Effect of transcutaneous electrical nerve stimulation and hypnosis on chronic low back pain

Efeito da estimulação elétrica nervosa transcutânea e hipnose na dor lombar crônica

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ABSTRACT

BACKGROUND AND OBJECTIVES: Among the main non-pharmacological analgesic techniques are physical therapies such as electrotherapy and cognitive-behavioral techniques, such as hypnosis. The objective of this study was to compare the analgesic effect of transcutaneous electrical nerve stimulation (TENS) and hypnosis in the control of chronic low back pain.
METHODS: A crossover study that included 19 young adults of both genders with chronic low back pain who underwent TENS and hypnosis, and pain education as a control group. The quality of pain was assessed by the McGill's questionnaire; pain intensity and threshold were assessed by the visual analog scale. The intensity of spontaneous pain, the threshold and intensity of pain induced by cold and the pressure pain threshold before the interventions, immediately after the interventions and 30 minutes after the end of the interventions were evaluated. Statistical analysis was performed with Generalized Mixed Linear Models, with 5% significance, and Cohen's G effect sizes.
RESULTS: There was a statistically significant decrease in the intensity of spontaneous and cold induced pain in the hypnosis and TENS groups compared to the pain education group. There was a statistically significant reduction of pain in the sensory and evaluation categories in the intervention groups compared to the control group. There was no significant difference for the pressure pain threshold and latency time for cold induced pain.
CONCLUSION: Hypnosis and TENS decreased the intensity of chronic low back pain with no statistically significant difference between them, but statistically different from the pain education control group.

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RESUMO

JUSTIFICATIVA E OBJETIVOS: Entre as principais técnicas analgésicas não farmacológicas estão as terapias físicas como a eletroterapia e técnicas cognitivo-comportamentais, como a hipnose. O objetivo deste estudo foi comparar o efeito analgésico da estimulação elétrica nervosa transcutânea (TENS) e hipnose no controle da dor lombar crônica.
MÉTODOS: Estudo do tipo cruzado que incluiu 19 adultos jovens de ambos os sexos portadores de dor lombar crônica, submetidos a TENS, hipnose e educação em dor como grupo controle. A qualidade da dor foi avaliada pelo questionário de McGill, a intensidade e o limiar da dor pela escala analógica visual. Foi avaliada a intensidade da dor espontânea, o limiar e a intensidade de dor ao frio e o limiar da dor à pressão, imediatamente após as intervenções e 30 minutos depois do final das intervenções. A análise estatística foi realizada com modelos lineares generalizados mistos, com 5% de significância, e tamanhos de efeito G de Cohen.
RESULTADOS: Houve diminuição estatisticamente significativa da intensidade da dor espontânea e ao frio nos grupos hipnose e TENS comparados ao grupo de educação em dor. Ocorreu redução do quadro álgico estatisticamente significativo nas categorias sensorial e avaliativa nos grupos intervenção comparados ao grupo controle. Não houve diferença significativa para o limiar de dor à pressão e o tempo de latência para a dor ao frio.
CONCLUSÃO: A hipnose e a TENS diminuíram a intensidade da dor lombar crônica sem diferença estatisticamente significativa entre si, porém estatisticamente diferentes em relação ao grupo controle.
Descritores: Dor lombar, Estimulação elétrica nervosa transcutânea, Hipnose, Modalidades de fisioterapia.

INTRODUCTION

Chronic low back pain (CLBP) is characterized by pain, discomfort or muscle fatigue in the lower third of the spine[1-4] and is considered a public health problem, constituting a heavy burden for health and social security systems[5].
The treatment of lumbar dysfunctions involves non-pharmacological drugs and analgesic techniques with physical therapies such as electrotherapy, which activates the sensitive-discriminative system and stimulates the pain suppressor system[6]; and with cognitive-behavioral techniques, such as hypnosis, which pro-

motes muscle relaxation, attention distraction and suggestion, interfering in the stimulation of pain[7].

