ORIGINAL ARTICLE

The transcutaneous electrical nerve stimulation of variable frequency intensity has a longer-lasting analgesic action than the burst transcutaneous electrical nerve stimulation in cancer pain

Estimulação elétrica nervosa transcutânea de intensidade e frequência variável tem ação analgésica mais duradoura que a estimulação elétrica nervosa transcutânea burst sobre a dor oncológica

Juliana Carvalho Schleder[1], Fernanda Aparecida Verner[2], Loriane Mauda[3], Débora Melo Mazzo[4], Luiz Cláudio Fernandes[5]

DOI 10.5935/1806-0013.20170122

ABSTRACT

BACKGROUND AND OBJECTIVES: Pain is one of the most frequent symptoms in cancer, and physical therapy offers non-invasive methods such as the transcutaneous electrical nerve stimulation for the relief of symptoms. The objective of this study was to compare the effect of the burst transcutaneous electrical nerve stimulation with the transcutaneous electrical nerve stimulation with variable intensity frequency in cancer pain.

METHODS: This study was conducted with 53 patients of the Hospital Erasto Gaertner, divided into two groups: burst transcutaneous electrical nerve stimulation and variable intensity frequency transcutaneous electrical nerve stimulation. Pain assessment was performed before and right after the electroanalgesia, and at every hour until completing 6 hours.

RESULTS: The group treated with burst transcutaneous electrical nerve stimulation maintained complete analgesia for 2 hours, returning to the initial score value within 6 hours of evaluation; the group of variable intensity frequency transcutaneous electrical nerve stimulation maintained complete analgesia for 4 hours, not returning to the initial score value within the 6 hours. When comparing the intensity of the pain between the groups there was a significant difference between them ($p<0.001$) in all the assessments from the third hour after the electroanalgesia, showing a significant difference ($p<0.001$) at the 3rd and 4th hour after the electroanalgesia. There was no difference at the 5th hour and at the 6th hour.

CONCLUSION: The variable intensity frequency transcutaneous electrical nerve stimulation provided a longer-lasting analgesia in cancer pain than the burst transcutaneous electrical nerve stimulation.

Keywords: Analgesia, Cancer, Pain, Physiotherapy modalities, Transcutaneous electrical nerve stimulation.

RESUMO

JUSTIFICATIVA E OBJETIVOS: Dor é um dos sintomas mais frequentes no câncer, e a fisioterapia dispõe de métodos não invasivos como a estimulação elétrica nervosa transcutânea para propiciar alívio do sintoma. O objetivo deste estudo foi comparar o efeito da estimulação elétrica nervosa transcutânea *burst* com a estimulação elétrica nervosa transcutânea de intensidade e frequência variável sobre a dor oncológica.

MÉTODOS: Esta pesquisa foi realizada com 53 pacientes, do Hospital Erasto Gaertner, divididos em dois grupos: estimulação elétrica nervosa transcutânea *burst* e estimulação elétrica nervosa transcutânea de intensidade e frequência variável. A avaliação do quadro álgico foi realizada antes, logo após a eletroanalgesia e de hora em hora até que completassem 6 horas.

RESULTADOS: O grupo tratado com estimulação elétrica nervosa transcutânea *burst* manteve analgesia completa por duas horas, retornando ao valor inicial do escore dentro das seis horas de avaliação; o grupo estimulação elétrica nervosa transcutânea de intensidade e frequência variável manteve analgesia completa por quatro horas, não retornando ao valor inicial do escore dentro das 6 horas. Observou-se na comparação da intensidade da dor entre os grupos que houve diferença significativa entre eles ($p<0,001$) em todas as avaliações a partir da 3ª hora após a aplicação da eletroanalgesia, mostrando diferença significativa ($p<0,001$) na 3ª e 4ª hora após a eletroanalgesia; na 5ª hora e na 6ª hora não houve diferença.

