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**RESEARCH ARTICLE**

# Effect of Pulsed Magnetic Field on Bone Density in Juvenile Rheumatoid Arthritis

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## *Abstract*

**Introduction:** Juvenile rheumatoid arthritis (JRA) has long been suspected to affect bone mineralization because of poor linear and skeletal growth, an increased number of fractures, and osteopenia, observed by radiography, in children with the disease. **Methods:** 30 children, with polyarticular JRA, aged 8 to 12 years were included. Children were randomized for treatment in two groups. In the study group received pulsed magnetic field therapy 3 times per week for successive 3 months. In the control group received the conventional physical therapy program only. Evaluation of bone mineral density (BMD) using Dual Energy X-ray Absorptiometry (DEXA) was performed before and after the treatment. **Results:** BMD of femur post treatment for the control and study groups was 0.735±0.166 and 0.866±0.125 (g/cm²) respectively. BMD of the lumbar spine for the control and study groups were 0.657±0.121 and 0.75±0.102 (g/cm²) respectively. BMD of total body for the control and study groups were 0.723±0.097 and 0.807±0.11 (g/cm²) respectively. The differences between both groups in their post treatment mean values of BMD was statistically significant as ($p<0.05$). **Conclusions:** Pulsed electromagnetic field therapy is effective, innovative, non-invasive, non-expensive and can be used as a new trend physical therapy modality in the treatment of osteoporosis in JRA.

## Introduction

Juvenile rheumatoid arthritis (JRA) is a disease that occurs in children beginning before sixteen years of age (Nevitt, 2004). Although JRA is a chronic disease of childhood, the actual cause of the disease is unknown (Hashkes and Laxer, 2005). Some common signs and symptoms of JRA are morning stiffness, joint guardian, fatigue, sleep disturbances and irritability (Tecklin, 2008).

Failure to develop adequate bone mineralization is common in children with JRA (Climaz and Falcini, 2010). Osteopenia is a condition where bone mineral is lower than normal. Osteoporosis is characterized by loss of both bone mass and micro architectural integrity resulting in an increased risk of fracture, growth retardation with associated morbidity and mortality (Cassidy and Hillman, 1997). Osteopenia and or osteoporosis occur in all of the JRA subtype and, most commonly found in the systemic and polyarticular disease. Osteopenia is a bone condition characterized by a decreased density of bone, which leads to bone weakening and an increased risk of fracture (Pepmueller et al., 1996).

Osteoporosis is also prevalent in children with JRA as the result of steroid use, nutritional disorders, and decrease in the quantity of load carried by the joints. It is documented that lumber vertebral bone density was significantly lower in children with JRA as compared with a control group and this was especially evident in those using steroids (Emery et al., 2005).

A bone mineral density (BMD) measurement is the best way to determine osteopenia and osteoporosis (Wang et al., 2002). BMD test can identify osteopenia and osteoporosis, determine the risk of fracture, assess growth retardation and measure the response to treatment. There is an association of increased demineralization of bones with duration of joint disease (Boman et al., 2008).

While juvenile arthritis is markedly different from adult rheumatoid arthritis, goals of management are similar, including reduction of joint inflammation, pain relief, prevention of disability and maintenance of function, the provision of education and attention to psychosocial, growth and development needs. A multi-disciplinary approach is required to deliver a comprehensive and effective program (Rosch and Markov, 2004).

Pulsed electromagnetic field (PEMF) exposure is approved by the United States Food and Drug Administration for the treatment of problems associated with musculoskeletal disorders, including delayed union or non-union fractures, failed joint fusions, and congenital pseudoarthroses (Bassett and Schink-Ascani, 1991). Specific joint disorders that have been investigated using this treatment modality include rheumatoid arthritis (RA) (Ganguly et al., 1998), osteoarthritis and rotator cuff tendonitis (Pipitone and Scott, 2001, and Trock, 2000)

Because treatment of osteoporosis with PEMF can have important consequences for today's standard treatment and only a few animal studies have been published on the subject so the aim of this study was to investigate the effects of PEMF on bone density in children with JRA.

## Material and Methods

### Subjects

Thirty children had polyarticular JRA participated in the study ranged in age from 8 to 12 years. They were recruited for the study from the Rheumatology Clinic, El-Noor Specialized Hospital, Makah, Saudi Arabia, according to the following criteria:

**Inclusion criteria:**

All patients should have fulfilled the American College of Rheumatology (ACR) criteria for polyarticular JRA:

(Presence of arthritis in five or more joints during first 6 months of disease. Symmetry of arthritis, however, the degree of involvement was varied. Cardinal hallmark signs and symptoms of joint involvement in JRA that generally were marked by pain, swelling and morning stiffness).

