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Distance electrotherapy versus low pulsed electromagnetic field in the treatment of lower back myofascial syndrome: A randomized control trial

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ABSTRACT

Background: The impact of low back pain is about 60% - 90% of the working-age population in the industrial society. Myofascial pain syndrome is characterized by shortening of the muscles with increased tone and associated with trigger points that aggravated during the activity of daily living.

Objective: To compare the effects of distance electrotherapy versus low pulsed electromagnetic fields on the treatment of lower back myofascial syndrome.

Methods: The 60 participants in this randomized, double-blinded, pre-post experimental study with lower back myofascial syndrome ranged in age from 30 to 50. The participants were classified into three groups at random and the three groups received the same traditional physical therapyprogram; group (A) (n = 20), which received distance electrotherapy, group (B) (n = 20),which received low pulsed electromagnetic field and group (C) (n=20) which received traditional physical therapy alone. Visual analog scale (VAS), Oswestry disability Questionnaire (ODQ) and the inclinometer were used to quantify pain intensity, functional disability and lumbar range of motion (ROM) for flexion and extension respectively, at the baseline and four weeks following therapy.

Results: Within-group comparisons revealed statistically significant improvements (P<0.05) in all outcome measures across all groups. All outcome measures for all groups showed a significant improvement in the between-group comparisons (P<0.05), with the distance electrotherapy group improving more than the low pulsed electromagnetic group.

Conclusion: Lower back myofascial syndrome can be effectively treated with distance electrotherapy, low pulsed electromagnetic field and traditional physical therapy, with distance electrotherapy being superior to both of these treatments.

Keywords: *Distance electrotherapy, Lower back myofascial syndrome, Low pulsed electromagnetic field, Traditional physical therapy.*

INTRODUCTION

Myofascial pain syndrome (MPS) is a common musculoskeletal problem, with the low back being one of the commonest affected regions [1-2].It is characterized by presence of myofascial trigger points (MTrPs) that are located in group of taut muscles. Exhaustion, local ischemia, bad biomechanical habits and persistent muscle overload can all cause MTrPs to develop [3-4]. MTrPs restricts the muscle's ROM, lowers circulation, starves the muscle of nutrition and oxygen and leads to a buildup of metabolic wastes that activate pain-sensing nerve terminals and trigger muscle spasms and inflammation, causing pain and discomfort in the lower back, much disability and inability to work [5].

Several treatments have been used for lower back MPS through physical therapies, pharmacologic agents, injections and other such therapies. There are many physical therapy modalities used to treatMPS such as ischemic compression, dry needling, spray and stretch, massage therapy, ultrasound, acupuncture and low pulsed electromagnetic field (LPEMF) therapy[1, 6-8].

The LPEMF in which electric energy generate series ofmagnetic pulses through injured tissues whereby each magnetic pulse induces a tinyelectrical signal that stimulates cellular repair, suppressing inflammatory responses,alleviate pain and increasing range of motion [9].

Based on a clinical trial of Thomas,[10] concluded that LPEMF may be a novel safeand effective therapy for use in subset of chronic pain. Smania, [11] reported that repetitive magnetic stimulation produced significantly better results than placebo inreducing trigger points pain in trapezius muscle.

Distance electrotherapy (DE) is a new medical device intended for professional use in the physical therapy in order to provide physical and therapeutic procedures of distance, or contactless (electrodeless). Eddy electric currents, developed on the basis of Faraday electromagnetic induction, are created in the tissues being treated when a device applicator is located in close proximity to these tissues. It has two fundamental types of electromagnetic therapeutic currents, pulsed currents (PC) and interference currents (IFC) [12].

For the treatment of a specific diagnosis and a specific patient, the choice of pulse or interference currents can be made. Also, the device represents 660 nm-wavelength light-emitting diodes (LEDs). Which consider adjunctive phototherapy used with DE, to make it more effective [12].

The effect of DE will be attributed to the combined effect of PC or IFC with LEDs. The effectiveness of these modalities had been reported in many researches in relief pain and improves function [13-15].