CONCLUSÃO: A estimulação elétrica nervosa transcutânea de intensidade e frequência variável promoveu maior tempo de analgesia sobre a dor oncológica que a estimulação elétrica nervosa transcutânea *burst*.

Descritores: Analgesia, Câncer, Dor, Estimulação elétrica nervosa transcutânea, Modalidades de fisioterapia.

INTRODUCTION

The control of cancer pain is routinely done through the evaluation of the symptom, drug administration, and surgical treat-

1. Universidade Federal do Paraná, Hospital Universitário Regional dos Campos Gerais, Departamento de Fisioterapia, Ponta Grossa, PR, Brasil.
2. Hospital Cajuru, Departamento de Fisioterapia, Curitiba, PR, Brasil.
3. Pontifícia Universidade Católica do Paraná, Curso de Medicina, Curitiba, PR, Brasil.
4. Universidade Estadual de Ponta Grossa, Hospital Universitário Regional dos Campos Gerais, Departamento de Fisioterapia, Ponta Grossa, PR, Brasil.
5. Universidade Federal do Paraná, Departamento de Fisiologia, Curitiba, PR, Brasil.

Submitted in May 10, 2017.
Accepted for publication in October 30, 2017.
Conflict of interests: none – Sponsoring sources: none

Correspondence to:
Rua Cruz e Souza nº 430 ap. 11 – Jardim Carvalho
84015-420 Ponta Grossa, PR, Brasil
E-mail: deboramazzo@uol.com.br

ment. However, its treatment should not be restricted to these conventional approaches[1,2]. Among the several non-phamacological approaches, there is a physiotherapeutic modality called transcutaneous electrical nerve stimulation (TENS)[3], that transmits electric current using electrodes located on the skin[2]. The current acts at the cellular level, exciting the peripheral nerve cells, causing the release of endogenous substances such as endorphins, enkephalins, and serotonin in the body[4], that consequently will affect segmentary and systemic levels. Its main advantages are not overwhelming organs and systems since it does not need to be metabolized; low cost; easy to use; and few adverse effects[5,6].

Some studies confirm the effectiveness of TENS in cancer pain[4,7]. However, patients tend to adapt themselves to the sensitivity of the continuous stimulaton[6,8]. In the face of this came the questioning if variations in the form of the transcutaneous electrical stimulation, as it occurs in TENS with variable intensity and frequency (VIF), would present better results in pain relief since the tendency to adaptation is lower.

Thus, the objective of this study was to investigate which modality has a better beneficial effect on cancer pain: TENS with modulated pulses (burst) or TENS VIF.

METHODS

This is a prospective, applied, experimental and quantitative study conducted at Hospital Erasto Gaertner (HEG). The sample was collected in a directed form for convenience, and the patients included in the study were hospitalized to undergo chemotherapy and/or radiotherapy, of both gender, who had a physiotherapy prescription, and that reported cancer-related pain. Patients below 18 years old with a complaint of pain not related to cancer were excluded from the sample. The size of the sample was estimated in a number higher than 20% of the population who had a prescription for physiotherapy during hospitalization, and that reported pain since this size is enough to represent the population. However, after the previous evaluation of the patients, the size of the sample was bigger, totalizing 73% of the evaluated patients.

Before starting the evaluation procedures and the current application, the patient signed the Free and Informed Consent Form (FICT). The initial evaluation, made by researcher 1, consisted of collecting information inherent to the patient's characteristics, type of cancer and the pain symptom. To evaluate pain characteristics, we used the McGill Pain Questionnaire, translated and adapted to the Portuguese language in 1996 by Pimenta and Teixeira[9], and the multidimensional pain evaluation scale (EMADOR)[10], that consists of a numerical scale (NS) from 1 to 10; the higher the numerical value, the higher is the pain reported by the patient; descriptors referring to the types of pain - acute or chronic; and an illustration of the body to register the site of pain.

