ESTIMULAÇÃO ELÉTRICA TRANSCUTÂNEA NO ALÍVIO DA DOR NO PÓS OPERATÓRIO DE CIRURGIAS CARDÍACAS

ELECTRICAL STIMULATION AFTER HEART SURGERY

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RESUMO

A estimulação elétrica nervosa transcutânea pode reduzir o quadro álgico dos pacientes em pós-operatório de cirurgia cardíaca. OBJETIVO: Verificar os benefícios no alívio da dor no pós-operatório de cirurgias cardíacas através dos efeitos da estimulação elétrica transcutânea, decorrentes de uma revisão sistemática da literatura. MÉTODO: Utilizou-se a identificação e seleção dos estudos através das bases de dados da pubmed*,* scielo**,** cochranelibrary, bvsalud, para extração dos dados e análise dos resultados provenientes de diferentes trabalhos realizados com estudo clínico randomizado, paralelo, controlado e cego ou não, publicados entre os anos de 1998 a 2020. Foi produzido um checklist QUOROM para se chegar a consistência desejada dos relatos de revisão sistemática valorizando a aplicação de pesquisas em diferentes escalas e contextos. Realizou-se a leitura dos estudos utilizados nessa pesquisa em sua completude e características específicas. RESULTADOS: Os estudos da revisão sistemática apresentaram o TENS como eficaz no controle e alívio da dor nos pós cirurgia cardíaca em sua maioria, com restrição de um autor que afirmou que o TENS convencional tende a ter um rápido início de analgesia, mas perde seu efeito rapidamente quando a estimulação é desativada. CONCLUSÕES: Para além do alívio da dor, diversos estudos comprovaram que o TENS pode ter um efeito sobre o sistema circulatório, cicatrização e sistemas inflamatórios, melhor recuperação da função respiratória, requerendo a diminuição de fármacos por apresentar menor quadro doloroso, mas é preciso atenção para a localização dos eletrodos estimuladores, por ser um importante determinante da eficácia da estimulação elétrica nervosa transcutânea.

Palavras-chave: Pós- operatório. Cirurgia cardíaca. Dor. Eletroestimulação.

ELECTRICAL STIMULATION AFTER HEART SURGERY

Transcutaneous elétricas nerve stimulation can reduce pain in patients after cardiac surgery. OBJECTIVE: To verify the benefits of pain relief in the postoperative period of cardiac surgeries through the effects of transcutaneous electrical stimulation, resulting from a systematic review of the literature. METHOD: The identification and selection of studies was used through the pubmed, scielo, cochranelibrary, bvsalud databases, for data extraction and analysis of results from different studies carried out with randomized, parallel, controlled and blinded clinical trials or not., published between 1998 and 2020. A QUOROM checklist was produced to reach the desired consistency of systematic review reports, valuing the application of research in

different scales and contexts. The studies used in this research were read in their completeness and specific characteristics. RESULTS: The studies of the systematic review presented TENS as effective in controlling and relieving pain after cardiac surgery for the most part, with the restriction of one author who stated that conventional TENS tends to have a rapid onset of analgesia, but loses its effect. quickly when stimulation is turned off. CONCLUSIONS: In addition to pain relief, several studies have shown that TENS can have an effect on the circulatory system, healing and inflammatory systems, better recovery of respiratory function, requiring the reduction of drugs because it presents less pain, but attention is needed. for the location of stimulating electrodes, as it is an important determinant of the effectiveness of transcutaneous electrical nerve stimulation.

Keywords: Postoperative. Cardiac surgery. Pain. Electro-stimulation.

INTRODUCTION

Scientific knowledge is enriching, it is always changing and pointing out new ways to alleviate the pain of individuals. Pain has been identified as one of the main sources of concern for patients in the postoperative period of cardiac surgery. The investigation is therefore justified by the need for significant evidence in the literature on the use of transcutaneous electrical stimulation (TENS) for pain relief in the postoperative period of cardiac surgeries. Due to the fact that there are still gaps about the use of transcutaneous electrical stimulation for postoperative pain relief, the reason for the investigation is focused on the search for scientific evidence to respond to the outlined objective, which is to verify the benefits in post-operative pain relief. -operative period of cardiac surgeries through the effects of transcutaneous electrical stimulation, resulting from a systematic review of the literature.