Up to author knowledge there is no previous research done to evaluate the effect of DE in MPS, Although IFC,LEDs and LPEMF therapy can be implemented in patients with lower back MPS, There is a lack of data on which of them superior in its effect. So the need for this study will contribute new knowledge to the field of physical therapy research regarding the effectiveness of DE and compare it to LPEMFas a physical therapy modality in the treatment of lower back MPS.

MATERIALS AND METHODS

Participants

Sixty participants, 30 to 50 years old, males and females, clinically diagnosed with lower back MPS (according to trigger points location at lower back muscles and aggravation of pain with back activities). The participants were referred from orthopedic out-clinics in rail way Hospital.

Participants were assessed and included in the study if they had lower back muscles with activated trigger points and had lower back pain for at least three months [16]. After being evaluated, some participants excluded to participate in the study because they were pregnant or nursing, had a history of prior back surgery, had a vertebral compression fracture, had a neurological deficit, had current lower extremity symptoms, or had cardiopulmonary disease with decreased activity tolerance [16]. A flowchart outlining the recruitment process was provided (Figure 1).

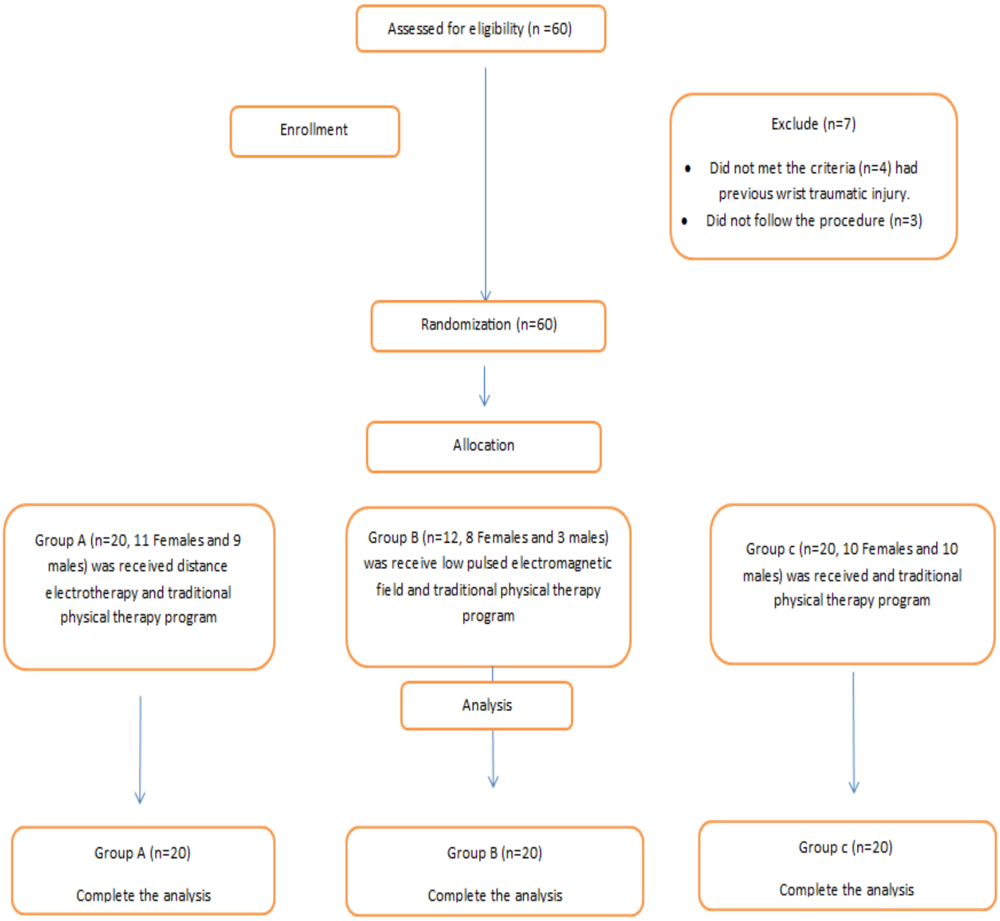

FIGURE 1: Flow chart for participants in the study.