After that, the patient raffled off the current that would be applied, without knowing which current it would be. The single application was made by a physiotherapist (Researcher 2) using the HTM® TENS-FES device portable, with burst parameters and pre-programmed VIF with maximum intensity tolerated by the patient, with duration of 40 minutes. In case the patient reported pain in more than two sites, the electrodes were placed on the site with higher reported pain, being related to cancer.

The pain revaluation, made by Researcher 1, who did not know the applied current, was done right after the removal of the device, and at every hour until completing 6 hours.

Figure 1 details the study design.

This study was approved by the Committee of Ethics in Research of the Hospital Erasto Gaertner (HEG) under number 2153-nov/2011.

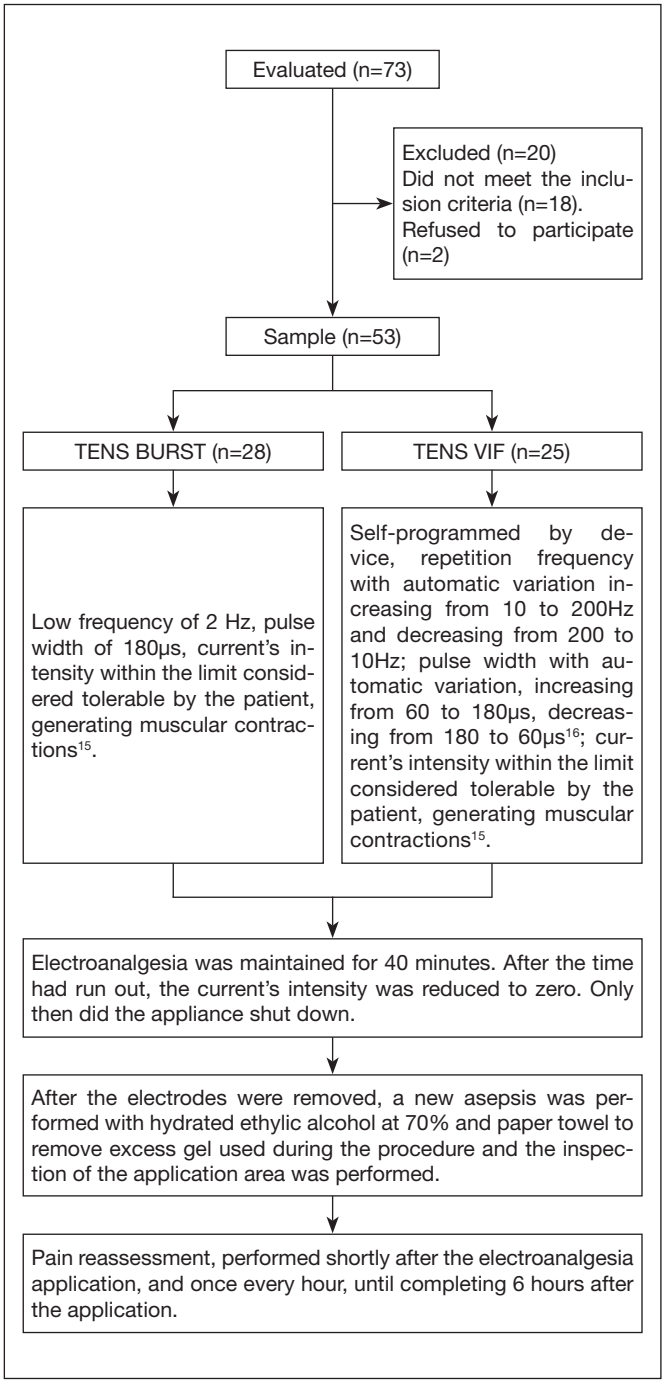

Figure 1. Details of the survey (attached file)

Statistical analysis

It was found that the sample did not follow the Gaussian distribution with the Kolmogorov-Smirnov test. Non-parametric Wilcoxon tests were used for the descriptive analysis of the data to check the difference between the evaluation before applying TENS and all the other evaluations of the same group; and the Mann-Whitney's U test to compare all evaluations between the groups. To better understand the treatment effect of each current, we calculated the differences in pain intensity rates at the fifth hour after the treatment and the necessary number to treat (NNT) to prevent any failures in the proposed treatment. To verify if there was an association between the pain classification identified by the patients and the electrotherapeutic resources applied, the Chi-square test was used. The significance level adopted for the statistical tests was 5% in a 95% confidence interval.

