



# Effect of Cold Application on Pain After Chest Tube Removal in Patients Undergoing Bypass Surgery

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## ABSTRACT

**Objectives:** This study investigated the effect of cold application on pain after chest tube removal in patients undergoing bypass surgery.

**Methods:** Data of 56 patients who underwent bypass surgery between August 2021 and November 2021 (46 males, 10 females; mean age: 62.8±9.2 years) were analyzed. The patients were divided into two groups: the intervention group (n=28) with cold application and the control group (n=28) without cold application. Demographic characteristics, pain, and vital signs of the patients were compared.

**Results:** The groups mostly felt pain in the tube site 20 min before cold application, during the procedure, and 20 min after the procedure, and a significant difference in pain quality was observed between the groups (p<0.05). No significant differences in pain severity and skin and body temperatures were observed between the two groups 20 min before the procedure. Pain intensity and skin and body temperatures of the intervention group decreased during and 20 min after the procedure. No significant differences in systolic blood pressure, diastolic blood pressure, heart rate, and respiration were observed between the two groups (p>0.05). In the control group, systolic and diastolic blood pressures and pulse rate increased during the procedure. The SpO<sub>2</sub> level of the intervention group was higher.

**Conclusion:** Cold application was effective in managing pain after chest tube removal in patients undergoing bypass surgery.

**Keywords:** Chest tube, cold application, coronary artery bypass, pain

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## Introduction

Coronary artery disease (CAD) has an increasing prevalence among countries. It is one of the most common diseases in Türkiye.<sup>[1]</sup> Coronary artery bypass graft (CABG) procedures with percutaneous coronary intervention are used in the surgical treatment of CAD. This procedure is among the most commonly performed cardiac surgeries. CABG treats blocked or narrowed vessels using grafting.<sup>[2]</sup> At the end of cardiac surgery, chest tubes (drain) are placed into the chest of the patient. One is placed in the thorax, and another in the mediastinal cavity. The inserted mediastinal and thoracic drains are used to drain air and blood accumulated in the pleural or mediastinal cavity or fluid accumulated in the pleural cavity, pericardial space, or lungs.<sup>[3,4]</sup> The inserted drains ensure hemodynamic stability in the postoperative period and prevent complications, such as pleural effusion, chylothorax, hemothorax, and empyema.<sup>[2-4]</sup>

Anxiety, discomfort, and pain are observed in patients with chest tubes placed after the surgical procedure.<sup>[5]</sup> It has been observed that postoperative pain in patients undergoing bypass surgery decreases after minimizing sensitivity to pain by stimulating pain receptors using cold application.<sup>[6]</sup>

Therefore, this study investigated the effects of cold application on pain after chest tube removal in patients undergoing bypass surgery.

## Methods

This clinical study included 56 patients who underwent coronary artery bypass surgery at the Cardiovascular Surgery Clinic of Acıbadem Altunizade Hospital between August 2021 and November 2021. In the power analysis, 56 individuals (n=28 in the intervention group and n=28 in the control group) were required to obtain 80% power

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at a 0.05 level of significance. Randomization of patient allocation to the groups was performed by drawing lots. The inclusion criteria were as follows: patients who underwent coronary artery bypass graft surgery, those aged between 18 and 80 years, those who could communicate, those who agreed to participate in the study, and those who had no allergy or sensitivity to cold. The "Patient Information Form," which included the personal information of the patients, the "Short-Form McGill Pain Questionnaire," which assessed the intensity and quality of pain, the Vital Signs Flow Sheet, and the Skin Temperature Evaluation Form were used.

The form developed by the researchers contained information about cold application, its duration and implementation, and patients' consent for the application.

The form, developed by the researcher, comprises nine questions about the patient's demographic characteristics, the name of the surgical procedure, the duration of tube insertion, smoking, alcohol use, and allergy status.

The form provides information on the skin temperature of the chest tube site measured before cold application, during the procedure, and 20 min after tube removal.

