

Evaluation of the Outcomes of Ice Application for the Control of Pain Associated with Chest Tube Irritation

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■ ABSTRACT:

The aim of this study was to evaluate the effectiveness of the use of ice for the control of pain associated with chest tube irritation. The randomized and single-blinded study consisted of 40 patients (20 in the control and 20 in the study group) who underwent thoracotomy with chest tube placement. The same general anesthesia protocol was used for all patients, and the procedure was performed by the same surgery team. Procedures such as decortication and thoracic wall resection were not included in the study. Standard postoperative analgesic methods were applied to all patients. Additionally, ice (in flexible and bendable cold gel packs wrapped in fine cloth sheaths) was applied to the chest tube insertion site at the 24th, 28th, 36th, and 40th postoperative hours for 20 minutes. To assess the effectiveness of ice application, Verbal Category Scale and Behavioral Pain Scale methods were used to measure the severity of pain. Average pain severity scores during the mobilization activities, including coughing and walking, were compared and found to be significantly lower in the study group patients who received cold therapy than in the control group patients ($p < .05$). Additionally, analgesic consumption was lower in the study group than in the control group patients ($p < .05$). As a result, the application of ice to the chest tube insertion site reduced pain associated with irritation along with the need for analgesics.

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Postoperative pain in patients undergoing thoracotomy is still an important problem that is the subject of many studies. Post-thoracotomy pain is defined as a severe acute traumatic pain resulting from incision (Roy & Eugene, 2003; Simon & Michael, 1993). Pain due to chest tube irritation in the chest tube insertion site is evaluated in the scope of post-thoracotomy pain, which impairs patient comfort by increasing the pain associated with thoracotomy (Mueller,

Tinguely, et al., 2000). Moreover, it has been reported in the literature that it increases the prevalence of complications such as postoperative atelectasis and accumulation of secretions (Richardson, Sabanathan, et al., 1999). Addressing pain related to cardiothoracic surgery, patients reported the postoperative pain associated with chest tube movement as an additional cause of pain independent of the pain associated with incision (Puntillo, 1994; Owen & Gould, 1997).

Generally, analgesics instead of nonpharmacologic methods are used for pain control. However, the highest level of pain control is achieved only through the concomitant use of drugs and nondrug methods (Bruce & Frank, 2006). The most common nonpharmacologic control methods include transcutaneous electrical nerve stimulation, heat and cold therapy, distraction, and massage.

COLD APPLICATION FOR PAIN CONTROL

The use of cold therapy for pain goes back to ancient times (Sauls, 2002). Studies have shown that, during the application, sensory and motor nerve conduction velocities decrease with reduced tissue temperature (Yağız, 2006; Streator, Ingersoll, et al., 1995). This is explained as the direct analgesic effect of cold application. It is assumed that cold receptors on the skin are stimulated by cold application and the stimuli that travel to the dorsal horn via large a fibers block the passage of pain signals. This process is called the indirect analgesic effect of cold application. The analgesic effect of cold application is also explained by the decrease in the conduction velocity of small nonmyelinated nerve fibers, which transmit pain stimuli from the periphery to the center (spinal cord) (Yağız, 2006). The methods that can be used for cold application include cold-packs, ice-water baths, iced towels, ice bags, ice massage, vapocoolant sprays, and combined cooling-compression systems.

The use of cold packs in the form of silica gel packs is the most commonly used method of cold application in clinics. The special silica gel soaked in water in a soft rubber envelope can be stored in special tanks, in which the temperature is maintained between -12.2°C (10.04°F) and -9.40°C (15.08°F), as well as in the deep freezers of refrigerators. The packs come in various sizes and shapes. Because they do not lose their softness after being cooled down, they adjust to body curves. Cold-packs can be used multiple times after being cooled down again.

Ice application is commonly used in orthopedic, gynecologic, and abdominal surgery. However, there

are few studies on the effectiveness of ice application in thoracotomy and chest tube insertion, and most of them focus on the management of pain that occurs during the insertion and removal of chest tubes (Puntillo & Ley, 2004).