Study design and randomization

This study is a randomized, double-blind, pre-posttest trail that spanned from July 2022 to December 2022. During the randomization phase, participants were divided into three groups according to whether they would receive DC and traditional physical therapy program (group A), LPEMF and traditional physical therapy program (group B), and traditional physical therapy program (group C). Using computer software (Microsoft Excel 2010) that produced a table of randomly chosen numbers, each of which corresponded to one of the three groupings (A or B or C). Participants were then divided into groups according to the number of their allocation codes. Without informing participants or evaluators, a researcher used drawing processes to determine who would be in group (A), group (B), or group (C). As a result, both the participants and the evaluators were blinded to the therapy allocation.

Ethical considerations

The current research has been authorized by the research ethics committee of the faculty of physical therapy at the Modern University for Technology and Information in Egypt with approval number REC/2111/MTI.PT/2204065. All participants were required to read an explanation of the experimental procedures and sign an informed consent form before the examination.

Procedure

The three groups received the same traditional physical therapyprogram.Twenty participants with lower back MPS participated in group (A), which received DC. Twenty participants with MPS participated in the group (B), which received a LPEMF. Twenty participantswith lower back MPS were in group (C), which received traditionalphysical therapyprogram. For four weeks, participants in each group attended three sessions a week.

The same traditional physical therapy program was administered to all participants in each group, which included ultrasound therapy,the ultrasound machine used was a Medserve (England NN114HE, Prosound / ULS1000, S/N: U05) for 5 minutes, 1Hz, continuous mode of application, and 1.5w/cm2 on the lower back [16],Gentle stretching exercise for the hamstring, calf, and back muscles for 30 seconds from long-setting [16] and back muscle strengthening exercises (active back extension and bridging) [16]. At the session, each exercise was performed three times with a 6-second hold.

Participants in group (A) received DE treatment using the EMBITRON VAS-07equipment (Better future,basic edition,made in Czech Republic). Participants were instructed to lie down in the prone position, leaving the area of the lower back uncovered. Inference current was used for the treatment, (base frequency 100HZ, swing frequency 100 HZ, and rectangular spectrum, treatment duration was 20 minutes,intenisty 60% and cureent period 100%). LEDs which stand in for secondary phototherapy, were applied concurrently with DE using wavelength 660 nm, at a distance of 25 cm between the patient and the applicator.

Participants in group (B) received LPEMF using ASA equipment (Sri Via A, Voltage 9-36057. Made in Italy). Participants are exposed to a LPEMF while lying on the prone position, with the following parameters being used: frequency 33 Hz, intensity 60% and duration 15 min.

Outcome measures

The VAS,ODQ and a digital inclinometer were used to evaluate the study’s participants. All participants had their measurements taken before and after the 4-week interventions (12 treatment sessions).

Pain severity

UtilizingVAS to assess, it is a reliable and valid instrument, which allows for continuous data processing, uses a 10 cm line with the numbers 0 (no pain) and 10 (worst pain) on either end. Participants were told to draw a mark down the line to indicate how much pain they have [17].

Functional disability

Adopting ODQ, it is a reliable and valid instrument. The participants choose the best sentence out of six from a list of ten multiple-choice questions that best reflects his back pain.Greater pain was indicated by higher scores. [Scores (0–20%) indicate minimal disability, Scores (21–40%) moderate disability, Scores (41–60%) severe disability, Scores (61%–80%) crippled, and Scores (81%–100%) bedridden patients] [18].

Lumbar flexion and extension assessment

An additional reliable and valid tool used to track spinal motion is an inclinometer, which is a hand-held, round, fluid-filled disc with a weighted gravity pendulum indication that remains pointing vertically [19]. Two inclinometers are used to determine the lumbar ROM. While the patient is upright, hip and lumbar ranges of motion are measured using inclinometers. To evaluate thehip motion, one is positioned on the sacrum. The patient is asked to bend as far forward as possible to measure lumber flexion and as far back as possible to measure lumber extension while the data from the two inclinometers are being recorded. The lumbar ROM can then be estimated using the difference between the two measurements [19].

