

Effect of applying cold gel pack on the pain associated with deep breathing and coughing after open heart surgery

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ABSTRACT

Background: Coughing and deep breathing after sternotomy causes severe pain. This study was conducted to assess the effect of cold therapy on the pain in patients undergoing open heart surgery.

Materials and Methods: In a randomized controlled trial (RCT) with crossover design, 50 eligible and consenting patients were recruited and randomly allocated to gel pack and non-gel pack groups on the first postoperative day. All patients performed four episodes of deep breathing and coughing (DB and C) every 2 h. Pain intensity was measured and compared at rest and after DB and C in both groups. At the end of the study, all patients were asked about their preferences for the cold gel pack application prior to DB and C. The study hypotheses were analyzed using repeated measures analysis of variance (RM-ANOVA).

Results: Data analysis showed significant reduction in pain scores ($P < 0.001$) after cold gel application. Forty-five (90%) patients were inclined to reapply the gel pack in the future.

Conclusion: Cold gel pack can reduce the pain associated with DB and C in cardiac surgery patients.

Key words: Cold gel pack, deep breathing and coughing, open heart surgery, pain

INTRODUCTION

Coronary heart diseases are responsible for almost half of all deaths in developed countries and 25% of deaths in developing countries.^[1] Revascularization of atherosclerotic arteries sometimes needs surgical intervention.^[2] Open heart surgery with median sternotomy is most commonly performed on patients with blocked heart vessels.^[3,4] Sternal incision pain is the most common patient complaint after these surgeries.^[2,5,6] It can impede normal respiration, deep breathing, effective coughing, and sputum clearance, and may result in respiratory dysfunction, hypoxemia, atelectasis, and pneumonia.^[7,8] So, effective pain management leads to earlier recovery, reduces the postoperative complications and duration of hospitalization,

and increases patient satisfaction.^[9] Various pharmacologic and nonpharmacologic therapies have been developed for pain management.^[2,10] One of the simplest and cheapest nonpharmacologic ways to relieve pain is the use of cold.^[11,12] Cold therapy is an effective and safe method with few complications or no side effects.^[2,10] Studies show that cold leads to pain control and increases pain threshold.^[13-15] There is a paucity of scientific evidence about the use of cold therapy in patients after cardiac surgery.^[16] This study was conducted to investigate the following hypotheses and questions: (1) Does cold gel pack reduce the pain associated with deep breathing and coughing (DB and C) after cardiac surgery? (2) What sensations do patients have during the application of cold gel packs over sternal incision dressing? (3) Do patients undergoing open heart surgery prefer cold therapy prior to DB and C?

MATERIALS AND METHODS

This study was a randomized controlled trial (RCT) with crossover design which was conducted in the cardiac surgery intensive care unit (ICU) at a university-affiliated hospital in Urmia, Iran. The crossover design allows each subject to serve as his/her own control, so we can effectively remove subject-to-subject variation from our investigation of the relative effect of treatment and this reduces variability and directly increases power. Data were gathered between

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8 a.m. and 5 p.m. In order to reduce variability among patients, cold therapy was applied on the first post-surgical day when they were oriented to place and time and able to report pain. All patients performed four episodes of DBandC (two with cold gel pack and two without it) every 2 h. The sequence of gel pack application was randomized, so that half of the patients were given gel pack for 15 min followed by a period of “no treatment” (so-called washout period) and then they were not given gel pack. The other half started without gel pack first, followed by the washout period and then treatment with gel pack was given. The washout period was 2 h. Random allocation to groups was performed using a random number table.

Inclusion criteria for patients included: (1) male or female patients scheduled to coronary artery bypass graft (CABG) surgery with median sternotomy, (2) age ≥ 21 years, (3) able to understand and speak Persian, (4) having minimum literacy of reading and writing, and (5) willing to give written informed consent. Exclusion criteria for patients included: (1) mechanically ventilated patients, (2) patients with diseases that affect pain measurement (delirium, dementia, or major depression, and severe visual, hearing, and verbal impairment), (3) contraindication to cold therapy use [e.g. Reynaud’s disease, cryoglobulinemia (clumping of plasma protein), sickle cell anemia, cold allergic conditions, and in areas with impaired sensation], (4) diabetic patients, (5) postoperative complications such as infection, bleeding, uncontrolled atrial fibrillation, and wound dehiscence.

Gel packs that were used as the cold source weighed 320 g and measured 25 cm by 10 cm. They were kept in the freezer on the patient service unit and were frozen until their temperature reached between 0°C and -5°C, then were removed from the freezer and placed in a cotton bag. The timer was activated for 15 min and gel pack was used directly over the sternal wound dressing. In the literature, controversy exists regarding the recommended length of application time which ranges from 5 to 60 min.^[17] To achieve the therapeutic effect of cold therapy, it is required to cool down tissues for at least 12 min.^[18] So, the 15-min application time was selected in this study to achieve the desired effect.

