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24

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THE EFFECT OF INTERFERENTIAL CURRENTS AND TENS ON PAIN AND FUNCTIONALITY IN PATIENTS WITH CHRONIC MECHANICAL LOW BACK PAIN

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ABSTRACT

Objective: This study aimed to compare the effects of interferential current (IFC) and transcutaneous electrical nerve stimulation (TENS) on pain, disability, and flexibility for treating patients with chronic low back pain (CLBP).

Materials and Methods: This study included 50 volunteer patients diagnosed with CLBP randomly assigned to IFC and TENS treatment. In addition to electrical stimulation, therapeutic ultrasound, hot packs, and exercise were administered to both groups. All patients underwent 20 sessions of treatment for 4 weeks and 5 days on weekdays. The Numerical Pain Scale, Oswestry Scale (ODI), and sit-and-reach test were used for evaluation. Patients were evaluated 3 times: before treatment, at the 10th session, and after treatment. The paired t-test was used for statistical analysis.

Results: Significant improvement was seen in both treatment groups' pain levels when the levels of pain before and after treatment were compared. Before and after treatment, both groups in the sit-and-reach test and Oswestry evaluation showed a significant improvement ($p>0.05$). The change in pain and disability scores did not show superiority in the TENS and IFC groups ($p>0.05$). Only in the sit-and-reach test did the IFC group show significantly more improvement after the 20th session treatment ($p=0.026$).

Conclusion: IFC and TENS should be used in patients with CLBP to control pain and improve function. However, studies with electrical currents determined by different biophysical parameters are needed to determine the superiority of TENS and IFC in terms of treatment outcome measures.

Keywords: Low back pain, TENS, interferential current, rehabilitation

INTRODUCTION

Approximately to 23% of people worldwide suffer from chronic low back pain, with an estimated 24-80% of patients experiencing recurrence every year[1]. Low back pain comprises an average of 9.6% of all emergency department visits and 0.9% of all hospital admissions[2].

Numerous factors can contribute to low back pain, and mechanical low back pain is the most prevalent type of chronic pain. Mechanical low back pain can also be defined as nociceptive pain. Back pain that originates intrinsically from the spine, intervertebral discs, or surrounding soft tissues is referred to as mechanical low back pain[2,3].

In addition to medical treatment, many physiotherapy and rehabilitation methods are used in the treatment of chronic low back pain (CLBP). Electrotherapy modalities are often preferred for pain control. Transcutaneous Electrical Nerve Stimulation (TENS), ultrasound (US), and interferential currents (IFC) are commonly preferred electrotherapy modalities in low back pain[2-4].

IFCs are amplitude-modulated currents resulting from the superposition of two or more medium-frequency sinusoidal type currents with a frequency of approximately 4000 Hz. The frequency of the resulting current is equal to the difference of the frequencies of two medium-frequency sinusoidal alternating currents, so its effect on tissue is similar to the effect of low-frequency currents. The most important feature of interference is that it encounters minimum skin resistance, unlike low-frequency currents, because it has a medium frequency during the entry of the current into the tissue. With this advantage, it can be applied to deep tissues without disturbing the patient[5,6]. It was stated in the literature that IFC provides a significant reduction in pain in low back pain[7].

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Transcutaneous electrical nerve stimulation can be considered as the most widely used low-frequency analgesic current in clinical practice by physiotherapists. It was first developed in 1965 based on the control theory by Razak Özdinçler[5]. Conventional TENS application produces inhibitory effects on nociceptive nerve conduction when used at high frequency (>100 Hz) and low intensity[5,8]. The gate control theory is based on the principle that both pain and superficial sensations are transported to the central nervous system via the substantia gelatinosa. Accordingly, if neurons entering the medulla spinalis from the same location are stimulated with painless stimuli, the transmission of pain to the higher centers are inhibited[5,6,8]. Meta-analyses indicate that there is moderate evidence that pain intensity during or immediately after TENS application is lower compared to placebo and that there are no serious adverse events[9].