Transcutaneous electrical nerve stimulation (TENS) is an analgesic technique for the relief of acute and chronic pain, including low back pain (LBP), applied with different frequencies, intensities and durations of stimulation pulses, aiming at activating ascending or descending antinociceptive pathways. Some studies point out that the effectiveness of TENS may depend on the frequency and neural accommodation, a process that occurs when a physiological response is continuously decreased, which can be an important factor for the perception of analgesic stimulus[8-11].

Hypnotic techniques have presented evidence in brain activities in locations related to pain. The "hypnotic trance", the basis of hypnosis, defined as a voluntary state in which the individual is more willing to accept suggestions without critical evaluation of information can produce a facilitating state of analgesia in the upper nervous centers[12,13] and can be useful as therapy for CLBP[14,15].

The hypothesis is that both techniques induce analgesia, but TENS may have superior results when the quality of pain perception presents a predominant sensory aspect and, conversely, hypnosis would present superior effects when the quality of pain is affective. This study aimed primarily to compare the effect of analgesic techniques, TENS and hypnosis in patients with CLBP, in a single application. The secondary objective was to evaluate whether the analgesic effect of the techniques occurs through different qualifications of pain perception.

METHODS

Quantitative and crossover study, with a sample consisting of 19 volunteers, of both genders (12 women and 7 men), with a mean age of 21.36±2.75 years old, height 1.71±0.09m, weight 75.24±17.81kg and body mass index (BMI) 25.56±4.24kg/m^2, that presented diagnosis of CLBP and that accepted to participate in the research, signing the Free and Informed Consent Term (FICT). For this sample size, based on the visual analog scale (VAS), difference of 1.5cm, standard deviation of 1.4, the power of the test was calculated at 80%.

Inclusion factors were: age between 18 and 30 years old, LBP for more than three months and readiness to participate in the study. The exclusion factors were: doing physiotherapeutic treatment by electroanalgesia, regardless of the used current, to have a cardiac pacemaker, to be pregnant, to have undergone surgical procedures in the spine, to have used analgesic drugs 24 hours before the interventions, to have contraindication against cold and to have red flags related to LBP[16].

Data collection and interventions were performed at the Physical Rehabilitation Center (CRF - Centro de Reabilitação Física) of UNIOESTE, by trained therapists, being only one therapist responsible for the application of each therapeutic method and the evaluations made by the same evaluator. The McGill pain questionnaire was applied for the qualification of painful perception and the VAS for quantification of pain. Evaluation of pain threshold and intensity of pain induced by cold, as well as evaluation of pressure pain threshold was also performed. All evaluations were performed sequentially before (AV1), just after (AV2) and 30 minutes after interventions (AV3).

All participants went through three interventions, one each week. The sample was randomly divided at https://www.graphpad.com/quickcalcs/randomize1/, and each individual received the interventions alternately once a week, for a total of three weeks, so that all were submitted to TENS, hypnosis and pain education (PE).

The McGill Pain Questionnaire is organized into four categories, with variable numbering for the words in each subclass. Volunteers were asked to choose one word from each subcategory, also being allowed to choose none. For the evaluation score the sum of the word values of each subclass was considered for each category score.

The VAS consists of a 10cm line, with the phrases "no pain" and "unbearable pain" at the extremes corresponding to "zero" and "10". Each individual chose a position on the line that best quantified their pain.

For the evaluation of the threshold and intensity of pain induced by cold, the temperature of an ice cube was measured with an infrared thermometer, which was positioned over the spinous process of the fifth lumbar vertebra (L5). The time from the placement of the cube to the moment the individual reported pain was measured and then the intensity of pain was evaluated by the VAS.

The pressure pain threshold was measured though the DDK-50 (Kratos®, São Paulo, Brazil) algometer, capable of exerting pressure of up to 50kgf. The volunteers were positioned in ventral decubitus position, palpation of the lumbar vertebrae was performed to identify the one with the greater discomfort, pressure was exerted by the algometer with a circular end of 1.2cm in diameter positioned 1cm beside the vertebra. Pressure was increased until the volunteer reported the onset of pain, and the pressure was recorded in gram-force.

