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ORIGINAL ARTICLE

LASER versus electromagnetic field in treatment of hemarthrosis in children with hemophilia

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Abstract Children with hemophilia usually have recurrent joint bleeding that leads to joint damage, loss of range of motion, and restriction of mobility, therefore affecting the quality of life in these children. The purpose of this study was to compare the effects of low-level laser therapy (LLLT) to that of pulsed electromagnetic field (PEMF) in treatment of hemarthrosis in children with hemophilia. Thirty boys with hemophilia A with ages ranging from 9 to 13 years were selected and assigned randomly, using sealed envelopes, into two equal intervention groups. The study group I received the traditional physical therapy program in addition to LLLT, whereas the study group II received the same physical therapy program given to the study group I in addition to PEMF. Both groups received the treatment sessions three times per week for three successive months. Pain, laboratory investigations, swelling, and range of motion (ROM) of the affected knee joint, in addition to physical fitness were evaluated before, at the end of the sixth week and at 12 weeks of the treatment program. Laser group showed significant improvement in all measured variables after the sixth week of treatment when compared with PEMF. By 12 weeks of treatment, there was a significant improvement in pain, ROM, ESR and leucocytes levels in laser group compared with PEMF, while there was no significant difference in knee circumferences and the 6-min walk test (6MWT) between both groups. Both groups showed significant improvement at 12 weeks of treatment compared with that at 6 weeks. Both LLLT and PEMF are effective modalities in reducing pain, swelling, increasing ROM and improving physical fitness. Twelve weeks of treatment of both modalities demonstrated significant improvement than 6 weeks of treatment. Laser therapy induced significant improvement than electromagnetic therapy in treatment of hemarthrosis-related problems in children with hemophilia.

Keywords Laser · Electromagnetic field · Hemarthrosis · Hemophilia

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Introduction

Hemophilia is a hereditary disorder associated with a recessive trace in the X chromosome resulting in a deficiency in the coagulation factor VIII (hemophilia A) or factor IX (hemophilia B) [1]. The severity of hemophilia can vary from mild to severe, according to the functional plasma levels of the clotting factor, and is associated with the severity of bleeding [2]. The clinical manifestations may include increased body temperature, pain, muscle atrophy, abnormal gait, weakness, hemarthrosis, reduced joint range of motion (ROM), or even the development of degenerative alterations in the joint [3]. Hemarthrosis, synovitis, and bruising are the most frequent complications for children with hemophilia and are frequently accompanied by marked muscle atrophy around the joint [4].

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Successful management of hemophilic arthropathy depends on the prevention of intra-articular bleeding and beginning immediate intervention, if bleeding occurs. Replacement therapy with recombinant factor VIII or IX is the first and essential step in the treatment of hemarthrosis [5]. Physical therapy interventions have a fundamental and an efficient role in the rehabilitation of these patients [6–8].

Laser therapy has become popular in the management of soft tissue injuries and other painful conditions [9]. Recently, low-level laser therapy (LLLT) is used to promote wound healing, reduce pain, decrease inflammatory status, and accelerate recovery after a musculoskeletal injury [10–13]. However, the scientific evidence to support its use is still unknown [14]. Low-level laser therapy is a recent option for enhancing muscle performance and is founded on the application of light in the range of 1 to 500 mW on a given region of the body for the promotion of tissue regeneration, the modulation of inflammation, and pain relief [15].

Pulsed electromagnetic field (PEMF) has been reported to be effective in reducing pain, healing ulcers, promote bone healing, and treat osteoarthritis and inflammatory diseases of the musculoskeletal system [16]. Also, it was reported that PEMF exposure significantly increases the anti-inflammatory effect suggesting its potential therapeutic use in the treatment of inflammatory bone and joint disorders [17].

Therefore, the purpose of the present study was to compare and investigate the effects of LLLT to that of PEMF on pain, laboratory examination, round measurement, and range of motion of the affected knee joint, in addition to physical fitness in children with hemophilia accompanied by hemarthrosis.