A ThermoFlash LX-26 thermometer, which measures skin temperature remotely, was used to assess the temperature of the chest tube entry site. Its suitability was approved by the American Society for Testing and Materials. Skin temperature measurements were performed at the hospital where our study was conducted.

The Short-Form McGill Pain Questionnaire was developed by Melzack in 1987.<sup>[7]</sup> The validity and reliability of the Turkish version of the questionnaire were assessed by Yakut in 2007.<sup>[8]</sup> This form provides information on the intensity, effect, and quality of pain. It comprises three parts. The first part measures the quality of pain, the second part measures pain intensity, and the third part measures pain experience.

Data were collected after obtaining the necessary institutional permission and ethics committee approval. Patients who arrived at the center where the study was conducted and met the study criteria were informed about the purpose, process, scope, and duration of the study. Subsequently, written consent was obtained from all 56 patients who voluntarily agreed to participate in the research.

In this study, 27×35 cm ice gel packs were used. Considering the possibility of ice burn or cold allergy, ice covers were used during application. Furthermore, these gel packs were used for patients in the hospital where this study was conducted.

Routine analgesic techniques were used in the study population. In the cardiovascular surgery clinic where

this study was conducted, on postoperative days 0 and 1, paracetamol (Flakon) was administered every 6 h as a routine treatment protocol. On postoperative days 2, 3, 4, and 5, paracetamol (500 mg tablet) was administered every 6 h. Analgesics were not administered to all patients as a routine treatment protocol before the procedure. Discharge of the patients was planned to be on the morning of the 5<sup>th</sup> postoperative day. Patients in the control group received these routine treatments, and those in the intervention group received cold application twice—20 min before and 20 min after the procedure—in addition to the aforementioned routine treatments. A different gel pack was used for each application.

Before chest tube removal on postoperative day 1, the Patient Information Form, the Vital Signs Flow Sheet, the Skin Temperature Evaluation Form, and the Short-Form McGill Pain Questionnaire were administered to the patients in the intervention group, and the data were recorded. Subsequently, a 20-min cold application was applied to an area of approximately 5–15 cm in diameter, with the chest tube entry site in the center. The literature has reported that if the skin temperature drops to 13.6°C or if the procedure lasts for 20 min, cold application can have an analgesic effect and be effective in relieving pain.<sup>[9]</sup> The cold application was applied during and 20 min after chest tube removal. The same forms and questionnaire were applied, and the data were recorded.

On postoperative day 1, patients in the control group were evaluated using the Patient Information Form, the Vital Signs Flow Sheet, the Skin Temperature Evaluation Form, and the Short-Form McGill Pain Questionnaire, and the data were recorded. The same forms and questionnaire were applied to patients in the intervention group during and 20 min after chest tube removal, and the data were recorded.

Statistical Package for the Social Sciences (version 25; IBM Corp., Armonk, NY, USA) was used in this study. Because the sample size was <30, nonparametric t-tests were applied. Analyses were performed with 95% confidence intervals (95% CIs). Frequency analysis was used in the distribution. The chi-square test was used to analyze the distributions in the intervention and control groups, the Mann–Whitney U test was performed for comparisons of the groups, and the Friedman test was used to determine significant differences between the median values of the dependent groups. P-values <0.05 were used to denote statistical significance.

## Results

When the descriptive characteristics of the patients were compared, no statistically significant differences were observed between the groups ( $p>0.05$ ) (Table 1).

