

## Effects of $\Delta F$ delivery ramp variation on the accommodation of the interferential current in healthy women\*

*Efeitos da variação da rampa de entrega do  $\Delta F$  sobre a acomodação da corrente interferencial em mulheres saudáveis*

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### SUMMARY

**BACKGROUND AND OBJECTIVES:** Interferential current is a common electrotherapy modality in physical therapy, but the regulation of its parameters is still empirical, being necessary studies to establish adequate parameters for its application. This study aimed at evaluating onset time of the first accommodation and the number of times it occurs during 10 minutes of interferential current application, varying its presentation form of delta F ( $\Delta F$ ) delivery ramps.

**METHOD:** The sample consisted of 18 women divided in 3 groups: Group A – 1:1 (variation every 1 second), in the 2<sup>nd</sup> day 1:5:1 (frequencies increase and decrease in 1 second and maintenance for 5 seconds), 3<sup>rd</sup> day – 6:6 (frequency increase and decrease in 6 seconds); Group B – 1:5:1 in the 1<sup>st</sup> day, in the 2<sup>nd</sup> day we used 6:6 and in the 3<sup>rd</sup> day 1:1; Group C – 6:6 in the 1<sup>st</sup> day, 1:1 in the 2<sup>nd</sup> and 1:5:1 in the 3<sup>rd</sup> day. Stimulation was above the sensory threshold during 10 minutes and volunteers would indicate the moment of the first accommodation and how many times would accommodation occur.

**RESULTS:** During accommodation threshold evaluation, no  $\Delta F$  delivery ramp presented significant difference. There has been significant difference in total num-

ber of accommodations when comparing ramp 1:5:1 to ramp 6:6 with the latter presenting the highest number of accommodations.

**CONCLUSION:**  $\Delta F$  delivery ramp has not influenced accommodation threshold and ramp 1:5:1 had the lowest number of accommodations as compared to ramp 6:6.

**Keywords:** Analgesia, Electric stimulation therapy, Electricity.

### RESUMO

**JUSTIFICATIVA E OBJETIVOS:** A corrente interferencial é modalidade de eletroterapia comum na prática fisioterapêutica, mas, a regulagem de seus parâmetros ainda é empírica, sendo necessários estudos que estabeleçam os parâmetros adequados para seu uso. O objetivo deste estudo foi avaliar o tempo de início da primeira acomodação e o número de vezes em que ela ocorreu durante 10 minutos de aplicação da corrente interferencial, variando a forma de apresentação das rampas de entrega do delta F ( $\Delta F$ ).

**MÉTODO:** A amostra foi composta por 18 mulheres, que foram divididas em 3 grupos: Grupo A – 1:1 (variação a cada 1 segundo), no 2<sup>o</sup> dia 1:5:1 (subida e descida das frequências em 1 segundo e manutenção por 5 segundos), 3<sup>o</sup> dia – 6:6 (subida e descida das frequência em 6 segundos); Grupo B – 1:5:1 no 1<sup>o</sup> dia, no 2<sup>o</sup> dia utilizou 6:6, e no 3<sup>o</sup> dia 1:1. Grupo C – 6:6 no 1<sup>o</sup> dia, 1:1 no 2<sup>o</sup> e 1:5:1 no 3<sup>o</sup> dia. A estimulação era acima do limiar sensitivo, durante 10 minutos, e as voluntárias indicavam o momento em que ocorria a primeira acomodação e quantas vezes ocorria.

**RESULTADOS:** Ao avaliar o limiar de acomodação, nenhuma das rampas de entrega de  $\Delta F$  apresentou diferença significativa. Para o número total de acomodações houve diferença significativa ao comparar a rampa

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1:5:1 com a rampa 6:6, sendo que esta apresentou maior número de acomodações.

**CONCLUSÃO:** A rampa de entrega do  $\Delta F$  não influenciou no limiar de acomodação e a rampa 1:5:1 foi a que obteve menor número de acomodações quando comparada com a rampa 6:6.

**Descritores:** Analgesia, Eletricidade, Terapia por estimulação elétrica.

## INTRODUCTION

Interferential current therapy is a type of electrical stimulation, since the device delivers medium frequency AC currents<sup>1</sup>. This therapy is described as the application of two phases of medium frequency currents (2 or 4 KHz) which are transmitted through the skin surface and the device produces a modulated amplitude current<sup>2</sup>. Resulting current has a frequency equal to the mean of the two currents and will have a new amplitude modulated frequency (AMF) equal to the difference between these currents (e.g., if a 4000 Hz and a 4100 Hz currents are mixed, resulting frequency will be 4050 Hz, with AMF of 100 Hz)<sup>3</sup>.

The literature describes interferential therapy as one of the most widely used electrotherapeutic modalities in the clinical practice<sup>4</sup>. It is indicated to increase muscle strength and resistance, to produce analgesia, to promote tissue recovery and to decrease spasticity<sup>5</sup>.