Materials and methods

Subjects

Thirty boys with hemophilia A, with ages ranging from 9 to 13 years, were included in this study. They were recruited from the out-patient clinic of physical therapy department, College of applied medical sciences, Najran University, Najran, KSA. They were assigned randomly into two equal intervention groups. The study group I consisted of 15 children who received the traditional physical therapy program in addition to LLLT, whereas the study group II consisted of 15 children and received the same physical therapy program in addition to PEMF therapy. Children in both groups were under the same medical treatment in the form of prophylactic factor VIII replacement therapy. They were selected with inclusion criteria, including children who were diagnosed as having moderate hemophilia A and had a bleeding frequency of about once per week, who were free from skeletal deformities, and approvals by their hematologists were obtained to start physical therapy program. Exclusion criteria, including children who had knee ankylosis or deformities and children who had surgical procedure, was performed 6 weeks before the exercise program. All boys and their parents were given an explanation of the purpose, procedures, and potential risks and benefits of the study. This work is carried out in accordance with the code of ethics of the world medical association (Declaration of Helsinki) for experiments involving humans. All parents of the children signed a consent form prior to participation. In addition, acceptance of the ethical committee of the University was taken.

Randomization

In the present study, 34 children were assessed for eligibility. Two children were excluded as they did not meet the inclusion criteria, and two children were excluded as their parents refused to participate in the study. Following the baseline measurements, randomization process was performed using closed envelopes. The investigator prepared 30 closed envelopes with each envelope containing a card labeled with either the group I or the group II. Finally, each child was asked to draw a closed envelope that contains weather he was allocated to the group I or the group II. The experimental design is shown as a flow diagram in Fig. 1.

Procedures

All procedures for evaluation were explained to all boys and their parents. Weight and height were recorded using calibrated floor scale ZT-120 model, Health scale. Each child was evaluated for pain, ESR, leucocytes, swelling, and knee flexion and extension ROM of the affected knee joint, in addition to physical fitness assessed by the 6-min walk test (6MWT) before, at the end of the sixth week and after 3 months of treatment by the same examiner who was blinded regarding the group to which each child was assigned.

Pain

Pain was measured by using the Visual analogue scale (VAS). It is a measurement instrument and was used to determine the degree of perceived pain. The child was asked to choose a number between 0 and 10 on a 10-cm chart with 0 indicating no pain and 10 indicating unbearable pain. The child marked the number corresponding to the pain intensity. Using VAS for pain assessment has some advantages in clinical trials as it is the most common and reliable type of pain scale [18].

