Effect of interferential current of different amplitude-modulated frequencies, on threshold and number of accommodations on healthy painless individuals*

Efeito da corrente interferencial de diferentes frequências moduladas pela amplitude no limiar e número de acomodações em indivíduos saudáveis sem dor

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ABSTRACT

BACKGROUND AND OBJECTIVES: Despite the widespread use of interferential current, controversy exists in the literature on the optimal stimulation parameters. The aim of this study was to evaluate the threshold and the total number of accommodations in subjects stimulated by different amplitude-modulated frequencies.

METHODS: The study is a clinical, cross-over trial with randomized and blinded convenience sample consisted of 20 healthy subjects, with mean age of 20.35 years, of both genders. Volunteers underwent interferential current for 20 minutes, the bipolar form, with electrodes placed on the elbow joint being positioned one above the superficiality of the ulnar nerve and the other of the median nerve. Equipment parameters were: base frequency of 4,000Hz, amplitude-modulated frequencies 1, 10 or 100Hz (according to the subgroup). Threshold and total number of accommodations were assessed.

RESULTS: For the accommodation threshold no significant differences were found (p>0.05). With regard to the number of accommodations, there have been significant differences between the frequencies of 10 and 100Hz (p<0.05).

CONCLUSION: There was no significant difference in the accommodation threshold; however, we observed significant differences between the frequencies of 10 and 100Hz.

Keywords: Electric stimulation therapy, Physical therapy modalities, Sensory thresholds, Transcutaneous electric nerve stimulation.

RESUMO

JUSTIFICATIVA E OBJETIVOS: Apesar do uso generalizado da corrente interferencial, há controvérsias na literatura sobre os parâmetros ideais de estimulação utilizados. O objetivo deste estudo foi avaliar o limiar e o número total de acomodações em indivíduos estimulados por diferentes frequências moduladas pela amplitude.

MÉTODOS: Trata-se de um ensaio clínico, cruzado, com amostra de conveniência aleatorizada e encoberta, composta por 20 indivíduos saudáveis, com idade média de 20,35 anos, de ambos os gêneros. Os voluntários foram submetidos a corrente interferencial por 20 minutos, na forma bipolar, com os eletrodos localizados na articulação do cotovelo, sendo posicionados um sobre a superficialidade do nervo ulnar e outro do nervo mediano. Os parâmetros do equipamento foram: frequência base de 4.000Hz, frequências moduladas pela amplitude de 1, 10 ou 100Hz (de acordo com o subgrupo do dia). Foi avaliado o limiar de acomodação e o número total de acomodações.

RESULTADOS: Para o limiar de acomodação não foram encontradas diferenças significativas (p>0,05); quanto ao número de acomodações houve diferenças significativas entre as frequências de 10 e 100Hz (p<0,05).

CONCLUSÃO: Observou-se que não houve diferença estatística quanto ao limiar de acomodações, porém, houve diferenças significativas entre as frequências de 10 e 100Hz.

Descritores: Estimulação elétrica neural transcutânea, Limiar sensorial, Modalidades de Fisioterapia,Terapia por estimulação elétrica.

INTRODUCTION

Interferential current (IC) is a widely used rehabilitation tool because it has few associated adverse effects[1]. Its primary objective is analgesia. Although precise mechanisms are still questioned, it is believed that the gate theory and increased nervous fibers depolarization threshold are involved[2-5].

Major IC characteristic is the mean frequency (2.4 or 8kHz) modulated by two slightly different sinusoidal currents, which generates amplitude-modulated frequency (AMF). Its effect is similar to that observed with low frequency current, such as

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transcutaneous electric nerve stimulation (TENS), however it brings less discomfort and goes deeper into tissues[6]. When just a pair of electrodes is used (bipolar application), currents interference is inside the device, being considered pre-modulated[5].
There are still controversies about ideal modulation ranges as well as about the role of AMF[7,8] and other parameters. Among them, there is Δf (frequency amplitude) and slope (Δf slope patterns, usually with variations in 1:1, 1:5:1 or 6:6 seconds, indicated for chronic, sub-acute and acute cases, respectively)[9,10]. Accommodation is a phenomenon induced by decreased number of nervous depolarizations due to repetitive and prolonged stimulation. In case of electric stimulation, to get constant stimulation, it is necessary to increase intensity whenever the individual reports stimulation decrease[11].
In spite of generalized IC use, no studies were found analyzing whether different AMF have different effects on accommodation. So, this study aimed at evaluating the threshold and total number of accommodations in individuals stimulated by different AMF for 20 minutes.

