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Effect of Cold Gel Pack on Controlling Pain Intensity Associated with Deep Breathing and Coughing Exercise after Cardiac Surgery

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Background: *Deep breathing and coughing exercises are the most painful activities during the days of post-cardiac surgery. The cold gel pack is an effective non-pharmacological method that decreases the pain intensity associated with these exercises.*
Purpose of the study: *was to assess the effect of cold gel pack on controlling pain intensity associated with deep breathing and coughing exercise after cardiac surgery.*
Setting: *the study was carried out in the Intensive care unit of open-heart surgery at the National Cardiac Institute, Imbabah, Giza Governorate, Egypt.*
Subjects: *A consecutive sample of 60 patients with cardiac surgery assigned randomly and alternatively into three equal groups, 20 patients for each group.*
Tools: *Three tools were used for data collection. A Structured interviewing questionnaire, Bio -physiologic measurement tool and Visual analogue pain scale (VAS).*
Results: *There was a highly statistically significant reduction in pain intensity in cold gel pack sessions compared to non-gel pack sessions among studied groups P < 0.001.*
Conclusion: *Application ofcold gel pack was effective for controlling pain intensity associated with deep breathing and coughing exercise in cardiac surgery patients.*
Recommendations: *Applied cold gel pack is an alternative non-pharmacological pain management method for cardiac surgery patients as it is cheap, readily available and has no contraindications.*
Key Words: *Cold Gel Pack, Pain Intensity, Deep Breathing and Coughing Exercise, Cardiac Surgery*

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I. Introduction

One of the most important causes of morbidity and mortality in both the developing and the developed countries is Coronary artery disease (CAD) (Sekhri et al., 2014). It is the leading cause of death in the United States with approximately 500,000-700,000 deaths each year, making it the cause of death in an estimated one - third of all deaths in the population for those older than 35 years (MedScape, 2019).In Egypt, the first cause of the top 10 causes of death in 2017 was from ischemic and coronary artery diseases in which the estimated percentage was 35.9% from total deaths (Institute for Health Metrics and Evaluation, 2017).

Cardiac surgeries are among the most complex medical operations that are accompanied with several potential complications such as, tissue contractions and postoperative pain after the surgery, which could occur because of sternal incision, transplantation site, and internal tissue sections at the insertion site of catheter and chest tube (Pishkarmofrad, Navidian, Azadi,Ahmadabadi, &Aliahmadi,2016).

Persistent pain is a common postsurgical symptom affecting 28-56% of cardiac surgery patients(Harrogate, Cooper, Thomas, Langford, & Anwar, 2018).Cardiac surgical patients feel pain due to the surgical incision made during the course of the surgery, and they also experience irritation and inflammation of the pleura from chest tubes (Koranyi, Barth, Trelle, Strauss, &Rosendahl, 2014). Pain after sternotomy in cardiac surgical patients is an ambient symptom during the first two postoperative days. This pain is described as aching, sharp, throbbing, stabbing, burning, sore, and tender by cardiac patients (AbuRuz & Alaloul, 2013).

The most painful experiences in the first two post-operative days are coughing and deep breathing exercises. Pain is not limited to these activities but its intensity increases with incentive spirometer use, range of motion in bed, standing up out of bed, chest tube manipulation, suctioning, dressing procedures, positioning,

chest physiotherapy, and catheterization. In spite of deep breathing and coughing exercises are essential for preventing post-operative respiratory complications, cardiac patients don't perform them effectively because of post sternotomy pain (Zencir&Eser, 2016).

Painafter cardiac surgerycan lead topostoperative pulmonary complications, as weak abdominal and intercostal muscle, reduced respiratory rate and inadequate lung expansion that lead to decreased inspiratory capacity and volume due to ineffective coughing and immobility. Pneumonia and atelectasis are the most common and serious complications in the third to the fifth postoperative day following cardiac surgery and are principal causes of increased mortality (Kol, Erdogan, Karslı,& Erbil, 2013).

Pharmacological methods alone cannot manage increased pain, especially pain associated with deep breathing and coughing exercises. The combination of pharmacological and non-pharmacological interventions is more satisfactory following open- heart surgery (Sethares, Chin, & Costa, 2013).Cold gel pack has been introduced as a noninvasive and non-pharmacological method that is inexpensive and easily applicable to relieve the pain (Haynes, 2015). It reduces inflammation and muscle pain, suppresses edema, and increases the recovery in the affected area (Andersen et al., 2015).

