Pulsed Magnetic Field Therapy of Knee Joint Impairment in Children with Juvenile Rheumatoid Arthritis

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ABSTRACT

Background and objective: *Juvenile rheumatoid arthritis (JRA) is the most common rheumatic disease of childhood. Magnetic therapy has been reported to be complementary to drug therapy for adult patients with rheumatoid arthritis. This study was conducted to examine the effecacy of using low-frequency low-intensity pulsed magnetic field therapy (LFLIPMF) (Frequency of 15Hz, intensity of 20 G and duration for 20 minutes per session, three sessions per week for successive 24 weeks) on improvement of knee joints in children with polyarticular JRA.* ***Study design and methods****: Thirty children, with polyarticular JRA, aged 10 to 14 years, were assigned randomly into two treatment groups. Subjects in the study group (n = 15) received traditional physical therapy program (Infrared radiation, stretching exercise and strengthing exrcises) as well as LFLIPMF for both knee joints. Whereas subjects in the control group (n = 15) were treated by using traditional physical therapy program only. In addition, both study and control groups were treated by the traditional regimen of medical treatment during the period of application. The data (isometic knee flexors and extensors) were evaluated before treatment and and then repeated after the suggested period of treatment. Data collected were used to compare pre and post treatment between two groups,* ***Results****: The results showed significant improvement in isometic knee flexors and extensors for both knee joints in pretreatment compared with post treatment in study and control groups and also significance improvement in knee flexor in study group compared with those of control group post treatment.* ***Conclusion****: on the basis of the present data, it can be concluded that as an adjuvant for proper pharmacological management adding LFLIPMF to traditional physical therapy program is an effective method to treat children with JRA. More reasearch is needed to examine why knee flexors were more responsive to this treatment than knee extensors. This study was conducted in The Faculty of Physical Therapy, Cairo University.*
Key words: *Juvenile Rheumatoid Arthritis, Magnetic Fields, knee.*

INTRODUCTION

Juvenile Rheumatoid Arthritis (JRA) is not a single disease but a syndrome of diverse etiologies. Both abnormal immunoregulation and cytokine production may play a role[9]. The child may not complain of pain at rest but active or passive motion of joint elicits pain, particularly at the extremes of the range of motion[15].

Any joint can be affected by polyarticular JRA, but large joints of the knees, wrists, elbows, and ankles are most frequently involved. The cervical spine and trempromandibular joints are often involved. Small-joints of the hands and feet may be involved early or late in the course of the disease[20]. Studies have documented deficits in muscular fitness in children with arthritis. Using an isokinetic dynamometer, found significantly lower peak isometric quadriceps in 30 children with JRA compared with controls[8].

Conservative management of JRA which include (medical treatment and physiotherapy) attempts to control the clinical manifestations of the disease, to prevent deformity, to maximize function and minimize the disability and handicap resulting from the underlying impairment or disease[4].

Since the magnetic field generated can penetrate through high resistance structures such as bone, fat, skin, clothes, or even plaster cast, it has been shown that, electromagnetic fields provide a practical exogenous method for inducing cell and tissue modification and correcting selected pathological states[3]. Magnetic fields were applied to promote bone healing, treat osteoarthritis and inflammatory diseases of the musculoskeletal system, alleviate pain and enhance healing of ulcers. This demonstrates how much magnetic field is beneficial for the field of physical therapy[25].

SUBJECTS, MATERIALS AND METHODS

Subjects

Thirty children have polyarticular JRA with onset of the disease ranged from 7 to 10 years participated in the study. The age of patients ranged from 10 to 14 years. They were selected for the study from the Rheumatology clinic at Cairo University specialized pediatric hospital" .Inclusion criteria: Presence of arthritis in five or more joints during first 6 months of the disease, and the presence of Cardinal hallmark signs and symptoms in these joints. Exclusion criteria: Children who have had systemic or oligoarthritis onset, and children who had advanced radiographic changes.

Children were randomly assigned into one of the two equal groups, study group or control group with a total number of 15 per group.

