

## Pulsed Electromagnetic Field - A Review in Musculoskeletal Conditions

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### Abstract

**Background:** Musculoskeletal problems like knee osteoarthritis, low back pain (LBP) and non-healing bone fractures are common conditions leading to pain, reduction in function and person's Quality of Life. Pulsed Electromagnetic Field (PEMF) Therapy is a reparative technique most commonly used in the field of orthopaedics. PEMF is a combined therapy of electrotherapy and magnetotherapy. Effect of PEMF depends upon interactions between electric fields, magnetic fields and biological tissue. PEMFs can produce currents without heating which directly modifies the interaction of cells with their environment and other cells around them, thus metabolism of the cells is improved. Certain studies have proved that Pulsed Electromagnetic Field therapy is clinically beneficial in such musculoskeletal conditions.

**Objective:** To review existent literature regarding the effect of treatment with Pulsed Electromagnetic Field in musculoskeletal conditions like LBP, knee osteoarthritis and non-healing long bone fractures on pain, functionality and quality of life.

**Methodology:** Databases were searched for systematic reviews and meta-analyses using Cochrane Library, ScienceDirect, Academia and PEDro databases searching for relevant studies that assessed the efficacy of PEMF therapy in musculoskeletal conditions. Three relevant articles were found regarding knee osteoarthritis, LBP and non-healing long bone fractures.

**Results:** One systematic review found that people with osteoarthritis who received PEMF therapy experienced pain relief of 15 points more compared to fake treatment, rating their pain to be 26 points lower on a scale of 0-100. Second systematic review was found about individuals suffering from LBP which had six studies eligible in qualitative analysis and five in quantitative, scoring 6.8 points according to PEDro Scale. The effect sizes indicated a remarkable reduction in pain intensity, favoring the PEMF groups, as well as, PEMF enhanced better functionality in individuals with LBP. Third systematic review was found about the delayed union and non-union of long bone fractures, suggesting that PEMF stimulation may offer some benefit in its healing process.

**Conclusion:** As per the evidence, PEMF therapy may provide moderate benefits for osteoarthritis sufferers by relieving pain, which in addition, improves functionality in individuals with LBP. Although PEMF may benefit the process of bone healing, definitive conclusions on treatment effect on non-healing fractures await further studies, since it is inconclusive and insufficient to inform current practice. Further research is needed to confirm PEMF therapy benefits on quality of life in osteoarthritis sufferers and different conditions of LBP, with standardized protocols and larger samples to achieve stronger conclusions.

**Keywords:** Pulsed Electromagnetic Field; Musculoskeletal Conditions; Osteoarthritis; Low Back Pain; Non-Healing Fractures

### Abbreviations

PEMF: Pulsed Electromagnetic Field; LBP: Low Back Pain; PEDro: Physiotherapy Evidence Database; FDA: Food and Drug Administration; OMERACT: Outcome Measures in Rheumatology Clinical Trials; MD: Mean Difference; SMD: Standardised Mean Difference; CI: Confidence

Interval; RR: Risk Ratio; NNT: Number Needed to Treat; CEBM: Center for Evidence-Based Medicine; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; SF-36: Short Form-36

### Introduction

PEMF therapy is a new approach to pain management which is a reparative technique most commonly used for the treatment of non-union fractures, failed fusions and other musculoskeletal conditions in the field of orthopaedics. PEMF is a combined therapy of electrotherapy and magnetotherapy that uses electromagnetic fields to produce a pulsing, moving energy. These energy waves could modify the means the body copes with pain. PEMF therapy has a vital role for the relief of pain since the treatment is sober, non-thermal, and has a low risk that works to boost healing of cellular activity and repair of tissues.

Science has shown that our bodies can produce magnetic fields of their own and that interaction of cells in the body takes place via electromagnetic frequencies. When electromagnetic energy of the cells is disrupted, it leads to the cell metabolism getting disturbed and this is not related to the actual cause of the problem. The chemistry and the function of the cells is addressed by PEMF, which then leads to an improvement in health and provides health-enhancing EMFs and frequencies to the cells. Within the body, every cell, tissue, organ and even bone is penetrated without being absorbed or altered when low frequency PEMFs of even the weakest strengths are passed right through the body - which in turn stimulate most of the chemical and electrical activities that take place in the tissues. Therapeutic PEMFs result in better health and functioning of the cells as they are designed in such a way so as to support cellular energy.

The Food and Drug Administration (FDA in USA) has approved PEMF as a therapeutic intervention for the fusion of fractured bones. Some devices have also been accepted to reduce the impairments like joint pain and swelling. It has been proven that Pulsed electromagnetic field therapy can play an important role in chronic pain associated with different types of connective tissue injury and joint diseases like osteoarthritis, fibromyalgia, osteoporosis, skin ulcers, as well as, in uniting bones, relief of pain, wound healing, control of edema, control of inflammation, accelerating the growth and repair of bone and soft tissue, and further potential applications.

Musculoskeletal problems like knee Osteoarthritis, LBP and non-healing bone fractures are common conditions leading to pain, reduction in function and person's Quality of Life. Thus, this article aims to review existent literature regarding the effect of treatment with Pulsed Electromagnetic Field (PEMF) in musculoskeletal conditions like LBP, knee osteoarthritis and non-healing fractures on pain, functionality and quality of life.

### Materials and Methods

Databases were searched for systematic reviews and meta-analyses using Cochrane Library, ScienceDirect, Academia and PEDro databases to assess the effectiveness of PEMF therapy in musculoskeletal conditions on pain, functionality and quality of life. The search was comprised to the period of April 2011 to October 2017. After searching for all the relevant databases, three articles were found regarding knee osteoarthritis, LBP and non-healing long bone fractures. Keywords used were Pulsed Electromagnetic Field, Musculoskeletal conditions, Osteoarthritis, Low back pain, Non-healing fractures.

