Use of different electrical stimulations for treating pain in women with temporomandibular disorders

Utilização de diferentes estimulações elétricas para o tratamento da dor em mulheres com disfunção temporomandibular

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Abstract

Objective: To analyze pain intensity in individuals with temporomandibular disorder (TMD) who were treated with ten sessions of transcutaneous electrical nerve stimulation (TENS) or high voltage electrical stimulation (HVES). **Methods**: Twenty-four women (22.98±1.86 years old) with a diagnosis of TMD in accordance with the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) were selected. Sixty percent of the participants had a diagnosis of TMD classified as group Ia and 40% as Ia and IIa. They were divided into two groups named TENS group (TG) and high-voltage group (HVG). Each participant received ten applications of either TENS (10Hz, modulated at 50%, 200μs and motor threshold intensity) or HVES (10Hz, twin pulses of 20μs each at intervals of 100μs between the twin pulses, 100volts and positive pole) twice a week for 30 minutes. To measure the pain intensity, a visual analog scale (VAS) was used. Statistical analyses were performed using t test and simple linear regression. **Results**: Comparison of the pre- and post-TENS conditions showed diminished pain intensity ($p<0.05$) in most sessions except for sessions 6, 7 and 8. In contrast, HVES reduced the pain intensity in all sessions ($p<0.05$). Evaluation of the pre-application values showed that both treatments decreased the pain intensity uniformly over the ten sessions ($p<0.05$). **Conclusions**: TENS and HVES both promoted reductions in pain intensity in women with TMD. HVES is a therapeutic resource recommended for such patients.

Key words: temporomandibular joint dysfunction; transcutaneous electrical stimulation; pain assessment; Physical Therapy.

Resumo

Objetivo: Analisar a intensidade da dor em indivíduos com disfunção temporomandibular (DTM) tratados com dez sessões de estimulação elétrica nervosa transcutânea (TENS) ou estimulação elétrica de Alta Voltagem (EEAV). **Métodos**: Foram selecionadas 24 mulheres (22,98±1,86 anos) com diagnóstico de DTM, segundo o Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), sendo 60% com diagnóstico de DTM do grupo Ia e 40% Ia e IIa. As voluntárias foram divididas em dois grupos denominados grupo TENS (GT) e Grupo Alta Voltagem (GAV). Em ambos os grupos as voluntárias receberam dez aplicações da TENS (10Hz modulada em 50%, 200 μs e intensidade no limiar motor) ou da EEAV (10Hz, pulsos gêmeos com 20μs cada e intervalo 100μs interpulsos gêmeos, 100Volts e pólo positivo) duas vezes por semana por 30 minutos. Para mensurar a intensidade da dor, foi utilizada a escala visual analógica (VAS). Para análise estatística, utilizou-se teste *t* de *Student* e análise de regressão linear simples. **Resultados**: Comparando-se as condições pré e pós TENS observa-se uma redução na intensidade da dor ($p<0,05$) na maioria das sessões, exceto na sexta, sétima e oitava, enquanto a EEAV reduziu a intensidade da dor ($p<0,05$) em todas as sessões. Avaliando-se os valores pré-aplicação, os dois recursos diminuíram a intensidade de dor de forma uniforme ao longo das dez sessões ($p<0,05$). **Conclusões**: A TENS e a EEAV promoveram redução da intensidade da dor em mulheres com DTM, sendo a EEAV mais um recurso indicado para o tratamento desses pacientes.

Palavras-chave: disfunção da articulação temporomandibular; estimulação elétrica transcutênea; avaliação da dor; Fisioterapia.

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Introduction

Temporomandibular disorder (TMD) is characterized by functional and pathological changes that affect the temporomandibular joint (TMJ), the masticatory muscles and, on occasion, other parts of the stomatognacthic system[1]. According to Magnusson, Egemark and Carlsson[2] the state of the mandibular, cervical and masticatory muscles present in the TMD is the greatest cause of non-dental pain in the orofacial region, and this has a major impact on the quality of life of the individual[3]. In this sense, the treatment of such an illness consists in counseling, drug therapy and physical therapy. Among the physical therapy treatments indicated for TMD are: exercise[4], massage[5], transcutaneous electrical nerve stimulation (TENS)[6-8], ultrasound[9], and laser[6].