Although IFC and TENS are the most commonly used methods in the treatment of low back pain, there are limited studies investigating and comparing their efficacy in the literature. Although the physiological mechanisms of TENS and IFC are similar, their superiority over each other when used for a certain period of time as traditional physiotherapy applications is limited in the literature[10]. The aim of this study was to compare the effects of IFC and TENS on pain, disability, and flexibility in patients with chronic mechanical low back pain.

MATERIALS AND METHODS

This prospective clinical interventional study was approved by the Clinical Research Ethics Committee of Marmara University (07/12/2018). The patients were informed verbally and written about the purpose, duration, and methods to be used before the study. All participants read and approved the "Informed Voluntary Consent Form" prepared in accordance with the standards set by the Ethics Committee.

Patients who were diagnosed with CLBP who applied to Private Tepe Medical Center Physical Therapy and Rehabilitation outpatient clinic between August and December 2019 were included in the study. Patients with mechanical low back pain for more than 12 weeks, literate and volunteered to participate in the study were included in the study. Patients with pacemakers and neurostimulators, diagnosed cancer, previous pelvic or spinal surgery or spinal cord injury, peripheral vascular disease and uncontrolled comorbid conditions, and pregnant or suspected pregnancy were excluded. Patients were not receiving any other treatment (including medication) that would affect the treatment program.

The numerical pain scale (NPS) was used to assess pain intensity. In this scale, "0" defines painlessness and "10" defines the highest pain[11]. Pain intensity during activity, at rest and during sleep was questioned.

Oswestry Scale was used to evaluate functional disability. The Turkish validity and reliability study was conducted by Yakut et al.[11]. The Oswestry scale includes 10 questions evaluating different activities of daily living and 6 options for each question. A score of 0-4 is considered as no disability, 5-14 as mild, 15-24 as moderate, 25-34 as severe and 35-50 as complete functional disability. The minimum score obtained from the scale is 0 and the maximum score is 50. A score of 50 indicates the highest level of functional disability[12].

The Sit and Reach Test was used to evaluate trunk flexibility. A ruler was placed on a 30 cm fixed wooden block. The individual was asked to reach forward with both hands in a long sitting position with the feet resting on the block and the knees in extension. The edge of the block was taken as 0, the 3rd finger of the right hand was taken as the reference point and the values passing the board were recorded as positive and the values failing to pass were recorded as negative. The test was repeated three times and the mean value was recorded[13]. The treatment programme was carried out by an experienced physiotherapist. The evaluation of outcome measurements and the treatment programme were performed by two physiotherapists. No blinding was used between those who implemented the treatment programme and those who evaluated the outcome measures.

In order to design the study group, the patients were divided into two groups by block randomization according to the order of arrival. Both groups received 20 sessions of treatment for a total of 4 weeks. In addition to therapeutic US, hot pack, and exercise treatment, participants in the IFC group received IFC for 20 minutes and those in the TENS group received TENS for 20 minutes.

In both groups, treatment was started with therapeutic US application. Therapeutic US (Chattanooga, Intelect Mobile, 2012 Taiwan) was calibrated at a frequency of 1 MHz and an intensity of 1.5 Watt/cm² for 5 minutes on the lumbar region (T12 to S1 paravertebral) in both groups. Then, a 30x30 cm hot pack (Çelenmed, 2019) heated in a 70 °C hot water boiler was wrapped in four layers of cotton towel and placed on the lumbar region and applied for 20 minutes. The IFC (Chattanooga, Intelect Combine Physiotherapy, 2012, Taiwan) was applied to the painful area (T12 to S1 paravertebral) with vacuum electrodes for 20 minutes with 4000 Hz (Channel-1) and 4100 Hz (Channel-2) frequency to create ΔF of 100 Hz interferential current in the tissues. The TENS (SPort, X32, 2019, China); 2 channels were applied over the lumbar region (T12 to S1) with 5x5 cm self-adhesive 4 electrodes were placed in a quadripolar arrangement for 20 minutes (pulse width: 50-100 μs and frequency: 60-120 Hz). Current intensity was applied at a strong but comfortable intensity in both groups. Before each session, skin preparation with alcohol was done to lower the skin's resistance to the current transmission.