The first systematic review assessed the benefits and harms of electromagnetic fields in the treatment of osteoarthritis as compared to placebo or sham. It included nine studies that reviewed the effect of PEMF therapy in 636 adults with osteoarthritis for a period of 4 to 26 weeks compared to sham or fake treatment. Outcomes were extracted from the publications according to Outcome Measures in Rheumatology Clinical Trials (OMERACT) guidelines. The results were expressed for continuous outcome measures in terms of mean difference (MD) or standardised mean difference (SMD) with 95% confidence interval (CI) and the dichotomous outcome measures were pooled using risk ratio (RR) and calculated the number needed to treat (NNT).

The second article was a systematic review of randomized controlled trials where two independent investigators performed a comprehensive database search of studies that took place between January 2005 to August 2015, by using Pubmed, Scopus, Cochrane Library

and PEDro databases. The article aimed to determine the effect of pulsed electromagnetic field therapy in pain relief and other complaints in patients with low back pain conditions. After screening the titles and abstracts of the selected databases, the potential relevant studies were selected and retrieved and the eligibility was applied according to the following inclusion criteria: (a) assessment of pain outcome; (b) use of pulsed electromagnetic field therapy; (c) prospective design; (d) randomized controlled trials; (e) English language studies. Two authors independently examined the quality and the level of evidence of the methods used in the studies. The PEDro scale was used for assessing quality and the Oxford Center for Evidence-Based Medicine (CEBM) scale was used as a reference to set the level of evidence. Quantification of intensity of pain was the main outcome of interest, which in addition to Oswestry Disability Index, were evaluated according to their means and values of standard deviation, and their differences in means were calculated, i.e. the difference in values at the study's end-point and baseline values. The Cohen's effect size was also calculated (within 95% confidence intervals). Thus, greater decrease on the pain intensity was reflected towards the experimental group as a result of positive effect.

The third systematic review aimed to assess the effectiveness of treatment with PEMF stimulation on long bone fractures in adults which had a delay in union or were not uniting. This review included four studies, which involved 125 participants. The effects of pulsed electromagnetic fields were evaluated in three studies and capacitive coupled electric fields in one study. The majority of data was related to non-union or delayed union of tibia. The studies were blinded randomized placebo-controlled studies. However, the studies had their limitations. Data extraction and risk of bias assessment were performed by two authors independently who selected studies. Risk ratios were used to assess the treatment effects and, data were pooled using a random-effects model, where appropriate.

### Results and Discussion

Li S., *et al.* [1] in their article, found that participants with osteoarthritis who received electromagnetic field treatment experienced pain relief of 15.10 points more (MD 15.10, 95% CI 9.08 to 21.13; absolute improvement 15%), rating their pain to be 26 points lower on a scale of 0 to 100, based on the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scale, after 4 to 26 weeks' treatment, compared to patients who received fake treatment; who rated their pain to be 11 points lower on a scale of 0 to 100. There was no statistically significant difference found on quality of life after 4 to 6 weeks' treatment with PEMF on a scale from 0 to 100 based on SF-36.

The second article by R Andrade., *et al.* [2] on LBP individuals, had six studies that they found eligible to be part of the qualitative analysis. They also found five studies to perform quantitative analysis. The studies scored 6.8 points out of 10 points on the PEDro scale. The studies were different concerning the therapeutic intervention of pulsed electromagnetic field stimulation, where the treatment period ranged from five days to three weeks, and the frequency of the treatment ranged from four times a day to only two times in a week. All studies reported the pain intensity, measured by visual analogue scale (VAS) or on the numerical pain rating scale (NPRS), to be remarkably reduced in low back pain patients. The reduction in pain was more in the PEMF groups, where the difference was close to the minimal clinically important difference. When the difference in intensity of pain was assessed from the beginning to the end of the study, pain intensity was found reduced from 2.1 to 6.4 points out of ten on the VAS and NPRS. However, two studies showed a small effect size and two studies showed a large effect size, when the effect sizes were analyzed. Functionality was assessed using several scales and index, of which Oswestry Disability Index was most commonly used. As an outcome, it showed improvements on the functionality of LBP individuals after application of PEMF therapy, however with small effect sizes despite its large mean differences from baseline to end-points.

The third article by Griffin XL., *et al.* [3] assessed the impact of PEMF therapy on delayed union and non-union of long bone fractures in adults, in which the proportion of participants whose fractures had united at a fixed time point was the primary measure of the clinical effectiveness of electromagnetic field stimulation. The results showed that the effect size which was pooled was small and not statistically significant. The pooled analysis showed a large amount of difference, both clinically and statistically. The effect of repeated follow-up on the heterogeneity in the studies was determined by conducting a sensitivity analysis. It showed that the effect size was not significant at the end of 24 weeks. Two trials found no reduction in pain and functional outcome measures were also not reported. Thus, the existing evidence does suggest that PEMF may help in the process of bone healing [4-8].

## Conclusion

As per the evidence, Pulsed Electromagnetic Field therapy seems to be able to relieve the pain intensity and improve functionality in individuals with low back pain conditions and osteoarthritis sufferers, as well as, offers some benefit in the treatment of delayed union and non-union of long bone fractures. However, more definitive conclusions on treatment effect of non-healing fractures await further studies, since it is inconclusive and insufficient to inform current practice. Further research is needed to confirm PEMF therapy benefits on quality of life in osteoarthritis sufferers and the different conditions of low back pain, with standardized protocols and larger samples to achieve stronger conclusions.

## Conflict of Interest

None.

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