**Exclusion Criteria:**

Patients with systemic or oligoarthritis onset, patients with advanced radiographic changes, including (bone destruction, bony ankylosis, knee joint subluxation, epiphyseal fractures, growth abnormalities related to marked skeletal changes of JRA) , patients who had congenital or acquired skeletal deformities, patients who had any cardiopulmonary dysfunctions all were excluded. All subjects gave written informed consent.

All patients were initially aware about and fully understand the purpose and procedures of the study and so an informed consent was obtained from each patient; giving agreement to participation and publication of the results of the study. All patients received the same medical treatment and the standard physical therapy program. To avoid a type II error, a preliminary power analysis (power = 0.87, $\alpha = 0.05$, effect size = 0.5) determined a sample size of 30 for this study. This effect size was chosen because it yielded a realistic sample size.

Patients were randomly assigned into two groups through two stages by a person who did not share any other part of the study. First; eligible patients who fulfilled the inclusion criteria were initially recorded. Secondly; all reported patients were randomly assigned to either PEMF or the control group through a random number generation using an online random permutation generator from http://www.randomization.com.

**Evaluation:**

All patients were assessed at baseline and at the end of therapy (after 3 months) by the same assessor who was blinded to treatment.

**Pain evaluation:**

Visual analogue scale (VAS) was used to assess levels of pain, both before (pre) and after (post) magnetic field. The pain scale ranged from no pain to worst (from no pain=0 to unbearable pain=10)

**Bone Mineral Density Evaluation:**

Dual Energy X-ray Absorptiometry (DEXA) (NORLAND): was used for evaluation of bone mineral density, which consists of the following; A central device that consists of a padded platform and a mechanical arm (scanner) that is adjusted to emit low dose x-ray on the area required for measurement.

Each child in both groups was evaluated before and after 3 months of treatment by DEXA (for measuring bone mineral density of the lumbar spine, neck of femur and total body), using a standard technique for measuring bone mineral content with very low dose of radiation of acceptable precision using bone mineral content in grams (gm) by area of bone measured ($cm^2$) and will express density as grams/ $cm^2$.

**Interventions:**

All children (control and study) received the standard physical therapy treatment for JRA, regardless of treatment allocation. The standard physical therapy program consisted of muscle stretching, strengthening exercises, proprioceptive training, gait and balance training for (one hour/day, 3 sessions/week) for successive 3 months. The study group underwent additional PEMF with the standard physical therapy treatment.

**PEMF Treatment:**

The child was asked to remove metal objects or anything sensitive to magnetic field such as chains, belts, watches, etc.… before lying on the bed. Then the child was placed in a comfortable supine lying position over the motorized bed. During application, the child was asked not to move and remain stable as much as possible. The appliance was connected to electrical mains supplying 230V± 10%.The solenoids were adjusted to be over both knee joints. The options of the appliance were adjusted with very low frequency (15 HZ), very low intensity (20 G) for 20 minutes, 3 sessions / week for successive 3 months (Trock et al., 1993).

**Standard Physical Therapy program:**

All children (control and study) received the standard physical therapy treatment for JRA, regardless of treatment allocation. The standard physical therapy program consisted of muscle stretching, strengthening exercises, proprioceptive training, gait and balance training for (one hour/day, 3 sessions/week) for successive 3 months.

**Statistical Analysis**

Statistical analysis was performed using SPSS version 16.0. Descriptive statistics of mean and standard deviation presented the child's age, weight, height and body mass index. Pain and BMD results pre- and post-treatment values were assessed using the t- test. Significance was accepted at the alpha level of < 0.05.

## Results

Thirty children with juvenile arthritis (22 boys and 8 girls) commenced the 3-months low frequency pulsed electromagnetic therapy and underwent final analysis at the end of the 3-months period. In the baseline evaluation, the results of this study revealed that there were non-significant differences between the two groups (control group and study group) before treatment (pre-test values) in the demographic characteristics including age, height, weight and body mass index. Also; results of this study revealed that there were non-significant differences between the two groups before treatment (pre-test values) in the measured variables, including right knee joint pain, left knee joint pain evaluated via visual analogue scale (VAS) and BMD measured via DEXA (Table 1).