Patients were asked to rate the severity of their pain using a horizontal scale that was numbered from 0 (absence of pain) to 10 (the most intense pain possible). The numerical rating scale (NRS) is well known and has acceptable reliability and validity, and was approved by many authors in patients with different diagnoses.^[2,19-22]

The following open-ended questions were asked every 5 min during each session of using cold gel pack to assess patients’ perception of cold therapy: How does the gel pack

feel on your chest? Can you describe the sensation to me? To assess their preferences about cold therapy, the following questions were asked at the end of the fourth session: Do you prefer cold therapy prior to DBandC? Why? Would you like to use this method again? Why or Why not? The answers were recorded on a paper at the patient’s bedside.

Data collection instruments used in this research were as follows:

1. A patient profile form that had been specifically designed for the study was completed by the patients. This five-part form consisted of: (1) demographic information part, stating their age, sex, level of education, marital status, religion, and employment; (2) general information part, stating their height, weight, body temperature, and the amount of hemoglobin; (3) present history information part, stating their diagnosis and type of cardiac surgery; (4) past history part, stating their underlying diseases like diabetes and hypertension and previous heart surgery; and (5) nursing history part that included history of smoking and opioid addiction, analgesics prescribed and administered (type, amount, and time at which medication was administered)
2. NRS for measuring the intensity of pain
3. Patients’ description form regarding their sensations and preferences that were transcribed verbatim on the paper.

A consecutive sample of 50 patients hospitalized with confirmed diagnosis of coronary artery disease (CAD) entered the study between 24 June 2012 and 20 August 2012. Patients who were scheduled for CABG were enrolled in the study. The ethics committee of Urmia Medical Sciences University (UMSU) and the hospital authorities approved the research protocol. Diseases such as Raynaud’s syndrome and sickle cell anemia were ruled out with a cardiac surgeon; also, the patient was enquired about allergy to cold. The voluntary nature of the study, confidentiality of information, and freedom to withdraw at any time were assured. Informed consent was obtained from each of the patients. The investigator described the study aims, NSR, and techniques for DB and C for each patient before the operation.

Patients were randomly allocated to begin the DB and C sessions either with the gel pack or without the gel pack. Prior to beginning DB and C sessions, the patients rated their baseline pain from 0 to 10 by the NSR. In the gel pack sessions, the investigator brought the gel pack from the freezer and placed it over the dressing covering the patient’s chest incision. A timer was activated for 15 minutes. The investigator remained with patients for 15 minutes when the gel pack was used. During the fifteen minutes 15 min of gel pack application, the patients were asked to describe the

sensation he/she they felt during gel pack application. After 15 minutes, the gel pack was picked up removed and the head of the bed was elevated between 45°C and 90°C in preparation for DB and C. In the sessions without gel pack sessions, the investigator prepared the patients for DB and C in the same manner as in gel pack sessions. A pillow or folded sheet was given to the patients for splinting purposes and DB and C was started for both groups. In each session, three cycles of three deep breaths were performed followed by an episode of coughing. The patient was asked to rate his/her pain from 0 to 10 on the NSR after completion of the third cycle. At the end of the fourth session, all patients were asked if they preferred the gel pack prior to DB and C.

RESULTS

The patients ranged in age from 22 to 75 years, and the average age was 58.3 ± 10.7 years in the group that began the trial with the gel pack and 60.7 ± 11.1 years in the group that began the trial without the gel pack. There were 50 patients (35 males and 15 females) recruited for this study from post cardiac surgery ICU, and no side effects or complications due to the cold therapy via gel pack were reported. All patients had one graft, and for all of them, saphenous vein was used. All patients had an admission diagnosis of CAD. Also, the results showed that there were no statistically significant differences in the variables such as age, gender, hemoglobin level, the time between receiving analgesic and intervention, and body mass index (BMI) in the two groups at the beginning of study ($P > 0.5$). All patients received drugs for postoperative pain management as needed. Average pain scores between the group that started with the gel pack [mean (M) = 4.56, standard deviation (SD) = 1.64] and the group that started without the gel pack (M = 5.36, SD = 1.7) were not significantly different ($t = -1.7$, $df = 48$, $P = 0.1$). A 2 (intervention) × 2 (session) × 2 (time) within-subjects repeated measures analysis of variance (RM-ANOVA) was conducted on the pain intensity scores before and after DB and C in patients undergoing open heart surgery by median sternotomy. The three independent variables were: intervention with two levels (gel pack and no gel pack application), session with two levels (a.m. and p.m.), and time with two levels (before and after). The dependent variable was pain intensity. The

M and SD values for the intensity scores are presented in Table 1. Pain scores after DB and C were, on average, 6.18/10 without gel pack compared to 3.81/10 with gel pack. The interaction between intervention and time was significant ($P < 0.001$) [Table 2] and indicated that the pain scores after DB and C were significantly lower when patients used the gel pack. The main effects with regard to intervention and session on pain were significant ($P < 0.001$) and with regard to time was non-significant ($P = 0.052$).

At the first time of applying cold gel pack, 48 (96%) patients reported feeling coolness and 2 (4%) patients felt numbness, and at the second time of applying cold gel pack, 37 (74%) patients reported feeling coolness and 4 (8%) patients felt cold, 9 (18%) experienced numbness, and no one experienced tingling. Five patients did not like the experience of cold. Of 50 patients, 45 (90%) stated they would use the gel pack for pain management in the future.

