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Interferential Current Electrotherapy is More Effective Thanthan TENS VIF in Cancer Pain Management

Corrente Interferencial é Mais Efetiva para Alívio da Dor Oncológica que a TENS VIF

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Abstract

Cancer diagnosis is increasing rapidly worldwide and pain is a common feature reported by cancer patients. Therapeutical approach on cancer pain is complex where less invasive methods with little side effects have been sought. The aim of this study was to compare transcutaneous electrical nerve stimulation (TENS) and interferential current (IC) therapies effects on cancer pain. Double blind study with 81 cancer pain patients. Subjects were set up into two groups: one treated with TENS VIF (n=42) and other with IC (n=39). Age, gender, duration of pain, tumor site and histology, medications, treatments, Karnofsky score and clinical state were evaluated. Pain was measured by EMADOR and McGill scores. Electroanalgesia was performed for 30 minutes, the equipments used were Neurodyn III Ibramed® and Neurovector generation 2000 Ibramed®. Electrodes were placed where there was higher intensity of pain according to what was shown by the patient through EMADOR, and each one got only one electrotherapy session. Pain intensity was significantly reduced in both groups ($p<0.001$) soon after and until 6th hour post electrotherapy. IC group had better results at 4th, 5th ($p<0.001$) and 6th hour ($p=0.022$). McGill score in TENS VIF group was significant until 4th hour and in the IC group was highly significant in all evaluated times ($p<0.001$). Analgesic effect of TENS VIF and IC electrotherapy was clinically effective, however, IC did cause better results regarding analgesia duration.

Keywords: Cancer Pain. Analgesia. Physical Therapy Modalities. Transcutaneous Electric Nerve Stimulation.

Resumo

O diagnóstico de câncer está aumentando rapidamente em todo o mundo e a dor é uma característica comum relatada por pacientes com câncer. A abordagem terapêutica da dor oncológica é complexa onde métodos menos invasivos e com poucos efeitos colaterais têm sido buscados. O objetivo deste estudo foi comparar os efeitos das terapias de estimulação elétrica nervosa transcutânea (TENS) e corrente interferencial (IC) na dor oncológica. Estudo duplo-cego com 81 pacientes com dor oncológica. Os indivíduos foram divididos em dois grupos: um tratado com TENS VIF (n=42) e outro com IC (n=39). Idade, sexo, duração da dor, local do tumor e histologia, medicamentos, tratamentos, pontuação de Karnofsky e estado clínico foram avaliados. A dor foi mensurada pelos escores EMADOR e McGill. A eletroanalgesia foi realizada por 30 minutos, os equipamentos utilizados foram Neurodyn III Ibramed® e Neurovector geração 2000 Ibramed®. Os eletrodos foram colocados onde havia maior intensidade de dor de acordo com o apresentado pelo paciente através da EMADOR. A intensidade da dor foi significativamente reduzida em ambos os grupos ($p<0,001$) logo após e até a 6ª hora pós-eletroterapia. O grupo CI teve melhores resultados na 4ª, 5ª ($p<0,001$) e 6ª hora ($p=0,022$). O escore de McGill no grupo TENS VIF foi significativo até a 4ª hora e no grupo IC foi altamente significativo em todos os tempos avaliados ($p<0,001$). O efeito analgésico da TENS VIF e da eletroterapia com IC foi clinicamente eficaz, porém a IC trouxe melhores resultados quanto à duração da analgesia.

Palavras-chave: *Dor do Câncer. Analgesia. Modalidades de Fisioterapia. Estimulação Elétrica Nervosa Transcutânea.*

1 Introduction

Cancer diagnosis is increasing rapidly worldwide[1] and pain is a common feature reported by cancer patients[2] usually of high intensity frequently causing disability[3] as it leads to less strength, mobility and vitality affecting the patient at physical, psychological, social and financial level[4,5]. Therapeutical approach on cancer pain is complex where less invasive methods with little side effects have been sought[5].

Many resources are available[1,5,6] and among them electrotherapy is a non-invasive approach used by physical therapists aiming to promote analgesia. Transcutaneous electrical nerve stimulation (TENS) and interferential current (IC) are therapies used to treat acute and chronic cancer pain[3]. TENS main active element is low-frequency pulsed currents (1-200Hz)[7] used usually in burst or intensity and frequency variation (VIF) modes[8] which leads to a release of endogenous opyoids[9]. Otherwise, IC is composed by two medium-frequency alternating current (1-10kHz) where one of which is amplitude modulated to generate a low frequency interference current (0-250Hz)[10,11]. The interference current generated is associated to lower skin resistance, deeper penetration and diminish undesirable cutaneous stimuli[3,7,12].

