

Comparison of the effects of interferential current between male and female healthy adults

Comparação dos efeitos da corrente interferencial entre homens e mulheres saudáveis

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ABSTRACT

AIMS: To assess accommodation phenomena characteristics (threshold, time and amplitude/intensity) during stimulation with interferential current, comparing male and female healthy adults.

METHODS: A non randomized clinical trial with intentional sampling by gender included 30 healthy adult volunteers aged between 18 and 25 years, who were divided in two groups (15 in the Female Group and 15 in the Male Group) and received a tetrapolar interferential current for 20 minutes, close to L1 and L5 vertebrae. The subjects were instructed to refer an intense but comfortable paresthesia sensation and to report the moment it diminished (accommodation), requiring increasing of the current intensity. The first three events of accommodation (AV1, AV2 and AV3), including time and amplitude threshold, were analyzed. The differences from AV1 to AV2 (D1) and AV2 to AV3 (D2) were also considered. The number of accommodations for each subject during the 20 minutes experiment was identified. ANOVA and Student's t-test were used for analysis and the significance level was set at 5%.

RESULTS: In the Male Group the mean time for accommodation was higher in AV3 compared to AV1 and AV2. In the Female Group the accommodation mean time was higher in AV3 in relation to AV2, and in AV2 in relation to AV1. No differences were found in the Male Group for D1 and D2, but in the Female Group, D2 was superior to D1. Women were accommodated more quickly than men in all three assessments, but the differences between one evaluation and another were constant considering both groups. Both groups showed similar current intensity behavior comparing the three evaluations within the same group. In the comparison between groups, women had lower mean values of intensity in the three evaluations. The Female Group had 7.5 ± 1.5 accommodations, and the Male Group had 5.9 ± 2.0 accommodations ($p=0.0367$) during the 20 minutes of the experiment.

CONCLUSIONS: In this sample of healthy young adults, men required higher interferential current amplitude to obtain a comfortable paresthesia and took more time to have accommodations, while women had more accommodation episodes.

KEY WORDS: electrical stimulation therapy; physical therapy modalities; sex characteristics; gender.

RESUMO

OBJETIVOS: Avaliar características dos fenômenos de acomodação (limiar, tempo e amplitude/intensidade) durante estimulação com corrente interferencial, comparando adultos saudáveis do gênero masculino e feminino.

MÉTODOS: Um ensaio clínico não randomizado com amostragem intencional por gênero incluiu 30 voluntários adultos saudáveis com idade entre 18 e 25 anos, que foram divididos em dois grupos (15 no Grupo Feminino e 15 no Grupo Masculino) e receberam uma corrente interferencial tetrapolar por 20 minutos, na altura das vértebras L1 e L5. Os sujeitos foram instruídos a referir uma sensação de parestesia intensa mas confortável e relatar o momento em que ela diminuiu (acomodação), requerendo aumento da intensidade da corrente. Foram analisados os três primeiros fenômenos de acomodação (AV1, AV2 e AV3), incluindo tempo e limiar de amplitude. Foram consideradas também as diferenças entre AV1 e AV2 (D1) e entre AV2 e AV3 (D2). Foi identificado o número total de acomodações para cada sujeito nos 20 minutos do experimento. Para a análise foram usados ANOVA e teste t de Student e o nível de significância foi definido em 5%.

RESULTADOS: No Grupo Masculino, o tempo médio para acomodação foi maior em AV3 comparado com AV1 e AV2. No Grupo Feminino, o tempo médio foi maior em AV3 em relação a AV2 e em AV2 em relação a AV1. Não foram encontradas diferenças no Grupo Masculino entre D1 e D2, mas no Grupo Feminino, D2 foi superior a D1. As mulheres apresentaram acomodação mais rapidamente do que os homens em todas as três avaliações, mas as diferenças entre uma avaliação e outra foram constantes considerando os dois grupos. Ambos os grupos apresentaram comportamento semelhante na intensidade da corrente, comparando as três avaliações dentro do mesmo grupo. Na comparação entre os grupos, as mulheres apresentaram valores médios de intensidade mais baixos em todas as três avaliações. O Grupo Feminino apresentou $7,5 \pm 1,5$ acomodações e o Grupo Masculino $5,9 \pm 2,0$ acomodações ($p=0,0367$) durante os 20 min do experimento.

CONCLUSÕES: Nesta amostra de jovens adultos saudáveis, os homens necessitaram de corrente interferencial com maior amplitude para obter uma parestesia confortável e demoraram mais tempo para apresentar acomodação, enquanto as mulheres tiveram mais episódios de acomodação.