DISCUSSION

Pain after thoracotomy is probably the most severe pain experienced after surgeries,^[23] and patients who underwent

Table 2: Interactions between intervention, session, and time found with RM-ANOVA

	F	P	Effect size (partial η-squared)
Three-way interaction (a.m.-p.m. + gel pack-no gel pack application+pre-post DB and C)	0.93	0.76	0.002
Two-way interaction (a.m.-p.m.+gel pack-no gel pack application)	271.94	<0.001	0.85
Two-way interaction (a.m.-p.m. + before-after DB and C)	0.012	0.91	0.0001
Two-way interaction (gel pack-no gel pack application+pre-post DB and C)	0.902	0.347	0.018
Main effect of intervention (gel pack-no gel pack application)	227.2	<0.001	0.82
Main effect of session (pre-post DB and C)	31.74	<0.001	0.39
Main effect of time (a.m.-p.m.)	3.96	0.052	0.075

RM-ANOVA: Repeated measures analysis of variance, DB and C: Deep breathing and coughing

Table 1: Means and standard deviations of pain intensity scores pre- and post-DB and C

Intervention	Session							
	a.m.				p.m.			
	Before M (SD)*	After M (SD)	Before M (SD)	After M (SD)	Before M (SD)	After M (SD)	Before M (SD)	After M (SD)
The group started with gel	4.56 (1.64)	3.76 (1.51)	4.16 (1.9)	5.96 (1.56)	3.96 (1.83)	3.4 (1.63)	5.96 (1.59)	5.96 (1.59)
The group started without gel	5.36 (1.70)	6.6 (1.55)	5.4 (1.71)	4.04 (1.4)	4.96 (1.24)	6.2 (1.38)	5.40 (1.70)	4.04 (1.4)

*Scale 0-10. The sessions in which the gel pack were used are indicated with gray color in each group. M (SD): Mean Standard deviation, DB and C: Deep breathing and coughing

cardiac surgeries report having most severe pain while coughing and deep breathing. Despite implementing pharmacologic interventions such as the use of nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids, pain control has been inadequate and it might impede deep breathing and effective coughing.^[2,3,7]

In this study, pain was significantly decreased with the use of cold gel packs. Pain scores after DBandC were lower with gel pack compared to without gel pack in all four sessions. The results of this study showed that cold therapy is an effective method for management of sternal incision pain associated with DBandC in cardiac surgery patients. In a similar study in which participants underwent four episodes of DBandC, two with the gel pack and two without it, a reduction of about 1 point on a 10-point scale was identified. Pain was statistically and clinically significantly reduced with the use of gel pack.^[2] Similar results were obtained with cold therapy in various conditions such as chest tube removal, soft tissue injuries, hernia, and orthopedic injuries.^[24-26] According to the NRS for pain intensity, pain scores from 1 to 3 on a 10-point scale are considered to be mild pain and scores above 3-6 as moderate pain.^[11] Patients in this study reported their pain as moderate ($M = 3.81/10$) when using the gel pack, as compared to severe pain ($M = 6.18/10$) reported without the gel pack. The decrease in 2.37 on the 10-point pain intensity scale was statistically significant ($P < 0.001$) with the RM-ANOVA.

Application of cold gel packs resulted in decreased skin temperature and the feeling of coolness, cold, and numbness in patients. No one experienced negative sensations such as tingling, aching, and burning with the application of the gel pack. Feeling of coolness was the most prevalent sensation during the application of the cold gel pack. Five patients did not like the experience of cold because they did not like feeling cold. Chailier *et al.* reported that 28% ($n = 9$) and 72% ($n = 23$) of the participants felt cold and coolness after the application of cold gel pack on the sternal incision site.^[2]

Most of the patients ($n = 45$, 90%) expressed that they would reapply the gel pack in the future. The main reasons for preferring cold gel pack were pain reduction ($n = 31$, 69%), feeling of coolness ($n = 3$, 6.7%), and both ($n = 11$, 24.4%). Cooling the sternum by the cold gel packs seems to be an appealing method for pain management and is perceived as being effective for pain reduction.^[2]

The samples of this study consisted mainly of males, which is a limiting factor. However, males are representative of patients undergoing cardiac surgeries, particularly CABG.^[2,27]

Future studies should investigate the effects of cold application combined with different pharmacologic and nonpharmacologic therapeutic techniques. Both superficial and deep temperature changes depend on the method of cold application, so future studies could also probe for more information about the effects of different temperatures, time periods, and ways of cold application (e.g. ice pack, ice towel, ice massage, and ice chip).

CONCLUSION

Application of cold gel pack was effective for reducing incisional pain associated with DB and C in cardiac surgery patients. Nurses spend more time with patients compared to other members of the treatment team in the clinical centers; so they are in the best position for pain management. They make important decisions regarding use of nonpharmacologic therapeutic interventions for pain management, and cold therapy is one of the nonpharmacologic methods that they can easily use.

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