**Table 1: The pre-test values of both groups**

| Character | Study group | Control group | T-Value | P-Value |
|---|---|---|---|---|
| | Mean ± SD | Mean ± SD | | |
| Age (years) | 12.22 ± 2.33 | 11.90 ± 2.74 | 0.145 | 0.707 ** |
| Height (Cm) | 145.9 ± 10.76 | 146.03± 11.38 | 0.001 | 0.974 ** |
| Weight (Kg) | 44.03 ± 10.2 | 44.47± 9.87 | 0.014 | 0.907 ** |
| BMI (kg/m$^2$) | 20.16 ± 2.24 | 20.55± 1.65 | 0.285 | 0.598 ** |
| Right Knee joint Pain | 5.53 ± 0.83 | 5.53 ± 0.64 | 0.000 | 1.000 ** |
| Left Knee joint Pain | 5.6 ± 0.83 | 5.67 ± 0.62 | 0.063 | 0.804 ** |

Level of significance at P<0.05 * = significant **= non-significant
SD: standard deviation M: Meter KG: Kilogram

When comparing the mean changes in levels of right knee pain, left knee pain between the two groups. Results revealed that there was significant reduction in levels of right and left knee pain. Furthermore; there are significant differences between both groups in levels of knee pain reduction in favor of the study group. (P-value < 0.05) (Table 2). Also, when comparing the mean changes in the levels of BMD between the two groups; this revealed that there was a significant increase in levels of BMD in both groups. Furthermore; there is a significant difference between both groups in BMD improvement in favor of the study group. (P-value < 0.05) (Table 2).

**Table 2: Comparison between pre and post-test values of both groups**

| Character | Study group | | T-Value | P-Value | Control group (B) | | T-Value | P-Value |
|---|---|---|---|---|---|---|---|---|
| | Pre | Post | | | Pre | Post | | |
| Right Knee joint Pain | 5.53 ± 0.83 | 2.87 ± 0.64 | 16.73 | 0.00 | 5.53 ± 0.64 | 3.67 ± 0.82 | 14.00 | 0.00 * |
| Left Knee joint Pain | 5.6 ± 0.83 | 2.93 ± 0.59 | 16.73 | 0.00 | 5.67 ± 0.62 | 3.60 ± 0.63 | 31.00 | 0.00 * |

Level of significance at $P<0.05$ * = significant ** = non-significant

The collected data of the current study were statistically treated to analyze the results of BMD of femur, lumbar spine and total BMD of the body for all children of both groups to study the effect of PEMF on BMD density in children with JRA.

When comparing the pre-treatment mean values of control and study groups, concerning BMD of femur, mean values ± SD were 0.718±0.166 and 0.596±0.179 (g/cm²) for both groups respectively. That indicated insignificant differences ($P>0.05$).The mean values ± SD of BMD of femur for both groups (control and study) was 0.735±0.166 and 0.866±0.125 (g/cm²) respectively. The differences between both groups in their post treatment mean values of BMD of the femur was significant as ($p<0.05$).When comparing the pre-treatment mean values of control and study groups, concerning BMD of the lumbar spine, the mean values ± SD were 0.633±0.129 and 0.588±0.105 (g/cm²) for both groups respectively. The mean difference of 0.045 indicated insignificant differences as ($P>0.05$) (Table3).

**Table (3): Comparison of the BMD mean values of the control and study groups**

| **Region** | **Femur** | | **Lumbar spine** | | **Total Body** | |
|---|---|---|---|---|---|---|
| **Time of Evaluation** | **Pre** | **Post** | **Pre** | **Post** | **Pre** | **Post** |
| **Control Group** | 0.718 | 0.735 | 0.633 | 0.657 | 0.705 | 0.723 |
| **Study Group** | 0.596 | 0.866 | 0.588 | 0.75 | 0.66 | 0.807 |
| **P Value** | p< 0.05 | | p< 0.05 | | p< 0.05 | |

P Value: Probability Value

The mean values ± SD of BMD of lumbar spine for both groups (control and study) were 0.657±0.121 and 0.75±0.102 (g/cm²) respectively. The difference between both groups in their post- treatment mean values ± SD of BMD of the lumbar spine was statistically significant as ($p<0.05$).When comparing the pre-treatment mean values of control and study groups, concerning BMD of the total body, the mean values ± SD were 0.705±0.094 and 0.66±0.077 (g/cm²) for both groups respectively. That indicated insignificant differences as ($P>0.05$).The mean values ± SD of BMD of total body for both groups (control and study) were 0.723±0.097 and 0.807±0.11 (g/cm²) respectively. The differences between both groups in their post- treatment mean values ± SD of BMD of the total body was statistically significant as ($p<0.05$) (Table3).