RESULTS

The burst group consisted of 13 male patients, and 15 female patients, the age of this group was 56.53±14.21 years, with a minimum of 23 years and a maximum of 81 years. The VIF group consisted of 15 male patients and 10 female patients. The age was 53.16±12.78 years, being 36 years the lower age and 83 years the highest.

The neoplastic topography of the groups varied between lungs, breast, stomach, ovaries, liver, lymphatic system, face, and neck. In burst group, 16 patients had a histological diagnosis of adenocarcinoma, 2 patients had lymphoma and 4, sarcoma, and 6 patients did not have such information in the medical record. In the VIF group, 14 patients had adenocarcinoma as histological diagnosis, 4 had lymphoma, 4 had sarcoma, and 3 patients did not have this information in their medical records.

Regarding the use of pain medication, all patients received analgesics, including anti-inflammatories or opioids. When evaluated by the EMADOR, the number of body sites that the patients reported pain in the burst group were n=10 (36%) at one site, n=15 (52%) at two sites and n=3 (12%) at three sites; and in the VIF group, n=5 (21%) had pain at one site, n=17 (69%) at two sites and n= 3 (10%) at three sites.

In the burst group, n=1 (4%) had pain in the thigh, n=2 (8%) in the arms, n=3 (11%) in the buttocks, n=4 (15%) in the chest region, n=4 (15%) in the cervical region, n=5 (18%) in the lumbar region, n=23 in the abdomen (36%), n=13 (47%) in pectoral region. In the VIF group n=2 (8%) of patients had pain in the arms, n=4 (16%) in the lumbar region, n=5 (20%) in the cervical region, n=8 (28%) in the abdomen, n=11 (44%) in the pectoral region, n=15 (60%) in the chest region.

In the classification of the type of pain, in the burst group n=12 (42.86%) of the patients classified pain as chronic and n=16 (57.14%) as acute. The VIF group had n=9 (36%) of the patients with the symptoms classified as chronic and n=16 (64%) as acute.

The percentage of each EMADOR describer reported by the patients in the burst group was n=12 (43%) chronic, depressing, overwhelming, deep, harmful, painful, unbearable, daunting, and uncomfortable, n=16 (57%) as acute, terrible, maddening, disastrous, tremendous, despairing, fulminant and monstrous, 100% described it as cruel. In the VIF group n=7 (28%) reported as disastrous, n=9 (36%) as chronic, depressing, overwhelming, harmful, painful, unbearable and uncomfortable, n=11 (44%) as daunting, n=14 fulminant (56%), n=16 (64%) as acute, terrible, maddening, tremendous, despairing, intense, monstrous, n=18 (72%) as deep and n=25 (100%) as cruel.

In the assessment of pain before the electroanalgesia between the groups (Mann-Whitney U test), no significant differences were found, both in the McGill score (p=0.538), and in the numeric pain rating scale (p=0.536). Both groups presented severe pain according to the numeric pain scale.

The comparison of the pain intensity reported by the patients and the score obtained with the McGill pain questionnaire between the pre-application evaluation of electroanalgesia and the post-application evaluations are described in table 1.

The intensity of the pain of the two groups, throughout the evaluations, is presented in figure 2.

As of the third hour after the application of the electroanalgesia, a significant difference was found in the VIF group (p<0.001 versus burst) in all evaluations until reaching 6 hours.

The McGill pain score of both groups throughout the assessments is shown in figure 3.