DESCRIPTORIOS: terapia por estimulação elétrica; modalidades de fisioterapia; características sexuais; gênero.

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Abbreviations: AV1, first evaluated event of current amplitude and accommodation threshold; AV2, second evaluated event of current amplitude and accommodation threshold; AV3, third evaluated event of current amplitude and accommodation threshold; BMI, body mass index; D1, difference between AV1 and AV2; D2, difference between AV2 and AV3; IC, interferential current; Unioeste, State University of West Paraná.

INTRODUCTION

Interferential current (IC) is a non-invasive therapeutic method frequently used by physiotherapists because of its analgesic effects. It has been popularized due to its application facility and because it allows to reduce the amount of medicines, which makes the treatment less expensive and with less side effects. The use of IC has been also indicated to improve muscular strength and endurance, to aid in tissue recovery, to reduce spasticity, and to manage cases of intestinal constipation [1-3].

During the electrostimulation, the current amplitude/intensity is gradually increased until the patient describes a sensation of deep paresthesia. As soon as this sensation is reduced along time, namely the accommodation phenomena, the intensity must be increased once more to keep the stimulation constant. The accommodation phenomena occurs when the physiological response is diminished as a consequence of persistent application of the same stimulus. The maintenance of a fixed frequency seems to be an important factor for the occurrence of accommodation. A study with transcutaneous electrical nerve stimulation in asymptomatic volunteers showed that there were no differences in the threshold and number of accommodation according to 7, 100 or 255 Hz [4-6].

IC is characterized by medium frequency with low modulation. However, there are controversies involving the requirement of modulation and some other features, as variations in the current frequency (Δf) and the forms for delivery the Δf (slope), which aims avoiding current accommodation during application. IC is usually used in a bipolar or tetrapolar arrangement. Due to the larger coverage area and effects, the tetrapolar arrangement has been reported to have advantages when compared to the bipolar. In the bipolar arrangement the current interference will occur inside the electrical equipment, while in the tetrapolar, two currents with slight different frequencies promote the interferential resultant effect directly in the patient [7-14].

Several endogenous and exogenous factors can influence the sensorial perception and the pain

threshold. For example, sexual hormones – specifically estrogen and progesterone – can exert a modulatory effect on neural functions and change superficial cutaneous sensibility. A review by Unruh [15] found that most studies described differences of pain sensation between genders, with females reporting higher intensity, duration and frequency of pain. This and other studies suggest relevant questions regarding the parameters of therapeutic modulation for analgesia between genders/sexes [15-22].

In view of the lack of published studies that seek to identify differences between genders in the accommodation phenomena using IC, the aim of the present study was to assess accommodation phenomena characteristics (threshold, time and amplitude/intensity) during the stimulation with IC, comparing male and female healthy adults.

METHODS

A non randomized clinical trial with intentional sampling by gender was conducted in the Clinic of the Course of Physiotherapy at the State University of West Paraná (Unioeste), campus of Cascavel, Paraná, Brazil, in September 2016. The study was approved by the Ethics Committee on Human Research of Unioeste (document number 1.231.470) and all the participants signed an informed consent.

The inclusion criteria were age between 18 and 25 years and no sensitive alteration from L1 to L5 dermatomes. Subjects were excluded of the study if they had: scar on electrodes placement area; previous treatment with electrostimulation; systemic diseases; fever during the study period; any cognitive or sensorial deficits; deep venous thrombosis; pregnancy; metallic implant; anti-inflammatory drug use; muscle or central nervous system depressive medicines; and alcoholic beverage, coffee or soft drink intake less than 24 hour prior to the study measurements. Subjects were selected to form a Female Group and a Male Group.

In order to test the accommodation phenomena, all participants were positioned lying down to receive the IC applied in a tetrapolar arrangement, 4000Hz (100 Hz AMF) [10, 11] for 20 minutes. The equipment used was the Neurovector Sapphire Line (Ibramed®, Brazil), which has the IC both in the bi-or tetra-polar form; carrier frequency of 2, 4 or 8 kHz; amplitude modulated frequency and slope between 1-100 Hz, and ramp delivery slope of 1:1, 1:5:1 or 6:6 seconds. The electrodes were placed in the paravertebral region of L1 and L5, about 3 cm distant from the spinous process

of the spine. After cleaning the lumbar skin region with alcohol 70%, the 8 cm² carbon rubber electrodes were soaked in hypoallergenic water-based gel for fixation with adhesive tape. All assessments and measurements were made in only one intervention.