## Discussion

This study was done to determine the efficacy of pulsed electromagnetic field treatment on BMD in children with JRA. PEMF therapy has been found to be effective in reducing pain and improving BMD in children with JRA.

JRA is the most common chronic rheumatic disease in childhood and one of the leading causes of pediatric acquired disability (Ruperto et al., 1997). JRA persists into adulthood in up to 55% of patients, and may have a major impact on physical or psychosocial function. Children with JRA have reduced vigorous physical activity levels, sports participation and decreased fitness. Muscle atrophy, weakness and anemia contribute to reduced fitness, but deconditioning from reduced physical activity is likely the greatest cause. Reduced participation because of disease symptom severity, treatment-related side effects or worries that exercise may aggravate disease is problematic (Klepper, 2003). So it was the cause to conduct this study on those children with JRA.

Generalized osteoporosis and fractures are major problems in children with JRA in which many factors such as, inflammation, long use of corticosteroid therapy, decreased calcium intake, hormonal disturbance and lack of physical activity can induce osteopenia and increased the risk of fractures (French et al., 2002).

Magnetic field therapy is now used as one of the most efficient and non- invasive modalities in the field of physical therapy for treatment of many pathological conditions and has been reported to be complementary to drug therapy for children with JRA.

The improvement in BMD of the femoral neck, lumbar spine and total body in the control group could be attributed to the effect of the designed physical therapy program on bone and connective tissues which adapt to mechanical loading like that experienced with exercises. It contributes to an increase in bone mass and can reduce bone demineralization which occurs with disuse. The results of this study could be explained by the fact that bone is a living tissue that constantly reforms, gaining or loosing strength according to how often it is used. Without exercise, bone loses density and becomes weaker. Bones that get regular exercise actually appear bigger and have more density as exercise actually encourages calcium absorption in bone. Like muscles, bones respond to increased blood flow and it is thought that the increased circulation prompted by exercise helps transport vital nutrients and minerals such as calcium to bones (Jessup et al., 2002).

Comparison between pre and post-treatment results of BMD of the femur, lumbar spine, and total body of study group revealed highly significant difference in the measured variables. The improvement in BMD in study group could be attributed to the positive effect of both the exercise program which had been explained in the control group in addition to the effect of low frequency and low intensity pulsed magnetic field therapy on bone tissue.

The improvement of BMD after PEMF exposure could be attributed to its piezoelectric effect on bone cells and hence produces stimulation of calcium deposition in bone. This is supported by the findings of Carpenter and Ayrapntyan, (2004), who concluded that application of PEMF results in the flow of ionic electric current in bone tubules which act as an action potential to the bone marrow to generate blood and collect calcium. These electrical impulses direct the bone growth and formation of bone cells through calcium deposition.

The results of the present study come in agreement with Darendelileret al., (2005), who proposed a number of different mechanisms by which PEMF affect bone tissue: firstly, it has been shown to stimulate calcification of the fibrocartilage. Second, the increased blood supply that arises due to PEMFs effect on ionic calcium channels have been implicated as a source of improved bone healing. Thirdly, PEMF has been suggested as having an inhibitory effect on the resorptive phase on bone repair, leading to the early formation of osteoids. A fourth mechanism by which PEMF is thought to have an effect on bone repair is its influence on increasing the rate of bone formation by osteoblasts.

Several cellular mechanisms including increases in growth factors, increases in mineralization, angiogenesis, collagen production and endochondral ossification result from PEMF stimulation. Also, it has been shown that there is a decreased osteoclastic activity following PEMF exposure (Pipitone and Scott, 2001).

The neurophysiological mechanism in which PEMF affect bone tissue has been explained by Selvam et al., (2007), who stated that PEMF has been shown to positively affect enzyme based processes at the cellular level and stimulate growth factors involved in cellular repair and bone formation. Every cell membrane carries an electromagnetic charge, and PEMF alter this charge by causing movement of ions across the cell membrane. PEMF have been shown to exert an anti-inflammatory effect through restoration of plasma membrane calcium ATPase activity.