MATERIALS AND METHODS

The study was conducted in the Thoracic Surgery Intensive Care Unit of Akdeniz University Hospital between April 1, 2008, and June 1, 2008. The effectiveness of application of ice to the chest tube insertion site in decreasing the pain due to chest tube irritation in patients undergoing thoracotomy and chest tube insertion was investigated.

The sample of the study consisted of 40 volunteering patients aged between 18 and 65 years, in each of whom two chest tubes were inserted after thoracotomy. Patients who could not be extubated in the first 2 hours after surgery and those who were not capable of comprehending and answering our questions during the interview were excluded from the study. Additionally, patients who underwent procedures such as decortication and thoracic wall resection, which are likely to affect pain threshold, were not included in the study. To achieve homogeneity, patients who underwent thoracotomy and pulmonary resection only were included in the study.

Before the data collection tools began to be used, the patients were informed of the study and their written consents were obtained. The study was approved by the Ethics Committee of Akdeniz University Medical School.

In this study, Verbal Category Scale and Behavioral Pain Scale were used to determine the severity of pain. Severity of pain was assessed right before the ice application and after the activity following the application of ice. The ice application was performed for 20 minutes during the 24th, 28th, 36th, and 40th postoperative hours, after the extubation of the patient and before deep breathing exercises and mobilization.

Verbal Category Scale

The scale, which is also called the Simple Descriptive Scale and is included in the introduction of the McGill Pain Questionnaire (Melzack, 1975), is a tool aimed at determining the severity of the pain perceived by the patient at the present moment. Since its publication in 1975, the validity, internal consistency, and practicality of the McGill Pain Questionnaire has been confirmed by numerous studies. It has also been used in studies of acute and chronic pain and laboratory-induced pain (Kuğuoğlu, Aslan, et al., 2003). The Verbal Category Scale is based on the selection of the

phrase that can best describe the current pain status of the patient. The severity of pain is assessed. The patient is asked to choose the score that best describes to his or her pain status.

Behavioral Pain Scale

The Behavioral Pain Scale scale was developed by Lawrence et al. in 1993 to evaluate the pain behaviors of children unable to express themselves verbally. The validity and reliability of the scale for use in adult patients were tested by Payen (2001) in 30 patients, and the final version of the scale for use in intensive care patients was established. The scale, of which the validity and reliability studies were conducted in Turkey, consists of three parameters: facial expression of the patient, position of the upper limbs, and compliance with ventilation (Badir & Eti, 2003). Each parameter is scored from 1 to 4 (1 = no pain; 2 = mild pain; 3 = moderate pain; 4 = severe pain). The lowest possible total score for the scale is 3, and the highest is 12. Higher scores indicate an increase in the severity of pain. Because only extubated patients were included in the present study, the third parameter, was not assessed. Accordingly, the lowest possible total pain score was 2 and the highest 8.

Analgesia

Thoracotomy and surgical resections were performed in all patients. The procedure was performed by the same surgical and anesthesia teams. The same postoperative analgesic method was used for all patients, and they all received the same type of analgesics. Any analgesics and anesthesia methods likely to affect pain level, such as catheters, were not used during the preoperative, intraoperative, and postoperative periods. Diclophenac 75 mg IM and once per day and tramadol 30 mg IV were administered to the control group patients, and the doses were increased upon request for analgesia.

We applied the same analgesic protocol with the study group and control group. But we also applied cold ice to the study group. After ice was applied to the chest tube insertion sites of the patients in the study group for 20 minutes at the scheduled hours and the patients were instructed to perform the deep breathing and walking exercises, their pain was assessed. To prevent discomfort during the application, 10×10 cm flexible cold gel packs were used (Fig. 1). The ice packs were placed on the site in fine cloth sheaths to prevent ice burns and used without delay to ensure that they would not get warmer at room temperature. At the end of the application, the temperature of the site was measured and after it fell down to $12\text{--}13$ °C ($53.6\text{--}55.4$ °F), the activities including deep breathing exercise, coughing, and walking