**Table 1.** Distribution of the patients according to descriptive characteristics

	Groups (n=56)				x <sup>2</sup>	p
	Intervention group (n=28)		Control group (n=28)			
	n	%	n	%		
Age						
≤60	13	46.4	9	32.1	1.20	0.278
>60	15	53.6	19	67.9		
Gender						
Female	3	10.7	7	25.0	1.95	0.163
Male	25	89.3	21	75.0		
Educational level						
Primary school	5	17.9	8	28.6	1.33	0.722
Secondary school	4	14.3	3	10.7		
High school	7	25.0	8	28.6		
University	12	42.9	9	32.1		
Smoking						
Yes	15	53.6	16	57.1	0.72	0.788
No	13	46.4	12	42.9		
Alcohol use						
Yes	12	42.9	7	25.0	1.99	0.158
No	16	57.1	21	75.0		
Allergy						
No	24	85.7	21	75.0	11.20	0.262
Food	1	3.6	7	14.3		
Pollen	2	7.1	0	0.0		
Drug	0	0.0	1	3.6		
Other	1	3.6	1	3.6		
		<b>Mean±SD</b>		<b>Mean±SD</b>	<b>x<sup>2</sup></b>	<b>p</b>
Mean age		61.64±9.39		64.14±9.16	-0.134	0.179
BMI (kg/m <sup>2</sup> )		28.34±4.09		27.78±4.09	-0.18	0.851
CTD (hours)		26.63±2.28		26.80±2.29	-0.27	0.791

X<sup>2</sup>: Chi-square test; SD: Standard deviation; BMI: Body mass index; CTD: Chest tube duration

In the intervention group, 57.1% of the patients had pain in the tube site 20 min before the procedure, 85.7% had pain in the tube site during the procedure, and 82.1% had pain in the tube site 20 min after the procedure. In the control group, 60.7% of the patients had pain in the tube site 20 min before the procedure, 85.7% had pain in the tube site during the procedure, and 71.4% had pain in the tube site 20 min after the procedure (Table 2).

In the intervention group, pain intensity 20 min before cold application was higher than that during and 20 min after the procedure. In the control group, pain intensity during cold application was higher than that 20 min before and after the procedure (Table 3).

A significant difference in the skin temperature scores of the patients during and 20 min after the procedure was

observed between the two groups ( $p < 0.05$ ). The mean scores of the control group were higher than those of the intervention group (Table 4).

Significant differences in the skin temperature scores obtained by the patients during and 20 min after the procedure were observed between the two groups ( $p < 0.05$ ). The control group had higher scores than the intervention group (Table 4).

Moreover, a significant difference in the body temperature values during the procedure ( $z = -6.03$ ;  $p < 0.01$ ) and 20 min after the procedure ( $z = -4.81$ ;  $p < 0.01$ ) was observed between the two groups, and the control group had higher scores than the intervention group. According to the results of the Mann-Whitney U test, no significant differences in systolic blood pressure, diastolic blood pressure, heart rate,

**Table 2.** Distribution of patients according to the location of pain before, during, and after the procedure

	Groups (n=56)				Total	
	Intervention group (n=28)		Control group (n=28)			
	n	%	n	%	n	%
Pain location (20 min before the procedure)						
Chest	4	14.3	6	21.4	10	17.9
Chest and back	1	3.6	2	7.1	3	5.4
Shoulder and chest	0	0.0	1	3.6	1	1.8
Back	3	10.7	0	0.0	3	5.4
Tube site	16	57.1	17	60.7	33	58.9
Tube site and arm	1	3.6	0	0.0	1	1.8
Tube site and chest	0	0.0	0	0.0	0	0.0
Tube site and shoulder	0	0.0	1	3.6	1	1.8
Tube site and back	3	10.7	1	3.6	4	7.1
Pain location (During the procedure)						
Chest	2	7.1	4	14.3	6	10.7
Chest and back	0	0.0	0	0.0	0	0.0
Shoulder and chest	0	0.0	0	0.0	0	0.0
Back	0	0.0	0	0.0	0	0.0
Tube site	24	85.7	24	85.7	48	85.7
Tube site and arm	0	0.0	0	0.0	0	0.0
Tube site and chest	0	0.0	0	0.0	0	0.0
Tube site and Shoulder	0	0.0	0	0.0	0	0.0
Tube site and back	2	7.1	0	0.0	2	3.6
Pain location (20 minutes after the procedure)						
Chest	3	10.7	1	3.6	4	7.1
Chest and back	0	0.0	0	0.0	0	0.0
Shoulder and chest	0	0.0	0	0.0	0	0.0
Back	0	0.0	0	0.0	0	0.0
Tube site	23	82.1	20	71.4	43	76.8
Tube site and arm	0	0.0	0	0.0	0	0.0
Tube site and chest	0	0.0	6	21.4	6	10.7
Tube site and shoulder	0	0.0	1	3.6	1	1.8
Tube site and back	3	7.2	0	0.0	1	1.8

and respiratory rate were observed between the two groups ( $p>0.05$ ). According to the results of the Friedman test, in the intervention group, the pulse rate during the procedure was higher than that 20 min before the procedure, whereas, in the control group, systolic and diastolic blood pressures and heart rate increased during the procedure.  $SpO_2$  levels were higher in patients who received cold application.

