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Effect of cold therapy on the pain of deep-breathing and coughing in patients after coronary artery bypass grafting

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ABSTRACT

Cold therapy, non-pharmacological pain management, can be used as a short-strong analgesic in relieving musculoskeletal pain. The aim of this study was to assess the impact of cold therapy on the pain relieving in patient undergoing coronary artery bypass grafting. This randomized clinical trial study was conducted in 46 eligible and consenting patients who recruited and randomly allocated to gel pack and non- gel pack groups after the first post-surgical day. All participants performed two episodes of deep breathing and coughing, with and without gel pack. In the gel pack group the quality of pain was measured before applying cold gel pack and after deep breathing and coughing (DB & C) and in the non-gel pack group was measured before and after DB & C episodes. The data were analyzed using repeated measures analysis of variance (RM-ANOVA), ANCOVA, t-test, and pair-t-test. The ANCOVA analysis revealed a significant reduction in sensory pain scores between pre- and post- application of the gel pack. Cold therapy reduces pain relating to deep breathing and coughing in patient undergoing coronary artery bypass grafting.

Key words: Cryotherapy, Coronary artery bypass, Cough, Pain, Respiration.

INTRODUCTION

Patients undergoing chest surgery experience a severe pain in the first 24 hours after surgery [1]. Despite global attention to pain management [2], pain management is still one of the biggest challenges in intensive care units [3]. Pain causes physiological and psychological responses. Physiological responses to pain and surgery are associated with the sympathetic nervous system activities which increases heart rate and blood pressure, heart irritability and respiration rate [4, 5]. The patients under cardiovascular surgery are more vulnerable to physiological effects of pain [6, 7]. Breathing intensifies acute pain after sternotomy [8] and prevents the patients to cough and breathe deeply. Impairment of breathing results in respiratory complications such as atelectasis after surgery. Coughing, deep breathing, chest physiotherapy and incentive spirometry are useful practices for preventing postoperative respiratory complications. Pain control is vital to maintain the patient's comfort and respiratory system complications after chest surgery [8, 9]. The most common barriers to effective pain management are incorrect pain assessment by health care providers or inefficiency of pain relief proceedings [10]. Incisional pain could be managed using

pharmacological and non-pharmacologic interventions [1]. Today the strong emphasis is on non-pharmacological pain relief methods including relaxation, touch therapy, music therapy, imagination, and applying heat and cold therapy [11, 12]. These methods are easy to use and may be acceptable to the patients and nurses also are capable of implementing them independently [12-14]. Cold therapy is a non-pharmacological and a cost-effective way of relieving pain [2, 11, 12]. Cold therapy advantages have been shown on pain management in orthopedic and sport injuries. However, studies on applying cold to relieve pain in surgical patients are limited [1, 15, 16]. In this study, we attempt to find out the effectiveness of cold gel pack (CGP) on controlling the sternal incision pain causing of cough and deep breathing in adult patients undergoing coronary artery bypass grafting CABG.

MATERIALS AND METHODS

The current crossover clinical trial study investigated the effect of cold therapy on post-sternotomy pain, caused by deep breathing and coughing in patients after a coronary artery bypass surgery. The samples were selected from one of the hospital in Uremia, Iran in summer 2012. The inclusion criteria were consciousness (being aware of time, place and person), being literate, ability to determine the quality of pain, and voluntarily to participate in the study. The exclusion criteria were diabetes, having impairments in visual, auditory and verbal communication. Of 51 patients who met the criteria, 46 were included in the study and they were randomly assigned to experimental and control groups. All patients were undergoing a median sternotomy technique for a CABG surgery with a saphenous vein graft. The data were collected using the McGill pain questionnaire [17-20], which included several demographic questions such as gender, age, weight, height, hemoglobin level. The McGill pain questionnaire items were adjusted based on Persian language. The words stabbing and sharp, which are of question number 3 and 4 means tiz in Persian. The words cramping and Gnawing, which are of question number 5 and 6 means sayeshi in Persian and the words splitting and punishing cruel, which are of question number 11 and 15, don't have a clear definition in Persian, thus, they were excluded because of language issues. A panel of experts approved the content validity of the questionnaire. The test-retest coefficient (0.99) showed a high reliability [21].