Materials

1- Hanoun medical system as muscle evaluator; Hanoun is considered one of the most objective instrumentation used for measurement of muscle. It has sensitive sensors to detect any applied force upon it. Algometer with pressure transducer dynamometer used for measurement in this study.
2- Magnetic field (Automatic PMT Quattro pro). ASA magnetic field is a device for magnetotherapy, its model is (Automatic PMT Quattro pro) and its serial number is (00001543). The unit consists of an appliance, motorized bed and solenoids. The appliance must be connected to electrical mains supplying 230 v ± 10% at a frequency of 50 or 60 Hz with earth connection. The intensity and spatial lay out of the generated magnetic field depend on the type of solenoid used.
3- Infrared radiation; Its model is 4004/2N and serial number is 00061928. The device has a power of 400w, voltage 203v and frequency of 50/60Hz.
4- Bicycle ergometer (Monark Rehab Trainer model 88 IE); It is an electronically braked ergometer; its power can be read in Watts at 50 pedal revolutions per minute. It is equipped with an electronic meter showing pedal revolutions per minute, the total pedal revolution and time function. There was an extra strap to provide complete fixation of the child’s foot on the ergometer pedal.
5- Treadmill apparatus (En Tred); The entire treadmill apparatus is a steel structure 2.4 meters long, and ½ meter wide. The unit is formed from a belt, two cylinders, and an

axle along its width. This unit is adjusted for uphill walking.

Methods of Evaluation

Knee muscle assessment: Obtained bilaterally for Knee extensor and Knee flexors muscle groups. The Hanoun medical system record 3 traile and give the avarage in Kg.

I- Measurements of knee extensors: The patients was optimally positioned in erect position over the plinth, the alogmeter was used just above the ankle joint, and the child was asked to perform knee extension against maximum resistance (isometric) for three trails (Fig. 1A).

II- Measurements of knee flexsors: The patients was optimally postioned in prone-lying postion over the plinth, the alogmeter was used just above the ankle joint from posterior aspect, and the child was asked to perform knee flexion againest maximum resistance (isometric) for three trials (Fig. 1B).

Fig. (1): Evaluation knee muscle strength (A) Knee Extensor (B) Knee Flexor.

Treatment Program

The nature and effects of the treatment were explained to the patient, each patient was treated successively for 72 sessions over a six months period at the rate of 3 sessions per week every other day, both study and control groups were received the traditional physical therapy program in the following order which included; superficial heat in the form of infrared radiation. for the both knees, therapeutic exercises program in the form of; stretching exercises and strengthing exercises by using bicycle ergometer and treadmill apparatus. In addition the study group received low frequency and low intensity pulsed magnetic field therapy. In addition, both study and control groups were treated by the traditional regimen of medical treatment during the period of application.

1- Magnetic field application

The patient was positioned in a comfortable supine-lying position over the motorized bed. The solenoids were adjusted to be over both knee joints (Fig. 2A). The options of the appliance was adjusted with very low frequency (15 HZ), very low intensity (20 G) and for (20) minutes. Similar protocol was used and reported by Trock, 2000[27].

2- Infrared radiation

The patient was placed in Supine - lying position, both knee joints were exposed. The skin to be treated was examined and the thermal sensation tested. The eyes were shielded by glasses for protection from infrared rays. The lamp was positioned at the distance about 60 – 75cm (Fig. 2B). The heat sensation was described to the patient who was asked to indicate the amount of heat and the area in which it was felt. The correct skin temperature the intensity of heating was controlled by altering the position of the lamp. Was achieved and the treatment was usually continued for about 20 min. and was determined by the fact that it takes about this time for the vascular adjustments to be completed[28].

3- Therapeutic exercise program

Stretching exercises were conducted to maintain the length and elastic recoil of all soft tissues liable to be tight especially the Achilles tendon, hamstrings, hip flexors and adductors in the lower limbs. it was designed individually for each patient.

Strengthening exercises by using bicycle Ergometer training First, the patient performed pedaling on a bicycle Ergometer starting with unloaded cycling for 3 minutes as warming up, and then with intensity of 50 ramps/minute for 5 minutes with few seconds rest in between, increased gradually to 10 minutes at the end of the treatment period (Fig. 2C).