Statistical analysis

Due to a lack of relevant literature and the inherent difficulties in evaluating the magnitude of the effect, pilot research with ten patients was carried out. Using the statistical program G*POWER, it was calculated that 20 cases in each group would be the smallest suitable sample size for the current study (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany). This software was adopted to determine the effect size. In the computations, 0.05, 0.2, effect size = 0.36, and allocation ratio N2/N1 = 1 were employed.

The statistical analyses were run using SPSS version 23 (Statistical Package for the Social Sciences). All of the study's data were presented using means and standard deviations. The differences between the pre-and post-treatment measures were evaluated using a paired t-test. The differences between the three groups were examined using a one-way analysis of variance (ANOVA), followed by a least-square difference (LSD) post hoc test. The significance level for each test in this study is set at 0.05.

RESULTS

A) Participants demographic data

Each category encompassed 20 participants; there was no marked disparity among the three groups of age, weight, height, and BMI ($p > 0.05$) as in (Table 1).

TABLE 1: Comparison of age, weight, height and BMI between the three groups (A, B, and C).

	Group (A) $\bar{X}$ **± SD**	**Group (B)** $\bar{X}$ **± SD**	**Group (C)** $\bar{X}$ **± SD**	**f-value**	**p-value**	**Level of significant**
Age (years)	38.95 ± 5.99	39.75 ± 5.93	40.45 ± 5.98	0.32	0.73	N. S
Weight (kg)	77.9 ± 7.67	77.55 ± 8.81	79.55 ± 7.45	0.36	0.702	N. S
Height (m)	1.69 ± 0.09	1.67 ± 0.18	1.69 ± 0.1	0.22	0.805	N. S
BMI (kg/m^2)	27.19 ± 1.18	27.69 ± 0.8	27.76 ± 1.16	1.73	0.187	N. S

$\bar{X}$: Mean. SD: Standard Deviation. f-value: ANOVA test value.
p-value: Probability value. NS: Non-Significant.

The gender distribution of group (A), group (B)and group (C) showed that there was no clear variance between the threegroups ($p > 0.05$) as in (Table 2).

TABLE 2: Comparison of the frequency distribution and chi-squared test for gender distribution between the three groups (A, B and C).

	Group (A) $\bar{X}$ **± SD**	**Group (B)** $\bar{X}$ **± SD**	**Group (C)** $\bar{X}$ **± SD**	**X^2**	**p-value**	**Level of significant**
Women	11 (55%)	12 (60%)	10 (50%)	0.23	0.646	NS
Men	9 (45%)	8 (40%)	10 (50%)			

$\bar{X}$: Mean. SD: Standard Deviation. X^2:Chi-squared value.
p-value: Probability value. NS: Non-Significant.

Measured variables

1) Pre-treatment comparison between the three groups (A, B and C)

When it comes to drawing a comparison between the pre-treatment of VAS, ODQ, trunk flexion, and extension values among the three groups,non-significant disparity reflected the measured variables between the three groups ($p > 0.05$) (Table 3).

2) Pre-and post-treatment comparison for groups (A, Band C)

When comparing the pre-and post-treatment value of VAS, ODQ, trunk flexion and extension values for groups (A), (B) and (C), the significant variances were revealed in all measured variables ($p < 0.05$) (Table 3).

3) Post-treatment comparison between the three groups (A, B, and C)

Significant changes in all measured variables between the three groups were found when comparing the post-treatment values of the VAS, ODQ and trunk flexion and extension values between groups (A, B, and C) ($p < 0.05$) (Table 3).

TABLE 3: Comparison of VAS, ODQ, trunk flexion, and extension for the three groups (A, B, and C).