TENS has been extensively used in physical therapy to treat pain in patients with TMD. Rodrigues, Oliveira and Bérzin[8] evaluated, among other variables, the effects of conventional TENS application (150Hz modulated at 50%, 20μs, sensorial threshold for 45 minutes) on the intensity of pain in women with TMD and found that this resource promoted significant pain reduction in the participants. The same result was obtained by Gonçalves, Ordenes and Rodrigues-Bigaton[10], although these authors applied TENS with different simulation parameters (10Hz modulated at 50%, 200μs and intensity at motor threshold for 30 minutes).

Kato et al.[6] assessed the effect of ten low-frequency TENS and laser applications (40 minutes) on nine TMD patients and found that both resources were effective in reducing pain in TMD patients.

Alvarez-Arenal et al.[7] demonstrated that 15 low-frequency TENS applications, in 45 to 60-minute sessions, and the use of the occlusal splints in patients with bruxism distributed into two treatment groups were not enough to significantly reduce the signs and symptoms of the TMD, including pain. The same results were found by Linde, Isacsson and Jonsson[11] who evaluated the effect of high-frequency TENS on 31 individuals with TMD.

As observed in the aforementioned studies, it can be stated that, although TENS is widely used in clinical practice, there is no consensus in the literature regarding its efficacy against pain in patients with TMD.

Another resource used in physical therapy is high-voltage electrical stimulation (HVES), indicated as an analgesic and tissue repairer. HVES is a therapeutic modality originally developed in the United States. It has a twin pulse, with an almost instantaneous rise and exponential falls; 0.1 millisecond pulses; usually fixed form and duration and variable double-pulse frequency, generally from 2 to 100Hz[12].

Unlike TENS, HEVS use in the treatment of pain in individuals with TMD has not been described in well-controlled studies. This fact justifies the undertaking of the present study. It is also worth noting that, although both electrical currents are indicated as analgesics, the choice of type, electrical parameters and number of sessions has not been scientifically established.

Given that TENS and HEVS are indicated to promote analgesia, it can be assumed that both treatments would promote analgesia in patients with TMD and that HEVS could be used as a possible physical therapy resource in the treatment of these patients.

Thus, the aim of this study was to analyze the intensity of pain in TMD patients treated with ten TENS or HEVS sessions.

Methods

Participants

The sample calculation was carried out by means of the software GraphPad StatMate version 1.01i 1998, with a 95% confidence interval and 80% power, the number of participants being set at ten.

Thirty-eight patients were evaluated, 29 of which were selected. Three women were excluded from the sample due to the use of pain medication and two gave up the treatment. Thus, 24 women took part in the study, with ages ranging from 18 to 29 (mean age 22.98±1.86 years) and body mass index (BMI) below 25. In group Ia (myofascial pain), 60% of the participants had TMD, and in groups Ia and IIa (disc displacement with reduction), 40% had TMD, according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). All participants signed consent form, and the research was approved by the Research Ethics Committee of Unimep (protocol 03/04 and 25/06).

The inclusion criteria for all patients were: presence of pain in the masticatory muscles during the functional activities for a period of one to five years; occlusive parafunction such as grinding or clenching for at least one year; muscle pain and/or soreness in the morning; and jaw popping.

The exclusion criteria were: systemic musculoskeletal diseases, history of facial and TMJ trauma; joint dislocation and limited ATM range of motion diagnosed by the RDC/TMD; use of braces and use of analgesic and/or anti-inflammatory medication.

The 24 participants were divided into two groups, the TENS group (TG) and the high-voltage group (HVG). The allocation of the participants to groups was based on the order of arrival

for the treatment, and the first treatment offered was TENS, followed by HVES. Although group allocation was not random, the groups were considered homogeneous in relation to age, BMI, and symptom duration.

In both groups, the participants received ten applications of TENS or HVES for 30 minutes, twice a week, according to the group to which they belonged. For the treatment with both resources, the participants remained in the dorsal decubitus position with a cushion under the knees during the applications.

For the application of the TENS, the following equipment was used: Dualpex 961, Transcutaneous Electrical Stimulator® (Quark Medical Products), two channels with four 3x5cm silicon-carbon transcutaneous electrodes. These electrodes were placed bilaterally on the preauricular area and on the masseter muscle, one channel on the right-hand side and the other on the left-hand side. The parameter adopted was 10Hz frequency modulated at 50%, i.e. the frequency variation was 10 to 5Hz, the pulse width was 200 microseconds (μs) and the intensity was at motor threshold, which was identified through visible muscle contraction.

