Efficacy of Magnetic Field on Risk of Falling and Bone Mineral Density in Elderly Osteoporotic Women

Islam Mohamed Elsaghir Hassan[1], Zahra Mohamed Hassan Serry[2], Gamal Hosny Abdelmaksoud[3], Joseph Wageh Saweres[4], Saif Mehmed[5,6]

1 Physiotherapist at Nasser institute for research and treatment, Egypt.
2 Professor of Physical Therapy for Cardiovascular/Respiratory Disorders & Geriatrics, Faculty of Physical Therapy, Cairo University, Egypt.
3 Professor of Orthopedics, Ahmed Maher Teaching Hospital, Egypt.
4 Lecturer of Physical Therapy, Basic Science Department, Faculty of Physical Therapy Suez Canal University, Egypt.
5 Lecturer of Physical Therapy Cardiovascular/Respiratory Disorders & Geriatrics, Faculty of Physical Therapy, Cairo University, Egypt.
6 Lecturer of Physical Therapy for Cardiovascular/Respiratory Disorders & Geriatrics, Faculty of Physical Therapy, Alsalam University, Egypt.
E-mail: saifmehmed@cu.edu.eg

KEYWORDS

Electromagnetic Field, Risk of Falling, Bone Mineral Density, Osteoporosis, Berg Balance Scale, Alkaline Phosphatase, Visual Analogue Scale.

ABSTRACT

Background: Osteoporosis, a prevalent condition affecting equally women and men, has been marked by reduced bone mass and structural degeneration.
PEMFs promote bone formation, reduce inflammation, and improve bone remodeling by boosting osteoblast development and differentiation.
Objective: The aim of this study was to examine the efficacy of pulsed electromagnetic field on bone mineral density and risk of falling in old women with osteoporosis.
Methods: The study included sixty older women with osteoporosis. The subjects were separated into two groups: 30 in each one. Group A received pulsed electromagnetic field and closed chain exercise; and group B received the closed chain exercises.
Results: A statistically significant improvement in the study group compared to the control group with percentage of improvement in femur BMD, lumbar BMD, risk of falling, BBS, ALP, VAS for L.L, VAS for back and OQLQ by 27.71 %, 27.84 %, 21.86 %, 21.64 %, 31.29 %, 54.06 %, 53.01 % and 33.45 % respectively.
Conclusion: Pulsed Electro Magnetic Field (PEMF) is a significant intervention, and it is recommended to be a part of physical therapy & rehabilitation protocols of elderly osteoporotic women.

1. Introduction

The worldwide incidence of osteoporosis was recently estimated to be 11.7 in men and 23.1 in women. The study demonstrated an international incidence of osteoporosis is relatively high, notably in Europe and Africa(Estell et al., 2021).

It was projected that during the first 20 years following menopause, bone loss may result in a 50% drop in trabecular bone and a 30% reduction in cortical bone, raising the fracture risk (Osterhof et al., 2016).

While the prevalence of osteoporosis is documented in Western countries, there were almost no significant findings based on population research in Africa. The prevalence of osteoporosis in Egypt is believed to be 21.9% in males and 28.4% in postmenopausal women, with 53.9% of women with osteopenia (Paruk, 2021).

Osteoporosis is an elevated indicator for fracture, similar to how hypertension has been linked to stroke. Osteoporosis strikes an extensive percentage of individuals, regardless of gender and ethnic groups, and its prevalence will increase as the general population aged. It's an inconspicuous sickness till fractures form that led to significant subsequent health complications and mortality (Cosman et al., 2014). Osteoporosis has become a disorder characterized by reduced bone density, degeneration of bone cells, and disturbance of bone the micro architecture. It could result in decreased durability of bones and arise in the possibility of fractures (Panel, 2001).

PEMF had been discovered to stimulate bone growth by stimulating the growth and differentiating of osteoblasts whereas suppressing the activity of osteoclasts during the breakdown of bone. PEMFs may impact Ca2+-related receptors on the cell wall of the bone, which play a role in bone remodeling and stability. Moreover, PEMF therapy may change the physiological pathology of osteoporosis through lowering inflammation and maybe decreasing pain via these mechanisms of regulation and changes in the remodeling of bone (Zhu et al., 2017).

2. Research Question:

Does adding electromagnetic field to closed-chain exercises affect the density of bone minerals and the possibility of falls in older women?

3. Methods:

3.1 Population:

60 female patients who had osteoporosis were be got involved with the study with varying in age from 50 to 70 years old and will be enrolled via women's health center in Nasser institute hospital.