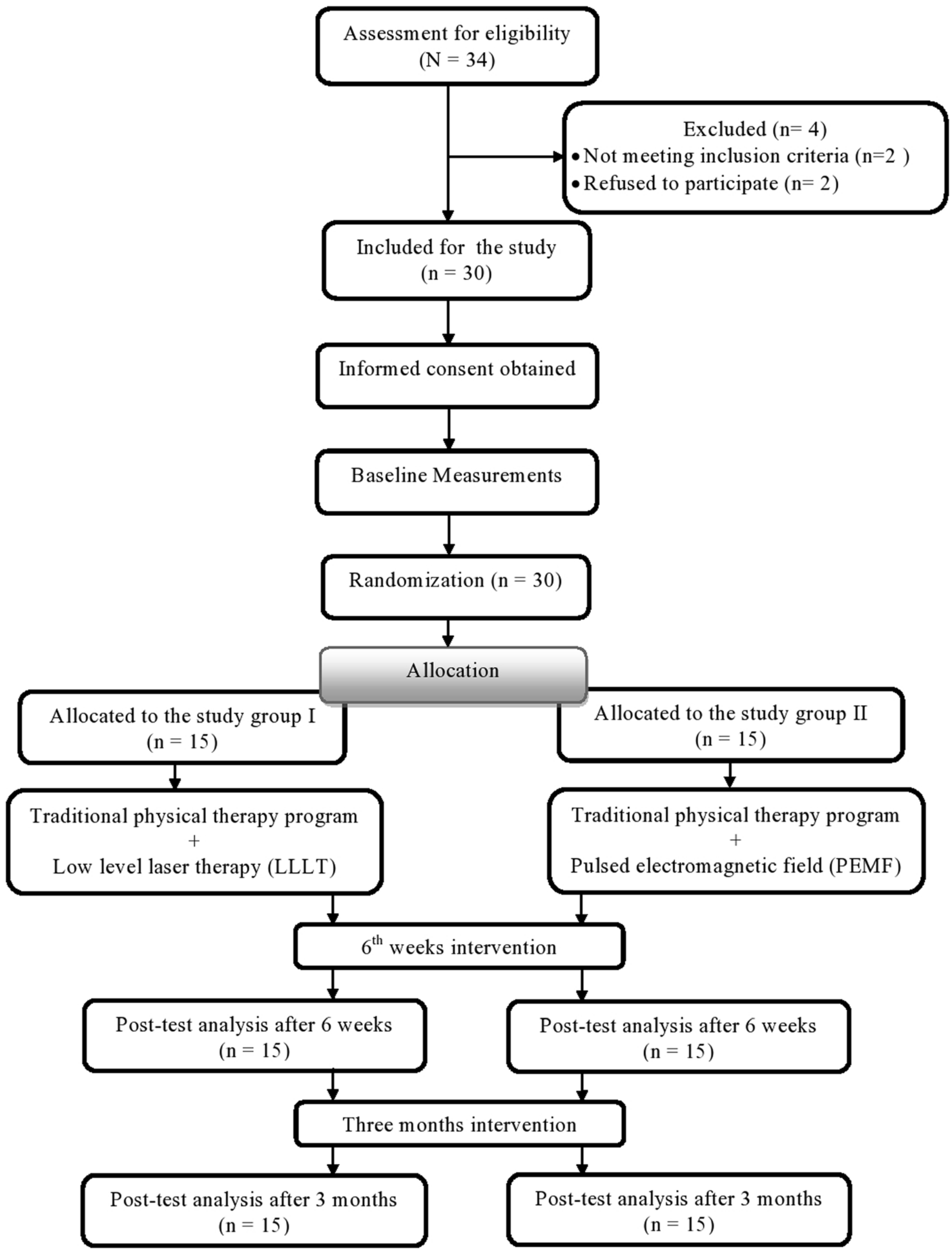

Fig. 1 Flow chart showing the experimental design of the study

Range of motion

Active ROM of the knee flexion and extension were measured with a universal goniometer according to the method described by Norkin and White [19]. They reported the reliability of goniometric measurements as good to excellent. Each child was allowed to lie in prone position, with both feet out of the bed; the trunk, both the lower limbs, and pelvis were completely supported on the bed with straps. The goniometer was placed on the lateral aspect of the knee joint, with the fulcrum on the lateral joint line. The stationary arm was placed parallel to the long axis of the thigh, whereas the movable arm was placed to the long axis of the leg. Two adhesive straps were used to stabilize each arm of the goniometer, and then the child was asked to move the leg in flexion then in extension.

Swelling

Children were asked to lie in supine position with both knees in the most comfortable position. The middle of the patella was determined. Using the tape measurement, circumference was measured in centimeter around the knee joint at the level of the mid-patella and immediately above the upper border of the patella.

Physical fitness

6MWT is used to measure walking ability and baseline cardiovascular function in children with disease or low levels of fitness [20]. The 6MWT is a submaximal, quantitative evaluation of functional exercise capacity and is reflective of the ability to perform daily physical activities. The short-term reproducibility of 6MWT is excellent [21]. The child was asked to walk on an unobstructed, rectangular pathway following the guidelines of the American Thoracic Society [21]. To ensure safety and to measure the exact distance walked in 6 min, the therapist followed closely with a stopwatch.