Treadmill training: Each child was asked to walk on the treadmill with a speed of 1.5 kilometers/hour and 0 degree inclination for 10 minutes according to McNevin et al., 2000[19], increased gradually to reach 3 kilometers/hour and 10 degrees inclination for 20 minutes at the end of the study (Fig. 2D).

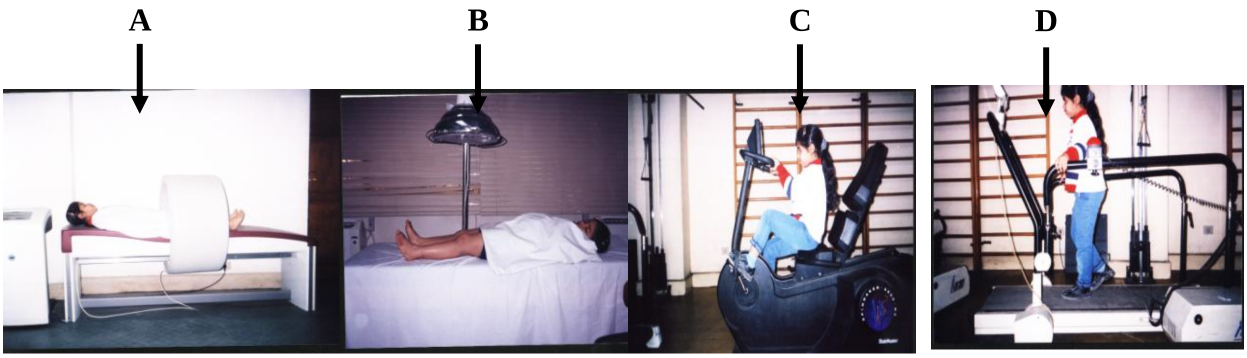

Fig. (2): (A) Magnetic field (B) Infrared radiation (C) Bicycle Ergometer training (D) Treadmill training.

Venue: This study was conducted in The Faculty of Physical Therapy, Cairo University.

RESULTS

Table (1): Comparison between means value of isokinetic muscle strength before treatment in the study and control groups.

Pre in study and control		Sum of Squares	df	Mean Square	F	Sig.
Pre Right Knee Flexors	Between Groups	.363	1	.363	.014	.906
	Within Groups	712.739	28	25.455		
	Total	713.102	29			
Pre Right Knee Extensors	Between Groups	62.785	1	62.785	1.062	.312
	Within Groups	1655.715	28	59.133		
	Total	1718.500	29			
Pre Left Knee Flexors	Between Groups	13.467	1	13.467	.843	.366
	Within Groups	447.280	28	15.974		
	Total	460.747	29			
Pre Left Knee Extensors	Between Groups	43.440	1	43.440	1.529	.226
	Within Groups	795.381	28	28.406		
	Total	838.822	29			

Regaring to the comparison between before treatment of the study and control. There is no significant difference in all items a showen in table 1.