The McGill pain questionnaire consisted of eleven questions and assessed two dimensions of pain: the sensory (eight words) and affective (three words) quality. The questions were scored on a four-point scale grading from zero to three. After obtaining permission from the ethics committee of the Uremia University of Medical Sciences and cardiac surgeon, the data were collected from the Post-Intensive-Care-Unit of the open heart surgery ward.

The eligible patients were selected and the consent form was achieved through a cover letter. The aims and implementing the pain management procedure were explained before surgery. The data were collected on the first day after surgery.

In order to reduce the measurement bias, data was collected between 8 AM and 12 MD. The patients underwent two periods of cough and deep breathing with and without using Cold Gel Pack (CGP). The washout period was 2 hours between procedures. The patients were randomly assigned into groups of A and B. The group A started with CGP and the group B started without CGP.

For the group A, the first period of trial was begun with the CGP and followed by the second period without CGP. The quality of pain was measured two times, first immediately before applying the CGP and second after coughing and deep breathing. Conversely, for the group B, The trial firstly began without CGP and followed by with CGP. The quality of pain in the first period was measured immediately before and after coughing and deep breathing in the group B. The frozen CGPs were placed in a cotton bag and were put on the incision area on the chest for 15 minutes. Besides, the incision area was covered with a thin layer of gauze. The bed elevated up to 45 to 90 degrees and a pillow was given to patient to support incision area during conducting deep breathing and coughing. Each period of intervention was consisted of three deep breathings (inhalation and exhalation), and a trial coughing. In addition, the body mass index [22-24], hemoglobin [25-27] gender [28-30] and age [31-33], are effective factors on pain, which were controlled as covariates in the current study. The data were analyzed using RM-ANOVA, ANCOVA, independent or paired t-Test by SPSS version 20.

RESULTS

Of the 46 selected patients, 12 (6 in each group) were female and 34 (17 in each group) were male. Table 1 shows the mean ± SD age of the patients in the group A was 59.48 ± 7.38 and in the group B was 62.09 ± 8.80. Two groups

of variables such as age, sex, hemoglobin level, body mass index were not statistically significant difference at baseline (all P > 0.05). The average scores of the sensory dimension of the quality of pain were significantly different between the groups A and B before intervention (P < 0.05). However, there was no significant difference between the average scores of the affective dimension of the quality of pain between the groups A and B before intervention (Table 2). The ANCOVA test showed that a significant difference between the sensory dimension of the quality of pain after intervention in both groups (P = 0.049). The RM-ANOVA test showed that the average scores of the affective dimension of the quality of pain between the two groups, A and B, were not statistically significant after intervention (P = 0.24) (Table 3). Besides, all patients received Indomethacin suppository in PRN for postoperative pain control.

Table 1. Comparison of means and standard deviations of age, hemoglobin, BMI, sensory and affective quality of pain between two study groups

Variables	G1: Mean (SD)	G2: Mean (SD)	95 % CI	P-Value
Age (year)	59.48 (7.83)	62.09 (8.80)	-7.56, 2.34	0.294
Hemoglobin (gr/dl)	11.06 (1.60)	10.82 (1.90)	-0.6, 1.07	0.572
BMI (kg/m^2)	25.23 (1.86)	25.26 (3.14)	-1.68, 1.51	0.965
Sensory-Pretest1	1.39 (1.41)	4.86 (3.81)	-5.19,-1.77	0.001
Sensory-Pretest2	1.96 (1.55)	5.04 (4.08)	-4.95, -1.22	0.002
Affective-pretest1	0.39 (0.89)	0.91 (1.78)	-1.73, 0.32	0.218
Affective-pretest2	0.43 (0.99)	0.91 (1.78)	-1.33, 0.38	0.267

G1, Group begins with gel first; G2, Group begins without gel first; SD, Standard deviation; CI, Confidence Interval; BMI, Body Mass Index