Laboratory investigation

Laboratory investigation of both groups was carried out in clinical pathology department by taking blood samples before, during, and after the suggested period of treatment. These samples were analyzed, and the results were considered. It included erythrocyte sedimentation rate (ESR) and complete blood count (CBC) including white blood cells (WBC).

Treatment

Physical therapy program

The children in both groups received the same physical therapy program for 1 h per session three times per week. In acute hemarthrosis, cold packs, isometric exercises, and passive ROM exercises were applied. In subacute hemarthrosis, isometric and isotonic exercises were given additionally. In chronic arthropathic joints, hot packs, strengthening, proprioception, and stretching exercises were applied. In addition, home program was prescribed to all children in both groups.

Low-level laser therapy

The children in the study group I received LLLT with a diode Gallium Aluminum Arsenate (Ga-Al-As) laser (RJ Laser, Reimers and Janssen, GmbH, Germany) with 810-nm wavelength, and maximum power output of 500 mW was used at medium power to generate a homogeneous laser spot of approximately 1 cm^2. Laser irradiation was directly applied for 40 s to five points including the medial and lateral side of the patellar tendon, medial and lateral side of the knee adjacent to the patella, and over the supra-patellar pouch. Each child received laser irradiation three times per week with power output of 50 mW and an energy density of 2 J/cm^2. The laser probe was attached directly to the skin to avoid reflecting and scattering of the laser beam [22].

Pulsed electromagnetic field

The children in the study group II received PEMF with ASA magnetic field device (Automatic PMT Quattro pro, Italy). It consists of an appliance, motorized bed, and solenoid. The appliance was connected to electrical mains supplying 230 V±10 % at a frequency of 50 or 60 Hz with earth connection. Children were asked to remove the metal objects or anything sensitive to the magnetic field such as chains, belts, and watches before starting treatment. Then, each child was asked to lie in a comfortable supine position over the motorized bed. The solenoid was adjusted to be over both knee joints. The parameters of the treatment program were selected and adjusted as a frequency of 15 Hz, intensity of 20 gauss, and duration for 20 min [23].

Data analysis

The normality of data was tested by using the Shapiro-Wilk test. Subject characteristics were compared between both groups using *t* test. Mixed MANOVA was conducted to compare the mean values of measured variables between the study group I and the study group II across three time periods (pretreatment, post-I, and post-II). The sample size was determined by using Slovin's Formula ($n=N/1+Ne^2$), where N represents the population size and e represents the margin of error. All statistical analysis was conducted through SPSS (statistical package for social sciences, version 19). The level of significance for all statistical tests was set at $p<0.05$.

Results

Testing the normal distribution of data

Shapiro-Wilk test was conducted to test the normal distribution of data for each dependent variable. The results revealed no significant deviation from normal distribution for all variables in both groups ($p>0.05$).

Subject characteristics

The mean±SD age, weight, and height of the study group I were 11.4±1.24 years, 30.2±1.85 kg, and 129.86±2.16 cm, respectively, and those of the study group II were 11.13±1.35 years, 31.06±1.38 kg, and 130.2±1.65 cm, respectively There was no significant difference between both groups in the mean age, weight, and height ($p>0.05$).