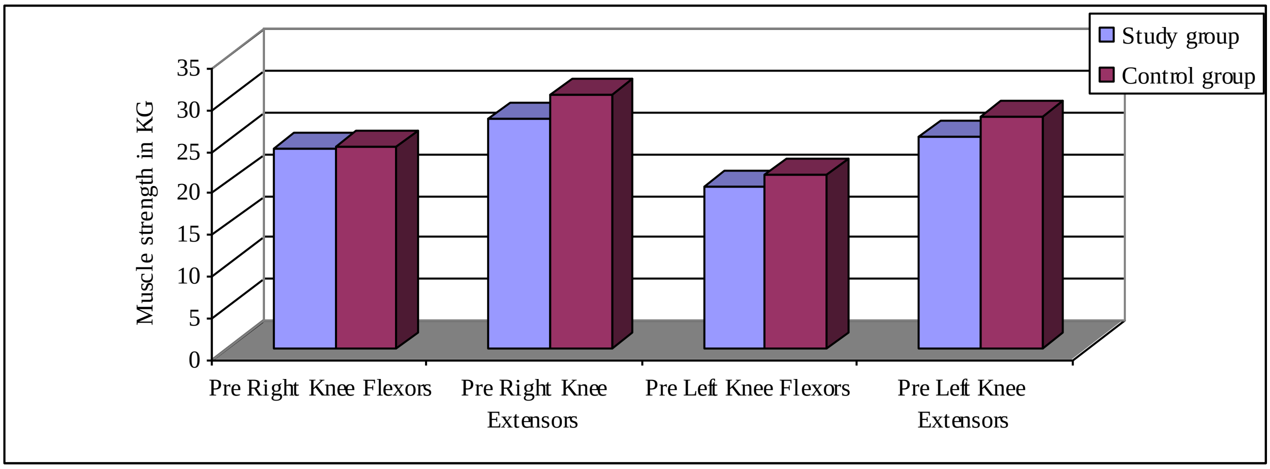

Fig. (3): Comparison between mean values of isokinetic muscle strengh for knee flexor and knee extensor Pre treatment in study and Control.

Table (2): Comparison between means value post treatment in the study and control groups.

Post in study and control		Sum of Squares	df	Mean Square	F	Sig.
Post Right Knee Flexors	Between Groups	375.240	1	375.240	14.710	.001
	Within Groups	714.249	28	25.509		
	Total	1089.490	29			
Post Right Knee Extensor	Between Groups	135.681	1	135.681	3.097	.089
	Within Groups	1226.827	28	43.815		
	Total	1362.508	29			
Post Left Knee Flexors	Between Groups	207.507	1	207.507	8.060	.008
	Within Groups	720.908	28	25.747		
	Total	928.415	29			
Post Left Knee Extensors	Between Groups	131.880	1	131.880	4.143	.051
	Within Groups	891.361	28	31.834		
	Total	1023.242	29			

Table (2) shows comparison between study and control groups after the treatment period. There is a significant difference at 0.05 for the right knee flexors. But not the extensors.

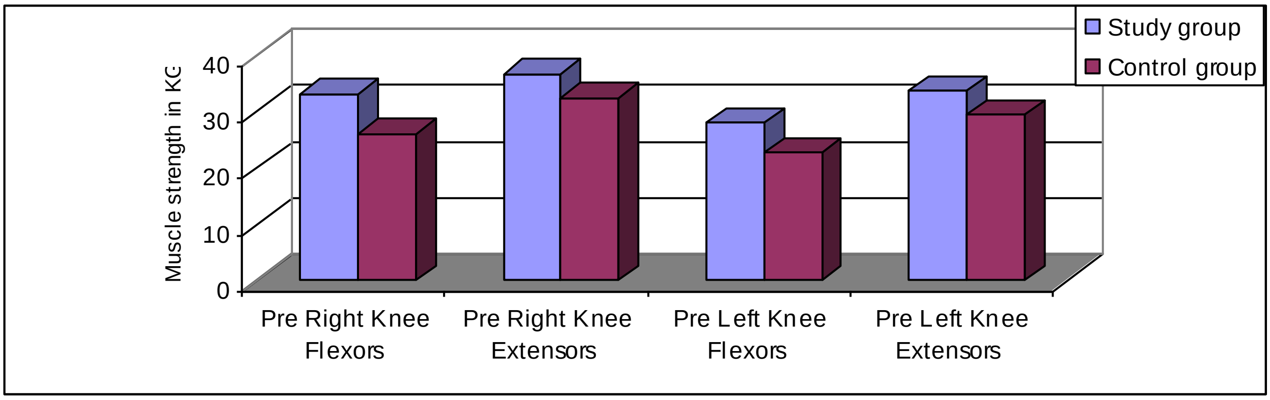

Fig. (4): Comparison between mean values of isokinetic muscle strength for knee flexor and knee extensor post treatment in study and control.

Table (3): Comparison isokinetic muscle strengh between mean values of knee flexor and knee extensor pre and post in study group.

