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Pulsed Electromagnetic Field Therapy and Dextrose Phonophoresis on Treatment of Iliohypogastric Neuralgia After Inguinal Herniorrhaphy

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Abstract

Purpose: to evaluate efficacy of pulsed electromagnetic field therapy (PEMFT) and Dextrose phonophoresis on treatment of iliohypogastric neuralgia after inguinal herniorraphy.

Methods: - 90 male and female patients with iliohypogastric postoperative neuralgia, were divided into three groups. Group (A) received the PEMFT in addition to the traditional physical therapy and medical care for 3 months. Group (B) received the 5% Dextrose phonophoresis in addition to the traditional physical therapy and medical care only for 3 months, Group (C) received the PEMFT (10 minutes) + 50 % Dextrose phonophoresis (10 minutes) in addition to the traditional physical therapy and medical care every other day for the 3 months as a total period of treatment. In this study the serum cortisol level, carbamazepine medicament intake and neuropathic pain scale were measured before and after the 3 months of treatment.

Results: - Results showed that both the PEMFT group and the + 50 % Dextrose phonophoresis group were effective and had a valuable effect in decreasing the postoperative chronic inguinal pain in the iliohypogastric postoperative neuralgia patients as evidenced by the highly significant decreases in SCL, CMI and NPS.

Conclusion: This study found a beneficial effect of both 50% dextrose phonophoresis and PEMF on scores in general of serum cortisol level, carbamazepine medicament intake and neuropathic pain scale in specific for patients with postoperative chronic inguinal pain in the iliohypogastric postoperative neuralgia patients. But the cumulative effect of both modalities as in the third study group was more beneficial than application of any one modality of them alone.

Key words (Pulsed electromagnetic field therapy, 50% Dextrose phonophoresis iliohypogastric postoperative neuralgia, Serum cortisol level and carbamazepine medicament intake).

INTRODUCTION:

Hernia can be defined as an abnormal protrusion of an organ or tissue resulting from a deformity in the wall of the cavity containing it. Inguinal hernias can be repaired through open procedures or laparoscopic procedures. Currently, the laparoscopic approach can be transabdominal extraperitoneal (TEP) or transabdominal preperitoneal (TAPP), both of which use mesh and are widely performed.[1]

Both are minimally invasive and can be performed easily and with smaller incisions. In addition, they allow improvements in quality of life, combined with a faster recovery period, reduction of postoperative pain, and morbidity.[2]

Inguinal hernia repair is one of the most common surgical procedures in the world, Persistent pain (neuralgia) and burning sensations (paresthesia) from the surgical incision extending laterally into the inguinal region and suprapubic region caused by Ili hypogastric nerve entrapment after inguinal herniorrhaphy, appendectomy, or lower quadrant blunt trauma are intractable and when persistent may result in severe morbidity.[3]

A further problem after inguinal hernia repair is chronic pain lasting more than 3 months, occurring in 10–12% of all patients.[4]

It is well known that the Ili hypogastric nerve can be inadvertently injured during the inguinal herniorrhaphy. Entrapment of the Ili hypogastric nerve may be caused by inadvertent suture placement, fibrous adhesions and cicatricial neuroma.[3]

Pain is common postoperatively; however, it is expected to occur in the first few days and to respond well to analgesics with progressive improvement, ceasing completely in a few weeks. Nevertheless, persistence of pain for a period longer than 3 months can be characterized as chronic pain. Postoperative pain is an important index, as it has direct implications on morbidity, healthcare-associated costs, and quality of life. It is, therefore, relevant to be evaluated in the surgical practice.[5]

Electromagnetic fields are now being used in many diseases such as skin, osseous, ligamental, or nervous reparation, diabetes, as well as myocardial or cerebral ischemia. It is believed that electromagnetic fields play its role in healing by guiding cellular movements that close wounds. It has been shown that fields can affect orientation, migration and proliferation of cells such as fibroblasts, myofibroblasts and keratinocytes, which are of key importance in healing.[6]

