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Comparison of diadynamic current, interferential current and transcutaneous electrical nerve stimulation therapies in patients with chronic low back pain

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Abstract

This study aims to compare the effects of diadynamic current (DDC), interferential current (IFC), and transcutaneous electrical nerve stimulation (TENS) therapies on pain and disability levels in patients with chronic low back pain (CLBP). Patients with chronic low back pain between the ages of 18-65 were included in the study. The patients were divided into three groups. The first group received DDC, the second group IFC, and the third group TENS. The patients were evaluated in terms of pain and disability levels before the treatment, the 0th day after the treatment, and the 1st month after the treatment. Thus, these three treatment modalities were compared in terms of their effectiveness. A total of 83 patients were included in the study. There was no statistically significant difference between the groups in terms of age, gender, BMI, disease duration, pain, and disability levels of the patients before treatment. A statistically significant difference was found between the 0th day before and after the treatment and the 1st month before and after the treatment in terms of pain and disability levels in all three groups. The VAS scores of the individuals in the IFC group were significantly lower on the 0th day and 1st month after the treatment than in the DDC and TENS groups. Although there was no statistically significant difference, when looked at clinically, the RMDQ scores of the individuals in the IFC group tended to decrease more than those in the DDC and TENS groups. All three treatment modalities are effective in patients with CLBP. However, IFC seems to be superior.

Keywords: chronic low back pain, diadynamic current, interferential current, transcutaneous electrical nerve stimulation

1. Introduction

Low back pain (LBP) is defined as muscle spasms and pain in the region between the lower border of the 12th rib and the lower gluteal fold. Chronic low back pain (CLBP) is a health problem in all age groups and creates significant financial burdens on health systems. Up to 90% of the adult population will suffer from LBP at some point in their lives (1). LBP is classified according to duration as acute, subacute, and chronic (<6 weeks, 6-12 weeks, > 12 weeks). CLBP constitutes 2% to 7% of LBP (2). While pain is self-limiting in 6 weeks or less in the majority of patients, it may last six weeks or longer in 10-40% of patients (3).

Acute LBP can be triggered by physical, psychosocial, or both factors. LBP is primarily due to non-specific causes. According to a study, it was shown that approximately 4% of patients with LBP in primary health care facilities had compression fractures, 3% had spinal stenosis, 2% had visceral disease, 0.7% had tumor or metastasis, and 0.01% had an infection (1, 4).

Patient education and pharmacological and non-pharmacological approaches constitute the basis of treatment. Pharmacological treatments are essential in the treatment of both acute and chronic LBP. Acetaminophen and NSAIDs are effective in the short-term control of pain. In addition, muscle relaxants, tramadol, some types of antidepressants, and antiepileptics have also been useful in treating LBP. Non-pharmacological treatment approaches aim to reduce the patient's pain and increase their functionality, and they can be combined with pharmacological treatments. These methods include exercise, heat application, back schools, manual therapy, massage, acupuncture, spinal manipulation, EMG biofeedback, back support, and cognitive behavioral therapy. Epidural steroid injections and local injections can also be used for treatment (3, 5).

TENS is a non-pharmacological treatment modality widely used in the management of LBP. It is a safe, non-invasive, and easy-to-use form of treatment. TENS units provide electrical stimulation to the underlying peripheral nerves through electrodes placed on the intact skin surface near the maximum source of pain. The gate control theory explains the pain relief

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effect of TENS. The given electrical currents prevent the transmission of pain signals from the spinal cord to the brain. According to the gate control theory, the electrical currents provided by TENS stimulate the A-beta to type sensory nerves under the skin; This reduces the transmission rate of the signals of the C-type nerve fibers carrying the pain sensation from the spinal cord to the brain. Another explanation is that it increases endorphins, the body's natural pain relievers. A-delta nerve fibers are activated to use the endorphin mechanism. In addition, A-delta nerve stimulation causes the spinal cord to release a molecule called enkephalin that suppresses pain signals (6).

IFC is a form of electrical therapy in which two medium-frequency currents are used to produce a low-frequency current. Low-frequency currents play a fundamental role in pain relief, which is one of the essential effects of interferential currents. The gate control theory explains this effect. Additionally, it removes pain-causing chemicals from the affected area through increased blood flow (7). The effect mechanism of IFC application is interesting. When two medium-frequency alternating currents are applied from the skin surface, these currents can reach deeper tissues due to their medium-frequency characteristics. As a result of the interaction of these two medium-frequency currents in deeper tissues, a low-frequency alternating current is obtained. Since IFC currents can reach deeper tissues, they create more muscle torque than low-frequency alternating currents (8).