Cold therapy appears to be a useful intervention to decrease acute pain among cardiac surgery patients and would be a useful supplement to surgical care (Keawnantawat,Thanasilp,&Preechawong, 2018).

Nurses are the cornerstone in predicting the physiological and psychological needs of the patients, eliminating their pain, anxiety, and stress. It seems that nurses can practice some non-pharmacological methods to reduce pain and improve the health conditions of patients, as they are responsible for patients' rest and pain alleviation (Merchan-Tahvanainen et al.,2017).

Significance of the study

Cold gel pack was not used in the hospital where this data were collected while it is recommended in many international hospitals, so it was highly informative to study the effect of applying cold gel pack on controlling pain intensity associated with deep breathing and coughing exercise after cardiac surgery.

Research Hypotheses

The following research hypotheses are formulated to achieve the aim of the study:

1. Patient who will applya cold gel pack will have decreased intensity of pain associated with deep breathing and coughing exercise than patients who will receive routine care.
2. Patients who will apply a cold gel pack application in the first two sessions will have decreased pain intensity than patients who will apply it in the second two sessions.

II. Methods

Research Design: quasi- experimental. **Setting:** The study was carried out in the Intensive care unit of open-heart surgery at the National Cardiac Institute, Imbabah, Giza Governorate, Egypt. **Sample:** A consecutive sample of 60 adult patients undergone Cardiac surgery was recruited. Inclusion criteria were **a)** Patients scheduled to cardiac surgery with median sternotomy. **b)**Age (21-60) years. **c)** First 24 hours postoperatively. Patients were excluded if they had **a)** Mechanical ventilation, as unconscious patient cannot express his\her pain. **b)** Patients with diseases that interfere with pain measurement (delirium, dementia, or major depression). **c)** Contraindication to cold therapy use such as Reynaud's disease, as it causes some areas of the body such as fingers and toes to feel numb and cold in response to cold temperatures or stress. - Sickle cell anemia as it is difficult for these pointed, inflexible, and sticky cells to travel through the narrow blood vessels and cold therapy cause vasoconstriction. **d)** Diabetic patients, as it causes impairment in the sensation due to neuropathy. **e)** Post-operative complications such as bleeding and wound dehiscence to prevent infection. **Sample size calculation:** was determined and calculated using the EPI info program and it was 60 patients at CI (coefficient interval) 99%. **Sampling technique:** Patients were assigned randomly and alternatively into three equal groups, 20 patients for each group for applying treatment protocol. Random allocation to groups was performed using a random number table.

G1: Those patients were given four sessions of deep breathing and coughing (two sessions with a cold gel pack and two without it) every 2 hours were applied. A cold gel pack was applied for 15 minutes in the first two sessions followed by a period of "no treatment" (so-called washout period) and then they were not given the cold gel pack in the second two sessions. The washout period was 2hours.**G2:** Those patients started the first two sessions without a cold gel pack, followed by the washout period and then the gel pack was applied in the second two sessions.**G3:** Those patients were exposed only to routine hospital care (Deep breathing & coughing exercise and analgesics).

Data Collection Tools:

I- Structured Interviewing Questionnaire: was developed by the researchers to identify the characteristics of the sample. It was comprised of two parts. **Part one: Social characteristics:** It was comprised of 5 questions included data related to patient's age, sex, marital status, education, and occupation. **Part two: Medical data:** It was comprised of 5 questions about diagnoses, previous use of cold therapy,the cause of its use, if it met the benefit or not and the side effects that appear after cold gel application such as low skin temperature, numbness, and dryness of the skin. **II-Bio physiologic measurement tool:** It was comprised of 2items about patient respiratory rateand oxygen saturation.**III-Visual Analogue Pain Scale (VAS):** It was developed by McCormack, Horne and Sheather., (1988) and it was used by the researcher to record subjective estimates of pain intensity. The measurement was from zero to ten to rate the patient's intensity of pain. 0= No pain, 1-3= Mild pain, 4-6= Moderate pain, 7-9 =Sever pain, 10 = Worst pain.