## Discussion

CAD is one of the most common diseases in Türkiye.<sup>[10]</sup> In coronary artery bypass surgery, a midsternotomy is performed. Because of the opening of the sternum during the operation, soft tissues and nerves in the chest wall are

damaged, and postoperative discomfort occurs. Surgical intervention and invasive methods cause respiratory complications and pain in the incision area.<sup>[11]</sup> Pain due to leg incision and retraction of the sternum during surgery and brachial plexus neuropathy may also occur due to saphenous vein grafting.<sup>[1]</sup>

Nowadays, nonpharmacological methods are also used to control pain in addition to pharmacological methods.<sup>[12]</sup> Anxiety, discomfort, and pain are observed in patients with chest tube insertion after surgery. Pain receptors are stimulated by stimuli that are too cold or too hot. The number of cold receptors in the body is higher than that of hot receptors.<sup>[13]</sup> Cold application is a common nursing

**Table 3.** Distribution of patients according to pain intensity before, during, and after the procedure

	Groups (n=56)				z	p
	Intervention group (n=28)		Control group (n=28)			
	Mean	SD	Mean	SD		
Pain intensity						
20 minutes before the procedure	2.32	0.61	2.43	0.57	-0.64	0.523
During the procedure	1.53	0.51	3.00	0.00	-6.99	0.000*
20 minutes after the procedure	1.04	0.19	2.43	0.63	-6.41	0.000*
X <sup>2</sup>	50.31		13.27			
p	0.000**		0.001**			

\*: p&lt;0.05; \*\*: p&lt;0.01.

**Table 4.** Distribution of patients according to skin temperature before, during, and after the procedure

	Groups (n=56)				z	p
	Intervention group (n=28)		Control group (n=28)			
	Mean	SD	Mean	SD		
Skin temperature (°C)						
20 min before the procedure	36.65	0.23	36.70	0.32	-0.14	0.888
During the procedure	35.88	0.20	36.81	0.28	-6.46	0.000*
20 min after the procedure	35.72	0.25	36.88	0.32	-6.44	0.000*
X <sup>2</sup>	50.31		13.27			
p	0.000**		0.001**			

\*: p<0.05; \*\*: p<0.01. z: Mann-Whitney U test, X<sup>2</sup>: Friedman test.

intervention. It reduces blood flow in the applied area, slows down the metabolism of the tissues affected, and has a painkiller effect. Therefore, cold application can be applied locally or generally.<sup>[14]</sup> It is the most frequently encountered nursing intervention in nursing care plans.

Cold application, which is a nonpharmacological method for managing pain, has an important place among nursing practices. One of the most common symptoms after CABG is pain, in addition to pulmonary complications.<sup>[15]</sup> Poor management of postoperative pain increases the risk of complications in patients, resulting in a reduction in patient comfort.<sup>[16]</sup> In a systematic review and meta-analysis, Chen et al.<sup>[17]</sup> (2021) stated that cold application is a safe and easy-to-administer nonpharmacological method for reducing pain, with immediate and lasting effects.

No statistically significant differences in the sociodemographic characteristics were found between the two groups (p>0.05). It can be stated that these variables might have affected the postoperative pain experience of

the patients in the intervention and control groups, and the similarities between the variables were important for the homogeneity of the groups.