For the TENS application, volunteers were positioned in ventral decubitus position on a treatment stretcher, and electrical stimulation was applied through the TENS device (Ibramed®, Amparo, Brazil), with phase duration of 250μs and frequency of 100Hz, by pairs of electrodes placed bilaterally, 1cm from the spinous processes of the lumbar vertebrae, from L1 to L5, for 30 minutes, at the patient›s tolerance level[17]. Each individual was warned that they would feel a tingling sensation from moderate to strong, but not pain, and when they felt the intensity of the current accommodating, they should tell the therapist, so that the intensity is increased.

The hypnosis was performed in an individual therapist/patient session lasting 30 minutes. The sessions took place in a room with light, temperature and reduction of external noise suitable for relaxation. After the trance was deepening, the patients were given suggestions for pain relief[18]. The volunteer was suggested to identify each painful point in the body and attribute to them shape, color and mass.

The subjects were slowly and calmly suggested that, for each respiratory movement, these points were becoming smaller, more transparent and light. The changes in shape, color and mass were becoming so intense that these points got loose like soap bubbles being carried far away until they blew up and disappeared, alluding to the pain that moved away and disappeared. At the end of the trance, the idea that the feeling of well-being and pain relief produced would be maintained indefinitely after the end of the session was reinforced.

The PE method was carried out by lectures addressed to the participants in order to provide information and clarify doubts regarding LBP. Support material was distributed at the end. The PE served as control, being performed only once for each individual. Evidence shows discrete results of isolated PE in individuals with CLBP[19].
This study was approved by the Research Ethics Committee of the State University of Western Paraná (2.681.234) (Brazilian Registry of Clinical Trials: RBR-7528X4).

Statistical analysis
The SPSS 20 software was used. The adopted significance level was 5% (α=0.05). The analyses were made through the Generalized Linear Mixed-effects Models (GLMMs) with Bonferroni post-hoc. In the tables, the significant differences between groups were pointed out by different capital letters and differences within the intervention groups by lowercase letters. Cohen's effect size analysis was performed according to the following classification: <0.2: trivial; 0.2-0.5: small; 0.5-0.8: moderate; >0.8: large.

RESULTS

The McGill questionnaire showed a decrease in scores in the four categories, with some differences between them, indicating a reduction in the pain scenario of the intervention groups. In the sensory category there were differences between the groups (p<0.001), moments (p<0.001) and interaction (p=0.017), for the PE moment there was no change in values, but reduction for the other two moments.
In the affective category there were differences between groups (p<0.001) and moments (p=0.016). In the evaluation category there were differences between groups, moments and interaction (p<0.001), showing that at the PE moment there was no reduction of scores, but there was for the other moments. In the miscellaneous category these results were repeated with differences between groups (p<0.001), moments (p=0.003) and interaction (p=0.019), and the evaluations within each moment showed that only after the TENS there was reduction of values (Table 1).
As for the effect size observed when comparing the subsequent evaluations with the first, it was possible to observe that for PE the effect size was trivial; for TENS they were moderate or large; and for hypnosis they varied from trivial to large (Table 2).
The pain intensity values, for both spontaneous and cold induced pain, showed that there were differences in groups (p<0.001 and p<0.001), moments (p<0.001 and p=0.002), as well as interaction (p=0.002 and p=0.036), indicating that there were no reductions only for PE. The pain thresholds, both at cold and pressure, did not present significant differences in comparisons between and within groups (p>0.05) (Table 3).
The size of the effect of PE, regardless of the analyzed variable, was trivial; however, for TENS and hypnosis, regarding the intensity measured by the VAS, they were large. Regarding the intensity of pain induced by cold measured by the VAS, TENS showed moderate and high results and hypnosis showed moderate; for the threshold of cold induced pain, the modalities varied from trivial to small and for the pressure pain threshold they were small and moderate for TENS in AV1-AV2 (Table 4).