Methods

Tools development: The first two tools were developed by the researcher, while tool three was developed by McCormacket al., (1988).**Validity of the tools:** All tools were tested for face and content validity by 5 experts in the field of Medical-Surgical Nursing Department Faculty of Nursing, Menoufia University. Modifications were done to ascertain relevance and completeness. **Reliability of the tools:** The reliability of tools was done to determine the extent to which items in the tools were related to each other by Cronbach's Co-efficiency Alpha for tool I (a=.088), for tool II (a=.085) and for tool III (a=.808). **Pilot study:** A pilot study was conducted prior to data collection on 10% of the study sample (6 patients). This was performed in order to test the clarity and applicability of the tools. Necessary modifications were done. These patients were excluded from the sample. **Ethical consideration:** An official letter from the faculty of Nursing was delivered to the responsible authorities of hospital and approval to conduct this study was obtained after an explanation of the aim of the study. Patients signed ethical written consent to participate in this study after an explanation of the purpose of study. Each patient was reassured that any information obtained would be confidential and would only be used for the study purpose. The researcher affirmed that participation in the study was entirely voluntary and anonymity of the patients was assured through coding data. Patients were also informed that refusal to participate wouldn't affect their care.

Data collection Procedure (Intervention):

Data collection extended from April 2018 to April 2019.Each patient agreed to participate in the study and fulfilled the inclusion criteria were interviewed individually by the researcher immediately on referral to the cardiothoracic surgery department.

The researcher entered the patient's room, introduced herself to the patient and explained the aim of the study, described the visual analogue scale for patients prior to starting data collection.On admission for every patient the patient's socio-demographic and medical data was filled by the researcher using tool I, bio-physiologic measurements were measured by using tool II. Patients in (G3) were assessed at baseline using tools I, tool II except for previous use of cold therapy. Random allocation to groups was done using a random number table.

Data was gathered between 8 am and 5 pm in order to reduce variability among patients. Cold gel pack was applied on the first post-surgical day when they were oriented to place and time and able to report pain. Gel packs that were used as the cold source weighed 390 g and measured 25 cm by 14cm. They were conserved in the freezer on the patient service unit and were frozen until their temperature reach between 0°C and −5°C, then removed from the freezer and placed in a cotton bag. The timer was activated for 15 min and the gel pack was applied directly over the sternal wound dressing. In the literature, to usea cold gel pack as a therapeutic modality, it must cool down tissues for at least 12 min so; 15-mins was selected to achieve the desired effect.

Study group patients were randomly allocated to begin the deep breathing and coughing sessions either with the cold gel pack or without the cold gel pack prior to beginning deep breathing and coughing sessions.All patients of G (I, II) performed four sessions of deep breathing and coughing (two with cold gel pack and two without it) every 2 hours.**G1:** the patients received cold gel pack for 15 minutes followed by a period of "no treatment" (so-called washout period) and then they werenotgiven gel pack.**G2:** the patients started without cold gel pack first, followed by the washout period and then cold gel pack was applied.

The gel pack sessions; the researcher 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 researcher remained with patients for 15 minutes when the gel pack was used. During the fifteen minutes of the gel pack application, the patients were asked to describe the sensation he/she feels during the gel pack application. After 15 minutes, the gel pack was picked up removed and the head of the bed was elevated between 45° and 90° in preparation for deep breathing and coughing. A pillow or folded sheet was given to the patients for splinting purposes and deep breathing and coughing started for both groups. In each session, three cycles of three deep breathing were

performed followed by an episode of coughing. The patient was asked to rate his/her pain from 0 to 10 on the Visual analogue scale after completion of the third cycle.

The sessions without the gel pack, the researcher prepared the patients for deep breathing and coughing in the same manner as in the gel pack sessions. At the end of the fourth session, all patients of G (I & II) will be asked if they preferred the gel pack prior to deep breathing and coughing. **G3:** patients were exposed only to routine hospital care.**G (1&2):** in the sessions with the application of a cold gel pack, the intensity of pain was measured two times,first immediately before applying the cold gel pack and second after coughing and deep breathing.In the sessions without application of cold gel pack, the intensity of pain was measured immediately before and after coughing and deep breathing.**G3:** the intensity of pain in the four sessions was measured immediately before and after coughing and deep breathing.Patients' pain intensity was assessed using tool III.

Statistical Analysis:

Data were collected, tabulated, statistically analyzed using an IBM personnel computer with Statistical Package for Social Science (SPSS) statistical package version 22 and Graphics were done using Excel program. The following statistics were appliedthat were: Descriptive statistics (Arithmetic Mean (X), Stander Deviation (SD), and Analytic Statistics (Paired t-test, Friedman testchi-square test (X^2), Mann-Whitney U Test, Multivariate analysis of variance (ANOVA).