In our study, it was determined that the patients had the most pain in the tube insertion site. Yılmaz (2017) found that both groups experienced pain in the tube site the most before, during, and after chest tube removal.<sup>[16]</sup> Ögüt (2018) reported that 94.29% of patients felt pain in the sternum incision area.<sup>[18]</sup> After chest tube insertion and during the time it remains placed, the endothelium extending into the chest cavity adheres to the tube. Therefore, the rupture of these adhesions with the force applied when pulling the tube causes acute pain.<sup>[19]</sup> Therefore, we believe that it was normal for patients to feel pain in the tube site.

In our study, in the intervention group, pain intensity 20 min before the procedure was higher than that during and 20 min after the procedure. In the control group, pain intensity during the procedure was higher than that 20 min before and after the procedure.

A study on patients undergoing cardiac surgery found that 20 min of cold application during the removal of the chest tube reduced pain intensity. In the same study, no significant difference in pain intensity was found 15 min after chest tube removal.<sup>[9]</sup> In another study on the effect of cold application on chest tube removal pain in 140 patients, it was found that patients in the experimental group experienced less pain than those in the control group.<sup>[19]</sup> Similarly, pain intensity in patients who received cold application before chest tube removal was measured using the visual analog scale and numerical rating scale at different time points, ranging from 5 to 15 min, and it was found that cold application was an effective pain control and relief strategy.<sup>[20]</sup>

In the literature, several studies have focused on the effect of cold application on pain.<sup>[21–23]</sup> In addition to thoracic surgery, some studies on cardiovascular surgery have been conducted. In these studies, cold application was performed for 15 or 20 min before tube withdrawal.

Furthermore, in the literature, pain assessment was performed before or during, immediately after, or 5 min after the tube withdrawal procedure. In contrast, in our study, in patients undergoing CABG, cold application was performed 20 min before and after chest tube withdrawal, and the severity of pain was evaluated. We found that cold application 20 min before the chest tube removal procedure reduces the severity of pain; this result supports the literature. Moreover, it can be said that continuing cold application after the thoracic tube removal procedure further reduces the severity of pain.

In our study, no significant difference in the skin temperature 20 min before the procedure was observed between the two groups. However, it decreased during and 20 min after the procedure in the intervention group and increased in the control group. An analgesic effect can be observed if the skin temperature drops to 13°C or if the cold application lasts for 20 min.<sup>[13,14]</sup> In a literature review, it was observed that a 20-min cold application was performed with ice gel packs before tube removal, and the intensity and location of pain and skin temperature were evaluated before and during the procedure.<sup>[6,24,25]</sup> In our study, it is believed that the skin temperature decreased due to the cold application applied to the intervention group 20 min before and after the procedure.

In our study, a significant difference in the body temperature values during and 20 min after the procedure was observed between the two groups, and when the averages were compared, the control group had higher body temperature values than the intervention group. No significant differences in systolic blood pressure, diastolic blood pressure, pulse rate, and respiratory rate were observed between the two groups ( $p > 0.05$ ). In the control group, systolic and diastolic blood pressures and pulse rate increased during the procedure. SpO<sub>2</sub> levels were higher in patients who received cold application.

In the literature, it has been reported that there is a difference in the indicators related to fever, pulse rate, systolic blood pressure, diastolic blood pressure, SpO<sub>2</sub>, and respiratory rate before, during, and after the procedure in patients who received cold application.<sup>[26,27]</sup>

In line with these results, no difference in body temperature before the procedure was observed between the two groups, and the body temperature of the control group was higher than that of the intervention group during and 20 min after the procedure. We think that this difference is a result of the cold application 20 min before and after the procedure. Cold application, which is a nonpharmacological method, to patients to bring the body temperature to normal levels when they are elevated is among the most common nursing interventions.

## Conclusion

A 20-min cold application before chest tube removal reduces pain intensity in patients undergoing bypass surgery. This result supports the literature. Furthermore, it was established that cold application during and after chest tube removal reduced pain severity.

## Disclosures

**Ethics Committee Approval:** The study was approved by The Acibadem Mehmet Ali Aydınlar Medical Research Ethics Committee (Date: 24/03/2021, No: 2021-06/07).

**Informed Consent:** Written informed consent was obtained from all patients.

**Peer-review:** Externally peer-reviewed.

**Conflict of Interest:** None declared.

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