The objective is also to identify the classification of pain; to verify if the physiotherapeutic intervention through TENS corroborates for the reduction of pain, for the improvement of the lung capacity and consequently in the lung volumes and capacities, as well as, in the mobility aid. Also, the objective is to recognize the different types of TENS, time of application, effect and indication, and to recognize if the effect of TENS promotes the release of endorphins, serotonin and analgesic hormones, thus decreasing cytokine levels.

METHODS

This systematic review of the literature on transcutaneous electrical stimulation for pain relief in the postoperative period of cardiac surgeries was carried out through a search in the scielo, pubmed, cochranelibrary, bvsalud databases, using as descriptors: Electrical Stimulation. transcutaneous. Pain relief. Postoperative. Cardiac surgeries. Articles in English and Portuguese were selected, between the years 1998 to 2020

INCLUSION CRITERIA

The search for articles was carried out in the second semester of 2021 and the first semester of 2022. The inclusion criteria for the articles were aimed at prioritizing works in a randomized clinical trial (RCT - Randomized Clinical Trial), parallel, controlled and blinded or not, published between the years 1998 to 2020 in patients who underwent cardiac surgery and who used TENS as an intervention and that had pain control among the results, with restriction for English and Portuguese languages and date of publication.

SEARCH STRATEGY

For the search strategy, the following descriptors were used: Postoperative. Cardiac surgery. Pain. Electro-stimulation. To increase the search sensitivity, the OR operator was used. To unite the groups of descriptors, the Boolean operator “and” was used to combine the search terms.

SELECTION OF STUDIES AND DATA EXTRACTION

The search for the selection of articles took place through the following steps: identification, selection, eligibility, translation of articles into English and inclusion. The identification step considered all articles found during the search period, evaluating the titles and abstracts of all articles, selecting those that met the eligibility criteria and excluding the rest. In the eligibility stage, the articles were read in full to confirm that they could be included and those that were repetitive and that brought electrostimulation for pain relief in other types of postoperative period other than cardiac surgery were excluded. The inclusion stage considered the articles that were

used in this systematic review. During the selection process, the articles were grouped in a reference manager. The information extracted from the selected articles was organized in a systematic review box containing the following information: first author, no gender predominance required, analgesic therapy plus physical therapy; TENS group that received analgesic therapy, physical therapy and TENS, study design, interventions, measurement instruments and results.

RESULTS

The search in the databases originated in a total of 64 articles: cochranelibrary (12), scielo (32), Pubmed (10), bvsalud (11). After excluding the articles that had duplicate information, 55 articles remained, and after analyzing the title and abstract, 28 were chosen for this study. Of the 28 articles selected, 8 presented information that was not fully consistent with this research and were excluded. After reading the articles in their entirety, 21 were selected that fit the inclusion criteria defined in this study. The author selection table, type and quality of studies, methodology and results, can be found in table 1 below:

Table 1: Authors researched, studies of therapeutic interventions and key outcome measure that characterized the baseline of the research

Oliveira, et al, 202	Systematic review Using the methodology PEAK.	methodological quality evaluated by the scale Peter.	Reduction in pain level after heart surgery, ranging your application of the first day to the third day of postoperative.
Sbruzzi, et al, 2012	Review and Meta-Analysis	Information obtained from data base: MEDLINE, LILACS and PUBMED	TENS associated with Analgesia pharmacological promoted greater pain compared to use placebo TENS in postoperative patients of thoracic surgery Information obtained from data base: MEDLINE, LILACS and PUBMED.
Paixão e Gardenghi, 2018	Test review clinical, randomized or not.	Diretrizes do Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement.	TENS is beneficial in pain control and strength improvement respiratory muscle after surge heart