The same exercise program was applied to both groups: (1) To stretch the lumbar extensor muscles, bilateral hip knee flexion was performed in the supine position with the help of the hands. The stretched position was maintained for 5 seconds. (2) To stretch the hip flexor muscles, one leg was in extension in the supine position, while the other side was maximally

flexed at the hip and knee and held in the stretched position for 5 seconds. (3) To strengthen the lumbar extensor muscles isometrically, the patient was taught to perform isometric contraction with the knees and hips in bilateral flexion, hands in the waist cavity, and the contraction was continued for 5 seconds (If the patient's lordosis was decreased, care was taken not to decrease the lordosis during the exercise). (4) To strengthen the abdominal muscles, the abdominal muscles were exercised isotonically with a half sit-up movement by extending the hands towards the knees in the hook position, and the patient was asked to count to 5 when he/she got up from the floor. (5) To stretch the hamstring muscles, straight leg raises were performed in the supine position with the help of a belt, and the patient was asked to wait 5 seconds at the endpoint. All exercises were performed as 10 repetitions, 1 set. Patients were evaluated before the treatment, after the 10th session, and 20th sessions. Clinical and demographic information was recorded on the evaluation form prepared by the investigators.

The type I error was taken to be α=0.05 and the type II error was taken to be β=0.10, with a confidence interval of 95%, assuming a 95% likelihood of demonstrating a 15% difference in the TENS and IFC groups. To achieve this, the sample size was set at 43 participants. The data were evaluated with the SPSS 15.0 statistical program. The Kolmogorov-Smirnov test was used to evaluate normality of data. The percentage distributions, standard deviation, and arithmetic mean were used to evaluate the demographic characteristics of the subjects. The Freidman's test was used for the comparison of within-group changes. "Mann-Whitney U" test was used for intergroup comparisons. p<0.05 was considered significant.

RESULTS

A total of 50 patients with CLBP were included in the study. Six patients did not continue the treatment programme and the study was completed with 44 patients. In the IFC group, there were 20 females (86.9%) and 3 males, while in the TENS group, there were 17 females (80.9%) and 4 males. There is no significant difference between the gender distribution in both groups (p=0.587). No significant difference was found between the mean age, height, weight, and body mass index values of the participants in the groups (p>0.005) (Table 1).

At the beginning of the study, there was no significant difference between the two groups except for activity pain scores (p=0.002), resting and nocturnal pain, Oswestry scores indicating functionality and mean scores of sit and reach test evaluating trunk flexibility (Table 2).

Between the 10th and 20th session, the reduction in rest, activity and night pain scores was higher in the TENS group than in the IFC group (p=0.004, p=0.002, p=0.006). The reduction in mean activity pain scores in the first 10 sessions was higher in the IFC group (p=0.014). In addition, the mean baseline activity pain levels of the patients in the IFC group were higher than the participants in the TENS group (Table 3, Figure 1). Evaluation of the changes obtained in the mean Oswestry scores showed that the IFC group was superior in terms of the changes that occurred in the first 10 sessions compared to baseline (Table 3). The TENS group was superior in the mean changes in Oswestry scores between the 10th and 20th sessions. The IFC group was superior in terms of both 10th and 20th session changes and baseline and 20th session changes when the amount of change obtained in the mean scores of the sit-reach test was compared.