Pre and post in study group	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Right Knee Flexors	-9.0667	4.64522	1.19939	-11.6391	-6.4942	-7.559	14	.000
Right Knee Extensors	-9.1533	4.82640	1.24617	-11.8261	-6.4806	-7.345	14	.000
Left Knee Flexors -	-8.3600	4.23856	1.09439	-10.7072	-6.0128	-7.639	14	.000
Left Knee Extensors	-8.2333	3.70784	.95736	-10.2867	-6.1800	-8.600	14	.000

Table (3) shows comparison between isokinetic muscle strength between pre and post in study group. There is a significant difference in all items in table (3).

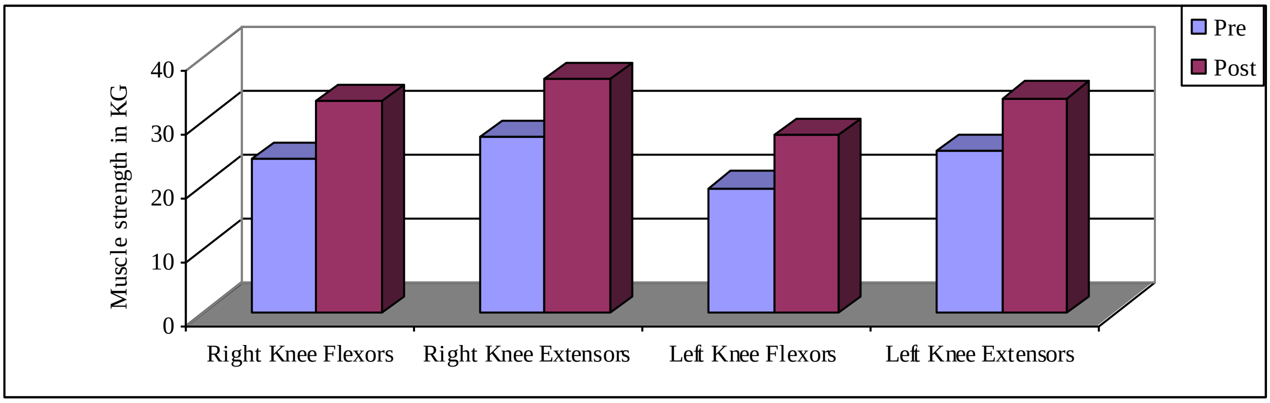

Fig. (5): Comparison between mean values of the knee flexor and the knee extensor pre and post in study group.

Table (4): Comparison between mean values of the knee flexor and the knee extensor pre and post in control group.

Pre and post in Control group	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Right Knee Flexors	-1.7733	1.96449	.50723	-2.8612	-.6854	-3.496	14	.004
Right Knee Extensors	-2.0067	1.46554	.37840	-2.8183	-1.1951	-5.303	14	.000
Left Knee Flexors -	-1.7600	1.90406	.49163	-2.8144	-.7056	-3.580	14	.003
Left Knee Extensors	-1.6333	1.92416	.49682	-2.6989	-.5678	-3.288	14	.005

Table (4) shows comparison between isokinetic muscle strength between pre and post in control group. There is a significant difference in all items in table (4).