METHODS

This is a crossover trial with randomized and blind convenience sample. Data were collected at UNIOESTE's Physical Rehabilitation Center (CRF) and volunteers came on predetermined times. Sample was made up of 20 people (13 females), with mean age of 20.35 years, mean weight of 63.95 kg, mean height of 1.69 m, and mean body mass index (BMI) of 22.13kg/m^2.
After being explained about study objectives and procedures, volunteers were submitted to evaluation to identify possible non inclusion factors. Inclusion criteria were availability to participate in evaluations and tests in predetermined days and times. Exclusion criteria were heart disease, metal implant, gestation, chronic pain or left upper limb injury, sensitivity changes, rheumatic diseases or any other contraindication to the use of electric stimulation or interferential current. After accepting the invitation and having confirmed their eligibility for the study, volunteers have signed the Free and Informed Consent Term (FICT).

Electric stimulation protocol and evaluation
Volunteers received electric stimulation with the Neurovector (Ibramed®) device, in the bipolar form, with electrodes placed on left elbow joint, being one positioned ion the superficiality region of the ulnar nerve and the other on the median nerve (Figure 1). Volunteers remained comfortably seated during electric stimulation. Electrodes were made of rubber-silicone with 8cm^2. Equipment parameters were: base frequency of 4000Hz, AMF according to the subgroup of the day, being the sample divided in three subgroups (A, B or C). Considering the crossover characteristic of the study, all volunteers went through all AMF (1, 10 or 100Hz). Data were collected with at least one-week rest between each evaluation. No Δf was used, thus no slope, since the objective was just to evaluate different AMF.

Figure 1. Positioning of electrodes on the superficiality region of ulnar and median nerves, close to elbow joint

After asepsis with cotton soaked in 70% alcohol, placement of electrodes and definition of parameters, the evaluator has gradually increased current intensity until a sensation of paresthesia was reported by the individual, with high, however not painful, current intensity. Volunteers were asked to report the moment when the sensation of paresthesia decreased, that is, accommodation threshold, which has been timed. Then, current intensity was increased until paresthesia returned to baseline level, and the increasing process was repeated in all opportunities volunteers have reported its decrease, being recorded the number of times this has happened (total accommodations), during 20 minutes of stimulation.

Statistical analysis
Analyzed data have not followed the normal curve and non-parametric tests were used for analysis, being groups compared by Friedman test, with Dunn's post-test. Significance level was 5%.
This study was approved by the Ethics Committee for Human Beings Research, State University of Western Parana, under opinion 143/2013.

RESULTS

There have been no significant differences (p>0.05) in accommodations threshold. There has been significant difference in total number of accommodations between 10 and 100Hz frequencies (p<0.05) (Table 1).

Table 1. Comparison of accommodation threshold of different amplitude-modulated interferential current frequencies used during 20 minutes of application.

		1Hz	10Hz	100Hz
Accommodation threshold	Median	132.0s	127.5s	140.0s
Number of accommodations	Median	2.500n	1.500n*	3.000n*

*Significant difference between 10 and 100Hz; s: seconds; n: number of accommodations.

DISCUSSION

IC has the advantage of reducing skin resistance, thus the discomfort normally produced by traditional low frequency currents, being able to stimulate peripheral nerves[6]. Our study intended to evaluate the effects of different AMF on accommodations threshold and number in healthy volunteers, by bipolar application on elbow joint[12]. The objective was to find an optimal stimulation pattern and also to prevent accommodations.

In clinical practice, higher frequencies (for example, 100Hz) are used for analgesia and seem to act according to the gate theory. Lower frequencies (for example, 10Hz) seem to stimulate A-delta and C fibers with consequent endogenous opioids release, thus improving local blood flow and physiologically blocking nervous conduction[12]. However, there are authors who do not believe that these frequencies may have physiological effects on hypoalgesia[7], one hypothesis being the placebo effect[13]. For chronic low back pain, intensity considered as "high", however "comfortable", is able to decrease pain[2].

IC has tools looking at preventing sensitivity to current accommodation, such as Δf and slope, however they have not shown to be effective to change accommodation threshold[9,10]. Previous studies investigating such parameters have shown frequencies similar to those investigated herein. Similar results may be observed, being that the only difference found was with regard to the number of accommodations according to frequency (10 or 100Hz). On the other hand, these frequencies were not different from 1 Hz with regard to the number of accommodations. There are still controversies about the base frequency[14] with regard to AMF[7,15]. However, this latter does not seem to be important for electric stimulation-induced analgesia.