Table 1. Demographic characteristics of the patients

	IFC Group n=23 Mean ± SD Min.-max	TENS Group n=21 Mean ± SD Min.-max	p-value
Age (years)	54.78±12.27 33-79	53.23±12.08 36-79	0.672
Weight (kg)	79.08±10.45 60-100	79.8±10.74 61-100	0.750
Height (cm)	163.47±6.90 155-180	163.14±9.21 148-187	0.804
BMI (kg/m^2)	29.70±4.56 23.44-41.62	30.03±3.89 25.39-38.29	0.690

IFC: Interferential currents, TENS: Transcutaneous Electrical Nerve Stimulation, SD: Standard deviation, Min.-max: Minumum-maximum, BMI: Body mass index

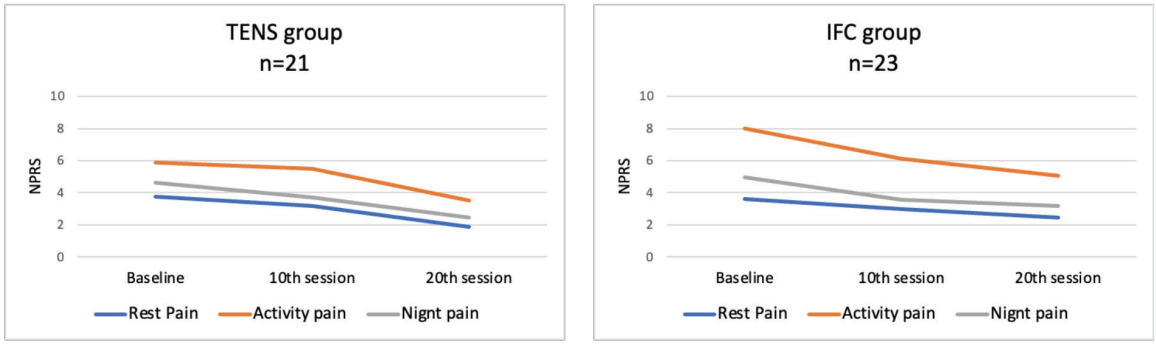

Figure 1. Change of pain scores in the groups

NPRS: Numeric Pain Rating Score, TENS: Transcutaneous Electrical Nerve Stimulation, IFC: Interferential currents

DISCUSSION

The results of this study showed that combined physiotherapy and rehabilitation approaches including IFC and TENS applications in the treatment of patients with chronic mechanical low back pain have similar effects in reducing pain scores and improving functionality at the end of treatment. After a 20-session treatment program, more improvement was obtained in the flexibility scores in the IFC group than in the TENS group.

Chronic mechanical back pain has significant functional and financial implications. Effective treatment is necessary for this pain syndrome, which affects a sizable portion of the population[1,14,15]. Pain has been identified as an important area to be evaluated in low back pain[2,16,17]. In individuals with low back pain, pain assessment is performed based on verbal expressions. These subjective data expressed by patients are transformed into objective data with the help of scales and instruments to provide feedback to patients and to provide measurements for clinicians. The NPS is a valid method widely used in the assessment of pain severity in low back pain. Dias et al.[17] evaluated the pain intensity of patients with low back pain immediately after 30 minutes of IFC application at 4 different frequencies and TENS application at 2 different frequencies by NPS and reported that IFC and TENS currents had similar effects in reducing pain[18]. The researchers also reported that both types of currents had a superior effect compared to the placebo treatment[18]. Facci et al.[18] applied 20 Hz, 330 msec TENS, and 2 Hz IFC for 30 min for 10 sessions after patient education in patients with low back pain. The researchers reported that the pain intensity of both currents decreased significantly in patients with both current types and that TENS and IFC currents

Table 2. Pain, disability and flexibility characteristics of patients at baseline: comparison between 10th and 20th session conclusion