Both currents analgesic effects have been suggested to affect the gate theory, endorphins and encephalins release, or physiological blockade[8,9] as well as ideal modulation ranges to treat different types of disorders are also not well known[13,14].

The aim of this study is to compare transcutaneous electrical nerve stimulation (TENS) and interferential current (IC) therapies effects on cancer pain.

2 Material and Methods

2.1 Study design

This is a double-blind study approved by local ethic committee of Erasto Gaertner Hospital registered by the number 168.016. During one year, 81 patients, male and female with cancer pain were enrolled, all of them, using analgesic opioids and non-opioids or anti-inflammatory only if necessary. Patients younger than 18 years who had non-cancer-related pain complaints were excluded from the sample. Sample size was estimated in an amount greater than 20% of the population that had prescription for physical therapy during their hospitalization, and reported pain, since this size is enough to represent the population.

Age, gender, duration of pain, tumor site and histology, medications, treatments, Karnofsky score and clinical state were evaluated. Cancer pain was assessed by McGill questionnaire[15] and multidimensional pain evaluation scale (EMADOR)[16], which consists of a numerical pain scale from 1 to 10 (pain intensity rates) where the higher the numerical value, the greater the pain reported by the patient; descriptors referring to types of pain, whether acute or chronic; and a body illustration to record pain location.

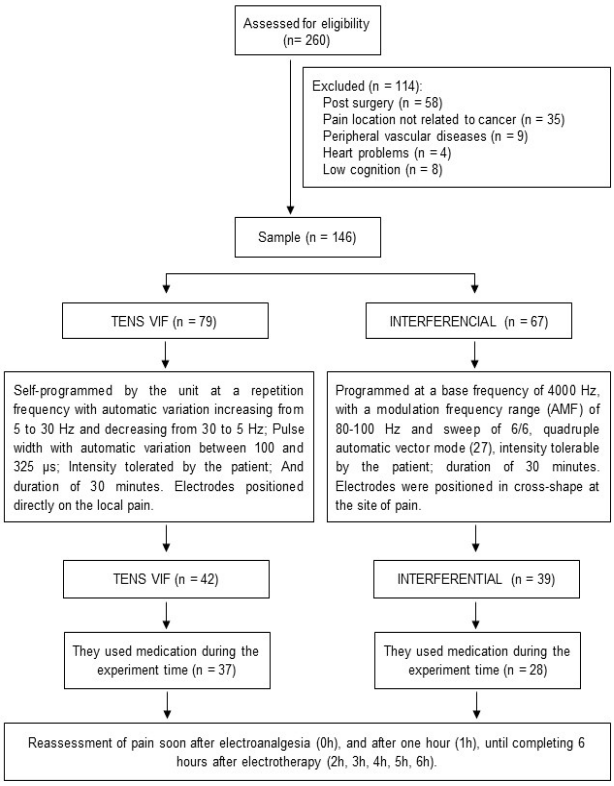
Patients submitted to TENS or IC electrotherapy were chosen randomly. Researcher 1, without knowing which current would be used, was responsible for assessing the patient's pain before and after electrotherapy. The division of patients between groups was made by drawing lots, the patient chose a sealed envelope at the time of application of the current and delivered it to researcher 2, who applied the current without revealing to the patient which it was.

The equipments used were Neurodyn III Ibramed® and Neurovector generation 2000 Ibramed®. Electrodes were placed where there was higher intensity of pain according to what was shown by the patient through EMADOR, and each one got only one electrotherapy session. Figure 1 illustrates the study design.

2.2 Statistical analysis

Data normality was performed by Shapiro-Wilk test (except age). Non-parametric statistical was done by Friedman with Wilcox test post-hoc or Mann-Whitney U test to independent samples. To further study treatment effect of each current differences in pain intensity, rates were calculated at the fourth hour after treatment and the number needed to treat (NNT) to prevent failure of the proposed treatment. Chi-squared test was used to identify association between electrotherapy and cancer pain. Significance level adopted for statistical tests was 5% in a 95% confidence interval.