III. Results

Variables	G1 (n=20)		G 2 (n=20)		G 3 (n=20)		X^2	P -value
	No	%	No	%	No	%		
Age *Mean ± SD*	47.10 ±2.7		50.20 ±7.0		50.95 ±2.9		Anova test 0.390(NS)	0.679
Marital status Married	20	100 %	20	100%	20	100%	NA	
Job								
Manual work	6	30 %	4	20 %	5	25 %	8.55(NS)	0.200
Adminstratory work	4	20 %	4	20 %	5	25 %		
Housewives	8	40 %	8	40 %	2	10 %		
Not working	2	10 %	4	20 %	8	40 %		

Table (1): Socio-Demographic Characteristics ofthe Studied Patients.

Distribution of socio-demographic characteristics of the studied Patients: the mean age of G1, 2 and 3respectively was 47.10±2.7 & 50.20 ± 7.0& 50.95 ± 2.9 respectively. Hundred percent of the studied patients were married. Regarding occupation, 40% were housewives in G 1&2 but 40% didn't work in G3. There were no statistically significant differences between G1, 2 and 3in relation to their Socio-demographic Characteristics.

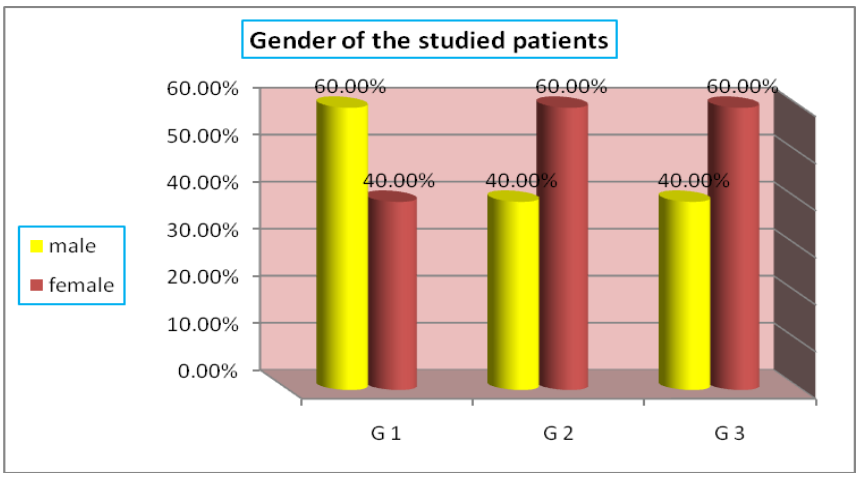

Figure (I): Gender of the studied patients.

Gender of the studied patients: 60 %of G1 were male and 60% of G2&3 were female.

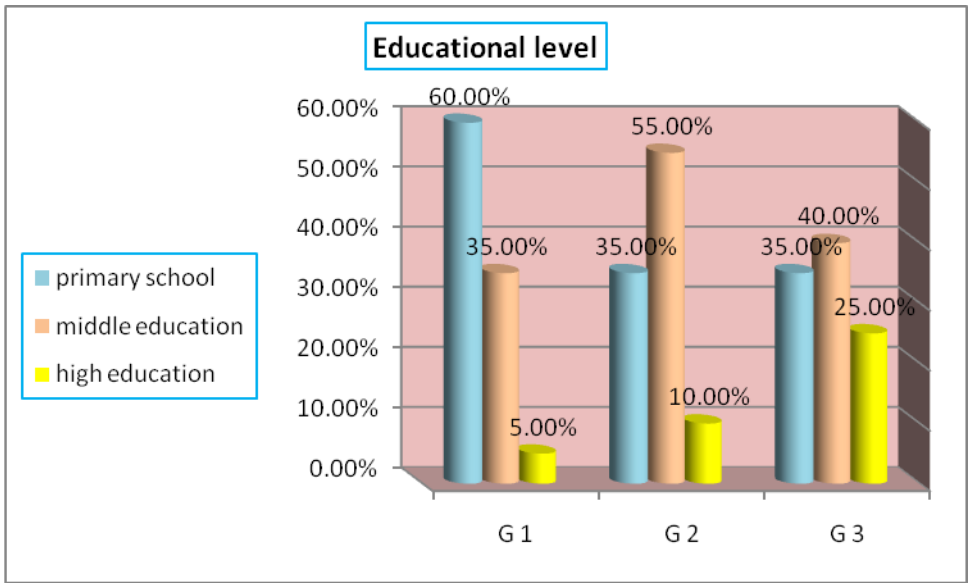

Figure (II): Educationallevel of studied patients.