After information regarding the protocol, the participant was instructed to report the moment of a comfortable intense paresthesia sensation while the amplitude of the stimulation was gradually increasing. After some time, as soon as the paresthesia diminished, the individual should report the moment of the current accommodation. This procedure was repeated in order to identify the first three accommodation phenomena. After that, the experiment was continued until completing 20 min, in order to count the total number of accommodations.

Every time the subject reported decreased paresthesia sensation, current amplitude was increased, and in this moment the new amplitude level showed in the stimulator display was annotated, as well as the time between each accommodation. The first three events of current amplitude and accommodation threshold (AV1, AV2 and AV3) were included in the analysis. For the second and the third measurements, the differences from AV1 to AV2, and AV2 to AV3, respectively named as D1 and D2, were considered.

Considering the standard deviation (13,0) of the mean current amplitude, and the detected difference of 12,0 mA, with a significance level of 5% and a power of 80%, the sample size in each group should be 14 subjects. These data were based on a pilot study.

After the Shapiro-Wilk test for evaluating normality, the one way analysis of variance (ANOVA) with Tukey post hoc test was applied for comparisons within groups. For comparisons between groups, the unpaired Student's t-test was used. The significance level was set at 5%.

RESULTS

Thirty subjects were enrolled, of whom 15 were assigned to the Female Group and 15 to the Male Group. Age and anthropometric characteristics of the sample are shown in **Table 1**.

The mean time of accommodation in the Male Group was higher in AV3 compared to AV1 and AV2. In the Female Group the accommodation mean time was different for the three evaluations: higher means occurred in AV3 in relation to AV2, and in AV2 in relation to AV1. No differences were found in the Male Group for D1 and D2, but in the Female Group D2 was superior to D1.

Table 1. Age and anthropometric characteristics of healthy adult volunteers separated in groups according to gender, evaluated at the Unioeste Physiotherapy Clinic. Cascavel, Paraná, Brazil, September 2016.

Caracteristics	Male Group n=15 (Mean±SD)	Female Group n=15 (Mean±SD)	p-value*
Age (years)	21.6±2.09	19.6±1.76	0.0086
Weight (kg)	75.5±14.5	59.5±9.28	0.0012
Height (m)	1.77±0.07	1.66±0.05	<0.0001
Body mass index (kg/m ²)	23.88±3.73	21.53±2.62	0.0561

* Unpaired Student's t-test.

In the comparison between groups, women were accommodated more quickly than men in all assessments, but the differences between one evaluation and another were constant considering both groups (**Table 2**).

Table 2. Time in seconds for occurrence of accommodation to the interferential current effects, in male and female groups of healthy adult volunteers evaluated at the Unioeste Physiotherapy Clinic. Cascavel, Paraná, Brazil, September 2016.

Evaluations and differences between each evaluation	Male Group n=15 (Mean±SD)	Female Group n=15 (Mean±SD)	p-value
AV1	196±143 ^{aA}	99±45 ^{aB}	0.0223
D1	183±99 ^{aA}	126±95 ^{abA}	0.1169
AV2	379±174 ^{aA}	224±111 ^{bb}	0.0071
D2	251±198 ^{aA}	171±76 ^{ba}	0.1611
AV3	631±329 ^{bA}	396±142 ^{cB}	0.0199

AV1, first evaluated event of current amplitude and accommodation threshold; AV2, second evaluated event of current amplitude and accommodation threshold; AV3, third evaluated event of current amplitude and accommodation threshold; D1, difference between AV1 and AV2; D2, difference between AV2 and AV3.

Comparisons within the groups performed by one-way ANOVA with Tukey post-test, and between groups by unpaired Student's t-test. The letters in superscript represent statistical differences (p<0,05). Small letters represent the differences within groups. Capital letters represent the differences between groups.

With regard to the number of accommodations during the 20 min period of the experiment, there was a significant difference between the Male Group, with 5.9±2.0 accommodations, and the Female Group, with 7.5±1.5 accommodations (p=0.0367).

Both groups showed similar current amplitude behavior comparing the three evaluations within the same group. In the comparison between groups, women had lower means of intensity in the three evaluations compared to men. When the differences between evaluations were assessed, only D1 presented lower means for women (**Table 3**).