Preventing current accommodation is important because it allows for the continuity of IC therapeutic effect and, although the tetrapolar form is able to go deeper, the bipolar form also produces high voltages in line with the circuit[6]. So, it is believed that stimulation tested in this study, in addition to being widely used, is feasible as bipolar electric analgesia standard: with high, however not painful, intensity.

The evaluation of healthy individuals may be considered a limitation to this study, since IC is clinically used in painful patients. So, future studies in individuals with painful syndromes are needed to observe analgesia and the effect of accommodation to electric stimulation as parameter for pain relief.

CONCLUSION

There has been no difference in accommodation threshold according to frequencies, however there has been a lower number of accommodations with 10Hz frequency as compared to 100Hz frequency. So, 10 Hz frequency seems to be more indicated for clinical use for this objective.

REFERENCES

1. Satter EK. Third-degree burns incurred as a result of interferential current therapy. Am J Dermatopathol. 2008;30(3):281-3.
2. Facci LM, Nowotny JP, Tormem F, Trevisani VF. Effects of transcutaneous electrical nerve stimulation (TENS) and interferential currents (IFC) in patients with nonspecific chronic low back pain : randomized clinical trial. São Paulo Med J. 2011;129(4):206-16.
3. Fuentes CJ, Armijo-Olivo S, Magee DJ, Gross DP. A preliminary investigation into the effects of active interferential current therapy and placebo on pressure pain sensitivity: a random crossover placebo controlled study. Physiotherapy. 2011;97(4):291-301.
4. Lara-Palomo IC, Aguilar-Ferrándiz ME, Matarán-Peñarrocha GA, Saavedra-Hernández M, Granero-Molina J, Fernández-Sola C, et al. Short-term effects of interferential current electro-massage in adults with chronic non-specific low back pain: a randomized controlled trial. Clin Rehabil. 2013;27(5):439-49.
5. Rocha CS, Lanferdini FJ, Kolberg C, Silva MF, Vaz MA, Partata WA, et al. Interferential therapy effect on mechanical pain threshold and isometric torque after delayed onset muscle soreness induction in human hamstrings. J Sports Sci. 2012;30(8):733-42.
6. Beatti A, Rayner A, Chipchase L, Souvlis T. Penetration and spread of interferential current in cutaneous, subcutaneous and muscle tissues. Physiotherapy. 2011;97(4):319-26.
7. Fuentes CJ, Armijo-Olivo S, Magee DJ, Gross D. Does amplitude-modulated frequency have a role in the hypoalgesic response of interferential current on pressure pain sensitivity in healthy subjects? A randomised crossover study. Physiotherapy. 2010;96(1):22-9.
8. Ozcan J, Ward AR, Robertson VJ. A comparison of true and premodulated interferential currents. Arch Phys Med Rehabil. 2004;85(3):409-15.
9. Guerra TE, Bertolini GR. Efeitos da variação da rampa de entrega do ΔF sobre a acomodação da corrente interferencial em mulheres saudáveis. Rev Dor. 2012;13(1):25-9.
10. Pivetta KM, Bertolini GR. Efeitos do ΔF sobre a acomodação da corrente interferencial em sujeitos saudáveis. Rev Bras Med Esporte. 2012;18(5):330-2.
11. Krueger-Beck E, Scheeren EM, Nogueira-Neto GN, Button VL da SN, Neves EB, Nohama P. Potencial de ação: do estímulo à adaptação neural. Fisioter Mov. 2011;24(3):535-47.
12. Artioli DP, Bertolini GR. Corrente interferencial vetorial: aplicação, parâmetros e resultados. Rev Soc Bras Clin Med. 2012;10(1):51-6.
13. Fuentes JP, Armijo Olivo S, Magee DJ, Gross DP. Effectiveness of interferential current therapy in the management of musculoskeletal pain: a systematic review and meta-analysis. PhysTher. 2010;90(9):1219-38.
14. Venancio RC, Pelegrini S, Gomes DQ, Nakano EY, Liebano RE. Effects of carrier frequency of interferential current on pressure pain threshold and sensory comfort in humans. Arch Phys Med Rehabil. 2013;94(1):95-102.
15. Gundog M, Atamaz F, Kanyilmaz S, Kirazli Y, Celepoglu G. Interferential current therapy in patients with knee osteoarthritis: comparison of the effectiveness of different amplitude-modulated frequencies. Am J Phys Med Rehabil. 2012;91(2):107-13.