Figure 1- Study design



Source: Resource data.

3 Results and Discussion

Sample characteristics of each group, such as: sex, age, neoplastic topography, histology, cancer staging, Karnofsky score, type of treatment in course, type of medicine in use and pain sites are shown in Table 1.

Table 1 - Sample characteristics

Group Characteristics	TENS VIF(n=42)	IC (N=39)
Sex		
Female	66.7% (n=28)	48.7% (n=19)
Male	33.3% (n=14)	51.3% (n=20)
Age	54.5±13.77 (26-90) y	57.85 ± 15.35 (22-81) y
Neoplastic topography		
Bone	2.4% (n=1)	5.1% (n=2)
Bone marrow	9.8% (n=4)	-
Breast	-	2.6% (n=1)
Colon	4.7% (n=2)	5.1% (n=2)
Endometrial	4.7% (n=2)	15.4% (n=6)
Esophagus	2.4% (n=1)	2.6% (n=1)
Liver	24.4% (n=10)	10.3% (n=4)
Lung	2.4% (n=1)	-
Lymphoma	2.4% (n=1)	7.6% (n=3)
Mediastin	4.7% (n=2)	7.6% (n=3)
Ovary	2.4% (n=1)	10.3% (n=4)
Pancreas	2.4% (n=1)	-
Prostate	2.4% (n=1)	-
Rectum	4.7% (n=2)	-

Group Characteristics	TENS VIF(n=42)	IC (N=39)
Sigmoid	4.7% (n=2)	2.6% (n=1)
Skin	2.4% (n=1)	-
Soft tissue	4.7% (n=2)	2.6% (n=1)
Spleen	11.9% (n=5)	23.1% (n=9)
Stomach	4.7% (n=2)	5.1% (n=2)
Testicles	2.4% (n=1)	-
Histology		
Adenocarcinoma	24.4% (n=10)	54.1% (n=20)
B cells lymphoma	2.4% (n=1)	-
Carcinoma	5.12% (n=21)	38.5% (n=15)
Hodgkin lymphoma	-	2.6% (n=1)
Melanoma	7.3% (n=3)	2.6% (n=1)
Myeloma	2.4% (n=1)	-
Sarcoma	9.8% (n=4)	-
T cells lymphoma	2.4% (n=1)	-
Not described	2.4% (n=1)	5.1% (n=2)
Cancer staging		
I	4.7% (n=2)	2.6% (n=1)
II	9.5% (n=4)	15.4% (n=6)
III	16.7% (n=7)	17.9% (n=7)
IV	40.5% (n=17)	43.6% (n=17)
Recurrence	2.4% (n=1)	20.5% (n=8)
Under evaluation	28.6% (n=13)	-
Karnofsky score		
50%	4.7% (n=2)	17.9% (n=7)
60%	16.7% (n=7)	10.2% (n=4)
70%	40.5% (n=17)	38.5% (n=15)
80%	16.7% (n=6)	15.4% (n=6)
90%	16.7% (n=6)	12.8% (n=5)
100%	9.5% (n=4)	5.1% (n=2)
Type of treatment in course		
Chemotherapy	33.0% (n=14)	41.0% (n=16)
Radiotherapy	35.7% (n=15)	17.9% (n=7)
Chemo and radiotherapy	7.1% (n=3)	15.4% (n=6)
No treatment at all	23% (n=10)	25.6% (n=10)
Type of medicine in use		
Analgesic non opioid	50.0% (n=21)	41.0% (n=17)
Analgesic opioid only	2.4% (n=1)	7.7% (n=3)
Analgesic non opioid plus opioid	45.2% (n=19)	46.1% (n=18)
Analgesic opioid plus anti inflammatory	2.4% (n=1)	2.6% (n=1)
Pain sites		
Abdomen and lumbar	47.6% (n=20)	64.1% (n=25)
Head and neck	-	2.6% (n=1)
Lower limbs	9.5% (n=4)	-
Torax	40.0% (n=17)	33.3% (n=13)
Upper limbs	2.4% (n=1)	-

TENS – Transcutaneous electrical nerve stimulation. VIF – intensity and frequency variation. IC – interferential current. y – years.
Source: resource data.

