Flexion& extension:

There was statistically non significant difference ($P > 0.05$) in pre treatment values between group A& B in Lumbar flexion & extension movements. While in the post treatment values, there was a statistically highly significant difference ($P < 0.01$) for Lumbar flexion and lumbar extension ($P < 0.0001$) also.

Table (1): Serum cortisol level pre and post treatment for both groups A and B

	<i>Serum Cortical Level</i>			
	Pre treatment		Post treatment	
Groups	Group (A)	Group (B)	Group (A)	Group (B)
Mean \pm SD	14.4 \pm 3.63	14.92 \pm 3.94	8.07 \pm 2.6	11.56 \pm 3.46
Mean difference	0.51		3.49	
t-value	0.37		3.11	
P-value	0.71		0.004	
S	NS		HS	

**Figure (1): Values of serum cortisol level pre and post treatment of both groups (A, B).****Table (2): lumbar flexion pre and post treatment of both groups A & B**

	Lumbar Flexion			
	Pre treatment		Post treatment	
Groups	Group (A)	Group (B)	Group (A)	Group (B)
Mean \pm SD	26.4 \pm 3.54	27.13 \pm 3.09	35.06 \pm 3.71	31.53 \pm 3.46
Mean difference	0.73		3.53	
t-value	0.6		2.69	
P-value	0.55		0.01	
S	NS		HS	

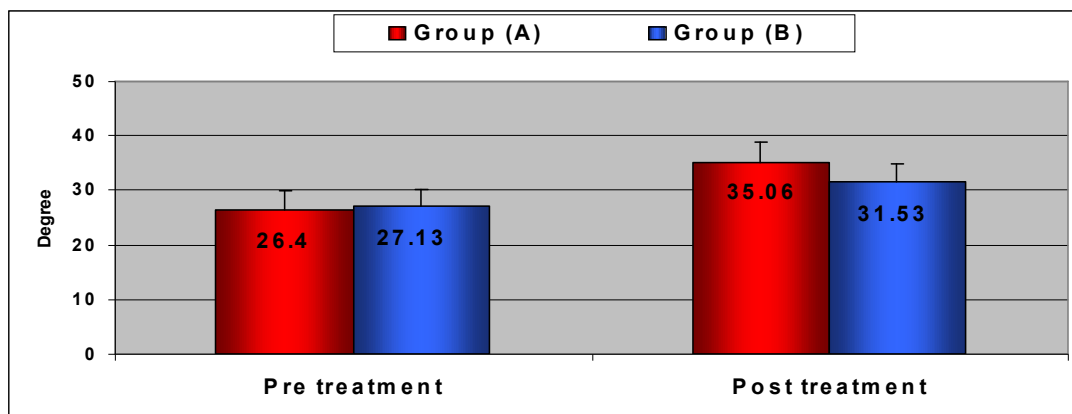
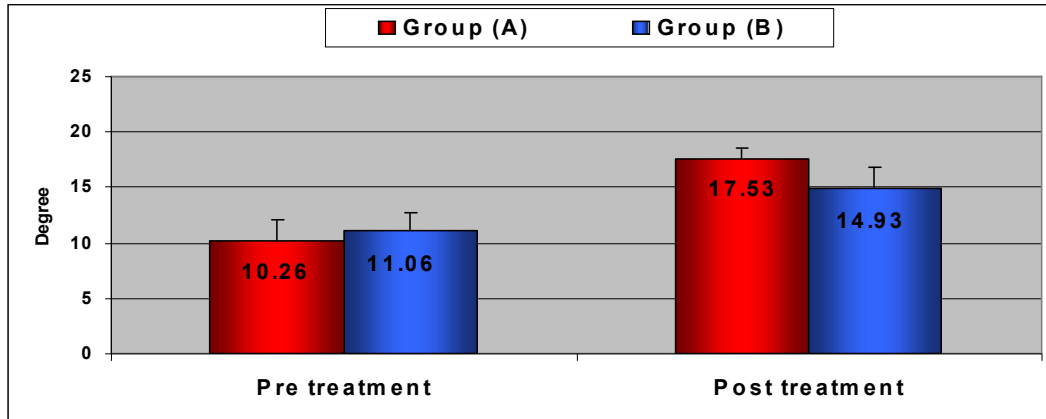
**Figure (2): Mean and \pm SD of lumbar flexion pre and post treatment of both groups (A& B).**

Table (3):): lumbar extension pre and post treatment of both groups A & B

	Lumbar Extension			
	Pre treatment		Post treatment	
Groups	Group (A)	Group (B)	Group (A)	Group (B)
Mean \pm SD	10.26 \pm 1.86	11.06 \pm 1.66	17.53 \pm 1.06	14.93 \pm 1.98
Mean difference	0.8		2.6	
t-value	1.23		4.48	
P-value	0.22		0.0001	
S	NS		HS	

**Figure (3): Mean and \pm SD of lumbar extension pre and post treatment of groups (A & B).****Table (4): lumbar right rotation pre and post treatment of both groups A & B**