Effect of treatment

- Mixed MANOVA was conducted to investigate the effect of treatment (laser versus electromagnetic) on VAS, knee flexion, and extension ROM, knee circumference at the level of and above patella, 6MWT, ESR, and leucocytes measurement. Table 1 shows descriptive statistics of dependent variables as well as the significant level of comparison between groups. Table 2 shows percent of change and comparison between the three time intervals pretreatment, at 6 weeks of treatment (post-I) and at 12 weeks of treatment (post-II).
- Mixed MANOVA revealed that there was a significant interaction between group and time, Wilks' Lambda (F=40.53, p=0.0001). There was a significant main effect of time, Wilks' Lambda (F=20.3.83, p=0.0001), and a significant main effect for group, Wilks' Lambda (F= 7.54, p=0.0001).
- There was no significant difference between groups pretreatment (p>0.05) for all dependent variable. While at post-I measurement, the study group I showed significant decrease in VAS (p=0.02), significant increase in knee flexion ROM (p=0.006), significant increase in knee extension ROM (p=0.006), significant decrease in knee circumference at the level and above the level of the patella (p<0.05), significant increase in 6MWT (p=0.03), and significant decrease in ESR and leucocytes (p=0.0001) compared with the study group II. At post-II measurement, the study group I showed significant decrease in VAS (p=0.0001), significant increase in knee flexion ROM (p=0.02), significant increase in knee extension ROM (p=0.0001), significant decrease in ESR (p= 0.01), and significant decrease in leucocytes (p=0.02) compared with the study group II, while there was no significant difference in knee circumferences and 6MWT between both groups at post-II measurement (p>0.05).
- Both groups showed similar trends across the three time intervals. There was a significant decrease in VAS, knee circumference above the level of the patella, ESR, and leucocytes in post-II measurement compared with pretreatment and post-I measurements in both groups (p<0.05). Also, there was a significant increase in knee flexion and extension ROM, and 6MWT in post-II compared with pretreatment and post-I measurements in both groups (p<0.05). Knee circumference at the level of the patella decreases significantly at post-II compared with pretreatment at post-I measurements in both groups (p<0.05), while there was no significant difference between post-I and post-II in the study group I (p>0.05), and there was a significant decrease in post-II compared with post-I in the study group II (p<0.05).

Discussion

The present study compared the effects of LLLT to that of PEMF on pain, ROM, swelling of the knee joints in addition to laboratory investigations, and physical fitness in children with hemarthrosis. The study continued for 12 weeks, and the evaluation was performed at two intervals. The first evaluation was performed at 6 weeks, and the final evaluation was performed at 12 weeks. The main findings of this study showed that LLLT induced significant and rapid improvements in all measured variables than PEMF when comparing posttreatment measurements between both groups after the two evaluation sets.

More recently, LLLT has shown interesting results regarding the repair of muscle damage, increase wound healing, reducing pain, and inflammation both in animal models [22, 24–27] as well as in humans [28, 29]. Several studies have demonstrated the effectiveness of LLLT in treating the inflammatory process, and these studies indicated the modulating property of laser light toward anti-inflammatory and pro-inflammatory mediators [30–32]. However, other studies have shown a failure of LLLT in conditions involving joint damage [33, 34]. The results of the current study clearly demonstrated the positive effects of LLLT in reducing pain, swelling, and increasing ROM of the knee joints, as well as reducing the values of ESR and leucocytes toward the normal values as much as possible, in addition to improved physical fitness in children with hemarthrosis than PEMF.

The results of the study group I showed the analgesic effect of LLLT in which there was a remarkable decrease in pain ratings on VAS. These results are congruent with Tam [28], who applied a pulsed diode laser, Ga As 904-nm wavelength, on patients (25–70 years) with rheumatic, degenerative, and traumatic pathologies, once per day for five consecutive days over trigger points, access points to the joints, and striated muscles adjacent to relevant nerve roots, and reported decreasing pain and improved the quality of life of these patients. The analgesic action of LLLT was also approved by Tanboga et al. [29] who investigated the effect of LLLT on pain during dental tooth-cavity preparation in children (6–9 years). They reported that the use of LLLT before cavity preparation decreased pain in pediatric dental patients.

The effects of LLLT in decreasing pain and consequently increasing ROM may be due to its anti-inflammatory action through its influence in modulating inflammatory mediators and inflammatory cells (macrophages and neutrophils) that results in a reduction in the inflammatory process. These results are consistent with Alves et al. [27] who applied LLLT (50 and 100 mW) in acute joint inflammation in rats and reported that LLLT has the ability to modulate inflammatory mediators and inhibit proliferation of inflammatory cells that makes it a suitable treatment for synovitis.

