

# The effects of TENS and IFC on people with chronic Low Back Pain

Evgenia Trevlaki, Savvina Theologou, Emmanouil Trevlakis, Alexandra Xristara-Papadopoulou  
Department of Physical Therapy, International Hellenic University, Sindos, Greece.

## Abstract

**Background:** The purpose of this review was to compare the effect of electrotherapy and specifically the effectiveness of IFC and TENS in pain management and functionality in patients with CLBP.

**Methods:** The results are presented as per the PRISMA reporting guideline. A search on Google Scholar, PubMed, PEDro, Science Direct and Cochrane Library was conducted for clinical trials designed to compare TENS and IFC at patients with CLBP in Greek and English language, with no limitation about the publication date.

**Results:** Six studies (n=6) were used that compared the effectiveness of TENS and IFC. A total of 704 patients were included in this review.

**Conclusion:** This review demonstrates that both ICF and TENS presents the same level of improvement on pain intensity and functionality of individuals with CLBP. The combination of the two currents was a more effective method than the use of the currents individually. ICF at 4 KHz frequency and 100 Hz pulse rate frequency showed a bigger impact on the immediate analgesia of individuals with CLBP.

**Keywords—***IFC; TENS; CLBP; Electrotherapy.*

## I. INTRODUCTION

Electrotherapy or electrical stimulation (ES) interventions are noninvasive treatments accounting for physical therapy (PT) interventions with electric currents. ES is commonly used in clinical interventions for pain relief and neuromuscular applications [1]. Currently, transcutaneous electrical nerve stimulation (TENS) and interferential therapy (IFT) are widely used in the analgesic area [2-3].

TENS therapy involves placing electrodes on the skin to stimulate peripheral sensory nerves, at an appropriate intensity, in the hope of alleviating pain via descending modulatory pathways [4-7]. Compared to TENS, IFT provides noninvasive medium-frequency ES, which has lower impedance in human soft tissue with minimal side effects [8]. IFC is an analgesic current that is widely used in clinical practice which results from the combination of currents from two different sources of electricity and offers analgesia [9]. The mechanism for pain relief is similar to the concept underlying TENS [10]. There are two primary

mechanisms underlying the effect of pain relief associated [11]. The gate control pain theory is most commonly cited as an explanation for the analgesic effect of IFC, even though the exact mechanism is not yet fully understood [12]. This theory proposes that the transmission of pain stimuli carried by small-diameter fibers (C and A $\delta$ ) is prevented by the activation of local inhibitory circuits of the dorsal spinal cord due to stimulation of large-diameter fibers (A $\beta$ ) [13]. The second is the endogenous opioid system, which occurs at the spinal cord level and in peripheral sensory neurons [14].

Electrotherapy, along with other physiotherapy practices such as massage, manual therapy mobilization and therapeutic exercise, especially when combined, prove beneficial for the patient [15]. The purpose of this review was to compare the effect of electrotherapy and specifically the effectiveness of IFC and TENS in pain management and functionality in patients with CLBP.

## II. METHODS

**Data design and strategy:** The results are presented as per the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) reporting guideline (supporting checklist/diagram) [16]. A search on Google Scholar, PubMed, PEDro, Science Direct and Cochrane Library was conducted, combing key words of the main parts of the topic like chronic low back pain or CLBP, pain relief, electrotherapy, transcutaneous electrical nerve stimulation or TENS and interferential current or IFC. Finally, six studies (n=6) were used that compared the effectiveness of TENS and IFC. A total of 704 patients were included in this review.

**Inclusion Criteria:** The review included only clinical trials designed to compare TENS and IFC at patients with CLBP in Greek and English language, with no limitation about the publication date.

**Study selection:** Eligibility screening of the studies was conducted in a blinded standardized way by two independent reviewers (Ev.T. and S.T.). Titles and abstracts were screened using and duplicate articles were excluded. After screening titles and abstracts, full paper copies were retrieved. Full text screening was also performed blinded by the same reviewers (Ev.T. and S.T.). Disagreements between authors during any stage of the screening process were resolved by consulting a third reviewer (Em.T.).