Table 1. Mean and standard deviation for the sensory, affective, evaluation and miscellaneous variables, by the McGill's pain questionnaire, with comparisons between and within groups

		Sensory	Affective*#	Evaluation	Miscellaneous
PE#	AV1	17±7Aa	4.4±3.9	3±1Aa	7±4Aa
	AV2	17±7Aa	4±4	2.6±1.2Aa	7±4Aa
	AV3	17±7Aa	4±4	3±1Aa	6.8±3.9Aa
TENS	AV1	13.1±7.5Ba	2.5±3	2.2±1Aa	4.7±4.5Ba
	AV2	7.9±7.1Bb	1±1.7	1.2±1.7Bb	2.2±3Bb
	AV3	7.5±5.6Bb	0.8±1.4	0.9±0.7Bb	1.6±1.9Bb
Hypnosis	AV1	11.7±6.8Ba	1.7±2.3	2±0.8Aa	2.7±2.5Ca
	AV2	5.7±4.6Bb	0.7±1.5	0.9±0.9Bb	1.9±2Ba
	AV3	8.4±5.4Ba	0.5±1.4	1.1±0.9Bb	1.9±2.1Ba

PE = pain education; TENS = transcutaneous electrical nerve stimulation.
Similar capital letters demonstrate statistical similarity between the groups for the same evaluation. Similar lower case letters demonstrate statistical similarity within the group for the different evaluations. *Significant difference between AV1 and AV3, regardless of the group. # Significant difference between PE and interventions, regardless of the moment.

Table 2. Observed effect size values for McGill's pain questionnaire items. Evaluations within subgroups, compared to the first evaluation (AV1)

		Sensory	Affective	Evaluation	Miscellaneous
PE	AV1 – AV2	0.0	0.0	0.0	0.0
	AV1 – AV3	0.0	0.0	0.0	0.0
TENS	AV1 – AV2	-0.70	0.58	-0.73	-0.66
	AV1 – AV3	-0.83	-0.72	-1.48	-0.90
Hypnosis	AV1 – AV2	-1.04	-0.53	-1.31	-0.35
	AV1 – AV3	-0.55	-0.62	-1.06	-0.31

PE = pain education; TENS = transcutaneous electric nerve stimulation.

Table 3. Mean and standard deviation for the variables of pain intensity, threshold in seconds and pain intensity induced by cold, as well as pressure pain threshold, with their respective comparisons between and within groups

		VAS	Threshold for cold	VAS for cold	Pressure pain threshold
PE	AV1	4.8±2Aa	8.4±11Aa	6±1Aa	5734±1890 Aa
	AV2	5±2Aa	8.5± 11Aa	6±1Aa	5744±1862 Aa
	AV3	5±2Ba	8.5±11 Aa	6±1Aa	5717±1812 Aa
TENS	AV1	4.9±2.2Aa	6.7±10.1 Aa	5.3±2ACa	5207±1628 Aa
	AV2	2±2.3Bb	10±12 Aa	4.2±1.1Bb	6004±1507 Aa
	AV3	2.1±1.5Bb	8.3±12.4 Aa	3.5±1.4Bb	5835±1670 Aa
Hypnosis	AV1	4.6±2.5Aa	7±11.3 Aa	4.7±1.9BCa	5584±1853 Aa
	AV2	2.5±2.5Bb	8.5±10.3 Aa	3.6±1.5Bb	6296±1884 Aa
	AV3	2.5±1.8Ba	9.2±12.5 Aa	3.9±1.4Bab	6273±2301 Aa

VAS = visual analog scale; PE = pain education; TENS = transcutaneous electrical nerve stimulation.
Similar capital letters demonstrate statistical similarity between the groups for the same evaluation. Similar lower case letters demonstrate statistical similarity within the group for the different evaluations.

Table 4. Values of observed effect sizes for pain intensities and thresholds. Evaluations within subgroups, compared to the first evaluation (AV1)

		VAS	Threshold for cold	VAS for cold	Pressure pain threshold
PE	AV1 – AV2	-0.03	0.01	0.04	0.01
	AV1 – AV3	-0.06	0.01	0.04	-0.01
TENS	AV1 – AV2	-1.27	0.29	-0.65	0.51
	AV1 – AV3	-1.43	0.14	-0.99	0.38
Hypnosis	AV1 – AV2	-0.84	0.14	-0.66	0.38
	AV1 – AV3	-0.94	0.19	-0.51	0.33

VAS = visual analog scale; PE = pain education; TENS = transcutaneous electrical nerve stimulation.