Educational level of the studied patients: 60%of G1 had a primary school and 55% & 40% had middle education in G2 &3respectively.

Table (2): Present Medical Data Historyof the StudiedPatients.

Variables	G1 (n=20)		G2 (n=20)		G3 (n=20)		X^2	P -value
	No	%	No	%	No	%		
Diagnosis								
- CABG	10	50 %	6	30%	10	50 %	17.17(NS)	0.143
- Mitral valve repair	3	15 %	9	45%	2	10 %		
- Aortic valve repair	2	10%	1	5%	3	15 %		
- Mitral valve repair & tricuspid repair	2	10%	0	0%	3	15 %		
- Mitral valve repair &aortic valve repair	1	5 %	4	20 %	1	5 %		
- Aortic valve repair &tricuspid valve repair	1	5%	0	0 %	0	0 %		
- Atrial septal defect	1	5 %	0	0 %	1	5 %		
Pre use of cold gel pack No	20	100 %	20	100 %			NA	
Side Effects of cold gel pack application in the current use							1.33(NS)	0.513
Low skin temperature	1	5 %	0	0 %				
Aching sensation	1	5 %	2	10 %				
No side effects	18	90 %	18	90 %				

Present Medical Data History of the Studied Patients: regarding diagnoses 50% of G1 & 3 had coronary artery bypass graft surgery and 45% of G 2 had Mitral valve repair. Regarding side effects of the cold gel pack application, there were no side effects in 90% of G 1, 2
There were no statistically significant differences between G 1, 2 and 3 in relation to present medical history.

Variables	G1				G2				G3			
	Pre (n=20)	Post (n=20)	Paired t-test	p-value	Pre (n=20)	Post (n=20)	Paired t-test	p-value	Pre (n=20)	Post (n=20)	Paired t-test	p-value
	Mean ± SD	*Mean ± SD*			*Mean ± SD*	*Mean ± SD*			*Mean ± SD*	*Mean ± SD*		
Respiratory rate												
First	33.45 ±6.7	33.00 ±6.7	.244(NS)	.810	32.50 ±6.2	31.45 ±6.1	.795(NS)	.436	31.20 ±8.2	31.95 ±8.5	-.673-(NS)	.509
Second	34.25 ±10.8	33.60 ±6.3	.320(NS)	.753	30.15 ±5.4	31.70 ±5.4	-1.101-(NS)	.285	30.10 ±7.8	32.00 ±9.3	-1.194-(NS)	.247
Third	30.65 ±6.9	30.25 ±7.2	.306(NS)	.763	31.75 ±4.4	30.05 ±3.9	1.146(NS)	.266	29.20 ±8.4	33.40 ±8.4	-2.948-(S)	.008
Fourth	28.85 ±7.5	30.80 ±6.0	-1.602-(NS)	.126	31.20 ±6.6	33.25 ±5.9	-1.633-(NS)	.119	29.50 ±7.9	32.60 ± 6.5	-2.616-(S)	.017
Oxygen saturation												
First	94.00 ±6.3	92.85 ±6.4	.894(NS)	.382	96.25 ±2.3	96.10 ±2.7	.497(NS)	.625	96.95 ±2.8	96.65 ±2.8	1.552(NS)	.137
Second	93.75 ±6.7	94.25 ±5.6	-.668-(NS)	.512	95.50 ±3.4	96.00 ±1.4	-1.141-(NS)	.268	96.85 ±3.5	97.30 ±2.0	-.744-(NS)	.466
Third	95.35 ±4.9	95.00 ±5.6	1.000(NS)	.330	95.40 ±3.1	96.55 ±1.9	**-2.669-(S)**	**.015**	97.40 ±2.7	97.85 ±2.1	-.750-(NS)	.463
Fourth	94.05 ±6.5	93.75 ±6.7	.767(NS)	.453	95.85 ±3.9	96.60 ±2.7	-1.359-(NS)	.190	97.15 ±2.6	97.50 ±1.9	-.924-(NS)	.367

Table (3): Mean ofPhysiological Measures of the Studied Patients in the Pre and Post-Intervention.

Mean of Physiological Measures of the Studied Patients in the Pre and Post Intervention: there was no statistically significant difference between pre and post-intervention for G1 in the respiratory rate and oxygen saturation in all sessions.