In the beginning, current intensity is gradually increased until patient reports a tingling sensation. As soon as this sensation decreases, that is, accommodates, intensity may be increased to maintain a constant stimulation<sup>6</sup>. The accommodation process occurs when a physiological response is continuously decreased with the repetitive application of a same stimulation. Initially, receptors respond with high frequency impulses, progressively decreasing as the stimulation becomes constant. Stimulation frequency maintenance is presented as a way of appearance of accommodation<sup>7</sup>.

There are different electric characteristics available in the interferential device, most of them allow the user to adjust such characteristics and there are few studies on optimal parameters for the use of the interferential device<sup>2,8,9</sup>.

$\Delta F$  is an AMF variation where there are frequency increases and decreases in patterns established in the equipment, which go from 1 to 100 Hz. So, if an AMF of 100 Hz is used with a  $\Delta F$  of 50 Hz, modulation variation will happen between 100 and 150 Hz. This will prevent accommodation because, in addition

to intensity, frequency change is another factor preventing accommodation<sup>10</sup>. In  $\Delta F$ , ramp patterns are used with frequency changes over baseline AMF as a function of time, always aiming at preventing accommodations, and for equipment lacking such resource, such as low frequency transcutaneous electrical nerve stimulation (TENS), it is important to increase current intensity to prevent it<sup>11</sup>.

There are also beliefs about the use of  $\Delta F$  delivery ramps, as ramp 1:1 for chronic cases, ramp 1:5:1 for sub acute cases and ramp 6:6 for acute cases. Therefore, there is the need for studies to establish whether there are  $\Delta F$  delivery ramp variation effects on accommodation, whether there are adequate parameters for the use of this device and even to help professionals who use the interferential device as therapy.

This study aimed at evaluating onset time (seconds) of the first accommodation and the number of times it occurred during 10 minutes of interferential current application, by comparing current accommodation and varying the presentation of  $\Delta F$  delivery ramps (1:1, 1:5:1, 6:6).

## METHOD

After the approval of the Ethics Committee for Research with Human Beings, State University of Western Paraná (UNIOESTE) under protocol 1043/2011, this quantitative crossover clinical trial with intentional and non-probabilistic sample was carried out. Participated in this study 18 healthy female volunteers with mean age of  $20.60 \pm 2.43$  years, body mass of  $58.33 \pm 9.19$  kg, height of  $1.67 \pm 0.06$  m and body mass index (BMI) of  $21.72 \pm 1.36$ . Patients were randomly distributed into groups. After being explained about study objectives and procedures, volunteers were submitted to evaluations to identify possible exclusion factors. After having accepted the invitation and being considered eligible for the study, volunteers signed the free and informed consent term.

Inclusion criteria were availability to participate in the evaluations and tests in predetermined days and times and patients should have used interferential current at least once in their lives. Exclusion criteria were absence in electrical stimulation days, presence of neurological or other diseases which could impair cognition, volunteers with clinical and surgical history on the spine and pregnancy.

Volunteers received bipolar interferential current (Neurovector, Ibramed®) with electrodes longitudinally

placed on an L<sub>1</sub> vertebra and another on an S<sub>1</sub> vertebra and care was taken to decrease skin resistance. Electrodes were of rubber-silicone with approximately 4 cm<sup>2</sup>. Equipment parameters: AMF 100 Hz,  $\Delta F$  50%, delta F delivery ramp depending on the day and on the group, intensity was increased until the sensory threshold was reached; then it was increased when the volunteer reported that it had decreased, that is, accommodated, during 10 minutes.

All volunteers received currents with delivery ramp and were divided in three groups (Figure 1):

- Group A (GA) – 1:1 (variation every second) in the 1<sup>st</sup> day, in the 2<sup>nd</sup> day 1:5:1 (frequencies increase and decrease in 1 second and maintenance for 5 seconds), and in the 3<sup>rd</sup> day 6:6 (frequency increase and decrease in 6 seconds);
- Group B (GB) – started with 1:5:1, in the 2<sup>nd</sup> day 6:6 and in the 3<sup>rd</sup> day 1:1;
- Group C (GC) – 6:6 in the 1<sup>st</sup> day, 1:1 in the 2<sup>nd</sup> day and 1:5:1 in the 3<sup>rd</sup> day.

Volunteers were evaluated for a total of 10 minutes and were oriented to say “yes” as soon as the current tingling sensation decreased. The evaluator has recorded how long individuals took to say the first “yes” and how many times they repeated “yes” during the 10 minutes of evaluation. Time was evaluated with a stopwatch and recorded in a table for further statistical analysis.