		(PRISMA	
Almeida, et al, 2018	Systematic review: clinical trials randomized with the criteria: human older than 18 years	Forty five patients, 32 men and 13 women	The use of TENS reduced the blood levels of pro-inflammatory cytokines.
Cipriano, et al, 2008	A visual analogue scale from 0 to 10 was used to assess pain.	The methodological quality of the articles assessed using the PEDro scale.	TENS was associated with significant reductions in postoperative pain.
Costa, et al, 202	Systematic review of controlled studies, based on PRISMA.	clinical outcomes programs of cardiac rehabilitation	The systematic review did not point to guarantees of the effectiveness of transcutaneous electrical nerve stimulation in the treatment of pain after cardiac surgery..
Vargas; Vieira e Balbueno, 2016	Research carried out in jou in the Licas, Scielo databases and Bireme	Twenty-five patients wit mean age of 59 participated, being 72 percent men.	Improvement of pain, strength muscles responsible for breathing.
Gregorini, et al, 2010,	Pain assessment from from the visual analogue scale, forcerespiratory musclewith the application TEN.	Divided into three groups: Group control, Study Group, Contrast-Placebo Group	The short-term TENS reduced the pain of patients in the postoperative period significantly.
Tonella;Araújo e Silva, 2006	clinical study, prospective, with random distribution, including 48 patients, that presented pain score.	analog scales Standard 100mm visuals they've been used to assess the pain.	Decreased pain in the Group Study, indicated only As an adjunct in post-operative pain control operative.
Chen, et al, 1998.	TENS as therapy Complementary and simultaneous stimulation at an acupoint site.	Analogic visual scale (VAS) from 0 to 10 was used to assess pain in regular intervals.	Stimulation effectiveness transcutaneous electrical decreased the need for opioid analgesics in postoperative.
Chandra, et al, 2010	Randomized study	Active/placebo TENS patients) or placebo /active TENS (17 patients) sequence. Intervention by two hours in order Random.	OTENS is a strategy Valuable for relieving postoperative pain after surgery thoracic; however, the effects are short-lived
Jalalmanesh, et al 2017	Crossover clinical tria	systematic reviews about clinical efficacy of TENS for pain in perioperative environments	The application of active TENS Significantly reduced intensity inpatients after surgery.
Johnson,2017, 2009	Critical review	Twenty patients were recruited in a group Control (n=10), with analgesic therapy plus physical therapy; and	Offer TENS as adjuvant to treatment basics of surgical pain. Patients submitted

		GroupTENS, therapy analgesic,physical therapy and TENS.	
Lima, et al, 2011	Patients subjected to surgery of revascularization of myocardium (MRS)	Published works of neuropathic pain, using aspubmed database, Cochrane LILACS.	TENS has been shown to be effective significant in reducing the pain and increased strength respiratory muscles in the 1st CRM DPO.
Miranda, et al, 2016.	Revisão sistemática do período de 2000 a 2016.	Cento e cinquenta pacientes submetidos à cirurgia valvar ou aórtica	O conceito aceito de dor atualmente não é ideal, é limitado, excluindo estados importantes de dor.
Moss, et al, 201	Randomized study	60 patients submitted the revascularization surgery myo rization cardio. received TENS and analgesia pharmacological, TENS placebo and analgesia pharmacological, or pharmacological analgesia isolated (control group)	The postoperative pain was similar between groups.
Mustafa, et al, 2008	Randomized study	Were found subsidies that try explain how TENS can act as adjuvant in control of pain.	TENS was more effective Than than placebo TENS or control treatments in decreasing pain andlimitation of intake of opioid medications and non-opioids during first period of]24 hours after MS.
Pena, Barbosa, Ischikawa, 208	Literature review	TENS technique must be used with moni and referral from a doctor	Despite several studies demonstrate effectiveness for pain relief with TENS, much has to be discuss and find out about the real role of this analgesic modality,

Pai, 2016	TENS is a non-pharmacolo method of control of pain, providing a small electric current through electrodes in skin, with effects painkillers.	Use of literature specialized data related in pain assessment.	Very important one multidisciplinary treatment of rehabilitation for the pain relief, ally to TENS.
Rigotti e Ferreira 2005.	Pain involves several components sensory, affective cognitive, social behavioral.	The sample with 20 subjects, in which 10 received application of TENS inoperative (control group) and 10 received application	For evaluation of patient pain, you can use a wide variety of one-dimensional scales to measure the

		of conventional TENS (Study group), after perforr from the scale collection visual analogue (EVA).	pain intensity.
Silva, et al, 2019	clinical study, randomized, parallel, controlled and blind, in the postoperative perio Cardiac surgery.	Visual analogue scale (EVA). The sample consisted of 20 subjects , of both genders, of which 10 received application of inoperative TENS (control group) and 10 subjects received application of conventional TENS (Study group)	TENS reduced the pain picture of post-operative patients operative of heart surgery and allowed the improvement of tidal volume.