	Lumbar right rotation			
	Pre treatment		Post treatment	
Groups	Group (A)	Group (B)	Group (A)	Group (B)
Mean \pm SD	13.46 \pm 1.99	14.06 \pm 1.9	19.2 \pm 1.61	17.13 \pm 1.72
Mean difference	0.6		2.06	
t-value	0.84		3.38	
P-value	0.4		0.002	
S	NS		HS	

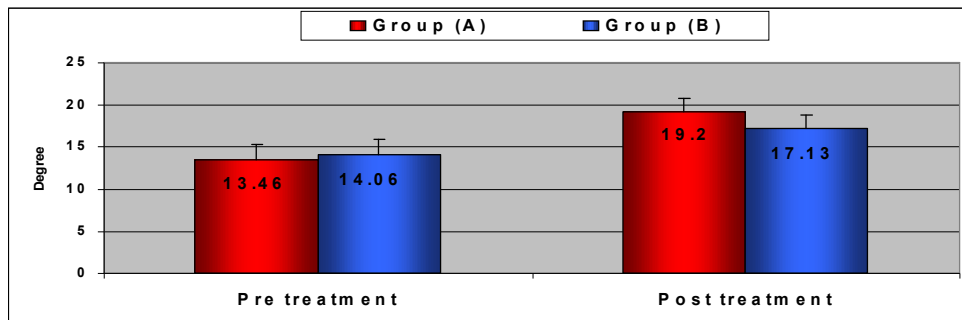
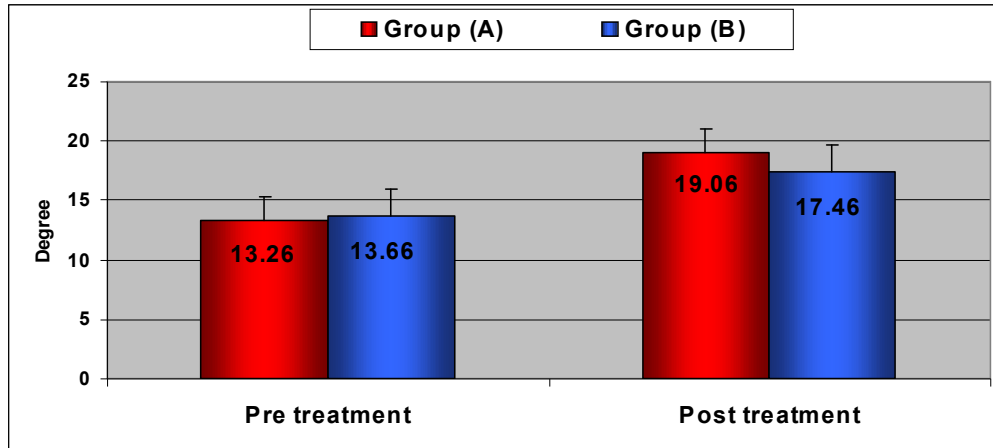
**Figure (4): Mean and \pm SD of lumbar right rotation pre and post treatment of both groups (A& B).**

Table (5): lumbar left rotation pre and post treatment of both groups A & B

	Lumbar left rotation			
	Pre treatment		Post treatment	
Groups	Group (A)	Group (B)	Group (A)	Group (B)
Mean \pm SD	13.26 \pm 2.05	13.66 \pm 2.35	19.06 \pm 1.9	17.46 \pm 2.23
Mean difference	0.4		1.6	
t-value	0.49		2.11	
P-value	0.62		0.04	
S	NS		HS	

**Figure (5): Mean and \pm SD of lumbar left rotation pre and post treatment of both groups (A& B).****Lumbar rotation:**

There was non statistically significant difference in pre treatment values between both groups A& B in lumbar right & left rotation. While, in the post treatment values there was a statistically highly significant difference ($P<0.002$) & ($P<0.04$) for right & left rotation respectively.

4. Discussion:

MLBP is one of the most common causes of inappropriate back function. Magnetic therapy and microcurrent have been reported to be effective in the treatment of patients with back pain. Our study was conducted to compare the effects of PEMF with frequency of 10Hz, intensity of 20 Gauss and duration for 20 minutes per session, 3 sessions per week for successive 4 weeks versus microcurrent for 20 minutes per session, three sessions per week for successive 4 weeks on improvement of back pain, and back range of motion in MLBP in post menopausal patients.

Thirty post menopausal female suffered from mechanical low back pain, were assigned randomly into two treatment groups. Group A received MLBP in addition to physical therapy program (infrared radiation, stretching exercise for

back and hamstring muscles and strengthening exercise for back and abdominal muscles). Whereas females in the group B were treated by micro-current therapy in addition to the same physical therapy program that given to group A. The results of the current study showed statistically significant improvement in pain levels and lumbar ROM in the group A more than group B at the end of 4 weeks treatment.