Table 1 Comparison between the study groups I and II at pretreatment, post-I, and post-II treatment

	Study group I $\bar{x}$±SD	Study group II $\bar{x}$±SD	MD MD	*p* value *p* value
Pretreatment				
VAS	6.26±0.96	6.46±0.99	−0.2	0.57*
Knee flexion (degrees)	94.6±6.45	93.06±6.23	1.54	0.51*
Knee extension (degrees)	105.84±8.97	103.57±7.82	2.27	0.46*
Knee circumference at the level of patella (cm)	29.42±0.71	29.21±0.65	0.21	0.4*
Knee circumference above the level of patella (cm)	30.85±1.23	30.46±0.61	0.39	0.28*
6MWT (meter)	263.53±35.13	264±30.89	−0.47	0.96*
ESR (mm/h)	35.22±2.5	36.16±1.68	−0.94	0.23*
Leucocytes (cells/μl)	8.31±0.13	8.35±0.28	−0.04	0.61*
Post-I (at 6 weeks of treatment)				
VAS	2.86±0.83	3.53±0.63	−0.67	0.02**
Knee flexion (degrees)	106±5.73	100.13±4.99	5.87	0.006**
Knee extension (degrees)	116.13±6.42	110.26±7.32	5.87	0.02**
Knee circumference at the level of patella (cm)	28.06±0.84	28.74±0.65	−0.68	0.02**
Knee circumference above the level of patella (cm)	29.08±0.5	29.86±0.69	−0.78	0.001**
6MWT (m)	295.66±33.26	269.33±31.61	26.33	0.03**
ESR (mm/h)	27.88±1.18	29.95±1.33	−2.07	0.0001**
Leucocytes (cells/μl)	7.55±0.22	7.96±0.26	−0.41	0.0001**
Post-II (at 12 weeks of treatment)				
VAS	0.66±0.48	1.93±0.45	−1.27	0.0001**
Knee flexion (degrees)	114.33±5.86	109.66±4.48	4.67	0.02**
Knee extension (degrees)	127.33±2.35	122.06±3.49	5.27	0.0001**
Knee circumference at the level of patella (cm)	28±0.84	28.23±0.56	−0.23	0.38*
Knee circumference above the level of patella (cm)	28.4±0.54	28.7±0.62	−0.3	0.16*
6MWT (m)	310.66±34.78	296.66±40.11	14	0.31*
ESR (mm/h)	22.16±1.66	24.09±2.25	−1.93	0.01**
Leucocytes (cells/μl)	7.15±0.23	7.4±0.33	−0.25	0.02**

$\bar{x}$ mean, *SD* standard deviation, *MD* mean difference, *p value* level of significance

*Nonsignificant; **significant

The effect of LLLT on inflammatory conditions has been widely studied and has proved useful in reducing the acute inflammatory process and its characteristics, such as edema, inflammatory cell contents, and reduction in the levels of cyclooxygenase-2 (COX-2) and prostaglandin E2 (PGE2) [35]. In addition to the reduction of the inflammatory process, which already produces pain relief, another effect of the laser therapy is stimulating the release of endogenous opioids peripherally [36].

LLLT provided a slight effect in the recovery of articular cartilage as approved by Puett and Griffin [37], and this decreases the amount of inflammatory mediators and stimulates the synthesis of proteoglycans and collagen providing an improved epithelioid arrangement of these fibers in the tissue. Also, Lin et al. [38] put the effect of a helium-neon laser (He Ne) in the production of stress proteins, which have a therapeutic effect on the preservation of chondrocytes, stimulating the repair of arthritic cartilage.

The results demonstrated that there was a decrease in laboratory investigations in both groups, as the overall percentages of change for ESR were 37.08 and 33.37 % in laser and magnetic groups, respectively. Moreover, the percentages of change for leucocytes were 13.95 and 11.37 % in laser and magnetic groups, respectively. The presented data support the evidence that LLLT and PEMF had been used as effective modalities for reducing pain, swelling, and inflammation and hence improving function. In addition, PEMF has positive anti-inflammatory effect that leads to decrease pain and improve function [16, 17].