Diadynamic currents (DDC) are single-phase sinusoidal if currents with a low frequency of up to 100 Hz. DDC consists of direct current and repetitive sinusoidal alternating currents. There are five types of DDC: Diphase fixe, Monophase fixe, Short period, Long period, and Rhythm syncope current. It has been reported that DDC may have beneficial effects in reducing pain through muscle fiber stimulation, pain masking, vasodilation, and hyperemia mechanisms (9).

In the light of all this information, we aimed to see and compare the effectiveness of DDC, IFC, and TENS treatment modalities on disability and pain in chronic low back pain patients.

2. Material and Methods

2.1. Study design, setting, and population

Eighty-three patients aged between 18-65 years with chronic low back pain who applied to the Hatay Training and Research Hospital Physical Medicine and Rehabilitation Outpatient Clinic were included in the study. To diagnose CLBP, detailed anamnesis of the patients was taken, general physical examinations, musculoskeletal and neurological examinations were performed, and hemogram, sedimentation rate, CRP, lumbar X-Ray, or lumbar MRI were taken. The patients were divided into three groups: Group 1 (DDC), Group 2 (TENS), and Group 3 (IFC). This study was carried out between May and November 2021 with the approval of the Hatay Mustafa Kemal University Ethics Committee (Decision no:01, date: 06.05.2021). A written informed consent form was obtained from all participants.

Firstly, a total of 10 minutes of DDC treatment consisting of diphasic fixed (2 min), courtes period (4 min), and long period (4 min) was applied to the patients in Group I. A total of 10 sessions of DDC treatment, five sessions per week, were applied.

A total of 10 sessions of conventional TENS were applied to the lumbar spine of the patients in Group II, with a frequency of 100 Hz and a pulse duration of 60 ms, five sessions per week. The amplitude intensity was adjusted to produce a slight tingling sensation without causing contractions or excessive discomfort. The treatment time was 30 minutes for each session with a two-channel portable TENS device.

IFC was applied to the patients in Group III for 30 minutes. Four electrodes were placed crosswise, so the pain area was in the middle. The input current frequency was set to be 4000 Hz, with a 100 Hz amplitude modulated frequency. A total of 10 sessions of IFC were applied, with five sessions per week.

A hot pack was applied to all three groups for ten sessions, each session for 30 minutes. BTL brand device was used for the application in all three groups.

The following were accepted as exclusion criteria from the study: Fracture, scoliosis, neurological disease, inflammatory rheumatologic disease, previous lumbar spine surgery, pregnancy, malignancy, infection, injection, or physical therapy for CLBP in the last three months, and symptom duration less than three months. Electrotherapy contraindication criteria such as a cardiac pacemaker, presence of dermatological problems, and epilepsy were also accepted as exclusion criteria.

The pain and disability levels of the patients were evaluated with questionnaire forms three times, before the treatment, on the 0th day after the treatment, and in the 1st month after the treatment. Patients with CLBP were asked about their age, weight, height, body mass index, how long they had low back pain complaints, and the treatments they received in the last three months. The patients' pain severity was evaluated using the VAS (Visual Analog Scale), and the disability status was assessed using the Roland-Morris Disability Questionnaire (RMDQ).

In this way, the effectiveness of the three treatment methods was compared by evaluating whether there was a change in pain and disability levels and, if there was, how much.

2.2. Statistical analysis

SPSS (Statistical Package for Social Sciences) 22.0 program was used to evaluate the data obtained from the study. The Shapiro Wilk test analyzed the normal distribution fit of continuous numerical variables. All data were given as mean ± standard deviation, median, minimum-maximum, frequency,

and percentage. Pearson Chi-Square Test determined statistical difference between groups in terms of categorical variables. The One-Way ANOVA Test determined the statistical difference between the groups in terms of continuous variables for normally distributed variables and the Kruskal Wallis Test for non-normally distributed variables. The Bonferroni correction method was used to compare repeated measurements within the same group. Analysis of Variance (ANOVA) was used for Repeated Measures. A p-value of <0.05 was considered significant according to statistical tests.