There was no statistically significant difference between pre and post-intervention for G2 in the respiratory rate and oxygen saturation in the four sessions but there were statistically significant differences between pre and post-intervention regarding oxygen saturation in the third session only.

There was no statistically significant difference between pre and post-intervention for G3 in the respiratory rate in the first and second sessions of intervention but there was a statistically significant difference in the third and fourth sessions of intervention.Regarding oxygen saturation, there was no statistically significant difference between pre and post-intervention in the four sessions of intervention.

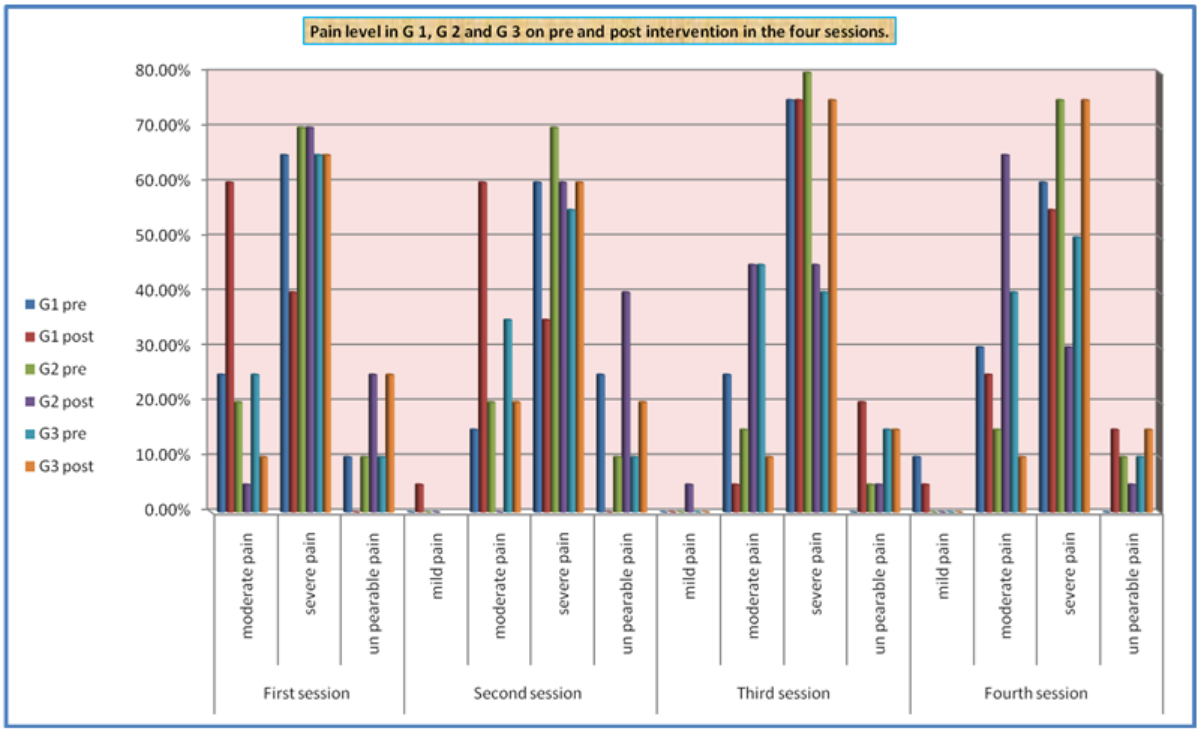

Figure (III): Pain Level in Studied Groups on Pre and Post-Intervention in the Four Sessions

Distribution of pain level in studied groups on pre and post-intervention in the four sessions: There were no statistically significant differences between G1&G2pre-intervention. Meanwhile, there were highly statistically significant differences between G1&G2 post-intervention in the four sessions.

There were no statistically significant differences between G1&G3 in the first and second sessions pre-intervention. Meanwhile, there were highly statistically significant differences between G1&G3 in the first and second sessions post-intervention.

There were no statistically significant differences between G2&G3 pre and post-interventionin the first and second sessions. While there were statistically significant differences between G2&G3 pre and post-interventionin the third and fourth sessions.