Pain and lumbar range of motion were assessed before and after treatment both groups. All patients in both groups had symptoms of low back pain. This agrees with Morki and Sinaki who reported that low back pain generally is marked by pain increasing during activity such as bending, twisting, lifting, prolonged sitting and standing. They also had decrease of functional ability and back range of motion due to pain and muscle spasm^{22,8,17}

The improvement of pain level was better in group A that treated by PEMF than group B that treated by microcurrent at the end of treatment. This result come in agreement with others who postulated that magnetic therapy has become one of the most rapidly emerging alternative therapies where magnets have been promoted for their analgesic and energizing effects with no side effects unlike

drugs^{20,29}. The analgesic effect of pulsed electromagnetic field therapy could be attributed to the physiologic mechanisms of pain relief which may be due to presynaptic inhibition or decreased excitability of pain fibers⁶. Other postulation is magnetic field influences the small C-fibers and produces a reversible blockade of sodium-dependent action potential firing and calcium dependent response to the irritant³⁰. Shupak et al., 2004 found that the analgesic effect of PEMF could be attributed to the neuropathic pain arising from firing of unmyelinated C fibers with accumulation of sodium and calcium channels because PEMF safely induce extremely low frequency current that can depolarize, repolarize neurons. It was hypothesized that this energy could potentially modulate neuropathic pain. Pulsed electromagnetic field can modulate the actions of hormones, antibodies and neurotransmitters surface receptor sites of a variety of cell types. This may cause changes in the transfer rate of electrons during the electron exchange between single molecules that may either slow down or accelerate chemical reaction²⁷.

Other explanation for pain improvement is that PEMF causes the membrane to be lowered to a hyper-polarization level of about (-90 mV) so it blocks the pain signal transmission. Magnetic field also influence ATP production; increases the supply of oxygen and nutrients via the vascular system; improves the removal of waste metabolites via the lymphatic system and help to rebalance the distribution of ions across the cell membrane thus reducing pain; reducing muscle spasm.¹⁵ In addition to analgesic effect, the PEMF has positive anti-inflammatory which leads to decrease pain and improve back function¹⁸

Regarding to the group B there was significant reduction of pain level after treatment but less than group A. This come in agreement with McMakin et al., 2005 who reported that the efficacy of microcurrent for reduction in pain improvement scores with accompanying substantial reduction in serum levels of the inflammatory cytokines IL-1 (which can increase the number of bone marrow cell), IL-6 which is a pro-inflammatory cytokine secreted to stimulate immune response to trauma especially in tissue damage. It is elevated in response to muscle contraction, and TNF-X and neuropeptide substance P. Beta-endorphin release and decreases in serum cortisol and increase Serotonin which is a neurotransmitter that helps you feel good. Others reported a favorable effect of MENS on pain control through the modification and recruitment of cell membrane ATP, this occurred mostly under conditions of chronic pain²¹. These results are contradicted with the work of Jennifer who found that

the biochemical increases in collagen formation after MENS are advantageous but may not be reflected when clinical measures such as ROM and pain measures are used. They also found that microcurrent stimulation was not effective in reducing pain and loss of ROM associated with muscle soreness¹⁰.

The results of lumbar ROM obtained in the current study showed that there was significant increase of lumbar flexion, extension, right and left rotation after treatment for the two groups but the improvement of group (A) was more than group (B). PEMF appeared to be effective in improvement of lumbar ROM. This occurred because the spine mobility was affected in MLBP patients as a result of pain avoidance behavior which caused the muscles and ligaments not to be used to their ultimate limits or full ROM. If the limited lumbar ROM was maintained for a long period of time, the ROM would actually decrease as the soft tissues shorten and strength decreases especially lumbar flexion as a result of shortening of the back and hamstring muscles². The improvement in trunk range of motion in MLBP patients in this study could be attributed to the positive analgesic effect, anti inflammatory effect and reduction at muscle spasm so improve lumbar mobility and range of motion²⁸. These results were supported by Van Nguen and Marks 2002 who found that PEMF decreases joint and muscle pain, decreases joint swelling and stiffness and improve soft tissue repair so increase mobility and quality of life²⁹. Also, the application of magnetic field to the musculoskeletal problem can reduce pain, inflammation and enhance movement⁶.

Regarding the patients in group B who received MENS, there was improvement in the lumbar ROM but less than that of the group A who received PEMF; this may be due to that MENS can mainly decrease the pain level which will improve the mobility which may be in a short term. This was supported by McMakin et al., 2005 who reported that MENS has been shown to be effective in the treatment of myofascial LBP as it reduced pain and increased range of motion²¹. These results are contradicted with Denegar who found that MENS provided transient analgesia but did not significantly reduce the loss of strength associated with muscle soreness.

The data obtained in this study revealed that both PEMF and MENS were effective modalities for treating MLBP as there were significant differences in pain level, lumbar ROM after treatment but PEMF was more effective than MENS in treating MLBP in post menopausal women. The significant difference between the PEMF group and MENS group might be related to the different mechanisms of action and the different effects of the PEMF on the living cells and tissues which included vasodilatation, analgesic action, anti-inflammatory action, healing acceleration

and anti-oedematous activity. This also might be due to the biological effects of the magnetic field on biological systems included several structural levels; subatomic, atomic, molecular, subcellular, cellular, tissue, organs and whole system.

In conclusion, it could be recommended that application of PEMF was effective as a treating method for MLBP in post menopausal women owing to its analgesic and anti-inflammatory effects so it helps in reducing pain and functional disability and improving lumbar range of motion.

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