### III. RESULTS

Tekgül study (2013) [17] aimed to specify and compare the effectiveness of TENS, IFC and placebo treatment for the handling of chronic mechanical pain in the low back area. In this study, 93 patients were included, aging between 40 and 65 years, who had been diagnosed with chronic mechanical LBP. The participants were randomly divided into 3 groups and each group received 10 sessions of physiotherapy for 2 weeks with one of the three treatment methods, one group received TENS, one IFC and one placebo treatment. More specifically, the 1st group (n=32) received 40 Hz frequency TENS treatment and pulse duration 100  $\mu$ s for 20 minutes, the 2nd group (n=30) received placebo electrotherapy for 20 minutes and the 3rd group (n=31) went through IFC treatment with 4 Hz sector frequency, 40 Hz stimulation frequency and 40 Hz pulse rate frequency for 20 minutes. Before, after and one week after the treatment, the patients were examined by the same curer in terms of pain on the VAS scale, in terms of the stability of the joint in the low back area with the measuring of the distance using the "hand-foot-toe" method, in terms of disability and functionality with the Pain Disability Index and the Modified Oswestry questionnaires respectively. The results showed that all 3 groups showed significant improvements regarding the measurements of the VAS scale after the treatment, while the VAS relaxation scores of the TENS group were significantly greater than the placebo group. The VAS every-day scores of the IFC group presented greater improvement than the placebo group. However, there were not statistically significant differences between the TENS and the IFC group. Moreover, the evaluation of the Oswestry questionnaire, as well as of the disability indicators of the placebo group showed improvement only the monitoring day, while the TENS and IFC groups indicated improvement not only after the treatment but also after the monitoring day. Both types of treatment showed better upturn in relation to the placebo group. Considering that TENS and IFC treatments were effective for the pain relief and for the enhancement of the functionality of the patients with chronic mechanical LBP, they could be used as an effective treatment.

Adnan et al.'s (2020) [18] study compared the effectiveness of TENS and the IFC at patients with non-specific CLBP. Regarding the sample of the study, it consisted of 30 patients (20 men, 10 women) aging between 18 and 60 years, who had been diagnosed with CLBP for more than 3 months' time and were randomly divided into 2 groups. The 1st group received TENS treatment (20 minutes) of 20 Hz frequency, pulse duration of 200 ms in combination with warm patches for 10 minutes, while the 2nd group received IFC treatment (20 minutes) of 4000 Hz frequency, pulse rate frequency of 20 Hz in combination with warm patches for 10 minutes as well. All the patients were evaluated before and after TENS and IFC treatments respectively, by the VAS scale of pain (scores 0 to 10) and by the ODI disability

indicator. It is worth noted that the pain average before the treatment was 6,47 for the first group and 5,60 for the second group, with the minimum pain score of 4 and the maximum pain score of 8 on the VAS. Both treatment methods, TENS and IFC, presented statistically significant decrease of pain and disability volume regarding individuals with CLBP.

In Facci et al.'s (2011) [19] study the TENS and IFC treatments in terms of effectiveness were compared among patients with non-specific CLBP. A total of 150 patients who were randomly divided into 3 groups participated in the controlled test. The 1st group underwent TENS treatment, the 2nd group IFC treatment and the 3rd group was the monitoring group. The patients at the 1st and 2nd group received 10 sessions of 30 minutes' each, while the monitoring group did not go through any treatment. All patients regardless of group were evaluated before and after the treatment on the VAS scale, with the McGill and Roland-Morris questionnaires. The results showed average reduction by 39,18 mm on the VAS scale with the use of TENS, by 44,86 mm with the use of IFC and by 8,53 for the 3rd group that did not receive any treatment. The Roland-Morris questionnaire showed an average reduction by 6,59 for the 1st group, 7,20 for the 2nd group and 0,70 for the 3rd group. Regarding the use of medication, 84% of the 1st group's patients stopped using medication after the treatment, 75% of the 2nd group's patients, and only 3,45% of the 3rd group's patients. There was not any difference between the groups that used TENS or IFC treatment for the handling of CLBP.

Dias et al. (2021) [20] compared the immediate pain-relieving effect of TENS and IFC with the use of different frequencies for the individuals' with CLBP treatment. A total of 280 individuals over 18 years old, with non-specific CLBP for more than 12 weeks and with NRS bigger than 3, participated. These individuals were randomly divided into 8 groups of 35 people in each one. So, the 1st group received 2 KHz/ 100 Hz IFC treatment, the 2nd group received 2 KHz/ 2 Hz IFC treatment, the 3rd group received 4 KHz/ 100 Hz IFC treatment, the 4th group received 4 KHz/ 2 Hz IFC treatment, the 5th group received placebo IFC treatment, the 6th group received 100 Hz frequency TENS treatment, the 7th group received 2 Hz TENS treatment and the 8th group received placebo TENS treatment. The individuals underwent only one TENS or IFC application for 30 minutes and the evaluations were done before and right after the intervention in 4 parts of the low back area, with the NRS scale for pain evaluation in order for pain volume evaluation to be accomplished, with the McGill questionnaire for the evaluation of the qualitative pain features and with the algometer for the measuring of pain pressure. Among the groups with the NRS, all interventions indicated big pain reduction in contradiction to the group that received placebo TENS. In the total MPQ scores, the groups that indicated significant scores compared to the placebo TENS were the 100 Hz and 2 Hz frequency TENS, while the 100 Hz TENS treatment