The instrument used for the application of the HVES was the microcontrolled Neurodyn High Volt® (Ibramed) with two channels and four 3x5cm active silicon-carbon electrodes and a 10x18cm dispersive electrode made of aluminum covered by wet felt. The electrodes were placed bilaterally on the anterior portion of the temporal muscle (channel 1) and on the masseter muscle (channel 2). The dispersive electrode was attached to the participants' cervical area because, according to Holcomb[13], it has to be significantly larger than the active one to reduce the current density, hence the need to place it in large areas. Furthermore, the bigger the distance between the active and dispersive electrodes is, the deeper the current[14].

The parameters used in the HVES were: 10Hz frequency, pulse width determined by the equipment with two 20μs twin pulses, each with a 100μs interval, intensity above 100v reaching motor threshold (visible muscle contraction) and positive polarity (anodic HVES) in both channels. The anodic stimulation was based on Alon[15], who claimed that the choice of one of the poles is made according to the patient's comfort and to the desired contraction intensity. According to Holcomb[13], both poles are indicated for analgesia. It is worth noting that in the present study motor stimulation was prioritized and, based on pilot studies, we found that the positive pole produced a more vigorous contraction of the masticatory muscles, therefore being chosen for the treatment.

Both equipments were tested with an oscilloscope (Tektronix TDS 210) according to the physical current parameters specified in the equipment. The equipment *timers* were also tested with three Technos stopwatches. This variable followed equipment specifications. In both equipments, gel was used under the silicon-carbon electrodes to allow the current to be conducted to the tissue. The electrodes had not been previously used.

To measure pain intensity, a Visual Analog Scale (VAS) was used. It consisted of a 10cm horizontal line with the words "no pain" on the left end and "worst pain" on the right end. The participants were advised to draw a vertical line across the horizontal line to indicate at what point the pain was. This stage was carried out before and immediately after each of the ten TENS and HVES applications. The participants did not have access to any of their previous notes so as not to be influenced by them.

The VAS data were analyzed by means of a centimeter (cm) ruler. Pain intensity was measured from the left end, which coincided with the ruler's 0 value, to the line drawn by the patient. It is worth noting that the examiner who analyzed the VAS data did not know to which group each participant belonged, whether the scales were from the pre- or post-application of the resources, nor whether the data were from the beginning or end of the ten applications.

Statistical analysis

The statistical analysis was initially based on the Shapiro-Wilk normality test (JMP® version 3.1.6.2). As the data indicated normal distribution, we used the *t* test for the analysis of the independent samples, in order to compare the mean values of pain intensity recorded in the VAS before and immediately after each TENS and HVES session.

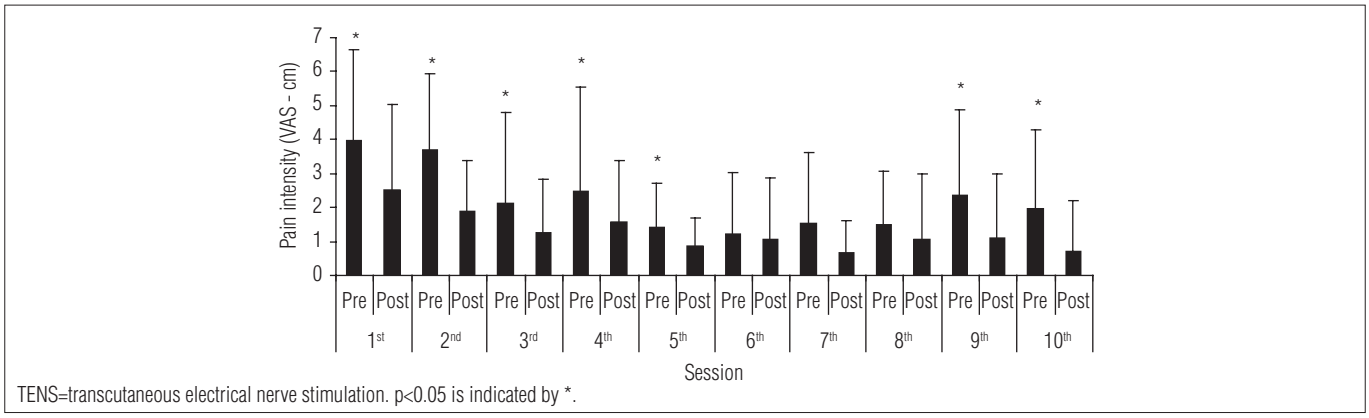
For the analysis and effect of both treatments, we used a simple linear regression analysis. It is worth noting that this analysis included only the mean values of pain intensity recorded in the VAS obtained before the application of each one of the resources. The post-treatment values were not analyzed due to the current's immediate effect.

For all calculations, a critical level of 5% ($p<0.05$) was set.