		Group (A) $\bar{X}$ **± SD**	**Group (B)** $\bar{X}$ **± SD**	**Group (C)** $\bar{X}$ **± SD**	**f-value**	**p-value**
VAS	Pre-treatment	7.75 ± 0.85	7.8 ± 0.77	8.1 ± 0.72	1.18	0.316^{NS}
	Post-treatment	2.8 ± 0.77	3.55 ± 0.83	4.8 ± 0.95	28.14	0.0001^{S}
	% of improvement	63.87%	54.49%	40.74%	-	-
	p-value	0.0001^{S}	0.0001^{S}	0.0001^{S}	-	-
ODQ	Pre-treatment	64.9 ± 5.28	65.1 ± 4.73	64.7 ± 4.34	0.03	0.966^{NS}
	Post-treatment	28.25 ± 4.95	35.8 ± 3.81	40.01 ± 5.25	31.95	0.0001^{S}
	% of improvement	56.47%	45.01%	38.16%	-	-
	p-value	0.0001^{S}	0.0001^{S}	0.0001^{S}	-	-
Trunk flexion	Pre-treatment	31.05 ± 3.5	30.05 ± 3.03	29.45 ± 2.35	1.45	0.243^{NS}
	Post-treatment	45.75 ± 2.88	41.95 ± 3.01	38.2 ± 2.65	35.17	0.0001^{S}
	% of improvement	47.34%	39.6%	29.71%	-	-
	p-value	0.0001^{S}	0.0001^{S}	0.0001^{S}	-	-
Trunk extension	Pre-treatment	7.3 ± 1.13	7.4 ± 1.23	7.2 ± 1.06	0.15	0.858^{NS}
	Post-treatment	19.55 ± 1.93	17.45 ± 1.91	15.15 ± 1.81	27.27	0.0001^{S}
	% of improvement	83.9%	67.9%	55.2%	-	-
	p-value	0.0001^{S}	0.0001^{S}	0.0001^{S}	-	-

$\bar{X}$: Mean. SD: Standard Deviation. f-value: ANOVA test value.
% of improvement: Percentage of improvement. p-value: Probability value.
NS: Non-Significant. S: Significant.

4) Post-treatment comparison between groups (A and B), groups (A and C), and groups (B and C):

Significant variations were observed between the two groups (A and B), (A and C) and (B and C) when comparing the post-treatment values of the VAS, ODQ, and trunk flexion and extension values ($p< 0.05$) (Table 4).

TABLE 4: Comparison post-treatment of VAS, ODI, trunk flexion,and extension between groups (A and B), groups (A and C), and groups (B and C).

Items	VAS					
	Group (A)	Group (B)	Group (A)	Group (C)	Group (B)	Group (C)
$\overline{X}$ ± SD	2.8 ± 0.77	3.55 ± 0.83	2.8 ± 0.77	4.8 ± 0.95	3.55 ± 0.83	4.8 ± 0.95
% of improvement	26.78%		71.42%		35.21%	
p-value	0.005		0.0001		0.0001	
Level of Significant	S		S		S	
	ODQ					
	Group (A)	Group (B)	Group (A)	Group (C)	Group (B)	Group (C)
$\overline{X}$ ± SD	28.25 ± 4.95	35.8 ± 3.81	28.25 ± 4.95	40.01 ± 5.25	35.8 ± 3.81	40.01 ± 5.25
% of improvement	26.73%		41.63%		11.76%	
p-value	0.0001		0.0001		0.007	
Level of Significant	S		S		S	
	Trunk flexion					
	Group (A)	Group (B)	Group (A)	Group (C)	Group (B)	Group (C)
$\overline{X}$ ± SD	45.75 ± 2.88	41.95 ± 3.01	45.75 ± 2.88	38.2 ± 2.65	41.95 ± 3.01	38.2 ± 2.65
% of improvement	8.31%		16.5%		8.95%	
p-value	0.0001		0.0001		0.0001	
Level of Significant	S		S		S	
	Trunk extension					
	Group (A)	Group (B)	Group (A)	Group (C)	Group (B)	Group (C)
$\overline{X}$ ± SD	19.55 ± 1.93	17.45 ± 1.91	19.55 ± 1.93	15.15 ± 1.81	17.45 ± 1.91	15.15 ± 1.81
% of improvement	10.74%		22.51%		13.18%	
p-value	0.001		0.0001		0.0001	
Level of Significant	S		S		S	

$\overline{X}$: Mean. SD: Standard Deviation. % of improvement: Percentage of improvement. p-value: Probability value. S: Significant.