Also, the results of this study are supported by the findings of Richard et al., (2008), who approved that in the moist surroundings of living bone, small piezoelectric potentials are rapidly caused by mechanical deformation. At physiological conditions, mechanical stress-generated potentials are formed by different mechanisms including: (a) the streaming potential, which is the electric potential difference between a liquid and a porous solid through which it is forced to flow, or (b) the electrokinetic processes, i.e. movement of ions because of fluid motion through the bone. The electromagnetic fields caused by these reactions are able to penetrate tissue and the magnetic field component can induce electric currents in the bone or muscle tissue by Faraday coupling.

This improvement in BMD of the treated areas can also be attributed to the effect of PEMFs on increasing bone mass in osteoporotic patients that is caused by the influence of binding to receptors at the cell surface and in turn can influence the cellular metabolism and stimulate growth, this leads to improvement of the alignment of trabecullae and cartilage. This is consisting with the conclusion of Fitzsimmanset al., (2005), who reported that, the PEMFs could also influence the gating mechanism that control the membrane concentration in lymphocytes and is capable of increasing net calcium flux in transport of various types of cations such as calcium. They also concluded that PEMFs can increase the calcium human osteoblast cells.

The biological basis of the effects of the magnetic fields on cells is highly complex. In an ideal cell at rest, proteins are distributed evenly over the membrane, but in the presence of an electric field crossing the membrane, they undergo electrophoretic attraction or repulsion, tending to shift towards poles which the cell presents in the directions of electric field. Therefore, the cell membrane, by virtue of its bioelectrical properties, is the site where influences of magnetic fields are most likely to be exerted. These results may be attributed to the following mechanisms by Olu et al., (1992), who approved that many of physical-chemical effects inside the tissue depend on the cellular membrane condition, as well as on its mechanical deformations and electrochemical potential. These membrane characteristics are strongly determined by the outer conditions, such as the temperature and ion concentrations in the aqueous solution surrounding the membranes. It is obvious that any outer stimulus like magnetic stimulation could affect these outer conditions, will affect the cellular membrane status through optical non-homogeneity factor that lead to imbalance of some process at the membrane level like the osmotic overpressure on the membrane, which can lead to its deformation.

Also, Jacobson et al., (2001), reported that magnetic fields produce piezoelectricity through the intra-cellular matrix, converting electromagnetic oscillations to mechanical vibration to induce molecular vibrations of frequencies responsible for biological amplifications of extremely weak triggers at the membrane surface. Piezoelectricity may be the common denominator for the specific actions of the various nonionizing, order-inducing biological effects. Piezoelectric mechanisms may be present in all physiological processes. Various structures are thought to be piezoelectric, including bone tissue, blood vessel walls and collagen fibers.

Decreased physical activity was considered one of the main causes that can develop decreased BMD in children with JRA. Physical activity was decreased in those children as a result of pain, inflammation and morning stiffness. So, the improvement in BMD in study group could be attributed to the increase in physical activity as a result of PEMF exposure which plays an important role in subsiding signs and symptoms of JRA. This comes in agreement with Weintraub, (1999), who reported that magnetic field influences the small C fibers. Also, Holcomb et al., (2000), found that exposure to magnetic field produces a reversible blockade of sodium-dependent action potential firing and calcium-dependent responses to the irritant. Another point of view explained that the physiological mechanism for pain relief due to application of magnetic field may be due to presynaptic inhibition or decreased excitability of pain fibers (Hinman et al., 2002).

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 effects, such as reduction in activity of channel phosphorylating enzymes (Segal et al., 1999). Also, Adey, (1999), approved that pulsed magnetic fields can modulate the actions of hormones, anti-bodies and neurotransmitters at surface receptor sites of a variety of cell types.

Jacobson et al., (2001), stated that the effect of magnetic field extends to structures such as connective tissue, muscles and organs, thus producing decreased inflammation, improved circulation, and diminution of pain and hence improved mobility of joints. These results come in agreement with Hinman et al., (2002), who reported that application of magnetic field to the musculoskeletal problems can reduce pain, decrease joint swelling, and enhance movement.

Track, (2004), also revealed that application of the magnetic field might promote cellular and sub-cellular molecular effects within damaged cartilaginous and bony tissues. Pulsed magnetic field can stimulate both bone and cartilage cells, thus improving joint function and joint integrity due to improved bone and cartilage maintenance and repair.