The VIF group presented a significant difference in the McGill score (p<0.001 versus burst) and at the 3rd and 4th hour after the electroanalgesia, at the 5th hour it was p=0.020 and at the 6th hour p=0.043 when compared with burst.

After finishing the electrotherapeutic application two hours later, there was the absence of pain in both groups. The patients pre-

Table 1. Comparison of the pain intensity and pain score by the McGill questionnaire of all the evaluations of the referred scores before the application of the transcutaneous electrical nerve stimulation

	Burst				VIF			
	Intensity		McGill		Intensity		McGill	
Before	10 (9-10)		48 (43-54)		9 (9-10)		51 (44-56)	
0 h	0 (0-0)	<0.001	0 (0-0)	<0.001	0 (0-0)	<0.001	0 (0-0)	<0.001
1st h	0 (0-0)	<0.001	0 (0-0)	<0.001	0 (0-0)	<0.001	0 (0-0)	<0.001
2nd h	0 (0-0)	<0.001	0 (0-0)	<0.001	0 (0-0)	<0.001	0 (0-0)	<0.001
3rd h	2 (0-2)	<0.001	44 (0-51)	0.012	0 (0-0)	<0.001	0 (0-0)	<0.001
4th h	5 (3.25-6.75)	<0.001	48 (43-54)	1.000	0 (0-0)	<0.001	0 (0-0)	<0.001
5th h	7,5 (7-8)	<0.001	48 (43-54)	1.000	2 (0-2)	<0.001	29 (0-52.5)	0.002
6th h	10 (9-10)	1.000	48 (43-54)	1.000	2 (0.3.5)	<0.001	41 (0-52.5)	0.008

Values described in median (first and third quartiles) and p values.

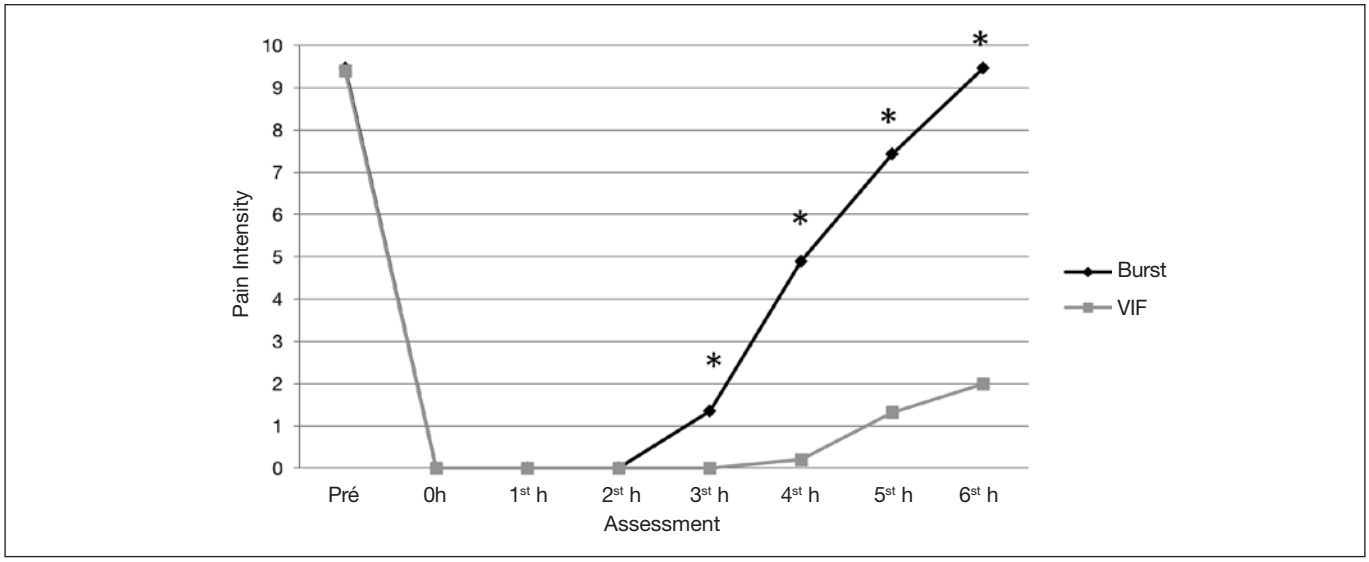

Figure 2. Pain intensity in both groups over the different evaluation moments
*p<0.001 versus VIF.