Pulsed electromagnetic field (PEMF) therapy is a physical therapy modality that has been widely used for increasing permeability of the cell membrane and blood circulation, increasing oxygen supply, increasing ATP production, stimulating healing process and epithelialization of the injured tissues, accelerating bone healing, improving fibroblastic as well as osteoblastic activities, plus its anti-inflammatory and analgesic effect.[7]

Therapeutic ultrasound is a commonly used modality that utilizes high-frequency sound waves (usually 1 to 3 MHz) that pass through the skin to underlying structures. Ultrasound has been purported to heat tissue, increase blood flow to skin, decrease pain secondarily by decreasing muscle spasm, and promote healing of various tissue.[8]

Phonophoresis provides higher local concentrations of the drug than with simple topical application, increasing permeability through structural changes in the skin, as well as through the convection mechanisms inherent to the ultrasound effect.[9] The acoustic cavitation mechanism inherent to this type of application is the main cause of improved drug migration through the skin.[10]

The combined use of the drug with skin penetration enhancers of substances called dendrimers.[11] further increases permeability[12] and takes advantage of the analgesic and anti-inflammatory effect provided by the action of ultrasound on the organism.[13]

Hypertonic dextrose is the most commonly injected solution. Although the mechanism of this treatment modality is not clearly understood, it is hypothesized that the solution creates a host

inflammatory response through the upgrading of chemical mediators. which results in stronger connective tissue, improved biomechanics, and joint function and soft tissue recovery.

Several reports have revealed the effects of dextrose prolotherapy in treating refractory musculoskeletal disorders such as low back pain, tendonitis, lateral epicondylitis, and ligament damage.

Therefore, we designed this study to investigate the effectiveness of dextrose phonophoresis versus PEMFT on treatment of iliohypogastric neuralgia after inguinal herniorrhaphy.

MATERIAL AND METHODS:

Subjects:

This study was carried out on ninety patients of both sex with postoperative neuralgia of the iliohypogastric nerve were referred from out-clinics of the general surgery departments in Cairo university hospitals (Kasr- El Aini hospital). Their ages were ranged from 30 to 50 years old. They were assigned randomly into three groups; The first study group (A) was composed of Thirty patients who received the PEMFT in addition to the traditional physical therapy and medical care for 3 months. The second study group (B) was composed of Thirty patients who received the 50% dextrose phonophoresis in addition to the traditional physical therapy and medical care for 3 months. The third study group (C) that composed of Thirty patients who received both the PEMFT and the 50% dextrose phonophoresis in addition to traditional physical therapy and medical care for 3 months.

Sample- size framework.

To avoid type 11 error, sample size calculation is performed using G*POWER statistical software (version 3.1.9.2;Franz Faul, Universitat Kiel, Germany) expecting large difference between groups; and revealed that the required sample size required for this study was N=90. Calculation is made With α=0.05, power 90%, effect size =0.42.

Criteria of selected subjects: Patients were chosen after a routine medical examination, all patients were approximately the age from 30-50 years old, all patients were conscious, nonsmokers and were under own prescribed medications described by their physicians, had post operative neuralgia of the iliohypogastric nerve that persists for a minimum one month beyond the acute onset postoperatively, they had no more than one affected side, they have not been undertaken another physical therapy electro- modality except the traditional physical therapy in the form of stretching and strengthening exercises to the affected groin,

Exclusion criteria: patients with life threatening disorders as renal failure, myocardial infarction or others were excluded from the study, patients who suffering from skin diseases, diabetes, varicose veins, trauma and peripheral vascular diseases were excluded, patients those are pregnant or presented with active malignancy were excluded from the study, patients who suffering from Myasthenia gravis, Hyperthyroidism, Haemorrhage, Acute viral diseases, Acute tuberculosis, Mental disorders or those with pace makers were excluded from the study Measurements were conducted before starting the treatment as a first record and at the end of the treatment (after 3 months of treatment) as a second (final) record.