Table 2 Comparison between pretreatment, post-I, and post-II treatment of the study groups I and II

	Pretreatment vs post-I % of change (p value)	Pretreatment vs post-II % of change (p value)	Post-I vs post-II % of change (p value)
Study group I			
VAS	54.31 (0.0001**)	89.45 (0.0001**)	76.92 (0.0001**)
Knee flexion (degrees)	12.05 (0.0001**)	20.85 (0.0001**)	7.85 (0.0001**)
Knee extension (degrees)	9.72 (0.0001**)	20.3 (0.0001**)	9.64 (0.0001**)
Knee circumference at the level of patella (cm)	4.62 (0.0001**)	4.82 (0.0001**)	0.21 (0.99*)
Knee circumference above the level of patella (cm)	5.73 (0.0001**(	7.94 (0.0001**)	2.33 (0.0001**)
6MWT (m)	12.19 (0.0001**)	17.88 (0.0001**)	5.07 (0.04**)
ESR (mm/h)	20.84 (0.0001**)	37.08 (0.0001**)	20.51 (0.0001**)
Leucocytes (cells/μl)	9.14 (0.0001**)	13.95 (0.0001**)	5.29 (0.0001**)
Study group II			
VAS	45.35 (0.0001**)	70.12 (0.0001**)	45.32 (0.0001**)
Knee flexion (degrees)	7.59 (0.0001**)	17.83 (0.0001**)	9.51 (0.0001**)
Knee extension (degrees)	6.45 (0.0001**)	17.85 (0.0001**)	10.7 (0.0001**)
Knee circumference at the level of patella (cm)	1.6 (0.0001**)	3.35 (0.0001**)	1.77 (0.0001**)
Knee circumference above the level of patella (cm)	1.96 (0.03**)	5.77 (0.0001**)	3.88 (0.0001**)
6MWT (m)	2.01 (0.009**)	12.37 (0.0001**)	10.14 (0.0001**)
ESR (mm/h)	17.17 (0.0001**)	33.37 (0.0001**)	19.56 (0.0001**)
Leucocytes (cells/μl)	4.67 (0.0001**)	11.37 (0.0001**)	7.03 (0.0001**)

$\bar{x}$ mean, *SD* standard deviation, *MD* mean difference, *p value*, level of significance, *post-I* at 6 weeks of treatment, *post-II* at 12 weeks of treatment

*Nonsignificant; **significant

The positive effect of LLLT on increasing physical performance may be attributed to decreased joint pain and swelling as well as its anti-inflammatory action. Therapeutic effects of LLLT include increased tissue microcirculation, an anti-inflammatory action, reduced oxidative stress, or a reduction in tissue ischemia (due to reduced release of reactive oxygen species) [25]. The results of the present study clearly demonstrated that the improvement in physical performance was greater in the laser group than in the magnetic group at 6 weeks of treatment. These results may be attributed to the effect of LLLT on the skeletal muscles, and these results are consistent with Vieira et al. [39] who applied LLLT combined with endurance training program to investigate its influence on isokinetic muscle performance of young women (21±1.78 years). They found that LLLT combined with an endurance training program leads to greater improvement in physical performance and reduction in fatigue than an endurance training program without LLLT. These results are also consistent with Ferraresi et al. [40] who investigated the effect of LLLT combined with physical strength training on human muscle performance compared with strength training only in young men (20.8±2.2 years). They concluded that strength training associated with LLLT can increase muscle performance in the isokinetic dynamometry compared with strength training only.

The improvement in physical fitness in the laser group may be attributed also to the analgesic effect and anti-inflammatory action of LLLT. These results are consistent with Fukuda et al. [41] who investigated the effect of LLLT using GaAs laser. They revealed that treatment with LLLT alleviated pain and improved functional ability over the short term, among patients with knee osteoarthritis.

Photophysical and photochemical effects of LLLT on the cells have been described by previous studies as those of Karu's research studies [42]. These effects promote primary and secondary reactions which in turn may determine changes in reduction and oxidation of molecules in cells through a photosignal transduction and its amplification in chain called secondary reactions which can occur hours or days after laser irradiation. All these changes promote photobiological effects which have clinical benefits such as analgesia, acceleration of repair processes, and reduction of inflammation.