Fonte: O autor

Patients undergoing cardiac surgery experience various procedures that generate pain. The presence of drains, tubes and, mainly, sternotomy are the main causes of postoperative pain ([1).Most works in the literature "do not focus on pain classification precisely in terms of physiological character, precisely because of the difficulty of accuracy in proving mechanisms only linked to one type or another of pain" [(2).] However, pain is defined as an unpleasant emotional experience related to actual orpotential tissue damage, being divided into "nociceptive" and "neuropathic" types. More recently, due to the possible concomitance of both types of pain, and the diagnostic difficulties, some authors recommend the use of the term "preeminently neuropathic pain" or "preeminently nociceptive pain", depending on the clinical pattern of presentation [(3).]

Pain can be classified as acute and chronic: Acute pain is related to traumatic, infectious or inflammatory conditions; on the other hand, chronic pain is that which lasts after the time allowed for the healing of an injury or that is associated with chronic pathological processes, which cause continuous or recurrent pain [(4)].

In the postoperative period (PO) of cardiac surgery, there is a reduction in the performance of the respiratory muscles, which include atelectasis, physical inactivity, resulting from the pain caused by the surgical process [(5)]. In this context, pain is seen

as a common phenomenon, which, in addition to causing suffering, can lead patients to unnecessary risks, causing several cardiovascular and respiratory changes in the body, in addition to disturbing movement, thus making analgesia a significant aspect in this period. As a resource to control pain after cardiac procedures and thoracotomies, transcutaneous electrical stimulation (TENS) has been widely used [6].

For non-pharmacological therapy of acute and chronic pain, TENS is a widely used resource, consisting of electrical stimulation of nerve fibers through electrodes placed on the surface of the intact skin, in which a pulsed electrical current is emitted. Among non-pharmacological treatments, transcutaneous electrical stimulation (TENS) represents a form of physical therapy intervention used to reduce pain, improve lung capacity and aid mobility [7].

Transcutaneous electrical nerve stimulation (TENS) is a method that uses electrical current applied to the skin for analgesic purposes. Transcutaneous electrical nerve stimulation (TENS) has as its main documented therapeutic purpose the reduction of pain; this benefit could produce secondary benefits in respiratory muscle strength and, consequently, in lung volumes and capacities [8].

Recent studies have noted that, in addition to analgesia, TENS may have an effect on the circulatory system, wound healing, and inflammatory systems [9]. They also identified several types of TENS that can be used to relieve pain [10]. as can be seen in table 1 below:

Table 1: Types of TENS

Tipo de TENS	Tempo de aplicação	Efeito	Indicação
TENS Convencional (Teoria das Comportas)	20 a 60 minutos, com intervalos de 30min	Estimulação seletiva de fibras (A beta), gerando confortável parestesia (efeito curto) ou pontadas, sem dor ou contração muscular	Dor aguda (superficial) e crônica[2]
TENS Acupuntura (Teoria Farmacológica)	20 a 30 minutos, preconizada 1 vez ao dia	Estimulação das fibras nociceptivas (A delta e C) e pequenas fibras motoras, gerando parestesia e contração visível (efeito longo), levando também à liberação de opiáceos endógenos	Dor crônica[4]
TENS breve intenso (Teoria Farmacológica)	± 15 minutos	Ativação de fibra (A delta e C), levando à diminuição dos espasmos contraturas (efeito temporário)	Junta efeitos da TENS convencional e acupuntura, levando ao efeito analgésico longo (beta endorfinas + inibição pré-sináptica)
TENS Burst (Teoria Farmacológica e das Comportas)	Mínimo de 30 min	Junta efeitos do TENS convencional e acupuntura, levando ao efeito analgésico longo (beta endorfinas + inibição pré-sináptica)	Mobilização articular, estiramento mantido ou massagem transversa (condições dolorosas locais)

Source: PENA, et. al., 2008.

“Conventional TENS tends to have a rapid onset of analgesia, but quickly loses its effect when stimulation is turned off [(11).] “ Although the main use of TENS is for pain control, important findings about other effects have been found, with physiological explanations not yet deeply clarified [(12).] Patients undergoing TENS showed better recovery of respiratory function after cardiac surgery, and were also less demanding of drugs because they had less pain [(13).]