3.2 Design:

In addition, this study adhered to all applicable national rules, institutional guidelines, and Declaration of Helsinki principles. Following informed consent, clients were assigned at random to either of two groups. Groups A and B each had thirty participants.

Randomization was implemented using a generated by computers randomization table and the SPSS (Statistical Package for Social Studies) application (version 25 for Windows). Every client received a specific identifying code, that was employed to separate individuals separated in 2 groups of equal size. The numerical index cards were subsequently placed in dark envelopes, and the blinded investigator unsealed them to allocate individuals to groups.

3.3 Assessment Equipment:

1- DEXA for measurement of bone mineral density:

BMD has been measured by Dual-energy X-ray absorptiometry (DEXA). (Hologic Corp. Software version 12.4, Bedford, MA 01730, USA) (Seeley et al, 1991).

2- Biodex Balance System: Risk of fall will be assessed using Biodex stability system for assessment of falling and balance (Schmitz and Arnold, 1998).

3- Berg Balance System: Berg Balance Scale is considered to be the gold standard. The Berg Balance Scale-Short Version evaluates balance throughout certain motion activities. The Short Form Berg Balance Scale is designed to assess both dynamic and static balance, as well as danger of falling, in adolescent and elderly individuals. (Wood-Dauphine S, Katherine, et al., 1997).

4-Bone Pain Assessment for (Lumbar & Leg): by using Visual Analogue Scale (from 0-10) to assess Bone of the patient (Zanoli et al., 2001)

5-Biochemical Marker Kits: Serum Alkaline Phosphatase will be measured.

6-Oteoporosis Quality of Life Questionnaire (OQLQ): There are few research investigating health-related quality of life devices in osteoporosis. We assessed the validity, reliability, and feasibility of the osteoporosis quality of life questionnaire (OQLQ) to the QUALEFFO (test version) in females with osteoporosis. (Ettinger et al., 1985)

3.4 Treatment Equipment:

1- PULSED MAGNETIC FIELD devise (PEMF)

2-Weight Lift Bar

3.5 Procedure

For Group (A)

PULSED ELECTROMAGNETIC FIELD devise (PEMF)

Protocol of Magnetic Field for the Osteoporotic Neck Femur:

- TIME: 30 Minutes POWER: 20 GAUSS
- FREQUENCY: 50 Hz DUTY CYCLE: 100%
- FREQUENCY OF SESSION: 2 Times/ Week
- PRECUTION OF USE:

1- Avoid any metal pieces with the patient during the session. 2-Ask if patient has any pace maker or not. 3--Intramedullary nail or plates and screw fixation

- *DURATION OF TREATMENT:12 Weeks.*

2- Closed Kinetic Chain Exercise:

Closed-kinetic-chain exercising protocol with duration of 12weeks with frequency of session 3 time per week in the form of extension, abduction and flexion of the hip joint and the intensity of exercise by using weights will be 60% of 1RM for 12 repetitions /3sets/ session for each group of muscles. (Ali Thabet et al ,2018).

A- Deadlift exercise:

The patient should stand in the front of the bar with a stance width less than shoulder width, feet close near the middle of the bar, hands grasping the bar outer the legs, and a knee angle to the joint of no more than 15 degrees of flexion. The barbell should remain in touch with the legs during the execution.(Flandez et al., 2020)

B- Bridging exercise:-

The subject is lying in a supine hooking position on the therapy table, bending his knees to ninety degree, foot resting onto the tabletop, and there arms interlaced across the chest. The clients were taught to push via their heels to elevate their hips towards the air while keeping position of the shoulders, hips, and knees straight. (Guthrie et al., 2012)

C- Squat lift exercise:-

Participants were told to lift a weighted box to their waistline from a starting position with their knees bent, back erect (squat lift), and feet similarly placed. The patients were closely supervised to ensure that they began each route in the same approximate place. (Scholz & McMillan, 1995)

For Group (B) Control group:

Perform only Closed Kinetic Chain Exercise

3.6 Data analysis

An unpaired t-test was used to compare subject characteristics between groups. The Shapiro-Wilk test was used to check the normal distribution of data, and Levene's test for homogeneity was conducted to test the homogeneity between groups. Within and between groups effects on BMD, risk of fall, BBS, ALP, VAS and OQLQ were investigated by mixed MANOVA. Multiple post-hoc tests were conducted using Bonferroni correction. A $p<0.05$ was the level of significance. SPSS software version 25 (IBM SPSS, Armonk, NY, USA) was used for all statistical tests

3.7 Sample size calculation:

A priori sample size in variation among the two independent means has been computed using visual analogue scale (VAS) data acquired in a pilot study of 10 individuals, 5 in every group, using G* power (version 3.1.9.2, Franz Faul, Universitat Kiel, Germany). The required sample size had been 20 participants within every group, with an alpha level of 5%, a type II error of 90%, and an effect size of 0.86.