IV. Discussion

Patients who developed cardiac surgeries have sensitized severe pain during deep breathing and coughing exercises. Pain alleviation in patients after cardiac surgery is one of the essential problems in intensive care units (Barr et al., 2013). Unless pain is managed it can increase the risk of developing atelectasis, respiratory infections, myocardial ischemia, stroke, heart failure, and thromboembolic diseases (King & Fraser, 2013). Indeed, the use of a non-pharmacologic alternative method such as cold therapy with fewer side effects has always been appropriate in preventing postoperative pain (Bastani, Hajizadeh, Sa`atchi, &Haghani, 2016).

Socio-demographic characteristics: the present study presented that there were no statisticallysignificant differences between the studied groups in their socio-demographic Characteristics and this is consistent with Khalkhali et al., (2014) and Ebrahimi-Rigi et al., (2016) who reported that the studied groups didn't differ significantly regarding age and sex.

Concerning gender, the current study found that the majority of the studied patients were female but this is different from the results of Khalkhali et al., (2014) who stated that the majority of the studied groups were male.

Regarding educational level, the present study revealed that about half of the studied participants had middle education. In this regard, Aburuz and Alaloul (2013) found that about half of the studied participants had high education. While, Pishkarmofrad et al., (2016) showed that most of the intervention and control groups were literate.

Regarding the diagnosis, our study revealed that about half of the G1 and G3 had coronary artery bypass graft surgery (CABG) and about half of G2 had mitral valve repair. This result was in agreement with Keawnantawat et al., (2018) who illustrated that one-third of participants underwent isolated CABG-surgery whereas about one third had isolated valvular surgery of both the study and control group.

Regarding side effects of the cold gel pack application the present study found that the majority of G1&2 had no side effects, this result was in line with Khalkhali et al., (2014) who found that there were no side effects or complications due to the cold therapy via gel pack reported.

Controlling pain intensity associated with deep breathing and coughing exercise after cardiac surgery: The current study hypothesized that patients who willapply a cold gel pack (G1&G2) will have decreased intensity of pain associated with deep breathing and coughing exercise than patients who will receive routine care (G3).

The result of the current study had shown thatthere were highly statistically significant differences between pre and post-intervention regarding pain in **G1**. Pain significantly decreased with the use of the cold gel pack. Pain scores after deep breathing and coughing exercise were decreased with the cold gel pack in the (first and second sessions) compared to without the cold gel pack in the (third and fourth sessions). Also, there were highly statistically significant differences between pre and post-intervention regarding pain in **G2**. Pain significantly decreased with the use of the cold gel pack. Pain scores after deep breathing and coughing exercise were decreased with the cold gel pack in the (third and fourth sessions) compared to without the cold gel pack in the (first and second sessions). That's because cold reduces inflammation and muscle pain, as well as activity of nociceptive receptors resulting in increased vasoconstriction and thus restriction ofbleeding in the damaged area. It is also effective in reducing hyperthermia (Andersen et al., 2015; Salvo, 2015).

The results of the present study were going with the results of Khalkhali et al., (2014) who illustrated that, pain significantly decreased with the use of the cold gel packs. Pain scores after deep breathing and coughing exercise were lower with the gel pack compared to without the gel pack in all four sessions after open-heart surgery.Also it was similar to the previous studies using cold modality to relieve pain after cardiac surgery by Chailler et al., (2010) who indicated the effectiveness of applying a cold gel pack on the sternotomy wound to eliminate pain during the episodes of deep breathing and coughing exercise.

The results of this study showed that the cold gel pack is an effective method for controlling pain associated with deep breathing and coughing in cardiac surgery patients.

The present study found that two-thirds of **G1** had severe pain in the first and second sessionsbefore applying a cold gel packbut about two-thirds of them had moderate pain after applying a cold gel pack. Compared to **G2** two-thirds of them had severe pain in the first and second sessions before deep breathing and coughing exercisebut more than two-thirds of them had severe pain after deep breathing and coughing exercise.

The majority of **G2** had severe pain in the third and fourth sessions before applying a cold gel pack but about half of them had moderate pain in the third session after applying a cold gel pack and two-thirds of them

had moderate pain in the fourth session after applying of a cold gel pack. While **G1**in the third and fourth sessions two-thirds of them had severe pain before deep breathing and coughing exercise andthe majority of them had severe pain after deep breathing and coughing exercise.After tissue damage,vasoactive agents such as histamine are released.These chemicals cause inflammation and leakage of fluid from blood vessels. Cold therapy reduces inflammation through the contraction of blood vessels and decreasing vasoactive agents of the damaged tissue. It alleviates pain by boosting the pain threshold by slowing down the conduction velocity of neural pathways (Bastani et al., 2016).