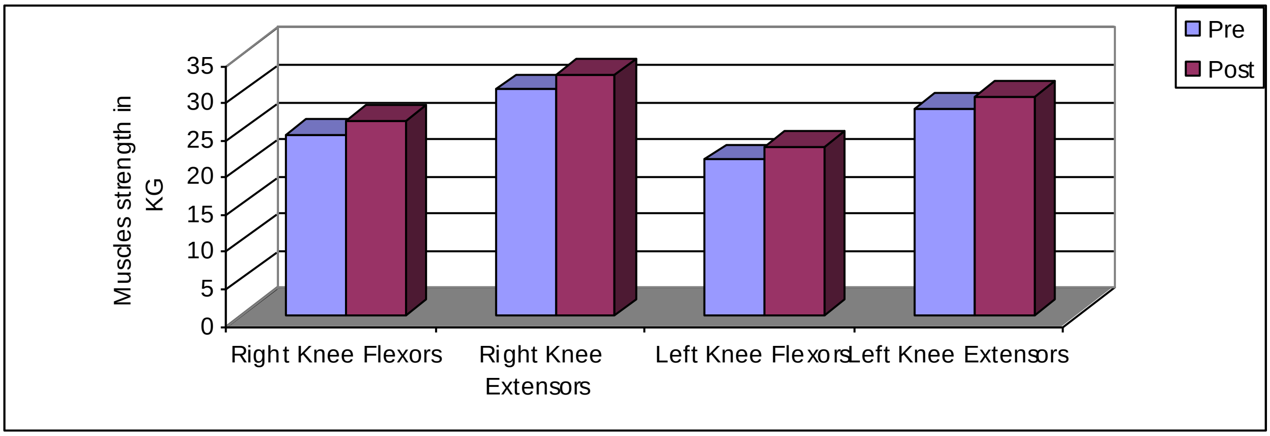

Fig. (6): Comparison between mean values of isokinetic muscle strengh for knee flexor and knee extensor pre and post in control group.

DISCUSSION

Juvenile rheumatoid arthritis (JRA) is one of the most common rheumatic disease of childhood. Magnetic therapy has been reported to be complementary to drug therapy for adult patients with rheumatoid arthritis. This study was conducted to examine the effects of low frequency and low intensity pulsed magnetic field therapy. Subjects in the study group received traditional physical therapy program (Infrared radiation, stretching exercise and strengthning exrcises) as well as (LFLIPMF) for both knee joints. Whereas subjects in the control group were treated by using traditional physical therapy program only. Isoknetic muscle strength assessment for the knee muscle groups were performed before the start of treatment and repeated at the end of the suggested period of treatment.

One of the major physical impaiment in children with JRA is the presence of muscle atrophy and muscle weakness[8,17]. From my own experience it may be reported that many factors may be considered as reasons for this physical impairment. One of these factors is the inactivation of muscles due to reflex inhibition near the inflamed joints. Secondly is the reduction of physical activity in general which leads to more generalized muscle weakness. Finally the presence of pain and its effect on limiting motion and ability of children with JRA to function normally.

Physical therapy aimed to control these factors will be successful in regaining muscle performance and increasing physical activity in children with JRA. In this study a significant imprvement of knee flexor muscle group was found between study and control group in post treatment outcome. One can infer that the reason for this imporvement is due to pain control effect of the magnetic field. Similar reports stated that magnetic fieled is efficient in controllling pain in patients with JRA by Trock et al., 1993[27]; Segal et al., 1999[26]; Jacobson et. al., 2001[12] and Hinman, 2002[10].

Furthermore, the analgesic effect of magnetic field therapy may have contributed to the overall improved efficiency of knee flexor muscles recorded in study group. The following explanation may be offered for this observation; the physiologic mechanism for pain relief due to the application of magnetic field may lead to presynaptic inhibition or decreased excitability of pain fibers[10]. Others postulated that magnetic field participation the small C fibers control[29]. Holcomb et. al., 2000[11] found that exposure to magnetic field produce a reversible blockade of sodium-dependent action potential firing and calcium-dependent responses to the irritant. The molecular mechanism of the effect of magnetic field may involve conformational changes in the ion channels or neuronal membrane. Evidence exists that pulsed magnetic fields can modulate the actions of hormones, anti-bodies and neurotransmitters at surface receptor sites of a variety of cell types[1].

On the other hand the improvement of muscle conditions specially of the flexor groups may be explained in the light of Trock, 2000[27] report who revealed that application of magnetic field might promote favorable transcriptional, 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.

Jacobson et. al., 2001[12] added that the effect of magnetic field extends to structures in the higher levels such as connective tissues, muscle and organs, thus producing less inflammation, improved circulation, diminution of pain and hence improved mobility of joints Also, these results come in agreement with Hinman, 2002[10] who reported that application of magnetic field to the musculoskeletal problems can reduce pain, decrease joint swelling, and enhance movement as in current study may improve the muscle strength.

The lack of improvement of knee extensor muscle group may be attributed to the correlation between quadriceps muscle weakness and knee joints dysfunctions. Many studies have suggested the existence of such correlation[22,24]. In addition the presence of knee effusion associated with JRA may have negative effect on the performance of the knee extensor mechanism.