4. Results:

Subject characteristics of group A and B were presented in Table (1). There was no significant difference between groups in all subject characteristics ($p > 0.05$).

Table 1. Comparison of subject characteristics between the group A and B:

	Group A	Group B			
	Mean ±SD	Mean ±SD	MD	t- value	p-value
Age (years)	58.80 ± 4.84	60.17 ± 5.55	-1.37	-1.02	0.31
Weight (kg)	77.13 ± 10.24	76.67 ± 9.24	0.47	0.19	0.85
Height (cm)	162.50 ± 7.81	164.33 ± 8.58	-1.83	-0.87	0.39
BMI (kg/m²)	29.20 ± 3.31	28.41 ± 2.96	0.79	0.97	0.33

SD, Standard deviation; MD, Mean difference, p value, Probability value

Effect of treatment on BMD, ALP, risk of fall, BBS, VAS and OQLQ:

There was a significant interaction effect of treatment and time (F = 18.14, p = 0.001). There was a significant main effect time (F = 271.68, p = 0.001). There was a significant main effect of treatment (F = 4.55, p = 0.001).

- Within group comparison

There was a significant increase in femur and lumbar BMD, BBS and OQLQ in both groups post treatment compared with that pre treatment (p <0.001). There was decrease in ALP, risk of fall, leg and back VAS in both groups post treatment compared with that pre treatment (p > 0.05). (Table 2-3).

- Between group comparison

Ther was a significant increase in femur and lumbar BMD, BBS and OQLQ of group A compared with that of group B post treatment (p < 0.01).

There was a significant decrease in ALP, risk of fall, leg and back VAS of group A compared with that of group B post treatment (p < 0.01). (Table 2-3).

5. Discussion:

The current research was planned as a randomized controlled clinical trial to evaluate the effect of magnetic fields on fall risk and density of bone in older females having osteoporosis. Sixty medically referred osteoporotic women were enrolled in this research project. The clients were selected at random and assigned to 2 equivalent matched groups control and study groups. The Study Group consisted of thirty female patients treated by electromagnetic field and closed chain exercise while the Control Group comprised of 30 female clients and treated by closed chain exercise only.

The present study, however, was conducted on sixty patients, and the therapeutic protocol was carried out 3 times every week for six weeks at every patient to compare results before and after treatment. The current research revealed that the use of the electromagnetic field and closed chain exercise was more effective for improving density of bone and risk of falling in osteoporotic elderly females in the experimental group compared to using the closed chain exercise just in the control group.

Table 2. Mean femur and lumbar BMD, ALP, risk of fall and BBS pre and post treatment of group A and B:

	Pre treatment Mean ±SD	Post treatment Mean ±SD	MD	% of change	p value
Femur BMD					
Group A	-2.67 ± 0.17	-1.93 ± 0.18	-0.74	27.71	0.001
Group B	-2.64 ± 0.16	-2.26 ± 0.14	-0.38	14.39	0.001
MD	-0.03	0.33			
p value	***p = 0.45***	***p = 0.001***			
Lumbar BMD					
Group A	-2.91 ± 0.24	-2.10 ± 0.24	-0.81	27.84	0.001
Group B	-2.87 ± 0.22	-2.32 ± 0.23	-0.55	19.16	0.001
MD	-0.04	0.22			
p value	***p = 0.48***	***p = 0.001***			
ALP (IU/L)					
Group A	97.37 ± 12.61	66.90 ± 12.73	30.47	31.29	0.001
Group B	95.50 ± 10.87	80.37 ± 10.68	15.13	15.84	0.001
MD	1.87	-13.47			
p value	***p = 0.54***	***p = 0.001***			
Risk of fall					
Group A	3.11 ± 0.53	2.43 ± 0.36	0.68	21.86	0.001
Group B	3.28 ± 0.45	2.72 ± 0.44	0.56	17.07	0.001
MD	-0.17	-0.29			
p value	***p = 0.19***	***p = 0.006***			
BBS					
Group A	23.43 ± 1.63	28.50 ± 2.22	-5.07	21.64	0.001
Group B	24.03 ± 1.67	25.97 ± 1.61	-1.94	8.07	0.001
MD	-0.60	2.53			
p value	***p = 0.17***	***p = 0.001***			