Assessment Parameters			IFC group n=23 Mean ± SD Min.-max	TENS group n=21 Mean ± SD Min.-max	p-value
Numeric pain scale	Rest pain score	Baseline	3.60±2.67 (0-10)	3.76±1.99 (1-8)	0.686
		10th session	3.00±2.02 0-7	3.19±2.01 (0-8)	0.840
		20th session	2.47±1.97 0-6	1.85±1.62 (0-6)	0.312
	Activity pain score	Baseline	8±1.90 (5-10)	5.9±1.90 (3-10)	**0.002**
		10th session	6.13±1.93 (3-10)	5.47±1.93 (3-10)	0.207
		20th session	5.04±2.09 (1-8)	3.52±1.80 (1-8)	**0.012**
	Night pain score	Baseline	4.95±3.29 (0-10)	4.61±2.29 (3-7)	0.603
		10th session	3.56±2.87 (0-9)	3.71±2.47 (0-10)	0.822
		20th session	3.17±2.96 (0-9)	2.47±1.99 (0-7)	0.635
Oswestry Disability Score (%)		Baseline	47.04±15.65 (16-72)	48.47±11.07 (24-68)	0.962
		10th session	35.82±15.75 (8-66)	47.52±14.44 (24-72)	**0.024**
		20th session	30.60±33.17 (2-60)	33.14±11.92 (16-52)	0.416
Sit & Reach Test (cm)		Baseline	-(-0.26)±8.20 [(-17)-16]	1.16±6.21 [(-15)-13]	0.604
		10th session	0.97±8.23 (-25)-15	1.61±6.46 (-15)-14	0.934
		20th session	2.93±7.55 (-20)-15	1.90±6.65 (-15)-15	0.294

Bold value denote statistical significance at the p<0.05 level, TENS: Transcutaneous Electrical Nerve Stimulation, IFC: Interferential currents, Min.-max: Minumum-maximum

Table 3. Comparison of changes in pain, functionality and flexibility at baseline, 10th and 20th session between groups

			IFC group n=23 Mean ± SD min.-max.	TENS group n=21 Mean ± SD min.-max.	p-value
Numeric Pain Scale	**Rest Pain Score**	**C1**	-0.60±1.85 (-6)-2	-0.57±0.92 (-2)-1	0.660
		C2	1.13±1.93 (-5)-2	-1.33±0.85 (-3)-0	0.051
		C3	-0.52±1.20 (-4)-2	-1.90±1.04 (-4)-0	**0.004**
	Activity Pain Score	**C1**	-1.86±1.79 (-6)-0	-0.47±1.16 (-2)-2	**0.014**
		C2	-2.95±1.42 (-6)-0	-2.42±0.81 (-4)-(-1)	0.195
		C3	-1.08±1.08 (-4)-0	-1.95±0.86 (-4)-(-1)	**0.002**
	Night Pain Score	**C1**	-1.39±2.46 (-9)-1	-0.90±2.04 (-4)-7	0.318
		C2	-1.78±2.59 (-10)-1	-2.14±1.82 (-5)-4	0.121
		C3	-0.39±1.07 (-3)-2	-1.23±0.83 (-3)-0	**0.006**
Oswestry Disability Score (%)		**C1**	-11.21±8.54 (-32)-2	-0.95±7.76 (-16)-18	**0.000**
		C2	-16.43±10.01 (-38)-2	-15.33±8.51 (-36)-6	0.494
		C3	-5.21±8.77 (-26)-8	-14.38±8.63 (-34)-0	**0.001**
Sit & Reach Test (cm)		**C1**	1.23±3.63 (-8)-8	0.45±0.66 (-1)-2	0.259
		C2	3.19±4.37 (-3)-13.5	0.73±0.88 (-1)-2	**0.026**
		C3	1.95±1.78 (0-6.5)	0.28±0.64 (-1)-2	**0.000**