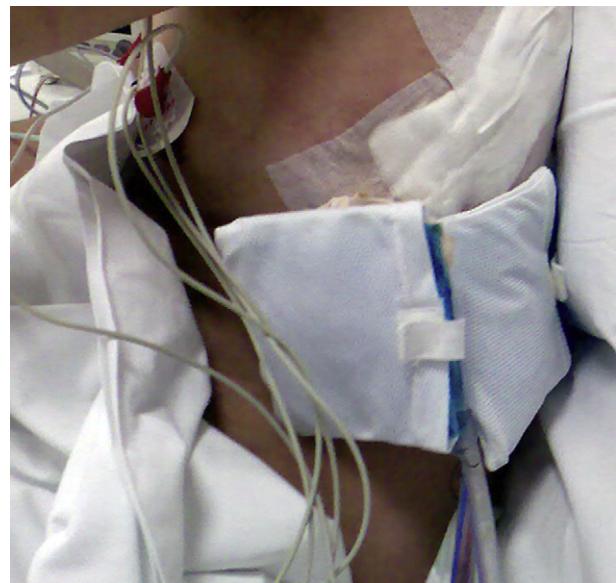


FIGURE 1. ■ Ice application on a patient.

5-10 steps in the intensive care unit were performed. The severity of pain was measured before the ice application and during the activities. Additionally, the Behavioral Pain Scale was scored by the nurses according to their observation of each patient's behavior.

Statistical Analysis

The data were evaluated using Statistical Package for the Social Sciences (SPSS), version 13.00. The quantitative variables such as age and pain score were expressed as mean \pm SD. A chi-squared (χ^2) test was used to determine the difference between the observed and expected frequencies in the independent groups. A *t* test comparing the significance of the difference between two means was used to compare the measured values of the two independent groups.

RESULTS

No statistically significant differences were found regarding the demographic characteristics of the patients in the study and control groups (Table 1). The mean age of the control group was 55.05 ± 11.4 years and that of the study group 51.95 ± 12.8 years. Significant differences were not observed between the two groups regarding age, gender, or educational level ($p > .05$).

It was determined that 70% of the patients in the control group ($n = 14$) and 55% of the patients in the experimental group ($n = 11$) underwent thoracotomy and lobectomy. Eighty percent of the patients in the control group ($n = 16$) and 70% of the patients in the study group ($n = 14$) did not have a previous

TABLE 1.
Description of Patients (N = 40)

	Control Group (n = 20)		Study Group (n = 20)		Total		
	n	%	N	%	N	%	p Value
Age, y							
25-50	6	30	5	25	11	27,5	.698
51-65	14	70	15	75	29	72,5	
Gender							
Female	6	30	7	35	13	35	.736
Male	14	70	13	65	27	65	
Type of surgical intervention							
Lobectomy	11	55	10	50	21	52,5	.518
Segmentectomy, wedge resection	9	45	10	50	19	47,5	

experience of chest tube insertion. All of the patients in the study and control groups had previous pain experiences, such as toothache, headache, and labor pain, and they reported that, during their previous pain experiences, they had always used analgesics to deal with pain. Statistical differences were not determined between the two groups regarding intervention types and previous experiences ($p > .05$).

Patients were queried about the characteristics of their pain, and chest tube pain was classified as stinging, sharp, stabbing, etc. (Table 2). Eighty percent of the patients in the two groups described a stinging pain associated with the irritation in the chest tube insertion site. Conversely, a stabbing pain was described by 65% of the patients in the control group and in only 10% of the patients in the study group, indicating

a statistically significant difference between the two groups ($p < .05$). The patients in the control group did not describe pain experienced as numbness, whereas 40% of the patients in the study group described this type of pain ($p < .05$; Table 2).

It was determined that both groups complained of pain in situations requiring physical activity, such as breathing exercises and mobilization. However, 90% of the patients in the control group complained of increasing pain during mobilization, whereas this complaint was reported by only 55% of the patients in the study group ($p < .05$).

During the activities, including deep breathing exercise, coughing, and walking, the patients' level of pain resulting from the irritation associated with the movement of the chest tube was scored by ticking the checkboxes in the Verbal Category Scale according to the severity of pain reported by the patients. The final severity of pain was determined by the combined evaluation of the two scales (Table 3).