Dropout criteria:

Participants who refused to take part in the study or declined to participate in the study were also eliminated. The research was carried out at general surgery department in Cairo university hospitals(Kasr El Aini hospital) from march 2022 to April 2023.

Instrumentation:

In this study the measuring equipment and tools were(the Elexcess twenty ten device): for blood serum analysis that was used for the measurement of serum cortisol level, Calculation of the carbamazepin medicament intake (CMI) in mg and Neuropathic Pain Scale: for examining the ability of specific treatments to improve neuropathic pain symptoms, while the therapeutic equipment and tools were the Pulsed electromagnetic field therapy unit (JAMAVA® S Magneto therapeutic apparatus) and the Sonopuls 434 Ultrasound Device (Ultra sonic therapy unit) to conduct 50% dextrose phonophoresis.[14]

Procedures:

Measurement procedures:

A- **Serum cortisol level measurement: (SCL):** Normal cortisol level ranged from 9-25 µg/dL at morning and patients with painful conditions tended to have higher than normal SCL, estimation of serum cortisol level was carried out before and after 3 months of treatment program. A venous blood sample of 8CC was taken at the morning, centrifuged and stored at 20ºC till analyzed.[15]

B- **Calculation of the carbamazepin medicament intake (CMI) in mg:** Was done before and after the treatment programme.[16]

C- [6]**Neuropathic Pain Scale:** The NPS is the first assessment tool developed specifically for neuropathic pain. The sensory qualities included selected based on the clinical experience of a physician involved in its development, containing seven questions relating to symptom intensity and quality: intense, sharp, hot, dull, cold, sensitive to light touch, and itch. There is also one question on temporal pattern (constant plus flairs, constant with fluctuation, flair only), one question on pain unpleasantness, and two questions on intensity of deep and surface pain. Each question, except for that pertaining to temporal pattern, is rated by the subject on a 0–10 scale.[15]

Treatment procedures:

1. **Procedures of PEMFTand 50% dextrose phonophoresis application:**

A brief description about PEMFT and 50% dextrose phonophoresis device and its valuable use was explained for each patient. Subjects were read and signed an informed consent form prior to the treatment procedures. Each session was conducted for 20 minutes over the inguinal region on the affected side for the 3 groups with the patient was placed in a comfortable supine position. All groups received training procedures included flexibility training, muscle strength training, and home exercises program once daily three times a week for 3 months as a total period of treatment**.**[17]

A.PEMF application

The strong programme (7)of the JAMAVA S electromagnetic therapeutic apparatus with magnetic field ranged from 10 to 70 mT south polarity and frequency ranged from 1.6 Hz to 50 Hz was the applied programme.[18]

B. 50% dextrose phonophoresis application:

US therapy was applied at frequency 1 MHz, pulsed mode 60% and a dose of 1.0 W/cm2 for 5 minutes unilaterally over the affected inguinal region,3 times aweek for 3 months, through adding 5gm of coupling media gel which contain 50% dextrose for each patient every session. [19]

Data analysis:

Serum cortisol level (SCL) in **µg /dl**., Calculation of the carbamazepin medicament intake (CMI) in mg and neuropathic Pain Scale (NPS) in degrees, were measured pre-treatment as a first record and after 3 months intervention as a second final record in the three groups. Collected data were fed into computer for the statistical analysis; descriptive statistics as mean, standard deviation, minimum and maximum were calculated for each group. The t-test was done to compare the mean difference of the two groups before and after application and within each group. Alpha point of 0.05 was used as a level of significance.[20]

Informed consent:

Informed consent has been obtained from all individuals included in this study.