group and the 4 KHz/ 100 Hz IFC treatment group showed better results in comparison to the placebo IFC treatment group. Finally, regarding the PPT algometer, the 4 KHz/ 100 Hz IFC treatment group indicated PPT enhancement in every part compared to the placebo TENS group and the 2 KHz/ 100 Hz IFC group. In conclusion, both TENS and IFC interventions indicated immediate relieving action for the handling of CLBP, with special emphasis on the 4 KHz frequency and 100 Hz pulse rate frequency interference currents.

In Kibar et al. (2020) [21] study the effectiveness of TENS and IFC treatment for the relief of CLBP was evaluated. A total of 123 people participated, aging between 18 and 70 years with CLBP for at least 3 weeks. Before the treatment, all patients in written agreement did physical exercise for 20 minutes at least 5 times a week. The individuals were randomly divided into 4 groups, where the 1st group (n=34) received treatment with a combination of TENS methods (continuous 100 Hz TENS and 2 Hz burst mode TENS) for 30 minutes, the 2nd group received IFC treatment (n=33) of 4000-4100 Hz frequency and of 100 Hz pulse rate frequency for 30 minutes, the 3rd group (n=33) received TENS treatment (30 minutes) and IFC treatment (30 minutes) and the 4th group (n=34) received placebo TENS (30 minutes) and IFC (30 minutes). All groups received thermotherapy for 20 minutes and totally accomplished treatment for 5 times a week and for 3 consecutive weeks. The range of the low back area was evaluated through an inclinometer and through the modified Schober test, the pain while doing activity was evaluated with the VAS scale whereas the RMPQ was administered for the specifying of the functional ability. The results of the readings showed that the 1st, 2nd and 3rd groups showed significant improvement but the 4th group did not show any improvement. The 3rd group's NRS, VAS measures, and total evaluation were better than the 2nd group's. The TENS/ IFC combination was better than the IFC regarding the patients' with CLBP improvement of the functional level and reduction of pain while doing activity, thus it was not better than the treatment using only TENS intervention. The combined treatment was also better than the other treatments concerning the doctors' and patients' assessments, but the differences in comparison with the TENS and IFC groups were not significant. Finally, there was not any improvement regarding the monitoring group.

Dohnert et al.'s (2015) [22] study compared the pain-relieving results of TENS and IFC treatments on patients with CLBP. The specimen was homogenous regarding gender, age, skin color, pain duration and it consisted of 28 patients (>18 years) who were randomly divided into 2 groups. The 1st group (n=14) who was the intervention group received IFC treatment of 4000 Hz frequency and of 20 Hz pulse rate frequency for 30 minutes. The VAS scale, the RMDQ and the ODI were used for the initial evaluation of the patients. In total, the patients underwent 10 sessions in 5 weeks' time and twice a week, because of which, significant improvements regarding pain sensation in both groups, as well as improvements regarding the patients' disability comparing the first and the last evaluation appeared. The researchers highlighted the fact that there were positive results concerning pain relief with the use of both TENS and IFC treatments.

Almeida et al. (2018) [23] conducted a systematic review and meta-analysis that aimed at investigating the effects of TENS and IFC currents on acute and chronic LBP. The studies used TENS and IFC currents as treatment method and the primary outcome was pain that was evaluated with VAS. The secondary outcomes were the WOMAC questionnaire and the RMDQ. A total of 8 studies with the total specimen of 825 patients were included. These studies included variations on their parameters that were used specifically regarding the duration and frequency of the pulse that ranged from 80 until 330 s and from 0,2 until 120 Hz respectively. The most used frequency was the one of 100 Hz, while the IFC frequency was defined at 4000 Hz in 6 studies, while in the remaining 2 it was not mentioned. Taking into account the application duration, the most used length of time was the one of 20 minutes (51,14%), followed by 30 minutes (28,57%) and one isolated study used 60 minutes' time. The volume was generally established by the sense of touch and the lack of visual contraction. In general, TENS treatment, as well as IFC treatment improved pain and functionality without statistically significant differences between them. Hence, the researchers concluded that TENS current and IFC current indicate similar results on pain outcome, however the small number of studies that were used in this meta-analysis showed that new clinical tests are needed.