After the activity including mobilization, the scales were administered to both groups and the averages of the two scales were calculated. The mean scores of the control and experimental groups, respectively, for the verbal/behavioral scales were as follows: 2.15/3.85 versus 2.00/3.00 after the activity performed during the 24th hour; 2.15/3.85 versus 2.00/3.00 after the activity performed during the 28th hour; 4.05/6.05 versus 1.30/2.30 after the activity performed during the 36th hour; and 3.10/5.05 versus 1.15/2.15 after the activity performed during the 40th hour. These findings indicated a statistically significant difference between the two groups ($p < .05$; Table 3).

The doses of analgesics used in the first 24 hours were identical between the two groups. However, significant differences were observed on the second and

TABLE 2.
**Characteristics of Pain Due to the Irritation
Caused by Chest Tube Drainage Catheters and
Activities Contributing to Pain (N = 40)**

	Control Group (n = 20)		Study Group (n = 20)		p Value
	n	%	n	%	
Characteristic of pain					
Stinging	16	80	16	80	1.000
Sharp	13	65	16	80	.288
Stabbing	13	65	2	10	.004*
Numbness	0	00	8	40	.008*
Activities increasing pain					
Mobilization	18	90	11	55	.003*
Breathing	9	45	7	35	.519
Coughing	17	85	16	80	.677

* $p < .05$.

TABLE 3.
Mean Pain Scores (VCS/BPS) Before and After Activity (N = 40)

Level of Pain	Control Group (n = 20)	Study Group (n = 20)	p Value
24th hour after extubation			
Before activity	2.15/3.85	3.45/4.15	.098
After activity	2.15/3.85	2.00/3.00	.000*
28th hour after extubation			
Before activity	2.65/3.55	3.10/4.05	.150
After activity	4.05/6.15	2.75/1.80	.000*
36th hour after extubation			
Before activity	2.25/4.10	2.95/4.24	.078
After activity	4.05/6.05	1.30/2.30	.000*
40th hour after extubation			
Before activity	1.90/3.00	2.00/3.15	.122
After activity	3.10/5.05	1.15/2.15	.000*

VCS = Verbal Category Scale; BPS = Behavioral Pain Scale.

*p < .05.

third days. On the second day, 375 mg diclophenac and 270 mg tramadol were consumed by the control group patients, of whom only 55% were able to perform coughing and walking (5-10 steps), whereas 75 mg diclophenac and 90 mg tramadol were consumed by the experimental group patients, of whom 90% of were able to perform coughing and walking (5-10 steps). The difference between the two groups was statistically significant ($p < .05$).

DISCUSSION

Stinging pain occurs as a result of acute stimuli, resulting in pain and movement away from the stimulant. As the severity of pain increases, the person feels the pain more intensely, in the form of a knife-stabbing pain (Holdcroft, 2003). Earlier studies have reported that patients hospitalized in intensive care units describe a sudden, severe, tormenting, and temporary pain resulting from aspiration, chest tube movement, and invasive interventions (Gelinias, 2007; Puntillo, 1990). Accordingly, pain related to chest tube movement has been defined as a sharp, stabbing, and biting pain in earlier studies describing patients' chest tube pain experiences (Stanik-Hutt, Soeken, et al., 2001).

In the present study, the rate of the patients describing the more severe, knife-stabbing, pain was lower in the study group (10%) than in the control group (60%). These findings suggest that the

application of ice on the chest tube drainage catheter insertion site affects the characteristic of pain.