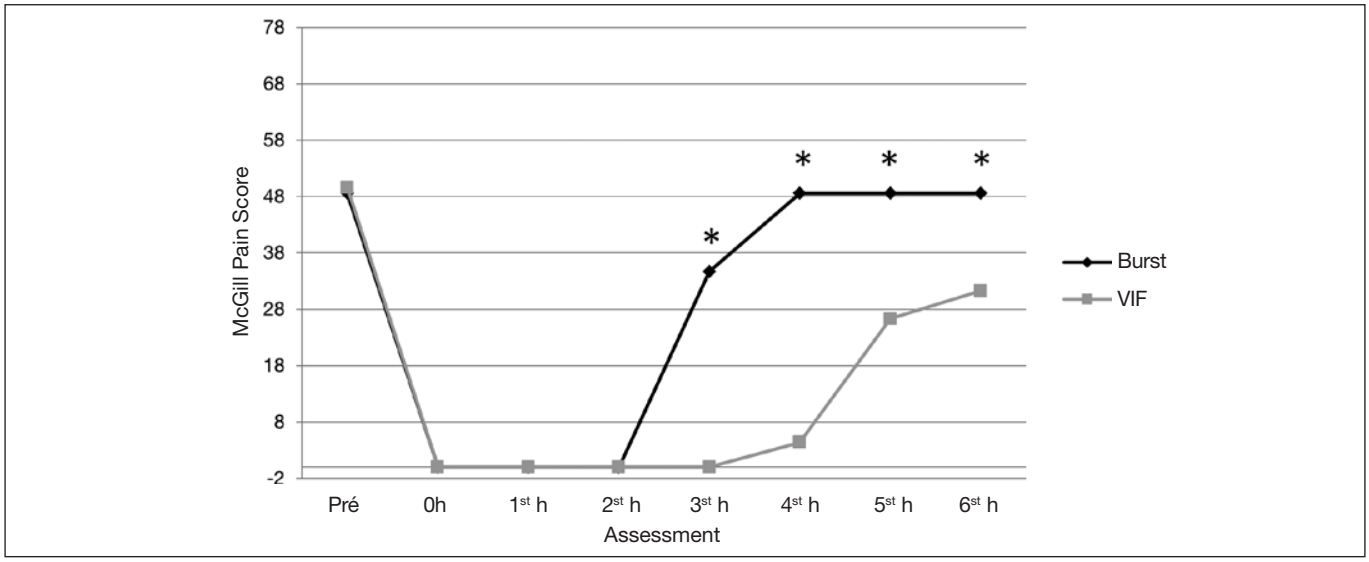

Figure 3. McGill pain score in both groups over the different evaluation moments
*p<0.001 versus VIF.

sented a mild pain at the 3rd and 4th hours after application, in both groups. At the 5th hour, they presented a mild pain n=10 (34%) of the patients in the burst group and n=16 (65.8%) in the VIF group, resulting in an NNT of 1.5 in the VIF group and 2.9 in the burst group. The moderate and intense pain was reported only by patients in the burst group. Table 2 shows the pain rating in the last evaluation.

