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Transcutaneous electrical nerve stimulation after coronary artery bypass graft surgery

Estimulação elétrica nervosa transcutânea após cirurgia de revascularização miocárdica

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Abstract

Introduction: **After cardiac surgery, patients have a limitation in respiratory muscle strength, which favors the appearing of pulmonary complications.**

Objective: **To evaluate the effectiveness of transcutaneous electrical nerve stimulation (TENS) on the painful process and respiratory muscle strength in patients undergoing coronary artery bypass graft (CABG).**

Methods: **The study included patients after on-pump CABG through sternotomy, general anesthesia, without being under the influence of neuromuscular blockade, with use of chest and mediastinal tubes, and extubation within 6 hours after the procedure and presenting index equal to or greater than three visual analog scale (VAS) of pain being on the first day after surgery. We recruited 20 patients divided into two groups with no predominance of sex: the control group (n = 10), who received more physiotherapy analgesic therapy, and TENS group received analgesic therapy, physiotherapy and TENS. The TENS was applied for 30 minutes, three times a day, a 3-hour period each application.**

Results: **For the degree of pain, there was an average start and end, respectively, 7.0 / 1.0 for the TENS group and 7.0 / 8.0 for the control group. For inspiratory muscle strength, - 102.5 cmH_2O / - 141.17 cm H_2O to the TENS group and - 97.0 cmH2O / - 100.3 cm H_2O for control. The expiratory muscle strength, 63cmH_2O/125 cmH_2O for the TENS group and 55.3 cmH_2O/ 53, 2 cmH_2O for the control group.**

Conclusions: **TENS has shown significant effectiveness in reducing pain, and the increase in respiratory muscle strength at first-day after CABG surgery.**

Descriptors: **Pain. Muscle strength. Transcutaneous electric nerve stimulation. Cardiovascular surgical procedures.**

Resumo

Introdução: **Após a cirurgia cardíaca, os pacientes apresentam limitação na força muscular respiratória, o que favorece a instalação de complicações pulmonares.**

Objetivo: **Analisar a eficácia da estimulação elétrica nervosa transcutânea sobre o processo doloroso e força muscular respiratória em pacientes submetidos à cirurgia de revascularização do miocárdio (CRM).**

Métodos: **Foram inclusos pacientes em pós-operatório de CRM por meio de esternotomia, com uso de circulação extracorpórea, anestesia geral, sem estar sob efeito de bloqueio neuromuscular, uso de drenos de tórax e mediastino, extubados até 6 horas pós-procedimento e apresentando índice igual ou superior a três na escala analógica visual da dor (EVA), estando no primeiro dia de pós-operatório (1º DPO). Foram recrutados 20 pacientes, divididos em dois grupos, sem predomínio de sexo: Grupo Controle (n=10), que recebeu terapia analgésica mais**

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fisioterapia; e Grupo TENS, que recebeu terapia analgésica, fisioterapia e TENS. A TENS foi aplicada por 30 minutos, três vezes ao dia, num intervalo de 3 horas cada aplicação.

Resultados: **Para o grau de dor, houve uma média inicial e final, respectivamente, de 7,0 e 1,0 para o Grupo TENS e 7,0 e 8,0 para o Grupo Controle. Para a Pimáx, a média inicial e final foi de, respectivamente, -102,5 cmH_2O e -141,17 cmH_2O para o Grupo TENS e -97,0 cmH_2O e -100,3 cmH_2O para o Controle. Quanto a Pemáx, a média inicial e final foi de, respectivamente, 63 cmH_2O e 125 cmH_2O para o Grupo TENS e 55,3 cmH_2O e 53,2 cmH_2O para o Grupo Controle.**

Conclusão: **A TENS demonstrou eficácia significativa na redução da algia e no aumento das forças musculares respiratórias no 1º DPO de CRM.**

Descritores: **Dor. Força muscular. Estimulação elétrica nervosa transcutânea. Procedimentos cirúrgicos cardiovasculares.**

INTRODUCTION

Pulmonary complications have been described by several authors as a major cause of postoperative morbidity [1-9]. Complications such as: decrease in forced expiratory volume in the first second (FEV_1), functional residual capacity (FRC), tidal volume (TV), arterial pressure oxygen (PaO_2), besides the increase of atelectasis [7.10, 11]. However, few studies are found reporting the effect on respiratory muscle strength [7,12].

According to the International Association for the Study of Pain, pain is defined as "an unpleasant sensory and emotional experience associated with actual or potential damage of tissues, or described in terms of this" [13]. Pain after surgery has completely multifactorial origin and may be caused due to surgical incision, pleural tubes, and procedures that the patient is subjected [14]. This is present even before the surgery and it is important in respiratory function in the postoperative period, which may aggravate bronchial hygiene. These findings lead us to develop different strategies in the treatment of pain and physical therapy that might interfere with pain, with consequent improvement in lung function [15].