Pain reduction may be due to the traditional physical therapy program and may be attributed to the effect of infrared which has been used as a form of heat for pain relief and reduction of muscle spasm. Also an increase in sensory nerve conduction might influence sensory responses via an increase in endorphins, which could, affect the pain gate mechanism and the decrease in pain may be due to the effect of therapeutic exercise[14].

Based on the above, the exercises were adapted to the individual patient's needs. The results of the current study there are significant improvement when compareing pre and post in both study and control for knee flexor and extensor musceles, As the therapeutic exercise is useful in the care of patients with juvenile rheumatoid arthritis. Exercise programs maintain and increase ROM[3], strengthen muscles[18], improve endurance and increase bone density[2]. Regular exercise may also improve the patient's overall function and well being[22]. There has been very little published research to assess the efficacy of therapeutic exercise for juvenile rheumatoid arthritis[13,21]. In addition to the heat therapy and therapeutic exercises, gait training was practised to minimize or eliminate observed deviations. Strengthening exercise was included in the study as a main part of the treatment program which my help the patient in both groups[6].

In conclusion significant difference was recorded in improvement of the knee flexor muscle post treatment in favor study group for JAR patients could be attributed to the positive effects of magnetic field on the musculoskeletal problems. The authors highly recommend the use of LFLIPMF togther with the traditional physical therapy program currently in use to achieve and optimize the outcome results needed when children with JRA are treated.

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الملخص العربي

المجال المغناطيسي المتقطع لعلاج الركبة عند أطفال الروماتويد

الرماتويد المفصلي أكثر الأمراض الروماتيزمية انتشاراً عند الأطفال وأثبت استخدام المجال المغناطيسي كعلاج مكمل للعلاج الدوائي عند الكبار المصابين بالروماتويد فاعليته ولقد أجريت هذه الدراسة لدراسة فاعلية استخدام المجال المغناطيسي المتقطع منخفض التردد و الشدة على التحسن في الركبة عند الأطفال المصابين بالروماتويد (تردد 15 هرتز ، شدته 20 ، ولمدة 20 دقيقة للجلسة ، 3 جلسات في الأسبوع {يوم بعد الأخر}، لمدة 24 أسبوع متتالية) . تم اختيار 30 طفل مصابين بالروماتويد ، تتراوح أعمارهم بين 10- 14 سنة ، قسموا عشوائيا لمجموعتين ، مجموعة الدراسة وتشمل 15 طفل حيث تم علاجها باستخدام العلاج الطبيعي {أشعة تحت الحمراء ، تمرينات استطالة و شد و تقوية } بالإضافة لاستخدام المجال المغناطيسي المتقطع منخفض التردد و الشدة . المجموعة الضابطة و تشمل 15 طفل تم علاجها باستخدام العلاج الطبيعي فقط. وقد أستخدم العلاج الدوائي التقليدي أثناء فترة العلاج في كلا المجموعتين . تم قياس القوة الأليزومترية لعضلات الثني والفرد بالركبة ، قورنت هذه النتائج في المجموعتين ، وقد أظهرت النتائج تحسن ملموس بين القوة الأليزومترية لعضلات ثنى و فرد الركبة ما قبل و ما بعد العلاج في كلا المجموعتين ، وأيضًا تحسن ملموس في عضلات ثنى الركبة في مجموعة الدراسة مقارنة بالمجموعة الضابطة . في ضوء البيانات المتاحة (الحالية) يمكن أن نستنتج أن استخدام المجال المغناطيسي المتقطع منخفض التردد والشدة بالإضافة إلى العلاج الطبيعي مع العلاج الدوائي طريقة فعالة لعلاج الأطفال المصابين بالروماتويد المفصلي . ونحتاج إلى دراسة أخرى لتوضيح سبب تحسن عضلات ثني الركبة أكثر من العضلات الفاردة لها .
الكلمات الدالة : المجال المغناطيسي ، الرماتويد المفصلي عند الأطفال ، الركبة .