3. Results

Eighty-three patients with CLBP diagnosis were included in the study. There was no statistically significant difference between the groups in terms of age, gender, BMI, and disease duration of the patients (p>0.05) (Table 1).

Table 1. Comparison of demographic characteristics

Variables		DDT (n= 28)	TENS (n= 27)	IFT (n=28)	p
Age (year) (Mean. ± SS)		49.60 ± 10.35	46.22 ± 10.15	47.64 ± 9.68	0.460*
BMI (kg/m²) (Mean. ± SS)		27.17 ± 2.59	27.71 ± 3.65	28.10 ± 3.19	0.549*
Disease duration [Median (Min-Max)]		33 (6-180)	24 (6-180)	30 (6-120)	0.784**
Gender (n/%)	Male	10 (35.7)	9 (33.3)	10 (35.7)	0.978***
	Female	18 (64.3)	18 (66.7)	18 (64.3)	

n: Number of Patients; SD: Standard Deviation; BMI: Body Mass Index; *One-Way Anova Test; **Kruskal Wallis Test; *** Pearson Chi-Square Test

There was no statistically significant difference between the pre-treatment VAS averages of the patients in all three groups (p>0.05). In the intragroup comparison, all three groups found a statistically significant difference between the mean VAS scores on day 0 before and after treatment and the 1st month before and after treatment. A statistically significant difference was found between the mean VAS scores of the individuals in all three groups on day 0 after treatment and one month after treatment (p=0.010, p=0.028, respectively). The VAS scores of the individuals in the IFC group tended to decrease more than those in the DDC and TENS groups.

There was no statistically significant difference between the RMDQ averages of the individuals in all three groups before, on day 0 after, and one month after treatment (p>0.05). In the intragroup comparison, all three groups found a statistically significant difference between the mean RMDQ scores at day 0 before and after treatment, and at the 1st month before and after treatment (p<0.001). There was no statistically significant difference between the mean RMDQ scores on day 0 after treatment and month one after treatment (p>0.05). Although there was no statistically significant difference, clinically, the RMDQ scores of the patients in the IFC group tended to decrease more than those in the DDC and TENS groups (Table 2).

Table 2. Comparison of VAS and RMDQ scores of the groups

		GROUP (Mean± SS)			p
		DDT (n= 28)	TENS (n= 27)	IFT (n=28)	
VAS	Before treatment	7.28 ± 1.18	7.48 ± 1.01	7.35 ± 1.16	0.808*
	Post-treatment (day 0)	4.96 ± 1.50	5.00 ± 1.35	3.92 ± 1.48	**0.010***
	Post-treatment (1st month)	4.78 ± 1.81	4.66 ± 1.75	3.64 ± 1.56	**0.028***
	p**	**<0.001[a]**	**<0.001[b]**	**<0.001[c]**	
RMDQ	Before treatment	14.10 ± 4.16	14.44 ± 3.61	14.42 ± 4.26	0.940*
	Post-treatment (day 0)	9.21 ± 3.78	9.22 ± 3.41	7.17 ± 3.58	0.056*
	Post-treatment (1st month)	8.92 ± 4.11	8.81 ± 3.90	6.85 ± 3.77	0.094*
	p**	**<0.001[a]**	**<0.001[b]**	**<0.001[c]**	

n: Number of Patients; SD: Standard Deviation; * One-Way Anova Test; **Analysis of variance in repeated measurements

a: There was a difference between the 0th day before and after the treatment, there was a difference between the 1st month before and after the treatment

b: There was a difference between the 0th day before and after the treatment, there was a difference between the 1st month before and after the treatment

c: There was a difference between the 0th day before and after the treatment, there was a difference between the 1st month before and after the treatment

4. Discussion

The aim of treatment in CLBP should be to reduce pain, provide mobility, prevent physical disability, and improve quality of life and biological functions. Patients' VAS scores and RMDQ values decreased after treatment with all three treatment modalities, and this decrease was statistically significant. In other words, we determined that these three treatment modalities were effective in terms of pain and disability scores.

Many physical therapy agents are frequently used in the treatment of LBP. Various electrotherapy applications are also frequently used in this field, but their superiority over each other is still controversial. Studies conducted by Brazilian researchers have determined that TENS and IFC modalities are highly effective in the treatment of low back pain. Faci et al. compared the effects of TENS and IFC modalities in patients with non-specific CLBP. In this study, which included 150 patients, three groups were formed. TENS was given to the first group and IFC to the second group. The third group was not given any physical stimulus. The results of this study show that TENS and IFC treatment produced significant effects such as a reduction in pain level, disability, and the number of NSAIDs used compared to the control group. However, no significant

difference was observed in the TENS and IFC treatment groups (10).