DISCUSSION

A comparison of the immediate effect of two analgesic techniques with different characteristics was evaluated in young adults with CLBP. The evidence was that both were effective, with advantages for TENS in pain induced by cold.

CLBP may not present well defined causes, so its etiology is multifactorial. Some etiological factors are more frequent, such as degenerative and inflammatory processes, as well as congenital or mechanical postural changes.

The imbalance between the effort required for a determined activity and the potential to develop it can generate pain[3,20]. The etiology of CLBP may be anatomical or physiological, however, psychosocial factors have a direct impact on the perception of pain, because emotional problems such as stress, depression, anxiety and fear interfere with neurological processes of pain modulation[21].

Knowledge of the pain pathways, as well as their basic mechanisms of action, is essential for understanding the pain scenario and for understanding the methods of intervention for pain relief[22]. Pain starts with activation of nociceptors in the periphery generating stimuli that are conducted to the central nervous system where they will be processed, generating the sensation of pain. Specific regions of the encephalus, such as the periaqueductal gray substance, the nucleus raphe magnus, the insular cortex and the medial prefrontal cortex play an important role in modulating nociceptive spinal activity and can contribute to cognitive and affective aspects. In chronic pain syndromes, the nociceptive system presents an altered threshold of response to pain, which generates pain scenarios as a response to stimuli considered to be non or mildly painful, therefore, the pain is maintained[23,24].

Neuroimaging studies related to pain modulation show changes in the activity of specific areas of the brain responsible for pain modulation when individuals receive stimuli of distraction through cognitive tasks during cold induced pain[25]. This study showed reduction in general pain scores and in the cold and hypnosis intervention, although for the latter the use of TENS showed better results.

The hypnotic technique can, besides shaping pain perception, influence sensory and affective aspects of pain perception[26,27]. In experimental studies, hypnotic analgesia has been shown to be associated with changes in pain thresholds, including brain activity, potentials related to somatosensory events and spinal reflexes. The more susceptible to hypnosis individuals are, the better the result obtained in relation to analgesia[25], something that was observed in this study, since the scores of the McGill questionnaire, which assessed the subjective character of pain, changed after the interventions. On the opposite, a study that evaluated the pain threshold in healthy individuals did not show alterations after hypnosis[28]. In addition to that, hypnosis was not advantageous compared to TENS in the evaluation of affective modality and presented similar results in the sensory modality.

The application of TENS reduced pain intensity, probably through ascending analgesic pathways, as in the Gate Control Theory[9,10]. A retrospective cohort study evaluated pain changes after 60 days of high frequency TENS use, suggesting that this therapy is an option for the treatment of chronic pain because it reduces pain in-

tensity, improving sleep and mood changes due to analgesic effects probably resulting from the activation of central pain inhibition[29], as demonstrated in this study, where there was a reduction in the intensity of spontaneous and cold induced pain.

No difference in the pressure pain threshold was observed in the present study, regardless of the technique used, unlike a study that showed significant increase in the pressure pain threshold with the use of TENS for 15 minutes at 120Hz and pulse duration of 100μs[30]. The authors evaluated the point of greatest pain and two more adjacent points, different from this study, which evaluated only one point lateral to the spinous process most painful on palpation.

New studies with different methods need to be developed in order to assess pressure pain, with longer therapy times, to evaluate the effects in longer terms. Another limitation of this study is that the control group received health education techniques, which may have influenced results[31]. However, when isolatedly applied, health education produces small effects on pain reduction[19,32].

CONCLUSION

Hypnosis and TENS techniques have reduced pain in patients with CLBP. There was no significant difference between the two techniques.

AUTHORS' CONTRIBUTIONS

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Funding acquisition, Data Collection, Research, Methodology, Writing - Preparation of the original
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