Initially, a cold sensation is felt on the spot where cold is applied and then, the pain associated with cold is perceived. Subsequently, the cold sensation diminishes and the pain, which is sometimes perceived as a burning sensation, increases. If cooling is continued, numbness and anesthesia occur. Some studies (Mancuso, Knight, et al., 1992; Palmer, Knight, et al., 1996) indicate that numbness is felt for 4-4.5 minutes after the application of ice and that this sensation may last between 30 minutes and 3 hours. Similar results were obtained in the present study during the activities, including breathing exercise and walking, which were performed subsequent to the application of ice to the chest tube insertion site for 20 minutes. The study group patients stated that they did not have complaints of pain due to irritation at the chest tube insertion site but felt pain with the movement of the arm on the side of the body on which the incision was made. On the other hand, the control group patients, as anticipated, felt a pain that was more severe than that of the thoracotomy incision site and complained of a stinging pain in the chest tube insertion site, which restricted movement and occurred during all mobilization and deep breathing exercises. As well as decreasing patient comfort through restriction of movement and exercise, this pain increases the risk of numerous complications, of which the most common are atelectasis and respiratory distress.

To obtain the desired physiologic effect, the application should last 20 minutes and the skin temperature should be decreased down to a constant level. It has been shown in many studies that skin temperature should be lowered to $<13.6^{\circ}\text{C}$ ($<56.48^{\circ}\text{F}$) for local analgesic effect, to 12.5°C (53.69°F) for a 10% decrease in nerve conduction velocity, and to $10-11^{\circ}\text{C}$ ($50-51.8^{\circ}\text{F}$) for a 50% decrease in enzyme activity (Stanik et al., 2001; Tasso, Linda 2004). Bugaj (1975) reported that applying ice to the chest tube insertion site for 10 minutes is effective in providing analgesia. Tasso & Linda (2004) reported that cold applications bring out an indirect analgesic effect by reducing the pressure and tension on nerve endings through the decrease in inflammation, spasm, and edema. Puntillo (1990) noted that patients with chest tubes receiving ketolorac experienced less pain than those not receiving the drug. Ketolorac is an antiinflammatory drug commonly used in the management of postoperative pain. Ice, on the other hand, is regarded to be an antiinflammatory nonpharmacologic agent. Thus, ice application cools down the tissue surrounding the chest tube insertion site and alleviates the pain by

providing an antiinflammatory effect (Sauls, 2002). The effectiveness of ice application is supported by the theory suggesting that cold causes a decrease in nerve conduction velocity and slows down the transmission of pain (Yağız, 2006).

As expected in the present study, a gradual increase in the mean pain severity scores of the control group patients was observed, whereas these scores remained markedly low in the experimental group patients. The difference between the two groups was significant ($p < .05$). Meanwhile, the consumption of analgesics was lower in the study group (75 mg diclophenac and 150 mg tramadol) than in the control group (375 mg diclophenac and 540 mg tramadol). Ice application resulted in a decrease in analgesic consumption and consequently provided a decrease in the potential medication side effects as well as well as a more cost-effective analgesic effect.

When an individual receives an unpleasant stimulant causing pain, he or she responds with avoidance and evasion (Holdcroft, 2003). Insufficient control of postoperative pain may cause unwillingness among patients to perform exercises such as deep breathing and walking. The acute traumatic post-thoracotomy pain is ranked near the top of the pain scale and has multiple origins, such as severe chest wall trauma involving displacement of ribs, peripheral nerve damage, and hypersensitivity of central nervous system. The severity of pain increases with sudden actions such as moving,

breathing, and coughing. The pain experienced after thoracotomy may be associated with either the incision or the movement of the indwelling chest tube catheter (Roy & Eugene, 2003). In studies about pain related to cardiothoracic surgery, the patients reported postoperative pain associated with chest tube movement as an additional cause of pain that is independent of the postoperative incision pain (Gelinas, 2007; Puntillo, 1990).

The present study found a higher number of patients reporting increased pain during movement in the control group (90%) than in the study group (55%), suggesting that ice application was effective in reducing pain associated with movement. Additionally, the higher number of patients capable of performing the activities including coughing, walking, and meeting personal hygiene needs in the study group than in the control group (75% vs. 55%, respectively) can also be attributed to the effectiveness of ice application.

CONCLUSION

The findings of the present study indicate that applying ice to the chest tube insertion site for 20 minutes decreases the severity of pain and reduces the need for analgesics. However, further clinical series with larger sample sizes are needed to support these results to allow for more widespread generalizability.

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