The results of the study group II demonstrated the reduction of pain ratings, swelling, and improved ROM of the knee joints, in addition to reduced ESR and leucocytes as well as improved physical fitness after exposure of PEMF. These results are consistent with Tiktinsky et al. [43] that showed PEMF relieved pain effectively in joint problems of 38 patients with hemophilia. In addition, the ROM of these painful joints and the patients' walking abilities improved significantly. These results are also consistent with Parhampour et al.

[44] who investigated the effect of resistance training and PEMF on bone metabolism and joint function in patients (20–35 years) with severe hemophilia and showed that PEMF could reduce pain, the most debilitating symptom in hemophilia, significantly in the right and left knees. They added that the patients in the PEMF group claimed to be more comfortable and can perform stair climbing and gentle running with less pain with respect to preintervention status as well as improved functional abilities of these patients. Moreover, pulsed electromagnetic fields may improve joint function and walking ability in high-risk patients with severe hemophilia when they do not have the ability to perform resistance exercises.

The increased covered distance during the 6MWT in the magnetic group reflected the positive effects of PEMF in improving mobility and physical fitness of these children. These results may be due to its analgesic and anti-inflammatory action, in addition to improved ROM and muscle performance. These results are supported by Diniz et al. [45] who found that PEMF activates synthesis of nitric oxide and enhance blood flow. Synthesis of nitric oxide in endothelial cells could be involved in enhancing blood flow in the periarticular compartment following treatment. A clinical study has shown that PEMF treatment after arthroscopic surgery results in faster and complete functional recovery compared to controls in the short term that is maintained at 3 years follow-up [46].

The results of both groups revealed that both modalities are considered effective in treating problems related to hemarthrosis in children with hemophilia. But, LLLT is more effective and had a quicker response when compared to PEMF. Scientifically, the obtained results can be relied on the fact that LLLT, when applied to the body tissues, delivers energy at a level sufficient to disturb local electron orbits and result in the generation of heat, initiate chemical change, disrupt molecular bonds, and produce free radicals. These are considered to be the primary mechanisms by which LLLT achieves its physiological and therefore its therapeutic effects, and the primary target is effectively the cell membrane [47]. There are a wide variety of physiological and cellular level effects that have been shown to be the result of laser treatment. Some include increased cellular metabolism, stimulation of macrophages, stimulation of mast cell degranulation, activation and proliferation of fibroblasts, and alteration of cell membrane potentials [43].

The present study has some clinical implications. First, the findings from this study suggested that to achieve better physical performance, improving muscle strength, increasing ROM, and pain management, LLLT should be one of the therapeutic modalities in the rehabilitation process for children with hemarthrosis. Second, the results of the present study confirmed the use of LLLT as it is more cheaper than PEMF. Third, since children with hemophilia are at higher risk of chronic diseases that are worsened by overweight or obesity, muscle weakness, reduced bone mineral density, and decreased fitness, physical activity needs to be a part of their lifestyle. Finally, these children, in the past, were prohibited in participation in sports activities; however, the findings of this study may encourage them to be active participants in physical and sports activities.

The present study has also some limitations including the small sample size in addition to the short duration of the study. It would be desirable to extend the duration of the study with a larger sample size. Therefore, future large-scale studies with a larger sample and longer duration are recommended to overcome these limitations and to increase the generalizability of the findings from this study.

Conclusion

The results of the present study demonstrated that both LLLT and PEMF are effective modalities in the treatment program of hemarthrosis. Both LLLT and PEMF are effective modalities in reducing pain, swelling, increasing ROM, and improving physical fitness. Twelve weeks of treatment of both modalities provide significant improvement than 6 weeks of treatment. Laser therapy provides significant and rapid improvement than electromagnetic therapy in the treatment of hemarthrosis-related problems in children with hemophilia.

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