Table 2. Frequency of pain rating reported by patients at the sixth hour after the electroanalgesia application

	Burst	VIF	p-value
Mild	0 (0%)	25 (100%)	<0.001
Moderate	0 (0%)	0 (0%)	
Intense	28 (100%)	0 (0%)	

DISCUSSION

The neoplastic topographies found in the present study varied among different regions, as did the study by Salamonde et al.[11] who studied 93 patients and the location also referred to several sites as the lung, uterus, large intestine, breast, prostate, bone marrow, kidney, liver, stomach, pancreas and small intestine. Loh and Gulati[12] analyzed the use of TENS to improve the functionality of cancer patients, and the topography was also very diverse, predominating the breast cancer and sarcomas.

Few studies have evaluated the action of TENS in a population with some specific type of cancer. Hurlow et al.[13] did a systematic review aiming to develop studies addressing the treatment of cancer pain in adults with the use of TENS, but only three

randomized controlled trials were included in the review, which evidences the lack of research on the subject.

Most patients had pain in more than one site. This same result was reported by Pimenta, Koizumi and Teixeira[14], who stated that every patient had reported pain in more than one site, averaging 1.8 different pain sites.

The pain level of both groups was initially high. When comparing the pain and intensity scores before the electroanalgesia, both levels were similar.

A study[15] evaluated 8 patients with sarcoma-related pain who were treated with high-frequency TENS, and, as in the present study, the McGill questionnaire was used to quantify pain before and after the application. Among the 8 patients, 7 had satisfactory results regarding the reduction of pain besides the improvement in functionality, showing the clinical efficacy of TENS both in movement and at rest.

In the comparison of the pain score and pain intensity between the groups, from the 3rd to the 6th hour after the electroanalgesia, there was a significant difference between them, that is, TENS VIF had a longer lasting analgesic effect than TENS burst. It is believed that this result occurred because in the TENS VIF it is established a minimum and maximum value and frequency, generating a variation of these values during the application. This function prevents, or at least delays, the onset of the accommodation effect[16].

In Loh and Gulati[12] retrospective study, the use of TENS was analyzed concerning the functionality improvement of 87 patients with different types of cancer, when the pain questionnaire was applied at the beginning of the treatment and two months later. At the end of two months of follow-up, 76 patients were evaluated, and among them, 69.7% reported benefits in the use of TENS, with improvement in pain and quality of life.

Johnson et al.[17] conducted a systematic review of the effect of TENS in acute pain. There were 19 randomized clinical trials, and among these, only four have compared two active currents. The authors reported difficulties due to the lack of information on the intensity, extent, duration, and frequency of the treatment sessions. Most studies used standard questionnaires to quantify pain. However very few clarified the moment when those questionnaires were applied, which does matter when the goal is to compare the duration of the analgesic action of the current.

Although the present study and the others cited do present positive results about the reduction of cancer pain, yet there is no consensus on the use of TENS in these patients. However, there is an increasing interest in investigating its effect, since it has been used in the control of acute and chronic pain in this population[18,19]. Another important point is that few studies focus on the parameters adjusted in that current. Gopalkrishnan and Sluka[20] analyzed the effects of two frequencies (100Hz and 4Hz), two pulse widths (100μs and 250μs) and two intensities (motor and sensory), during 20 minutes, on hyperalgesia and induced inflammation in rats. In that study, to the surprise of the authors, only the frequency had relation with analgesia. It is worth mentioning that the parameters were fixed and did not vary as in our study. Based on the preceding, the use of electroanalgesia with TENS, with the parameters used, was effective in the treatment of cancer pain, since this type of intervention does not cause addiction and has no adverse effects[18,20].

CONCLUSION

The use of TENS, with the used parameters, has efficiently reduced the cancer pain for at least 3 hours. The best results were found with the use of the TENS VIF current regarding analgesia duration compared to TENS_ burst.