DISCUSSION

The focal point of the current academic work is to compare the effects of DE versus LPEMF on the treatment of lower back MPS. According to the findings of our study, DE combined with traditional physical therapy program had a superior effect in improving all outcome measures more effectively than LPEMF combined with traditional physical therapy program andtraditional physical therapy program alone.

1- Group (A)

The completion of the treatment program results revealed an extremely significant reduction in low back pain (LBP). Up to authors knowledge there haven't been any studies done on the effectiveness of DE in treating lower back MPS .

Since DE uses PC, IFC and LEDs, the effect of pain relief was a result of both the IFCthat was used and the LEDseffects.

The results of the study are therefore in line with earlier studies that show IFC and LEDs are efficient at reducing pain. There were many study results come in agreement with our study. Rajfur et al.,[13]revealed that applying IFC treatment deeper into the tissues was more effective than transcutaneous electrical nerve stimulation (TENS) currents and high voltage in reducing pain and enhancing functional abilities in patients with LBP. In their research, Facci et al.,[14]compared IFC and TENS treatmentson 152 patients, their findings demonstrated that these techniques were successful in treating persistent LBP.

In contrast to the current findings, earlier studies found no differences in the treatment of acute or chronic LBP between IFCand other methods, including spinal manipulation [20], general exercise, muscle release techniques[21], and motorized traction combined with massage [22].

Additionally, the improvement for the group (A) is helped by LEDs. This result is consistent with other investigations. According to Lin et al., [15] results, LEDs therapy can cure non-specific LBP by reducing pain and fatigue and enhancing function, quality of life, and fear-avoidance beliefs.

The DE ability to relieve pain may be ascribed to interference currents effects as well as light-emitting diodes' effects. The gate control theory explains the interference current's pain-reducing action [23]. According to this idea, stimulation of large-diameter afferent fibers (Aβ) encourages the activation of regional inhibitory circuits in the spinal cord's dorsal horn, which prevents pain impulses transported by small-diameter fibers (C and Aδ) from reaching higher centers [24], additionally, as a result, the tissues are deeply penetrated by interferential stimulation, which results in significant and long-lasting pain reduction and functional capacity enhancement.

Increases in microcirculation and nitric oxide synthesis, increased endorphin release, nerve transmission modulation, and modulation of important inflammatory mediators like inhibitory cyclooxygenase and prostaglandin E2 are some of the mechanisms by which LEDs have been shown to relieve pain [25].

The outcomes also showed a highly improvement in function after the treatment plan. These findings supported by Rajfur et al., [13] and Facci et al., [14] results who found that individuals with LBP significantly improved in function as a result of using interferential current. The favorable analgesic impact of the interferential current and LEDs, which results in a decrease in pain and an increase in back functions, could be the cause of the patients' improved functional abilities in this study.

The results also showed a highly increase in lumbar flexion and extension after the therapy procedures. These results back up those by Tantawy et al.,[26] who stated that, in individuals with chronic LBP, discovered that exercise therapy plus IFC treatment for four weeks significantly increased lumbar ROM and decreased discomfort. The improvement in trunk range of motion could be attributed to the positive analgesic effects of the IFC and LEDs, which reduced muscular spasms, improved lumbar mobility and range of motion in the study's participants [26].

2- Group (B)

The results demonstrated a highly significant reduction in LBP by the time the treatment program was complete. These findings are consistent with those of Elshiwi et al., [27] and Lee et al., [28]. Oke et al., [29], Jacobson et al., [30] and Hinman et al., [31] showed that considerable pain alleviation for patients with LBP due to use of LPEMF.

There are numerous theories that attempt to explain how LPEMF therapy works to reduce pain. According to one notion, LPEMF therapy could cause Eddy currents in biological tissues. Another is the gate control theory, which states that electrical stimulation can reduce pain signals to some extent by directly altering the nervous system, motivating inhibitory sensory neurons [32], or indirectly affecting genes by local electrochemical interference[33]. According to recent theories, LPEMF therapy can affect the genes that make up pain-related pathways like those for endogenous opioids and eicosanoid enzymes[34]. Any of these could be proposed as the underlying mechanisms accountable for the study's findings.