Results of the present study demonstrated that the magnetic field has a positive effect on BMD through increasing calcium deposition in bones and improving the activity of osteoblasts and this can be explained by the findings of Hosokwa et al., (2000), who revealed that the mechanism of magnetic field that causes calcium to precipitate in bone tissue is not related to sex hormones and can promote the growth and control the activity of osteoblast cells resulting in increase of overall bone density. It accelerates the formation of bone collagen in combination with calcium in addition to effectively promote fixation of dissociated intracellular calcium and prevent release of calcium from bone cells.

Neil, (2002), also reported that pulsed magnetic field exposure might be useful in the treatment of bone fracture, spinal fusion, bone formation and bone transplant, also this comes in agreement with Mandronero, (2000), who concluded that magnetic field enhances bone tissue formation. Bone mineral densities of the treated radii measured by densitometry increased significantly in the intermediate area of the field during the exposure period of PEMFs.

As confirmed by Chang et al., (2005), who reported that, properly applied PEMFs may have clinical application in the prevention and treatment of osteoporosis.

Low frequency magnetic fields can increase the calcium concentration in lymphocytes in the same manner as a physiological stimulus such as antibodies, and increase net calcium flux in human osteoblast-like cells. The increase in net calcium flux is frequently dependent on magnetic field which induces a maximum potential gradient across the cell membrane (Fitzsimmans and Baylink, 2005). This comes in agreement with Li et al., (2006), who reported that the physical-chemical interactions between biological tissues and PEMF may occur outside the cell and then propagate and amplify through conventional or novel signal transduction pathways. A stimulation of transduction pathways is apparent by PEMF, resulting in increased cytosolic $Ca^{2+}$ and activation of calmodulin, which finally stimulate osteoblastic cell proliferation.

Regarding arms, comparison between the mean values of pre and post-treatment results of study group revealed significant difference. These results revealed that the electromagnetic field has both direct effect through improving BMD in the exposed areas (femoral neck and lumbar spine) and also the indirect effect through improving BMD in unexposed areas (both arms) and this could be explained that PEMF can affect many biological systems such as hormonal system and can affect metabolism. This was supported by the finding of Bellosi et al., (2001), who approved that there is a decrease of the level of glucose, total cholesterol and triglycerides in the plasma chemistry of rats after magnetic field exposure and showed that the magnetic field affected the hormonal system, directly or indirectly.

The improvement in BMD of arms in the study group may explain the indirect effect of magnetic field in increasing BMD. Effect of magnetic field may be demonstrated on bone markers in which bone-specific alkaline phosphatase (BAP), a marker of bone formation and present in serum blood, was increased following exposure of PEMF. Also, deoxypyridinoline (DPD), a marker of bone resorption and present in urine, was decreased following exposure of PEMF. This comes in accordance with Qichang and Tianzhixiu, (2001), who revealed that magnetic field (MF) exposure, resulted in an increase in bone-specific alkaline phosphatase (BAP) levels in the serum as well as in bone forming cells indicating increased osteoblast growth and activity. On another hand, deoxypyridinoline (DPD), a product of bone metabolism, was reduced after MF exposure indicating a decrease in osteoclast activity. The increase in BAP and decrease in DPD suggested that MF exposure should bring about an increase in bone minerals and calcium by stimulating bone forming osteoblasts and inhibiting the activity of osteoclasts and subsequently preventing bone breakdown.

The indirect effect of PEMF on the body can be demonstrated through its influence on blood, hormones, oxygen and metabolism and this comes in agreement with Sieron and Cieslar, (2003), who reported that magnetic field can influence enzymatic and hormonal activity, free oxygen radicals, carbohydrates, proteins and lipid metabolism, dielectric and rheological properties of blood as well as behavioral reactions and activity of central dopamine receptor. This was supported by the findings of Potzl, (2004), who reported that the therapy with electromagnetic fields is a complex method, which can improve metabolism of bone tissues and its structures through slowing or preventing loss of bone because of the recreation of the piezoelectric effect, building of bone substance due to the activation of calcium metabolism and stimulation of calcium deposits in the bone, indirect effects of PEMF due to regulation of the hormone system, which plays a crucial role in regulating metabolism of minerals and improvement of overall well-being and increased activity will have a positive impact on symptoms of osteoporosis.

## Conclusion

Pulsed electromagnetic field therapy is effective, innovative, non-invasive, non-expensive and can be used as a new trend physical therapy modality in increasing bone mineral density in children with juvenile rheumatoid arthritis

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