Bold value denote statistical significance at the p<0.05 level, C1: Mean change from baseline to week 10, C2: Mean change from baseline to week 20, C3: Mean change from baseline to week 10 to session 20, TENS: Transcutaneous Electrical Nerve Stimulation, IFC: Interferential currents, Min.-max: Minumum-maximum

were similar in reducing pain[19]. They also reported that both current applications were superior in pain reduction compared to the control group[19]. Grabiańska et al.[19] reported that pain intensity decreased significantly in patients with low back pain after two weeks of IFC and TENS treatment and this change was similar in the two treatment groups[20]. Rajfur et al.[20] divided patients with low back pain into 6 groups as conventional TENS (100 Hz, 100 µs), acupuncture-like TENS (200 Hz, 10 µs), IFC (50-100 Hz, 100 µs). Diadynamic current, high-voltage electrical stimulation and control group and applied electrotherapy for 15 sessions in addition to exercise therapy[21]. Unlike other researchers, Rajfur et al.[20] reported that the reduction in pain intensity at the end of 15 sessions was greater in the IFC group and provided superior effect compared to two different TENS applications. The researchers attributed this effect to the fact that IFC application is a medium frequency current and acts on deeper tissues[21].

In this study, similar to the studies of Dias et al.[17], Facci et al.[18] and Grabiańska et al.[19], were determined that IFC and TENS applications had similar effects in terms of pain intensity reduction values after a 20-session treatment program.

Functional/disability measures, pain severity measures, and measures for how pain affects social life and general mental health are all used to assess low back pain (LBP). Physicians and patients use both generic and condition-specific measures as functional measures for LBP management[21]. The Oswestry Disability Index is one of the most widely used scales for the assessment of symptoms and functionality of patients with chronic low back pain[14]. In their study, Rajfur et al.[20] found that interferential current application resulted in more improvement

in Oswestry-assessed functioning than TENS current as a result of 15 sessions of different electrotherapy applications. In their study, Facci et al.[18] questioned the disability of the patients with the Rolland-Morris Disability Questionnaire[19]. The researchers reported that disability improved at a similar level in the TENS and IFC groups, but did not change in the control group[19]. In this study, there was a significant improvement in Oswestry scores in both IFC and TENS groups after the treatment program, but it was determined that the two groups showed similar changes before and after treatment.

Low back pain is frequently linked to the spine's reduced flexibility[22,23]. In this study, sit-reach test was used to evaluate spinal flexibility. Rajfur et al.[20] evaluated spinal flexibility with the Schober test in their study. The researchers reported that IFC and TENS currents applied in addition to a 15-session exercise program had a similar effect on improving flexibility. In the present study, flexibility improved in both groups after the treatment program, but the increase in flexibility in the IFC group was found to be superior to the TENS group.

In a recent study, it was determined that patients with low back pain wanted to know the problems that caused the pain, a decrease in pain, and an increase in the ability to perform activities of daily living, respectively[24]. According to the results of this study, IFC and TENS currents applied in addition to the basic exercise program in patients with chronic mechanical low back pain significantly reduced the pain at night, rest, and activity and improved disability levels of the patients.

Study Limitations

It is noteworthy that our study has some limitations, such as the absence of a control group and the fact that the electrical current intensity applied to the participants for each session was not recorded. Another limitation of the study is that although pain parameters such as rest, activity, and night pain were examined in detail, the participants were not questioned about how much they were exposed to functional activities that stimulate pain. Future studies with larger sample sizes are needed to examine the effects of different biophysical properties of these electrotherapy methods.

CONCLUSION

It has been determined that two different electrotherapy modalities, which are applied for analgesic and pain modulation in addition to exercise therapy in patients with chronic low back pain and which are most frequently preferred for this purpose in the clinic, are not different from each other. Our results support the results of the studies in the literature which aimed to evaluate shorter-term and immediate effects.

Ethics

Ethics Committee Approval: This prospective clinical interventional study was approved by Marmara University Clinical Research Ethics Review Board with approval number: 879, approval date: 07.12.2018.

Informed Consent: Written informed consent was obtained from all participants.

Authorship Contributions

Surgical and Medical Practices: T.K.Ç., Concept: T.K.Ç., N.S., Design: T.K.Ç., N.S., Data Collection or Processing: N.S., B.S., A.A., Analysis or Interpretation: T.K.Ç., B.S., A.A., Literature Search: T.K.Ç., N.S., B.S., A.A., Writing: T.K.Ç., N.S., B.S., A.A.

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