The electrical stimulation recruits the Aβ afferent fibers, of tactile stimulus that reach the posterior horn of the spinal cord, which reduces the passage of information from type C fibers, which conduct pain, through the action of the inhibitory interneuron [(14).] TENS associated with pharmacological analgesia promoted greater pain relief compared to placebo TENS in patients in the postoperative period of thoracic surgery, both in the thoracotomy and sternotomy approaches. In sternotomy, it has also been shown to be more effective than controlled pharmacological analgesia in relieving pain, but with no significant effect on lung function [(15).]

TENS can be used in the hospital postoperative routine as an adjunct to conventional analgesia, because, in addition to being non-invasive and non-pharmacological, it is

comfortable and some studies have observed less need for the use of drugs to control pain [14].

The location of stimulating electrodes seems to be an important determinant of the effectiveness of transcutaneous electrical nerve stimulation in decreasing the need for postoperative opioid analgesics [16].

In carrying out studies, they proved that TENS was effective in controlling postoperative pain in patients on the 1st POD of myocardial revascularization surgery, avoiding the excessive use of analgesics, as well as improving respiratory muscle strength, especially in MEP, this muscle is so important for airway patency and prevention of pulmonary complications. They suggest the inclusion of TENS in the hospital postoperative routine as an alternative to drug therapy, which is effective, cheap, non-invasive, without side effects, providing better well-being, without pain within an intensive care unit [3].

In a clinical, prospective study, with random distribution, with electrostimulation time of 30 minutes, they found that there was a decrease in pain in the Study Group, in some moments and parameters. However, they recommend additional studies, since the use of TENS is indicated only as an adjunct in the control of postoperative pain [17].

In another clinical, randomized, parallel, controlled and blind study where data on postoperative pain after cardiac surgery were collected, the visual analogue scale (VAS) was used to assess pain before and after the application of TENS. The duration of electrical stimulation application was thirty minutes, being performed on the first postoperative day, 1st POD after the application of VAS and ventilometry in both groups, and inoperative in the Control Group. The frequency used in TENS was 100 Hz, with a pulse width of 75 µs. The stimulation intensity was adjusted, according to the patient's report, regarding the sensation of moderate paresthesia, but without any

discomfort. Table 2 below presents the data concerning the analysis variables submitted to the use of conventional and inoperative TENS [18].

Table 2: Visual Analog Scale (VAS)

VARIÁVEIS	GRUPOS			
	Controle (n=10)		Estudo (n=10)	
Escala de DOR - EVA	Antes 5,5 ± 1,71	Depois 4,2 ± 1,87	Antes 7,2 ± 1,87 (a)	Depois 4,3 ± 1,70 (b)
Volume minuto (Vmin)	12,69 ± 4,92	10,26 ± 3,34	12,01 ± 3,17	11,94 ± 3,31
Capacidade Vital (L)	1,60 ± 0,36	1,71 ± 0,35	1,46 ± 0,22	1,62 ± 0,19
Volume Corrente (mL)	526,1 ± 228,27	438,9 ± 104	478,6 ± 103,80	470,6 ± 84,94
Frequência Respiratória (rpm)	23,3 ± 7,43	23,7 ± 6,32	25,4 ± 6,70	25,4 ± 6,00
Índice de Tobin (rpm/L)	47,68 ± 25,57	56,42 ± 19,47	55,77 ± 20,56	56,14 ± 17,82

Fonte: Silva, et.al., 2019.

The result in table 2 shows that the use of transcutaneous electrical nerve stimulation reduced the pain of patients in the postoperative period of cardiac surgery and allowed an improvement in tidal volume. This result suggests the feasibility of applying TENS to reduce pain in these patients, and it may be a technique used as a routine in the postoperative service as an aid in reducing pain [18].

“The effect of TENS promotes the release of endorphins, serotonin, and analgesic hormones, thereby lowering cytokine levels [19]. “ TENS is an extremely safe and viable method, being possible to apply it daily with minimal adverse effects (p.5) [19]”. Based on the PICO strategy for electroanalgesia through TENS, it reduced pain in subjects undergoing cardiac surgery. In addition, it was possible to note that there are improvements in respiratory parameters, such as increased volume and lung capacity [20]. The anachronistic, description and definition as a PICO strategy can be found in table 1 below:

Quadro 1: Descrição da estratégia PICO

Acrônimo	Descrição	Definição
P	Paciente	Pacientes submetidos à cirurgia cardíaca (cirurgia de revascularização do miocárdio e troca valvar)
I	Intervenção	Aplicação de estimulação elétrica transcutânea
C	Controle	Pacientes que não receberam a intervenção (TENS)
O	Desfechos	Dor e parâmetros ventilatórios

Fonte: Oliveira, et. al, 2017.