TABLE I. COLLECTIVE RESULTS OF THE STUDIES THAT WERE USED FOR THE TREATMENT OF CLBP WITH THE USE OF TENS AND IFC TREATMENTS.

Author	Method	Sample	Intervention	Conclusion
Tekgöl et al. 2013	Doctoral dissertation	93	1 <sup>st</sup> group: TENS 2 <sup>nd</sup> group: IFC 3 <sup>rd</sup> group: placebo	Both treatments, TENS and IFC were beneficial for pain relief and enhanced the functionality level of the patients with mechanical CLBP compared to the placebo treatment.
Adnan et al., 2020	RCT	30	1 <sup>st</sup> group: TENS 2 <sup>nd</sup> group: IFC	Both treatment methods, TENS and IFC were effective for the reduction of pain volume and disability of the patients with CLBP.



Facci et al., 2011	RCT	150	1 <sup>st</sup> group: TENS 2 <sup>nd</sup> group: IFC 3 <sup>rd</sup> group: monitoring group	There was not any difference between TENS and IFC when it comes to the treatment of CLBP.
Dias et al., 2021	R-placebo-CT	280	1 <sup>st</sup> group: IFC, 2 KHz/ 100 Hz 2 <sup>nd</sup> group: IFC, 2 KHz/ 2 Hz 3 <sup>rd</sup> group: IFC, 4 KHz/ 100 Hz 4 <sup>th</sup> group: IFC, 4 KHz/ 2 Hz 5 <sup>th</sup> group: placebo IFC 6 <sup>th</sup> group: TENS, 100 Hz 7 <sup>th</sup> group: TENS, 2 Hz 8 <sup>th</sup> group: placebo TENS	Both TENS and IFC showed immediate pain-relieving results on CLBP, and especially the 4 KHz/ 100 Hz IFC.
Kibar et al., 2020	R double blind, sham-CT	123	1 <sup>st</sup> group: TENS 2 <sup>nd</sup> group: IFC 3 <sup>rd</sup> group: TENS + IFC 4 <sup>th</sup> group: placebo TENS + placebo IFC	The TENS/IFC combination was more effective than IFC when it comes to the patients' with CLBP improvement of functionality and pain reduction. The improvement was not significantly bigger than the one accomplished only by using TENS treatment.
Dohnert et al., 2015	RCT	28	1 <sup>st</sup> group: IFC 2 <sup>nd</sup> group: TENS	There were positive results regarding CLBP improvement, both by using TENS and IFC, without significant differences among the transcutaneous currents.

#### IV. DISCUSSION

In this review, six studies (n=6) were included with a total of 704 patients that compared the effectiveness of TENS and IFC. All studies compared the two approaches, while some studies (n=4) included a control no-treatment group.

Regarding the application of TENS and IFC that is stated in 3 studies [17-19], it seems that both treatment methods showed the same effectiveness, as they contribute to pain relief and to the enhancement of the functionality level. The findings of one study [20] constitute an important indication of the effectiveness of the IFC current, concluding that 4 KHz frequency and 100 Hz pulse rate frequency had a big impact on the immediate analgesia of individuals with CLBP. In addition, a study [21] showed that the combination of the two currents was a more effective method than the use of the currents individually. Finally, the findings of another study [22] showed that both the use of TENS and IFC current was beneficial for pain relief, while they also improve the individual's functionality however, more studies need to be conducted in order for which method is more effective to be determined.

The results of this study come with agreement with the previous literature. According to Almeida et al. review [23] TENS treatment, as well as IFC treatment improved pain and functionality without statistically significant differences between them. Hence, the researchers concluded that TENS current and IFC current indicate similar results on pain outcome. The application of TENS and mainly the bTENS has presented to contribute short-term to pain adjustment and to the limitation of painkiller consumption when it comes to patients with CLBP. There was contradictory evidence that showed that TENS currents when used as an isolated treatment cannot be supported. [24]. At Savvina et al. review [25] IFC showed a positive effect

on reducing pain and improving the functioning of patients with CLBP. This approach presents to be a sufficient intervention method combined or not with other therapies.

#### V. CONCLUSION

This review demonstrates that both ICF and TENS presents the same level of improvement on pain intensity and functionality of individuals with CLBP. The combination of the two currents was a more effective method than the use of the currents

individually. A 4 KHz frequency and 100 Hz pulse rate frequency of ICF showed a bigger impact on the immediate analgesia of individuals with CLBP. Further research is needed to define the proper dose, frequency and combination of these two electrotherapy approaches in order to provide clear guidelines for clinicians.

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