The results also showed a very noticeable improvement in function after the treatment period. These results corroborate with those of Oke et al. [29], Lisi et al., [35], Jacobson et al., [30] and Lee et al., [28] who discovered that PEMF application significantly improved function in those with LBP.

The improvement in the patient's functional abilities in this study may be attributable to the magnetic field's favorable anti-inflammatory and analgesic effects, which reduced pain and inflammation and improved back functions. The results also showed a very noticeable increase in lumbar flexion and extension after the treatment regimen. These results supported the claims made by Hinman et al., [31] who applied a magnetic field to a musculoskeletal problem could reduce pain and inflammation while enhancing movement.

According to a recent academic study, a pulsed electromagnetic field's effects on pain relief and muscle spasm relaxation led to improvements in trunk ROM in those with chronic mechanical LBP [36]. A magnetic field reduce joint and muscle pain, joint swelling andstiffness and increase soft tissue repair somobility and quality of life are improved by these impacts [37–38].

3- Group (C)

According to statistical comparisons of the control group pre- and post-pain assessment values, there was a significant difference between the pre- and post-treatment levels of back pain. Traditional physical treatment may be responsible for pain relief and be related to: Ultrasound improves the threshold of pressure produced by pain receptors, following application of ultrasound, the conduction velocity of the pain-producing small diameter nerve fibers (A delta fibers) decreased whereas the conduction velocity of the big diameter nerve fibers (A beta) increased [39]. It results in a considerable tissue heat that changes the connective tissues viscoelastic characteristics, making it more pliable and extensible [40].According to Khalil et al.,[41]research, stretching exercises for the hamstrings and back muscles helped low back pain sufferers feel less discomfort and were more flexible.

Functional abilities after therapy for the group (C) showed significantly improvement. O'Sullivan et al.,[42]assessment of the patient's level of functional abilities, they note dan improvement in functional abilities. Because a human is capable of consciously recruiting more motor neurons and raising their firing rate, a rise in myoelectric activity level following strengthening workouts suggests improved function of the neuromuscular system [42].

This conclusion has also been backed up by research by Van et al., [43] who discovered that exercise therapy is effective in improving function in the treatment of chronic low back pain.

Lumbar range of motion (flexion and extension) in group (C) exhibited a considerably larger improvement, as determined by the statistical comparison of pre-and post-values. Magnusson et al., [44] found that after a physical therapy program that included strength and flexibility exercises, functional ability and range of motion of lumbar flexion, extension, lateral right bending, and lateral left bending improved due to increased muscle strength, decreased pain, improved muscle flexibility, and improved motor control skills, provide evidence in support of this conclusion.

Moreover, Battie et al.,[45]found that individuals with persistent back problems reported feeling better in their range of motion after participating in a flexibility program. Kim et al.,[46] noted that core stability exercise and hip muscle stretching are effective at improving physical function and improve range of motion in patient with nonspecific low back pain. Improvements in the patient's physical activity, psychological state, and pain alleviation were to blame for the decline in impairment and rise in range of motion, according to Sullivan et al., [47].

Limitations

The study was age-specific (30-50), there have been no prior studies on the effectiveness of DE for treating lower back MPS and the lack of follow-up makes it difficult to say how long these changes might remain in the participants. The authors advise future researchers to target various age groups in their sample and include various follow-up times in their study design in light of this.

Also, only sixty people were included in the sample, which may limit generality. However, to identify the bare minimum a necessary number of participants, the authors performed a power test.

Strength

The current study's use of an objective, valid, and trustworthy measurement tool could be seen as a point of strength in our attempt to determine the effect of DE versus LPEMF on the treatment of the lower back MPS which previously did not report.

Weakness

No study comparing DE to LPEMFfor treating lower back MPS could be viewed as a weak point.

CONCLUSION

The lower back MPS can be effectively treated with DE, LPEMF and traditional physical therapy program, with DE being superior to both of these approaches.

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CONFLICTS OF INTEREST

No conflict of interest has been declared by the authors of this academic work.

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