Table 2. Comparison of sensory and affective quality of Pain between two study groups after intervention

Quality of pain	Mean Group A	Mean Group B	M.Dif	Std.Error	95%CI	P-Value
Sensory	3.73	4.48	-0.75	0.37	-1.76,-0.23	0.049*
Affective	0.21	0.91	-0.50	0.420	-1.99,0.98	0.240†
*ANCOVA; †RM-ANOVA; M.dif, Mean Difference; Std.Error, Standard Error; CI, Confidence Interval						

Table 3. Comparison of sensory and affective quality of pain in two groups before and after intervention

Study Groups	Quality of pain	With Gel	Without Gel	P-value
A	Sensory	4 (2.11)	7 (5.32)	0.004
	Affective	0.91 (1.78)	0.91 (1.78)	1.00
B	Sensory	1.95 (0.93)	3.47 (1.62)	<.001
	Affective	0.39 (0.89)	0.44 (0.99)	0.328

DISCUSSION

The aim of this RCT study was to evaluate the effect of Cold therapy on the sensory and affective dimensions of the quality of pain, which caused by coughing and deep breathing in the patients after a CABG surgery. The average age of the study population indicates that the risk of coronary artery disease is common in middle-aged patients. According to some scholars and researchers' ideas, heart disease at an early age is on the rise more than ever in Iran [34].

The Body Mass Index, hemoglobin, gender and age were controlled as covariates in this study. No significant difference in covariates indicates homogeneity in the study populations with regard to the controlled variables. A significant difference in the above variables in the gel pack group could be attributed to the effectiveness of interventions in that group. Cold activates inhibitory neurons and harnesses nerves originate from the gray matter of the spinal cord dorsal horn and reduces the transmission of pain and obstructs the raising nerves. Cold reduces nerve conduction velocity, local blood flow and cellular metabolism. These functions result in activating the inflammatory response to trauma which reduces pain, swelling, muscle spasm and ischemic damage [35-37], to create the effects of cold therapy it is necessary that the tissue reach to a certain level of cool. The cold therapy affect as an analgesic when the skin surface temperature reaches approximately 14.6 °C [38]. It is suggested that cold should be used for at least 12 minutes to show its analgesic effects [15].

The American Academy of Orthopedic Surgeons has recommended a 20-minute cold therapy every 1-2 hours to manage pain and swelling after knee surgery [1, 15]. A pilot study was shown that a 15-minute cold therapy was more tolerable in compared to a 12- or 20-minute procedure for the patients. No complications were reported by the patients or observed in our study.

The results indicate that the application of CGP was effective to reduce the sensory dimension of the quality of pain in the patients after the CABG surgery. The finding of our study was supported the results of Gandom kaar et al. (2010) on using the cold therapy in reducing the sensory quality of pain score after chest tube removal [21]. However, the CGP was not effective on the affective dimension of the quality of pain. WHY. This finding was in line with the Demir et al. (2010) study's results, which were not significant difference in the affective dimension of the quality of pain in the study population [39].

The results showed that applying CGP can effect on the sensory dimension of the quality of pain. The findings of the current study partially supported the Gate-control-theory of pain which expresses cold influence on the physical, affective and cognitive dimensions of pain. Cold activates inhibitory neurons and harnesses nerves originate from the gray matter of the spinal cord dorsal horn and reduces the transmission of pain and obstructs the raising nerves. The pain impulses are, therefore, not transmitted to the brain [39]. And its perception also reduces [11].The findings support intensity and quality features of pain language [40,41].

We applied only the CGP for control the sternal incision pain, while the patients had also a chest tube. It is recommended that the future study should be used the CGP for Sternal and chest tube incision simultaneously to determine its effect on controlling pain. The other limitation was using painkiller after surgery that was out of researcher's control.

It seems that applying regional cold therapy reduces the sense of pain, especially when it is due to musculoskeletal injuries. Cold therapy is effective on the sensory dimension of pain quality in sternal incision caused by coughing and deep breathing in patients undergoing a CABG surgery.

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