Ethical approval:

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the declaration of Helsinki, and has been approved by the Ethical Review Committee of the College of Physical therapy [approval No:P.T.REC/012/003628]

Results:

As shown in table (1), the mean value of the SCL in **µg /dl** before PEMFT treatment was (36.316 ± 5.844), while after treatment was (32.2400 ± 2.423) **µg /dl.** These results revealed a highly significant decrease in the SCL ($P < 0.0001$). While in the second group (50%Dextrose), the mean value of the SCL before treatment was (36.355 ± 0.453) **µg /dl, while** after treatment was (32.2300 ± 2.3323 **µg /dl. These** results also revealed a highly significant decrease in the SCL ($P < 0.0001$).

While in the second group (50%Dextrose), the mean value in the third group (PEMFT and 50%Dextrose) of the SCL before treatment was (36.3500 ± 0.3486) **µg /dl, while** after treatment was (25.433 ± 0.422 **µg /dl. These** results also revealed a highly significant decrease in the SCL ($P < 0.0001$).

Table (1): Comparison of the mean values of the serum cortisol level measurement (SCL) in **µg /dl, before and after treatment in the three groups**

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	**SD**	**Mean**	**SD**				
PEMFT Group (A)	**36.316**	**0.3422**	**32.2400**	**2.423**	**4.07600**	**9.12**	**0.0001**	**Highly Significant Decrease**
50% Dextrose phonophoresis	**36.355**	**0.4053**	**32.2300**	**2.3323**	**4.12500**	**9.54**	**0.0001**	**Highly significant**

Group(B)								**Decrease**
Both PEMFT+50% dextrose phonophoresis group(C)	**36.3500**	**0.3486**	**25.433**	**0.422**	**10.9170**	**109.24**	**0.0001**	**Highly significant Decrease**

As shown in table (2), the mean value of the carbamazepine medicament intake (CMI) in mg before PEMFT treatment was (70.8222 ± 9.4216) in the first group (PEMFT), while after treatment was (23.2222 ± 6.2317) mg these results revealed a significant decrease, (P>0.0001).

While in the 50%Dextrose phonophoresis group, the mean value of the carbamazepin medicament intake (CMI) in mg before treatment was (71.5556 ± 1.5671) mg, but after treatment was (22.4000 ± 7.5262) in the carbamazepin medicament intake (CMI) in mg, these results revealed a highly significant reduction in of the (P < 0.0001).

Also, in the third group (Both PEMFT+50% Dextrose group) the carbamazepine medicament intake (CMI) in mg before treatment was (72.4000 ± 7.5161), but after treatment was (17.4000 ± 11.5412), these results revealed a highly significant reduction.

Table (2): Comparison of the mean values of the carbamazepine medicament intake (CMI) in mg before and after treatment in the three groups

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	**SD**	**Mean**	**SD**				
PEMFT Group (A)	**70.822**	**9.4621**	**23.2222**	**6.2317**	**47.5998**	**23.01**	**0.0001**	**Highly Significant decrease**
50% Dextrose phonophoresis Group(B)	**71.5556**	**1.5671**	**22.4000**	**7.5262**	**49.1556**	**35.02**	**0.0001**	**Highly Significant decrease**
Both PEMFT+50% dextrose phonophoresis group(C)	**72.4000**	**7.5161**	**17.4000**	**11.5412**	**55.0000**	**21.87**	**0.0001**	**Highly Significant decrease**

As shown in table (3), the mean value of the neuropathic pain score (NPS) in degrees before treatment was (65.1222 ± 3.3602) in the PEMFT group, while after treatment was (43.0556 ± 7.8216). These results revealed a highly significant decrease, (P > 0.0001).

While in the 50%Dextrose phonophoresis group, the mean value of the (NPS) in degrees before treatment was (65.1665 ± 3.0165) degrees, but after treatment was (42.9912 ± 7.4615), these results revealed a highly significant reduction in of the (NPS) in degrees (P < 0.0001).

Also, in the third group (both PEMFT+50% Dextrose phonophoresis) the neuropathic pain score (NPS) in degrees before treatment was (65.200±3.0644) degrees but after treatment was (29.4998 ± 0.7432) degrees these results revealed a highly significant reduction in of the (NPS) in degrees (P < 0.0001).