Results

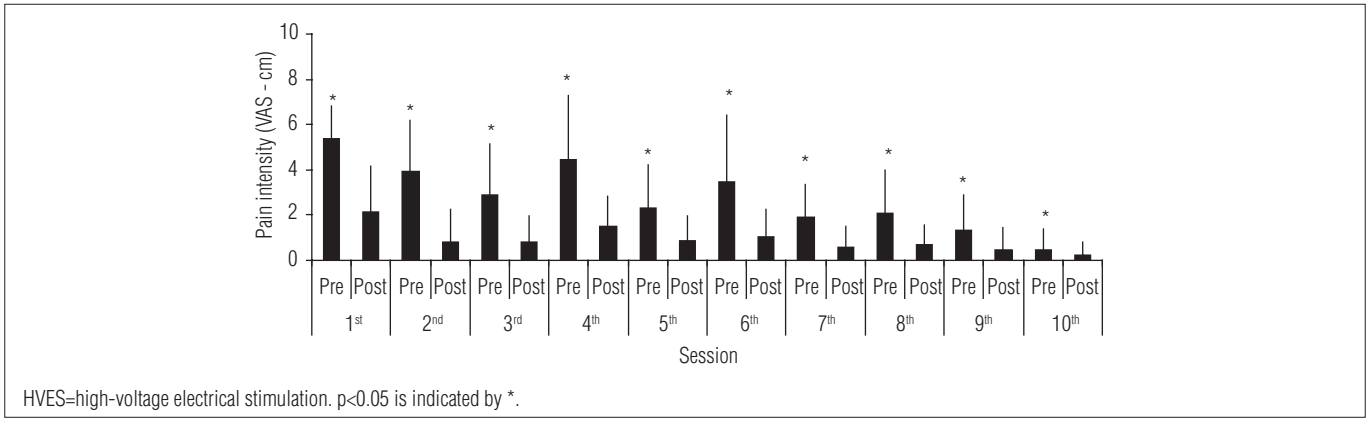
Figures 1 and 2 display the results of the comparison for the mean values of pain intensity recorded in the VAS before and after TENS and HVES.

Figure 1 shows that TENS promoted a statistically significant reduction ($p<0.05$) in pain intensity in most of the sessions, except for the sixth and eighth sessions. Figure 2, in turn, shows that HVES promoted a statistically significant reduction ($p<0.05$) in pain intensity in all sessions.



TENS=transcutaneous electrical nerve stimulation. p<0.05 is indicated by *.

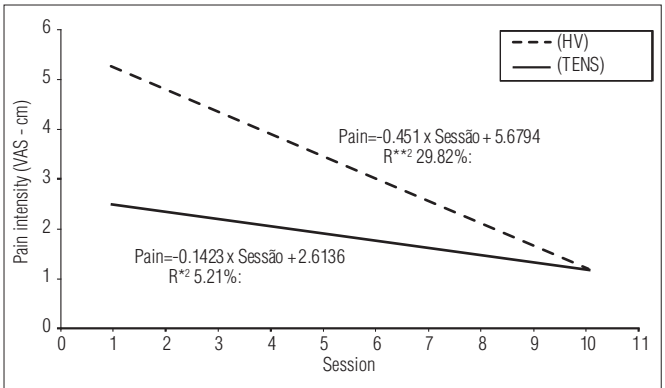
Figure 1. Comparison of the mean values of pain intensity registered in the VAS (cm), before (pre) and after (post) each TENS session (n=12).



HVES=high-voltage electrical stimulation. p<0.05 is indicated by *.

Figure 2. Comparison of the mean values of pain intensity recorded in the VAS (cm), before (pre) and after (post) each HVES session (n=12).

According to Figure 3, the mean values of pain intensity recorded in the VAS before the TENS and HVES applications decreased steadily over the course of the ten sessions carried out twice a week.



TENS=transcutaneous electrical nerve stimulation. HVES=high-voltage electrical stimulation.

Figure 3. The mean values of pain intensity recorded in the VAS (cm), before (pre) and after (post) each session of TENS and HVES (n=24).

Discussion

The results of this study indicate that both the TENS and HVES reduced pain intensity, and that this reduction was statistically significant in all HVES group sessions and in most of the TENS group sessions, except for the sixth, seventh, and eighth sessions.

The data from the TENS group obtained in the present study confirm the findings of Rodrigues, Oliveira and Bérzin[8], Gonçalves, Ordenes and Rodrigues-Bigaton[10] and Kato et al.[6], who observed a significant pain reduction immediately after the application of the high[8] and low-frequency[10] TENS.