The present study results were in the same line with Pishkarmofrad, Navidian, Azadi&Aliahmadi, (2016)who illustrated that, localized cryotherapy using ice packs significantly reduced the postoperative thoracic pain of the patients undergoing coronary artery bypass graft surgery, lowering the severity of pain to the mild level and they have reported that Cold therapy is effective on the sensory dimension of pain quality in sternal incision caused by coughing and deep breathing in patients undergoing coronary artery bypass graft surgery. Also, Ebrahimi-Rigi, et al., (2016) whose results indicated that the application of cold gel pack was effective to reduce the sensory dimension of the quality of pain in the patients after the coronary artery bypass graft surgery.

The current study found that two-thirds of **G1**had severe pain in the first and second sessions before applying a cold gel pack but about two-thirds of them had moderate pain after applying a cold gel pack. Meanwhile, two-thirds of **G3** had severe pain in the first and second sessions before deep breathing and coughing exercise and two-thirds of them had severe pain after deep breathing and coughing exercise.

Also,the present study found that the majority of **G2**had severe pain in the third and fourth sessions before applying a cold gel pack but about half of them had moderate pain in the third session after applying a cold gel pack and two-thirds of them had moderate pain in the fourth session after applying a cold gel pack.While about half of **G3** had moderate pain in the third session and half of them had severe pain in the fourth session before deep breathing and coughing exercise and the majority of them had severe pain in the third and fourth sessionsafter deep breathing and coughing exercise.A Cold gel pack is believed to help control pain by inducing local anesthesia resulting in reducing discomfort and pain in the damaged area.

The recent results came in the same line as Keawnantawat et al., (2018) whose results showed that the experimental group had significantly lower mean pain than the control group. In addition, pain scores in the experimental group were significantly decreased during the first 72 postoperative hours. Thus, cold therapy was effective in reducing pain after cardiac surgery during the acute phase.

The current study also hypothesized that patients who will receive a cold gel pack application in the first two sessions will have decreased pain intensity than patients who will receive it in the second two sessions.The results of our study didn't support this hypothesis and illustrated that the pain score increased in the third and fourth sessions than the first and second sessions post-intervention in **G1**. Meanwhile, in **G2,** the pain score in the first and second sessions post-intervention was high to become lower in the third and fourth sessions post-intervention.This means that patients who received a cold gel pack application in the first two sessions didn't have decreased pain intensity in the next two sessions than patients who received it in the second two sessions, so the cold gel pack has temporary effect and don't last for long period of time for relieving pain associated with deep breathing and coughing exercise after cardiac surgery.

The current study also wasn't in accordance with the study of Zencir and Eser (2016) who concluded that cold therapy had a positive effect on pain management early post-cardiac surgery but was not effective for the pain associated with deep breathing exercises.

Regarding Physiological Parameters for the Studied Patients, our study cleared that there were no statistically significant differences between pre and post-intervention for the G1, G2, and G3in the respiratory rate and oxygen saturation in the four sessions of intervention. But there were statistically significant differences between pre and post-intervention for G2, regarding the oxygen saturation in the third session and G3 regarding the respiratory rate in the third and fourth sessions of intervention. This came in the same line with the results of Zencir and Eser (2016) who reported that the spirometric volume values between the gel pack and no-gel pack periods in the first and second postoperative dayswere not significantly different.

From the forgoing discussion, it can be concluded that the cold gel pack is an effective non-pharmacologic intervention for controlling pain intensity associated with deep breathing and coughing exercise after cardiac surgery.

V. Conclusions:

The findings of this study illustrated that:

- The application of a cold gel pack was effective for reducing sternal pain associated with deep breathing and coughing exercise in cardiac surgery patients.
- Cold gel pack has a temporary effect and doesn't last for a long period of time as there was a significant increase in the pain score in the third and fourth session than first and second session post-intervention in**G1**.

VI. Recommendations:

- Cold gel pack should be used as an alternative non-pharmacological pain management method for cardiac surgery patients as it is cheap, readily available and has no contraindications.
- Application of cold gel pack can reduce the consumption of sedatives and painkillers and consequently side effects of these drugs.
- Cold gel pack saves high costs of medication and medical advice for relief and control of pain.

Implications for further researches:

- It is recommended for future studies to assess the effects of cold gel pack on different post-surgical intervals.
- Future studies should examine the effect of cold gel pack on reducing pain caused by other operations.

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