Table (3): Comparison of the (NPS) in degrees, before and after treatment in the three groups

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	**SD**	**Mean**	**SD**				
PEMFT Group (A)	**65.1222**	**3.3602**	**43.0556**	**7.8216**	**22.0666**	**14.20**	**0.0001**	**Highly Significant decrease**
50% Dextrose phonophoresis Group(B)	**65.1665**	**3.0165**	**42.9912**	**7.4615**	**22.1753**	**15.09**	**0.0001**	**Highly Significant decrease**
Both PEMFT+50% dextrose phonophoresis group(C)	**65.200**	**3.0644**	**29.4998**	**0.7432**	**35.7002**	**62.01**	**0.0001**	**Highly Significant decrease**

Discussion:

The study revealed a highly significant decrease in Serum Cortisol Level (SCL) records between different treatment groups, particularly notable between PEMFT alone and the combined approach of PEMFT with 50% dextrose phonophoresis and traditional physical therapy (P < 0.0001). In addition, significant decreases in second records of the Carbamazepine Medication Intake (CMI) were observed between the groups. Furthermore, the study indicated a highly significant decrease in the

second CMI record after three months of PEMFT and 50% dextrose phonophoresis application and traditional physical therapy, compared to the first CMI record ($P < 0.0001$). When comparing the means of the first pre-treatment records of the Neuropathic Pain Scale (NPS) in the three groups, non-significant differences were observed. However, highly significant decreases in second NPS records were noted between PEMFT alone and the combined PEMFT with 50% dextrose phonophoresis and traditional physical therapy group ($P < 0.0001$).

The findings of the study align with previous research regarding the therapeutic mechanisms of dextrose, including the stimulation of local healing and reduction of joint instability. This parallels the assertions made by [21] on the cartilage-specific anabolic growth resulting from intra-articular dextrose injection. Additionally, the study's agreement with [22] and other researchers in their findings regarding the pain-relieving effects of PEMF provides further support for the observed outcomes. It is worth noting the consistent findings across studies regarding the ability of PEMF to attenuate the development of painful diabetic peripheral neuropathy (DPN), as well as its potential to prevent or reverse abnormalities observed in animal models. Furthermore, the agreement with the conclusions of [23] on the efficacy of diclofenac phonophoresis in reducing pain in myofascial pain syndrome and the findings of [24] on the superiority of phonophoresis with diclofenac and thiocolchicoside gel treatment in acute back pain patients strengthens the credibility of the current study's outcomes.

Implications and Further Research:

The study's results carry implications for the clinical management of postoperative chronic inguinal pain and iliohypogastric postoperative neuralgia. The cumulative effect of PEMFT and 50% dextrose phonophoresis in the combined treatment group demonstrated more substantial benefits than the application of either modality alone. These findings suggest the potential of combined therapies in effectively managing postoperative chronic inguinal pain. Moreover, the observed outcomes call for further research to explore the long-term effects and broader applications of combined PEMFT and dextrose phonophoresis treatment. Future studies should investigate the specific mechanisms through which these modalities interact to produce enhanced pain relief and cellular effects, as well as their implications for different patient populations and pain conditions. The discussion presented is based on the provided content, incorporating references to [21,22,23,24] and others.

Conclusion:

The study supports the potential benefits of PEMFT and 50% dextrose phonophoresis in pain management, especially when used in combination with traditional physical therapy techniques. The mechanisms of action highlighted emphasize the multifaceted ways in which these modalities may alleviate pain and improve physiological processes.

Limitations of the study

The study was constrained by two factors: the psychological and physical condition of the patients throughout the treatment duration, as well as the small size of the sample. Additional tools for measurement may be required to ensure optimal reliability. Examining the long-term results is crucial to evaluate the effects of the treatment methods. The limitations of this study are that there was no follow-up.

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Conflict of interest

The authors state no conflicts of interest in this work.

Disclosure statement

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