The transcutaneous electrical nerve stimulation (TENS) is a physical therapy feature widely used for symptomatic relief of pain and it can be a useful adjunct in the management of postoperative pain [11-16]. This form of stimulation does not produce systemic effects, it is not invasive or pharmacological, it is not addictive, nor does it have side effects and absolute contraindications it is a low-cost procedure, in addition to allow the patient to participate more completely in physical therapy [11 , 17]. It has been reported in the literature that pain relief after surgery by the use of TENS is associated to the reduction of the use of opiates [10,16,18-20].

Its physiology stimulates nerve fibers that transmit signals to the brain, interpreted by the thalamus as pain. The basis of the effect of TENS is given as the Theory of Gates, developed in 1965 by Melzack & Wall, who claimed that the overstimulation of type A fibers promotes blocking of incoming stimulus by type C fibers in the gates of the posterior horn of the spinal cord in the jelly substance and the transmission cells (T cells) [16].

The objective of this study was to analyze the effectiveness of conventional TENS on the painful process and respiratory muscle strength in patients undergoing coronary artery bypass grafting through median sternotomy.

METHODS

This study was performed in 5-month period from November 2008 until April 2009, at the Cardiac ICU of the Instituto de Doenças do Coração (IDC) of Santa Casa de Misericordia de Maceió. It was a field study, controlled, which included 20 patients of both genders, aged from 40 to 60 years of age, undergoing coronary artery bypass grafting through median sternotomy with cardiopulmonary bypass (CPB), general anesthesia, use of chest and mediastinal tubes, extubated within six hours after ICU admission (Fast Track) and showing a rate equal to or greater than three in the visual analog scale of pain (VAS).

We used as exclusion criteria: diabetes mellitus, age under 40 and over 60 years, patients with cognitive deficit, with center and / or peripheral neurological sequelae, with painful symptoms of undiagnosed cause, with the presence of metallic implants, pacemaker patients undergoing coronary artery bypass grafting by thoracotomy, who had local infection, still under the effect of neuromuscular blocking agent, and not adapting to the use of TENS.

Patients were approached directly and individually, on the first day after surgery (1 POD) in the cardiac ICU, and after being informed about the procedures they would be exposed, we obtained the signatures of the term of informed consent (IC) according to the resolution 196/96 CONEP. The study protocol was approved by the Ethics and Research Committee of FCBS (CEP-FCBS / CESMAC), protocol 511/08 on September 1, 2008.

The distribution of patients according to sex, was sequentially and alternately, where the first patient received the number one, number two the second and so on, the odd numbers being directed to the control group and even numbers to the TENS group. Patients, thus, were divided into two groups: control group (followed the usual routine of analgesics and physiotherapy at the hospital) and TENS group (followed the usual routine of analgesics and physiotherapy at the hospital, plus the conventional TENS). Both groups consisted of 10 patients, with no predominance of gender.

We used an electrical stimulation unit that contains the conventional TENS brand Orion, with two channels, with silicon electrodes, rectangular shape (5 x 3.5 cm). As a means of contact it was used aqueous gel, and for attachment, masking tape. We used two channels where the electrodes were arranged in parallel and pericicatricial fashion at 4 cm from the surgical incision. The duration of application was 30 minutes, being held on the 1st POD for three times, at 14, 17 and 20 hours.

The frequency that was used in TENS was 80 to 110 Hz, with pulse widths between 50 and 80 μs. The intensity of stimulation was modified according to the patient's report and being adjusted based on an intense feeling of numbness that would not cause discomfort, not being increased during application.

For pain assessment it was used VAS, graduated from zero to ten, where zero means no pain and ten, severe pain, being applied before and after. Similarly, measurement was made of muscle strength (MIP) and expiratory muscle strength (MEP) through the manometer brand Marshall Town, before and after, being carried from the functional residual capacity (FRC) for three times, where the highest value was considered, and the patient placed in a 60° Fowler. The data were stored on a folder developed for this purpose.

The sample size was calculated in 10 subjects for each group (standard deviation of 10, a difference of 12 to be detected; significance level of 5% test power of 80%) via the software online Graphpad ® using as a means of calculation the page of the Laboratory of Epidemiology and Statistics of the Institute Dante Pazzanese, which is available online (www.lee.dante.br/pesquisa/amostragem / calculo_amostra.html). To compare the ratings between the control group and TENS group it was used the nonparametric test of Mann-Whitney, adopting the significance level of 5% (0.05). To compare the ratings before and after for each group we used the nonparametric test of Wilcoxon, adopting the significance level of 5%. Subsequently, being tabulated and processed in a spreadsheet (Microsoft Excel 2000 for Windows).

Table 1. Description of the sample regarding the time of cardiac surgery, cardiopulmonary bypass time, degree of pain, MIP and MEP in patients undergoing coronary artery bypass grafting through median sternotomy.