In contrast, the results of this research contradict Alvarez-Arenal et al.[7] and Linde, Isacsson and Jonsson[11], who showed that TENS at low-frequency[7] and high-frequency[11] did not significantly reduce pain of patients with bruxism and TMD, respectively. This divergence may be attributed to the way pain was assessed and to the sample characteristics. Alvarez-Arenal et al.[7] did not quantify the pain by means of the VAS, but through the patients' reports. They also assessed patients with bruxism, a fact that may have influenced the results. In the study by Linde, Isacsson and Jonsson[11], the treatment was

given only once a week for six weeks and pain was recorded in the VAS only at the beginning and at the end of treatment, not being considered individually at each session.

With regard to the effect of the treatment on pain intensity, a simple linear regression analysis shows that the variables "pain" and "sessions" are inversely proportional, i.e. as the number of sessions increased, the intensity of pain was attenuated in both groups. Such a result agrees with the conclusions drawn by Ido, Rothenbühler and Janz[16], who studied fibromyalgia patients and demonstrated that the intensity of pain is steadily reduced with the increase in the number of low-frequency TENS sessions applied three times a week. The same result was recorded by Kato et al.,[6] who examined the effect of ten low-frequency TENS applications, and found a decrease in the pain intensity values, measured by the VAS after the period of intervention.

As previously stated, localized muscle pain is one of the most common symptoms of TMD and, according to Larsson et al.[17], this presence of pain results from the local muscle ischemia. Tullberg et al.[18] in turn report that the reduction in microcirculation may lead to the release of chemical mediators which make the peripheral nerves more sensitive, thus causing pain. Based on these claims and those of Okada et al.[19], treatments that improve blood flow are effective for relieving muscle pain in TMD patients.

In this context, it is believed that the reduction in pain intensity in both groups can be attributed to two main therapeutic effects of the currents: analgesia and circulation enhancement, which may have been achieved because of the low frequency and the high intensity of the electrical stimulation.

As for the increase in blood flow, it is known that high-intensity, motor-threshold electrical stimulation by means of TENS and HVES, as put forward in this study, generates a pumping effect (due to the rhythmic muscle contraction and relaxation) that increases localized blood flow and reduces interstitial edema and the accumulation of metabolic residue[20].

Cramp et al.[21] compared the effects of low- and high-frequency electrical stimulation on skin blood flow and temperature in 30 healthy individuals. They concluded that low-frequency stimulation increases local blood flow when compared to high-frequency application, but none of these stimulations affected skin temperature at the site of application. The authors claim that low-frequency TENS causes cutaneous vasodilation, perhaps due to the inhibition of the sympathetic nervous system.

Goldman et al.[22] report that HVES promotes a slow increase in blood flow, reaching near normal standards depending on the number of applications. The increased blood flow promoted by HVES was also observed by Goldman et al.[23], but under the experimental conditions of the present study, it is not possible to assert that the anodic HVES promoted a circulatory increment in the masticatory muscles of women with TMD.

In regard to analgesia, when electrical stimulation elicits a strong, rhythmic (high-intensity) and non-tetanic (low-frequency) muscle contraction, such as those used in the present study for both groups, and increases arterial blood flow to the stimulated area, there is a greater generation of analgesia and activation of mechanisms that release endogenous opiates. Therefore, stimulation at motor level is efficient in the modulation of clinical, experimentally induced pain[24].

After comparing the analgesic effect of TENS and HEVS, it can be stated that HVES is more effective when it comes to pain control in patients with TMD. Figure 1 shows that TENS reduced pain significantly in seven out of ten sessions, whereas the significant analgesic effect of HVES was observed in all of the ten sessions. Figure 3 suggests that pain reduction seems to have been greater among the women who received HVES. Although plausible, these claims cannot be made based on the results of the present study because the intensity of pain in the HVES group was greater than that of the TENS group. Due to this difference, we chose not to do a comparative analysis between the groups, but to analyze them separately.

The difference in pain intensity found in both groups may have occurred because of the non-random distribution of the participants, as the criteria for sample selection and pain evaluation were the same for both groups. Therefore, the limitation of the present study (non-random selection of participants) must be taken into account in future experiments as well as the inclusion of a placebo group, especially for the application of HVES, given the lack of studies on the clinical efficacy of this resource for analgesia.

Conclusions

In the experimental conditions carried out, it can be stated that the hypothesis suggested by the study has been confirmed as both TENS and HVES promoted a reduction in the intensity of pain in women with TMD. Therefore, HVES is one more resource indicated in the treatment of patients with this type of disorder.

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