There was no statistical significance in age (p>0.05), cancer staging (p=0.462) and Karnofsky score (p=0.334) between the groups. The length of time in which the patients from TENS VIF group were sensing pain ranged from 3 days to 3 years. In IC group, ranged from 1 day to 3 years (p=0.377 vs. TENS). In pre electroanalgesia moment, there was no statistical difference among the groups regarding pain (Table 2) and most of the patients reported pain as severe (76.2% TENS and 79.5% IC, p=0.23).

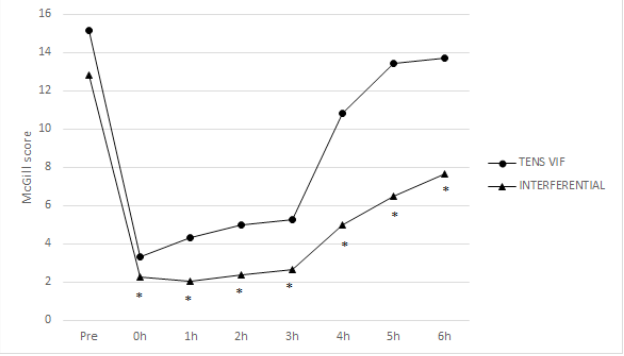
Table 2 - Pain intensity and McGill score before and after electrotherapy

	TENS VIF				Interferential			
	Intensity		McGill		Intensity		McGill	
Pre	8 (6.75 - 10)		14.5 (10 – 18.25)		9 (7 - 10)		12 (9 -17)	
0h	2 (2 - 4)	*<0.001*	3 (1 - 5)	*<0.001*	2 (1 - 4)	*<0.001*	1 (1 - 3)	*<0.001*
1h	2.5 (2 – 4.25)	*<0.001*	3.5 (1 - 6)	*<0.001*	2 (1 - 4)	*<0.001*	1 (0 - 3)	*<0.001*
2h	3 (2 - 5)	*<0.001*	3.5 (1 - 7)	*<0.001*	3 (1 - 4)	*<0.001*	1 (0 - 3)	*<0.001*
3h	3 (2 - 5)	*<0.001*	4 (1 - 7)	*<0.001*	3 (2 - 5)	*<0.001*	1 (1 - 3)	*<0.001*
4h	6 (4.75 – 7.25)	*<0.001*	11 (5 - 15)	<0.002	4 (2 - 6)	*<0.001*	1 (1 - 7)	*<0.001*
5h	7 (5 - 8)	*<0.001*	13,5 (8 - 17)	<0.077	5 (3 - 7)	*<0.001*	5 (1 - 12)	*<0.001*
6h	8 (5 - 9)	*<0.001*	14 (8 - 17)	<0.155	6 (5 - 8)	*<0.001*	7 (1 - 15)	*<0.001*

Data presented as median and first and third quartiles.
Source: resource data.

Before electrotherapy, both, pain intensity and McGill scores were elevated. Following TENS VIF or IC electrotherapy both parameters were reduced significantly except in TENS VIF group for McGill score at the 5th and 6th hour, which did return to initial values (p>0.05). McGill score comparison between TENS VIF and IC group (Figure 2) showed a statistical difference starting at first hour post electrotherapy (p<0.001).

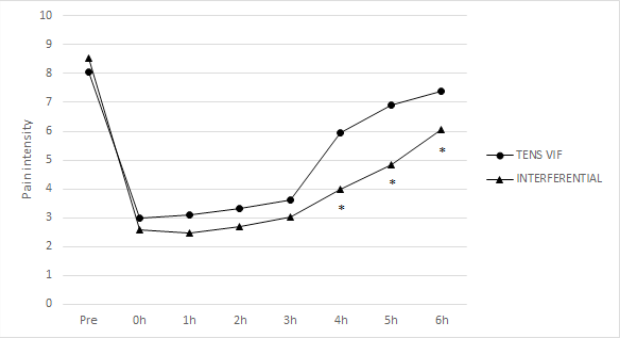
Figure 2 - McGill score from TENS VIF and IC group evaluated pre and until 6 hours after electrotherapy. * p<0.001 *vs.* TENS VIF



Source: resource data.

Remarkable reduction regarding pain intensity post electrotherapy is shown in Figure 3. In both groups the reduction was kept until 3 hours post procedure and then the effect starts to fade away, however IC electrotheraphy was more effective than TENS VIF (p<0.001).