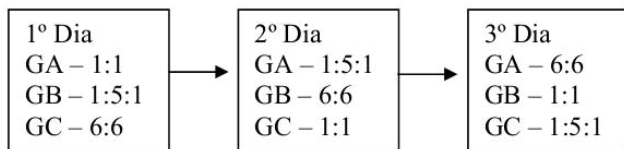


Figure 1 – Flowchart representing the stages of the research, being that the three groups received all forms of stimulation, however in different days.

### Statistical analysis

Data normality was evaluated by Shapiro-Wilk test. Then, statistical analysis was performed with presentation of accommodation threshold data in mean and standard deviation with inferential analysis by ANOVA for repetitive measures and Bonferroni post-test. Data on number of accommodations in 10 minutes were presented as median and 1<sup>st</sup> and 3<sup>rd</sup> quartiles, using Friedman test for comparison and Dunn’s post-test. Significance level for all cases was 5%.

### RESULTS

There has been no significant difference in results of all  $\Delta F$  delivery ramps for accommodation threshold. But for the total of observed accommodations there has been significant difference when comparing ramp 1:5:1 to ramp 6:6 with the latter with the highest number of accommodations ( $p < 0.05$ ) (Table 1).

### DISCUSSION

Electrical stimulation is widely used worldwide<sup>5</sup> since decreased pain improves functionality and quality of life<sup>12</sup>. Interferential current is effective to treat painful conditions<sup>13</sup> and may also be applied to other clinical conditions, such as edema reduction, tissue remodeling, bone healing, treatment or urinary incontinence<sup>2</sup> and primary dysmenorrhea<sup>14</sup>.

Our study aimed at analyzing  $\Delta F$  delivery ramp in interferential currents since the literature is extremely poor in this regard, because even querying databases as Pubmed, Scielo and academic Google, no other studies addressing such subject were found. So, we tried to be based on indications of user manuals of electrotherapy equipment where it is mentioned that the ramp 6:6 is never “still”, as it is the case with the others (1:1 and

Table 1 – Comparison between time for the first accommodation and number of accommodations in different IC  $\Delta F$  in a 10-minute period.

Ramp	Accommodation Threshold		Total Accommodations		
	Mean	Standard Deviation	Q1	Median	Q3
1:1	26.89 s	13.01 s	4.00	4.00	5.00
1:5:1	28.50 s	12.96 s	2.75	4.00	4.00
6:6	30.17 s	14.58 s	4.00	5.00*	5.00

Accommodation threshold was measured in seconds (s). Q1 – 1st quartile, Q3 – 3rd quartile. \* Significant difference as compared to 1:5:1.

1:5:1). It is continuously varying, that is, in the first six seconds it increases surpassing all frequencies within the chosen extension until it reaches the highest frequency, and immediately decreases in the next six seconds. This is automatically repeated. From the three types of ramps, this is the most agreeable, being a frequently used way to prevent accommodation.

However, one should take into consideration that  $\Delta F$  delivery way may interfere little on accommodation because AMF may not be important for the stimulation effect, that is, baseline frequency variation may be very small as compared to AMF frequency<sup>15</sup>. In our study, baseline frequency variation was 4050 Hz to 4075 Hz and AMF variation was 100 to 150 Hz. So, regardless of the chosen delivery way, results have pointed to equal accommodation thresholds, and number of accommodations slightly worse for 6:6 as compared to 1:5:1. This may be occurred because its variation is that of the slowest delivery, however it is controversial whether AMF works or not, since some authors<sup>15,16</sup> mention that AMF does not seem to influence mechanical pain sensitivity in healthy individuals, being unlikely that it would cause a hypoalgesic clinical or physiological effect. A study<sup>5</sup> advocates that modulated current is more comfortable than the current without modulation. It also reports that bipolar current has better effects, with deeper action than the tetrapolar current, thus justifying the use of the bipolar current, as it was the case in this study. It is worth stressing that for low frequency stimulation modalities without devices such as  $\Delta F$  delivery ramp, it is indicated that current intensity should always be high<sup>17</sup> even if amplitude has to be increased for such<sup>11</sup>.

This study was carried out with healthy individuals because the objective was to evaluate the number of accommodations and not its therapeutic goals. For being a crossover study, there has been a plan with 3 sub-groups randomly chosen where all volunteers received the current for 3 consecutive days and the 3 types of ramps, thus working as their own control during comparisons. In the clinical practice, interferential current therapy is a commonly used modality by physical therapists, even without many scientific evidences confirming the adequate parameters for the use of such modality. There are few studies on the subject showing that there is no scientific standardization about application ways and parameters of  $\Delta F$  delivery ramps, about accommodation thresholds and numbers. So, such facts such foster new studies with further methodological rigor addressing this subject.

## CONCLUSION

Analysis of results has shown that  $\Delta F$  delivery ramp has not influenced accommodation threshold and that ramp 1:5:1 had the lowest number of accommodations as compared to ramp 6:6, thus with a slightly better result.

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