In another study, although IFC and TENS treatment modalities were influential in treating pain due to lumbar discopathies, the DDC treatment modality seems ineffective (11). Another study found that both DDC and TENS modalities can relieve pain and improve functional abilities in patients with lumbar discopathy (12). In their studies, Sayıtır and Yıldızgören showed that both DDC and TENS treatments were effective on pain after one month of treatment. They also showed that the pain relief achieved with DDC in CLBP patients was as effective as that provided by TENS (9).

While some studies indicate that DDC is effective in acquiring physical functions, they also show that it is useless (11, 12). Our study found all three treatment modalities effective in terms of pain and disability scores.

Conflicting results have been obtained in studies with CLBP patients comparing the efficacy of TENS and IFC. In the study of Tella et al., positive results were obtained on pain and disability in both the IFC and TENS groups, and the effectiveness of both treatment modalities was evaluated as similar (13). Again, a systematic review emphasized that TENS and IFC modalities successfully reduced pain and that physical medicine and rehabilitation specialists could prefer both methods. In this review, it was stated that both methods reduced pain equally. Equal improvements in VAS scores were found in six of the eight studies evaluated in this review, regardless of current type and frequency (14). Some studies have shown that IFC therapy tends to be better than TENS at controlling pain and reducing pain medication intake, but it did not reach statistical significance (14). Zeng et al. evaluated the benefits of electrical stimulation and concluded that IFC was a more promising treatment for pain relief (15). Acedo et al. compared the effects of TENS and IFC treatments on upper trapezius relaxation and pain control in patients with chronic non-specific neck discomfort. They found that IFC provided upper trapezius relaxation at the end of 3 sessions, but TENS application did not change muscle tension. Both modalities successfully reduced pain, but IFC was associated with a better clinical improvement (16). In a study comparing the effectiveness of IFC, TENS, and splint therapy in patients with carpal tunnel syndrome, it was found that IFC was more effective than TENS in terms of VAS, symptom severity, and functional capacity (17).

Rajfur et al. found that DDC had poor efficacy in improving pain and function. Although TENS and high voltage are more effective treatment options, they have not been as effective as IFC in penetrating deep tissues (11).

To our knowledge, our work is the second study in the literature to compare these three treatment modalities in patients with CLBP, and it is highly significant in this respect. We found that all three treatments were effective on pain and disability levels in CLBP patients. We discovered that IFC was statistically superior to the other two treatment methods on pain score. When evaluated clinically, we found that IFC decreased more in disability scores, although not statistically. We have tried to show with the references above that there are quite contradictory results on this subject in the literature. This contradiction may be because pain or disability assessments are a complex and multidimensional process, but evaluating them with one-dimensional scales may yield different results.

The study's limitations are as follows: 1- The number of patients could have been kept higher. 2- A placebo or control group could be included. 3- Due to the complex nature of pain and disability, multiple assessment scales could have been used instead of a single scale. 4- Combined efficacy of treatment modalities could be evaluated. 5- The effects of these treatment methods on the frequency of painkiller use could be considered. 6- The differences in frequency, pulse duration, electrode size, and intensity variability on treatment efficacy were not evaluated. 7- The results were evaluated before the treatment, on the 0th day after the treatment, and on the 1st month after. A longer follow-up period and preservation of treatment efficacy were not evaluated. 8- The effectiveness of these treatment methods on specific causes of low back pain was not assessed.

CLBP is a common health problem. TENS, DDC and IFC are effective on pain and disability in the treatment of CLBP. When the literature is examined in terms of the effectiveness of these methods, it is seen that there are contradictions between the results. We found that the efficacy of the IFC treatment method is better than TENS and DDC. There is a need for larger, well-designed, and standardized studies that minimize the limitations mentioned above to determine the most effective treatment method.

Conflict of interest

Authors declare that there is no conflict of interest.

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Authors' contributions

Concept: A.U., M.G., Design: A.U., M.G., Data Collection or Processing: A.U., Analysis or Interpretation: M.G., Literature Search: M.G., A.U., Writing: M.G., A.U.

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