Through a systematic review and meta-analysis of RCTs, the studies concluded that TENS provides an additional effect to pharmacological analgesia, as it promoted greater pain relief when compared to placebo TENS in patients in the postoperative period of thoracic surgery, both in the thoracotomy and thoracotomy approach. by sternotomy. In sternotomy, it was also more effective than controlled pharmacological analgesia in relieving pain, but with no significant effect on lung function. TENS can be recommended as an additional treatment for pain relief in thoracic surgeries [15]. And through another systematic review pointed out the non-guarantee of the effectiveness of transcutaneous electrical nerve stimulation in the treatment of pain after cardiac surgery [21].

DISCUSSION

Although some authors [21,10] have not verified the effectiveness of TENS in promoting analgesia, in different painful conditions, present in the postoperative period of cardiac surgery, and another experience pointed only as an adjunct to pain relief [14, 17], the results of this review study, most of them corroborate stating that TENS presents a significant reduction in pain and an increase in respiratory muscle strength in the 1st POD of CRM [3] and, Vargas, Vieira and Balbueno [5] highlight the improvement in pain and strength of the muscles responsible for breathing using TENS.

TENS has been widely used to control pain after cardiac procedures and thoracotomies6 and, among non-pharmacological treatments, TENS represents a form of physical therapy intervention indicated for pain relief, lung capacity evolution and mobility aid [7]. And Almeida, et al,[9] point out that TENS can still have an effect on the circulatory system, healing and inflammatory systems, while Pai [11] points out that conventional TENS tends to have an instant onset of analgesia, but quickly loses its effect. when stimulation is turned off. However, Mustafa, et al.[12], Cipriano Júnior et al,[13] point out that patients undergoing TENS showed better recovery of respiratory function after cardiac surgery, being also less dependent on drugs due to less pain.

A systematic review [15] confirmed that TENS associated with pharmacological analgesia promoted greater pain relief compared to placebo TENS in patients in the postoperative period of thoracic surgery, both in the thoracotomy and sternotomy approach. TENS, in addition to being non-invasive and non-pharmacological, is comfortable and some studies have observed less need for the use of drugs to control pain [14], as well as having secondary benefits in respiratory muscle strength and, consequently, in lung volumes and capacities [(8).]. It is worth mentioning that pain tolerance and types of pain, variables evaluated here, are rarely reported [1, 2].

The use of TENS after cardiac surgery reduced the patients' pain and allowed for an improvement in tidal volume[18], with TENS being an extremely safe and viable method[19]. Also, studies carried out by Oliveira, et. Al [20], based on the PICO strategy for electroanalgesia through TENS, decreased pain in individuals undergoing cardiac surgery and improved respiratory parameters, such as increased volume and lung capacity, corroborating the words of Gregorini [8].

The location of stimulating electrodes is shown to be a relevant determinant of the effectiveness of transcutaneous electrical nerve stimulation in reducing the need for postoperative opioid analgesics [16], as well as a multidisciplinary rehabilitation treatment for pain relief, combined with TENS[11].

CONCLUSION

The researched studies pointed to divergent results, such as that TENS presents only immediate relief, while it is activated, and another experience pointed out that the use of TENS is indicated only as an adjunct in the control of postoperative pain.

However, most studies register the benefits of TENS as an effective method in the postoperative period of cardiac surgery and add to the improvement of muscle strength, lung capacity and mobility aid, promoting the release of endorphins, serotonin and analgesic hormones, thus decreasing cytokine levels, being extremely feasible, but it is important to pay attention to the location of the stimulating electrodes.

It is suggested to continue the studies, as the theme of this research is of paramount relevance for the construction and expansion of new knowledge and scientific answers about the benefits of TENS in the postoperative period of cardiac surgery.