REFERENCES

1. Minson FP (Org.). II Consenso nacional de dor oncológica. São Paulo: Moreira Jr; 2011.
2. Coutaux A. Non-pharmacological treatments for pain relief: TENS and acupuncture. Joint Bone Spine. 2017;20. pii: S1297-319X(17)30016-7.
3. Sampaio LR, Moura CV, Resende MA, Recursos fisioterapêuticos no controle da dor oncológica: revisão da literatura. Rev Bras Cancerol. 2005;51(4):339-46.
4. Yasukawa AS, Andrade BA, Cristofani LM, Neuroestimulação elétrica transcutânea para controle da dor decorrente da infusão de quimioterápicos em crianças com câncer. Rev Dor. 2009;10(1):29-32.
5. Yeng LT, Stump P, Kaziyama MJ, Imamura M, Greve JM. A. Medicina Física e reabilitação em doentes com dor oncológica. Rev. Med. 2001;80(ed. esp. pt.2):245-55.
6. Searle RD, Bennet MI, Johnson MI, Callin S, Radford H. Transcutaneous electrical nerve stimulation for cancer bone pain. Journal of pain and symptom management. 2009;37(3):424-8.
7. Pena R, Barbosa LA, Ishikawa NM, Estimulação elétrica transcutânea do nervo (tens) na dor oncológica – uma revisão da literatura. Rev Bras Cancerol. 2008;54(2):193-9.
8. Pantaleão MA, Laurino MF, Gallego NL, Cabral CM, Rakel B, Vance C, et al. Adjusting pulse amplitude during transcutaneous electrical nerve stimulation (TENS) application produces greater hypoalgesia. J Pain. 2011;12(5):581-90.
9. Pimenta CA, Teixeira MJ. Questionário de dor McGill: proposta de adaptação para a língua portuguesa. Rev Esc Enf USP. 1996;30(3):473-83.
10. Sousa FF, Pereira LV, Cardoso R. Hortense P. Escala multidimensional de avaliação de dor (EMADOR). Rev Lat-Am Enfermagem. 2010;18(1):1-9.
11. Salamonde GL, Verçosa N, Barrucand L, Costa AF. Análise clínica e terapêutica dos pacientes oncológicos atendidos no programa de dor e cuidados paliativos do Hospital Universitário Clementino Fraga Filho no ano de 2003. Rev Bras Anestesiol. 2006;56(6):602-18.
12. Loh J, Gulati A. The use of transcutaneous electrical nerve stimulation (TENS) in a major cancer center for the treatment of severe cancer-related pain and associated disability. Pain Med. 2015;16(6):1204-10.
13. Hurlow A, Bennett MI, Robb KA, Johnson MI, Simpson KH, Oxberry SG. Transcutaneous electrical nerve stimulation (TENS) for cancer pain in adults. Cochrane Database Syst Rev. 2012;(3):CD006276.
14. Pimenta CA, Koizumi MS, Teixeira MJ. Dor no doente com câncer: características e controle. Rev Bras Cancerol. 1997;43(1):1-9.
15. Loh J, Gulati A. Transcutaneous electrical nerve stimulation for treatment of sarcoma cancer pain. Pain Manag. 2013;3(3):189-99.
16. Agne JE. Eu sei eletroterapia. Santa Maria: Pallotti; 2011. 123-4p.
17. Johnson MI, Paley CA, Howe TE, Sluka KA. Transcutaneous electrical nerve stimulation for acute pain. Cochrane Database Syst Rev. 2015;(6):CD006142.
18. Silva JG, Santana, CG, Inocêncio, KR, Orsini M, Machado S, Bergmann A. Electrocortical analysis of patients with intercostobrachial pain treated with TENS after breast cancer surgery. J Phys Ther Sci. 2014;26(3):349-53
19. Bennett MI, Hughes N, Johnson MI. Methodological quality in randomised controlled trials of transcutaneous electric nerve stimulation for pain: low fidelity may explain negative findings. Pain. 2011;152(6):1226-32.
20. Gopalkrishnan P, Sluka KA. Effect of varying frequency, intensity, and pulse duration of transcutaneous electrical nerve stimulation on primary hyperalgesia in inflamed rats. Arch Phys Med Rehabil. 2000;81(7):984-90.