Figure 3 - Pain intensity from TENS VIF and IC group evaluated pre and until 6 hours after electrotherapy. * p<0.001 *vs.* TENS VIF



Source: resource data.

Number needed to treat (NNT) was calculated based on pain symptoms in the 4th hour, resulting in a NNT of 6 in TENS VIF group, and 3 in IC group. Pain score in the last evaluation and its association with electrotherapeutic resources is reported in the Table 3, with no statistical significance (p=0.056).

Table 3 - Pain score in TENS VIF and IC group at the 6th hour post electroanalgesia.

	TENS VIF	Interferential	*p*
Mild	1 (2.38%)	7 (17.94%)	0.056
Moderate	14 (33.33%)	12 (30.77%)	
Severe	27 (64.29%)	20 (51.28%)	

Source: resource data.

TENS efficacy on cancer pain has been shown[9,17] however, as the application goes on, accommodation of excited sensory nerve fibers occurs partially or completely. Electrotherapy provides relief on pain cancer by activation of sensory fibers, which respond initially at high rate frequency, leading to activation of gate mechanisms and endogenous opioid system[3,18]. Progressively, these stimuli gets lower and come to an end[18,19] allowing the return of noxious stimulus. To minimize the effect of stimulus accommodation we used, in this study, TENS VIF mode, which in a previous study showed longer-lasting analgesic action than another mode of TENS on cancer pain[20]. Despite many reports about TENS on relief of cancer pain,[5,9,21] there is no consensus about ideal parameters[22] and their effects are controversial[18,23].

IC also has no ideal parameters consensus[14], moreover, there is no complete understanding about its effect on physiology, however it has been stated that it is able to inhibit the autonomic nervous system[24] leading to vasodilatation. Perhaps this is one of the reasons why IC has been poorly studied. To minimize this effect on circulation, here frequency of 4.000 Hz, AMF 80-100 Hz and sweep 6/6 quadripolar automatic vector mode for 30 minutes, the same used by Noble et al was used .[24] which reported lower vasodilation effect. Another important issue is that IC is not a polarized current, meaning that it cannot transport macromolecules such as malignant cells[12].

This lack of consensus about ideal settings for TENS and IC limits its application, since it can be associated with metastasis acceleration by angiogenesis stimulation[25].

Tumor sites in our study were quite broad, and the same was found in another study that verified the used medication, instead of electrotherapy, for cancer pain treatment in 80 patients[26] Most of patients had carcinoma and cancer staging IV followed by adenocarcinoma and cancer staging III. These features have been reported also by other studies[9,21,27].

Karnofsky score reveals that 70% of patients care for themselves but are unable to carry normal activity or a proper work. This might be related to cancer staging IV and also to analgesics and other medications they were taking[28].

The huge relief of cancer pain soon after the application of electrotherapy corroborates Rajfurn et al study[29] which evaluated TENS and IC on lumbar chronic pain and suggested that both currents were efficient to treat pain but, IC therapy led to remission of symptoms more effectively.

Electrotherapy by TENS and IC were applied in healthy subjects with ischemic-induced pain but did not find statistical significance between both electrotherapies[30]. In McGill score IC therapy did cause analgesia longer than TENS VIF lasting until 6th hour. Despite both currents have VIF, the better results of IC might be due to its current characteristics, which is quadripolar, distinguishing its physical conception with curative properties and resolution, that promotes metabolic effects leading to structural and functional restoration of damaged tissues and perhaps, analgesia is a result of these

repairs[10,19]. Our study has many limitations like difficulty setting the exact site and type of pain and scarcity of reports about TENS and IC therapies on cancer pain to discuss, but the main limitation is the lack of long-term follow-up to verify the clinical outcome of these patients, in order to infer application safety of these currents in cancer patients and their relationship with survival, thus we suggest further studies on this subject.

4 Conclusion

Treatment of oncological pain should have an interdisciplinary, wide-range approach using non-pharmacological and non-invasive methods. Our data demonstrate that electroanalgesia by TENS VIF and IC with the parameters used was clinically effective and reduced cancer pain markedly up to three hours. Better results were found using IC compared to TENS VIF regarding analgesia duration. There are few studies on the subject and also insufficient molecular evidence to recommend or reject the use of these resources on cancer pain treatment.

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