REFERENCES

1. MOSS E, MILLER CS, JENSEN H, BASMADJIAN A, BOUCHARD D, CARRIER M et al. A randomized trial of early versus delayed mediastinal drain removal after cardiac surgery using silastic and conventional tubes. **Interact Cardiovasc Thorac Surg**. 2013;17(1):110-5. doi: 10.1093/icvts/ivt123.

2. MIRANDA, Carla Ceres Villas; JUNIOR, Lauro de Franco Seda; PELLOSO, Lia Rachel Chaves do Amaral. Nova classificação fisiológica das dores: o atual conceito de dor neuropática. **Rev. dor** 17 https://doi.org/10.5935/1806-0013.20160037 (suppl 1) • 2016 •

3. LIMA, Paula Monique Barbosa; FARIAS; Rebeca Taciana Fernandes de Brito; CARVALHO, Aline Carla Araújo; SILVA, Patrícia Nobre Calheiros da; FILHO, Nailton Alves Ferraz; BRITO, Rosinete Fernandes de. Estimulação elétrica nervosa transcutânea após cirurgia de revascularização miocárdica. **Artigos Originais • Braz. J. Cardiovasc. Sur**g. 26 (4) • Dez 2011 • https://doi.org/10.5935/1678-9741.20110049.

4. RIGOTTI, Marcelo; FERREIRA, Adriano**.** Intervenções de enfermagem ao paciente com dor. São Paulo. **Arq Ciênc Saúde** 2005 jan-mar;12(1):50-4.

5. VARGAS MHM, VIEIRA R, BALBUENO RC. Atuação da fisioterapia na reabilitação cardíaca durante as fases I e II. Uma revisão da literatura**. Rev. Contexto & Saúde**. 2016: 16(30): 85-91.

6. CHANDRA A; BANAVALIKER JN; DAS PRADEEP, K e HASTI S. Use of transcutaneous electrical nerve stimulation as an adjunctive to epidural analgesia in the management of acute thoracotomy pain. **Indian Journal of Anaesthesia**, 2010, 54(2).

7. PAIXÃO, Viviane Chagas; GARDENGHI, Giulliano. Efeitos da Estimulação Elétrica Transcutânea (TENS) no pós-operatório de cirurgia cardíaca. **Revista Brasileira de Saúde Funcional**. V. 5, nº 2, ISSN: 2358-8691, 2018.

8. GREGORINI, Cristie; JUNIOR, Gerson Cipriano; AQUINO, Leticia Moraes de; BRANCO, João Nelson Rodrigues; BERNARDELLI, Graziella França. Estimulação elétrica nervosa transcutânea de curta duração no pós-operatório de cirurgia cardíaca. Artigos Originais • **Arq. Bras. Cardiol**. 94 (3) • Mar 2010 • https://doi.org/10.1590/S0066-782X2010000300011.

9. ALMEIDA, Tábata Cristina do Carmo; FIGUEIREDO, Francisco Winter Dos Santos; FILHO, Valter Cordeiro Barbosa; ABREU, Luiz Carlos de; FONSCA, Fernando Luiz Affonso; ADAMI, Fernando. Effects of Transcutaneous Electrical Nerve Stimulation on Proinflammatory Cytokines: Systematic **Review and Meta-Analysis. Review Mediators Inflamm. National Library of Medicine**. 2018 Apr 2; 2018:1094352. Doi: 10.1155/2018/1094352. Collection 2018.

10. PENA, Rodrigo; BARBOSA, Leandro A.; ISCHIKAWA. Estimulação Elétrica Transcutânea do Nervo (TENS) na Dor Oncológica – uma Revisão de Literatura. **Revista brasileira de Cancerologia** 2008: 54 (2): 193-199.ISSN 2176-9745.

11. PAI, Marcus Yu Bin. TENS pode trazer alívio imediato para dor. (2016) **Journal of the Brazilian Medical Association** (AMB). CRM-SP: 158074 / RQE: 65523 – 65524.

12. MUSTAFA, Emmiler; OZLEM, Solak; CEVDET, Kocogullari; UMIT, Dundar; ERCUMENT Ayva; YUKSEL, Ela; AHMET, Cekirdekci; VURAL, Kavuncu. Control of acute postoperative pain by transcutaneous electrical nerve stimulation after open cardiac operations: a randomized placebo-controlled prospective study**. National Library of Medicine,** 2008, 11(5): E300-3DOI: 10.1532/hsf98.20081083 PMID: 1894824.