SD, Standard deviation; MD, Mean difference; p value, Probability value

The enhancement in BMD of the regions that were treated may additionally be due to the impact of PEMFs on the rise in BM in osteoporotic people, that can be explained by the impact of attaching to the receptors on the cell surface, that in consequently may impact the metabolism of cells and promote growth, resulting in to an

enhancement in the orientation of cartilage and trabeculae. **(Alghadir et al., 2014).** PEMF was identified to stimulate development of bone by stimulating growth and osteoblasts maturation whilst preventing osteoclasts activity during the breakdown of bones. PEMFs could affect Ca2+-related receptors upon the bone cell membrane, which have an essential role in regulation within the maintenance of remodeling the bone.

In addition, PEMF treatment could change the physiopathology of bone loss by lowering irritation and maybe reducing discomfort via these mechanisms of regulation and changes in remodeling of the bones. **(Zhu et al., 2017).**

Table 3. Mean leg and back VAS and OQLQ pre and post treatment of group A and B:

	Pre treatment	Post treatment	MD	% of change	p value
	Mean ±SD	Mean ±SD			
Leg VAS					
Group A	6.03 ± 1.13	2.77 ± 1.22	3.26	54.06	0.001
Group B	6.13 ± 1.41	3.73 ± 1.20	2.40	39.15	0.001
MD	-0.10	-0.96			
	p = 0.76	***p = 0.003***			
Back VAS					
Group A	7.30 ± 0.99	3.43 ± 0.86	3.87	53.01	0.001
Group B	6.93 ± 1.31	4.17 ± 1.02	2.76	39.83	0.001
MD	0.37	-0.74			
	p = 0.23	***p = 0.004***			
OQLQ					
Group A	55.73 ± 8.86	74.37 ± 7.01	-18.64	33.45	0.001
Group B	52.40 ± 8.34	68.60 ± 6.93	-16.20	30.92	0.001
MD	3.33	5.77			
	p = 0.14	***p = 0.002***			

SD, Standard deviation; MD, Mean difference; p value, Probability value

6. Conclusion:

Pulsed Electro Magnetic Field (PEMF) is a significant intervention and it's recommended to be a part of physical therapy and rehabilitation protocols of elderly osteoporotic women.

7. Recommendations

The results of the study considered the following recommendations: -

1) Recommendations for therapists, put posters in orthopaedic clinics and women health clinics for recommendations of the use of electromagnetic field therapy in addition to the closed chain kinetic exercises used for physical therapy rehabilitation programe for all osteoporotic elderly women patients for improving their bone mineral density, risk of falling and quality of life.

2) Recommendations for further researchers:

Study the effect of high power laser in osteoporotic elderly women.

Study the effect of whole body vibration on elderly osteoporotic women.

Study the impact of pulsed electromagnetic field treatment on elderly osteoporotic men.

8. Declarations

Author Contributions:

Every author played roles in the research's conceptualization and design, collection of data, analysis, and interpretation, as well as assessing the final results. The authors reviewed and authorized the last version of the manuscript.

-Informed consent statement:

Prior to participating in the research, all participants provided informed written permission. Details that may reveal the study subjects' identities have been withheld.

Data Availability Statement:

The data gathered and analyzed in this research's work are available upon demand to the corresponding researcher, Joseph Wageeh Saweres (josephwageeh83@gmail.com). Due to privacy and ethical considerations, access to the data is subjected to approval from the relevant institutions and may require appropriate agreements regarding data protection and confidentiality. Demands for access to information are going to be considered on an individual basis to make sure it is conformity with ethical standards and regulatory constraints. The authors are committed to promoting transparency and scientific rigor and are willing to share the data with interested researchers, subject to the necessary permissions and safeguards

Ethical approval:

The research project was authorized by the Faculty of Physical Therapy, Cairo University's Ethical Comity, with approval number P.T.REC/012/003340.

Statement of Human and Animal Rights:

The research followed the standards established in the Helsinki Protocol. In this investigation, we get informed consent from every participant and safeguard their privacy and confidentiality while also respecting their independence and variety. These fundamental liberties are given to everyone, whatever their nationality, gender, language, ethnic or national origin, religion, colour, or any other status

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Conflicts of Interest:

The researchers reported no problems of advantage or interest.

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