Table 3. Amplitude of the interferential current (in milli-amperes) that was necessary to maintain the paresthesia after each episode of accommodation, for male and female groups of healthy adult volunteers evaluated at the Unioeste Physiotherapy Clinic. Cascavel, Paraná, Brazil, September 2016.

Evaluations and differences between each evaluation	Male Group n=15 (Mean±SD)	Female Group n=15 (Mean±SD)	p-value
AV1	54.8±19.5 ^{aA}	28.9±11.4 ^{aB}	<0.0001
D1	8.8±4.3 ^{bA}	5.9±2.5 ^{bB}	0.0333
AV2	63.6±20.6 ^{aA}	34.9±12.9 ^{aB}	<0.0001
D2	7.0±3.0 ^{bA}	5.5±3.3 ^{bA}	0.1900
AV3	70.6±21.3 ^{aA}	40.3±14.8 ^{aB}	<0.0001

AV1, first evaluated event of current amplitude and accommodation threshold; AV2, second evaluated event of current amplitude and accommodation threshold; AV3, third evaluated event of current amplitude and accommodation threshold; D1, difference between AV1 and AV2; D2, difference between AV2 and AV3.

Comparisons within the groups performed by one-way ANOVA, with Tukey post-test, and between groups by unpaired Student's t-test. The letters in superscript represent statistical differences ($p < 0,05$). Small letters represent the differences within groups. Capital letters represent the differences between groups.

DISCUSSION

IC is an electrotherapy resource widely used all over the world due to its indication for a diversity of conditions [3, 9, 23]. However, although there are technical ways of limiting the accommodation threshold, its effectiveness is questionable. As a consequence, a periodic manual rise of the current amplitude is needed [10, 11]. Therefore, studies addressing the accommodation variables regarding differences between genders are relevant in order to look for special procedures while stimulating male or female populations.

In the present study, healthy male and female adults were studied, to verify the accommodation phenomena threshold in different current intensities and to compare the difference of the thresholds between men and women. Healthy subjects were chosen because there was no intention to observe the therapeutic effects of the IC, and for a better control of the variables, as seen in other similar studies [7, 14, 24-26].

The results showed that the males took more time for accommodation and the time between accommodations were more constant compared to the females, who had crescent times between each accommodation. Additionally, females had a higher number of accommodations than males. There are well documented gender characteristics in young adults that could explain such differences, as fat deposition [27]. Farias et al. [28] body mass index (BMI) observed that corporal fat and abdominal circumference of scholar

female teenagers increased significantly in one year, even with conventional school physical education. According to Chumlea et al. [29] there is a positive relation between the skeletal maturation and the rise of corporal fat in young females in comparison to males of the same age. During biological maturation, boys gain more muscle strength and increase muscle mass diminishing the corporal fat percentage; on the contrary, girls have the action of estrogen hormone, increasing its corporal fat [30].

Although women were lighter and lower, the BMI means were similar in the Female Group and the Male Group. However, notwithstanding the exclusion of participants with under and overweight, no corporal fat analysis was made, and this may be considered a limitation of this study. Furthermore, we suggest that future studies should control the estrous cycle in the female group, as the velocity of the sensorimotor functions can be modified depending on the level of circulatory hormones, especially estrogen and progesterone [20,22].

According to Alabas et al. [31], different stereotypes could play a more important role than gender in relation to pain. It is possible that during this study some participants could have faced higher current intensities than others because of their own tolerance, so we suggest that further studies may take the psychological profile into account while choosing the sample. Since other variables, such as pulse duration, may be important in the analgesia produced by electrical currents [32], as well as in the tolerance to the treatment [33], it is suggested that new studies be performed altering carrier frequencies and comprising several days of therapy.

Within each group we could observe a regular stability regarding the intensities and the magnitude of current amplitude increase. Differences, however, occurred between genders, with males needing higher intensities to obtain adequate stimuli. At least for the first difference (D1), higher amount of current was necessary for them to refer comfortable but intense paresthesia. Since intensity is a very important variable for the analgesic purpose of electric currents, as presented by Moran et al. [34] regarding the use of transcutaneous electrical nerve stimulation, electrical stimulation in men may require an equipment that delivers higher current intensities.

From the presented data, we concluded that in this sample of healthy adults, men required higher IC amplitude to obtain a comfortable paresthesia and took more time to have accommodations, while women had more accommodation episodes in the same period.

NOTES

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This study did not receive financial support from outside sources.

Conflicts of interest disclosure

The authors declare no competing interests relevant to the content of this study. They claim to have had full access to all available data and they take full responsibility for the integrity of the results described herein.

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