13. CIPRIANO Gerson JR, CARVALHO Antonio Carlos de camargo, BERNARDELLI Graziella França, PEREZ, Paulo Alberto Tayar. Local short-term transcutaneous electrical nerve stimulation after cardiac surgery: effect on pain, pulmonary function and electrical muscle activity. **Interact Cardiovasc Thorac Surg**. 2008 Ago;7(4):539-43.

14. JOHNSON MI. Transcutaneous Electrical Nerve Stimulation (TENS) as an Adjunct for Pain Management in Perioperative Settings: **A Critical Review. Expert Review of Neurotherapeutics,** 2017: 1-46.

15. SBRUZZI, Graciele; SILVEIRA, Scheila Azeredo; SILVA, Diego Vidaletti; CORONEL Christian Correa, PLENTZ, Rodrigo Della Méa**. T**ranscutaneous electrical nerve stimulation after thoracic surgery: systematic review and meta-analysis of 11 randomized trials**. Rev Bras Cir Cardiovasc**. Jan-Mar 2012;27(1):75-87. doi: 10.5935/1678-9741.20120012.

16. CHEN, L; TANG, J; WHITE, P. F P F; SLONINSKY, A; WENDER, R H; NARUSE, R; KARIGER, R. The effect of location of transcutaneous electrical nerve stimulation on postoperative opioid analgesic requirement: acupoint versus nonacupoint stimulation. **Clinical Trial, Anesth Analg**. 1998 Nov;87(5):1129-34.

17. TONELLA, Rodrigo Marques; ARAÚJO, Sebastião; SILVA, Áurea Maria Oliveira da. Estimulação elétrica nervosa transcutânea no alívio da dor pós-operatória relacionada com procedimentos fisioterapêuticos em pacientes submetidos a intervenções cirúrgicas abdominais. **Rev. Bras. Anestesiol**. 56 (6) • Dez 2006 • https://doi.org/10.1590/S0034-70942006000600007

18 SILVA, Francis Igor Ribeiro da; NÓBREGA, Diego Figueiredo; BARBOSA, Kevan Guilherme Nóbrega; SILVA, Rodrigo Neves; MOUSINHO, Kristiana Cerqueira; FARIAS, Tâminez de Azevedo; SILVA, Cláudia Vivian de Oliveira Sylvia Marques da; SANTOS, Renata Marinho de Albuquerque Natanael Barbosa dos. DOI 10.22533/at.ed.5191923124. **Efeitos da Estimulação Elétrica Nervosa transcutânea em pós-operatório de cirurgia cardíaca**. Organizadora Marina

Casagrande do Canto. – Ponta Grossa, PR: Atena Editora, 2019. ISBN 978-85-7247-851-9 DOI 10.22533/at.ed.519192312.

19. JALALMANESH M, HEIDARI S, KAZEMI M, RAHIMI-BASHAR F, ROSTAMI HR. Effect of transcutaneous electrical nerve stimulation on pain intensity in reduced consciousness patients: A randomized clinical trial**. Nursing Practice Today**. 2017;4(1):35-43.

20. OLIVEIRA, Ana Paula Silva; CERQUEIRA, Natale Sena; CORDEIRO, André Luiz; OLIVEIRA, Alberto Manoel Sarkis; MIRANDA, Íngara Keisle São Paulo Barretto. Estimulação elétrica transcutânea para tratamento da dor após cirurgia cardíaca: uma revisão sistemática. Journals BAHIANA- SCHOOL OF MEDICINE AND PUBLIC HEALTH. **Rev. Pesqui. Fisioter**., Salvador, 2020 Maio;10(2):324-333 Doi: 10.17267/2238-2704rpf.v10i2.2808 | ISSN: 2238-2704.

21. COSTA, Sâmia Aimê Flor da; FONSECA, Elivelton da Costa; MENEZES, João Vitor Normando de; FILHO, Luiz Euclides Coelho de Souza; TORRES, Daniel da Costa; NORMANDO, Valéria Marques Ferreira. O efeito da estimulação elétrica nervosa transcutânea no limiar de dor no pós-operatório de cirurgia cardíaca: uma revisão sistemática. **Revista Eletrônica Acervo Saúde** / Electronic Journal Collection Health | ISSN 2178-2019

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