	TENS (n=10)						Control (N=10)					
		Before		After				Before		After		
	N	Mean	SD	Mean	SD	P	N	Mean	SD	Mean	SD	*P*
Total	10						10					
T. CPB		95´						75´				
T. CC		255´						240´				
Age		54.2						55.1				
Pain		7.0	1.78	1.0	0.67	0.001		7.0	2.01	8.0	1.96	0.2748
MIP		-102.5	14.87	-141.17	13.65	0.003		-97.0	54.65	-100.30	54.52	1
MEP		63.0	37.23	125.0	34.47	0.003		55.3	8.96	53.20	8.96	1

T. CPB- Cardiopulmonary bypass time (min), T. CC - Time of cardiac surgery (min) MIP - Maximal inspiratory pressure (cmH_2O), MEP – Maximal expiratory pressure (cmH_2O)

RESULTS

Twenty individuals consisted the homogeneous sample, with no predominance of gender in the ICU of Instituto de Doenças do Coração (IDC) of Santa Casa de Misericordia de Maceió. The description of sex in groups, the mean duration of surgery and CPB, degree of pain, MIP and MEP start and end are shown in Table 1.

We observed the use of medication in the control group during the time of intervention, from 14h to 20h30. Of the ten patients in the control group, four were treated with sodium dipyrone and two with morphine sulfate. Only one patient of the TENS group requested analgesic and the remaining patients did not require drug therapy in the schedule above due to significant pain relief.

As for heart rate (bpm), no significant changes were noted during the hours of research, both in the control group as in the TENS group.

Comparisons within the TENS group showed to be significant in all parameters evaluated, with a reduction in algia, increased respiratory muscle strength and decrease in requests for analgesics. This was not seen in the control group.

DISCUSSION

Several authors [21-23] evaluated patients who underwent cardiac surgery for the location and intensity of pain during the hospitalization, pain influence on pulmonary function and its correlation with the characteristics of the individual and the surgical procedure and concluded that there was significant damage to lung function, without full recovery until the 5th POD.

The postoperative pain control is essential for comprehensive care to surgical patients, as prolonged painful stimuli appear to predispose to more severe pain and complications in the postoperative period [24]. Since the 1970s, the effects of TENS have been studied on acute and chronic pain. Some studies were extended to also benefit the algesic processes occurring in the postoperative period [25].

According to Brodsky and Mark [26], the results after lateral thoracotomy or sternotomy are varied; with many studies supporting the effectiveness of TENS in patients undergoing such surgeries and others claiming that TENS has little or no value after these procedures. In a study of 324 patients undergoing different types of chest surgery, Benedetti et al. [27] reported that TENS has little or no benefit after procedures associated with severe pain (posterolateral thoracotomy). In pain score suggested by the authors, the patients in this study had a moderate degree of pain, however, unlike the results seen by them, the patients in this study had reduced the degree of pain regardless of TENS having been associated with drug therapy or not. Nonetheless in their study there was no assessment of pain, but the consumption of opioid analgesics.

After heart surgery, patients have a limitation in respiratory muscle strength compared to before surgery, which facilitates the installation of pulmonary complications. Emmiller et al. [28], Navarathnam et al. [29], Lima et al. [30] and Klin et al. [31] evaluated the effects in their studies of TENS in cardiac postoperative and found that electrical stimulation decreases the level postoperative pain and reduces the amount of analgesics compared to placebo group or control group. A similar result was found in this study regarding pain reduction in TENS group, differing only in reducing pain in the control group, where it remained in this study. This fact has allowed the improvement of respiratory muscle strength and increased volumes and lung capacity, proving to be a valuable tool in the hands of the physiotherapist in hospital [31].

Cipriano et al. [32], after studying the transcutaneous electrical nerve stimulation in short-term pain control after cardiac surgery, concluded that there was an improvement in respiratory muscle strength and increased lung volume and capacity, as well as reducing the degree of pain demonstrating the positive effects on pulmonary function after use of TENS [32]. In this study, the use of TENS led to significant increase in both MIP (P <0.003) and in the MEP (P <0.003), whereas in the control group results were maintained.

Several studies have concluded that TENS is effective in controlling postoperative pain after median sternotomy after cardiac surgery, confirming the results of this study, and it could be useful when patients had burning pain [27,28,32-34].

Although there are many controversies and rejection in relation to the use of TENS in any post-operative and the few studies specifically in cardiac surgery, we observed that there is a tendency to the effectiveness of TENS in the results found than otherwise, which was confirmed in the present study, which showed a significant reduction in the degree of pain and also significant increases in MIP and MEP values after the use of TENS.

CONCLUSION

According to our results, TENS was effective in controlling postoperative pain in patients in the 1st POD of coronary artery bypass grafting, avoiding excessive use of analgesics, as well as the improvement in respiratory muscle strength, especially in MEP, this muscle is so important for airway patency and prevention of pulmonary complications. Hence, we suggest the inclusion of TENS in the hospital postoperative routine as an alternative to drug therapy,

which is effective, inexpensive, non-invasive, with no side effects, providing better welfare, without pain within an intensive care unit.

It is suggested, therefore, the continuity of the study in order to reinforce the results found in this study, as well as broaden the scientific answers on the subject.

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